BOTANICAL SCOPING REPORT FOR THE PROPOSED SOYUZ 4 WIND ENERGY FACILITY, NORTHERN CAPE PROVINCE

Prepared for:

Soyuz 4 (Pty) Ltd

Prepared by:

Biodiversity Africa

30 Chudleigh Road
Plumstead, 7800
Cape Town, Western Cape

June 2022

Details of Company

Name	Biodiversity Africa
Email	Tarryn@biodiversityafrica.com
Tel	071 332 3994 or 078 340 6295
Address	30 Chudleigh Road Plumstead, 7800 Cape Town

Author

Tarryn Martin (Botanical Specialist) (*Pri. Sci. Nat* 008745)

Tarryn has over ten years of experience working as a botanist, nine of which are in the environmental sector. She has worked as a specialist and project manager on projects within South Africa, Mozambique, Lesotho, Zambia, Tanzania, Cameroon, Swaziland and Malawi. The majority of these projects required lender finance and consequently met both in-country and lender requirements.

Tarryn has extensive experience writing botanical impact assessments, critical habitat assessments, biodiversity management plans, biodiversity monitoring plans and Environmental Impact Assessments to International Standards, especially to those of the International Finance Corporation (IFC). Her experience includes working on large mining projects such as the Kenmare Heavy Minerals Mine, where she monitored forest health, undertook botanical impact assessments for their expansion projects and designed biodiversity management and monitoring plans. She has also project managed Environmental Impact Assessments for graphite mines in northern Mozambique and has a good understanding of the Mozambique Environmental legislation and processes.

Tarryn holds a BSc (Botany and Zoology), a BSc (Hons) in African Vertebrate Biodiversity and an MSc with distinction in Botany from Rhodes University. Tarryn's Master's thesis examined the impact of fire on the recovery of C3 and C4 Panicoid and non-Panicoid grasses within the context of climate change for which she won the Junior Captain Scott-Medal (Plant Science) for producing the top MSc of 2010 from the South African Academy of Science and Art as well as an Award for Outstanding Academic Achievement in Range and Forage Science from the Grassland Society of Southern Africa.

Tarryn is a professional member of the South African Council for Natural Scientific Professionals (since 2014).

Declaration of Independence

Tarryn Martin (Botanical Specialist)

- I, Tarryn Martin, declare that, in terms of the National Environmental Management Act, 1998 (Act No. 107 of 1998), as amended and the Amended Environmental Impact Assessment Regulations, 2017;
- I act as the independent specialist in this application;
- I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant;
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting the specialist report relevant to this application, including knowledge of the Act, Regulations and any guidelines that have relevance to the proposed activity;
- I will comply with the Act, Regulations and all other applicable legislation;
- I have no, and will not engage in, conflicting interests in the undertaking of the activity;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the application by the competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- All the particulars furnished by me in this report are true and correct; and
- I realise that a false declaration is an offence in terms of regulation 48 and is punishable in terms of section 24F of the Act.

…….. ……

SIGNED DATE

Non-Technical Summary

Introduction

The applicant Soyuz 4 (Pty) Ltd is proposing the development of a commercial Wind Energy Facility (WEF) and associated infrastructure on a site located approximately 23 km South East of Britstown within the Emthanjeni Local Municipality and the Pixley ka Seme District Municipality in the Northern Cape Province.

Five additional WEF's are concurrently being considered on the surrounding properties and are assessed by way of separate impact assessment processes in accordance with the 2014 Environmental Impact Assessment Regulations (GN No. R982, as amended) for listed activities contained in Listing Notices 1, 2 and 3 (GN R983, R984 and R985, as amended). These projects are known as Soyuz 1 WEF, Soyuz 2 WEF, Soyuz 3 WEF, Soyuz 5 WEF and Soyuz 6 WEF.

It is proposed that the WEF will comprise of up to 75 turbines with a contracted capacity of up to 480 MW and will have an actual (permanent) footprint of up to 150 ha.

Methodology

A desktop assessment was undertaken prior to the site visit to determine the vegetation types present, identify species of conservation concern that might occur on site and identify the conservation status of the project site. This was followed by a field survey which was undertaken during the late flowering season from 10-20 March 2022. The purpose of the survey was to assess the site-specific botanical state of the project area by recording the species present (both indigenous and alien invasive species), identifying sensitive ecosystems such as rocky outcrops, riparian areas or areas with species of conservation concern, and identifying the current land use.

The project site is located within the Nama-Karoo Biome which is situated on the central plateau of the western half of South Africa extending into south-eastern Namibia. This region is characterised by an arid climate with most rainfall occurring over the summer months (December to April).

Results

Two vegetation types were recorded within the project site; Eastern Upper Karoo and Upper Karoo Hardeveld.

Eastern Upper Karoo

The Eastern Upper Karoo vegetation type is the dominant vegetation type within the project site. occurring on gently sloping plains that are typically interspersed with rocky areas of Upper Karoo Hardeveld. This vegetation type is characterised by dwarf microphyllous shrubs interspersed with grasses such as *Aristida* and *Eragrostis.* Although the vegetation present is near natural, it does show evidence of disturbance from grazing.

Within the project site there were distinct differences in species assemblages within this vegetation type. Areas characterised by shallow calcrete soils were dominated by dwarf karoo scrub with a low grass cover. Species assemblages included *Eriocephalus ericoides, Chrysocoma ciliata, Pentzia incana, Ruschia intricata, Aptosimum spinescens* and *Asparagus exvuvialis. Chrysocoma ciliata* typically colonises over-grazed areas characterised by disturbance and as such indicates that areas where it is abundant are considered degraded.

Species assemblages within washes were similar to those observed within the shallow calcrete soils and were dominated by dwarf karoo scrub dominated by *Chrysocoma ciliata.* Grass cover in these areas was sparse.

Deeper soils typically had a higher grass cover and fewer shrubs. Species assemblages included *Chloris virgata, Aristida congesta, Aristida diffusa, Eriocephalus ericoides, Eragrostis lehmanniana, Stipagrostis ciliata* and *Pentzia incana*.

Eastern Upper Karoo is listed as Least Concern with a conservation target of 21%. Although listed as poorly protected, current data indicates that 97% of this vegetation type remains intact.

Upper Karoo Hardeveld

This vegetation type is relatively widespread and is associated with steep slopes and ridges including dolerite dykes and sills that form mesas, buttes and koppies within the site. These areas are typically more diverse than the Eastern Upper Karoo and includes species such as *Searsia burchelli, Euclea coriacea, Lycium cinereum, Lycium horridus, Diospyros lycioides, Boophone disticha, Aloe claviflora, Hermannia cf. vestita, Cheilanthes eckloniana, Themeda triandra* as well as on occasion succulents such as *Stomatium mustellinum* and *Curio radicans.*

Upper Karoo Hardeveld is listed as Least Concern and has a conservation target of 21%. Although listed as poorly protected, it is estimated that 100% of the natural remaining extent is intact.

Floristics

A total of 81 species from 35 families were recorded within the project site. Of the 81 recorded species, 75 species are listed as least concern and six are listed as Not Evaluated. No Species of Conservation Concern (SCC) were recorded on site and no SCC were identified in the Plants of Southern Africa (POSA) database for the general area.

The DFFE screening report for the project site lists one SCC (*Tridentea virescens*) that could occur within the site. Properties further south also list *Hereroa concava* as possibly occurring within the area and as such the likelihood of occurrence for both species was assessed. *Hereoa concava* was determined to have a moderate likelihood of occurrence on shale plateaus and outcrops and *Tridentea virescens* was determined to have a high likelihood of occurrence within the washes present on site. Since these two species are associated with specific niche habitats, project infrastructure can be placed to avoid impacting these populations should they be found on site.

Sensitivity

The turbines and access roads are mostly situated within Eastern Upper Karoo with some infrastructure occurring in the Upper Karoo Hardeveld and one roads occurring within the Wash. The SEI for these vegetation types have been assessed and Upper Karoo Hardeveld is of Medium Sensitivity and Eastern Upper Karoo is of low sensitivity meaning that construction within these areas is permissible from a botanical perspective.

Vegetation associated with the washes was assigned a high SEI. Where feasible, it is recommended that infrastructure should avoid being located within these areas. Road crossings would be permissible.

The species environmental guideline document states for areas of medium sensitivity, development activities of medium impact are acceptable and for areas with a low SEI, development activities of medium to high impact are acceptable. In both instances these must be followed by appropriate restoration activities.

Some infrastructure is located within an ESA. The biodiversity features driving the ESA classification includes all natural wetlands and rivers and it is therefore recommended that infrastructure is placed outside of the ESA and where this is not feasible the footprint within the ESA is minimised.

Recommendations

It is recommended that the following conditions are included in the Final EMPr as well as the conditions of the Environmental Authorisation (EA), if granted:

- The remaining vegetation within the property should remain intact so that it can continue to function as an ecological corridor for species movement.
- All necessary plant permits must be obtained prior to the commencement of any construction activities.
- Where feasible, laydown areas must be placed in previously disturbed sites.
- A walkthrough of the final layout must be undertaken by a botanist and if populations of SCC will be impacted, infrastructure should be moved to avoid these areas. Where this is not feasible, a search and rescue plan will be required.
- If any SCC are to be impacted, these must be relocated to nearest appropriate habitat.
- Construction vehicles and machinery must not encroach into identified 'no-go' areas or areas outside the project footprint.
- Topsoil (20 cm, where possible) must be collected and stored in an area of low sensitivity and used to rehabilitate impacted areas that are no longer required during the operational phase (e.g. laydown areas).
- Employees must be prohibited from collecting any plants.
- Alien invasive plant clearing should be undertaken in line with an Alien Vegetation Management plan, which should be compiled as part of the EMPr and implemented with immediate effect.

- Only indigenous plant species typical of the local vegetation and approved by a botanist should be used for the rehabilitation of natural habitat.

Conclusion

Project infrastructure should be designed to avoid sensitive features such as the washes. Further to the above, impacts on the terrestrial plant species and associated habitats can be reduced to acceptable levels through the implementation of mitigation measures. The specialist is therefore of the opinion that the development can proceed provided the recommendations contained in this report are implemented

Table of Contents

1. Introduction 15

1.1. Project Description 15

1.2. Objectives 19

1.3. Limitations and Assumptions 19

2. Methodology 20

2.1. Project Area 20

2.2. DFFE Screening Report 20

2.3. International Finance Corporation 20

2.4. Desktop Assessment 21

2.5. Field Survey 22

2.6. Site Sensitivity Assessment 24

2.7. Description of impact analysis methodology used 24

3. Description of the receiving environment 29

3.1. Biophysical Description 29

3.2. Vegetation 30

3.2.1. Eastern Upper Karoo 30

3.2.2. Northern Upper Karoo 31

3.2.3. Upper Karoo Hardeveld 31

3.3. Floristics 35

3.4. **Alien Species** 36

4. Sensitivity Assessment 37

4.1. Northern Cape Biodiversity Spatial Plan 37

4.2. Site sensitivity 39

5. Impact Assessment 42

5.1. Construction and Operational Phase Impacts 42

6. Conclusions and Recommendations 43

6.1. Conclusions 43

6.2. Recommendations 43

6.3. Ecological Statement and Opinion of the Specialist 44

7. References 45

Appendix 1: Plant Species recorded on site 46

Appendix 2: Proof of SACNASP registration and highest qualification 48

Appendix 3: CV 50

List of Figures

Figure 1.1: Location of the WEF cluster in relation to the towns of De Aar and Britstown. Soyuz 4 WEF is located in the south west. 17
Figure 1.2: Infrastructure map showing the position of the turbines, internal roads, substations, temporary laydown areas and warehousing and auxiliary buildings and batching plants..... 18
Figure 2.1: Map showing sample sites and tracks in relation to the WEF cluster and the Soyuz 4 WEF 23
Figure 3.1: National vegetation map for the project site 32
Figure 3.2: Photograph illustrating Eastern Upper Karoo vegetation occurring on plains with shallow calcrete soils and dominated by dwarf succulent shrubs..... 32
Figure 3.3: Photograph illustrating the washes that occur in the Eastern Upper Karoo vegetation.... 33
Figure 3.4: Photograph illustrating Eastern Upper Karoo vegetation occurring on plains with deeper soils and characterised by a high grass cover 33
Figure 3.5: Photograph illustrating Upper Karoo Hardeveld vegetation occurring on mesas and buttes 34
Figure 3.6: Vegetation map for the project site based on data gathered from the field survey 34
Figure 4.1: Map illustrating the project site in relation to CBAs and ESAs. 38
Figure: 4.2: Sensitivity map of the proposed project site showing areas of high, moderate and low sensitivity. 41

List of Tables

Table 2.1: Summary of DFFE screening report themes relevant to this study 20
Table 2.1: Criteria for establishing Site Ecological importance and description of criteria 24
Table 2.2: Evaluation Criteria. 25
Table 2.3: Description of Overall Significance Rating 27
Table 2.4: Post-mitigation Evaluation Criteria 28
Table 3.1: Number of families and species recorded within the project site. 35
Table 3.2: Assessment of the likelihood of occurrence of SCC identified in the literature as possibly occurring within the site. 36
Table 3.3: List of exotic plant species recorded on site 36
Table 4.2: Sensitivity assessment for each vegetation type within the project site 39

Glossary of Terms

Alien Invasive Species refers to an exotic species that can spread rapidly and displace native species causing damage to the environment

Biodiversity is the term that is used to describe the variety of life on Earth and is defined as "*the variability among living organisms from all sources including terrestrial, marine and other aquatic ecosystems, and the ecological complexes of which they are part; this includes diversity within species, between species, and of ecosystems*" (Secretariat of the Convention on Biological Diversity, 2005).

