ECOLOGICAL ASSESSMENT REPORT

PROPOSED MAJUBA SOLAR ENERGY FACILITY NEXT TO THE MAJUBA POWER STATION

MPUMALANGA

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Executive Summary

Eskom Holdings (SOC) Ltd have appointed Savannah Environmental (Pty) Ltd to manage the EIA process for a photovoltaic Solar Energy Facility next to the Majuba Power Station, Mpumalanga.

This report discusses the approach and findings of an ecological field study, in addition to a literature survey carried out for the study area to assess the likelihood of ecological sensitivities occurring on the study area. The findings of this report should be used to guide the design of the final layout of the proposed development as well as environmental issues that will have to be adequately addressed and mitigated during the design, construction, operational and decommissioning phase.

The selected property falls within the original extent of the Amersfoort Highveld Clay Grassland (Unit Gm13) as defined by Mucina and Rutherford (2006), undulating plains with small scattered patches of dolerite outcrops. The vegetation in its natural state consists of a short closed grass cover, largely dominated by a dense *Themeda triandra* layer, with a relatively high diversity of grasses, herbs and geophytes (Mucina and Rutherford 2006). Many of the herbs resprout every year from below-ground storage tubers, usually early in the growing season before the grasses reach their full cover.

The Mpumalanga Biodiversity Conservation Plan classified a small central portion of the study area as of Least Concern, whilst the remainder has been classified as having no natural habitat remaining. This was confirmed during the field study – with a small area of relatively diverse grassland remaining, whilst the largest portion of the study area consists of rehabilitated (semi-natural) grasslands.

Overall, the species diversity of the study area is low, comprising less than 10% of the floral diversity recorded in the greater area. Nevertheless, a few species of conservation concern observed as well as wetlands on the area should be taken into account during the design of the layout and the future environmental management of the proposed development.

Annual and geophytic species have highly variable emerging patterns, depending on the timing and amount of rainfall received during a season. It is thus quite possible that especially the diversity of geophytic (bulbous) and annual species within the study area will be higher than could be determined during the survey.

Three vegetation associations could be identified (section 5.2):

» Association 1: *Themeda triandra – Helichrysum pilosellum* Grasslands
    - Sensitivity: Medium

» Association 2: Semi-natural Grasslands
    - Sensitivity: Low
» Association 3: *Eucalyptus – Pennisetum clandestinum* Depression
    - Sensitivity: Medium

In addition, evidence of several wetlands could be identified – where these were clearly visible they have been mapped as wetlands, but are described in more detail in the wetlands delineation report

Several alien invasive plants have been observed on the study site, with more species in close proximity (see section 5.5). For all species, there is a very high risk of spread throughout the project area following disturbance. This implies that a detailed Invasive Plant Management Plan will have to be in place prior to commencement of activity and be diligently followed and updated throughout the project cycle up to the decommissioning phase.

Small groups of burrows have been found, which must be monitored prior to construction to ensure that no harm comes to amphibians, reptiles or small mammals living in these burrows.

It is not expected that the development will compromise the survival of or significantly impact the conservation status of any flora or terrestrial vertebrate species on the study area or beyond. The most significant impacts are expected to be on ecosystem health and functionality, which should remain relatively intact if all mitigation recommendations are implemented; and the associated integrity of surrounding wetlands.

The most pressing issues identified by this study are:

» Existing high levels of air-borne coal dust that is polluting plants and soils
» All listed alien invasives and potential invasives within the development footprint area will have to be entirely cleared prior to development, not only to prevent spread of these species but also to ensure efficient maintenance of the proposed development
» An ongoing monitoring program will be necessary to control and/or eradicate newly emerging invasives
» Newly cleared soils will have to be revegetated and stabilised as soon as construction has been completed
    - Soils are prone to capping and erosion and need to be stabilised by a permanent grass or suitable indigenous vegetation layer.
    - Locally occurring grass species become moribund and die off if not grazed or burnt regularly. It is thus recommended to allow either seasonal sheep grazing to reduce dead biomass accumulation on grass tufts or implement a regular mowing program (possibly twice

a year). This will also greatly reduce the risk of fire, which is a natural component of grassland dynamics.

