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ECOLOGY & BIODIVERSITY

WORTEL MINE NEAR AGGENEYS, NORTHERN CAPE PROVINCE

BOTANICAL STUDY
AND
ASSESSMENT

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Authors: Gerhard Botha &
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PROPOSED MINING OF SILLIMANITE ON THE FARM WORTEL 42 NORTH OF AGGENEYS, NORTHERN CAPE PROVINCE

Report Title: Botanical Study and Assessment

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I. DECLARATION OF CONSULTANTS INDEPENDENCE

- act/ed as the independent specialist in this application;
- regard the information contained in this report as it relates to my specialist input/study to be true and correct, and
- do not have and will not have any financial interest in the undertaking of the activity, other than remuneration for work performed in terms of the NEMA, the Environmental Impact Assessment Regulations, 2014 and any specific environmental management Act;
- have and will not have any vested interest in the proposed activity proceeding;
- have disclosed, to the applicant, EAP and competent authority, any material information that have or may have the potential to influence the decision of the competent authority or the objectivity of any report, plan or document required in terms of the NEMA, the Environmental Impact Assessment Regulations, 2014 and any specific environmental management Act;
- am fully aware of and meet the responsibilities in terms of NEMA, the Environmental Impact Assessment Regulations, 2014 (specifically in terms of regulation 13 of GN No. R. 326) and any specific environmental management Act, and that failure to comply with these requirements may constitute and result in disqualification;
- have provided the competent authority with access to all information at my disposal regarding the application, whether such information is favourable to the applicant or not; and
- am aware that a false declaration is an offense in terms of regulation 48 of GN No. R. 326.

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January 2020

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January 2020

II. REQUIREMENTS REGARDING A SPECIALIST ASSESSMENT

Requirements of Appendix 6 – GN R326 EIA Regulations of 7 April 2017	Sections where this is addressed in the Specialist Report
1. (1) A specialist report prepared in terms of these Regulations must contain- a) details of- i. the specialist who prepared the report; and ii. the expertise of that specialist to compile a specialist report including a curriculum vitae;	Page I and Appendix 6 & 7
b) a declaration that the specialist is independent in a form as may be specified by the competent authority;	Page I
c) an indication of the scope of, and the purpose for which, the report was prepared;	Section 1 (1.3, 1.4, 1.5)
(cA) an indication of the quality and age of base data used for the specialist report;	Section 2 (2.1 - 2.3)
(cB) a description of existing impacts on the site, cumulative impacts of the proposed development and levels of acceptable change;	Section 6 (6.2 – 6.4)
d) the duration, date and season of the site investigation and the relevance of the season to the outcome of the assessment;	Section 2.6 and 2.8
e) a description of the methodology adopted in preparing the report or carrying out the specialised process inclusive of equipment and modeling used;	Section 2
f) details of an assessment of the specifically identified sensitivity of the site related to the proposed activity or activities and its associated structures and infrastructure, inclusive of a site plan identifying site alternatives;	Section 2 (2.6) and Section 5
g) an identification of any areas to be avoided, including buffers;	N/A
h) a map superimposing the activity including the associated structures and infrastructure on the environmental sensitivities of the site including areas to be avoided, including buffers;	Section 5
i) a description of any assumptions made and any uncertainties or gaps in knowledge;	Section 2.8
j) a description of the findings and potential implications of such findings on the impact of the proposed activity, including identified alternatives on the environment or activities;	Section 5 and 6
k) any mitigation measures for inclusion in the EMPr;	Section 6
l) any conditions for inclusion in the environmental authorisation;	Section 6
m) any monitoring requirements for inclusion in the EMPr or environmental authorisation;	Section 6
n) a reasoned opinion- i. as to whether the proposed activity, activities or portions thereof should be authorised; (iA) regarding the acceptability of the proposed activity or activities; and ii. if the opinion is that the proposed activity, activities or portions thereof should be authorised, any avoidance, management and mitigation measures that should be included in the EMPr, and where applicable, the closure plan;	Section 7
o) a description of any consultation process that was undertaken during the course of preparing the specialist report;	N/A
p) a summary and copies of any comments received during any consultation process and where applicable all responses thereto; and	N/A

q) any other information requested by the competent authority.	N/A
2) Where a government notice gazetted by the Minister provides for any protocol or minimum information requirement to be applied to a specialist report, the requirements as indicated in such notice will apply.	N/A

III. LIST OF ABBREVIATIONS:

CARA: Conservation of Agricultural Resources Act 43 of 1983
CBA: Critical Biodiversity Area
CITES: Convention on International Trade in Endangered Species of Wild Fauna and Flora
CR: Critically Endangered (threat status)
DAFF: Department of Agriculture, Forestry and Fisheries
DEA: Department of Environmental Affairs
DENC:NC: Department of Environment and Nature Conservation: Northern Cape Province
DWS: Department of Water and Sanitation
NCNCA: Northern Cape Nature Conservation Act (Act No. 9 of 2009)
DDD: Data Deficient – Insufficient Information (threat status)
DDT: Data Deficient – Taxonomically Problematic (threat status)
NFA: Nation Forest Act 1998; No 84 of 1998
DEA: Department of Environmental Affairs
EA: Environmental Authorisation
ECO: Environmental Control Officer
EIA: Environmental Impact Assessment: EIA regulations promulgated under section 24(5) of NEMA and published in Government Notice R. 543 in Government Gazette 33306 of 18 June 2010
EI: Ecological Infrastructure
EIS Ecological Importance and Sensitivity
EMPr: Environmental Management Programme
EN: Endangered (threat status)
ESA: Ecological Support Areas
EX: Extinct (threat status)
EW: Extinct in the Wild
FEPA: Freshwater Ecosystem Priority Area
FW: Facultative wetland species – usually grow in wetlands (67 – 99% occurrence) but occasionally found in non-wetland areas
GIS: Geographical Information System

CIS: Conservation Important Species (species listed within IUCN and South African Red Data Lists or that are protected within relevant international, national and provincial legislation
GPS: Global Positioning System
IAPs: Invasive Alien Plants
IP: Invasive Plant (indigenous or alien)
LC: Least Concern
LT: Least threatened
LFA: Landscape Functional Analysis (Tongway and Hindley 2004)
NFA: National Forest Act 84 of 1998
NE: Not Evaluated (threat status)
NEMA: National Environmental Management Act 107 of 1998
NEM:BA National Environmental: Biodiversity Act (Act No. 10 of 2004)
NFEPA: National Freshwater Ecosystem Priority Areas, identified to meet national freshwater conservation targets (CSIR, 2011)
NT: Near Threatened (treat status)
NWA: National Water Act No.36 of 1998
OW: Obligate wetland species
PES: Present Ecological State, referring to the current state or condition of an environmental resource in terms of its characteristics and reflecting a change from its reference condition
RE: Regionally Extinct
SANBI: South African National Biodiversity Institute
TOPS: Threatened and Protected Species in terms of section 56 of the National Environment: Biodiversity Act (NEM:BA) of 2004 (Species list as published within Gazette No. 30568, 14 December 2007)
VU: Vulnerable (treat status)

IV. LIST OF DEFINITIONS:

Accelerated soil erosion: Soil erosion induced by human activities.
Acceptable cover: An acceptable cover shall mean that not less than 40% (in regions receiving less than 400 mm rain per annum), of the area rehabilitated and/or planted, shall be covered with grass and other species and that there shall be no bare patches of more than 500 cm in maximum dimension.
Alien: originating from another country or continent and originally different environment, commonly used to describe plants that are not indigenous to South Africa and have become problematic (spreading rapidly, threatening existing biodiversity)

Allelopathic components: one or more biochemical compound produced by a plant and released through leaf litter or roots that suppresses the growth, survival, and reproduction of other surrounding vegetation

Alluvium soils: Sedimentary material found in regions fringing river courses and composed of detrital matter transported and deposited by the river.

Bare soil: Un-vegetated soil surface, unaltered by humans

Biodiversity: The wide variety of plant and animal species occurring in their natural environment (habitats). The term encompasses different ecosystems, landscapes, communities, populations, and genes as well as the ecological and evolutionary processes that allow these elements of biodiversity to persist over time.

Biome: A broad ecological spatial unit representing major life zones of large natural areas, and defined mainly by vegetation structure, climate as well as major large-scale disturbance factors (such as fire) (after Low & Rebelo, 1998).

Bushveld: A local regional term translated from the Afrikaans 'bosveld' and generally applied to various forms of savanna vegetation south of the miombo belts in southern Africa. In regional terms (Central Bushveld), used for the elevated plateaus between Pretoria in the south and Limpopo River in the north.

Bush encroachment: means stands of plants of the kinds specified in CARA Table 4, where individual plants are closer to each other than three times the mean crown diameter

Catchment: A catchment is an area where water is collected by the natural landscape. In a catchment, all rain and run-off water eventually flow to a river, wetland, lake or ocean, or into the groundwater system.

Calcareous: Pertaining to a soil or rock containing calcium carbonate, or related minerals, so that it effervesces (bubbles of CO_2) when treated with acid. Usually formed from shells or chemical precipitation, these soils and rocks tend to have a coastal distribution (modified after Low & Rebelo, 1998)

Calcrete: A rock formed in the soil profile at the water table when calcium carbonate accumulates and cements particles together to form a hard rock band (Low & Rebelo, 1998)

Chert: Cryptocrystalline quartz of organic or inorganic origin. Also, the rock formed by the precipitation of this material, which can form bands or layers of nodules in sedimentary rocks

Climax: That vegetation type or plant community structure that occurs at the end of the seral cycle. The climax communities may not be the final endpoint of the succession: frequent or even rare events, such as fire, frost, harvesting, or hurricanes, may hold the communities in a stable subclimax indefinitely (Low & Rebelo, 1998)

Compacted soil surface: A soil surface that has been hardened by an outside source, causing the soil to be more compacted than the surrounding area.

Conservation: The safeguarding of biodiversity and its processes (often referred to as Biodiversity Conservation).

Conservation Important Plant: Any plant species that are protected within relevant international, national and/or provincial legislation and any species that is listed within the Red List of South African plants (version 2017.1).

Container plants: Container plants include all vegetation that is bought or supplied in acceptable containers from nurseries or vegetation lifted out of their natural position and placed in containers.

Decimal degrees: Degrees of latitude and longitude expressed in decimal format rather in degrees, minutes and seconds.

Desirable end state: the future condition or target on which the rehabilitation is designed and that will serve later as a basis for rehabilitation success evaluation. This can be based on a reference site or modeled according to available information on historic vegetation

Ecotone: A zone in which two or more vegetation types or ecosystems merge. These areas may be rich in species from both systems or may occur as species-poor fringes.

Ecosystem Goods and Services: The goods and benefits people obtain from natural ecosystems. Various different types of ecosystems provide a range of ecosystem goods and services. Aquatic ecosystems such as rivers and wetlands provide goods such as forage for livestock grazing or sedges for craft production and services such as pollutant trapping and flood attenuation. They also provide habitat for a range of aquatic biota.

Ecological rehabilitation: The process of assisting the recovery of a degraded or damaged ecosystem in a trajectory that renders the ecosystem fully functional, stable, and able to develop further, but not necessarily returning to the original historic state.

Ecological restoration: The process of assisting the recovery of an ecosystem that has been degraded damaged or destroyed, in a trajectory that ultimately returns the ecosystem to its natural successional stage.

Ecosystem: The combination of biota within a given area, together with a suitable environment that sustains the biota and the interactions between biota. It can have a spatial unit of any size but shows some degree homogeneity as far as structure, function and species composition is concerned. Small-scale ecosystems typically link up to larger-scale ecosystems and all contribute to the ecosystem function and services at the landscape-scale.

Endemic: Refers to a plant, animal species or a specific vegetation type that is naturally restricted to a particular defined region (not to be confused with indigenous). A species of animal may, for example, be endemic to South Africa in which case it occurs naturally anywhere in the country, or endemic only to a specific geographical area within the country, which means it is restricted to this area and grows naturally nowhere else in the country.

Ephemeroid: Referring to the life-form of a perennial plant that makes occasional appearances above-ground and maintains perennating organs underground (e.g. bulbous plants)

Establishment of grass: All procedures necessary to produce an acceptable cover of grass on an area.

Establishment Period: The Establishment Period is defined as the period beginning from the actual planting or placing of vegetation until three months thereafter, unless otherwise specified or unless grass cover is unacceptable or unless plants have not taken.

Extinction debt: is a concept that describes the future extinction of species due to events in the past. Extinction debt occurs because of time delays between impacts on a species, such as destruction of habitat or reduction of population size, and the species' ultimate disappearance.

Floristic Classification: Referring to the use of plant species composition (flora) as a criterion for characterising or classifying vegetation

Forb: A plant without secondary thickening (i.e. non-woody), usually living for only one or two seasons

Function/functioning/functional: Used here to describe natural systems working or operating in a healthy way, as opposed to dysfunctional, which means working poorly or in an unhealthy way.

Geophytic: resprouting during the growing season from an underground storage organ such as bulbs, corms, tubers or rhizomes, and dying back completely during unfavourable seasons

Geoxylic Suffrutex: A plant with annual or short-lived woody above-ground shoots sprouting from a massive or extensive, perennial, underground stem

Graminoid: Pertaining to an herbaceous growth form characterised by a 'grass-like' appearance (tufted growth, usually long and narrow leaves, secondary root system) and including plants such as grasses, restios, sedges, and rushes.

Grassland: Vegetation dominated by grasses (or graminoids) usually with a single-layered structure and sometimes with an open, woody plant cover.

Habitat: The general features of an area inhabited by animal or plant which are essential to its survival (i.e. the natural "home" of a plant or animal species).

Indigenous: refers to a plant or animal that occurs naturally in the place in which it is currently found

Invasive plant: a kind of plant which has under section 2 (3) of CARA been declared an invader plant, and includes the seed of such plant and any vegetative part of such plant which reproduces itself asexually

Intact: Used here to describe a natural environment that is not badly damaged, and is still operating healthily.

Koppie: Small hill or hillock, an Afrikaans term adopted by South African English

Landscape: Consists of a mosaic of two or more ecosystems that exchange organisms, energy, water, and nutrients.

Land Type: Map unit denoting land, mappable at 1:250 000 scale, over which there is a marked uniformity of climate, terrain form and soil pattern.

Mitigate/Mitigation: Mitigating impacts refers to reactive practical actions that minimize or reduce in situ impacts. Examples of mitigation include "changes to the scale, design, location, siting, process, sequencing, phasing, and management and/or monitoring of the proposed activity, as well as restoration or rehabilitation of sites". Mitigation actions can take place anywhere, as long as their effect is to reduce the effect on the site where a change in ecological character is likely, or the values of the site are affected by those changes (Ramsar Convention, 2012).

Nursery conditions: These are the necessary conditions to maintain the healthy growth of rescued and/or container plants. This includes protection of such plants against wind, frost, direct sunlight, pests, rodents, diseases, and drought. It also includes the provision of suitable water, fertilizer and any other measures required to maintain the container plants.

Period of Maintaining: The Period of Maintaining is defined as the period following directly after the Establishment Period until the end of the Period of Maintenance for the whole Contract as defined in the General Conditions of Contract unless otherwise specified.

Regic Soils: Pertaining to a blanket of soil, usually sand, which has been deposited over another soil or rock, and which has not yet had time to develop profiles or layers

Plagioclimax community: An area/habitat/plant community in which anthropogenic (human) influences have prevented the ecosystem from developing further. The ecosystem may have been stopped from reaching its full climax or deflected towards a different climax by activities such as long-term ploughing, deforestation, burning, grazing and trampling by domestic animals, etc.

Revegetation: The process of establishing a vegetative cover on exposed soils, regardless of species composition or structure, as long as the species are non-invasive and their presence will not impede the gradual process of ecological rehabilitation or –restoration.

Risk: A prediction of the likelihood and impact of an outcome; usually referring to the likelihood of a variation from the intended outcome.

Savanna: Typically, vegetation with a grass-dominated herbaceous layer and scattered low to tall trees. It includes the closed woodland and open woodlands of Edwards (1983) with a tree cover less than 75% and generally greater than 1%

Savannoid / Savanna grasslands: Pertaining to open wooded grassland structurally similar to savanna, but from climatic reasons not belonging to the Savanna Biome. Savannoid vegetation is encountered within temperate zones.

Soil Erosion: is a natural process whereby the ground level is lowered by wind or water action and may occur as a result of inter alia chemical processes and or physical transport on the land surface**.**

Scarifying: To roughen the surface of soil as preparation for seeding or topsoil addition.

Succession: A series of stages in which different plants and animals colonise an area following some kind of disturbance. The final stage of the succession is called the 'climax', but various disturbances may prevent the vegetation from attaining its potential climax

Thornveld: A woodland savanna dominated by trees with thorns, mainly Acacia species.

Threatened Ecosystem: In the context of this document, refers to Critically Endangered, Endangered and Vulnerable ecosystems.

Threat Status: Threat status (of a species or community type) is a simple but highly integrated indicator of vulnerability. It contains information about past loss (of numbers and/or habitat), the number and intensity of threats, and current prospects as indicated by recent population growth or decline. Anyone of these metrics could be used to measure vulnerability. One much-used example of a threat status classification system is the IUCN Red List of Threatened Species (BBOP, 2009).

Vegetation structure: The horizontal, vertical and temporal arrangement of vegetation, i.e. spatially explicit, e.g. layers, patches, etc.

Vegetation texture: The composition of the vegetation in terms of species, growth forms, life forms, leaf morphological types, etc.

Watercourse: Means a river or spring; a natural channel in which water flows regularly or intermittently: a wetland, lake or dam into which, or from which, water flows: und any collection of water which the Minister may, by notice in the Gazette, declare to be a watercourse, and a reference to a watercourse includes, where relevant, its bed and banks (National Water Act, 1998).

Wetland: Refers to land which is transitional between terrestrial and aquatic systems where the water table is usually at or near the surface, or the land is periodically covered with shallow water, and which land in normal circumstances supports or would support vegetation typically adapted to life in saturated soil (National Water Act, 1998).

WGS84: Abbreviation of 'World Geodetic System of 1984'. A geocentric datum and geographical coordinate system created by the United States military and in world-wide use (ESRI 2006).

Trimming: To neatly round off the levels of existing or previously shaped earthworks to blend in with the levels of other earthworks, constructed works, or natural landforms.

Transformation: The conversion of an ecosystem to a different ecosystem or land use type.

Topsoil: uppermost layer of soil, in natural vegetation maximally 30 cm, in cultivated landscapes the total depth of cultivation, containing the layer with humus, seeds, and nutrients. Topsoils that are applied to landscapes to be rehabilitated must be free of

refuse, large roots and branches, stones, alien weeds and/or any other agents that would adversely affect the topsoils suitability for re-vegetation.

White grass: Veld management term for (usually) tussock grasses (Stipagrostis, Aristida) turning veld into white plains through their conspicuous plumage of hairs on the seeds at the state of ripening and dispersal.

Weed: a plant that grows where it is not wanted, and can, therefore, be an indigenous or alien species. An unwanted plant growing in a garden is just called a weed, but the 198 listed IPs are called "declared weeds and invaders".

(Coetzee 2005, Clewell et al. 2005, SER 2004)

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PROPOSED MINING OF SILLIMANITE ON THE FARM WORTEL 42, NORTH OF AGGENEYS, NORTHERN CAPE PROVINCE

BOTANICAL STUDY AND ASSESSMENT

1. INTRODUCTION

1.1 Applicant

Greenmined Environmental (Pty) Ltd. on behalf of Jan Jacob De Clercq Van Zyl

1.2 Project

The project will be known as Koenabib Mine.

1.3 Proposed Activity

Van Zyl Sillimanite intents to apply a mining permit to mine 5 ha of portion 1 of the farm Wortel 42 (Figure 1 and 2) which fallsin the Khâi-Ma Local Municipality in the Registration Division of Namaqualand RD, Northern Cape Province.

The area earmarked for the proposed mining falls on a section of the farm that was previously used for sillimanite re-mining and the intention of this application is to increase the existing stockpile to a quarry. The mining methods will make use of blasting means of explosives in order to loosen the hard rock. The material is then loaded and hauled out of the excavation to the mobile crushing and screening plants. The sillimanite will be screened to various sized stockpiled. The sillimanite will be stockpiled and transported to clients via trucks and trailers. All activities will be contained within the boundaries of the site. Blasting will only occur once every six (6) to eight (8) weeks.

The mining activities will consist out of the following:

» Stripping and stockpiling of topsoil;
» Blasting;
» Excavating;
» Crushing;

» Stockpiling and transporting;
» Sloping and landscaping upon closure of the site; and
» Replacing the topsoil and vegetation the disturbed area.

The mining site will contain the following:
» Drilling equipment;
» Excavating equipment;
» Earth moving equipment;
» Crushing and screening plants.
» Access Roads;
» Site Office (6m Containers);
» Security Gate;
» Site vehicles;
» Parking area for visitors and site vehicles;
» Washbay;
» Bunded diesel (20 000l tank) and oil storage facilities;
» Ablution Facilities (6m Container with Septic Tank); and
» Weigh Bridge.

The proposed mining area will be reached via the existing access road to the quarry, making use of the existing internal / haul roads to access the material within the mining area.

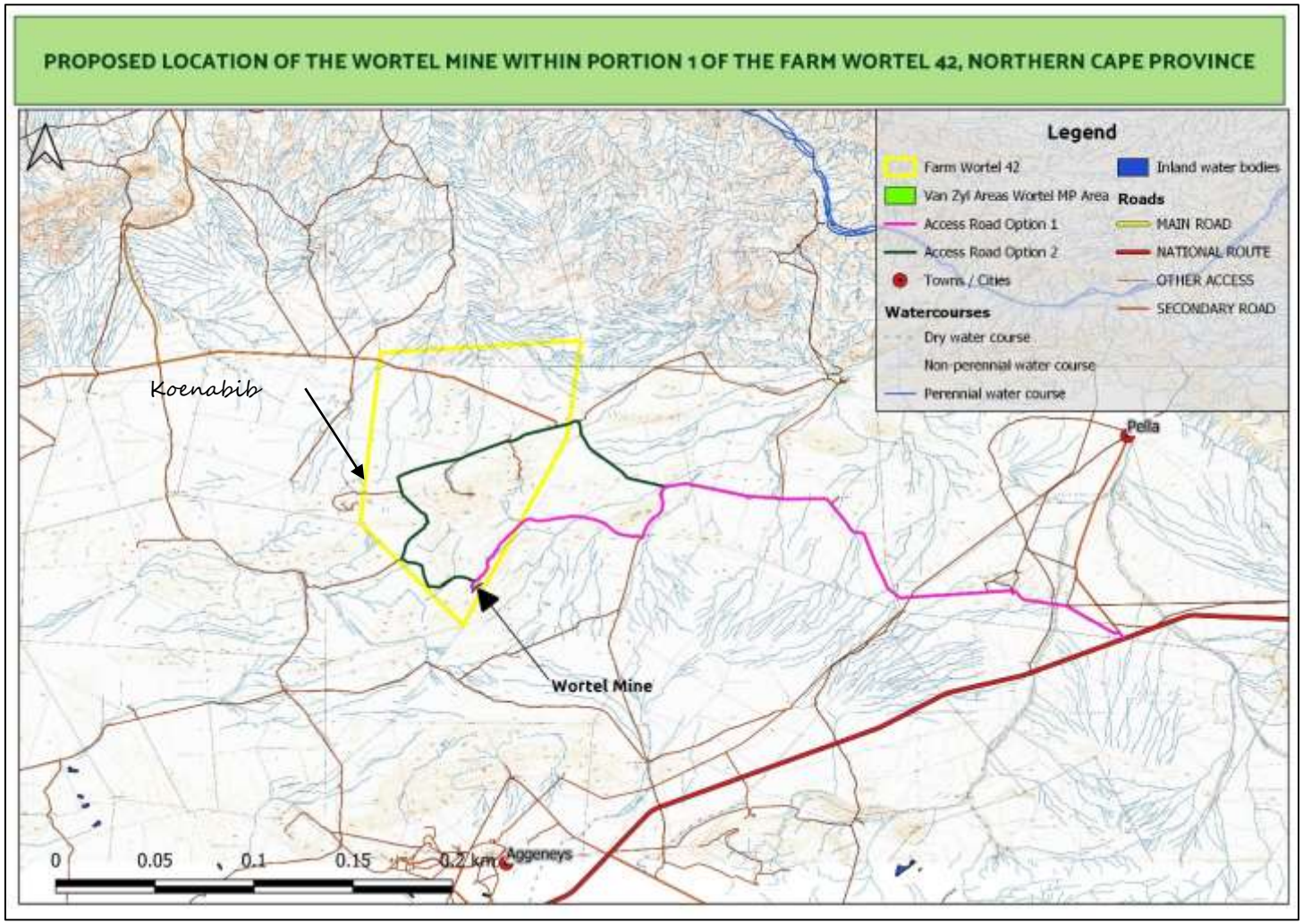

Figure 1: Location map of the proposed Wortel Mine as well as the access road options.