Habitat Fragmentation occurs when large expanses of habitat are transformed into smaller patches of discontinuous habitat units isolated from each other by transformed habitats such as farmland.

Natural Habitat refers to habitats composed of viable assemblages of plant and/or animal species of largely native origin and/or where human activity has not essentially modified an area's primary ecological function and species composition.

Project Area is defined as the area that will be directly impacted by project infrastructure such as the roads, turbine hardstands and offices.

Project area of influence (PAOI) refers to the broader area around the project area that may be indirectly impacted by project activities.

Protected Area is a clearly defined geographical space, recognised, dedicated and managed, through legal or other effective means, to achieve the long-term conservation of nature with associated ecosystem services and cultural values**.** *(IUCN Definition 2008)*

Acronyms

CBA	Critical Biodiversity Area
CR	Critically Endangered
CCR	Core Cape Subregion
ECO	Environmental Control Officer
EN	Endangered
EIA	Environmental Impact Assessment
EOO	Extent of Occupancy
GBIF	Global Biodiversity Information Facility
GIS	Geographical Information System
IUCN	International Union for Conservation of Nature
LC	Least Concern
MTS	Municipal Transformer Station
NEMBA	National Environmental Management Biodiversity Act
PNCO	Provincial Nature Conservation Ordinance
SCC	Species of Conservation Concern
QDS	Quarter Degree Square
SA	South Africa
SANBI	South African National Biodiversity Institute
SCC	Species of Conservation Concern
TOPS	Threatened and Protected Species
VU	Vulnerable

Specialist Check List

The contents of this specialist report complies with the legislated requirements as described in the Protocol for the Specialist Assessment and Minimum Report Content Requirements for Environmental Impacts on Terrestrial Biodiversity (GN R. 320 of 2020).

SPECIALIST REPORT REQUIREMENTS ACCORDING TO GN R. 320			SECTION OF REPORT
3.1	The Terrestrial Biodiversity Specialist Assessment Report must contain, as a minimum, the following information:		
	3.1.1	Contact details of the specialist, their SACNASP registration number, their field of expertise and a curriculum vitae;	Page 2 Appendix 2 and 3
	3.1.2	A signed statement of independence by the specialist;	Page 3
	3.1.3	A statement of the duration, date and season of the site inspection and the relevance of the season to the outcome of the assessment;	Section 2.5
	3.1.4	A description of the methodology used to undertake the site verification and impact assessment and site inspection, including equipment and modelling used, where relevant;	Chapter 2
	3.1.5	A description of the assumptions made and any uncertainties or gaps in knowledge or data as well as a statement of the timing and intensity of site inspection observations;	Section 1.3
	3.1.6	A location of the areas not suitable for development, which are to be avoided during construction and operation (where relevant);	Chapter 4
	3.1.7	Additional environmental impacts expected from the proposed development;	Chapter 5
	3.1.8	Any direct, indirect and cumulative impacts of the proposed development;	TBD
	3.1.9	The degree to which the impacts and risks can be mitigated;	TBD
	3.1.10	The degree to which the impacts and risks can be reversed;	
	3.1.11	The degree to which the impacts and risks can cause loss of irreplaceable resources;	
	3.1.12	Proposed impact management actions and impact management outcomes proposed by the specialist for inclusion in the Environmental Management Programme (EMPr);	Section 6.2
	3.1.13	A motivation must be provided if there were development footprints identified as per paragraph 2.3.6 above that were identified as having a “low” terrestrial biodiversity sensitivity and that were not considered appropriate;	N/A
	3.1.14	A substantiated statement, based on the findings of the specialist assessment, regarding the acceptability, or not, of the proposed development, if it should receive approval or not; and	Section 6.3
	3.1.15	Any conditions to which this statement is subjected.	Section 6.2
3.2	The findings of the Terrestrial Biodiversity Specialist Assessment must be incorporated into the Basic Assessment Report or the Environmental Impact Assessment Report, including the mitigation and monitoring measures as identified, which must be incorporated into the EMPr where relevant.		✓
3.3	A signed copy of the assessment must be appended to the Basic Assessment Report or Environmental Impact Assessment Report.		

1. INTRODUCTION

1.1. Project Description

The applicant Soyuz 4 (Pty) Ltd is proposing the development of a commercial Wind Energy Facility (WEF) and associated infrastructure on a site located approximately 46 km South of Britstown within the Ubuntu Local Municipality and the Pixley ka Seme District Municipality in the Northern Cape Province (Figure 1.1).

Five additional WEF's are concurrently being considered on the surrounding properties and are assessed by way of separate impact assessment processes in accordance with the 2014 Environmental Impact Assessment Regulations (GN No. R982, as amended) for listed activities contained in Listing Notices 1, 2 and 3 (GN R983, R984 and R985, as amended). These projects are known as Soyuz 1 WEF, Soyuz 2 WEF, Soyuz 3 WEF, Soyuz 5 WEF and Soyuz 6 WEF.

A preferred project site with an extent of approximately 125 000 ha has been identified as a technically suitable area for the development of the six WEF projects. It is proposed that each WEF will comprise of up to 75 turbines with a contracted capacity of up to 480 MW and will have an actual (permanent) footprint of up to 150 ha.

The Soyuz 4 WEF project site covers approximately 14 200 ha and comprises the following farm portions:

- The Farm Altringham No. 19
- The Farm No. 18
- Remaining Extent of the Farm Allemans Dam No. 17
- Remaining Extent (Portion 0) of the Farm Allemans Combuis No. 1
- Remaining Extent of Portion 1 of the Farm Combuisfonteion No. 142
- Portion 1 of the Farm Allemans Dam No. 17.

The Soyuz 4 WEF project site is proposed to accommodate the following infrastructure, which will enable the wind farm to supply a contracted capacity of up to 480 MW (Figure 1.2):

- Up to 75 wind turbines with a maximum hub height of up to 160 m and a rotor diameter of up to 200 m;
- A transformer at the base of each turbine;
- Concrete turbine foundations;
- Turbine, crane and blade hardstands;
- Temporary laydown areas (with a combined footprint of up to 14 ha) which will accommodate the boom erection, storage and assembly area;
- Battery Energy Storage System (with a footprint of up to 5 ha);
- Cabling between the turbines, to be laid underground where practical;

- Two on-site substations with a combined footprint of up to 4 ha in extent to facilitate the connection between the wind farm and the electricity grid;
- Access roads to the site and between project components inclusive of stormwater infrastructure. A 12 m wide road corridor may be temporarily required during construction and then rehabilitated to 6m wide permanent road after construction. The WEF will have a total road network of up to 125 km.
- A temporary site camp establishment and concrete batching plants (with a combined footprint of up to 2 ha); and
- Operation and Maintenance buildings (with a combined footprint of up to 2 ha) including a gate house, security building, control centre, offices, warehouses, a workshop and visitor's centre.

In order to evacuate the energy generated by the WEF to the national grid, a separate Basic Assessment will be undertaken to assess two grid connection alternatives:

- Alternative 1: A 132 / 400kV overhead powerline (OHL) within a 500 m wide assessment corridor from the Switching Station on site to a proposed new 132 / 400 kV MTS located north of the WEF and adjacent to the Hydra – Kronos 400 kV line.

- Alternative 2: A 132 / 400 kV overhead powerline (OHL) within a 500 m assessment corridor from the Switching Station on site to a proposed new 132 / 400 kV MTS located south of the WEF and adjacent to the Droerivier - Hydra 400 kV line.

The EA applications for the wind farm project and grid connection infrastructure are being undertaken in parallel as they are co-dependent, i.e. one will not be developed without the other.

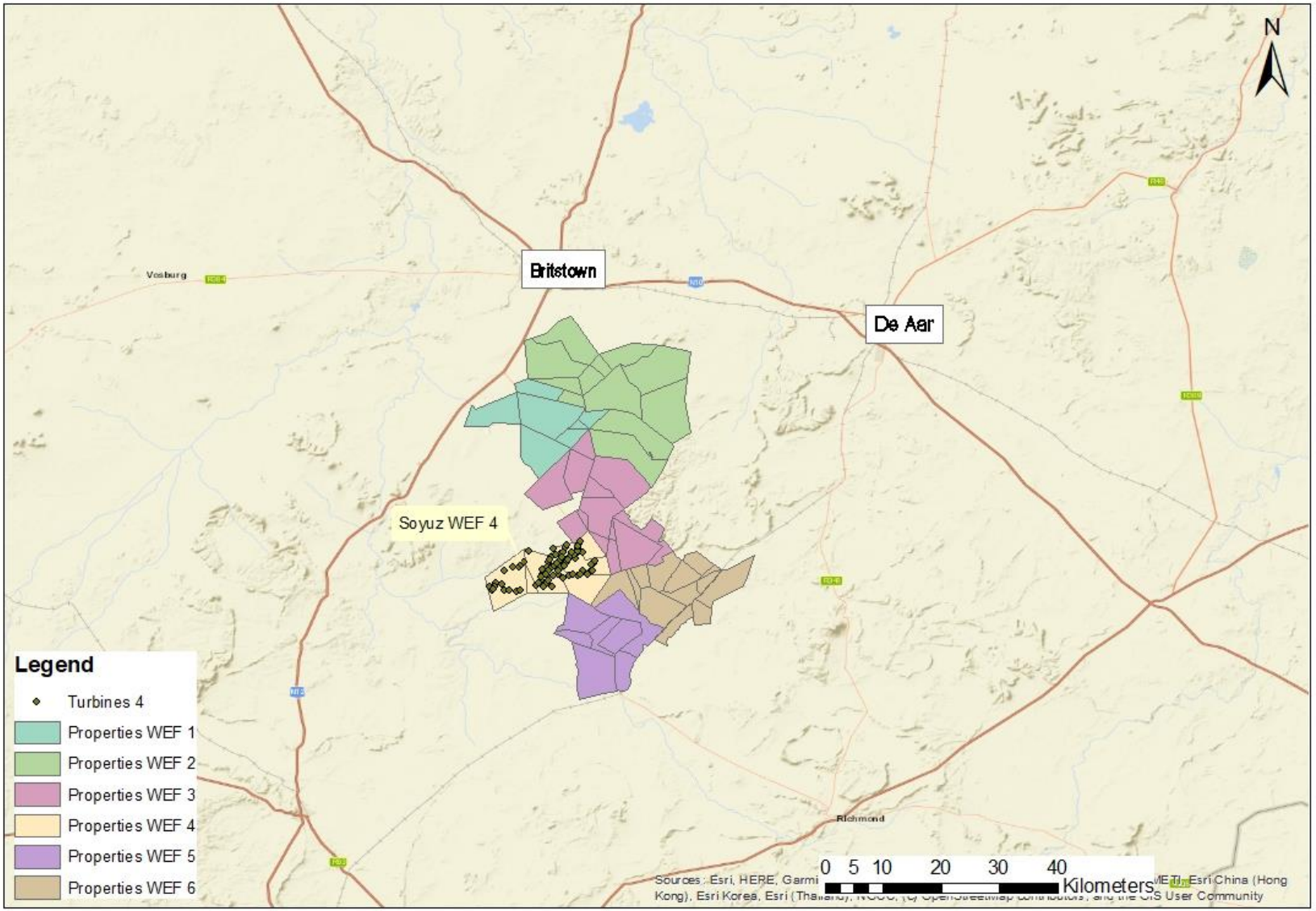


Figure 1.1: Location of the WEF cluster in relation to the towns of De Aar and Britstown. Soyuz 4 WEF is located in the south west.

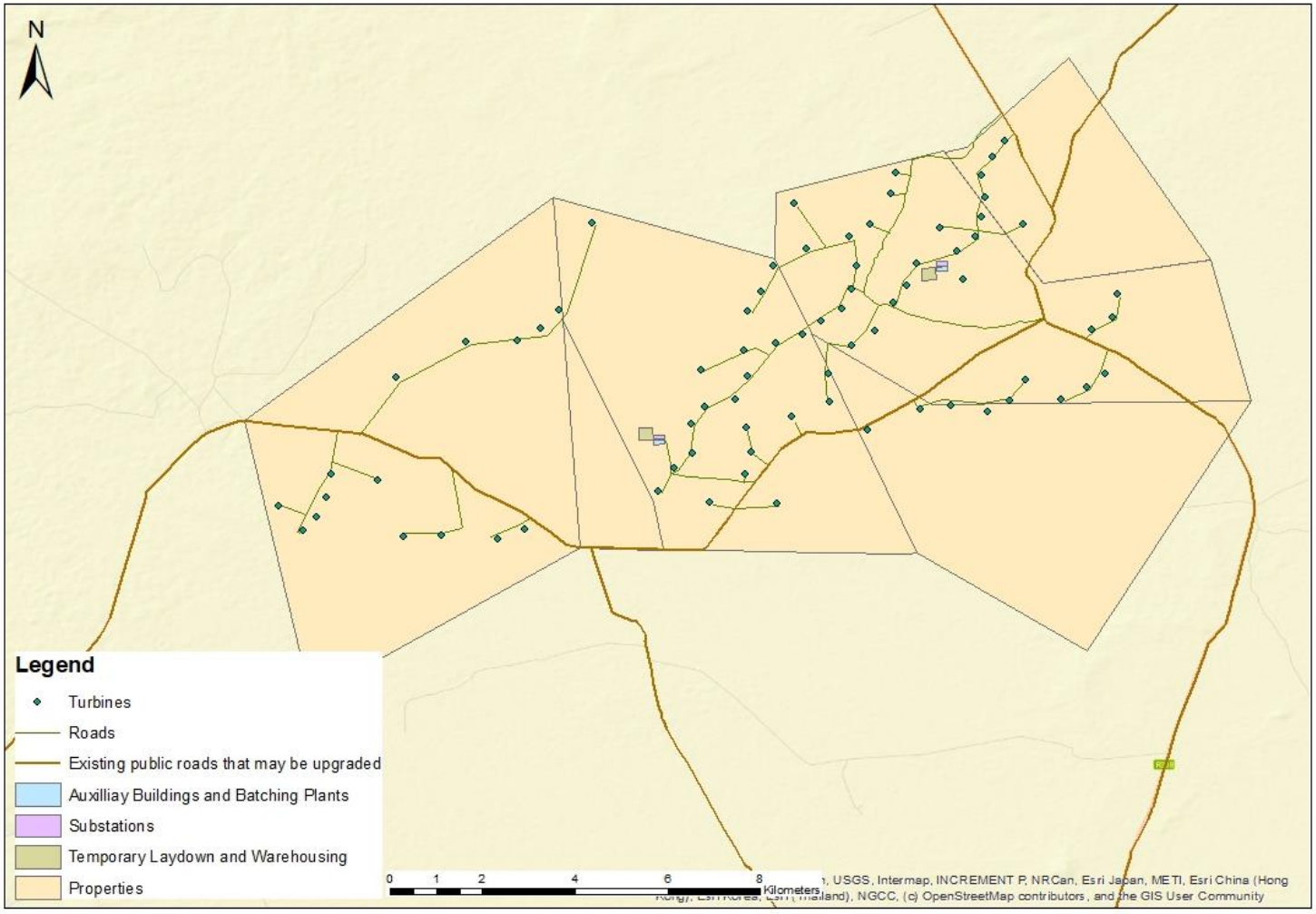


Figure 1.2: Infrastructure map showing the position of the turbines, internal roads, substations, temporary laydown areas and warehousing and auxiliary buildings and batching plants