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1. General Information

1.1. Applicant

Eskom Holdings (SOC) Ltd have appointed Savannah Environmental (Pty) Ltd to manage the EIA process for a photovoltaic Solar Energy Facility next to the Majuba Power Station, Mpumalanga.

Project
Majuba Solar Energy Facility

Proposed Activity
» A PV array with a total generating capacity of up to 65 MW
» Inverter and transformer buildings
» On-site substation or switching station
» Underground cabling between project components
» A direct grid connection from the development to the existing Eskom substation at Majuba Power Station
» Upgrading of existing access roads and possibly creating new access roads to the proposed development site
» Construction of associated infrastructure such as workshops, office, guard houses and fencing
» As part of the construction process, sections of vegetation on the property will need to be cleared

1.2. Declaration of Independence

A signed declaration of independence for the investigating specialist is attached in Appendix A.

1.3. Specialist Investigator

This report has been prepared by:
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A *Curriculum Vitae* and summary of expertise of the compiler is attached as Appendix B of this document.

Specialist affiliation

South African Council for Natural Scientific Professions (SACNASP) (Pr.Sci.Nat; Registration no. 400079/10, Botanical Science, Ecological Science).
South African Association of Botanists (www.sabotany.com)
Desert Net International (www.european-desertnet.eu)

1.4. 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. The author, however, accepts no liability for any actions, claims, demands, losses, liabilities, costs, damages and expenses arising from or in connection with services rendered, and by the use of the information contained in this document. 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 a main report relating to the current investigation, this report must be included in its entirety.

Scope and Purpose of Report

To conduct an ecological study and impact assessment of the selected study area where the establishment of a Solar Energy Facility is proposed and provide a professional opinion on ecological issues listed pertaining to the target area to aid in future decisions regarding the proposed project.

1.5. Legislation

This study has been conducted in accordance with the following legislation:

1.5.1. Provincial

» The Mpumalanga Nature Conservation Act (Act 10 of 1998) and subsequent amendments
» Mpumalanga Tourism and Parks Agency Act (Act 5 of 2005)

1.5.2. 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 and regulations

» National Veld and Forest Fire Act (Act No. 101 of 1998)
» Conservation of Agricultural Resources Act (CARA) (Act No. 43 of 1983) and amendments

2. Introduction

South Africa is committed to the Convention of Biological Diversity, and has introduced several legislative mechanisms to ensure that the preservation and sustainable use of all biological diversity, including ecosystem, species, and genetic diversity, is guaranteed for the benefit of current and future generations in South Africa and beyond. Arid, semi-arid and dry sub-humid areas, covering an estimated 91% of South African land area (Hoffman and Ashwell 2001), including the study area, are particularly prone to degradation arising from human activities, leading to the acceleration of soil erosion, deterioration of the biotic, abiotic and economic properties of soil, and the long-term loss of natural vegetation (UNCCD 1995) and associated habitats for fauna. Recovery is further hampered by ongoing changes in global climate, leading to a higher incidence of extreme climatic events. There is thus an increasing pressure on reduced emissions of greenhouse gases. In the energy generating sector emissions can be reduced by switching more to renewable energy sources, such as solar- and wind-generated electricity. However, the construction of renewable energy facilities, although regarded a 'green technology', do impose several, potentially negative, impacts on the environment on which they are built.

This report lists the findings of an ecological evaluation of the site selected by Eskom for the development of a photovoltaic energy facility to help evaluate the most likely impacts of such a development on the affected environment.

3. Study Area

3.1. Locality

The proposed photovoltaic (PV) solar energy facility is located on the farm Witkoppies 81 IS, on which the Majuba Power Station has been built. This is approximately 13 km south-west of Amersfoort, within the Seme Municipality, Mpumalanga. The selected site for the energy facility consists of about 97 ha just south-east of the Majuba Power Station (Figure 1). This site and an adjacent buffer of about 100 m is considered as the study area.