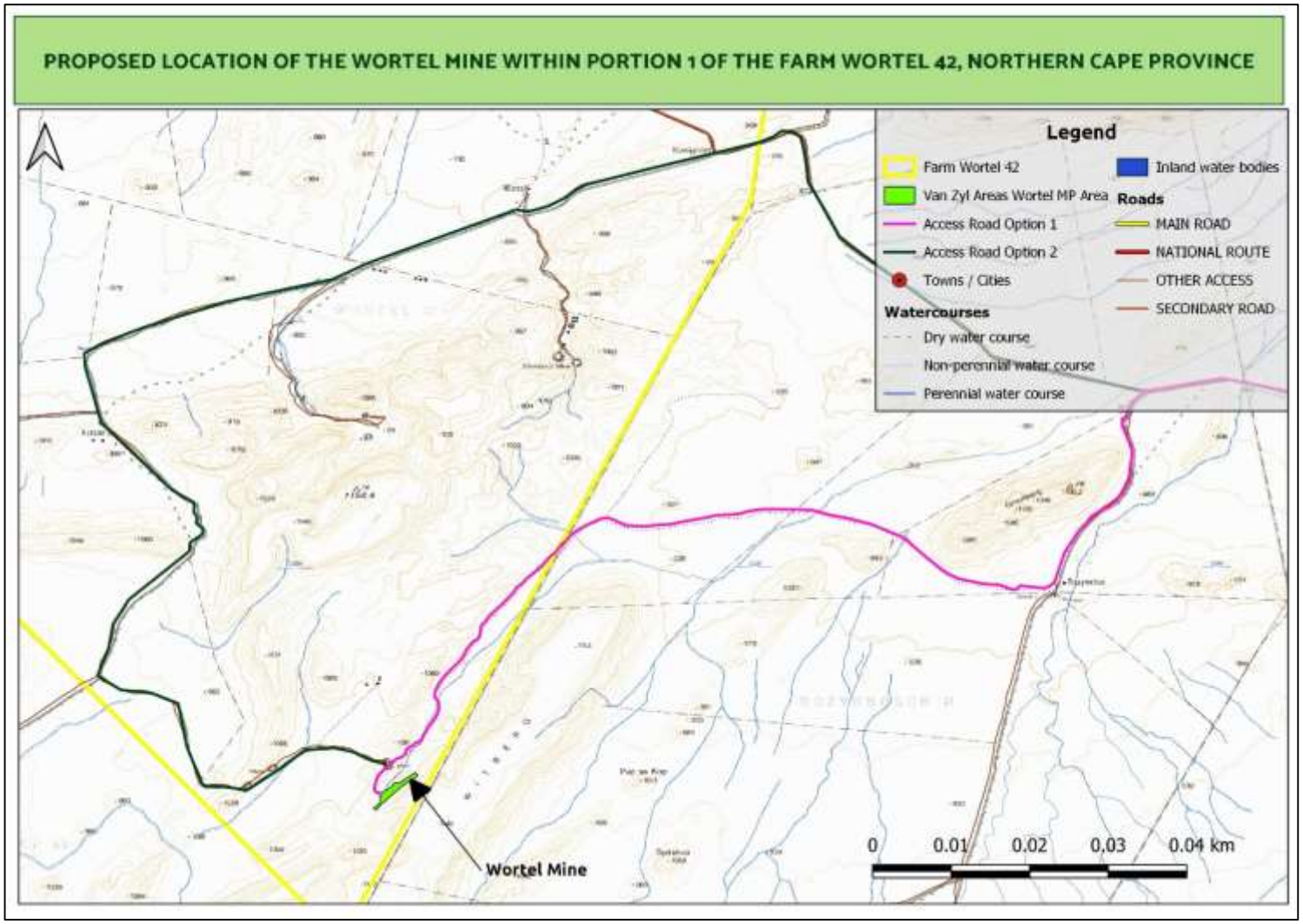

Figure 2: Location map of the proposed Wortel Mine within Portion 1 of the Farm Wortel 42.

1.4 Terms of reference

To conduct a botanical study for a basic assessment of the target area where the establishment of the mine is proposed to be located and provide a professional opinion on botanical issues pertaining to the target area to aid in future decisions regarding the proposed project.

1.5 Conditions of this report

Findings, recommendations, and conclusions provided in this report are based on the authors best scientific and professional knowledge and information available at the time of compilation. No form of this report may be amended or extended without the prior written consent of the author. Any recommendations, statements or conclusions drawn from or based on this report must clearly cite or make reference to this report. Whenever such recommendations, statements or conclusions form part of the main report relating to the current investigation, this report must be included in its entirety.

1.6 Relevant legislation

The following legislation was taken into account whilst compiling this report:

Provincial

» The Northern Cape Nature Conservation Act / NCNCA (Act No 9 of 2009) in its entirety, with special reference to:
  - Schedule 1: Specially Protected/Threatened Species
  - Schedule 2: Protected Species

The above-mentioned Nature Conservation Ordinance accompanied by all amendments is regarded by the Northern Cape Department of Environment and Nature Conservation (DENC) as the legally binding, provincial documents, providing regulations, guidelines and procedures with the aim of protecting game and fish, the conservation of flora and fauna and the destruction of problematic (vermin and invasive) species.

National

» National Environmental Management Act / NEMA (Act No 107 of 1998), and all amendments and supplementary listings and/or regulations
» Environment Conservation Act (ECA) (No 73 of 1989) and amendments

» National Environmental Management Act: Biodiversity Act / NEMA:BA (Act No. 10 of 2004) and amendments
» National Forest Act 1998 / NFA (No 84 of 1998)
» National Veld and Forest Fire Act (Act No. 101 of 1998)
» Conservation of Agricultural Resources Act / CARA (Act No. 43 of 1983) and amendments

International

» Convention on International Trade in Endangered Species of Fauna and Flora (CITES)
» The Convention on Biological Diversity
» The Convention on the Conservation of Migratory Species of Wild Animals

2. METHODOLOGY

2.1 Assessment Approach and Philosophy

The assessment will be conducted according to the 2014 EIA Regulations, as amended 7 April 2017, as well as within the best-practice guidelines and principles for biodiversity assessment as outlined by Brownlie (2005) and De Villiers et al. (2005).

This includes adherence to the following broad principles:

» That a precautionary and risk-averse approach be adopted towards projects which may result in substantial detrimental impacts on biodiversity and ecosystems, especially the irreversible loss of habitat and ecological functioning in threatened ecosystems or designated sensitive areas: i.e. Critical Biodiversity Areas (as identified by systematic conservation plans, Biodiversity Sector Plans or Bioregional Plans) and Freshwater Ecosystem Priority Areas.
» Demonstrate how the proponent intends complying with the principles contained in section 2 of the National Environmental Management Act, 1998 (Act No. 107 of 1998), as amended (NEMA), which, amongst other things, indicates that environmental management should, in order of priority aim to:
    - Avoid, minimise or remedy disturbance of ecosystems and loss of biodiversity;
    - Avoid degradation of the environment;
    - Avoid jeopardising ecosystem integrity;
    - Pursue the best practicable environmental option by means of integrated environmental management;
    - Protect the environment as the people's common heritage;

- Control and minimise environmental damage; and
- Pay specific attention to management and planning procedures pertaining to sensitive, vulnerable, highly dynamic or stressed ecosystems.

These principles serve as guidelines for all decision-making concerning matters that may affect the environment. As such, it is incumbent upon the proponent to show how proposed activities would comply with these principles and thereby contribute towards the achievement of sustainable development as defined by the NEMA.

In order to adhere to the above principles and best-practice guidelines, the following approach forms the basis for the study approach and assessment philosophy:

The study will include data searches, desktop studies, site walkovers/field survey of the property and baseline data collection, describing:

» A description of the broad botanical characteristics of the site and its surrounds in terms of any mapped spatial components of ecological processes and/or patchiness, patch size, relative isolation of patches, connectivity, corridors, disturbance regimes, ecotones, buffering, viability, etc.

In terms of pattern, the following will be identified or described:

Community and ecosystem level

» The main vegetation type, its aerial extent, and interaction with neighbouring types, soils or topography;
» Threatened or vulnerable ecosystems (cf. new SA vegetation map/National Spatial Biodiversity Assessment1, fine-scale systematic conservation plans, etc).

Species-level

» Red Data Book (RDB) species (giving location if possible, using GPS)
» The viability of an estimated population size of the RDB species that are present (include the degree of confidence in prediction based on availability of information and specialist knowledge, i.e. High=70-100% confident, Medium 40-70% confident, low 0-40% confident) The likelihood of other RDB species, or species of conservation concern, occurring in the vicinity (include degree of confidence).

Other pattern issues

» Any significant landscape features or rare or important vegetation associations such as seasonal wetlands, alluvium, seeps, quartz patches or salt marshes in the vicinity.
» The extent of alien plant cover of the site, and whether the infestation is the result of prior soil disturbance such as ploughing or quarrying (alien cover resulting from disturbance is generally more difficult to restore than an infestation of undisturbed sites).
» The condition of the site in terms of current or previous land uses.

In terms of process, the following will be identified or described:

» The key ecological "drivers" of ecosystems on the site and in the vicinity, such as fire.
» Any mapped spatial component of an ecological process that may occur at the site or in its vicinity (i.e. corridors such as watercourses, upland-lowland gradients, migration routes, coastal linkages or inland-trending dunes, and vegetation boundaries such as edaphic interfaces, upland-lowland interfaces or biome boundaries)
» Any possible changes in key processes e.g. increased fire frequency or drainage/artificial recharge of aquatic systems.
» Furthermore, any further studies that may be required during or after the EIA process will be outlined.
» All relevant legislation, permits, and standards that would apply to the development will be identified.
» The opportunities and constraints for development will be described and shown graphically on an aerial photograph, satellite image or map delineated at an appropriate level of spatial accuracy.

2.2 Data scouring and review

Data sources from the literature and GIS spatial information was consulted and used where necessary in the study and include the following (also refer to Table 1):

Vegetation:
» Vegetation types and their conservation status were extracted from the South African National Vegetation Map (Mucina and Rutherford 2006) as well as the National List of Threatened Ecosystems (2011), where relevant.
» Critical Biodiversity Areas for the site and surroundings were extracted (CBA Map for Northern Cape Province obtained from http://bgis.sanbi.org/fsp/project.asp).

» Information on plant and animal species recorded for the surrounding was extracted from the SABIF/SIBIS database hosted by SANBI. This is a considerably larger area than the study area but is necessary to ensure a conservative approach as well as counter the fact that the site itself has probably not been well sampled in the past.
» The IUCN conservation status of the species in the list was also extracted from the database and is based on the Threatened Species Programme, Red List of South African Plants (Version 2017.1).

Ecosystem:

» Freshwater and wetland information was extracted from the National Freshwater Ecosystem Priority Areas assessment, NFEPA (Nel et al. 2011). This includes rivers, wetlands, and catchments defined under the study.
» Important catchments and protected areas expansion areas were extracted from the National Protected Areas Expansion Strategy 2008 (NPAES).
» Critical Biodiversity Areas were extracted from the Northern Cape Conservation Plan (Oosthuysen & Holness, 2016), available from the SANBI BGIS web portal.

Table 1: Information and data coverages used to inform the ecological assessment.

	Data/Coverage Type	Relevance	Source
Biophysical Context	**Colour Aerial Photography**	Desktop mapping of habitat/ecological features	National Geo-Spatial Information (NGI)
	Latest Google Earth™ imagery	To supplement available aerial photography	Google Earth™ On-line
	1:50 000 Relief Line (5m Elevation Contours GIS Coverage)	Desktop mapping of terrain and habitat features	Client
	1:50 000 River Line (GIS Coverage)	Highlight potential on-site and local rivers and wetlands and map local drainage network.	CSIR (2011)
	National Land-Cover	Shows the land-use and disturbances/transformations within and around the impacted zone.	DEA (2015)
	South African Vegetation Map (GIS Coverage)	Classify vegetation types and determination of reference primary vegetation	Mucina & Rutherford (2012)
	NFEPA: river and wetland inventories (GIS Coverage)	Highlight potential on-site and local rivers and wetlands	CSIR (2011)
Conservation and	**NFEPA: River, wetland and estuarine FEPAs** (GIS Coverage)	Shows location of national aquatic ecosystems conservation priorities	CSIR (2011)
	National Biodiversity Assessment – Threatened Ecosystems (GIS Coverage)	Determination of national threat status of local vegetation types	SANBI (2011)

	Northern Cape Biodiversity Conservation Plan (GIS Coverage)	Determination of provincial terrestrial/freshwater conservation priorities and biodiversity buffers	SANBI (2016)
	SANBI's PRECIS (National Herbarium Pretoria Computerized Information System) electronic database	Determination of plant species composition within the region as well as potential conservation important plants.	http://posa.sanbi.org 2020-01-20_181608464-BRAHMSOnlineData
	Red Data Books (Red Data Lists of Plants)	Determination of endangered and threatened plants,	Red List of South African Plants (2011)

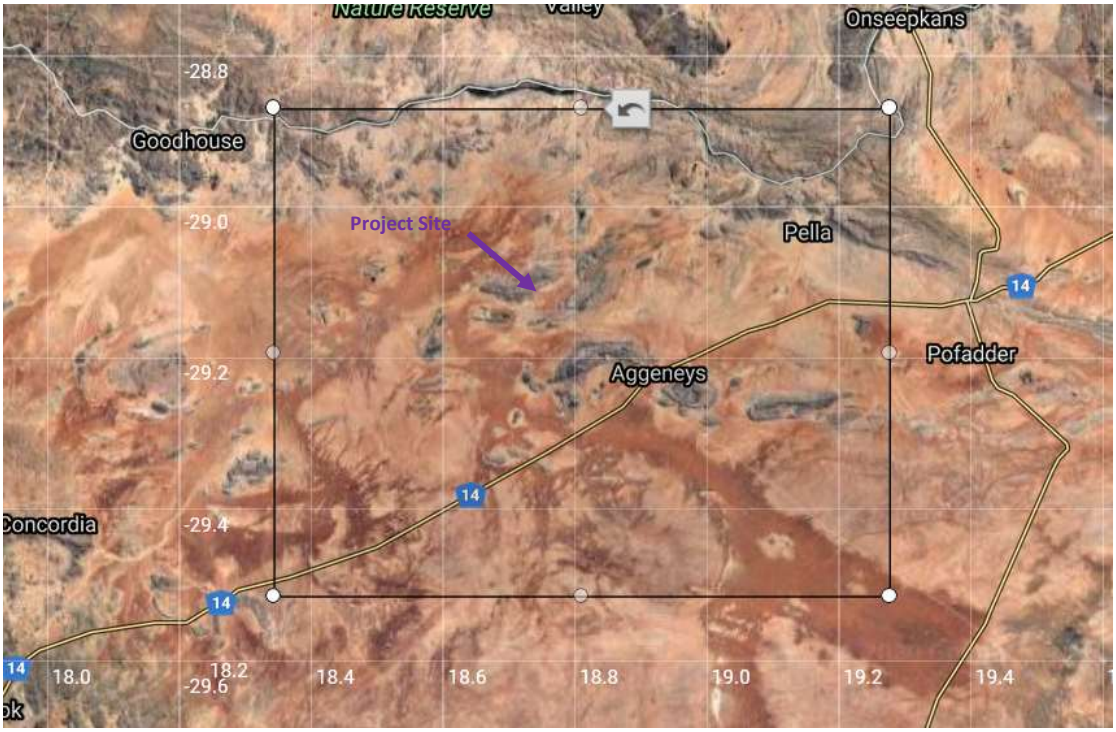

Figure 3: Extracted area and sample locations from POSA. Extracted data was used to compile a plant species list of species that may potentially occur within the project site and provide an indication of potential conservation important species that may be found within the area.

2.3 BOTANY: Methods to be followed during Field Sampling and Assessment

As part of the BA process, a detailed field survey of the vegetation of the development footprint was undertaken (on the 23th and 24th of January 2020) with the main purpose of:

» Inspecting the various habitat, vegetation and landscape units that are present the mining site and to correlate such observations with the results of the desktop study.

» Identifying all observed species that were recorded within the development footprint.

» Providing a list of protected and redlist species.
» Noting the presence of sensitive habitats such quartz patches, drainage lines and unique edaphic environments,

These features were mapped onto satellite imagery of the site.

Aspects of biodiversity that were used to guide the interpretation and assessment of the study area are summarized below (Table 2).

Table 2: Summary of the different aspects of biodiversity considered in the assessment of the study site.

Intrinsic / Ecological Values
Species-level aspects of biodiversity
» Protected species of flora; » Threatened Species (Red Data List); » Keystone species performing a key ecological role; » Large or congregatory species population; » Endemic species or species with restricted ranges; » Previously unknown species.
Community & ecosystem-level aspects of biodiversity
» Distinct or diverse communities or ecosystems; » Unique ecosystems; » Locally adapted communities or assemblages; » Species-rich or diverse ecosystems; » Communities with a high proportion of endemic species or species with restricted ranges; » Communities with a high proportion of threatened and/or declining species; » The main uses and users of the area and its ecosystem goods and services: important ecosystem services, valued ecosystem goods, valued cultural areas.
Community & ecosystem-level aspects of biodiversity
» Key ecological processes (e.g. seed dispersal, pollination, primary production, carbon sequestration); » Areas with large congregations or species and/or breeding grounds; » Migration routes/corridors; » Importance as a link or corridor to other fragments of the same habitat, to protected or threatened or valued biodiversity areas; » Importance and role in the landscape with regard to arrange of 'spatial components of ecological processes', comprising processes tied to fixed physical features (e.g. soil or vegetation interfaces, river or sand movement corridors, upland-lowland interfaces) and flexible processes (e.g. upland-lowland gradients and macro-climatic gradients), as well as important movement or migration corridor for species.

2.4 Assessing species of conservation concern:

Species of conservation concern are species that have high conservation importance in terms of preserving South Africa's biodiversity. A description of the

different SANBI categories of species of conservation concern is provided in Table 3, below.

Table 3: South African Red List Categories for species of conservation significance (adapted from SANBI, on-line at http://redlist.sanbi.org/redcat.php).

Present State			
Species of Conservation Concern		Extinct (EX)	A species is Extinct when there is no reasonable doubt that the last individual has died. Species should be classified as Extinct only once exhaustive surveys throughout the species' known range have failed to record an individual.
		Extinct in the Wild (EW)	A species is Extinct in the Wild when it is known to survive only in cultivation or as a naturalized population (or populations) well outside the past range.
		Regionally Extinct (RE)	A species is Regionally Extinct when it is extinct within the region assessed (in this case South Africa), but wild populations can still be found in areas outside the region.
	Threatened Species	Critically Endangered, Possibly Extinct (CR PE)	Possibly Extinct is a special tag associated with the category Critically Endangered, indicating species that are highly likely to be extinct, but the exhaustive surveys required for classifying the species as Extinct has not yet been completed. A small chance remains that such species may still be rediscovered.
		Critically Endangered (CR)	A species is Critically Endangered when the best available evidence indicates that it meets at least one of the five IUCN criteria for Critically Endangered, indicating that the species is facing an extremely high risk of extinction.
		Endangered (EN)	A species is Endangered when the best available evidence indicates that it meets at least one of the five IUCN criteria for Endangered, indicating that the species is facing a very high risk of extinction.
		Vulnerable (VU)	A species is Vulnerable when the best available evidence indicates that it meets at least one of the five IUCN criteria for Vulnerable, indicating that the species is facing a high risk of extinction.
		Near Threatened (NT)	A species is Near Threatened when available evidence indicates that it nearly meets any of the IUCN criteria for Vulnerable, and is, therefore, likely to become at risk of extinction in the near future.
		Critically Rare	A species is Critically Rare when it is known to occur at a single site, but is not exposed to any direct or plausible potential threat and does not otherwise qualify for a category of threat according to one of the five IUCN criteria.
		Rare	A species is Rare when it meets at least one of four South African criteria for rarity, but is not exposed to any direct or plausible potential threat and does not qualify for a category of threat according to one of the five IUCN criteria.
		Declining	A species is Declining when it does not meet or nearly meet any of the five IUCN criteria and does not qualify for Critically Endangered, Endangered, Vulnerable or Near Threatened, but there are threatening processes causing a continuing decline of the species.
		Data Deficient – Insufficient Information (DDD)	A species is DDD when there is inadequate information to make an assessment of its risk of extinction, but the species is well defined. Listing of species in this category indicates that more information is required and that future research could show that a threatened classification is appropriate.
Other		Data Deficient – Taxonomically Problematic (DDT)	A species is DDT when taxonomic problems hinder the distribution range and habitat from being well defined so that an assessment of risk of extinction is not possible.
		Least Concern (LC)	A species is Least Concern when it has been evaluated against the IUCN criteria and does not qualify for any of the above categories. Species classified as Least

			Concern are considered at low risk of extinction. Widespread and abundant species are typically classified in this category.
		Not Evaluated (NE)	species is Not Evaluated when it has not been evaluated against the criteria. The national Red List of South African plants is a comprehensive assessment of all South African indigenous plants, and therefore all species are assessed and given a national Red List status. However, some species included in Plants of southern Africa: an online checklist are species that do not qualify for national listing because they are naturalized exotics, hybrids (natural or cultivated), or synonyms. These species are given the status Not Evaluated and the reasons why they have not been assessed are included in the assessment justification.

As mentioned, flora of conservation significance (including threatened, protected and rare species) likely to occur in the various habitats of the study area were assessed at a desktop level using the outputs of SANBI's PRECIS (National Herbarium Pretoria Computerized Information System) electronic database. This information was used to identify potential habitat in the project area that could support these species based on information on each species' particular habitat preferences which were obtained from SANBI online species database. Special attention was given to the identification of any of these Red Data species as well as the identification of suitable habitat for Red Data species observed during field investigations.

2.5 Ecological Mapping

Mapping has been done by comparing georeferenced ground survey data to the visual inspection of available Google-Earth Imagery (which is a generalised colour composite image without any actual reflectance data attached to it) and in that way extrapolating survey reference points to the entire study area. Delineations are therefore approximate, and due to the intricate mosaics and often gradual mergers of vegetation units, generalisations had to be made. Mapped units will thus show where a certain vegetation unit is predominant, but smaller inclusions of another vegetation type in this area do exist but have not been mapped separately. The latter would require a supervised classification of georeferenced raw SPOT or similar satellite imagery (with all reflectance data), which has not been available to this project due to the high cost of such imagery.

2.6 Sensitivity Analysis and Criteria

The determination of specific ecosystem services and the sensitivity of ecosystem components, both biotic and abiotic, is rather complex and no single overarching

criterion will apply to all habitats studied. The main aspects of an ecosystem that need to be incorporated in a sensitivity analysis, however, include the following:

» Describing the nature and number of species present, taking into consideration their conservation value as well as the probability of such species to survive or re-establish itself following disturbances, and alterations to their specific habitats, of various magnitudes
» Identifying the species or habitat features that are 'key ecosystem providers' and characterising their functional relationships (Kremen 2005)
» Determining the aspects of community structure that influence function, especially aspects influencing stability or rapid decline of communities (Kremen 2005)
» Assessing key environmental factors that influence the provision of services (Kremen 2005)
» Gaining knowledge about the spatial-temporal scales over which these aspects operate (Kremen 2005).

This implies that in the sensitivity analysis not only aspects that currently prevail on the area should be taken into consideration, but also if there is a possibility of a full restoration of the original environment and its biota, or at least the rehabilitation of ecosystem services resembling the original state after an area has been significantly disturbed.
According to the above, sensitivity classes have been summarised as follows:

» **Very High Sensitivity:** Areas that contain critical and/or unique habitats have a very high sensitivity; such areas usually serve as habitats for rare/endangered species or perform critical and irreplaceable ecological roles. Very high sensitivity areas are no-go areas and developments in such areas should be avoided at all costs.
» **High Sensitivity:** High sensitivity areas are those that usually have a high biodiversity value or important ecological roles, and it is expected that impacts on such areas will likely be high; these areas include natural or transformed land. It might be difficult to mitigate all impacts appropriately in high sensitivity areas, and thus development within these areas is undesirable and should proceed with caution.
» **Medium Sensitivity:** The impacts on medium sensitivity areas are likely to be mostly local with the risk of secondary impacts (such as erosion) being low; these areas include natural or previously transformed land. On the condition that appropriate mitigation measures are implemented, development within medium sensitivity areas will have relatively little ecological impact.
» **Low Sensitivity:** The impact on ecological processes and plant diversity in a low sensitivity area is likely to be negligible. Areas of low sensitivity are those

areas where natural vegetation has already been transformed, for example as a result of intensive agricultural practices such as crop production. The majority of developments would have little ecological impact in low sensitivity areas. The majority of the site is a Low Sensitivity area since it has already been heavily transformed due to past mining activities.

2.7 Impact Assessment Methodology

The assessment methodology is in accordance with the recent revised 2014 EIA regulations. The significance of environmental impacts is a function of the environmental aspects that are present and to be impacted on, the probability of an impact occurring and the consequence of such an impact occurring before and after implementation of proposed mitigation measures.

The significance of environmental impacts is to be assessed by means of the criteria of extent (scale), duration, magnitude (severity), probability (certainty) and direction (negative, neutral or positive).