1.2. Objectives

The objectives of the botanical assessment are as follows:

- Undertake a desktop assessment of the site to determine its sensitivity and species of conservation concern (SCC) that could be present within the site.
- Undertake a field survey, to record the following information:
    - Species present
    - Identification of species that are either protected (TOPS and PNCO) or considered threatened (CR, EN, VU) on the South African Red Data List
    - Assess the level of degradation/ecological status of the site (i.e. intact, near natural, transformed).
- Assess the sensitivity of each site using the sensitivity analysis outlined in the Species Environmental Guideline Document (2021).
- For areas of moderate and high sensitivity, assess the impact that the construction of the project infrastructure will have on the vegetation and plant SCC.
- Where necessary, provide mitigation measures to reduce the impact of the infrastructure on the environment.
- Provide a specialist statement/opinion.

1.3. Limitations and Assumptions

This report is based on current available information and, as a result, the following limitations and assumptions are implicit:

- Species of Conservation Concern (SCC) are difficult to find and may be difficult to identify, thus species described in this report do not comprise an exhaustive list. It is almost certain that additional SCCs are present.
- Sampling could only be carried out at one stage in the annual or seasonal cycle. The survey was conducted in late summer when most plants were still in flower, but it is likely that some early flowering geophytes may have gone undetected. However, the time available in the field, and information gathered during the survey was sufficient to provide enough information to determine the status of the affected area.
- This is a botanical assessment and does not include an assessment of faunal species likely to occur on site. Faunal assessments have been done separately.
- The assessment has been undertaken to meet the Protocol for the Specialist Assessment and Minimum Report Requirements for Environmental Impacts on Terrestrial Biodiversity (2020), Species Environmental Assessment Guidelines (2021) and Performance Standard 6 of the International Finance Corporation (IFC) (2012).

2. METHODOLOGY

2.1. Project Area

The “project area” or “impacted project site” is defined as the area that will be directly impacted by project infrastructure during both construction (temporary) and operation (permanent), such as the roads, turbine hardstands and offices.

The project area of influence (PAOI) refers to the broader area around the project area that may be indirectly impacted by project activities.

2.2. DFFE Screening Report

The DFFE Screening report identifies environmental sensitivities for the project site. This is based on available desktop data and requires that a suitably qualified specialist verify the findings. Of relevance to this report is the plant species theme and the terrestrial biodiversity theme (Table 2.1). Comment has been provided in the table below indicating how these themes have been assessed.

Table 2.1: Summary of DFFE screening report themes relevant to this study

Theme	Sensitivity	Assessment
Plant Species Theme	Moderate • Likely presence of *Hereroa concave* (VU) • Likely presence of *Tridentea virescens* (Rare)	The likelihood of occurrence for these species was assessed (section 3.3) based on distribution records and available habitat on site.
Terrestrial Biodiversity Theme	Very High • Ecological support area present • Site occurs within a FEPA catchment	Comment has been provided on the impact of the project on the ESA present (section 4.1). The aquatic report will provide comment on the significance of the project occurring in the FEPA catchment.

2.3. International Finance Corporation

Since the project is to lenders standards, the survey and assessment needs to meet the standards set out by the International Finance Corporation (IFC). Of relevance to this project is IFC Performance

Standard (PS) 6 and the accompanying guidance notes which are used to guide biodiversity assessments in modified, natural and critical habitats. The aim of this PS is to protect and conserve biodiversity, maintain ecosystem services and promote the sustainable management and use of natural resources through the adoption of practices that integrate conservation needs and development (IFC, 2012b). Biodiversity assessments should therefore include the following:

- Direct and indirect project-related impacts on biodiversity and ecosystem services that include consideration of threats such as habitat loss, degradation and fragmentation, invasive alien species, overexploitation, hydrological changes, nutrient loading, and pollution.
- Baseline studies should include a literature review, stakeholder engagement and consultation, in-field surveys and other relevant assessments.
- For sites with potentially significant impacts on natural and critical habitats and ecosystem services, the baseline should include in-field surveys over multiple seasons. In-field surveys/assessments should be recent, and data should be acquired for the actual site of the project's facilities, including related and associated facilities, and the project's area of influence.
- Existing spatial data and landscape mapping should be included in the analysis, especially for areas located in natural and critical habitats.
- An accurate account of threats, including regional level threats that are relevant to the study area and its area of influence should be provided and any pre-existing threats and the extent to which the project might exacerbate them must be described.

South African Environmental Legislation is rigorous and aligned with the principals set out in the IFC. As such, the requirements listed above have been addressed in this report, with the exception of stakeholder engagement which is addressed in the EIA.

2.4. Desktop Assessment

A desktop assessment was undertaken prior to the site visit to determine the vegetation types present, identify species of conservation concern that might occur on site and identify the conservation status of the project site. Key resources were consulted including:

- The DFFE screening report for the site.
- The South African Vegetation Map (Mucina and Rutherford, 2018).
- The Northern Cape Biodiversity Spatial Planning Tool (2016).
- The IUCN Red List of Ecosystems for South Africa (SANBI, 2021).
- National Biodiversity Management: Biodiversity Act (NEMBA) List of Threatened or Protected Species.
- The National Biodiversity Assessment (SANBI, 2018).
- The Plants of Southern Africa (POSA) database.
- iNaturalist.

A species list was compiled for the site and the likelihood of occurrence assessed for species listed as Critically Endangered, Endangered, Vulnerable and Near Threatened (Section 3.3).

2.5. Field Survey

A field survey was undertaken during the late flowering season from 10-20 March 2022. The purpose of the survey was to assess the site-specific botanical state of the project area by recording the species present (both indigenous and alien invasive species), identifying sensitive ecosystems such as rocky outcrops, riparian areas or areas with species of conservation concern, and identifying the current land use.

The project site was walked, and sample plots were analysed by determining the dominant species in each plot, as well as any alien invasive species and potential SCC occurring within the plots. Each sample plot was sampled until no new species were recorded. Vegetation communities were then described according to the dominant species recorded from each type, and these were mapped and assigned a sensitivity score. Figure 2.1 illustrates the location of the sample plots. The entire WEF cluster was sampled and adequate data gathered for the vegetation types present to provide an assessment of the impacts of the project on the vegetation and species present.

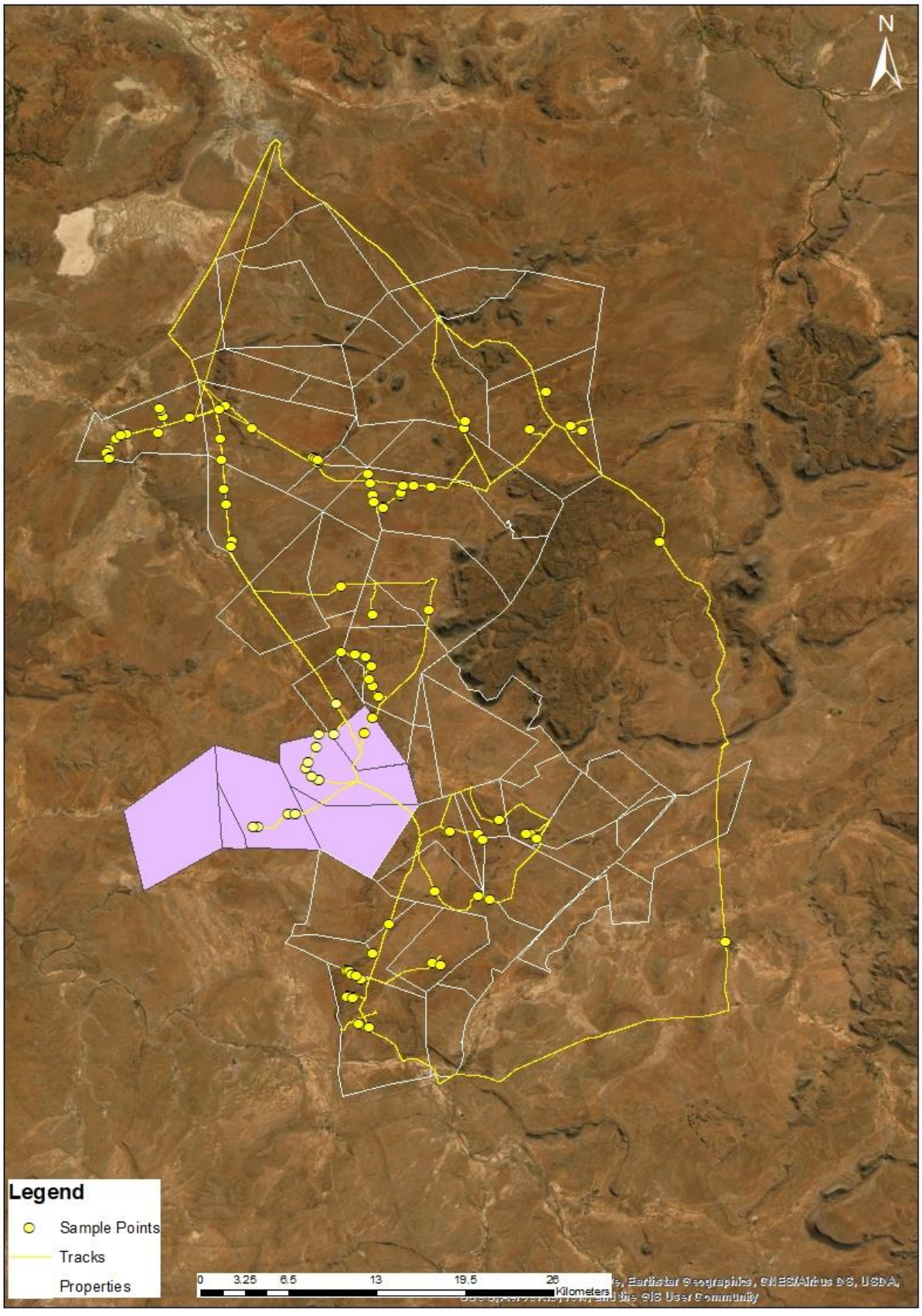


Figure 2.1: Map showing sample sites and tracks in relation to the WEF cluster and the Soyuz 4 WEF

2.6. Site Sensitivity Assessment

The Species Environmental Assessment Guideline (SANBI, 2021) was applied to assess the Site Ecological Importance (SEI) of the project area. The habitats and the species of conservation concern in the project area were assessed based on their conservation importance, functional integrity and receptor resilience (Table 2.1). The combination of these resulted in a rating of SEI and interpretation of mitigation requirements based on the ratings.

The sensitivity map was developed using available spatial planning tools as well as by applying the SEI sensitivity based on the field survey.

Table 2.1: Criteria for establishing Site Ecological importance and description of criteria

Criteria	Description
Conservation Importance (CI)	*The importance of a site for supporting biodiversity features of conservation concern present e.g. populations of Threatened and Near-Threatened species (CR, EN, VU & NT), Rare, range-restricted species, globally significant populations of congregatory species, and areas of threatened ecosystem types, through predominantly natural processes.*
Functional Integrity (FI)	*A measure of the ecological condition of the impact receptor as determined by its remaining intact and functional area, its connectivity to other natural areas and the degree of current persistent ecological impacts.*
Biodiversity Importance (BI) is a function of Conservation Importance (CI) and the Functional Integrity (FI) of a receptor.	
Receptor Resilience (RR)	*The intrinsic capacity of the receptor to resist major damage from disturbance and/or to recover to its original state with limited or no human intervention.*
Site Ecological Importance (SEI) is a function of Biodiversity Importance (BI) and Receptor Resilience (RR)	

2.7. Description of impact analysis methodology used

To ensure a balanced and objective approach to assessing the significance of potential impacts, a rating scale developed by CES has been created in accordance with the requirements outlined in Appendix 1 of the EIA Regulations (2014 and subsequent 2017 & 2021 amendments).

Impact significance pre-mitigation

This rating scale adopts six key factors to determine the overall significance of the impact prior to mitigation:

1. **Nature of impact:** Defines whether the impact has a negative or positive effect on the receiving environment.
2. **Type of impact:** Defines whether the impact has a direct, indirect or cumulative effect on the environment.