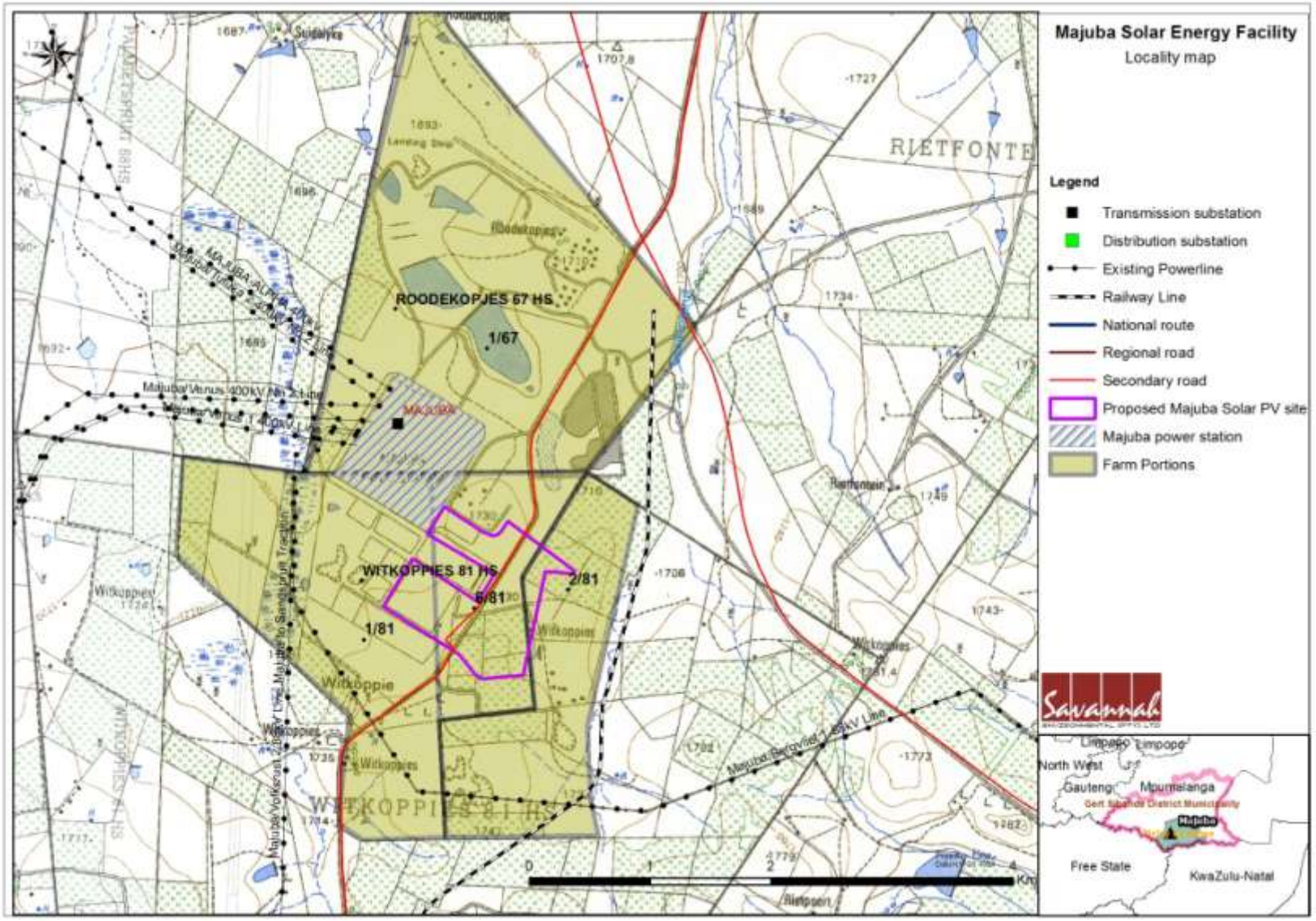

Figure 1: Locality of the Majuba power station and site for the proposed solar energy facility