» The **nature**, which includes a description of what causes the effect, what will be affected and how it will be affected.
» The **extent**, wherein it is indicated whether the impact will be local (limited to the immediate area or site of development) or regional, and a value between 1 and 5 is assigned as appropriate (with 1 being low and 5 being high).
» The **duration**, wherein it was indicated whether:
  - the lifetime of the impact will be of a very short duration (0 – 1 year) – assigned a score of 1;
  - the lifetime of the impact will be of short duration (2 – 5 years) – assigned a score of 2;
  - medium-term (5 -15 years) – assigned a score of 3;
  - long term (> 15 years) – assigned a score of 4; or
  - permanent – assigned a score of 5.
» The **magnitude**, quantified on a scale from 0 – 10, where 0 is small and will have no effect on the environment, 2 is minor and will not result in an impact on processes, 4 is low and will cause a slight impact on processes, 6 is moderate and will result in processes continuing but in a modified way, 8 is high (processes are altered to the extent that they temporarily cease), and 10 is very high and results in complete destruction of patterns and permanent cessation of processes.
» The **probability** of occurrence, which describes the likelihood of the impact actually occurring. Probability is estimated on a scale of 1 -5, where 1 is very improbable (probably will not happen), 2 is improbable (some possibility, but

low likelihood), 3 is probable (distinct possibility), 4 is highly probable (most likely) and 5 is definite (impact will occur regardless of any prevention measures).

» The **significance** is determined through a synthesis of the characteristics described above and can be assessed as **LOW**, **MEDIUM** or **HIGH**; and
» the **status**, which was described as either positive, negative or neutral;
» the degree of which the impact can be reversed;
» the degree to which the impact may cause irreplaceable loss of resources; and
» the degree to which the impact can be mitigated.

The significance was calculated by combining the criteria in the following formula:

S=(E+D+M)P where;

» S = Significance weighting
» E = Extent
» D = Duration
» M = Magnitude
» P = Probability

The significance weightings for each potential impact are as follows;

» < 30 points: **LOW** (i.e. where the impact would not have a direct influence on the decision to develop in the area),
» 30 – 60 points: **MEDIUM** (i.e. where the impact could influence the decision to develop in the area unless it is effectively mitigated),
» > 60 points: **HIGH** (i.e. where the impact must have an influence on the decision process to develop in the area).

2.8 Assumptions and Limitations

This report deals exclusively with a defined area and the impacts upon flora biodiversity and natural ecosystems in that area.

» All relevant project information provided by the applicant and engineering design team to the ecological specialist was correct and valid at the time that it was provided.
» Probably the most significant potential limitation associated with such a sampling approach is the narrow temporal window of sampling.
  - Temporal variation plays an important role in the structure and patterns of plant biodiversity, plant communities, and plant species occurrences. As such, a single site visit may therefore not fully catalogue all plant species

diversity in an area, for example due to seasonal variation of vegetation, since the temporal window of sampling is narrow. Thus, the ideal situation would be to visit a site several times during different seasons, which would ensure that most, if not all, plant species present are observed and recorded. However, time and cost constraints make multiple site visits nearly impossible, and the species observed and recorded at the time of the site visit should therefore be critically evaluated as they might not fully represent the complete plant community.

Indeed, the site was surveyed during one of the driest months of the year, namely January. This, together with the fact that the area has experienced a prolonged drought with below average rainfall for the past seven years, means that some annual, short-lived, ephemeral (plants surviving unfavourable conditions as seeds), geophytic (species with underground storage organs), or other cryptic species may not have been observed/detected, especially those that completely die back during dormancy. Furthermore, flowers and fruits are crucial for the complete and accurate identification of plant species and any absence of such flowers and fruits might therefore prevent the complete and accurate identification of such plant species (for example species of the family Aizoaceae). Flowering and fruiting times are both species specific and conditional on certain environmental cues being met (for example adequate rainfall), and there were thus invariably some plant species that were not flowering and/or fruiting during the period in which the site visit was conducted. Due to the aforementioned potential limitations, a list of protected or endangered species known to occur in the area was used to supplement the list of species observed and recorded during the site visit. This combined list is sufficiently conservative and cautious to account for the study limitations.

3. THE IMPORTANCE OF BIODIVERSITY AND CONSERVATION

The term 'Biodiversity' is used to describe the wide variety of plant and animal species occurring in their natural environment or 'habitat'. Biodiversity encompasses not only all living things but also the series of interactions that sustain them, which are termed 'ecological processes. South Africa's biodiversity provides an important basis for economic growth and development; and keeping our biodiversity intact is vital for ensuring the on-going provision of ecosystem services, such as the production of clean water through good catchment management. The role of biodiversity in combating climate change is also well recognised and further

emphasises the key role that biodiversity management plays on a global scale (Driver et al., 2012). Typical pressures that natural ecosystems face from human activities include the loss and degradation of natural habitat, invasive alien species, pollution and waste and climate change (Driver et al.,2012). High levels of infrastructural and agricultural development typically restrict the connectivity of natural ecosystems, and maintaining connectivity is considered critical for the long-term persistence both ecosystems and species, in the face of human development and global climatic change. Loss of biodiversity puts aspects of our economy and quality of life at risk and reduces socioeconomic options for future generations as well. In essence, then, sustainable development is not possible without it.

4. DESCRIPTION OF THE AFFECTED ENVIRONMENT - BASELINE

4.1 Broad-Scale Vegetation Patterns

The site lies entirely within the Eastern Gariep Rocky Desert vegetation type (Mucina & Rutherford, 2006) (Figure 4). The unit comprises about 2568 km2 of land area and is classified as Least Threatened, since its conservation target is 34% with 99.7% of the unit still remaining; the vegetation type has thus not significantly been transformed. The vegetation type comprises all the rocky desert areas along the Orange River, including Groot Pellaberge, Dabenorisberge, Abbasasberge, and many smaller mountains between Pella and Vioolsdrif, with an altitudinal range of about 250 – 1 205 m at the highest peak of the Groot Pella.

Variation in habitat types are mainly controlled by topography, aspect, local climate and lithology. The vegetation type is characterised by hills and mountains mostly with bare rock outcrops that are very sparsely covered with shrubby vegetation. The southern ravines and rocky drainage lines are typically covered by a higher cover of plants including; *Abutilon pycnodont, Asparagus suaveolens, Ficus cordata, Searsia populifolia* and *S. viminalis*. On the higher southern slopes *Justicia orchioides* is often dominant, with localised grassland directly below steep cliffs (*Enneapogon scaber, Triraphis ramosissima* and *Danthoniopsis ramosa*). The south facing quartzite cliffs and steep slopes support chasmophytes such as *Ficus ilicina, Aloe dabenorisana* and *Bowiea gariepensis*. On the summits and higher northern slopes there is a much higher diversity of succulent species such as Euphorbia *avasmontana, Aloe dichotoma, A. microstigma* subsp. *microstigma, Pelargonium aridum* and *Kleinia longiflora* (Mucina & Rutherford, 2006)

This vegetation type comprises a geology of mainly leucocratic biotite gneiss and quartz-feldspar gneiss of the Stalhoek Complex in the east, and in the west granodiorite, adamellite, leucogranite, tonalite and diorite of the Vioolsdrif Suite and intermediate and acid volcanics of the Haib Subgroup of the Orange River Group. The substrate is very rocky, with little or no soils, and land type lc. A nearby vegetation type is the wash plains of the Eastern Gariep Plains Desert.

Table 4: Key species associated with the Eastern Gariep Rocky Desert according to Mucina and Rutherford (2006).

DOMINANT SPECIES	
Growth Form	**Key Species**
Small Tree	*Senegalia (Acacia) mellifera, Boscia albitrunca, B. foetida, Ehretia rigida, Euclea pseudebenus, Maerua gilgii, Pappea capensis*
Succulent Tree	*Aloidendron (Aloe) dichotoma*
Stem-& Leaf-succulent Shrubs	*Brownanthus pseudoschlichtianus, Ceraria fruticulosa, Psilocaulon subnodosum, Ruschia barnardii*
Stem-succulent Shrubs	*Ceraria namaquensis, Commiphora capensis, C. cervifolia, C. gracilifrondosa, C. namaensis, Euphorbia avasmontana, E. friedrichiae, E. gariepina, E. gregaria, E. guerichiana, E. virosa*
Leaf-succulent Shrubs	*Aloe dabenorisana, A. gariepensis, Mesembryanthemum inachabense, Prenia tetragona, Trianthema parvifolia, Tylecodon rubrovenosus, Zygophyllum decumbens, Z. microcarpum, Z rigidum*
Shrubs	*Adenolobus gariepensis, Antherothamnus pearsonii, Aptosimum tragacanthoides, Barleria lancifolia, B. rigida, Cadaba aphylla, Calicorema capitate, Diospyros acocksii, Dyerophytum africanum, Eriocephalus scariosus, Hermannia stricta, Justicia orchioides, Monechma mollissimum, Petalidium setosum, Rhigozum obovatum, Searsia populifolia, Sisyndite spartea*
Graminoids	*Enneapogon scaber, Schmidtia kalahariensis, Stipagrosist anomala, S. ciliata. S. obtusa,*
Perennial Herbs	*Abutilon pycnodont Chascanum garipense, Codon royenii, Rogeria longiflora, Tribulus cristatus*
Geophytic Herb	*Bowiea gariepensis*
Succulent Herb	*Mesembryanthemum guerichianum*
Annual Herbs	*Cleome angustifolia subsp. diandra, C. foliasa var. lutea*
ENDEMIC SPECIES	
Growth Form	**Key Species**
Small Tree	*Ozoroa namaquensis*

Leaf-succulent Dwarf Shrub	*Tylecodon sulphureus*

A species list from the SANBI database (POSA) containing the species that have been recorded to date within the surroundings of the study area has been compiled. POSA generated species lists also contain updated Red Data species status according to the Red List of South African Plants published by SANBI in Strelitzia 25 (Raimondo *et al*. 2009, updated 2013). Only protected and red data species that may potentially occur in the study area have been listed within the baseline study section of this report. The actual field survey confirmed which of the species already recorded actually occurs in the study area, and indicates the presence of additional species that may not have been recorded in official databases to date.

A total of 787 species have been recorded within the broader area, with a high diversity of succulent forbs and shrubs (216 recorded species). Non-succulent forbs were also relative well represented within the area with 163 species recorded. Dwarf shrubs and shrubs/small trees are moderately represented within the area with 73 and 87 species recorded. Of the 774 indigenous species previously recorded, 147 species are South African Endemics. Alien Plant diversity within the affected region is regarded as relatively low with a total of 14 species recorded and listed within the POSA species list. Of these 14 species 5 have been listed as Invasive Alien plants with the most notable/significant plants listed being; *Salsola kali, Prosopis velutina, P. glandulosa, P. pubescens, Nicotiana glauca* and *Argemone ochroleuca*.

4.2 Species of Conservation Concern

A total of about 32 red data plant species is known to occur in the broad area surrounding the site, as obtained from the SANBI SIBIS database and Threatened Species Programme, Red List of South African Plants (2011). These species of conservation concern are listed below in Table 5. The majority of these species are from the Aizoaceae (which includes the formerly classified family of Mesembryanthemaceae, now regarded as a subfamily of Aizoaceae). They are associated with many of the quartzite patches of the surrounding areas, as well as the dry north facing mountain slopes. As a result, the actual number of species of conservation concern which might occur within the site should be significantly less, since the site is not characterised by dense patches of quartz which typically host many endemics and redlisted species However, the endemic and endangered *Anacampseros herreana* was observed on the way to the site at a different locality among quartzite pebbles, and it is possible that this species might occur in the

vicinity of the site, since the site does have some quartzite elements (although to a much lesser degree than the surrounding areas).

Furthermore, apart from the previous observed red data species a total of 258 species have been recorded which are protected within the Northern Cape Nature Conservation Act (Act No. 9 of 2009). Of these 258 species, only 12 species are Specially Protected namely; *Ozoroa dispar, O. namaensis, O. namaquensis, Pachypodium namaquanum, Aloe dabenorisana, Pelargonium carnosum, P. crithmifolium, P. pulchellum, P. spinosum, P. xerophyton, Pelargonium* spp. and *Ornithogalum bicornutum*. The high number of protected species are mainly due to the fact that the entire Mesembryanthemaceae Sub Family (Aizoaceae Family), Crassulaceae Family and Euphorbia Genus (Euphorbiaceae Family) are protected within this Act. These species are extremely diverse and abundant with this area.

Table 5: Red List Flora species that have been listed within the SANBI database and have been recorded within the region surrounding the study site.

FAMILY	SPECIES	IUCN STATUS
Anacampserotaceae	*Anacampseros herreana*	**EN**
Apiaceae	*Anginon jaarsveldii*	**EN**
Asphodelaceae	*Bulbine ophiophylla*	**EN**
Scrophulariaceae	*Microdon capitatus*	**EN**
Aizoaceae	*Conophytum achabense*	**VU**
Aizoaceae	*Conophytum smorenskaduense*	**VU**
Aizoaceae	*Lithops dinteri*	**VU**
Aizoaceae	*Lithops olivacea*	**VU**
Fabaceae	*Crotalaria pearsonii*	**VU**
Iridaceae	*Tritonia marlothii*	**VU**
Aizoaceae	*Conophytum blandum*	**NT**
Aizoaceae	*Conophytum limpidum*	**NT**
Aizoaceae	*Dinteranthus wilmotianus*	**NT**
Apocynaceae	*Ectadium virgatum*	**NT**
Asteraceae	*Helichrysum marmarolepis*	**NT**
Crassulaceae	*Crassula decumbens*	**NT**
Fabaceae	*Bauhinia bowkeri*	**NT**
Lobeliaceae	*Cyphia longiflora*	**NT**
Tecophilaeaceae	*Cyanella cygnea*	**NT**
Acanthaceae	*Acanthopsis hoffmannseggiana*	**DD**
Aizoaceae	*Drosanthemum breve*	**DD**

Aizoaceae	*Drosanthemum fulleri*	**DD**
Aizoaceae	*Drosanthemum godmaniae*	**DD**
Aizoaceae	*Ruschia aggregata*	**DD**
Aizoaceae	*Trichodiadema obliquum*	**DD**
Anacampserotaceae	*Anacampseros recurvata*	**DD**
Campanulaceae	*Wahlenbergia divergens*	**DD**
Campanulaceae	*Wahlenbergia roelliflora*	**DD**
Crassulaceae	*Adromischus diabolicus*	**DD**
Fabaceae	*Leobordea oligocephala*	**DD**
Scrophulariaceae	*Nemesia fleckii*	**DD**
Scrophulariaceae	*Phyllopodium maxii*	**DD**

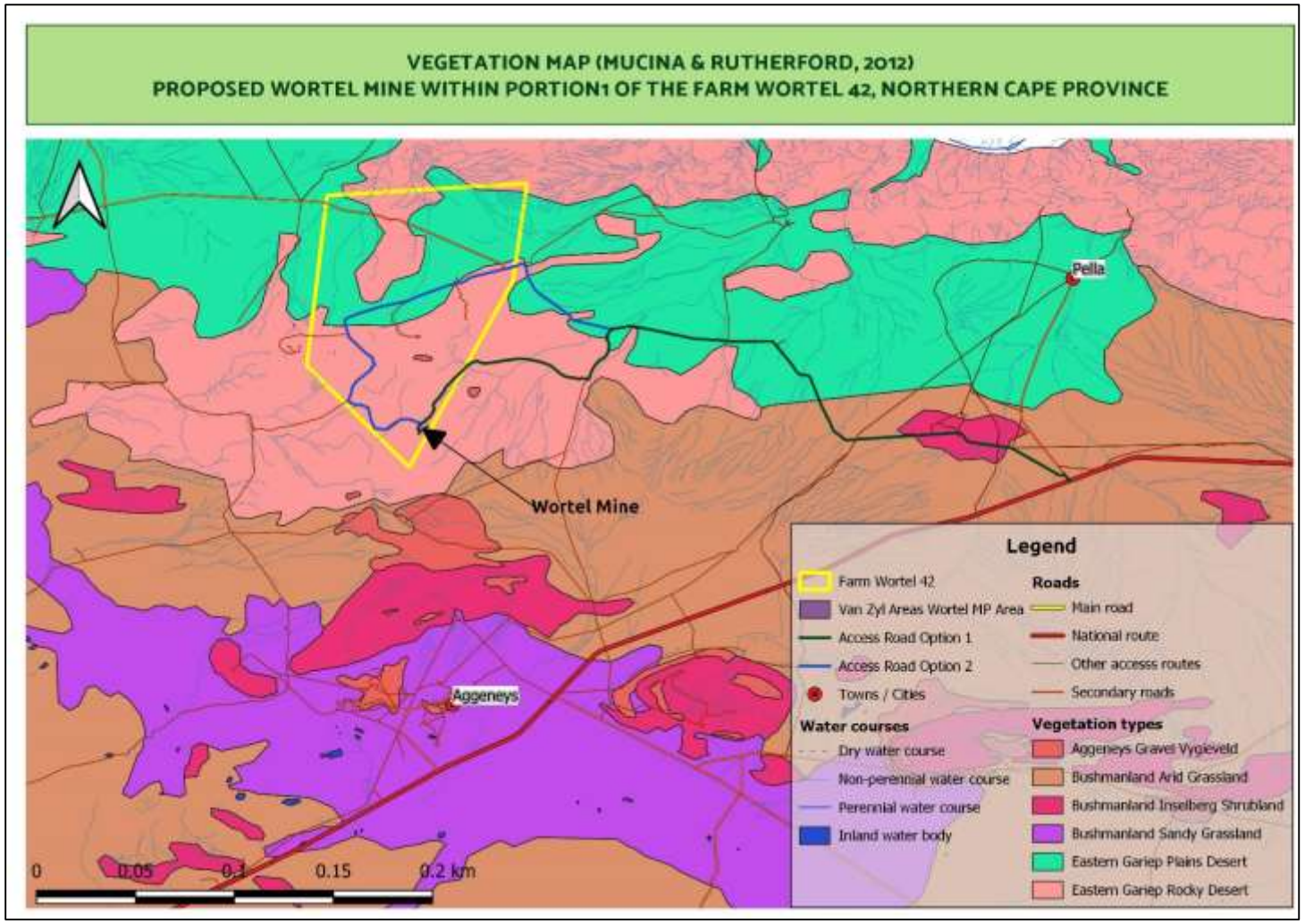

Figure 4: Map illustrating the different vegetation units found within the region.

4.3 Conservation Planning / Context

4.3.1 National Protected Areas Expansion Strategy

Focus areas for land-based protected area expansion are large, intact and unfragmented areas of high importance for biodiversity representation and ecological persistence, suitable for the creation or expansion of large protected areas. The focus areas were identified through a systematic biodiversity planning process undertaken as part of the development of the National Protected Area Expansion Strategy 2008 (NPAES). They present the best opportunities for meeting the ecosystem-specific protected area targets set in the NPAES and were designed with a strong emphasis on climate change resilience and requirements for protecting freshwater ecosystems. These areas should not be seen as future boundaries of protected areas, as in many cases only a portion of a particular focus area would be required to meet the protected area targets set in the NPAES. They are also not a replacement for fine-scale planning which may identify a range of different priority sites based on local requirements, constraints, and opportunities.

According to the NPAES spatial data (Holness, 2010), the proposed mining footprint is located outside of any Focus Area. However, the mining footprint is located in close proximity to the Kamiesberg Bushmanland Augrabies NPAES. Subsequently this NPAES Focus Area will not be impacted by the Wortel (Van Zyl Sillimanite) Mine.

The proposed access road options traverses' small portions that is included in this NPAES, however due to the fact that only existing roads will be utilised, there will be no impact on this potential protected area as a result of the access road.

4.3.2 National Level of Conservation Priorities (Threatened Ecosystems)

The vegetation types of South Africa have been categorized according to their conservation status which is, in turn, assessed according to the degree of transformation and rates of conservation. The status of a habitat or vegetation type is based on how much of its original area still remains intact relative to various thresholds. On a national scale, these thresholds are as depicted in the table below, as determined by the best available scientific approaches (Driver et al. 2005). The level at which an ecosystem becomes Critically Endangered differs from one ecosystem to another and varies from 16% to 36% (Driver et al. 2005).

Table 6: Determining ecosystem status (from Driver et al. 2005). *BT = biodiversity target (the minimum conservation requirement.

Habitat remaining (%)			
	80–100	least threatened	LT
	60–80	vulnerable	VU
	*BT–60	endangered	EN
	0–*BT	critically endangered	CR

A national process has been undertaken to identify and list threatened ecosystems that are currently under threat of being transformed by other land uses. The first national list of threatened terrestrial ecosystems for South Africa was gazetted on 9 December 2011 (National Environmental Management: Biodiversity Act or NEMBA: National list of ecosystems that are threatened and in need of protection, G 34809, GoN 1002, 9 December 2011). The purpose of listing threatened ecosystems is primarily to reduce the rate of ecosystem and species extinction by preventing further degradation and loss of structure, function, and composition of threatened ecosystems (SANBI, 2011). The NEMBA provides for listing of threatened or protected ecosystems, in one of four categories: critically endangered (CR), endangered (EN), vulnerable (VU) or protected. There are four main types of implications of listing ecosystems:

» Planning related implications which are linked to the requirement in the Biodiversity Act (Act 10 of 2004) for listed ecosystems to be taken into account in municipal IDPs and SDFs;
» Environmental authorisation implications in terms of NEMA and the EIA regulations;
» Proactive management implications in terms of the National Biodiversity Act;
» Monitoring and reporting implications in terms of the Biodiversity Act.

According to Mucina and Rutherford (2006), this vegetation type is classified as Least Threatened with a conservation target of 34%. Currently, none of the vegetation type is conserved in statutory conservation areas. Only 0.3% of this vegetation type has been transformed (Table 7).

Furthermore, this area is **Not** listed (Figures 5 and 6) within the Threatened Ecosystem List (NEMA:BA).

It is highly unlikely that this development will have an impact on the status of the Vegetation Type due to the extent of the development as well as the presence of already disturbed areas within the footprint (existing mine) and the fact that only existing access roads will be used.

Table 7: Conservation status of the vegetation type occurring in and around the study area.

Vegetation Type	Target (%)	Transformed (%)	Conserved (Statutorily & other reserves)	Conservation Status	
				Driver *et al.*, 2005; Mucina & Rutherford, 2006	National Ecosystem List (NEMA:BA)
Eastern Gariep Rocky Desert	34%	0.3%	0%	Least Threatened	Not Listed

4.3.3 Critical Biodiversity Areas and Broad Scale Ecological Processes

Critical Biodiversity Areas have been identified for all municipal areas of the Northern Cape Province (Oosthuysen & Holness, 2016) and are published on the SANBI website (bgis.sanbi.org). This biodiversity assessment identifies CBAs which represent biodiversity priority areas that should be maintained in a natural to near-natural state. The CBA maps indicate the most efficient selection and classification of land portions requiring safeguarding in order to maintain ecosystem functioning and meet national biodiversity objectives (refer to Table 8 for the different land management objectives set out for each CBA category). According to these maps, large tracks of land within the region falls either within Critical Biodiversity Areas 2 (CBA2) or Ecological Support Areas (ESA).

The entire mining footprint is located within a CBA2. Furthermore, both access road options will traverse mostly CBA2 and Other Natural Areas with small areas listed as CBA1 being impacted. These CBA2 areas are regarded as largely intact and undisturbed, with intermediate irreplaceability or flexibility in terms of the area required to meet biodiversity targets. The isolated patches of CBA1 are mainly associated with natural, undisturbed inselbergs, steep slopes, large plateaus and corridors along major watercourse systems. These habitats provide unique niche habitats, refuge for sensitive flora and fauna (in the face of potential climate change) and they are typically susceptible to erosion if the vegetation cover is removed.

However, the preferred mining footprint is located almost entirely within the historical mining footprint which is in a highly disturbed and transformed state. Subsequently this area contains very few natural elements and similarly contribute very little to the functionality and services that would typically characterise such a classification (CBA2). As such, if the proposed development is restricted to the footprint area provided in this report, minimal impacts would occur on the surrounding natural areas, listed as CBA2.

In terms of the access roads, both options are along existing roads and would also subsequently have a minimal impact on the CBA areas.

Table 8: Relationship between Critical Biodiversity Areas categories (CBAs) and land management objectives

CBA category	Land Management Objective
Protected Areas (PA) & CBA 1	***Natural landscapes:*** » Ecosystems and species are fully intact and undisturbed. » These are areas with high irreplaceability or low flexibility in terms of meeting biodiversity pattern targets. If the biodiversity features targeted in these areas are lost then targets will not be met. » These are landscapes that are at or past their limits of acceptable change.
CBA 2	***Near-natural landscapes:*** » Ecosystems and species largely intact and undisturbed. » Areas with intermediate irreplaceability or some flexibility in terms of the area required to meet biodiversity targets. There are options for loss of some components of biodiversity in these landscapes without compromising the ability to achieve targets. » These are landscapes that are approaching but have not passed their limits of acceptable change.
ESA	***Functional landscapes:*** » Ecosystem moderately to significantly disturbed but still able to maintain basic functionality. » Individual species or other biodiversity indicators may be severely disturbed or reduced. » These are areas with low irreplaceability with respect to biodiversity pattern targets only.
ONA (Other Natural Areas) and Transformed	Production landscapes: Manage land to optimise sustainable utilisation of natural resources.