3. **Duration:** Defines the relationship of the impact to temporal scales. The temporal scale defines the significance of the impact at various time scales as an indication of the duration of the impact. This may extend from the short-term (less than 5 years, equivalent to the construction phase) to permanent. Generally, the longer the impact occurs the greater the significance of any given impact.
4. **Extent:** Describes the relationship of the impact to spatial scales i.e. the physical extent of the impact. This may extend from the local area to an impact that crosses international boundaries. The wider the spatial scale the impact extends, the more significant the impact is considered to be.
5. **Probability:** Refers to the likelihood (risk or chance) of the impact occurring. While many impacts generally do occur, there is considerable uncertainty in terms of others. The scale varies from unlikely to definite, with the overall impact significance increasing as the likelihood increases.
6. **Severity or benefits:** The severity/beneficial scale is used in order to scientifically evaluate how severe negative impacts would be, or how beneficial positive impacts would be on the receiving environment. The severity of an impact can be evaluated prior and post mitigation to demonstrate the seriousness of the impact if it is not mitigated, as well as the effectiveness of the mitigation measures. The word 'mitigation' does not only refer to 'compensation', but also includes concepts of containment and remedy. For beneficial impacts, optimization refers to any measure that can enhance the benefits. Mitigation or optimisation should be practical, technically feasible and economically viable.

For each impact, the duration, extent and probability are ranked and assigned a score. These scores are combined and used to determine the overall impact significance prior to mitigation. They must then be considered against the severity rating to determine the overall significance of an activity. This is because the severity of the impact is far more important than the other three criteria. The overall significance is either negative or positive (Criterion 1) and direct, indirect or cumulative (Criterion 2).

Table 2.2: Evaluation Criteria.

Duration (Temporal Scale)	
Short term	*Less than 5 years*
Medium term	*Between 5-20 years*
Long term	*Between 20 and 40 years (a generation) and from a human perspective also permanent*
Permanent	*Over 40 years and resulting in a permanent and lasting change that will always be there*
Extent (Spatial Scale)	
Localised	*At localised scale and a few hectares in extent*
Study Area	*The proposed site and its immediate environs*
Regional	*District and Provincial level*

National	*Country*	
International	*Internationally*	
Probability (Likelihood)		
Unlikely	*The likelihood of these impacts occurring is slight*	
May Occur	*The likelihood of these impacts occurring is possible*	
Probable	*The likelihood of these impacts occurring is probable*	
Definite	*The likelihood is that this impact will definitely occur*	
Severity Scale	*Severity*	*Benefit*
Very Severe/ Beneficial	An irreversible and permanent change to the affected system(s) or party(ies) which cannot be mitigated.	A permanent and very substantial benefit to the affected system(s) or party(ies), with no real alternative to achieving this benefit.
Severe/ Beneficial	Long term impacts on the affected system(s) or party(ies) that could be mitigated. However, this mitigation would be difficult, expensive or time consuming, or some combination of these.	A long-term impact and substantial benefit to the affected system(s) or party(ies). Alternative ways of achieving this benefit would be difficult, expensive or time consuming, or some combination of these.
Moderately severe/Beneficial	Medium to long term impacts on the affected system(s) or party (ies), which could be mitigated.	A medium to long term impact of real benefit to the affected system(s) or party(ies). Other ways of optimising the beneficial effects are equally difficult, expensive and time consuming (or some combination of these), as achieving them in this way.
Slight	Medium- or short-term impacts on the affected system(s) or party(ies). Mitigation is very easy, cheap, less time consuming or not necessary.	A short to medium term impact and negligible benefit to the affected system(s) or party(ies). Other ways of optimising the beneficial effects are easier, cheaper and quicker, or some combination of these.
No effect/don't or can't know	The system(s) or party(ies) is not affected by the proposed development.	In certain cases, it may not be possible to determine the severity of an impact.

** In certain cases, it may not be possible to determine the severity of an impact thus it may be determined: Don't know/Can't know.*

Table 2.3: Description of Overall Significance Rating

Significance Rate		*Description*
Don't Know		*In certain cases, it may not be possible to determine the significance of an impact. For example, the primary or secondary impacts on the social or natural environment given the available information.*
NO SIGNIFICANCE		*There are no primary or secondary effects at all that are important to scientists or the public.*
LOW NEGATIVE	***LOW POSITIVE***	*Impacts of low significance are typically acceptable impacts for which mitigation is desirable but not essential. The impact by itself is insufficient, even in combination with other low impacts, to prevent the development being approved. These impacts will result in negative medium to short term effects on the natural environment or on social systems.*
MODERATE NEGATIVE	**MODERATE POSITIVE**	*Impacts of moderate significance are impacts that require mitigation. The impact is insufficient by itself to prevent the implementation of the project but in conjunction with other impacts may prevent its implementation. These impacts will usually result in a negative medium to long-term effect on the natural environment or on social systems.*
HIGH NEGATIVE	***HIGH POSITIVE***	*Impacts that are rated as being high are serious impacts and may prevent the implementation of the project if no mitigation measures are implemented, or the impact is very difficult to mitigate. These impacts would be considered by society as constituting a major and usually long-term change to the environment or social systems and result in severe effects.*
VERY HIGH NEGATIVE	***VERY HIGH POSITIVE***	*Impacts that are rated as very high are very serious impacts which may be sufficient by itself to prevent the implementation of the project. The impact may result in permanent change. Very often these impacts are unmitigable and usually result in very severe effects or very beneficial effects.*

Impact significance post-mitigation

Once mitigation measures are proposed, the following three factors are then considered to determine the overall significance of the impact after mitigation.

1. **Reversibility Scale**: This scale defines the degree to which an environment can be returned to its original/partially original state.
2. **Irreplaceable loss Scale:** This scale defines the degree of loss which an impact may cause.
3. **Mitigation potential Scale:** This scale defines the degree of difficulty of reversing and/or mitigating the various impacts and ranges from very difficult to easily achievable. Both the practical feasibility

of the measure, the potential cost and the potential effectiveness is taken into consideration when determining the appropriate degree of difficulty.

Table 2.4: Post-mitigation Evaluation Criteria

Reversibility	
Reversible	*The activity will lead to an impact that can be reversed provided appropriate mitigation measures are implemented.*
Irreversible	*The activity will lead to an impact that is permanent regardless of the implementation of mitigation measures.*
Irreplaceable loss	
Resource will not be lost	*The resource will not be lost/destroyed provided mitigation measures are implemented.*
Resource will be partly lost	*The resource will be partially destroyed even though mitigation measures are implemented.*
Resource will be lost	*The resource will be lost despite the implementation of mitigation measures.*
Mitigation potential	
Easily achievable	*The impact can be easily, effectively and cost effectively mitigated/reversed.*
Achievable	*The impact can be effectively mitigated/reversed without much difficulty or cost.*
Difficult	*The impact could be mitigated/reversed but there will be some difficultly in ensuring effectiveness and/or implementation, and significant costs.*
Very Difficult	*The impact could be mitigated/reversed but it would be very difficult to ensure effectiveness, technically very challenging and financially very costly.*

The following assumptions and limitations are inherent in the rating methodology:

- Value Judgements: Although this scale attempts to provide a balance and rigor to assessing the significance of impacts, the evaluation relies heavily on the values of the person making the judgment.
- Cumulative Impacts: These affect the significance ranking of an impact because it considers the impact in terms of both on-site and off-site sources. This is particularly problematic in terms of impacts beyond the scope of the proposed development. For this reason, it is important to consider impacts in terms of their cumulative nature.
- Seasonality: Certain impacts will vary in significance based on seasonal change. Thus, it is difficult to provide a static assessment. Seasonality will need to be implicit in the temporal scale, with management measures being imposed accordingly (e.g. dust suppression measures being implemented during the dry season).

3. DESCRIPTION OF THE RECEIVING ENVIRONMENT

Climate, topography, geology and soils all influence the vegetation types and species present within an area. As such, a description of the biophysical features present within the site has been provided.

3.1. Biophysical Description

The project site is located within the Nama-Karoo Biome which is situated on the central plateau of the western half of South Africa extending into south-eastern Namibia (Mucina *et al.,* 2011). This region is characterised by an arid climate with most rainfall occurring over the summer months (December to April). Mean Annual Rainfall (MAR) increases from 70mm in the north-west (near the desert biome) to 500mm in the south-east with rainfall quantity and reliability increasing eastwards. The project site is located in the north-eastern portion of the biome, near Britstown, and receives a MAR of 165mm per annum (meteoblue.com, Accessed: 16-04-22) with mean annual highs reaching 32 ^{o}C and mean annual lows of 2^{o}C.

The Nama-Karoo is underlain by a succession of sedimentary rocks that includes the Cape Supergroup followed by Dwyka tillites and then other fossil rich sediments of the Karoo Supergroup (Mucina *et al.,* 2011). Volcanic activity in the area has resulted in intrusions of igneous rock resulting in the formation of dolerite sills and dykes. Igneous rock is more resistant to weathering than sedimentary rock resulting in the formation of mesas, buttes and plateaus within the biome. These features are often characterised by a higher species diversity than the low-lying flat areas.

Soils that have arisen from the sedimentary and igneous rock are typically weakly structured and skeletal (Mucina *et al.,* 2011). The project area is characterised by moderately deep, calcareous, sandy-clay loams which contain calcrete and calcareous horizons in the flat areas and shallow soils on the slopes and plateaus of the mesas and buttes.

The climatic variation, geology and soils associated with this region have given rise to a complex of plains and Hardeveld dominated by dwarf succulent shrubs interspersed with grasses, geophytes and annual herbs (Mucina *et al.,* 2011). Variation in the timing of the rainfall and the amount received between years has resulted in variation in the structure, cover and productivity of the vegetation present as well as a diversity of plant forms that range from ephemerals, annuals, geophytes, C_3 and C_4 grasses, succulents, deciduous and evergreen perennial shrubs and trees.

Other factors that have influenced the structure and composition of the vegetation within the biome include grazing of domestic livestock and wildlife, fires and rainfall. Increased grazing pressure or fire events followed by heavy rainfall makes this biome prone to erosion.

3.2. Vegetation

Vegetation types and distributions specific to the project site are described based on the National Vegetation Map (Figure 3.1) and data gathered during the field survey (Figure 3.6).

3.2.1. Eastern Upper Karoo

The Eastern Upper Karoo vegetation type is the dominant vegetation type within the project site. It is relatively widespread occurring in the Northern Cape, Eastern Cape and Western Cape Provinces between Carnarvon, Loxton, De Aar, Petrusville and Venterstad in the north, Burgersdorp, Hofmeyer and Cradock in the east and the Great Escarpment in the south (Mucina *et al.,* 2011).

It occurs on gently sloping plains that are typically interspersed with rocky areas of Upper Karoo Hardeveld in the west, Besemkaree Koppies Shrubland in the northeast and Tarkastad Montane shrubland in the southeast. This vegetation type is characterised by dwarf microphyllous shrubs interspersed with grasses such as *Aristida and Eragrostis.*

Eastern Upper Karoo occurs within the flat to gently sloping areas of the site and is broken up by high lying ridges of Upper Karoo Hardeveld (Figure 3.6). Although the vegetation present is near natural, it does show evidence of disturbance from grazing.

Within the project site there were distinct differences in species assemblages within this vegetation type. Areas characterised by shallow calcrete soils were dominated by dwarf karoo scrub with a low grass cover (Figure 3.2). Species assemblages included *Eriocephalus ericoides, Chrysocoma ciliata, Pentzia incana, Ruschia intricata, Aptosimum spinescens* and *Asparagus exvuvialis. Chrysocoma ciliata* typically colonises over-grazed areas characterised by disturbance and as such indicates that areas where it is abundant are considered degraded (Fitchett *et al.*, *2017)*.

Species assemblages within washes were similar to those observed within the shallow calcrete soils and were dominated by dwarf karoo scrub dominated by *Chrysocoma ciliata* (Figure 3.3). Grass cover in these areas was sparse.

Deeper soils typically had a higher grass cover and fewer shrubs. Species assemblages included *Chloris virgata, Aristida congesta, Aristida diffusa, Eriocephalus ericoides, Eragrostis lehmanniana, Stipagrostis ciliata* and *Pentzia incana* (Figure 3.4).

Eastern Upper Karoo is listed as Least Concern with a conservation target of 21%. Although listed as poorly protected, current data indicates that 97% of this vegetation type remains intact (RLE, 2021).

3.2.2. Northern Upper Karoo

The Northern Upper Karoo occurs in the Northern Cape and Free State Provinces and is described as a shrubland dominated by dwarf karoo shrubs, grasses and *Senegalia mellifera subsp. Detinens* (Mucina *et al.,* 2011).

This vegetation type is listed as Least Concern with a conservation target of 21%. Although listed as not protected, current data indicates that 94% of this vegetation type remains intact (RLE, 2021).

This vegetation type was not recorded on site.

3.2.3. Upper Karoo Hardeveld

This vegetation type is relatively widespread occurring in the Northern Cape, Eastern Cape and Western Cape Provinces between Middelpos, Strydenberg, Richmond and Nieu-Bethesda. It is associated with steep slopes and ridges including dolerite dykes and sills that form mesas, buttes and koppies, as well as parts of the Great Escarpment. These areas are typically covered by large boulders and rocks and support dwarf karoo scrub and grasses belonging to the genera *Aristida, Eragrostis and Stipagrostis* (Mucina *et al.,* 2011).

Upper Karoo Hardeveld occurred on the slopes and plateaus of the mesas and dykes present within the site (Figure 3.5). These areas are typically more diverse than the Eastern Upper Karoo and includes species such as *Searsia burchelli, Euclea coriacea, Lycium cinereum, Lycium horridus, Diospyros lycioides, Boophone disticha, Aloe claviflora, Hermannia cf. vestita, Cheilanthes eckloniana, Themeda triandra* as well as on occasion succulents such as *Stomatium mustellinum* and *Curio radicans.*

Upper Karoo Hardeveld is listed as Least Concern and has a conservation target of 21%. Although listed as poorly protected, it is estimated that 100% of the natural remaining extent is intact.