3.2. Surrounding environment

3.2.1. Climate and rainfall

The climate for Majuba has been derived from climatic data summarised for Amersfoort (en.climate-data.org, Figure 2), located about 13 km south-west of Majuba. The area receives about 650 - 750 mm of rain on average per year. From May to September, rainfall is minimal, with most rainfall occurring from late October to March, peaking between November and January. Temperatures in summer peak during December and January at a daily average of 25.5°C, with an average of 16.5°C for June. During July, night temperatures are on average 0°C, with frosts during winter common.

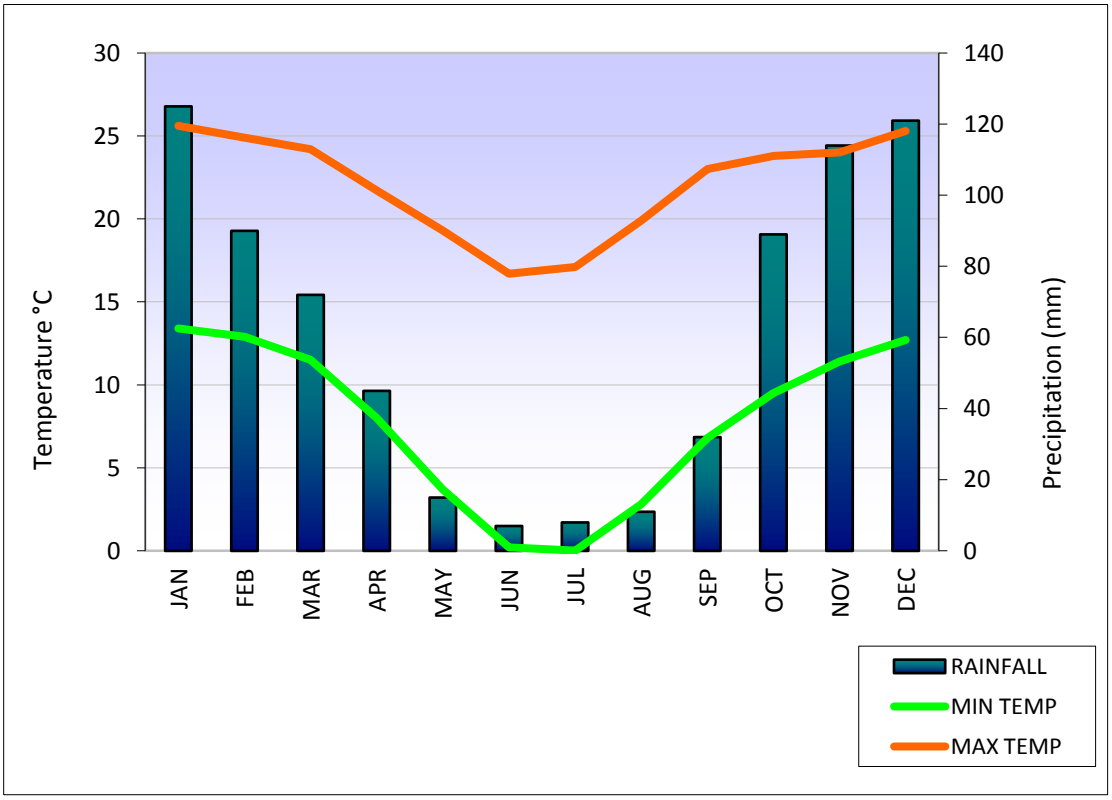

Figure 2: Climate summary for the study area.

3.2.2. Topography, soils and wetlands

From data available on the BGIS website, the following could be determined:
The site is expected to be slightly undulating. Within close proximity of the site are several valley floor wetlands (vleis) and slope seepage areas.