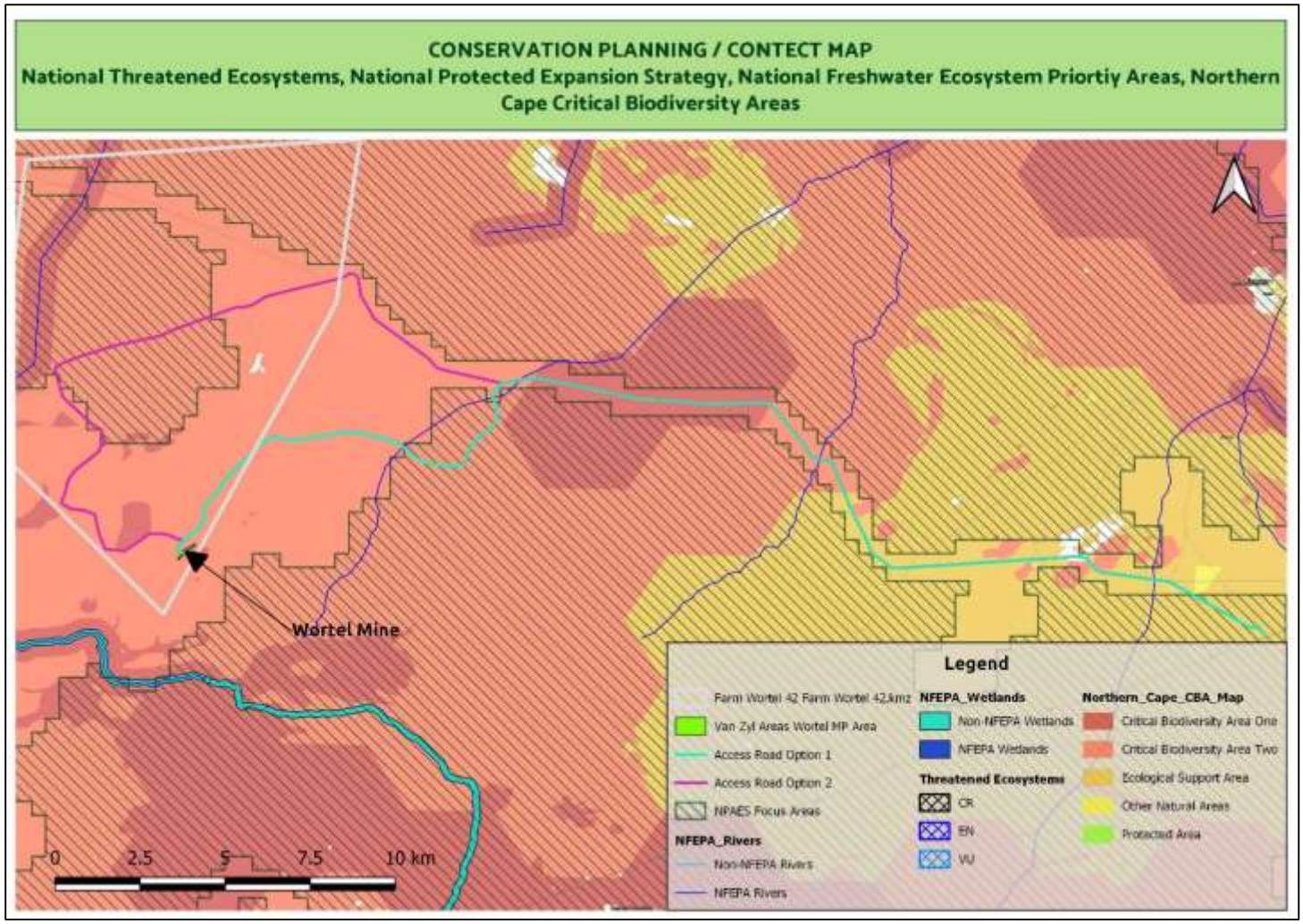

Figure 5: Map illustrating the various conservation priority areas found within the greater surroundings.

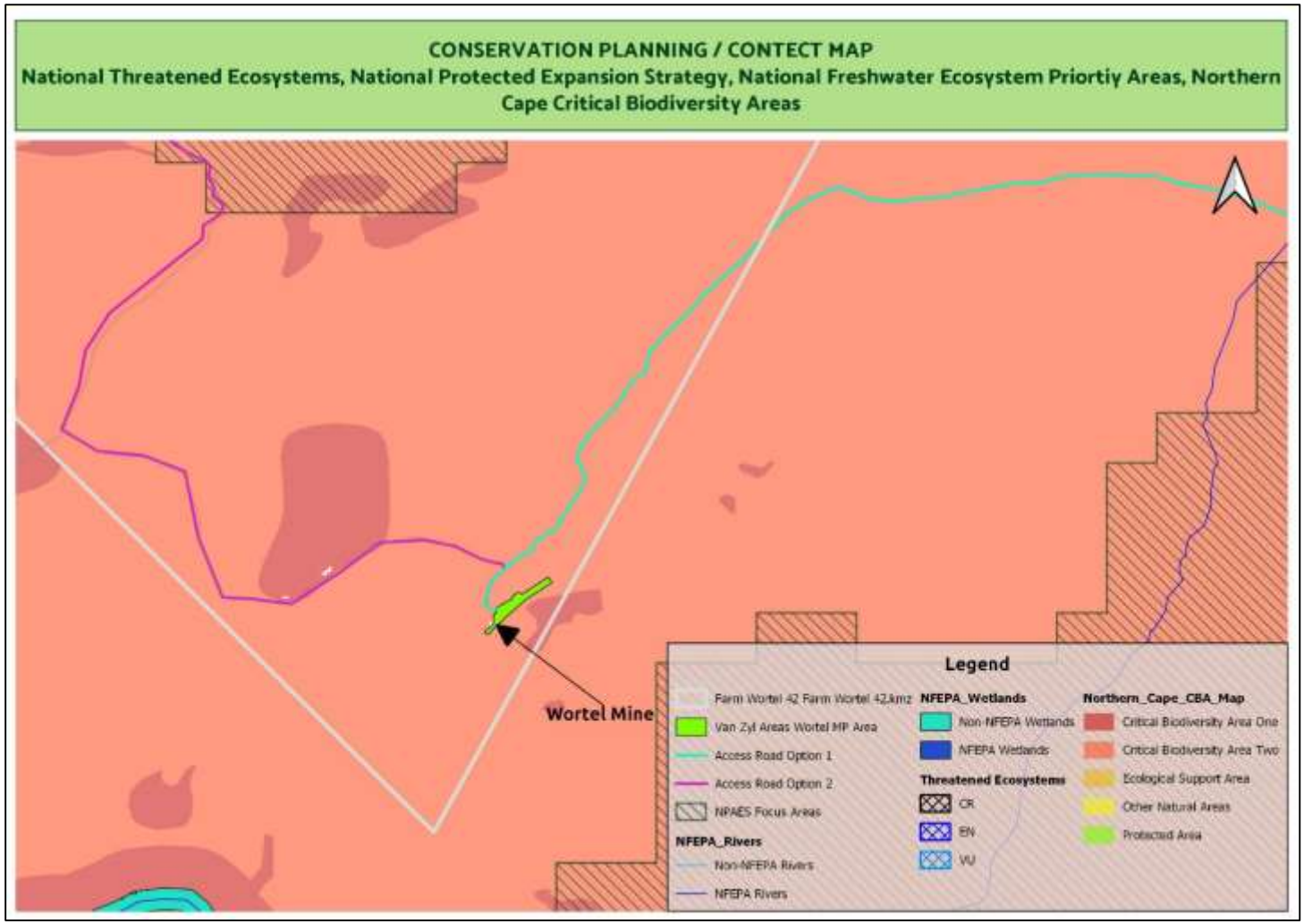

Figure 6: Map illustrating the various conservation priority areas found within the immediate surroundings of the proposed Wortel Mine.

5. FINDINGS OF THE BOTANICAL ASSESSMENT

5.1 Site Specific Vegetation Description – Fine Scale Vegetation Patterns

In this section, the different habitats and vegetation patterns observed within the study site are described. As these are field-based observations taken directly from the site, they are of greater reliability and pertinence than the results of the National Vegetation Map which is at a coarse scale and does not represent the detail of the site adequately. The habitat map derived for the study site is provided in Figure 7 and their sensitivity ratings are provided in Figure 8.

The vegetation of the study site resembles a severely modified and transformed form of Eastern Gariep Rocky Desert surrounded by mostly natural vegetation. Disturbances and modifications are mainly due to historical mining activities and access roads.

There was little variation in the plant communities present on site. The site is situated on the south-western slope of a rocky outcrop characterized by large quartzitic- gneiss- and Schist boulders and rocks with shallow to absent topsoils. Isolated pockets of deeper soils are present along this ridge and may allow for taller shrubs to persist. Most of the site has already been heavily transformed and disturbed as a result of past mining efforts, and vegetation in the disturbed areas specifically is very sparse. Ground truthing of the site confirmed that the vegetation of the site is relatively uniform overall, with little turnover across the site, which corroborates its classification as a single type.

As mentioned, the disturbed areas (comprising most of the proposed mining footprint) was very sparsely covered by vegetation, comprising of *Brownanthus cf. cilliatus, Acanthopsis disperma, Mesembryanthemum schenkii, Thesium aggregatum* and *Tribulus zeyheri*. Especially M. schenkii and B.cf. cilliatus were prominent within this disturbed area. The dominant plant species of the natural vegetation growing on the slope is *Euphorbia gregaria*, with scattered individuals of *Aloidendron dichotomum* (previously known as *Aloe dichotoma*), *Boscia albitrunca, B. foetida*. Various species of the family Aizoaceae, subfamily Mesembryanthemoideae, was found growing on the undisturbed slopes, of which *Schantesia ruedebuschii* and *Ruschia spinosa* were the most significant forming fairly large populations along this south-west facing slope. Also, worth mentioning was the observation of single species of the endemic shrub, *Ozoroa dispar* just outside of the highly disturbed area.

Even though, both access road options will traverse existing roads, resulting in a minimal impact on natural vegetation, some sections will have to be addressed in order for these roads to accommodate the movement of vehicles associated with the proposed mine.

» Access Road Option 1: The first 14km from the mine will traverse a farm road (mostly twin track) that haven't been used for a while and subsequently this road is in a poor state and some maintenance of the road will be necessary in order for this road to accommodate the movement of mining vehicles. Even though no sensitive flora was observed within the tracks / road, some sensitive tree and shrub species such as *Boscia albitrunca, B. foetida, Vachelia erioloba, Ozoroa dispar and Euclea pseudebenus* where recorded within close proximity to the road and may be potentially impacted if this portion of the road is upgraded.
» Access Road Option 2: The first 8km from the mine will traverse a narrow twin track which will also likely have to be addressed in order to accommodate vehicle movement associated with the proposed mine. Similarly, sensitive trees and shrubs such as *Boscia foetida, B. albitrunca and Aloidendron dichotomum* as well as some protected succulent species occur in close proximity and may potential be affected.

These mentioned species can be successfully avoided and it is recommended that following the final route selection a qualified Botanist should conduct a walk-through of the mentioned road sections, wherein all conservation important / sensitive flora is mapped.

From a floristic perspective both routes are acceptable if the above-mentioned mitigation measures are implemented.

Table 9: Summary of results for the Study Site.

Proposed Wortel Mine (Van Zyl Sillimanite Mine)	**Habitat Sensitivty**	**Low:** Proposed development Footprint, includig access roads	**Photographs:** 
		Medium: Surrounding natural vegetation	
	No-Go Areas	None identified	
	Present Ecological Status (PES)	**D: Largely Modified**	
Substrate	» South-western slope of a rocky outcrop » Soils poorly developed, shallow to absent. » Abundance of grit/gravel and larger stones		
Species richness	**Low: 31** Indigenous Species		
Alien Invasive Plants	**None recorded**		
Conservation Important Plants	*Boscia albitrunca, Aloidendron dichotomum, Ruschia spinosa, Mesembryanthemum schenkii, Schantesia ruedebuschii, Brownathus cf. cilliatus, Boscia foetida, Euphorbia gregaria, Euphorbia gariepina* ***No Red Data Species Recorded**		
Slope	» South-western slope of a rocky ridge		

	» Average slope: 31%		
Disturbance	**<u>Proposed mining Footprint</u>: Very High** » Severely altered landscape due to historical mining activities. » Very low to extremely sparse vegetation cover. **<u>Areas surrounding mining footprint</u>: Low** » Mostly natural and undisturbed appart from a few twin tracks and the larger access road to the old mining area.	**Naturalness:**	**<u>Proposed mining footprint:</u> Low** » Very low to extremely sparse vegetation cover. » Extremely little of the original, natural vegetation cover remain within the development site. **<u>Areas surrounding mining footprint</u>: High** » Mostly natural and undisturbed appart from a few twin tracks and the larger access road to the old mining area.
Habitat Integrity:	**<u>Proposed mining Footprint</u>: Low** » A large change in ecosystem processes and loss of natural habitat and biota and have occurred within the mining footprint. » However, this disturbed area covers a small persentage of the total surface of this rocky outcrop with most of the habitat integrity still intact.	**Biotic integrity**	» Proposed mining Footprint: Low » Significant habitat transformation due to historical mining activities » Loss of natural vegetation within this area » The result of this historical distubance is the local alteration and loss of available natural habitat, affecting local biodiversity. » However, this disturbed area covers a small persentage of the total surface of this rocky outcrop with most of the habitats still intact subsequently having little impact on the biotic integrity of this outcrop. » During the operation of the mine, disturbance and human movement within this area may periodically affect the faunal component, especially interms of 'shy' and senstivie species that will move away during the opperational phase. » Sufficient undisturbed, natural habitat exist within the area and subsequently this disturbance (within the earmarked footprint) will not have an impact on the biotic integrity of the larger surrounding landscape.
Anthropogenic importance and potential	**Agricultural Potential: Low**	**Conclusion and Mitigation Requirements**	» This area is of a low ecological sensitivity. » Development activities within this area are allowed. » Development activities within this area are unlikely to have a significant impact on regional ecological functionality. » Operational activities should be restricted to the development footprint as indicated within this study. » Pre-construction/operation Botanical walk-through should occur in order to GPS tag all conservation important species
Conservation value	**Moderate** » Eventhoug situated within a CBA2 the area is highly disturbed		

	» Situated outside of any NPAEs » Highly disturbed and transformed habitat. » No Red Data Species » Low level of protected species.		that may be at riks of being disturbed / destroyed by the mining activities. » No conservation important species may be re-located / disturbed or destroyed without the necessary Permits in plase (obtained from the relevant nature conservation authorities) » A vegetation rehabilitation and management plan is also vital for the stabilisatin of soils and the prevention of potential erosion from occuring or becoming exacerbated. » An invasive alien plant management plan should be compiled address the mitigation and management of such species throughout the operational phase as well as post-operational phase. » Rehabilitation progress, erosion and IAP monitoring can occur sumiltaniously post-operational phase and should occur bi-annual for a minimum of two years.
Ecosystem Functions	**Highly limited functions and services** » Potential niche habitats for fauna » Nich habitat for specific flora species » Small-scale moisture retention under rocks		

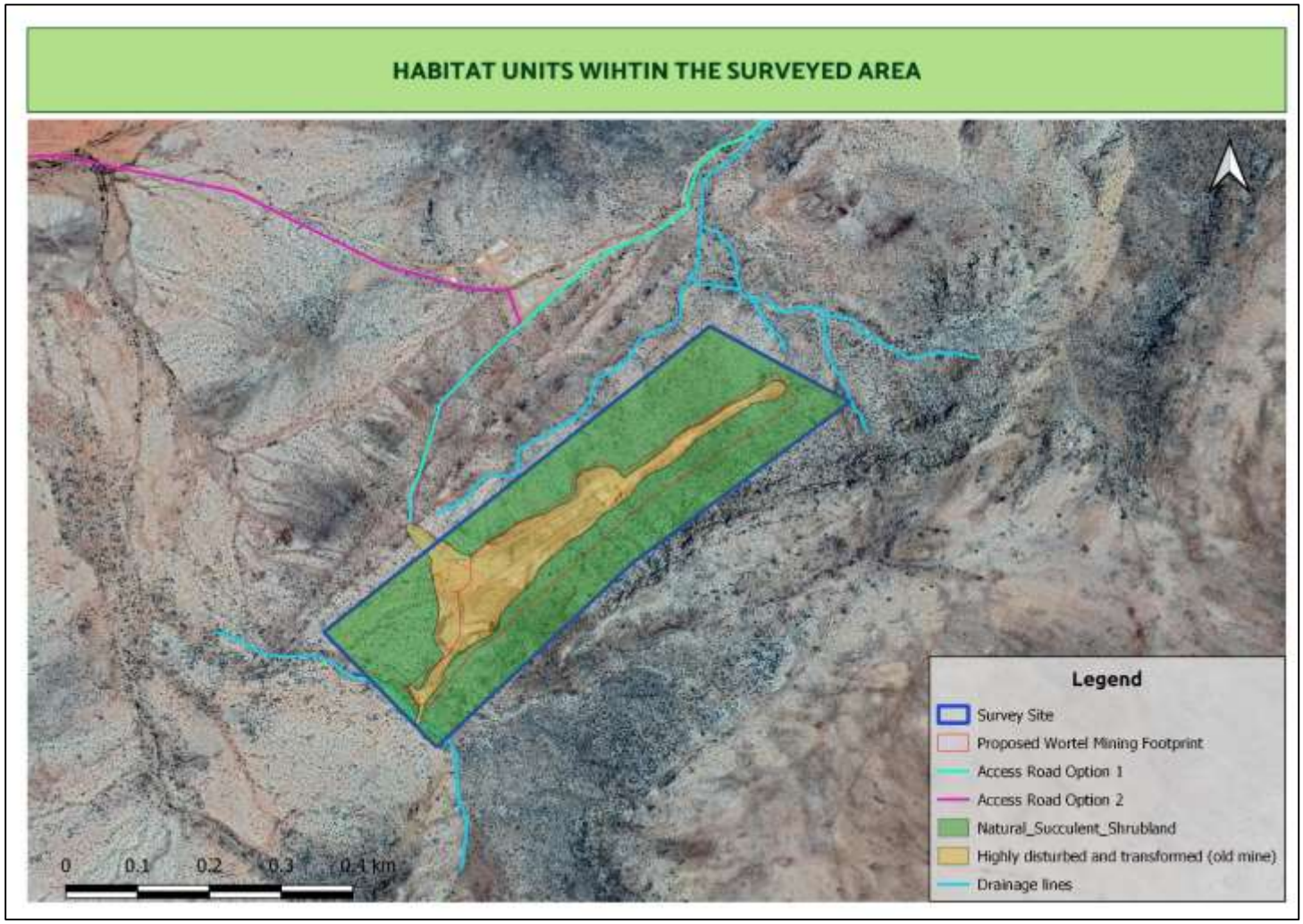

Figure 7: Map illustrating the habitat units identified within the survey site.

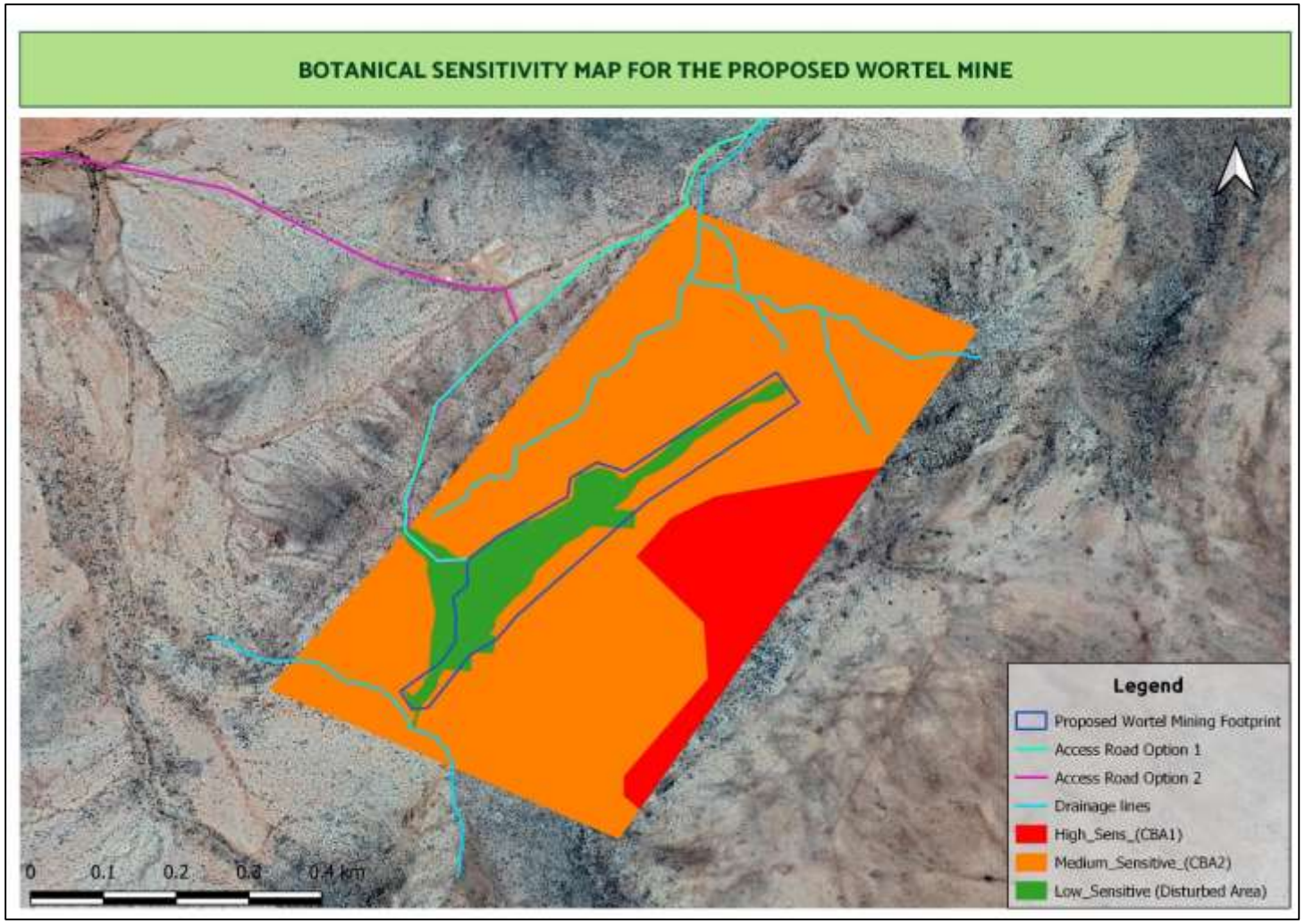

Figure 8: Map illustrating the botanical sensitivity of the project site.

5.2 Species of Conservation Concern

Species of conservation concern are species of flora (plants) and fauna (animals) that have a high conservation importance in terms of preserving South Africa's high biological diversity and include not only threatened species that have been classified as 'at high risk of extinction in the wild' (i.e. Critically Endangered CR, Endangered EN, Vulnerable VU), but also those classified in the categories Near Threatened (NT), Critically Rare, Rare, Declining and Data Deficient. Protected species are listed in international conventions, national acts and provincial ordinances that regulate activities such as the hunting, collection, and trade of species. If a subpopulation of a species of conservation concern is found to occur on a proposed development site, it would be one indicator that development activities could result in significant loss of biodiversity, bearing in mind that loss of subpopulations of these species will either increase their extinction risk or may, in fact, contribute to their extinction

5.2.1 Flora of conservation significance

As previously mentioned, a species list was obtained from the SANBI database (POSA) for the study area and surrounding environment. According to this list a total of about 32 plant species of conservation concern is known to occur in the broad area surrounding the site.

During the site survey no listed Red Data floral species were recorded within the surveyed site. A total of 9 species were however recorded which are protected within either National Forest Act or within the Northern Cape Nature Conservation Act. Refer to the table below for a list of these species.

Table 10: Conservation Important Flora Species recorded within the surveyed site. National Forest Act (NFA), Northern Cape Nature Conservation Act (NCNCA).

SPECIES	GROWTH FORM	STATUS
Aloidendron dichotomum	Small Succulent Tree	NCNCA, NFA
Boscia albitrunca	Small Tree	NFA, NCNCA
Boscia foetida	Small Tree	NCNCA
Brownanthus cf. cilliatus	Succulent Dwarf Shrub	NCNCA
Schwantesia ruedebuschii	Succulent Dwarf Shrub	NCNCA
Mesembryanthemum schenkii	Succulent Forb	NCNCA
Ruschia spinosa	Succulent Dwarf Shrub	NCNCA
Euphorbia gariepina	Succulent Shrub	NCNCA

Euphorbia gregaria	Succulent Shrub	NCNCA

6. ASSESSMENT OF PROPOSED IMPACTS

6.1 Assumptions

The following is assumed and/or known:

- » A thorough botanical walkthrough of all footprint areas will be conducted to detect and relocate, where possible, all plant species of conservation concern by a suitably qualified botanist prior to commencement of activities.
- » Throughout the duration of the mining activities, the footprint will be routinely cleared of all alien invasive plants if detected.
- » The site establishment itself will be associated with clearing of vegetation within the footprint only.
- » After decommissioning, a continuous vegetation layer will be the most important aspect of ecosystem functionality within and beyond the project site.
- A weakened or absent vegetation layer not only exposes the soil surface but also lacks the binding and absorption capacity that creates the buffering functionality of vegetation to prevent or lessen erosion as a result of floods.