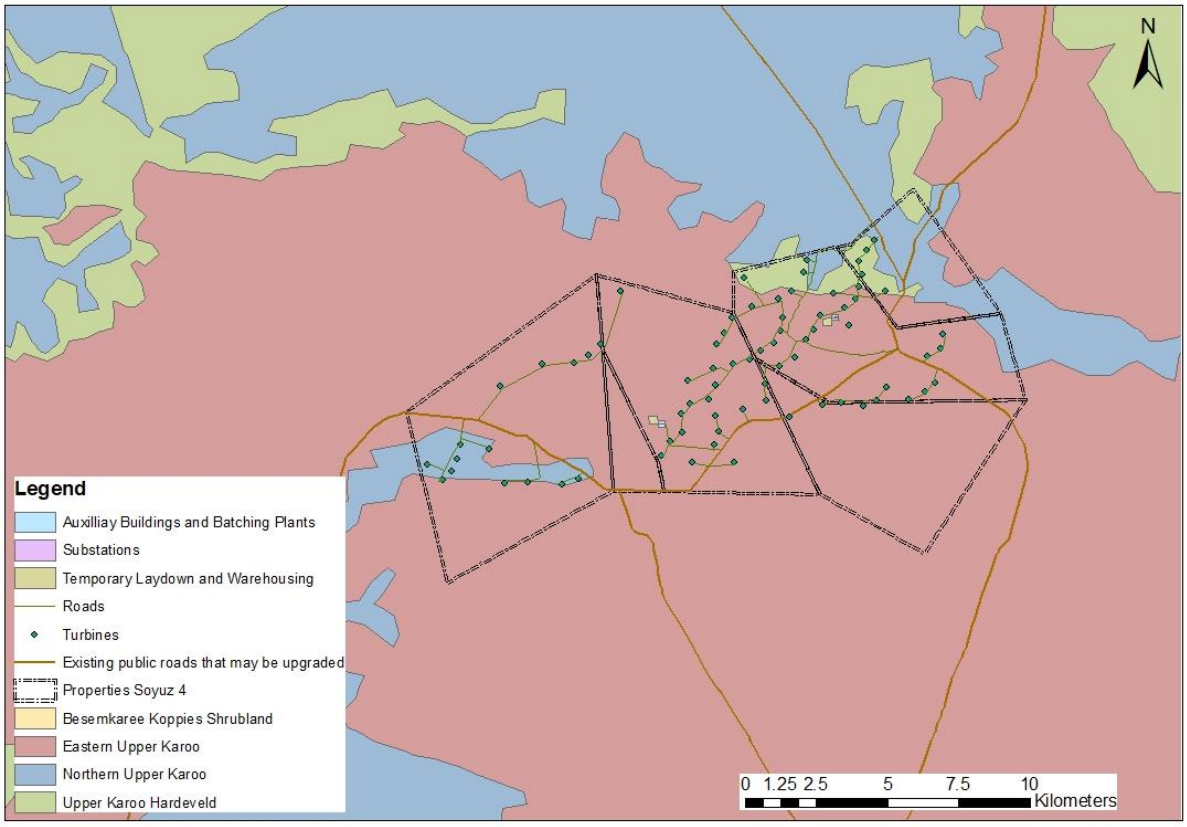


Figure 3.1: National vegetation map for the project site

Figure 3.2: Photograph illustrating Eastern Upper Karoo vegetation occurring on plains with shallow calcrete soils and dominated by dwarf succulent shrubs

Figure 3.3: Photograph illustrating the washes that occur in the Eastern Upper Karoo vegetation.

Figure 3.4: Photograph illustrating Eastern Upper Karoo vegetation occurring on plains with deeper soils and characterised by a high grass cover

Figure 3.5: Photograph illustrating Upper Karoo Hardeveld vegetation occurring on mesas and buttes

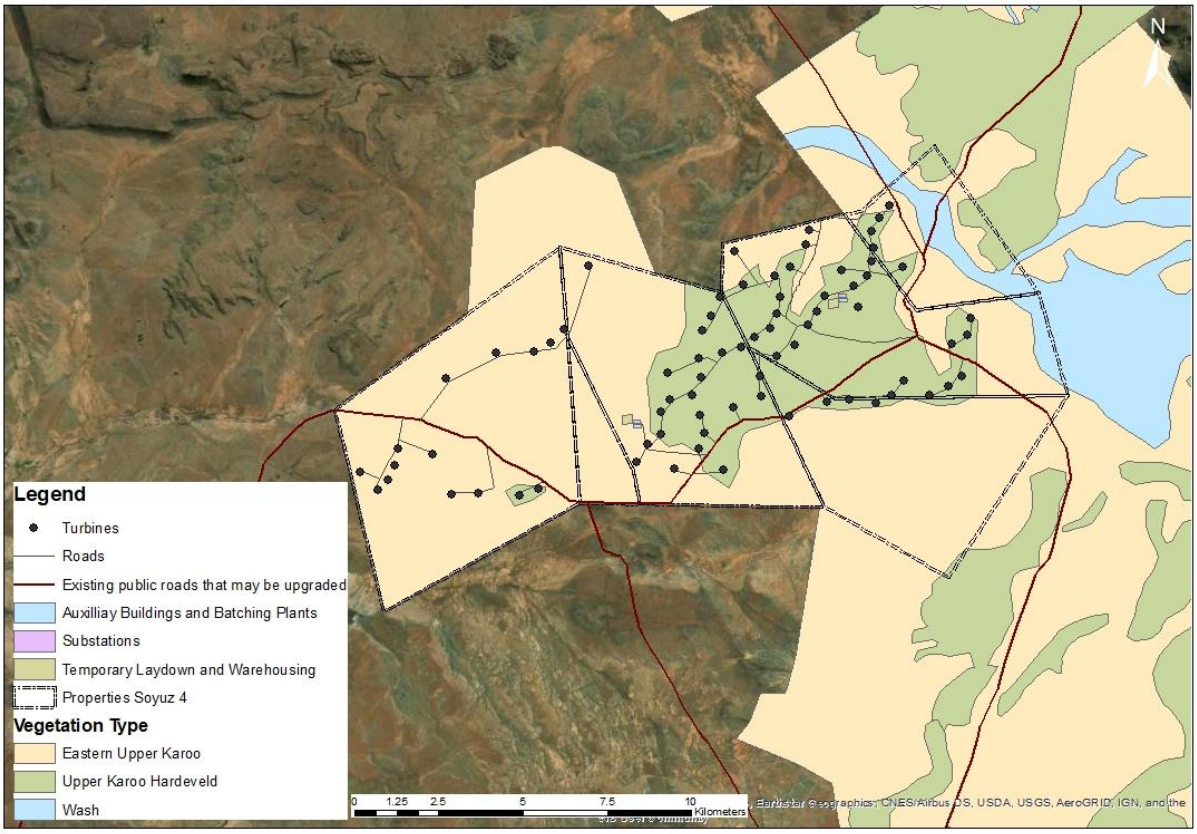


Figure 3.6: Vegetation map for the project site based on data gathered from the field survey

3.3. Floristics

A total of 81 species from 35 families were recorded within the project site (Table 3.1) (a full species list has been included in Appendix 1). The Asteraceae family had the highest number of species (13 species) followed by Poaceae (ten species), Amaranthaceae and Scrophulariaceae (both had four species) and then Aizoaceae, Anacardiaceae, Asparagaceae, Ebenaceae, Malvaceae and Solanaceae (all with three species). Of the 81 recorded species, 75 species are listed as least concern and six are listed as Not Evaluated. No Species of Conservation Concern (SCC) were recorded on site (refer to section 3.4 for further details) and no SCC were identified in the Plants of Southern Africa (POSA) database for the general area.

Although no SCC were recorded, one species is listed as Schedule 1 and fourteen as Schedule 2 species on the Northern Cape Nature Conservation Act (2009). These species will require permits for their removal/destruction if impacted by project infrastructure.

The DFFE screening report for the project site lists two SCC that could occur within the site:

- *Hereroa concava*
- *Tridentea virescens*

The likelihood of occurrence within the site was assessed for both species (Table 3.2). *Hereoa concava* was determined to have a moderate likelihood of occurrence on shale plateaus and outcrops and *Tridentea virescens* was determined to have a high likelihood of occurrence within the washes present on site. Since these two species are associated with specific niche habitats, project infrastructure can be placed to avoid impacting these populations should they be found on site.

Table 3.1: Number of families and species recorded within the project site.

FAMILY	Number of Species	FAMILY	Number of Species	FAMILY	Number of Species
ASTERACEAE	13	AMARYLLIDACEAE	2	HYACINTHACEAE	1
POACEAE	10	APOCYNACEAE	2	IRIDACEAE	1
AMARANTHACEAE	4	ASPHODELACEAE	2	LAMIACEAE	1
SCROPHULARIACEAE	4	CAMPANULACEAE	2	MELIANTHACEAE	1
AIZOACEAE	3	AGAVACEAE	1	OXALIDACEAE	1
ANACARDIACEAE	3	BIGNONIACEAE	1	PEDALIACEAE	1
ASPARAGACEAE	3	BRASSICACEAE	1	PTERIDACEAE	1
EBENACEAE	3	CACTACEAE	1	RUSCACEAE	1
FABACEAE	3	CARYOPHYLLACEAE	1	THYMELAEACEAE	1
MALVACEAE	3	CRASSULACEAE	1	VERBENACEAE	1
SOLANACEAE	3	CUCURBITACEAE	1	ZYGOPHYLLACEAE	1
ACANTHACEAE	2	EUPHORBIACEAE	1	HYACINTHACEAE	1

Table 3.2: Assessment of the likelihood of occurrence of SCC identified in the literature as possibly occurring within the site.

Family	Species	Status	Likelihood of Occurrence	Comment
AIZOACEAE	*Hereroa concava*	VU	Moderate	*Hereroa concava* is a poorly known species thought to occur between Beaufort West, Richmond and De Aar although its distribution range is unknown (Raimondo and von Staden, 2020). It has an estimated extent of occurrence (EOO) of 12 151km^2 and is known from 3 to 5 locations. This species is typically found to occur on flats and plateaus with shale outcrops. There are some shale outcrops present on site and as such this species may occur at these sites. The likelihood of occurrence is moderate.
APOCYNACEAE	*Tridentea virescens*	Rare	High	*Tridentea virescens* is widespread occurring from Warmbad in southern Namibia to Kakamas and Prieska in the Northern Cape and Prince Albert and Aberdeen in the Eastern Cape (Victor, 2009). This species is typically associated with stony ground and hard loam in floodplains. The washes present within the site offer suitable habitat although they show evidence of grazing and degradation. The likelihood of occurrence of this species is high.

3.4. **Alien Species**

Six exotic species were recorded within the project site (Table 3.3) and were typically found within disturbed sites such as along road verges. Of these six species, only one (*Opuntia ficus-indica*) is a listed (Category 1b) alien invasive species. The spread of a category 1b species is prohibited and as such an alien invasive management plan for the removal of this species must be included in the EMPr.

Table 3.3: List of exotic plant species recorded on site

Family	*Species*	Status
AGAVACEAE	*Agave americana*	Not Evaluated
AMARANTHACEAE	*Atriplex semibaccata*	Not Evaluated
AMARANTHACEAE	*Chenopodium phillipsianum*	Not Evaluated
CACTACEAE	*Opuntia ficus-indica*	Category 1b Invasive
AMARANTHACEAE	Salsola gemmifera	Not Evaluated
ANACARDIACEAE	*Schinus molle*	Not Evaluated

4. SENSITIVITY ASSESSMENT

4.1. Northern Cape Biodiversity Spatial Plan

The Northern Cape Critical Biodiversity Area Map (2016) maps biodiversity priority areas, including Critical Biodiversity Areas (CBAs), Ecological Support Areas (ESAs) and Other Natural Areas (ONAs) which require safeguarding to ensure the persistence of biodiversity and ecosystem functioning, through a systematic conservation planning process.

Critical Biodiversity Areas are defined in the NBA (2018) as *"areas required to meet biodiversity targets for ecosystems, species and ecological processes, as identified in a systematic biodiversity plan".* The provided map distinguishes between CBA 1 areas, which are those that are likely to be in a natural condition, and CBA 2 areas, which are areas that are potentially degraded or represent secondary vegetation.

ESA's are "*Areas that are not essential for meeting biodiversity targets, but that play an important role in supporting the functioning of Protected Areas (Pas) or CBAs and are often vital for delivering ecosystem services. They support landscape connectivity, encompass the ecological infrastructure from which ecosystem goods and services flow, and strengthen resilience to climate change*" (WCBSP Handbook, 2017). ESA's should be maintained in a functional and natural state although some habitat loss may be acceptable.

ONAs are "*Areas that have not been identified as a priority in the current biodiversity spatial plan but retain most of their natural character and perform a range of biodiversity and ecological infrastructure functions."* (WCBSP Handbook, 2017). Habitat and species loss must be minimised in ONAs.

Although there are CBAs and ESAs within the project area, only one ESA will be affected by project infrastructure (Figure 4.1). The biodiversity features driving the ESA classification includes all natural wetlands and rivers. It is recommended that infrastructure is placed to avoid this area, and where avoidance is not possible, minimise the footprint, to reduce the impact of the project on the functioning of the ESA. In this instance only a road is located within an ESA and as such impacts will be minimal.