The soils are expected to have a marked accumulation of clay, be strongly structured and have a favourable fertility. Depth is restricted, with imperfect drainage, slow water infiltration and hence seasonal wetness. This also makes the soils highly erodible where not vegetated.

3.2.3. Vegetation overview

The selected property falls within the original extent of the Amersfoort Highveld Clay Grassland (Unit Gm13, Figure 3) as defined by Mucina and Rutherford (2006).

As explained in the Mpumalanga Biodiversity Conservation Plan Handbook (Ferrar and Lötter 2007): "African grasslands are particularly old, stable and resilient ecosystems. Most plants are perennials and surprisingly long lived, with very few annual species, which are the pioneer plants needed to repair disturbance. This makes our grasslands vulnerable to destruction by cultivation; once ploughed they are invaded by weedy pioneer plants that are mostly alien. Although many grassland plants do produce seed, very little germinates, most being used as vital food for their rich rodent and insect fauna. … The large number of rare and endangered species in grasslands is a particular problem for environmental impact assessment. They are mostly small, very localised and visible for only a few weeks in the year when they flower. Most surveys will not pick them up and special skills are required to locate and identify them reliably. Highest biodiversity is found in rocky grassland habitats and on sandy soils. Clay soils generally have the lowest biodiversity in grasslands."

The Amersfoort Highveld Clay Grassland has undulating plains with small scattered patches of dolerite outcrops. The vegetation consists of a short closed grass cover, largely dominated by a dense *Themeda triandra* layer. Other common grasses include *Andropogon appendiculatus*, *Brachiaria serrata*, *Digitaria monodactyla*, *Eragrostis* species, *Elionurus muticus*, *Harpochloa falx*, *Heteropogon contortus* and *Setaria* species. The diversity of grasses and herbs is very high (Mucina and Rutherford 2006). Common patches of tall shrubs usually contain *Diospyros austro-africana*, *Diospyros lycioides* and a variety of lower shrubs, including *Anthospermum rigidum*, *Helichrysum melanacme*, *Chaetacanthus costatus* and *Gnidia* species.

Mucina and Rutherford (2006) regard this vegetation type as Vulnerable. Although it is not currently listed under NEMA:BA, none is currently protected, with some 25% already permanently transformed. Australian Black Wattle has already invaded many outcrop- and stream areas, while overgrazing has led to an invasion of *Seriphium plumosum* (Mucina and Rutherford 2006).