6.2 Localised vs. cumulative impacts: some explanatory notes

Ecosystems consist of a mosaic of many different patches. The size of natural patches affects the number, type, and abundance of species they contain. At the periphery of patches, influences of neighbouring patches become apparent, known as the 'edge effect'. Patch edges may be subjected to increased levels of heat, dust, desiccation, disturbance, invasion of exotic species and other factors. Edges seldom contain species that are rare, habitat specialists or species that require larger tracts of undisturbed core habitat. Fragmentation due to development reduces core habitat and greatly extends edge habitat, which causes a shift in the species composition, which in turn puts great pressure on the dynamics and functionality of ecosystems (Perlman & Milder 2005).

Cumulative impacts of developments on population viability of species can be reduced significantly if new developments are kept as close as possible to existing developed and/or transformed areas or, where such is not possible, different sections of development be kept as close together as possible.

Due to the extent of this proposed mining footprint (smaller than 5 ha) as well as the location of the mining area within an already largely transformed and disturbed area along with the similar locations and sizes of the other proposed mining area (Wortel Mine) these mining activities will have a **very limited contribution** to the cumulative impacts of the area and will **not:**

» compromise the ecological functioning of the larger "natural" environment; and
» disrupt the connectivity of the landscape for fauna and flora and impair their ability to respond to environmental fluctuations.

Excessive clearing of vegetation can and will influence runoff and stormwater flow patterns and dynamics, which could cause excessive accelerated erosion of plains and intermittent drainage lines, and this could also have detrimental effects on the lower-lying areas.

- Rehabilitation and revegetation of all surfaces disturbed or altered during the operational phase are desirable.

Disturbance of indigenous vegetation creates a major opportunity for the establishment of invasive species and the uncontrolled spread of alien invasives into adjacent rangelands.

» A regular monitoring and eradication protocol must be part of all the developments' long-term management plans.

After decommissioning, a continuous vegetation layer will be the most important aspect of ecosystem functionality within and beyond the project site.

- A weakened or absent vegetation layer not only exposes the soil surface but also lacks the binding and absorption capacity that creates the buffering functionality of vegetation to prevent or lessen erosion as a result of floods.

6.3 Identification of Potential Botanical Impacts and Associated Activities

Potential botanical impacts resulting from the proposed project would stem from a variety of different activities and risk factors associated with the site-establishment and operation phases of the project including the following:

6.3.1 Site-establishment and Operational Phase

- Human presence and uncontrolled access to the site may result in negative impacts on fauna and flora through poaching of fauna and uncontrolled collection of plants for traditional medicine or other purposes.
- Site clearing and exploration activities for site establishment.
- Vegetation clearing could impact locally listed plant species. Vegetation clearing would also lead to the loss of vegetation communities and habitats for fauna and potentially the loss of faunal species, habitats, and ecosystems. On a larger and cumulative scale (if numerous and uncontrolled developments are allowed to occur in the future) the loss of these vegetation communities and habitats may potentially lead to a change in the conservation status of the affected vegetation type as well as the ability of this vegetation type and associated features to fulfil its ecological responsibilities (functions).
- Soil compaction and increased erosion risk would occur due to the loss of plant cover and soil disturbance created during the construction phase. This may potentially impact the downstream watercourses and aquatic habitats. These potential impacts may result in a reduction in the buffering capacities of the landscape during extreme weather events.
- Invasion by alien plants may be attributed to excessive disturbance to vegetation, creating a window of opportunity for the establishment of these alien invasive species. In addition, regenerative material of alien invasive species may be introduced to the project site by machinery traversing through areas with such plants or materials that may contain regenerative materials of such species.
- Presence and operation of mining vehicles and machinery on the project site. This will create a physical impact as well as generate noise, potential pollution and other forms of disturbances at the site.
- The facility will require management and if this is not done effectively, it could impact adjacent intact areas through impacts such as erosion and the invasion of alien plant species.

6.3.2 Cumulative Impacts

- The loss of unprotected vegetation types on a cumulative basis from the broad area may impact the country's ability to meet its conservation targets.
- Transformation of intact habitat would contribute to the fragmentation of the landscape and would potentially disrupt the connectivity of the landscape for fauna, avifauna, and flora and impair their ability to respond to environmental fluctuations.

6.4 Assessment of Impacts

The impacts identified above are assessed below, during the site-establishment and operation phases of the facility as well as before and after mitigation.

6.4.1 Assessment of impacts associated with Site-establishment and Operational Phases

Impact 1: *Potential Impacts on vegetation and listed and protected plant species*

Impact Nature: Vegetation clearing will lead to the loss of current habitat within the proposed mining footprint and is an inevitable consequence of this type of activity. The extent of this mining footprint is however very small (<5ha) and the vegetation type within the affected area has a relatively widespread distribution, subsequently the loss of local vegetation within the mining footprint would be of relatively minor significance when considered at a broad scale. Furthermore, protected plant species within the mining footprint would also be impacted.		
	Without Mitigation	**With Mitigation**
Extent	Local (1)	Local (1)
Duration	Permanent (5)	Long-term (4)
Magnitude	Minor (2)	Minor (1)
Probability	Definite (5)	Highly Probable (4)
Significance	**Medium (40)**	**Low (24)**
Status	Negative	Negative
Reversibility	Low	Low
Irreplaceable loss of resources	Unlikely	Unlikely
Can impacts be mitigated?	Reasonably but with limited full restoration potential.	
Residual Impacts	Very limited in extent (**Not Significant**): » Likely in the form of an altered vegetation cover.	

Impact 2: *Potential increased erosion risk during and post-operational phase*

Impact Nature: During the operational phase, there will be a lot of disturbed and loose soil at the site which will render the area vulnerable to erosion. It is critically important that proper erosion control measures and structures are put in place and maintained over the lifespan of the project.		
	Without Mitigation	**With Mitigation**
Extent	Local and immediate surroundings (2)	Local (1)
Duration	Long-term (4)	Short-term (1)

Magnitude	Low (4)	Minor (3)
Probability	Definite (5)	Probable (3)
Significance	**Medium (50)**	**Low (15)**
Status	Negative	Negative
Reversibility	Moderate	High
Irreplaceable loss of resources	Moderate potential	Unlikely
Can impacts be mitigated?	Yes, to a large extent	
Residual Impacts	The loss of fertile soil and soil capping resulting in areas that cannot fully rehabilitate itself with a good vegetation cover. With appropriate avoidance and mitigation, residual impacts will be **very low on existing natural areas**.	

Impact 3: *Increased alien plant invasion during the operational phase*

Impact Nature: Increased alien plant invasion is one of the greatest risk factors associated with this activity. The disturbed and bare ground that is likely to be present at the site during and after the operational phase would leave the site vulnerable to alien plant invasion during the operation phase if not managed. Furthermore, the National Environmental Management Biodiversity Act (Act No. 10 of 2004), as well as the Conservation of Agricultural Resources Act, (Act No. 43 of 1983) requires that listed alien species are controlled in accordance with the Act.		
	Without Mitigation	**With Mitigation**
Extent	Local and immediate surroundings (2)	Local (1)
Duration	Permanent (5)	Short-term (1)
Magnitude	Moderate (6)	Minor (2)
Probability	Highly Probable (4)	Probable (3)
Significance	**Medium (52)**	**Low (12)**
Status	Negative	Negative
Reversibility	Moderate	High
Irreplaceable loss of resources	Low Probability	Unlikely
Can impacts be mitigated?	Yes, to a large extent	
Residual Impacts	With appropriate mitigation such as regular monitoring and eradication residual impacts will be **very low** and will likely comprise of few alien plants establishing for short periods of time between monitoring and eradication phases.	

6.4.2 Assessment of Cumulative Impacts

Cumulative Impact 1: *Reduced ability to meet conservation obligations and targets*

Impact Nature: The loss of unprotected vegetation types on a cumulative basis from the broader area impacts the Province's ability to meet its conservation targets.		
	Overall impact of the proposed project considered in isolation	**Cumulative impact of the project and other projects within the area**
Extent	Local (1)	Regional (2)
Duration	Long Term (4)	Long-Term (4)
Magnitude	Small (0)	Minor (2)
Probability	Very Improbable (1)	Highly Improbable (2)
Significance	**Low (5)**	**Low (16)**
Status	Neutral	Slightly Negative
Reversibility	Low	Low
Irreplaceable loss of resources	Highly unlikely	Unlikely
Can impacts be mitigated?	Yes, to a large extent	

Cumulative Impact 2: *Impacts on Broad-Scale Ecological Processes*

Impact Nature: Transformation of intact habitat could potentially compromise ecological processes as well as ecological functioning of important habitats and would contribute to the fragmentation of the landscape and would potentially disrupt the connectivity of the landscape for fauna and flora and impair their ability to respond to environmental fluctuations.		
	Overall impact of the proposed project considered in isolation	**Cumulative impact of the project and other projects within the area**
Extent	Local (1)	Regional (2)
Duration	Long Term (4)	Long-Term (4)
Magnitude	Small (0)	Minor (2)
Probability	Very Improbable (1)	Highly Improbable (2)
Significance	**Low (5)**	**Low (16)**
Status	Neutral	Slightly Negative
Reversibility	Low	Low

Irreplaceable loss of resources	Highly unlikely	Unlikely
Can impacts be mitigated?	Yes, to a large extent	

Cumulative Impact 3: *Cumulative impacts due to other mines within the greater surroundings - Large-scale disturbance of indigenous vegetation*

Impact Nature: Cumulative loss of habitats (including sensitive habitats) and an increase in the fractured nature of the landscape may lead to the loss of features responsible for maintaining biodiversity and providing ecosystem goods and services and may potentially lead to; » A change in the status of the affected vegetation type, subsequently also reducing the ability to meet national conservation obligations and targets; » A reduction in biodiversity and even the loss of some species from the area; » Fracturing and isolation of landscapes may cut off important migration routes and prevent genetic variability thus reducing "genetic health" which may, in turn, lead to weaker species incapable to adapt and react to potential environmental changes and consequently also to a reduction in biodiversity and the extinction of some species from certain areas; » Large-scale disturbance of indigenous vegetation creates a major opportunity for the establishment of invasive species and the uncontrolled spread of alien invasives into adjacent agricultural land and rangelands.		
	Overall impact of the proposed project considered in isolation	**Cumulative impact of the project and other projects within the area**
Extent	Local (1)	Regional (2)
Duration	Long Term (4)	Long Term (4)
Magnitude	Small (0)	Minor (1)
Probability	Highly Improbable (1)	Improbable (2)
Significance	**Low (5)**	**Low (14)**
Status	Neutral to slightly negative	Slightly Negative
Reversibility	Low	Low
Irreplaceable loss of resources	Unlikely	Low Probability
Can impacts be mitigated?	Yes, to a large extent	

6.5 Impact Mitigation and Management

IMPACT	MITIGATION
Site-Establishment and Operation Phase	
Impact 1: Potential Impacts on vegetation and listed and protected plant species	» Pre-construction walk-through of the final mining footprint, by a suitably qualified botanist, for species of conservation concern that would be affected (also to comply with the Northern Cape Nature Conservation Act and DENC/DAFF permit conditions). » Pre-construction walk-through should also be conducted of the final access route with emphasis on the areas of the route that will traverse narrow twin tracks and areas that will have to be upgraded. » Permits must be kept on-site and in the possession of the flora search and rescue team at all times. » Pre-construction environmental induction for all staff on site must be provided to ensure that basic environmental principles are adhered to. This includes awareness of no littering, appropriate handling of pollution and chemical spills, avoiding fire hazards, minimising wildlife interactions, remaining within demarcated construction areas, etc. » Contractor's EO must provide supervision and oversight of vegetation clearing activities and other activities which may cause damage to the environment, especially at the initiation of the project, when the majority of vegetation clearing is taking place. » Blanket clearing of vegetation must be limited to the proposed mining footprint and associated infrastructure. No clearing outside of the minimum required footprint to take place. » Topsoil must be stripped and stockpiled separately during site preparation and replaced over disturbed areas on completion » Ensure that laydown areas, construction camps, and other temporary use areas are located in areas of low sensitivity and are properly fenced or demarcated as appropriate and practically possible. » All vehicles to remain on demarcated roads and no unnecessary driving in the veld outside these areas should be allowed. » Regular dust suppression during operation. » No plants may be translocated or otherwise uprooted or disturbed for rehabilitation or other purposes without express permission from the Contractor's EO and without the relevant permits. » No fires must be allowed on-site. » After the operation, rehabilitate an acceptable vegetation layer according to rehabilitation recommendations as provided within a site-specific Rehabilitation Plan compiled by a suitably qualified botanist

	○ Revegetation should occur naturally where topsoils were not severely altered
Impact 3: Potential increased erosion risk during and post-operational phase	» Any erosion problems within the borrow pit area as a result of the mining activities observed should be rectified immediately and monitored thereafter to ensure that they do not re-occur. » Mining within steep slopes will need to ensure that adequate slope protection is provided. » All bare areas resulting from the development should be re-vegetated, post-operation, with locally occurring species, to bind the soil and limit erosion potential. » Roads and other disturbed areas within the project area should be regularly monitored for erosion problems and problem areas should receive follow-up monitoring to assess the success of the remediation. » Silt/sediment traps/barriers should be used where there is a danger of topsoil or material stockpiles eroding and entering downstream drainage lines and other sensitive areas. » These sediment/silt barriers should be regularly maintained and cleared so as to ensure effective drainage of the areas » Topsoil should be removed and stored separately from subsoil. Topsoil should be reapplied where appropriate as soon as possible in order to encourage and facilitate rapid regeneration of the natural vegetation on cleared areas. » Stockpiles must be protected from erosion, stored on flat areas where possible, and be surrounded by appropriate berms. » Any erosion points created during construction should be filled and stabilized immediately. » Practical phased development and vegetation clearing should be practiced so that cleared areas are not left un-vegetated and vulnerable to erosion for extended periods of time. » Construction of gabions and other stabilisation features must be undertaken to prevent erosion, where deemed necessary.
Impact 5: Increased alien plant invasion during the operational phase	» Alien species must be removed from the site as per NEMBA requirements. » A suitable weed management strategy to be implemented in the construction and operation phases. » Regular monitoring for alien plants at the site should occur and could be conducted simultaneously with erosion monitoring. » When alien plants are detected, these should be controlled and cleared using the recommended control measures for each species to ensure that the problem is not exacerbated or does not re-occur and increase to problematic levels.

	» Clearing methods should aim to keep disturbance to a minimum and must be undertaken in accordance with relevant guidelines. » No planting or importing of any alien species to the site for landscaping, rehabilitation or any other purpose should be allowed.
Cumulative Impacts	
Cumulative Impact 1: Reduced ability to meet conservation obligations and targets	» The activity footprints of various proposed mining locations in the area must be kept to a minimum and natural vegetation should be encouraged to return during the post-operational phase. » Reduce the footprint of mining areas within sensitive habitat types as much as possible.
Cumulative Impact 2: Impacts on Broad-Scale Ecological Processes	» The footprints of the individual mining areas should be kept to a minimum and natural vegetation should be encouraged to return to disturbed areas post-operational phase. » Reduce the footprint of mining areas within sensitive habitat types as much as possible.
Cumulative Impact 3: Cumulative impacts due to upgrade of roads and nearby borrow pits - Large-scale disturbance of indigenous vegetation	» The footprints of the individual mining areas should be kept to a minimum and natural vegetation should be encouraged to return to disturbed areas post-operational phase. » Reduce the footprint of mining areas within sensitive habitat types as much as possible.

7. CONCLUSION

The proposed mining footprint will be approximately 5 ha in extent and will be located within Portion 1 of the Farm Wortel 42.

The proposed mining footprint is mostly located within the existing footprint of the historical mining area and subsequently within an already disturbed and transformed location.

The study area is situated in the Desert biome. The vegetation type covering the study area is Eastern Gariep Rocky Desert which is listed as Least Concern by Mucina and Rutherford (2012) and is furthermore not listed within the Threatened Ecosystem List (NEM:BA). Furthermore, the study site itself is located outside of any CBAs and / ESAs according to the Northern Cape CBA Spatial Data.

It is highly unlikely that this development will have an impact on the status of the Ecosystem and Vegetation Types due to the limited extent of the mine as well as the presence of already disturbed areas within the footprint. Furthermore, this mine will not have a significant impact on the services and functions provided by the surrounding natural habitats and development within this area is regarded as acceptable.

In terms of local-level biodiversity, the site is not exceptional and the site is not highly sensitive in this regard, as there are no unique, threatened of otherwise unique habitats present which are not widely available in the wider landscape. As a result, the majority of impacts associated with the development of the site are likely to be local in nature and not of wider significance. Although there are a number of nationally or provincially protected species at the site, none of these are rare and the loss of the affected individuals from the development footprint would not be of wider significance or compromise the viability of the local populations of these species.

In terms of the likely botanical impacts associated with the mine, impacts on vegetation during the operation phase are likely to be relatively moderate (rated mostly as medium significance prior to mitigation) and are difficult to mitigate as little can be done to avoid the large amounts of disturbance associated with this phase of the development. As the affected vegetation type is relatively widespread and the footprint area is regarded as limited in extent and placed within an already, largely transformed and disturbed area, the impact on vegetation, as already mentioned, is likely to be of locally high intensity but is not considered to be of broader significance. Potential cumulative impacts are also furthermore regarded

limited and of low significance due to small footprint sizes of all the proposed borrow pits as well as the location of these borrow pits within largely transformed and disturbed habitats.

Subsequently the proposed development area is largely well located in terms of avoiding sensitive receptors and the development will not compromise the survival of any specific flora or terrestrial vertebrate species on the study area or beyond if mitigation measures are fully implemented.

From a botanical perspective, no objective or motives (identification of impacts of high significance, etc.) were identified which would hinder the establishment of the proposed mine. Activities and Impacts are regarded as acceptable from a botanical perspective and will not cause detrimental impacts to the local flora, located within the affected area and surroundings. Therefore, it is the opinion of the specialist that the development may be authorised, subject to the implementation of the recommended mitigation measures.

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9. APPENDICES

Appendix 1: Plant Species List of the mining footprint and immediate surroundings

Family	Species
Acanthaceae	Acanthopsis disperma
Acanthaceae	Blepharis furcata
Acanthaceae	Blepharis macra
Aizoaceae	Mesembryanthemum schenkii
Aizoaceae	Ruschia spinosa
Aizoaceae	Schwantesia ruedebuschii
Aizoaceae	Brownanthus (cilliatus)
Amaranthaceae	Salsola aphylla
Asphodelaceae	Aloidendron dichotomum
Asteraceae	Berkheya spinosissima
Asteraceae	Eriocephalus ericoides
Asteraceae	Eriocephalus merxmuelleri
Asteraceae	Pentzia sp.
Asteraceae	Pteronia scariosa
Bignoniaceae	Rhigozum trichotomum
Capparaceae	Boscia albitrunca
Capparaceae	Boscia foetida
Capparaceae	Cadaba aphylla
Crassulaceae	Cotyledon orbiculata
Euphorbiaceae	Euphorbia gariepina
Euphorbiaceae	Euphorbia gregaria
Kewaceae	Kewa salsoloides
Limeaceae	Limeum aethiopicum
Malvaceae	Abutilon austro-africanum
Poaceae	Eragrostis trichophora
Poaceae	Stipagrostis obtusa
Santalaceae	Thesium aggregatum
Scrophulariaceae	Aptosimum spinescens
Zygophyllaceae	Tetraena retrofracta
Zygophyllaceae	Tribulus zeyheri
Anacardiaceae	Ozoroa dispar

Appendix 2: Plant Species List of the region (POSA Generated List)

Species in bold are those that were confirmed within the surveyed site

Family	Species	Family	Species
Acanthaceae	***Acanthopsis disperma***	Crassulaceae	*Crassula corallina*
Acanthaceae	*Acanthopsis hoffmannseggiana*	Crassulaceae	*Crassula cotyledonis*
Acanthaceae	*Acanthopsis villosa*	Crassulaceae	*Crassula decumbens*
Acanthaceae	*Barleria lichtensteiniana*	Crassulaceae	*Crassula deltoidea*
Acanthaceae	*Barleria papillosa*	Crassulaceae	*Crassula elegans*
Acanthaceae	*Barleria rigida*	Crassulaceae	*Crassula exilis*
Acanthaceae	*Barleria sp.*	Crassulaceae	*Crassula garibina*
Acanthaceae	***Blepharis furcata***	Crassulaceae	*Crassula grisea*
Acanthaceae	***Blepharis macra***	Crassulaceae	*Crassula macowaniana*
Acanthaceae	*Blepharis mitrata*	Crassulaceae	*Crassula mesembrianthemopsis*
Acanthaceae	*Blepharis sp.*	Crassulaceae	*Crassula muscosa*
Acanthaceae	*Justicia australis*	Crassulaceae	*Crassula namaquensis*
Acanthaceae	*Justicia divaricata*	Crassulaceae	*Crassula sericea*
Acanthaceae	*Justicia dregei*	Crassulaceae	*Crassula sp.*
Acanthaceae	*Justicia guerkeana*	Crassulaceae	*Crassula subaphylla*
Acanthaceae	*Justicia incana*	Crassulaceae	*Crassula tabularis*
Acanthaceae	*Justicia leucoderme*	Crassulaceae	*Crassula tenuipedicellata*
Acanthaceae	*Justicia saxatilis*	Crassulaceae	*Crassula thunbergiana*
Acanthaceae	*Justicia spartioides*	Crassulaceae	*Crassula tomentosa*
Acanthaceae	*Justicia thymifolia*	Crassulaceae	*Crassula whiteheadii*
Acanthaceae	*Petalidium setosum*	Crassulaceae	*Tylecodon racemosus*
Acanthaceae	*Petalidium sp.*	Crassulaceae	*Tylecodon reticulatus*
Agavaceae	*Chlorophytum sp.*	Crassulaceae	*Tylecodon rubrovenosus*
Aizoaceae	*Aizoon asbestinum*	Crassulaceae	*Tylecodon sp.*
Aizoaceae	*Aizoon burchellii*	Crassulaceae	*Tylecodon sulphureus*
Aizoaceae	*Aizoon canariense*	Cucurbitaceae	*Coccinia rehmannii*
Aizoaceae	*Amphibolia rupis-arcuatae*	Cucurbitaceae	*Corallocarpus dissectus*
Aizoaceae	*Antimima hantamensis*	Cucurbitaceae	*Cucumis africanus*
Aizoaceae	*Antimima nordenstamii*	Cucurbitaceae	*Cucumis sagittatus*
Aizoaceae	*Antimima papillata*	Cucurbitaceae	*Kedrostis africana*

Family	Species	Family	Species
Aizoaceae	*Antimima sp.*	Cucurbitaceae	*Kedrostis capensis*
Aizoaceae	*Antimima tuberculosa*	Cucurbitaceae	*Trochomeria debilis*
Aizoaceae	*Antimima vanzylii*	Cyperaceae	*Afroscirpoides dioeca*
Aizoaceae	*Cephalophyllum fulleri*	Cyperaceae	*Cyperus bellus*
Aizoaceae	*Cephalophyllum parvibracteatum*	Cyperaceae	*Cyperus indecorus*
Aizoaceae	*Cephalophyllum sp.*	Cyperaceae	*Cyperus laevigatus*
Aizoaceae	*Cephalophyllum staminodiosum*	Cyperaceae	*Cyperus marginatus*
Aizoaceae	*Cheiridopsis denticulata*	Cyperaceae	*Fimbristylis bisumbellata*
Aizoaceae	*Cheiridopsis derenbergiana*	Cyperaceae	*Isolepis hemiuncialis*
Aizoaceae	*Cheiridopsis schlechteri*	Ebenaceae	*Diospyros acocksii*
Aizoaceae	*Conicosia elongata*	Ebenaceae	*Diospyros lycioides*
Aizoaceae	*Conophytum achabense*	Ebenaceae	*Diospyros ramulosa*
Aizoaceae	*Conophytum angelicae*	Ebenaceae	*Diospyros sp.*
Aizoaceae	*Conophytum blandum*	Ebenaceae	*Euclea crispa*
Aizoaceae	*Conophytum calculus*	Ebenaceae	*Euclea pseudebenus*
Aizoaceae	*Conophytum flavum*	Ebenaceae	*Euclea sp.*
Aizoaceae	*Conophytum friedrichiae*	Ebenaceae	*Euclea undulata*
Aizoaceae	*Conophytum fulleri*	Elatinaceae	*Bergia anagalloides*
Aizoaceae	*Conophytum limpidum*	Equisetaceae	*Equisetum ramosissimum*
Aizoaceae	*Conophytum lithopsoides*	Euphorbiaceae	*Euphorbia braunsii*
Aizoaceae	*Conophytum longum*	Euphorbiaceae	*Euphorbia dregeana*
Aizoaceae	*Conophytum lydiae*	Euphorbiaceae	*Euphorbia exilis*
Aizoaceae	*Conophytum marginatum*	**Euphorbiaceae**	***Euphorbia gariepina***
Aizoaceae	*Conophytum maughanii*	Euphorbiaceae	*Euphorbia gariepina*
Aizoaceae	*Conophytum pageae*	Euphorbiaceae	*Euphorbia glanduligera*
Aizoaceae	*Conophytum pellucidum*	**Euphorbiaceae**	***Euphorbia gregaria***
Aizoaceae	*Conophytum praesectum*	Euphorbiaceae	*Euphorbia inaequilatera*
Aizoaceae	*Conophytum smorenskaduense*	Euphorbiaceae	*Euphorbia mauritanica*
Aizoaceae	*Conophytum sp.*	Euphorbiaceae	*Euphorbia namaquensis*
Aizoaceae	*Conophytum subfenestratum*	Euphorbiaceae	*Euphorbia phylloclada*
Aizoaceae	*Conophytum vanheerdei*	Euphorbiaceae	*Euphorbia rhombifolia*
Aizoaceae	*Conophytum verrucosum*	Euphorbiaceae	*Euphorbia serpens*
Aizoaceae	*Dinteranthus wilmotianus*	Euphorbiaceae	*Euphorbia sp.*
Aizoaceae	*Drosanthemum albens*	Euphorbiaceae	*Euphorbia spartaria*