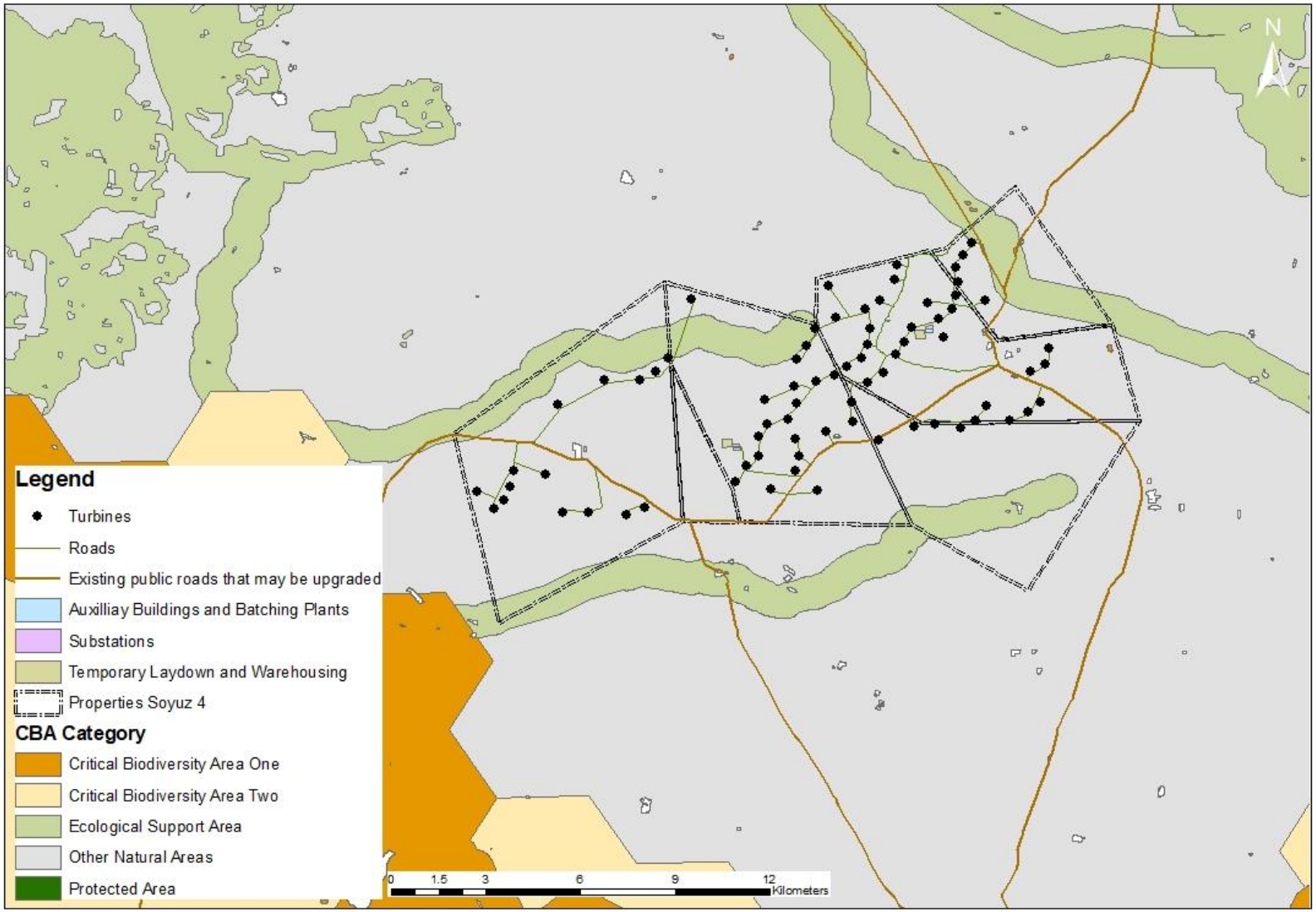


Figure 4.1: Map illustrating the project site in relation to CBAs and ESAs.

4.2. Site sensitivity

The Species Environmental Assessment guideline (SANBI, 2021) was applied to assess the Site Ecological Importance (SEI) of the project area. The habitats and the species of conservation concern in the project area were assessed based on their conservation importance, functional integrity and receptor resilience (Table 6.2). The combination of these resulted in a rating of SEI (Figure 4.2).

The Eastern Upper Karoo vegetation within the site shows evidence of disturbance from grazing pressure and although extensive has a low species diversity and low likelihood of SCC occurring within this unit. This vegetation type was found to have an SEI score of low (Table 4.2).

The Upper Karoo Hardeveld has a high species diversity with niche habitats for species only found on the slopes of the mesas and buttes that make up this vegetation type. This vegetation type has a medium SEI score.

The Washes (a subset of the Eastern Upper Karoo) could possibly contain populations of the vulnerable species *Tridentia virescens* and, based on the disturbed sites recorded on site, will have a medium resilience to disturbance. The overall SEI for this vegetation type is high.

Figure 4.2 illustrates that infrastructure is located within the Eastern Upper Karoo (Low SEI) and the Karoo Hardeveld (Medium SEI). No infrastructure is located within the washes (High SEI).

Table 4.2: Sensitivity assessment for each vegetation type within the project site

Habitat / Species	Conservation Importance (CI)	Functional Integrity (FI)	BI	Receptor Resilience	SEI
Eastern Upper Karoo	Low	High	Medium	High	**Low**
	No confirmed or highly likely populations of SCC or range restricted species	Good habitat connectivity of near-intact vegetation that shows some evidence of past and current disturbance		The Eastern Upper Karoo has a relatively low species diversity with a high grass cover and shows evidence of past and current disturbance in the form of grazing. It is therefore anticipated that the Eastern Upper Karoo that does not occur within a wash will recover to its current state relatively quickly (less than 10 years). **The Eastern Upper Karoo found within the washes has been assessed separately under "wash".	
Upper Karoo Hardeveld	Low	High	Medium	Medium	**Medium**
	No confirmed or highly likely populations of SCC or range restricted species	Good habitat connectivity of near-intact vegetation that shows some		The Upper Karoo Hardeveld has a higher species diversity than the Eastern Upper Karoo with a number of species present in niche rocky outcrops that are not present on the flat and expansive Eastern Upper Karoo. These areas are also more susceptible to erosion. To	

Habitat / Species	Conservation Importance (CI)	Functional Integrity (FI)	BI	Receptor Resilience	SEI
		evidence of past and current disturbance		rehabilitate these sites to 70% of their current species composition would take more than 10 years.	
Wash	High	High	High	Medium	**High**
	Highly likely occurrence of *Tridentea virescens*	Good habitat connectivity of near-intact vegetation that shows some evidence of past and current disturbance		The washes are characterised by the presence of dwarf karoo shrubs. In areas that have been disturbed, these have been replaced by ruderal and exotic species. To rehabilitate these sites to 70% of their current species composition would take more than 10 years.	

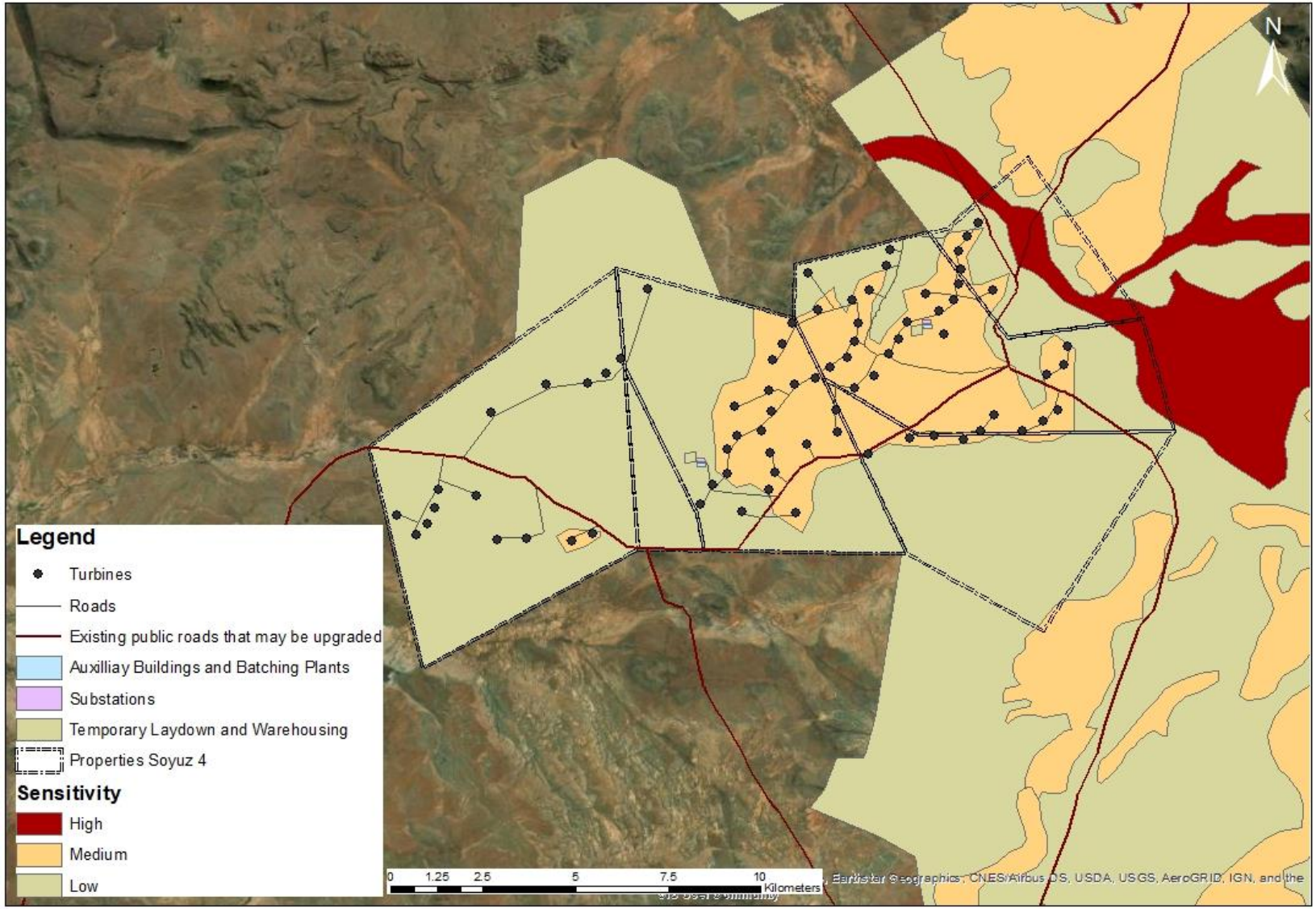


Figure: 4.2: Sensitivity map of the proposed project site showing areas of high, moderate and low sensitivity.

5. IMPACT ASSESSMENT

5.1. Construction and Operational Phase Impacts

The clearing of vegetation for the construction of the WEF facility, access roads and associated infrastructure could result in the following impacts:

- The direct and permanent loss of vegetation types and associated plant species, including species of conservation concern
- Clearing of vegetation resulting in breaks in habitat that will lead to habitat fragmentation and edge effects
- Clearing of vegetation and subsequent disturbance to the soil, and therefore seed bank, leading to the infestation of alien invasive plant species and other ruderal species.
- Heavy machinery associated with clearing of vegetation and construction of the WEF facility and access roads causing an increase in dust emissions resulting in impacts on plant productivity.

The spatial extent, temporal scale and impact significance will vary for each impact, and these will be individually assessed in the botanical impact assessment report. This scoping report does not include an assessment of impacts.

6. CONCLUSIONS AND RECOMMENDATIONS

6.1. Conclusions

The turbines and access roads are mostly situated within Upper Karoo Hardeveld with some infrastructure occurring in the Eastern Upper Karoo. The SEI for these vegetation types have been assessed and Upper Karoo Hardeveld is of Medium Sensitivity and Eastern Upper Karoo is of low sensitivity meaning that construction within these areas is permissible from a botanical perspective.

The species environmental guideline document states for areas of medium sensitivity, development activities of medium impact are acceptable and for areas with a low SEI, development activities of medium to high impact are acceptable. In both instances these must be followed by appropriate restoration activities.

Vegetation associated with the washes was assigned a high SEI. Where feasible, it is recommended that infrastructure should avoid being located within these areas. Road crossings would be permissible.

A road crossing is located within an ESA. The biodiversity features driving the ESA classification includes all natural wetlands and rivers and it is therefore recommended that infrastructure is placed outside of the ESA and where this is not feasible, the footprint within the ESA is minimised.

6.2. Recommendations

It is recommended that the following conditions are included in the Final EMPr as well as the conditions of the Environmental Authorisation (EA), if granted:

- The remaining vegetation within the property should remain intact so that it can continue to function as an ecological corridor for species movement.
- All necessary plant permits must be obtained prior to the commencement of any construction activities.
- Where feasible, laydown areas must be placed in previously disturbed sites.
- A walkthrough of the final layout must be undertaken by a botanist and if populations of SCC will be impacted, infrastructure should be moved to avoid these areas. Where this is not feasible, a search and rescue plan will be required.
- If any SCC are to be impacted, these must be relocated to nearest appropriate habitat.
- Construction vehicles and machinery must not encroach into identified ‘no-go’ areas or areas outside the project footprint.
- Topsoil (20 cm, where possible) must be collected and stored in an area of low sensitivity and used to rehabilitate impacted areas that are no longer required during the operational phase (e.g. laydown areas).

- Employees must be prohibited from collecting any plants.
- Alien invasive plant clearing should be undertaken in line with an Alien Vegetation Management plan, which should be compiled as part of the EMPr and implemented with immediate effect.
- Only indigenous plant species typical of the local vegetation and approved by a botanist should be used for the rehabilitation of natural habitat.