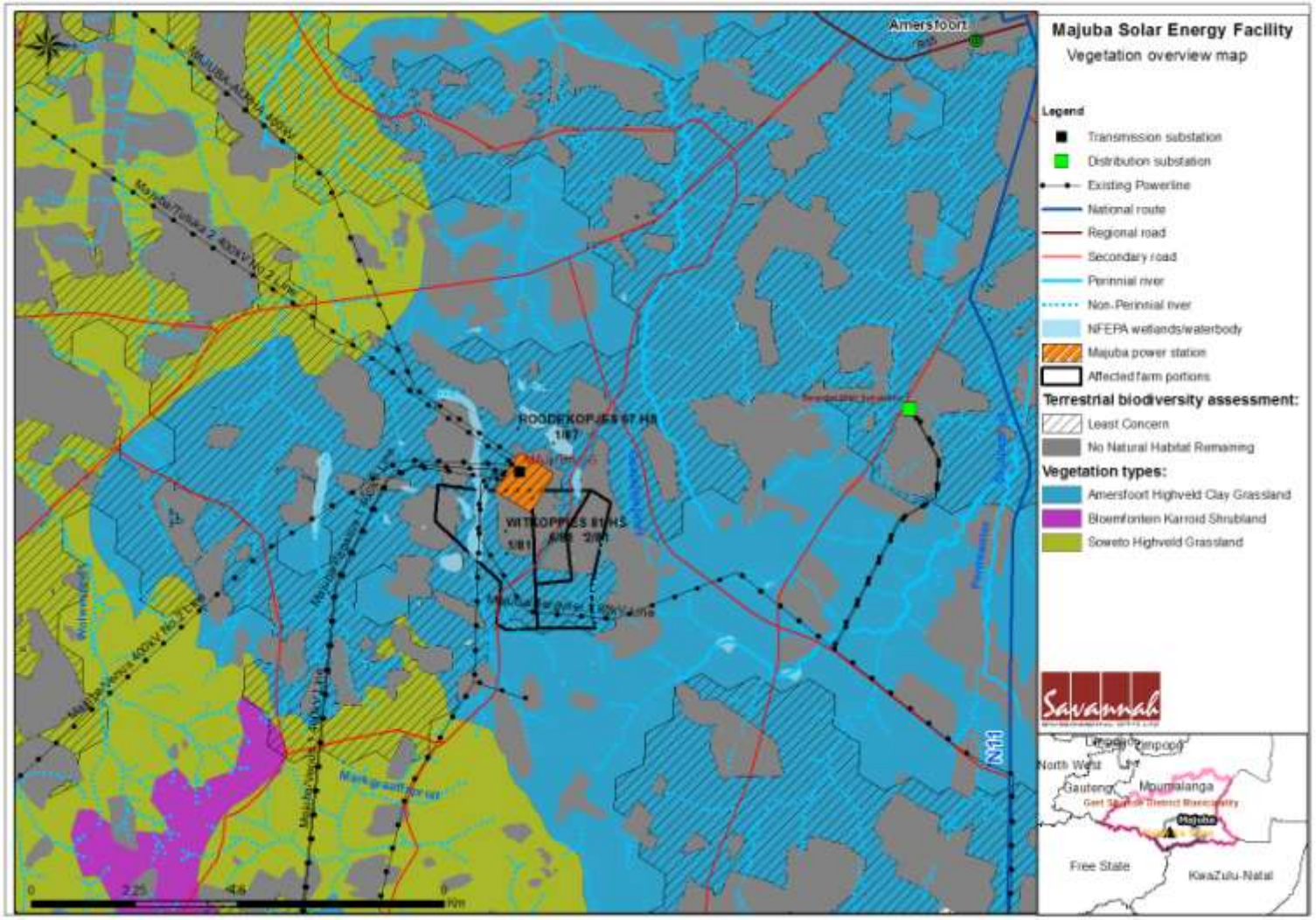

Figure 3: The original extent of the vegetation types on the proposed development site after Mucina and Rutherford (2006), and the relevant Mpumalanga Biodiversity Assessment Categories.

3.3. Mpumalanga Conservation Planning

The systematic conservation planning undertaken for Mpumalanga and culminating in the publishing of the Mpumalanga Biodiversity Conservation Plan Handbook (Ferrar and Lötter 2007) determined the state of ecosystems, desirable conservation targets and hence rated different vegetation types according to the amount of undisturbed land needed to be kept in that state to meet conservation targets. The resulting irreplaceability values were translated into biodiversity assessment categories. These categories are:

- » Protected areas: already managed for biodiversity protection;
- » Irreplaceable: 100% Irreplaceable - no other options available to meet targets;
- » Highly Significant: 50 - 99% Irreplaceable - very limited options available to meet targets;
- » Important & Necessary: lower irreplaceability value, less than 50% but still required to meet targets;
- » Least Concern: areas of natural habitat that could be used to meet some targets but not needed now, as long as other areas are not lost
- » No natural habitat remaining: virtually all natural habitat has been irreversibly lost as a result of cultivation, timber plantations, mining, urban development

For the above landscape/ecosystem categories, the following land-use guidelines relevant to the proposed development have been developed:

T6. LEAST CONCERN

Biodiversity assets in these landscapes contribute to natural ecosystem functioning, ensure the maintenance of viable species populations and provide essential ecological and environmental goods and services across the landscape. Although these areas contribute least to the achievement of biodiversity targets they have significant environmental, aesthetic and social values and should not be viewed as wastelands or carte-blanche development zones.