Family	Species	Family	Species
Aizoaceae	*Drosanthemum breve*	Euphorbiaceae	*Euphorbia spinea*
Aizoaceae	*Drosanthemum fulleri*	Euphorbiaceae	*Euphorbia virosa*
Aizoaceae	*Drosanthemum godmaniae*	Euphorbiaceae	*Jatropha orangeana*
Aizoaceae	*Drosanthemum hispidum*	Fabaceae	*Adenolobus garipensis*
Aizoaceae	*Drosanthemum intermedium*	Fabaceae	*Bauhinia bowkeri*
Aizoaceae	*Drosanthemum karrooense*	Fabaceae	*Calobota angustifolia*
Aizoaceae	*Drosanthemum latipetalum*	Fabaceae	*Calobota sericea*
Aizoaceae	*Drosanthemum luederitzii*	Fabaceae	*Calobota spinescens*
Aizoaceae	*Drosanthemum praecultum*	Fabaceae	*Crotalaria excisa*
Aizoaceae	*Drosanthemum sp.*	Fabaceae	*Crotalaria meyeriana*
Aizoaceae	*Drosanthemum subclausum*	Fabaceae	*Crotalaria pearsonii*
Aizoaceae	*Drosanthemum subcompressum*	Fabaceae	*Crotalaria sp.*
Aizoaceae	*Eberlanzia ebracteata*	Fabaceae	*Crotalaria virgultalis*
Aizoaceae	*Ebracteola fulleri*	Fabaceae	*Cullen tomentosum*
Aizoaceae	*Galenia collina*	Fabaceae	*Cyamopsis serrata*
Aizoaceae	*Galenia crystallina*	Fabaceae	*Dichilus pilosus*
Aizoaceae	*Galenia meziana*	Fabaceae	*Indigastrum argyroides*
Aizoaceae	*Galenia namaensis*	Fabaceae	*Indigastrum niveum*
Aizoaceae	*Galenia papulosa*	Fabaceae	*Indigofera alternans*
Aizoaceae	*Galenia rigida*	Fabaceae	*Indigofera auricoma*
Aizoaceae	*Galenia sarcophylla*	Fabaceae	*Indigofera evansiana*
Aizoaceae	*Galenia secunda*	Fabaceae	*Indigofera heterotricha*
Aizoaceae	*Galenia sp.*	Fabaceae	*Indigofera hololeuca*
Aizoaceae	*Galenia squamulosa*	Fabaceae	*Indigofera meyeriana*
Aizoaceae	*Hereroa hesperantha*	Fabaceae	*Indigofera nudicaulis*
Aizoaceae	*Hereroa pallens*	Fabaceae	*Indigofera pungens*
Aizoaceae	*Hereroa sp.*	Fabaceae	*Indigofera sordida*
Aizoaceae	*Ihlenfeldtia excavata*	Fabaceae	*Indigofera sp.*
Aizoaceae	*Ihlenfeldtia vanzylii*	Fabaceae	*Leobordea oligocephala*
Aizoaceae	*Lampranthus godmaniae*	Fabaceae	*Leobordea platycarpa*
Aizoaceae	*Lampranthus otzenianus*	Fabaceae	*Lessertia depressa*
Aizoaceae	*Lapidaria margaretae*	Fabaceae	*Lessertia diffusa*
Aizoaceae	*Leipoldtia laxa*	Fabaceae	*Lessertia frutescens*
Aizoaceae	*Leipoldtia schultzei*	Fabaceae	*Lessertia incana*

Family	Species	Family	Species
Aizoaceae	*Leipoldtia sp.*	Fabaceae	*Lessertia macrostachya*
Aizoaceae	*Lithops dinteri*	Fabaceae	*Lessertia pauciflora*
Aizoaceae	*Lithops julii*	Fabaceae	*Lessertia sp.*
Aizoaceae	*Lithops olivacea*	Fabaceae	*Lotononis falcata*
Aizoaceae	*Lithops sp.*	Fabaceae	*Lotononis fruticoides*
Aizoaceae	*Malephora lutea*	Fabaceae	*Lotononis parviflora*
Aizoaceae	*Mesembryanthemum amplectens*	Fabaceae	*Lotononis rabenaviana*
Aizoaceae	*Mesembryanthemum arenosum*	Fabaceae	*Lotononis sp.*
Aizoaceae	*Mesembryanthemum articulatum*	Fabaceae	*Lotononis sparsiflora*
Aizoaceae	*Mesembryanthemum coriarium*	Fabaceae	*Melolobium adenodes*
Aizoaceae	*Mesembryanthemum crystallinum*	Fabaceae	*Melolobium candicans*
Aizoaceae	*Mesembryanthemum delum*	Fabaceae	*Melolobium canescens*
Aizoaceae	*Mesembryanthemum dinteri*	Fabaceae	*Melolobium microphyllum*
Aizoaceae	*Mesembryanthemum exalatum*	Fabaceae	*Microcharis disjuncta*
Aizoaceae	*Mesembryanthemum excavatum*	Fabaceae	*Parkinsonia africana*
Aizoaceae	*Mesembryanthemum gariusanum*	Fabaceae	*Pomaria lactea*
Aizoaceae	*Mesembryanthemum guerichianum*	Fabaceae	*Prosopis glandulosa*
Aizoaceae	*Mesembryanthemum inachabense*	Fabaceae	*Prosopis pubescens*
Aizoaceae	*Mesembryanthemum latipetalum*	Fabaceae	*Prosopis sp.*
Aizoaceae	*Mesembryanthemum lignescens*	Fabaceae	*Prosopis velutina*
Aizoaceae	*Mesembryanthemum nitidum*	Fabaceae	*Ptycholobium biflorum*
Aizoaceae	*Mesembryanthemum noctiflorum*	Fabaceae	*Requienia sphaerosperma*
Aizoaceae	*Mesembryanthemum nodiflorum*	Fabaceae	*Rhynchosia schlechteri*
Aizoaceae	*Mesembryanthemum nucifer*	Fabaceae	*Rhynchosia totta*
Aizoaceae	*Mesembryanthemum oculatum*	Fabaceae	*Schotia afra*
Aizoaceae	*Mesembryanthemum quartziticola*	Fabaceae	*Senegalia mellifera*
Aizoaceae	***Mesembryanthemum schenkii***	Fabaceae	*Tephrosia dregeana*
Aizoaceae	*Mesembryanthemum sp.*	Fabaceae	*Tephrosia limpopoensis*
Aizoaceae	*Mesembryanthemum subnodosum*	Fabaceae	*Trigonella anguina*
Aizoaceae	*Mesembryanthemum tetragonum*	Fabaceae	*Vachellia erioloba*
Aizoaceae	*Phyllobolus sp.*	Fabaceae	*Vachellia karroo*

Family	Species	Family	Species
Aizoaceae	*Ruschia aggregata*	Fabroniaceae	*Fabronia sp.*
Aizoaceae	*Ruschia barnardii*	Frankeniaceae	*Frankenia pulverulenta*
Aizoaceae	*Ruschia brakdamensis*	Funariaceae	*Funaria clavata*
Aizoaceae	*Ruschia centrocapsula*	Funariaceae	*Goniomitrium africanum*
Aizoaceae	*Ruschia cradockensis*	Gentianaceae	*Orphium frutescens*
Aizoaceae	*Ruschia divaricata*	Gentianaceae	*Sebaea pentandra*
Aizoaceae	*Ruschia kenhardtensis*	Geraniaceae	*Monsonia ciliata*
Aizoaceae	*Ruschia muricata*	Geraniaceae	*Monsonia crassicaulis*
Aizoaceae	*Ruschia robusta*	Geraniaceae	*Monsonia glauca*
Aizoaceae	***Ruschia spinosa***	Geraniaceae	*Monsonia parvifolia*
Aizoaceae	*Ruschia uncinata*	Geraniaceae	*Monsonia spinosa*
Aizoaceae	*Schlechteranthus albiflorus*	Geraniaceae	*Monsonia umbellata*
Aizoaceae	*Schlechteranthus pungens*	Geraniaceae	*Pelargonium carnosum*
Aizoaceae	*Schlechteranthus stylosus*	Geraniaceae	*Pelargonium crithmifolium*
Aizoaceae	*Schwantesia marlothii*	Geraniaceae	*Pelargonium pulchellum*
Aizoaceae	*Schwantesia pillansii*	Geraniaceae	*Pelargonium sp.*
Aizoaceae	***Schwantesia ruedebuschii***	Geraniaceae	*Pelargonium spinosum*
Aizoaceae	*Schwantesia sp.*	Geraniaceae	*Pelargonium xerophyton*
Aizoaceae	*Schwantesia triebneri*	Gigaspermaceae	*Chamaebryum pottioides*
Aizoaceae	*Stomatium fulleri*	Gisekiaceae	*Gisekia africana*
Aizoaceae	*Tetragonia acanthocarpa*	Hyacinthaceae	*Albuca cooperi*
Aizoaceae	*Tetragonia arbuscula*	Hyacinthaceae	*Albuca glandulifera*
Aizoaceae	*Tetragonia microptera*	Hyacinthaceae	*Albuca namaquensis*
Aizoaceae	*Tetragonia reduplicata*	Hyacinthaceae	*Albuca setosa*
Aizoaceae	*Tetragonia sp.*	Hyacinthaceae	*Albuca sp.*
Aizoaceae	*Titanopsis hugo-schlechteri*	Hyacinthaceae	*Albuca spiralis*
Aizoaceae	*Trianthema parvifolia*	Hyacinthaceae	*Albuca suaveolens*
Aizoaceae	*Trianthema sp.*	Hyacinthaceae	*Bowiea volubilis*
Aizoaceae	*Trichodiadema littlewoodii*	Hyacinthaceae	*Daubenya namaquensis*
Aizoaceae	*Trichodiadema obliquum*	Hyacinthaceae	*Dipcadi gracillimum*
Aizoaceae	*Trichodiadema setuliferum*	Hyacinthaceae	*Drimia intricata*
Aizoaceae	*Trichodiadema sp.*	Hyacinthaceae	*Drimia toxicaria*
Aizoaceae		Hyacinthaceae	*Lachenalia carnosa*
Alliaceae	*Tulbaghia tenuior*	Hyacinthaceae	*Lachenalia giessii*

Family	Species	Family	Species
Amaranthaceae	*Amaranthus capensis*	Hyacinthaceae	*Lachenalia inconspicua*
Amaranthaceae	*Calicorema capitata*	Hyacinthaceae	*Lachenalia polypodantha*
Amaranthaceae	*Chenopodium murale*	Hyacinthaceae	*Lachenalia sp.*
Amaranthaceae	*Dysphania ambrosioides*	Hyacinthaceae	*Lachenalia undulata*
Amaranthaceae	*Hermbstaedtia glauca*	Hyacinthaceae	*Lachenalia xerophila*
Amaranthaceae	*Leucosphaera bainesii*	Hyacinthaceae	*Ledebouria sp.*
Amaranthaceae	***Salsola aphylla***	Hyacinthaceae	*Ledebouria undulata*
Amaranthaceae	*Salsola barbata*	Hyacinthaceae	*Massonia bifolia*
Amaranthaceae	*Salsola columnaris*	Hyacinthaceae	*Ornithogalum bicornutum*
Amaranthaceae	*Salsola esterhuyseniae*	Hyacinthaceae	*Ornithogalum deltoideum*
Amaranthaceae	*Salsola kalaharica*	Hyacinthaceae	*Ornithogalum dubium*
Amaranthaceae	*Salsola kali*	Hyacinthaceae	*Ornithogalum nanodes*
Amaranthaceae	*Salsola koichabica*	Hyacinthaceae	*Ornithogalum pruinosum*
Amaranthaceae	*Salsola patentipilosa*	Hyacinthaceae	*Ornithogalum sp.*
Amaranthaceae	*Salsola rabieana*	Hydnoraceae	*Hydnora africana*
Amaranthaceae	*Salsola sp.*	Hypoxidaceae	*Empodium sp.*
Amaranthaceae	*Sericocoma avolans*	Hypoxidaceae	*Pauridia scullyi*
Amaranthaceae	*Sericocoma pungens*	Iridaceae	*Babiana hypogaea*
Amaryllidaceae	*Brunsvigia bosmaniae*	Iridaceae	*Ferraria variabilis*
Amaryllidaceae	*Brunsvigia comptonii*	Iridaceae	*Gladiolus equitans*
Amaryllidaceae	*Brunsvigia namaquana*	Iridaceae	*Gladiolus orchidiflorus*
Amaryllidaceae	*Brunsvigia sp.*	Iridaceae	*Gladiolus saccatus*
Amaryllidaceae	*Crinum bulbispermum*	Iridaceae	*Gladiolus sp.*
Amaryllidaceae	*Gethyllis grandiflora*	Iridaceae	*Hesperantha rupicola*
Amaryllidaceae	*Haemanthus sp.*	Iridaceae	*Lapeirousia fabricii*
Amaryllidaceae	*Hessea sp.*	Iridaceae	*Lapeirousia littoralis*
Amaryllidaceae	*Hessea speciosa*	Iridaceae	*Lapeirousia plicata*
Amaryllidaceae	*Hessea stenosiphon*	Iridaceae	*Lapeirousia sp.*
Anacampserotaceae	*Anacampseros albissima*	Iridaceae	*Moraea herrei*
Anacampserotaceae	*Anacampseros baeseckei*	Iridaceae	*Moraea polystachya*
Anacampserotaceae	*Anacampseros herreana*	Iridaceae	*Tritonia karooica*
Anacampserotaceae	*Anacampseros karasmontana*	Iridaceae	*Tritonia marlothii*
Anacampserotaceae	*Anacampseros papyracea*	**Kewaceae**	***Kewa salsoloides***
Anacampserotaceae	*Anacampseros quinaria*	Lamiaceae	*Acrotome pallescens*

Family	Species	Family	Species
Anacampserotaceae	*Anacampseros recurvata*	Lamiaceae	*Salvia garipensis*
Anacampserotaceae	*Anacampseros ruschii*	Lamiaceae	*Stachys flavescens*
Anacardiaceae	*Ozoroa dispar*	Lamiaceae	*Stachys lamarckii*
Anacardiaceae	*Ozoroa namaensis*	Lamiaceae	*Stachys linearis*
Anacardiaceae	*Ozoroa namaquensis*	Lamiaceae	*Stachys rugosa*
Anacardiaceae	*Searsia burchellii*	Limeaceae	*Limeum aethiopicum*
Anacardiaceae	*Searsia pendulina*	**Limeaceae**	***Limeum aethiopicum***
Apiaceae	*Anginon jaarsveldii*	Limeaceae	*Limeum arenicolum*
Apiaceae	*Dasispermum capense*	Limeaceae	*Limeum argute-carinatum*
Apocynaceae	*Carissa bispinosa*	Limeaceae	*Limeum dinteri*
Apocynaceae	*Cryptolepis decidua*	Limeaceae	*Limeum myosotis*
Apocynaceae	*Cynanchum viminale*	Loasaceae	*Kissenia capensis*
Apocynaceae	*Ectadium virgatum*	Lobeliaceae	*Cyphia longiflora*
Apocynaceae	*Fockea comaru*	Lophiocarpaceae	*Lophiocarpus polystachyus*
Apocynaceae	*Gomphocarpus cancellatus*	Loranthaceae	*Septulina glauca*
Apocynaceae	*Gomphocarpus filiformis*	Loranthaceae	*Septulina ovalis*
Apocynaceae	*Hoodia alstonii*	Loranthaceae	*Tapinanthus oleifolius*
Apocynaceae	*Hoodia flava*	**Malvaceae**	***Abutilon austro-africanum***
Apocynaceae	*Huernia barbata*	Malvaceae	*Abutilon dinteri*
Apocynaceae	*Larryleachia marlothii*	Malvaceae	*Abutilon pycnodon*
Apocynaceae	*Larryleachia picta*	Malvaceae	*Hermannia abrotanoides*
Apocynaceae	*Larryleachia sp.*	Malvaceae	*Hermannia affinis*
Apocynaceae	*Microloma incanum*	Malvaceae	*Hermannia amoena*
Apocynaceae	*Microloma sagittatum*	Malvaceae	*Hermannia bicolor*
Apocynaceae	*Orbea namaquensis*	Malvaceae	*Hermannia burchellii*
Apocynaceae	*Pachypodium namaquanum*	Malvaceae	*Hermannia cernua*
Apocynaceae	*Pergularia daemia*	Malvaceae	*Hermannia comosa*
Apocynaceae	*Piaranthus geminatus*	Malvaceae	*Hermannia confusa*
Apocynaceae	*Quaqua mammillaris*	Malvaceae	*Hermannia disermifolia*
Apocynaceae	*Stapelia similis*	Malvaceae	*Hermannia fruticulosa*
Apocynaceae	*Stapelia sp.*	Malvaceae	*Hermannia gariepina*
Apocynaceae	*Tridentea dwequensis*	Malvaceae	*Hermannia jacobeifolia*
Asparagaceae	*Asparagus asparagoides*	Malvaceae	*Hermannia leucantha*
Asparagaceae	*Asparagus exuvialis*	Malvaceae	*Hermannia macra*

Family	Species	Family	Species
Asparagaceae	*Asparagus ovatus*	Malvaceae	*Hermannia minutiflora*
Asparagaceae	*Asparagus pearsonii*	Malvaceae	*Hermannia modesta*
Asparagaceae	*Asparagus retrofractus*	Malvaceae	*Hermannia paucifolia*
Asparagaceae	*Asparagus suaveolens*	Malvaceae	*Hermannia pulchella*
Asphodelaceae	*Aloe claviflora*	Malvaceae	*Hermannia sp.*
Asphodelaceae	*Aloe dabenorisana*	Malvaceae	*Hermannia spinosa*
Asphodelaceae	*Aloe gariepensis*	Malvaceae	*Hermannia stricta*
Asphodelaceae	*Aloe karasbergensis*	Malvaceae	*Hermannia tomentosa*
Asphodelaceae	*Aloe microstigma*	Malvaceae	*Hibiscus elliottiae*
Asphodelaceae	***Aloidendron dichotomum***	Malvaceae	*Hibiscus engleri*
Asphodelaceae	*Bulbine fragilis*	Malvaceae	*Radyera urens*
Asphodelaceae	*Bulbine frutescens*	Meliaceae	*Nymania capensis*
Asphodelaceae	*Bulbine longifolia*	Melianthaceae	*Melianthus elongatus*
Asphodelaceae	*Bulbine ophiophylla*	Melianthaceae	*Melianthus pectinatus*
Asphodelaceae	*Bulbine praemorsa*	Menispermaceae	*Antizoma miersiana*
Asphodelaceae	*Bulbine sp.*	Molluginaceae	*Adenogramma glomerata*
Asphodelaceae	*Bulbine striata*	Molluginaceae	*Hypertelis spergulacea*
Asphodelaceae	*Haworthiopsis tessellata*	Molluginaceae	*Pharnaceum albens*
Asphodelaceae	*Trachyandra divaricata*	Molluginaceae	*Pharnaceum aurantium*
Asphodelaceae	*Trachyandra jacquiniana*	Molluginaceae	*Pharnaceum brevicaule*
Asphodelaceae	*Trachyandra laxa*	Molluginaceae	*Pharnaceum croceum*
Asphodelaceae	*Trachyandra sp.*	Molluginaceae	*Pharnaceum sp.*
Asphodelaceae	*Trachyandra tortilis*	Molluginaceae	*Pharnaceum viride*
Aspleniaceae	*Asplenium cordatum*	Molluginaceae	*Suessenguthiella scleranthoides*
Asteraceae	*Amellus epaleaceus*	Moraceae	*Ficus cordata*
Asteraceae	*Amellus tridactylus*	Moraceae	*Ficus ilicina*
Asteraceae	*Amphiglossa tomentosa*	Neuradaceae	*Grielum humifusum*
Asteraceae	*Amphiglossa triflora*	Neuradaceae	*Grielum sinuatum*
Asteraceae	*Arctotis dimorphocarpa*	Nyctaginaceae	*Phaeoptilum spinosum*
Asteraceae	*Arctotis fastuosa*	Ophioglossaceae	*Ophioglossum sp.*
Asteraceae	*Arctotis hirsuta*	Orobanchaceae	*Alectra orobanchoides*
Asteraceae	*Arctotis leiocarpa*	Orobanchaceae	*Hyobanche rubra*
Asteraceae	*Arctotis venusta*	Oxalidaceae	*Oxalis adenodes*
Asteraceae	*Athanasia minuta*	Oxalidaceae	*Oxalis annae*

Family	Species	Family	Species
Asteraceae	*Berkheya annectens*	Oxalidaceae	*Oxalis beneprotecta*
Asteraceae	*Berkheya canescens*	Oxalidaceae	*Oxalis furcillata*
Asteraceae	*Berkheya chamaepeuce*	Oxalidaceae	*Oxalis inconspicua*
Asteraceae	*Berkheya spinosissima*	Oxalidaceae	*Oxalis obtusa*
Asteraceae	***Berkheya spinosissima***	Oxalidaceae	*Oxalis pes-caprae*
Asteraceae	*Chrysocoma longifolia*	Oxalidaceae	*Oxalis sonderiana*
Asteraceae	*Chrysocoma microphylla*	Oxalidaceae	*Oxalis sp.*
Asteraceae	*Chrysocoma puberula*	Papaveraceae	*Argemone ochroleuca*
Asteraceae	*Chrysocoma sparsifolia*	Passifloraceae	*Adenia repanda*
Asteraceae	*Cineraria canescens*	Pedaliaceae	*Sesamum capense*
Asteraceae	*Cotula coronopifolia*	Pedaliaceae	*Sesamum triphyllum*
Asteraceae	*Crassothonna sedifolia*	Phyllanthaceae	*Phyllanthus loandensis*
Asteraceae	*Didelta carnosa*	Phyllanthaceae	*Phyllanthus parvulus*
Asteraceae	*Dimorphotheca pinnata*	Phyllanthaceae	*Phyllanthus pentandrus*
Asteraceae	*Dimorphotheca polyptera*	Plumbaginaceae	*Dyerophytum africanum*
Asteraceae	*Dimorphotheca sinuata*	Plumbaginaceae	*Limonium dregeanum*
Asteraceae	*Doellia cafra*	Poaceae	*Aristida adscensionis*
Asteraceae	*Eriocephalus africanus*	Poaceae	*Aristida congesta*
Asteraceae	*Eriocephalus ambiguus*	Poaceae	*Aristida dasydesmis*
Asteraceae	*Eriocephalus brevifolius*	Poaceae	*Aristida engleri*
Asteraceae	***Eriocephalus ericoides***	Poaceae	*Aristida parvula*
Asteraceae	***Eriocephalus merxmuelleri***	Poaceae	*Aristida sp.*
Asteraceae	*Eriocephalus microphyllus*	Poaceae	*Aristida vestita*
Asteraceae	*Eriocephalus pedicellaris*	Poaceae	*Brachiaria glomerata*
Asteraceae	*Eriocephalus scariosus*	Poaceae	*Cenchrus ciliaris*
Asteraceae	*Eriocephalus sp.*	Poaceae	*Centropodia glauca*
Asteraceae	*Eriocephalus spinescens*	Poaceae	*Chloris virgata*
Asteraceae	*Euryops dregeanus*	Poaceae	*Cladoraphis spinosa*
Asteraceae	*Euryops multifidus*	Poaceae	*Cynodon dactylon*
Asteraceae	*Euryops sp.*	Poaceae	*Dactyloctenium aegyptium*
Asteraceae	*Euryops subcarnosus*	Poaceae	*Danthoniopsis ramosa*
Asteraceae	*Felicia australis*	Poaceae	*Digitaria eriantha*
Asteraceae	*Felicia brevifolia*	Poaceae	*Dregeochloa calviniensis*
Asteraceae	*Felicia clavipilosa*	Poaceae	*Ehrharta calycina*