6.3. Ecological Statement and Opinion of the Specialist

Project infrastructure should be designed to avoid sensitive features such as the washes. Further to the above, impacts on the terrestrial plant species and associated habitats can be reduced to acceptable levels through the implementation of mitigation measures. The specialist is therefore of the opinion that the development can proceed provided the recommendations contained in this report are implemented.

7. REFERENCES

Fitchett, J.; Bamford, M.K.; Mackay, A.W. and Grab, S. 2017. Chrysocoma ciliata L. (Asteraceae) in the Lesotho Highlands: an anthropogenically introduced invasive or a niche coloniser? Biological Invasions. 19 (1): 1-18.

Milton, S.J. and Dean, W.R.J. 2000. Disturbance, drought and dynamics of desert dune grassland, South Africa. *Plant Ecology*. 150: 37-51

Raimondo, D. & von Staden, L. 2020. *Hereroa concava* L.Bolus. National Assessment: Red List of South African Plants version 2020.1. Accessed on 2022/04/29

Mucina, L.; Rutherford, M.C.; Palmer, A.J.; Milton, S.J.; Scott, L.; Lloyd, J.W.; van der Merwe, B.; Hoare, D.B.; Bezuidenhout, H.; Vlok, J.H.J.; Euston-Brown, D.I.W.; Powrie, L.W. and Dold, A.P. 2011. Nama-Karoo Biome IN: Mucina, L. and Rutherford, M.C. (eds) 2011. The Vegetation of South Africa, Lesotho and Swaziland. *Strelitzia* 19. South African National Biodiversity Institute, Pretoria.

Red List of terrestrial Ecosystems of South Africa. (2021). SANBI and DFFE.

South African National Biodiversity Institute (SANBI). 2020. *Species Environmental Assessment Guideline. Guidelines for the implementation of the Terrestrial Fauna and Terrestrial Flora Species Protocols for environmental impact assessments in South Africa*. South African National Biodiversity Institute, Pretoria. Version 2.1 2021.

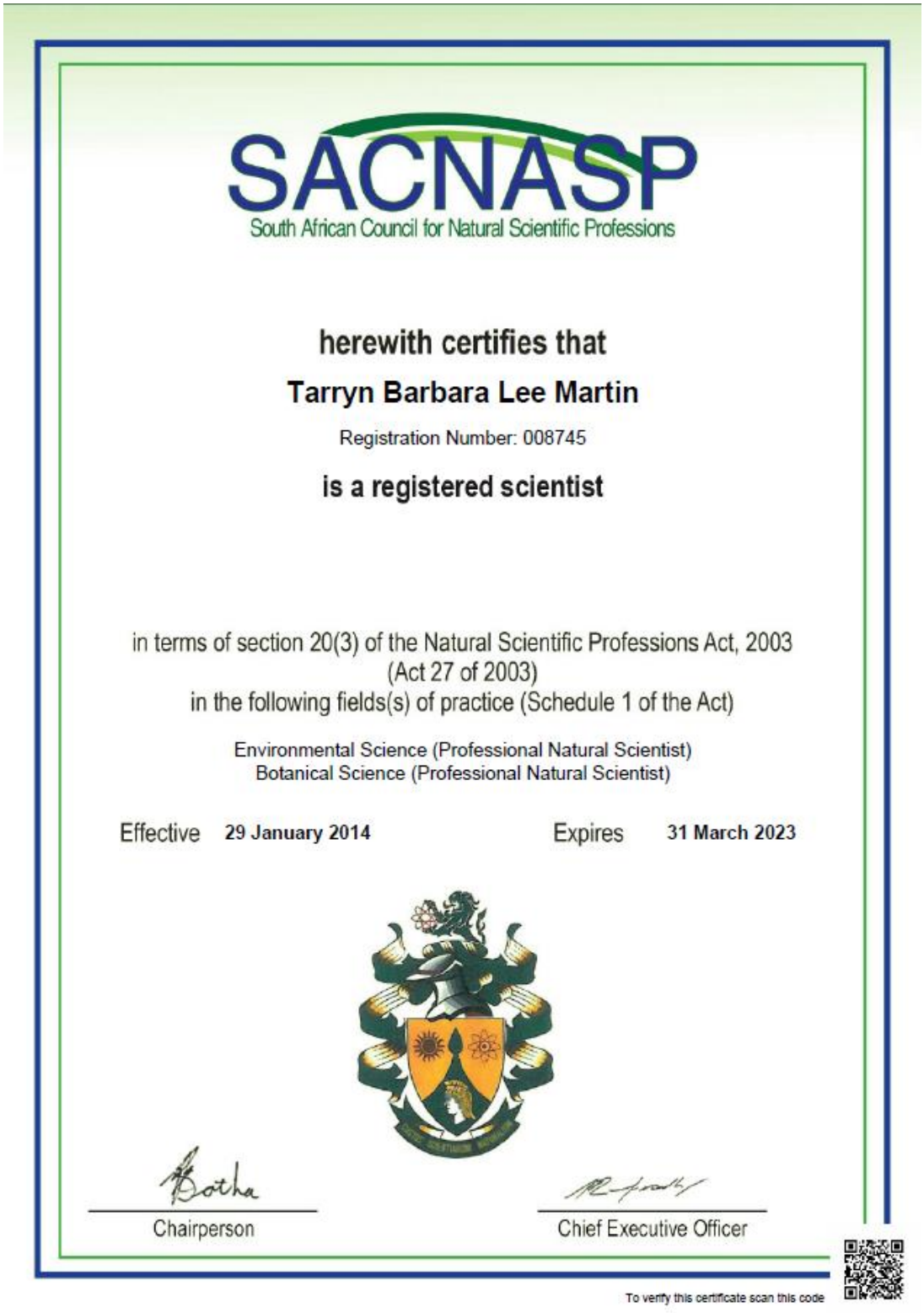
Victor, J.E. 2009. Tridentea virescens (N.E.Br.) L.C.Leach. National Assessment: Red List of South African Plants version 2020.1. Accessed on 2022/05/03

APPENDIX 1: PLANT SPECIES RECORDED ON SITE

Family	*Species*	SA Red Data List	Northern Cape Nature Conservation Act (2009)
AGAVACEAE	*Agave americana*	Not Evaluated	
ASPHODELACEAE	*Aloe broomii*	Least Concern	Schedule 2
ASPHODELACEAE	*Aloe claviflora*	Least Concern	Schedule 2
AMARYLLIDACEAE	*Ammocharis coranica*	Least Concern	Schedule 2
SCROPHULARIACEAE	*Aptosimum procumbens*	Least Concern	Schedule 3
SCROPHULARIACEAE	*Aptosimum spinescens*	Least Concern	Schedule 3
POACEAE	*Aristida congesta*	Least Concern	Schedule 3
POACEAE	*Aristida diffusa*	Least Concern	Schedule 3
ASPARAGACEAE	*Asparagus exuvialis*	Least Concern	Schedule 3
ASPARAGACEAE	*Asparagus laricinus*	Least Concern	Schedule 3
ASPARAGACEAE	*Asparagus striatus*	Least Concern	Schedule 3
AMARANTHACEAE	*Atriplex semibaccata*	Not Evaluated	
ACANTHACEAE	*Barleria rigida*	Least Concern	Schedule 3
ASTERACEAE	*Berkheya pinnatifida*	Least Concern	Schedule 3
ACANTHACEAE	*Blepharis capensis*	Least Concern	Schedule 3
AMARYLLIDACEAE	*Boophone disticha*	Least Concern	Schedule 2
AMARANTHACEAE	*Caroxylon aphyllum*	Least Concern	Schedule 3
HYACINTHACEAE	*cf Albuca*	Least Concern	Schedule 3
POACEAE	*cf Tragus berteronianus*	Least Concern	Schedule 3
VERBENACEAE	*Chascanum pinnatifidum*	Least Concern	Schedule 3
PTERIDACEAE	*Cheilanthes eckloniana*	Least Concern	Schedule 3
AMARANTHACEAE	*Chenopodium phillipsianum*	Not Evaluated	
POACEAE	*Chloris virgata*	Least Concern	Schedule 3
ASTERACEAE	*Chrysocoma ciliata*	Least Concern	Schedule 3
BRASSICACEAE	*Cleome angustifolia*	Least Concern	Schedule 3
CRASSULACEAE	*Crassula exilis*	Least Concern	Schedule 2
CUCURBITACEAE	*Cucumis sp*	Least Concern	Schedule 3
ASTERACEAE	*Curio radicans*	Least Concern	Schedule 3
ASTERACEAE	*Dicoma capensis*	Least Concern	Schedule 3
EBENACEAE	*Diospyros austro-africana*	Least Concern	Schedule 3
EBENACEAE	*Diospyros lycioides*	Least Concern	Schedule 3
POACEAE	*Enneapogon desvauxii*	Least Concern	Schedule 3
POACEAE	*Eragrostis curvula*	Least Concern	Schedule 3
POACEAE	*Eragrostis lehmanniana*	Least Concern	Schedule 3
ASTERACEAE	*Eriocephalus africanus*	Least Concern	Schedule 3
ASTERACEAE	*Eriocephalus ericoides*	Least Concern	Schedule 3
RUSCACEAE	*Eriospermum corymbosum*	Least Concern	Schedule 3

EBENACEAE	*Euclea coriacea*	Least Concern	Schedule 3
EUPHORBIACEAE	*Euphorbia stellispina*	Least Concern	Schedule 2
ASTERACEAE	*Euryops lateriflorus*	Least Concern	Schedule 3
ASTERACEAE	*Felicia filifolia*	Least Concern	Schedule 3
POACEAE	*Fingerhuthia africana*	Least Concern	Schedule 3
APOCYNACEAE	*Gomphocarpus tomentosus*	Least Concern	Schedule 2
ASTERACEAE	*Helichrysum zeyheri*	Least Concern	Schedule 3
MALVACEAE	*Hermannia comosa*	Least Concern	Schedule 3
MALVACEAE	*Hermannia sp*	Least Concern	Schedule 3
MALVACEAE	*Hermannia vestita*	Least Concern	Schedule 3
ASTERACEAE	*Hertia pallens*	Least Concern	Schedule 3
FABACEAE	*Indigofera alternans*	Least Concern	Schedule 3
SCROPHULARIACEAE	*Jamesbrittenia tysonii*	Least Concern	Schedule 2
THYMELAEACEAE	*Lasiosiphon polycephalus*	Least Concern	Schedule 3
FABACEAE	*Lessertia frutescens*	Least Concern	Schedule 1
SOLANACEAE	*Lycium cinereum*	Least Concern	Schedule 3
SOLANACEAE	*Lycium horridum*	Least Concern	Schedule 3
MELIANTHACEAE	*Melianthus comosus*	Least Concern	Schedule 3
FABACEAE	*Melolobium candicans*	Least Concern	Schedule 3
IRIDACEAE	*Moraea polystachya*	Least Concern	Schedule 2
CACTACEAE	*Opuntia ficus-indica*	Category 1b Invasive	
ASTERACEAE	*Osteospermum spinescens*	Least Concern	Schedule 3
OXALIDACEAE	*Oxalis obliquifolia*	Least Concern	Schedule 2
APOCYNACEAE	*Pachypodium succulentum*	Least Concern	Schedule 2
SCROPHULARIACEAE	*Peliostomum leucorrhizum*	Least Concern	Schedule 3
ASTERACEAE	*Pentzia cf quinquefida*	Least Concern	Schedule 3
ASTERACEAE	*Pentzia incana*	Least Concern	Schedule 3
CARYOPHYLLACEAE	*Pollichia campestris*	Least Concern	Schedule 3
AIZOACEAE	*Psilocaulon junceum*	Least Concern	Schedule 2
BIGNONIACEAE	*Rhigozum obovatum*	Least Concern	Schedule 3
AIZOACEAE	*Ruschia intricata*	Least Concern	Schedule 2
AMARANTHACEAE	Salsola gemmifera	Not Evaluated	
ANACARDIACEAE	*Schinus molle*	Not Evaluated	
ANACARDIACEAE	*Searsia burchellii*	Least Concern	Schedule 3
ANACARDIACEAE	*Searsia lancea*	Least Concern	Schedule 3
PEDALIACEAE	*Sesamum capense*	Least Concern	Schedule 3
LAMIACEAE	*Stachys cuneata*	Least Concern	Schedule 3
POACEAE	*Stipagrostis ciliata*	Least Concern	Schedule 3
AIZOACEAE	*Stomatium mustellinum*	Least Concern	Schedule 2
POACEAE	*Themeda triandra*	Least Concern	Schedule 3
CAMPANULACEAE	*Wahlenbergia albens*	Least Concern	Schedule 3
CAMPANULACEAE	*Wahlenbergia nodosa*	Least Concern	Schedule 3
SOLANACEAE	*Withania somnifera*	Least Concern	Schedule 3
ZYGOPHYLLACEAE	*Zygophyllum incrustatum*	Least Concern	Schedule 3

APPENDIX 2: PROOF OF SACNASP REGISTRATION AND HIGHEST QUALIFICATION



SACNASP
South African Council for Natural Scientific Professions

herewith certifies that

Tarryn Barbara Lee Martin

Registration Number: 008745

is a registered scientist

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

Environmental Science (Professional Natural Scientist)
Botanical Science (Professional Natural Scientist)

Effective **29 January 2014** Expires **31 March 2023**

Chairperson

Chief Executive Officer

To verify this certificate scan this code

RHODES UNIVERSITY

THIS IS TO CERTIFY THAT

TARRYN BARBARA LEE MARTIN

WAS THIS DAY AT A CONGREGATION OF THE UNIVERSITY
ADMITTED TO THE DEGREE OF

MASTER OF SCIENCE

IN

BOTANY

WITH DISTINCTION

VICE CHANCELLOR

DEAN OF THE FACULTY OF SCIENCE

REGISTRAR

GRAHAMSTOWN
10 APRIL 2010

APPENDIX 3: CV

CONTACT DETAILS

Name	**Tarryn Martin**
Name of Company	**Biodiversity Africa**
Designation	Director
Profession	Botanical Specialist and Environmental Manager
E-mail	tarryn@biodiversityafrica.com
Office number	+27 (0)71 332 3994
Education	2010: Master of Science with distinction (Botany) 2004: Bachelor of Science (Hons) in African Terrestrial Vertebrate Biodiversity 2003: Bachelor of Science
Nationality	**South African**
Professional Body	**SACNASP**: South African Council for Natural Scientific Profession: Professional Natural Scientist (400018/14) **SAAB**: Member of the South African Association of Botanists **IAIASa**: Member of the International Association for Impact Assessments South Africa Member of Golden Key International Honour Society
Key areas of expertise	• Biodiversity Surveys and Impact Assessments • Environmental Impact Assessments • Critical Habitat Assessments • Biodiversity Management and Monitoring Plans

PROFILE

Tarryn has over ten years of experience working as a botanist, nine of which are in the environmental sector. She has worked as a specialist and project manager on projects within South Africa, Mozambique, Lesotho, Zambia, Tanzania, Cameroon and Malawi.