Family	Species	Family	Species
Asteraceae	*Felicia filifolia*	Poaceae	*Ehrharta pusilla*
Asteraceae	*Felicia hirsuta*	Poaceae	*Eleusine coracana*
Asteraceae	*Felicia muricata*	Poaceae	*Enneapogon cenchroides*
Asteraceae	*Felicia namaquana*	Poaceae	*Enneapogon desvauxii*
Asteraceae	*Felicia sp.*	Poaceae	*Enneapogon scaber*
Asteraceae	*Foveolina dichotoma*	Poaceae	*Eragrostis biflora*
Asteraceae	*Gazania jurineifolia*	Poaceae	*Eragrostis brizantha*
Asteraceae	*Gazania lichtensteinii*	Poaceae	*Eragrostis gummiflua*
Asteraceae	*Geigeria pectidea*	Poaceae	*Eragrostis homomalla*
Asteraceae	*Geigeria vigintisquamea*	Poaceae	*Eragrostis lehmanniana*
Asteraceae	*Gnaphalium confine*	Poaceae	*Eragrostis mexicana*
Asteraceae	*Gorteria alienata*	Poaceae	*Eragrostis nindensis*
Asteraceae	*Gorteria corymbosa*	Poaceae	*Eragrostis porosa*
Asteraceae	*Gorteria integrifolia*	Poaceae	*Eragrostis procumbens*
Asteraceae	*Gymnodiscus linearifolia*	Poaceae	*Eragrostis rotifer*
Asteraceae	*Helichrysum argyrosphaerum*	Poaceae	*Eragrostis sarmentosa*
Asteraceae	*Helichrysum gariepinum*	Poaceae	*Eragrostis sp.*
Asteraceae	*Helichrysum hebelepis*	**Poaceae**	***Eragrostis trichophora***
Asteraceae	*Helichrysum herniarioides*	Poaceae	*Fingerhuthia africana*
Asteraceae	*Helichrysum marmarolepis*	Poaceae	*Lagurus sp.*
Asteraceae	*Helichrysum micropoides*	Poaceae	*Leucophrys mesocoma*
Asteraceae	*Helichrysum obtusum*	Poaceae	*Melinis repens*
Asteraceae	*Helichrysum oxybelium*	Poaceae	*Odyssea paucinervis*
Asteraceae	*Helichrysum pulchellum*	Poaceae	*Oropetium capense*
Asteraceae	*Helichrysum pumilio*	Poaceae	*Panicum arbusculum*
Asteraceae	*Helichrysum sp.*	Poaceae	*Paspalum distichum*
Asteraceae	*Helichrysum tomentosulum*	Poaceae	*Phragmites australis*
Asteraceae	*Helichrysum zeyheri*	Poaceae	*Polypogon monspeliensis*
Asteraceae	*Hirpicium echinus*	Poaceae	*Schismus barbatus*
Asteraceae	*Ifloga molluginoides*	Poaceae	*Schismus schismoides*
Asteraceae	*Kleinia cephalophora*	Poaceae	*Schmidtia kalahariensis*
Asteraceae	*Kleinia longiflora*	Poaceae	*Schmidtia pappophoroides*
Asteraceae	*Lasiopogon glomerulatus*	Poaceae	*Setaria verticillata*
Asteraceae	*Lasiopogon muscoides*	Poaceae	*Sporobolus nervosus*

Family	Species	Family	Species
Asteraceae	*Lasiospermum brachyglossum*	Poaceae	*Stipagrostis amabilis*
Asteraceae	*Litogyne gariepina*	Poaceae	*Stipagrostis anomala*
Asteraceae	*Lopholaena cneorifolia*	Poaceae	*Stipagrostis brevifolia*
Asteraceae	*Myxopappus acutilobus*	Poaceae	*Stipagrostis ciliata*
Asteraceae	*Nidorella resedifolia*	Poaceae	*Stipagrostis hochstetteriana*
Asteraceae	*Nolletia gariepina*	Poaceae	*Stipagrostis namaquensis*
Asteraceae	*Oedera humilis*	**Poaceae**	***Stipagrostis obtusa***
Asteraceae	*Oncosiphon grandiflorus*	Poaceae	*Stipagrostis uniplumis*
Asteraceae	*Oncosiphon piluliferus*	Poaceae	*Tragus berteronianus*
Asteraceae	*Oncosiphon suffruticosus*	Poaceae	*Tricholaena capensis*
Asteraceae	*Orbivestus cinerascens*	Poaceae	*Tricholaena monachne*
Asteraceae	*Osteospermum armatum*	Poaceae	*Triraphis ramosissima*
Asteraceae	*Osteospermum grandiflorum*	Polygalaceae	*Polygala leptophylla*
Asteraceae	*Osteospermum hyoseroides*	Polygalaceae	*Polygala seminuda*
Asteraceae	*Osteospermum karrooicum*	Portulacaceae	*Portulaca kermesina*
Asteraceae	*Osteospermum muricatum*	Portulacaceae	*Portulaca pilosa*
Asteraceae	*Osteospermum sp.*	Potamogetonaceae	*Potamogeton crispus*
Asteraceae	*Othonna arbuscula*	Potamogetonaceae	*Potamogeton pectinatus*
Asteraceae	*Othonna cyclophylla*	Pottiaceae	*Pottia sp.*
Asteraceae	*Othonna daucifolia*	Pottiaceae	*Pseudocrossidium crinitum*
Asteraceae	*Othonna euphorbioides*	Pottiaceae	*Syntrichia ammonsiana*
Asteraceae	*Othonna furcata*	Pottiaceae	*Tortula atrovirens*
Asteraceae	*Othonna lasiocarpa*	Pottiaceae	*Trichostomum brachydontium*
Asteraceae	*Othonna macrophylla*	Pteridaceae	*Cheilanthes deltoidea*
Asteraceae	*Othonna perfoliata*	Pteridaceae	*Cheilanthes kunzei*
Asteraceae	*Othonna quercifolia*	Pteridaceae	*Cheilanthes sp.*
Asteraceae	*Othonna sp.*	Ptychomitriaceae	*Ptychomitriopsis aloinoides*
Asteraceae	*Pegolettia oxyodonta*	Resedaceae	*Oligomeris dipetala*
Asteraceae	*Pegolettia retrofracta*	Rhamnaceae	*Ziziphus mucronata*
Asteraceae	*Pegolettia sp.*	Ricciaceae	*Riccia cavernosa*
Asteraceae	*Pentatrichia petrosa*	Rubiaceae	*Anthospermum spathulatum*
Asteraceae	*Pentzia argentea*	Rubiaceae	*Kohautia caespitosa*
Asteraceae	*Pentzia globosa*	Rubiaceae	*Kohautia cynanchica*
Asteraceae	*Pentzia lanata*	Rubiaceae	*Kohautia sp.*

Family	Species	Family	Species
Asteraceae	***Pentzia sp.***	Rubiaceae	*Plocama crocyllis*
Asteraceae	*Pentzia spinescens*	Ruscaceae	*Eriospermum bakerianum*
Asteraceae	*Pteronia acuminata*	Ruscaceae	*Eriospermum bifidum*
Asteraceae	*Pteronia ciliata*	Ruscaceae	*Eriospermum ernstii*
Asteraceae	*Pteronia glabrata*	Ruscaceae	*Eriospermum pusillum*
Asteraceae	*Pteronia glauca*	Ruscaceae	*Eriospermum roseum*
Asteraceae	*Pteronia incana*	Ruscaceae	*Eriospermum sp.*
Asteraceae	*Pteronia leucoclada*	Salicaceae	*Salix mucronata*
Asteraceae	*Pteronia lucilioides*	Salvadoraceae	*Azima tetracantha*
Asteraceae	*Pteronia mucronata*	Santalaceae	*Lacomucinaea lineata*
Asteraceae	***Pteronia scariosa***	**Santalaceae**	***Thesium aggregatum***
Asteraceae	*Pteronia sp.*	Santalaceae	*Viscum rotundifolium*
Asteraceae	*Pteronia unguiculata*	Sapindaceae	*Dodonaea viscosa*
Asteraceae	*Rhynchopsidium pumilum*	Sapindaceae	*Pappea capensis*
Asteraceae	*Senecio arenarius*	Scrophulariaceae	*Antherothamnus pearsonii*
Asteraceae	*Senecio bulbinifolius*	Scrophulariaceae	*Anticharis sp.*
Asteraceae	*Senecio cardaminifolius*	Scrophulariaceae	*Aptosimum albomarginatum*
Asteraceae	*Senecio cinerascens*	Scrophulariaceae	*Aptosimum indivisum*
Asteraceae	*Senecio eenii*	Scrophulariaceae	*Aptosimum procumbens*
Asteraceae	*Senecio flavus*	**Scrophulariaceae**	***Aptosimum spinescens***
Asteraceae	*Senecio niveus*	Scrophulariaceae	*Aptosimum tragacanthoides*
Asteraceae	*Senecio pinguifolius*	Scrophulariaceae	*Aptosimum viscosum*
Asteraceae	*Senecio piptocoma*	Scrophulariaceae	*Cromidon minutum*
Asteraceae	*Senecio sarcoides*	Scrophulariaceae	*Diascia engleri*
Asteraceae	*Senecio sisymbriifolius*	Scrophulariaceae	*Diascia runcinata*
Asteraceae	*Senecio sp.*	Scrophulariaceae	*Hebenstretia parviflora*
Asteraceae	*Ursinia arida*	Scrophulariaceae	*Hebenstretia sarcocarpa*
Asteraceae	*Ursinia cakilefolia*	Scrophulariaceae	*Hebenstretia sp.*
Asteraceae	*Ursinia nana*	Scrophulariaceae	*Jamesbrittenia adpressa*
Asteraceae	*Ursinia speciosa*	Scrophulariaceae	*Jamesbrittenia aridicola*
Aytoniaceae	*Plagiochasma rupestre*	Scrophulariaceae	*Jamesbrittenia glutinosa*
Bartramiaceae	*Philonotis dregeana*	Scrophulariaceae	*Jamesbrittenia integerrima*
Bignoniaceae	***Rhigozum trichotomum***	Scrophulariaceae	*Jamesbrittenia maxii*
Boraginaceae	*Codon royenii*	Scrophulariaceae	*Jamesbrittenia ramosissima*

Family	Species	Family	Species
Boraginaceae	*Ehretia alba*	Scrophulariaceae	*Jamesbrittenia sp.*
Boraginaceae	*Ehretia sp.*	Scrophulariaceae	*Limosella inflata*
Boraginaceae	*Heliotropium ciliatum*	Scrophulariaceae	*Lyperia tristis*
Boraginaceae	*Heliotropium ovalifolium*	Scrophulariaceae	*Manulea burchellii*
Boraginaceae	*Heliotropium tubulosum*	Scrophulariaceae	*Manulea gariepina*
Boraginaceae	*Lobostemon echioides*	Scrophulariaceae	*Manulea nervosa*
Boraginaceae	*Trichodesma africanum*	Scrophulariaceae	*Microdon capitatus*
Boraginaceae	*Wellstedia dinteri*	Scrophulariaceae	*Nemesia anisocarpa*
Brassicaceae	*Heliophila carnosa*	Scrophulariaceae	*Nemesia cheiranthus*
Brassicaceae	*Heliophila crithmifolia*	Scrophulariaceae	*Nemesia fleckii*
Brassicaceae	*Heliophila deserticola*	Scrophulariaceae	*Nemesia ligulata*
Brassicaceae	*Heliophila lactea*	Scrophulariaceae	*Nemesia lilacina*
Brassicaceae	*Heliophila minima*	Scrophulariaceae	*Nemesia maxii*
Brassicaceae	*Heliophila seselifolia*	Scrophulariaceae	*Nemesia sp.*
Brassicaceae	*Heliophila sp.*	Scrophulariaceae	*Peliostomum junceum*
Brassicaceae	*Heliophila trifurca*	Scrophulariaceae	*Peliostomum leucorrhizum*
Brassicaceae	*Heliophila variabilis*	Scrophulariaceae	*Peliostomum virgatum*
Brassicaceae	*Lepidium desertorum*	Scrophulariaceae	*Peliostomum viscosum*
Brassicaceae	*Lepidium englerianum*	Scrophulariaceae	*Phyllopodium maxii*
Brassicaceae	*Lepidium trifurcum*	Scrophulariaceae	*Polycarena pubescens*
Bryaceae	*Bryum argenteum*	Scrophulariaceae	*Selago divaricata*
Bryaceae	*Bryum sp.*	Scrophulariaceae	*Selago sp.*
Burseraceae	*Commiphora cervifolia*	Scrophulariaceae	*Sutera cooperi*
Burseraceae	*Commiphora gracilifrondosa*	Scrophulariaceae	*Zaluzianskya affinis*
Burseraceae	*Commiphora namaensis*	Scrophulariaceae	*Zaluzianskya benthamiana*
Campanulaceae	*Wahlenbergia annularis*	Scrophulariaceae	*Zaluzianskya diandra*
Campanulaceae	*Wahlenbergia campanuloides*	Scrophulariaceae	*Zaluzianskya sanorum*
Campanulaceae	*Wahlenbergia divergens*	Solanaceae	*Lycium bosciifolium*
Campanulaceae	*Wahlenbergia meyeri*	Solanaceae	*Lycium horridum*
Campanulaceae	*Wahlenbergia oxyphylla*	Solanaceae	*Lycium pumilum*
Campanulaceae	*Wahlenbergia prostrata*	Solanaceae	*Nicotiana glauca*
Campanulaceae	*Wahlenbergia roelliflora*	Solanaceae	*Nicotiana longiflora*
Campanulaceae	*Wahlenbergia sp.*	Solanaceae	*Solanum burchellii*
Capparaceae	***Boscia albitrunca***	Solanaceae	*Solanum capense*

Family	Species	Family	Species
Capparaceae	*Boscia foetida*	Solanaceae	*Solanum humile*
Capparaceae	***Boscia foetida***	Solanaceae	*Solanum tomentosum*
Capparaceae	***Cadaba aphylla***	Tamaricaceae	*Tamarix usneoides*
Capparaceae	*Maerua gilgii*	Tecophilaeaceae	*Cyanella cygnea*
Caryophyllaceae	*Dianthus laingsburgensis*	Tecophilaeaceae	*Cyanella hyacinthoides*
Caryophyllaceae	*Dianthus micropetalus*	Tecophilaeaceae	*Cyanella lutea*
Caryophyllaceae	*Dianthus namaensis*	Urticaceae	*Forsskaolea candida*
Caryophyllaceae	*Spergularia media*	Vahliaceae	*Vahlia capensis*
Celastraceae	*Gymnosporia buxifolia*	Verbenaceae	*Chascanum garipense*
Celastraceae	*Gymnosporia heterophylla*	Verbenaceae	*Chascanum namaquanum*
Celastraceae	*Gymnosporia linearis*	Verbenaceae	*Chascanum pumilum*
Celastraceae	*Gymnosporia sp.*	Verbenaceae	*Verbena litoralis*
Cleomaceae	*Cleome angustifolia*	Zygophyllaceae	*Augea capensis*
Cleomaceae	*Cleome foliosa*	Zygophyllaceae	*Roepera foetida*
Cleomaceae	*Cleome kalachariensis*	Zygophyllaceae	*Roepera leptopetala*
Cleomaceae	*Cleome oxyphylla*	Zygophyllaceae	*Roepera pubescens*
Cleomaceae	*Cleome paxii*	Zygophyllaceae	*Sisyndite spartea*
Colchicaceae	*Colchicum bellum*	Zygophyllaceae	*Tetraena chrysopteron*
Colchicaceae	*Colchicum melanthoides*	Zygophyllaceae	*Tetraena microcarpa*
Colchicaceae	*Colchicum walteri*	**Zygophyllaceae**	***Tetraena retrofracta***
Colchicaceae	*Ornithoglossum dinteri*	Zygophyllaceae	*Tetraena rigida*
Colchicaceae	*Ornithoglossum sp.*	Zygophyllaceae	*Tetraena simplex*
Colchicaceae	*Ornithoglossum undulatum*	Zygophyllaceae	*Tribulus cristatus*
Colchicaceae	*Ornithoglossum vulgare*	Zygophyllaceae	*Tribulus pterophorus*
Crassulaceae	*Adromischus diabolicus*	Zygophyllaceae	*Tribulus sp.*
Crassulaceae	*Adromischus nanus*	Zygophyllaceae	*Tribulus terrestris*
Crassulaceae	*Cotyledon orbiculata*	Zygophyllaceae	*Tribulus zeyheri*
Crassulaceae	***Cotyledon orbiculata***	**Zygophyllaceae**	***Tribulus zeyheri***
Crassulaceae	*Crassula brevifolia*	Zygophyllaceae	*Zygophyllum dregeanum*
Crassulaceae	*Crassula campestris*	Zygophyllaceae	*Zygophyllum sp.*
Crassulaceae	*Crassula columnaris*		
Acanthaceae	***Acanthopsis disperma***	Crassulaceae	*Crassula corallina*
Acanthaceae	*Acanthopsis hoffmannseggiana*	Crassulaceae	*Crassula cotyledonis*

Appendix 3. Specialist CV.

CURRICULUM VITAE:

Gerhard Botha

Name:	:	Gerhardus Alfred Botha
Date of Birth	:	11 April 1986
Identity Number	:	860411 5136 088
Postal Address	:	PO Box 12500
		Brandhof
		9324
Residential Address	:	3 Jock Meiring Street
		Park West
		Bloemfontein
		9301
Cell Phone Number	:	084 207 3454
Email Address	:	gabotha11@gmail.com
Profession/Specialisation	:	Ecological and Biodiversity Consultant
Nationality:	:	South African
Years Experience:	:	8
Bilingualism	:	Very good – English and Afrikaans

Professional Profile:

Gerhard is a Managing Director of Nkurenkuru Ecology and Biodiversity (Pty) Ltd. He has a BSc Honours degree in Botany from the University of the Free State Province and is currently completing a MSc Degree in Botany. He began working as an environmental specialist in 2010 and has since gained extensive experience in conducting ecological and biodiversity assessments in various development field, especially in the fields of conventional as well as renewable energy generation, mining and infrastructure development. Gerhard is a registered Professional Natural Scientist (Pr. Sci. Nat.)

Key Responsibilities:

Specific responsibilities as an Ecological and Biodiversity Specialist include, inter alia, professional execution of specialist consulting services (including flora, wetland and fauna studies, where required), impact assessment reporting, walk through surveys/ground-truthing to inform final design, compilation of management plans, compliance monitoring and audit reporting, in-house ecological awareness training to on-site personnel, and the development of project proposals for procuring new work/projects.

Skills Base and Core Competencies

- Research Project Management
- Botanical researcher in projects involving the description of terrestrial and coastal ecosystems.
- Broad expertise in the ecology and conservation of grasslands, savannahs, karroid wetland, and aquatic ecosystems.
- Ecological and Biodiversity assessments for developmental purposes (BAR, EIA), with extensive knowledge and experience in the renewable energy field (Refer to Work Experiences and References)
- Over 3 years of avifaunal monitoring and assessment experience.
- Mapping and Infield delineation of wetlands, riparian zones and aquatic habitats (according to methods stipulated by DWA, 2008) within various South African provinces of KwaZulu-Natal, Mpumalanga, Free State, Gauteng and Northern Cape Province for inventory and management purposes.
- Wetland and aquatic buffer allocations according to industry best practice guidelines.
- Working knowledge of environmental planning policies, regulatory frameworks, and legislation
- Identification and assessment of potential environmental impacts and benefits.
- Assessment of various wetland ecosystems to highlight potential impacts, within current and proposed landscape settings, and recommend appropriate mitigation and offsets based on assessing wetland ecosystem service delivery (functions) and ecological health/integrity.
- Development of practical and achievable mitigation measures and management plans and evaluation of risk to execution
- Qualitative and Quantitative Research
- Experienced in field research and monitoring
- Working knowledge of GIS applications and analysis of satellite imagery data
- Completed projects in several Provinces of South Africa and include a number of projects located in sensitive and ecological unique regions.

Education and Professional Status

Degrees:

- *2015:* Currently completing a M.Sc. degree in Botany (Vegetation Ecology), University of the Free State, Bloemfontein, RSA.
- *2009:* B.Sc. Hons in Botany (Vegetation Ecology), University of the Free State, Bloemfontein, RSA.
- *2008:* B.Sc. in Zoology and Botany, University of the Free State, University of the Free State, Bloemfontein,

RSA.

Courses:

- *2013*: Wetland Management (ecology, hydrology, biodiversity, and delineation) – University of the Free State accredited course.
- *2014*: Introduction to GIS and GPS (Code: GISA 1500S) – University of the Free State accredited course.

Professional Society Affiliations:

- The South African Council of Natural Scientific Professions: Pr. Sci. Nat. Reg. No. 400502/14 (Botany and Ecology).

Employment History

- December 2017 – Current: Nkurenkuru Ecology and Biodiversity (Pty) Ltd
- 2016 – November 2017: ECO-CARE Consultancy
- *2015 - 2016*: Ecologist, Savannah Environmental (Pty) Ltd
- *2013 – 2014*: Working as ecologist on a freelance basis, involved in part-time and contractual positions for the following companies
  - Enviroworks (Pty) Ltd
  - GreenMined (Pty) Ltd
  - Eco-Care Consultancy (Pty) Ltd
  - Enviro-Niche Consulting (Pty) Ltd
  - Savannah Environmental (Pty) Ltd
  - Esicongweni Environmental Services (EES) cc
- *2010 - 2012*: Enviroworks (Pty) Ltd

Publications

Publications:

- Botha, G.A. & Du Preez, P.J. 2015. A description of the wetland and riparian vegetation of the Nxamasere palaeo-river's backflooded section, Okavango Delta, Botswana. S. *Afr. J. Bot*., **98**: 172-173.

Congress papers/posters/presentations:

- Botha, G.A. 2015. A description of the wetland and riparian vegetation of the Nxamasere palaeo-river's backflooded section, Okavango Delta, Botswana. 41st Annual Congress of South African Association of Botanists (SAAB). Tshipise, 11-15 Jan. 2015.
- Botha, G.A. 2014. A description of the vegetation of the Nxamasere floodplain, Okavango Delta, Botswana. 10st Annual University of Johannesburg (UJ) Postgraduate Botany Symposium. Johannesburg, 28 Oct. 2014.