She has extensive experience writing botanical impact assessments, critical habitat assessments, biodiversity management plans, biodiversity monitoring plans and Environmental Impact Assessments to International Standards, especially to those of the International Finance Corporation (IFC). Her experience includes working on large mining projects such as the Kenmare Heavy Minerals Mine, where she monitored forest health, undertook botanical impact assessments for their expansion projects and designed biodiversity management and monitoring plans. She has also project managed Environmental Impact Assessments for graphite mines in northern Mozambique and has a good understanding of the Mozambique Environmental legislation and processes.

Tarryn holds a BSc (Botany and Zoology), a BSc (Hons) in African Vertebrate Biodiversity and an MSc with distinction in Botany from Rhodes University. Tarryn's Master's thesis examined the impact of fire on the

recovery of C_3 and C_4 Panicoid and non-Panicoid grasses within the context of climate change for which she won the Junior Captain Scott-Medal (Plant Science) for producing the top MSc of 2010 from the South African Academy of Science and Art as well as an Award for Outstanding Academic Achievement in Range and Forage Science from the Grassland Society of Southern Africa. Tarryn is a professional member of the South African Council for Natural Scientific Professionals (since 2014).

EMPLOYMENT EXPERIENCE

Director and Botanical Specialist, Biodiversity Africa

July 2021 - present

- Botanical and ecological assessments for local and international EIAs in Southern Africa
- Identifying and mapping vegetation communities and sensitive areas
- Designing and implementing biodiversity management and monitoring plans
- Designing rehabilitation plans
- Designing alien management plans
- Critical Habitat Assessments
- Large ESIA studies
- Managing budgets

Principal Environmental Consultant, Branch Manager and Botanical Specialist, Coastal and Environmental Services

May 2012-June 2021

- Botanical and ecological assessments for local and international EIAs in Southern Africa
- Identifying and mapping vegetation communities and sensitive areas
- Designing and implementing biodiversity management and monitoring plans
- Designing rehabilitation and biodiversity offset plans
- Designing alien management plans
- Critical Habitat Assessments
- Large ESIA studies
- Managing budgets
- Cape Town branch manager
- Coordinating specialists and site visits

Accounts Manager, Green Route DMC

October 2011- January 2012

- Project and staff co-ordination
- Managing large budgets for incentive and conference groups travelling to southern Africa
- Creating tailor-made programs for clients
- Negotiating rates with vendors and assisting with the ground management of inbound groups to ensure client satisfaction.

Camp Administrator and Project Co-ordinator, Windsor Mountain International Summer Camp, USA

April 2011 - September 2012

- Co-ordinated staff and camper travel arrangements, main camp events and assisted with marketing the camp to prospective families.

Freelance Project Manager, Green Route DMC

November 2010 - April 2011

- Project and staff co-ordination
- Managing large budgets for incentive and conference groups travelling to southern Africa
- Creating tailor-made programs for clients
- Negotiating rates with vendors and assisting with the ground management of inbound groups to ensure client satisfaction.

Camp Counselor, Windsor Mountain Summer Camp, USA

June 2010 - October 2010

NERC Research Assistant, Botany Department, Rhodes University, Grahamstown in collaboration with Sheffield University, Sheffield, England

April 2009 - May 2010

- Set up and maintained experiments within a common garden plot experiment
- collected, collated and entered data
- Assisted with the analysis of the data and writing of journal articles

Head Demonstrator, Botany Department, Rhodes University

March 2007 - October 2008

Operations Assistant, Green Route DMC

September 2005 - February 2007

- Project and staff co-ordination
- Managing large budgets for incentive and conference groups travelling to southern Africa
- Creating tailor-made programs for clients
- Negotiating rates with vendors and assisting with the ground management of inbound groups to ensure client satisfaction

PUBLICATIONS

- Ripley, B.; Visser, V.; Christin, PA.; Archibald, S.; Martin, T and Osborne, C. Fire ecology of C_3 and C_4 grasses depends on evolutionary history and frequency of burning but not photosynthetic type. *Ecology.* 96 (10): 2679-2691. 2015
- Taylor, S.; Ripley, B.S.; Martin, T.; De Wet, L-A.; Woodward, F.I.; Osborne, C.P. Physiological advantages of C_4 grasses in the field: a comparative experiment demonstrating the importance of drought. *Global Change Biology*. 20 (6): 1992-2003. 2014
- Ripley, B; Donald, G; Osborne, C; Abraham, T and Martin, T. Experimental investigation of fire ecology in the C3 and C4 subspecies of *Alloteropsis semialata. Journal of Ecology.* 98 (5): 1196 - 1203. 2010
- South African Association of Botanists (SAAB) conference, Grahamstown. Title: Responses of C3 and C4 Panicoid and non-Panicoid grasses to fire. January 2010
- South African Association of Botanists (SAAB) conference, Drakensberg. Title: Photosynthetic and Evolutionary determinants of the response of selected C3 and C4 (NADP-ME) grasses to fire. January 2008

COURSES

- Rhodes University and CES, Grahamstown
- EIA Short Course 2012
- Fynbos identification course, Kirstenbosch, 2015.
- Photography Short Course, Cape Town School of Photography, 2015.
- Using Organized Reasoning to Improve Environmental Impact Assessment, 2018, International IAIA conference, Durban

CONSULTING EXPERIENCE

International Projects

- 2020 – 2021: Project manager for the 2Africa subsea cable ESIA in Mozambique.
- 2020 – 2021: Project manager for the Category B EIA for the Wihinana Graphite Mine, Cabo delgado, Mozambique
- 2020 – 2021: Project manager for the category B exploration ESIA for Sofala Heavy Minerals Mine, Inhambane, Mozambique
- 2020: Critical Habitat Assessment for a graphite mine in Cabo Delgado, Mozambique. This assessment was to IFC standards.
- 2020: Analysed the botanical dataset for Lurio Green Resources and provided comment on the findings and gaps.
- 2020: Biodiversity Management Plan and Monitoring Plan for mine at Pilivilli in Nampula Province, Mozambique. This assessment was to IFC standards.
- 2019: Botanical Assessment for a cocoa plantation, Tanzania. This assessment was to IFC standards.
- 2019: Critical Habitat Assessment, Biodiversity Management Plan and Ecosystem Services Assessment for JCM Solar Farm in Cameroon. This assessment was to IFC standards.
- 2019: Undertook the Kenmare Road and Infrastructure Botanical Baseline Survey and Impact Assessment for an infrastructure corridor that will link the existing mine at Moma to the new proposed mine at Pillivilli in Nampula Province, Mozambique. This assessment was to IFC standards.
- 2012 – Present: Kenmare Terrestrial Monitoring Program Project Manager and Specialist Survey, Nampula Province, Mozambique.
- 2018: Conducted a field survey and wrote a botanical report to IFC standards for the proposed Balama Graphite Mine Environmental and Social Impact Assessment (ESIA) in Cabo Delgado Province, Mozambique.
- 2018: Co-authored the critical habitat assessment chapter for the proposed Kenmare Pilivilli Heavy Minerals Mine.
- 2018: Authored the Conservation Efforts chapter for the Kenmare Pilivilli Heavy Minerals Mine.
- 2017-2018: Co-authored and analysed data for the Kenmare Bioregional Survey of *Icuria dunensis* (species trigger for critical habitat) in Nampula Province, Mozambique. This was for a mining project that needed to be IFC compliant.
- 2017: Conducted a field survey and wrote a botanical report to IFC standards for the proposed Ancuabe Graphite Mine Environmental and Social Impact Assessment (ESIA) in Cabo Delgado Province, Mozambique.
- 2017-2018: Managed the Suni Resources Montepuez Graphite Mine Environmental Impact Assessment. This included the management of ten specialists, the co-ordination of their field surveys, regular client liaison and the writing of the Environmental Impact Assessment Report which summarised the specialists findings, assessed the impacts of the proposed mine on the environment and provided mitigation measures to reduce the impact.
  I was also the lead botanist for this baseline survey and impact assessment and undertook the required field work and analysed the data and wrote the report.
- 2017: Undertook the botanical baseline survey and impact assessment for the proposed Kenmare Pilivili Heavy Mineral Mine in Nampula Province, Mozambique. This was to IFC Standards.
- 2017: Ecological Survey for the Megaruma Mining Limitada Ruby Mine Exploration License, Cabo Delgado, Mozambique.

- 2016: Undertook the botanical baseline survey and impact assessment, wrote an alien invasive management plan and co-authored the biodeiveristy monitoring plan for this farm. The project was located in Zambezia Province, Mozambique.
- 2015-2016: Conducted the Triton Minerals Nicanda Hills Graphite Mine Botanical Survey and Impact Assessment. Was also the project manager and specialist co-ordinator for this project. The project was located in Cabo Delgado Province, Mozambique.
- 2015: Was part of the team that undertook a Critical Habitat Assessment for the Nhangonzo Coastal Stream site at Inhassora in Mozambique that Sasol intend to establish drill pads at. This project needed to meet the IFC standards.
- 2014: Lurio Green Resources Wood Chip Mill and Medium Density Fibre-board Plant, Project Manager and Ecological Specialist, Nampula Province, Mozambique. 2014-2015.
- 2013-2014: LHDA Botanical Survey, Baseline and Impact assessment, Lesotho.
- 2014: Biotherm Solar Voltaic Ecological Assessment, Zambia.
- 2013-2014: Lurio Green Resources Plantation Botanical Assessment, Vegetation and Sensitivity Mapping, Specialist Co-ordination, Nampula Province, Mozambique.
- 2013: Syrah Resources Botanical Baseline Survey and Ecological Assessment., Cabo Delgado Mozambique.
- 2013-2014: Baobab Mining Ecological Baseline Survey and Impact Assessment, Tete, Mozambique.

South African Projects

- 2021 - Present: Project Manager for the Sturdee Energy Solar PV facility, Western Cape
- 2021: Ecological Assessment for the Sturdee Energy Solar PV facility, Western Cape
- 2021: Rehabilitation plan for a housing development (Hope Village)
- 2020: Ecological Assessment for the Eskom Juno-Gromis Powerline deviation, Western Cape
- 2020: Project Manager for the Basic Assessment for SANSA development at Matjiesfontein (Western Cape). Project received authorization in 2021.
- 2020: Ecological Assessment for construction of satellite antennae, Matjiesfontein, Western Cape
- 2019: Ecological Assessment for a wind farm EIA, Kleinzee, Northern Cape
- 2019: Ecological Assessment for two housing developments in Zeerust, North West Province
- 2019: Botanical Assessment in Retreat, Cape Town for the DRDLR land claim.
- 2019: Cape Agulhas Municipality Botanical Assessment for the expansion of industrial zone, Western Cape, South Africa, 2019.
- 2018: Ecological Assessment for the construction of a farm dam in Greyton, Western Cape.
- 2018: Conducted the Ecological Survey for a housing development in Noordhoek, Cape Town
- 2018: Conducted the field survey and developed an alien invasive management plan for the Swartland Municipality, Western Cape.
- 2017: Undertook the field survey and co-authored a coastal dune study that assesses the impacts associated with the proposed rezoning and subdivision of Farm Bookram No. 30 to develop a resort.
- 2017: Project managed and co-authored a risk assessment for the use of Marram Grass to stabilise dunes in the City of Cape Town.
- 2015-2016: iGas Saldanha to Ankerlig Biodiversity Assessment Project Manager, Saldanha.
- 2015: Innowind Ukomoleza Wind Energy Facility Alien Invasive Management Plan, Eastern Cape Province, South Africa.

- 2015: Savannah Nxuba Wind Energy Facility Powerline Ecological Assessment, ground truthing and permit applications, Eastern Cape South Africa.
- 2014: Cob Bay botanical groundtruthing assessment, Eastern Cape, South Africa.
- 2013-2016: Dassiesridge Wind Energy Facility Project Manager, Eastern Cape, South Africa.
- 2013: Harvestvale botanical groundtruthing assessment, Eastern Cape, South Africa.
- 2012: Tsitsikamma Wind Energy Facility Community Power Line Ecological Assessment, Eastern Cape, South Africa.
- 2012: Golden Valley Wind Energy Facility Power Line Ecological Assessment, Eastern Cape, South Africa.
- 2012: Middleton Wind Energy Facility Ecological Assessment and Project Management, Eastern Cape, South Africa.
- 2012: Mossel Bay Power Line Ecological Assessment, Western Cape, South Africa.
- 2012: Groundtruthing the turbine sites for the Waainek Wind Energy Facility, Eastern Cape, South Africa.
- 2012: Toliara Mineral Sands Rehabilitation and Offset Strategy Report, Madagascar.