Other

- Guest speaker at IAIAsa Free State Branch Event (29 March 2017)

- Guest speaker at the University of the Free State Province: Department of Plant Sciences (3 March 2017):

References:

- Christine Fouché
  Manager: GreenMined (Pty) LTD
  Cell: 084 663 2399
- Professor J du Preez
  Senior lecturer: Department of Plant Sciences
  University of the Free State
  Cell: 082 376 4404

CURRICULUM VITAE:

Jan-Hendrik Keet, PhD

Address: Unit 29 Avignon, Hillcrest Road
Land en Zeezicht, Somerset West
South Africa
7130
Email: jhkeet@hotmail.com
Phone: +27 71 451 4853

Expertise and experience

- Current profession: Post Doctoral Researcher – Centre for Invasion Biology (Department of Botany and Zoology), Stellenbosch University
- Specialisation: Botany, ecology, invasive plant species, and invasion biology
- Years of experience: 7 years
- Published in various national and international scientific journals

Skills and competencies

- Invasive species biology
- Plant biogeography and ecology
- Plant identification and taxonomy
- Vegetation surveys and mapping
- Soil microbiomes, function, and chemistry
- Geographic Information Systems

- Data analysis and Statistics in R Statistical Software

Tertiary education

- *2015 – 2019: Stellenbosch University, Stellenbosch, South Africa. Doctor of Philosophy (Botany)*
- *2013 – 2014: University of the Free State, Bloemfontein, South Africa. Magister Scientiae (Botany)*
- *2012: University of the Free State, Bloemfontein, South Africa. Bachelor of Science Honours (Botany) - cum laude*
- *2009 – 2011: University of the Free State, Bloemfontein, South Africa. Bachelor of Science (Chemistry with Physics and Biology) - cum laude*

Employment history

- *2011: Part-time demonstrator. Department of Plant Sciences, University of the Free State, Bloemfontein, South Africa*
- *2010: Part-time lab assistant. Department of Chemistry, University of the Free State, Bloemfontein, South Africa*
- *2007 – 2009: Shop Manager. Christian Tees, Brandwag Centre, Bloemfontein*

Certifications

- *SAGIC Invasive Species Consultant (Cape Town, South Africa), March 2016*
- *GIS Intermediate (NQF level 5): Hydrological modelling and terrain analysis using digital elevation models (University of the Free State, South Africa), 2014*
- *Good Laboratory Practice seminar presented by Merck Millipore South Africa, 2012*
- *Laboratory Safety seminar presented by Merck Millipore South Africa, 2012*

Appendix 4. Specialist's Work Experience and References

WORK EXPERIENCES

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References

Gerhard Botha

ECOLOGICAL RELATED STUDIES AND SURVEYS

Date Completed	Project Description	Type of Assessment/Study	Client
2019	Sirius Three Solar PV Facility near Upington, Northern Cape	Ecological Assessment (Basic Assessment)	Aurora Power Solutions
2019	Sirius Four Solar PV Facility near Upington, Northern Cape	Ecological Assessment (Basic Assessment)	Aurora Power Solutions
2019	Lichtenburg 1 100MW Solar PV Facility, Lichtenburg, North-West Province	Ecological Assessment (Scoping and EIA Phase Assessments)	Atlantic Renewable Energy Partners
2019	Lichtenburg 2 100MW Solar PV Facility, Lichtenburg, North-West Province	Ecological Assessment (Scoping and EIA Phase Assessments)	Atlantic Renewable Energy Partners

2019	Lichtenburg 3 100MW Solar PV Facility, Lichtenburg, North-West Province	Ecological Assessment (Scoping and EIA Phase Assessments)	Atlantic Renewable Energy Partners
2019	Moeding Solar PV Facility near Vryburg, North-West Province	Ecological Assessment (Basic Assessment)	Moeding Solar
2019	Expansion of the Raumix Aliwal North Quarry, Eastern Cape Province	Fauna and Flora Pre-Construction Walk-Through Assessment	GreenMined
2018	Kruisvallei Hydroelectric 22kV Overhead Power Line, Clarens, Free State Province	Faunal and Flora Rescue and Protection Plan	Zevobuzz
2018	Kruisvallei Hydroelectric 22kV Overhead Power Line, Clarens, Free State Province	Fauna and Flora Pre-Construction Walk-Through Assessment	Zevobuzz
2018	Proposed Kruisvallei Hydroelectric Power Generation Scheme in the Ash River, Free State Province	Ecological Assessment (Basic Assessment)	Zevobuzz
2018	Proposed Zonnebloem Switching Station (132/22kV) and 2X Loop-in Loop-out Power Lines (132kV), Mpumalanga Province	Ecological Assessment (Basic Assessment)	Eskom
2018	Clayville Thermal Plant within the Clayville Industrial Area, Gauteng Province	Ecological Comments Letter	Savannah Environmental
2018	Iziduli Emoyeni Wind Farm near Bedford, Eastern Cape Province	Ecological Assessment (Re-assessment)	Emoyeni Wid Farm Renewable Energy
2018	Msenge Wind Farm near Bedford, Eastern Cape Province	Ecological Assessment (Re-assessment)	Amakhala Emoyeni Renewable Energy
2017	H2 Energy Power Station near Kwamhlanga, Mpumalanga Province	Ecological Assessment (Scoping and EIA phase assessments)	Eskom
2017	Karusa Wind Farm (Phase 1 of the Hidden Valley Wind Energy Facility near Sutherland, Northern Cape Province)	Ecological Assessment (Re-assessment)	ACED Renewables Hidden Valley
2017	Soetwater Wind Farm (Phase 2 of the Hidden Valley Wind Energy Facility near Sutherland, Northern Cape Province)	Ecological Assessment (Re-assessment)	ACED Renewables Hidden Valley
2017	S24G for the unlawful commencement or continuation of activities within a watercourse, Honeydew, Gauteng Province	Ecological Assessment	Savannah Environmental
2016 - 2017	Noupoort CSP Facility near Noupoort, Northern Cape Province	Ecological Assessment (Scoping and EIA phase assessments)	Cresco
2016	Buffels Solar 2 PV Facility near Orkney, North West Province	Ecological Assessment (Scoping and EIA phase assessments)	Kabi Solar
2016	Buffels Solar 1 PV Facility near Orkney, North West Province	Ecological Assessment (Scoping and EIA phase assessments)	Kabi Solar
2016	132kV Power Line and On-Site Substation for the Authorised Golden Valley II Wind Energy Facility near Bedford, Eastern Cape Province	Ecological Assessment (Basic Assessment)	Terra Wind Energy
2016	Kalahari CSP Facility: 132kV Ferrum–Kalahari–UNTU & 132kV Kathu IPP–Kathu 1 Overhead Power Lines, Kathu, Northern Cape Province	Fauna and Flora Pre-Construction Walk-Through Assessment	Kathu Solar Park
2016	Kalahari CSP Facility: Access Roads, Kathu, Northern Cape Province	Fauna and Flora Pre-Construction Walk-Through Assessment	Kathu Solar Park
2016	Karoshoek Solar Valley Development – Additional CSP Facility including tower infrastructure associated with authorised CSP Site 2 near Upington, Northern Cape Province	Ecological Assessment (Scoping Assessment)	Emvelo

2016	Karoshoek Solar Valley Development –Ilanga CSP 7 and 8 Facilities near Upington, Northern Cape Province	Ecological Assessment (Scoping Assessment)	Emvelo
2016	Karoshoek Solar Valley Development –Ilanga CSP 9 Facility near Upington, Northern Cape Province	Ecological Assessment (Scoping Assessment)	Emvelo
2016	Lehae Training Academy and Fire Station, Gauteng Province	Ecological Assessment	Savannah Environmental
2016	Metal Industrial Cluster and Associated Infrastructure near Kuruman, Northern Cape Province	Ecological Assessment (Scoping Assessment)	Northern Cape Department of Economic Development and Tourism
2016	Semonkong Wind Energy Facility near Semonkong, Maseru District, Lesotho	Ecological Pre-Feasibility Study	Savannah Environmental
2015 - 2016	Orkney Solar PV Facility near Orkney, North West Province	Ecological Assessment (Scoping and EIA phase assessments)	Genesis Eco-Energy
2015 - 2016	Woodhouse 1 and Woodhouse 2 PV Facilities near Vryburg, North West Province	Ecological Assessment (Scoping and EIA phase assessments)	Genesis Eco-Energy
2015	CAMCO Clean Energy 100kW PV Solar Facility, Thaba Eco Lodge near Johannesburg, Gauteng Province	Ecological Assessment (Basic Assessment)	CAMCO Clean Energy
2015	CAMCO Clean Energy 100kW PV Solar Facility, Thaba Eco Lodge near Johannesburg, Gauteng Province	Ecological Assessment (Basic Assessment)	CAMCO Clean Energy
2015	Sirius 1 Solar PV Project near Upington, Northern Cape Province	Fauna and Flora Pre-Construction Walk-Through Assessment	Aurora Power Solutions
2015	Sirius 2 Solar PV Project near Upington, Northern Cape Province	Fauna and Flora Pre-Construction Walk-Through Assessment	Aurora Power Solutions
2015	Sirius 1 Solar PV Project near Upington, Northern Cape Province	Invasive Plant Management Plan	Aurora Power Solutions
2015	Sirius 2 Solar PV Project near Upington, Northern Cape Province	Invasive Plant Management Plan	Aurora Power Solutions
2015	Sirius 1 Solar PV Project near Upington, Northern Cape Province	Plant Rehabilitation Management Plan	Aurora Power Solutions
2015	Sirius Phase 2 Solar PV Project near Upington, Northern Cape Province	Plant Rehabilitation Management Plan	Aurora Power Solutions
2015	Sirius 1 Solar PV Project near Upington, Northern Cape Province	Plant Rescue and Protection Plan	Aurora Power Solutions
2015	Sirius Phase 2 Solar PV Project near Upington, Northern Cape Province	Plant Rescue and Protection Plan	Aurora Power Solutions
2015	Expansion of the existing Komsberg Main Transmission Substation near Sutherland, Northern Cape Province	Ecological Assessment (Basic Assessment)	ESKOM
2015	Karusa Wind Farm near Sutherland, Northern Cape Province)	Invasive Plant Management Plan	ACED Renewables Hidden Valley
2015	Proposed Karusa Facility Substation and Ancillaries near Sutherland, Northern Cape Province	Ecological Assessment (Basic Assessment)	ACED Renewables Hidden Valley
2015	Eskom Karusa Switching Station and 132kV Double Circuit Overhead Power Line near Sutherland, Northern Cape Province	Ecological Assessment (Basic Assessment)	ESKOM
2015	Karusa Wind Farm near Sutherland, Northern Cape Province)	Plant Search and Rescue and Rehabilitation Management Plan	ACED Renewables Hidden Valley
2015	Karusa Wind Energy Facility near Sutherland, Northern Cape Province	Fauna and Flora Pre-Construction Walk-Through Assessment	ACED Renewables Hidden Valley

2015	Soetwater Facility Substation, 132kV Overhead Power Line and Ancillaries, near Sutherland, Northern Cape Province	Ecological Assessment (Basic Assessment)	ACED Renewables Hidden Valley
2015	Soetwater Wind Farm near Sutherland, Northern Cape Province)	Invasive Plant Management Plan	ACED Renewables Hidden Valley
2015	Soetwater Wind Energy Facility near Sutherland, Northern Cape Province	Fauna and Flora Pre-Construction Walk-Through Assessment	ACED Renewables Hidden Valley
2015	Soetwater Wind Farm near Sutherland, Northern Cape Province	Plant Search and Rescue and Rehabilitation Management Plan	ACED Renewables Hidden Valley
2015	Expansion of the existing Scottburgh quarry near Amandawe, KwaZulu-Natal	Botanical Assessment (for EIA)	GreenMined Environmental
2015	Expansion of the existing AFRIMAT quarry near Hluhluwe, KwaZulu-Natal	Botanical Assessment (for EIA)	GreenMined Environmental
2014	Tshepong 5MW PV facility within Harmony Gold's mining rights areas, Odendaalsrus	Ecological Assessment (Basic Assessment)	BBEnergy
2014	Nyala 5MW PV facility within Harmony Gold's mining rights areas, Odendaalsrus	Ecological Assessment (Basic Assessment)	BBEnergy
2014	Eland 5MW PV facility within Harmony Gold's mining rights areas, Odendaalsrus	Ecological Assessment (Basic Assessment)	BBEnergy
2014	Transalloys circulating fluidised bed power station near Emalahleni, Mpumalanga Province	Ecological Assessment (for EIA)	Trans-Alloys
2014	Umbani circulating fluidised bed power station near Kriel, Mpumalanga Province	Ecological Assessment (Scoping and EIA)	Eskom
2014	Gihon 75MW Solar Farm: Bela-Bela, Limpopo Province	Ecological Assessment (for EIA)	NETWORX Renewables
2014	Steelpoort Integration Project & Steelpoort to Wolwekraal 400kV Power Line	Fauna and Flora Pre-Construction Walk-Through Assessment	Eskom
2014	Audit of protected *Acacia erioloba* trees within the Assmang Wrenchville housing development footprint area	Botanical Audit	Eco-Care Consultancy
2014	Rehabilitation of the N1 National Road between Sydenham and Glen Lyon	Peer review of the ecological report	EKO Environmental
2014	Rehabilitation of the N6 National Road between Onze Rust and Bloemfontein	Peer review of the ecological report	EKO Environmental
2011	Illegally ploughed land on the Farm Wolwekop 2353, Bloemfontein	Vegetation Rehabilitation Plan	EnviroWorks
2011	Rocks Farm chicken broiler houses	Botanical Assessment (for EIA)	EnviroWorks
2011	Botshabelo 132 kV line	Ecological Assessment (for EIA)	CENTLEC
2011	De Aar Freight Transport Hub	Ecological Scoping and Feasibility Study	EnviroWorks
2011	The proposed establishment of the Tugela Ridge Eco Estate on the farm Kruisfontein, Bergville	Ecological Assessment (for EIA)	EnviroWorks
2010 - 2011	National long-haul optic fibre infrastructure network project, Bloemfontein to Beaufort West	Vegetation Rehabilitation Plan for illegally cleared areas	NEOTEL
2010 - 2011	National long-haul optic fibre infrastructure network project, Bloemfontein to Beaufort West	Invasive Plant Management Plan	NEOTEL
2010 - 2011	National long-haul optic fibre infrastructure network project, Bloemfontein to Beaufort West	Protected and Endangered Species Walk-Through Survey	NEOTEL
2011	Optic Fibre Infrastructure Network, Swartland Municipality	Botanical Assessment (for EIA) - Assisted Dr. Dave McDonald	Dark Fibre Africa
2011	Optic Fibre Infrastructure Network, City of Cape Town Municipality	Botanical Assessment (for EIA) - Assisted Dr. Dave McDonald	Dark Fibre Africa
2010	Construction of an icon at the southernmost tip of Africa, Agulhas National Park	Botanical Assessment (for EIA)	SANPARKS
2010	New boardwalk from Suiderstrand Gravel Road to Rasperpunt, Agulhas National Park	Botanical Assessment (for EIA)	SANPARKS
2010	Farm development for academic purposes (Maluti FET College) on the Farm Rosedale 107, Harrismith	Ecological Assessment (Screening and Feasibility Study)	Agri Development Solutions
2010	Basic Assessment: Barcelona 88/11kV substation and 88kV loop-in lines	Botanical Assessment (for EIA)	Eskom Distribution
2011	Illegally ploughed land on the Farm Wolwekop 2353, Bloemfontein	Vegetation Rehabilitation Plan	EnviroWorks

WETLAND DELINEATION AND HYDROLOGICAL ASSESSMENTS

Date Completed	Project Description	Type of Assessment/Study	Client
In progress	Steynsrus PV 1 & 2 Solar Energy Facilities near Steynsrus, Free State Province	Wetland Assessment	Cronimet Mining Power Solutions
2019	Lichtenburg 1 100MW Solar PV Facility, Lichtenburg, North-West Province	Surface Hydrological Assessment (Scoping and EIA Phase)	Atlantic Renewable Energy Partners
2019	Lichtenburg 2 100MW Solar PV Facility, Lichtenburg, North-West Province	Surface Hydrological Assessment (Scoping and EIA Phase)	Atlantic Renewable Energy Partners
2019	Lichtenburg 3 100MW Solar PV Facility, Lichtenburg, North-West Province	Surface Hydrological Assessment (Scoping and EIA Phase)	Atlantic Renewable Energy Partners
2019	Moeding Solar PV Facility near Vryburg, North-West Province	Wetland Assessment (Basic Assessment)	Moeding Solar
2018	Kruisvallei Hydroelectric 22kV Overhead Power Line, Clarens, Free State Province	Wetland Assessment (Basic Assessment	Zevobuzz
2017	Nyala 5MW PV facility within Harmony Gold's mining rights areas, Odendaalsrus	Wetland Assessment	BBEnergy
2017	Eland 5MW PV facility within Harmony Gold's mining rights areas, Odendaalsrus	Wetland Assessment	BBEnergy
2017	Olifantshoek 10MVA 132/11kV Substation and 31km Power Line	Surface Hydrological Assessment (Basic Assessment)	Eskom
2017	Expansion of the Elandspruit Quarry near Ladysmith, KwaZulu-Natal Province	Wetland Assessment	Raumix
2017	S24G for the unlawful commencement or continuation of activities within a watercourse, Honeydew, Gauteng Province	Aquatic Assessment & Flood Plain Delineation	Savannah Environmental
2017	Noupoort CSP Facility near Noupoort, Northern Cape Province	Surface Hydrological Assessment (EIA phase)	Cresco
2016	Wolmaransstad Municipality 75MW PV Solar Energy Facility in the North West Province	Wetland Assessment (Basic Assessment)	BlueWave Capital
2016	BlueWave 75MW PV Plant near Welkom Free State Province	Wetland Delineation	BlueWave Capital
2016	Harmony Solar Energy Facilities: Amendment of Pipeline and Overhead Power Line Route	Wetland Assessment (Basic Assessment)	BBEnergy

AVIFAUNAL ASSESSMENTS

Date Completed	Project Description	Type of Assessment/Study	Client
2019	Sirius Three Solar PV Facility near Upington, Northern Cape	Avifauna Assessment (Basic Assessment)	Aurora Power Solutions

2019	Sirius Four Solar PV Facility near Upington, Northern Cape	Avifauna Assessment (Basic Assessment)	Aurora Power Solutions
2019	Moeding Solar PV Facility near Vryburg, North-West Province	Avifauna Assessment (Basic Assessment)	Moeding Solar
2018	Proposed Zonnebloem Switching Station (132/22kV) and 2X Loop-in Loop-out Power Lines (132kV), Mpumalanga Province	Avifauna Assessment (Basic Assessment)	Eskom
2017	Olifantshoek 10MVA 132/11kV Substation and 31km Power Line	Avifauna Assessment (Basic Assessment)	Eskom
2016	TEWA Solar 1 Facility, east of Upington, Northern Cape Province	Wetland Assessment (Basic Assessment	Tewa Isitha Solar 1
2016	TEWA Solar 2 Facility, east of Upington, Northern Cape Province	Wetland Assessment	Tewa Isitha Solar 2

ENVIRONMENTAL IMPACT ASSESSMENT

- Barcelona 88/11kV substation and 88kV loop-in lines – BA (for Eskom).
- Thabong Bulk 132kV sub-transmission inter-connector line – EIA (for Eskom).
- Groenwater 45 000 unit chicken broiler farm – BA (for Areemeng Mmogo Cooperative).
- Optic Fibre Infrastructure Network, City of Cape Town Municipality – BA (for Dark Fibre Africa (Pty) Ltd).
- Optic Fibre Infrastructure Network, Swartland Municipality – BA (for Dark Fibre Africa).
- Construction and refurbishment of the existing 66kV network between Ruigtevallei Substation and Reddersburg Substation – EMP (for Eskom).
- Lower Kruisvallei Hydroelectric Power Scheme (Ash river) – EIA (for Kruisvallei Hydro (Pty) Ltd).
- Construction of egg hatchery and associated infrastructure – BA (For Supreme Poultry).
- Construction of the Klipplaatdrif flow gauging (Vaal river) – EMP (DWAF).

ENVIRONMENTAL COMPLIANCE AUDITING AND ECO

- National long haul optic fibre infrastructure network project, Bloemfontein to Laingsburg – ECO (for Enviroworks (Pty) Ltd.).
- National long haul optic fibre infrastructure network project, Wolmaransstad to Klerksdorp – ECO (for Enviroworks (Pty) Ltd.).
- Construction and refurbishment of the existing 66kV network between Ruigtevallei Substation and Reddersburg Substation – ECO (for Enviroworks (Pty) Ltd.).
- Construction and refurbishment of the Vredefort/Nooitgedacht 11kV power line – ECO (for Enviroworks (Pty) Ltd.).
- Mining of Dolerite (Stone Aggregate) by Raumix (Pty) Ltd. on a portion of Portion 0 of the farm Hillside 2830, Bloemfontein – ECO (for GreenMined Environmental (Pty) Ltd.).
- Construction of an Egg Production Facility by Bainsvlei Poultry (Pty) Ltd on Portions 9 & 10 of the farm, Mooivlakte, Bloemfontein – ECO (for Enviro-Niche Consulting (Pty) Ltd.).

- Environmental compliance audit and botanical account of Afrisam's premises in Bloemfontein – Environmental Compliance Auditing (for Enviroworks (Pty) Ltd.).

OTHER PROJECTS:

- Keeping and breeding of lions (*Panthera leo*) on the farm Maxico 135, Ficksburg – Management and Business Plan (for Enviroworks (Pty) Ltd.)
- Keeping and breeding of lions (*Panthera leo*) on the farm Mooihoek 292, Theunissen – Management and Business Plan (for Enviroworks (Pty) Ltd.)
- Keeping and breeding of wild dogs (*Lycaon pictus*) on the farm Mooihoek 292, Theunissen – Management and Business Plan (for Enviroworks (Pty) Ltd.)
- Existing underground and aboveground fuel storage tanks, TWK AGRI: Pongola – Environmental Management Plan (for TWK Agricultural Ltd).
- Existing underground fuel storage tanks on Erf 171, TWK AGRI: Amsterdam – Environmental Management Plan (for TWK Agricultural Ltd).
- Proposed storage of 14 000 L of fuel (diesel) aboveground on Erf 32, TWK AGRI: Carolina – Environmental Management Plan (for TWK Agricultural Ltd).
- Proposed storage of 23 000 L of fuel (diesel) above ground on Portion 10 of the Farm Oude Bosch, Humansdorp – Environmental Management Plan (for TWK Agricultural Ltd).
- Proposed storage of 16 000 L of fuel (diesel) aboveground at Panbult Depot – Environmental Management Plan (for TWK Agricultural Ltd).
- Existing underground fuel storage tanks, TWK AGRI: Mechanisation and Engineering, Piet Retief – Environmental Management Plan (for TWK Agricultural Ltd).
- Existing underground fuel storage tanks on Portion 38 of the Farm Lothair, TWK AGRI: Lothair – Environmental Management Plan (for TWK Agricultural Ltd).

WORK EXPERIENCES

&

References

Jan-Hendrik Keet, PhD

Publications

- Hirsch H, Allsopp MH, Canavan S, Cheek M, Geerts S, Geldenhuys CJ, Harding G, Hurley BP, Jones W, **Keet J-H**, Klein H, Ruwanza S, van Wilgen BW, Wingfield MJ, Richardson DM (**2019**) *Eucalyptus camaldulensis* in South Africa – past, present, future, *Transactions of the Royal Society of South Africa*, https://doi.org/10.1080/0035919X.2019.1669732.
- Le Roux JJ, Hui C, Castillo ML, Iriondo, JM, **Keet J-H**, Khapugin, AA, Médail F, Rejmánek M, Theron G, Yannelli FA, Hirsch H (**2019**) Recent anthropogenic plant extinctions differ in biodiversity hotspots and coldspots. *Current Biology*, https://doi.org/10.1016/j.cub.2019.07.063.

- **Keet J-H**, Ellis A G, Hui C, Le Roux JJ (**2019**) Strong spatial and temporal turnover of soil bacterial communities in South Africa's hyperdiverse fynbos biome. *Soil Biology and Biochemistry* **136:** 107541, https://doi.org/10.1016/j.soilbio.2019.107541.
- Le Roux JJ, Ellis AG, Van Zyl L-M, Hosking ND, **Keet J-H**, Yannelli F (**2018**) Importance of soil legacy effects and successful mutualistic interactions during Australian acacia invasions in nutrient-poor environments. *Journal of Ecology* **105**(6): 2071-2081, https://doi.org/10.1111/1365-2745.1296.
- **Keet J-H**, Ellis A G, Hui C, Le Roux JJ (**2017**) Legume–rhizobium symbiotic promiscuity and effectiveness do not affect plant invasiveness. *Annals of Botany* **119**(8): 1319-1331, https://doi.org/10.1093/aob/mcx028.
- Le Roux JJ, **Keet J-H**, Mutiti B, Ellis AG (**2017**) Cultivation may not dramatically alter rhizobial community diversity or structure associated with rooibos tea (*Aspalathus linearis* Burm.f.) in South Africa. *South African Journal of Botany* **110**: 87-96, https://doi.org/10.1016/j.sajb.2017.01.014.
- Le Roux JJ, Hui C, **Keet J-H**, Ellis AG (**2017**) Co-introduction vs ecological fitting as pathways to the establishment of effective mutualisms during biological invasions. *New Phytologist* **215**:1354–1360. https://doi.org/10.1111/nph.14593.
- Nsikani M, Novoa A, Van Wilgen B, **Keet J-H**, Gaertner M (**2017**) *Acacia saligna*'s soil legacy effects persist up to ten years after clearing: Implications for ecological restoration. *Austral Ecology* **42**(8): 880-889, https://doi.org/10.1111/aec.12515.
- **Keet J-H**, Cindi D, Du Preez PJ (**2016**) Assessing the invasiveness of *Berberis aristata* and *B. julianae* (Berberidaceae) in South Africa: management options and legal recommendations. *South African Journal of Botany* **105**: 299-28, https://doi.org/10.1016/j.sajb.2016.04.012.

Conferences

- 46th South African Association of Botanists conference (Qwa-Qwa, South Africa), January 2020, ***Alnus glutinosa* (L.) Gaertn. [Black Alder]: *an emerging invader in South Africa***
- International Association for Food Protection (IAFP; Louisville, Kentucky, USA), July 2019.
- Ecological Society of America Conference, (New Orleans, Louisiana, USA), August 2018 **Invasive legumes dramatically impact soil bacterial community structures but not function**
- Legumes for Life Workshop (Stellenbosch, South Africa), May 2018 **Legume-rhizobium symbiotic promiscuity and effectiveness do not affect plant invasiveness**
- Fynbos Forum Conference (Swellendam, South Africa), July 2017 **Assessing the impacts of invasive legumes on soil conditions and microbial community composition in a biodiversity hotspot**
- 43rd South African Association of Botanists Conference (Cape Town, South Africa), January 2017, **Legume-rhizobium symbiotic promiscuity and effectiveness do not affect plant invasiveness** *Best PhD presentation*

- 43rd Annual Research Symposium on the Management of Biological Invasions Conference (Worscester, South Africa), May 2016, **Legume-rhizobium symbiotic promiscuity does not determine plant invasiveness**
- Evolutionary dynamics of tree invasions: drivers, dimensions, and implications for management (Stellenbosch, South Africa), November 2015
- Neobiota: 8th International Conference on Biological Invasions (Antalya, Turkey), November 2014, **Assessing the threat and potential for management of Berberis spp. (Berberidaceae) in South Africa**
- 42nd Annual Symposium on the Management of Invasive Alien Plants (Karridene Beach Hotel, Durban, South Africa)
- XXth Association for the Taxonomic Study of the Flora of Tropical Africa International Conference (Stellenbosch, South Africa), January 2014
- 41st Annual Symposium on the Management of Invasive Alien Plants (Cape St. Francis, South Africa), May 2013

EIA and other surveys

- Specialist Invasive Alien Plant Species Report: Prepared for: Mpact Corrugated, Kuils River (Western Cape), July 2019
- Proposed Township development, Country view, Gauteng: Biodiversity Impact Assessment (Flora) – Specialist Report prepared for Zone Land Solutions (PTY) Ltd, July 2015
- Colenso Anthracite Coal Mining and Power Station Project: Biodiversity Impact Assessment (Flora) – Specialist Report prepared for Zone Land Solutions (PTY) Ltd, July 2015