Development options are widest in these areas. At the broad scale, these areas and those where natural habitat has been lost (see 7, below) serve as preferred sites for all forms of development (Land-Use types 5 – 15). Land-use planners are still required to consider other environmental factors such as socioeconomic efficiency, aesthetics and the sense-of-place in making decisions about development. Prime agricultural land should also be avoided for all non-agricultural land uses.

Land-use and administrative options for positive biodiversity outcomes include:

- » Where this category of land occurs close to areas of high biodiversity value, it may provide useful ecological connectivity or ecosystem services

functions, e.g. ecological buffer zones and corridors or water production. In these situations encouragement needs to be given to biodiversity-friendly forms of management and even restoration options where appropriate;

» Develop incentives to reverse lost biodiversity for selected parcels of land where buffer zones and connectivity are potentially important;
» Standard application of EIA and other planning procedures required;
» Along with Category T7. Below, these areas to serve as preferred sites for all forms of urban and industrial development (Land-Use Types 10 – 15).

T7. NO NATURAL HABITAT REMAINING

Areas with no natural habitat remaining are preferred sites for development, even more so than for 6, above. However, in selecting sites for urban and industrial development, planners need to make a special effort to avoid building on areas of high agricultural potential. Prime agricultural land is coming under the same pressures as land with high biodiversity value and needs to be protected for its ability to produce food and fibre sustainably.

Land-use and administrative options for positive biodiversity outcomes include:

» Where this category of land occurs close to areas of high biodiversity value, and is located to potentially serve useful ecological connectivity functions, such as in ecological corridors, encourage restoration and re-vegetation options;
» For individual parcels of land identified as having specific biodiversity values, actual or potential, develop incentives to restore lost biodiversity and connectivity;
» Consider the negative impacts of land uses on these areas which have off-site impacts, e.g. controlling use of pesticides, on neighbouring areas of natural habitat, especially if they are of high biodiversity value;
» Encourage landowners and developers to use indigenous plants, especially trees, where aesthetic or functional options exist.

Land Use Types defined:

1 – 4 BIODIVERSITY-FRIENDLY LAND USES:

» Land-Use Type 1. Conservation Management
» Land-Use Type 2. Extensive Game Farming
» Land-Use Type 3. Extensive Livestock Production
» Land-Use Type 4. Rural Recreational Development

5 – 9 HIGH IMPACT RURAL LAND USES

» Land-Use Type 5. Rural (Communal) Settlement – subsistence agriculture
» Land-Use Type 6. Dryland Crop Cultivation
» Land-Use Type 7. Intensive Animal Farming
» Land-Use Type 8. Irrigated Crop Cultivation

» Land-Use Type 9. Timber Production

10 – 15 URBAN INDUSTRIAL LAND USES

» Land-Use Type 10. Urban and Business Development
» Land-Use Type 11. Major Development Projects
» Land-Use Type 12. Linear Engineering Structures
» Land-Use Type 13. Water Projects and Transfers
» Land-Use Type 14. Underground Mining
» Land-Use Type 15. Surface Mining, Dumping and Dredging

4. Methods

4.1. Vegetation Survey

The site was visited on 13 January 2015 for a vegetation survey. At the time of the survey, vegetation was actively growing, although some of the annual species were not yet in flower.

Prior to the site visit, the vegetation was delineated into homogenous units on currently available Google Earth imagery. At several sites within each homogeneous unit, a survey of total visible floristic composition and the relative cover percentage of each species was recorded, following established vegetation survey techniques (Mueller-Dombois & Ellenberg 1974; Westhoff & Van der Maarel 1978). These methods have been used as the basis of a national vegetation survey of South Africa (Mucina *et al.* 2000) and are considered an efficient method of describing vegetation and capturing species information. Notes were additionally made of the general habitat and any other features, biotic and abiotic, that might have an influence on the composition of landscape components and functioning of the landscape.

Surveys for Environmental Assessments are usually not exhaustive due to time and budget constraints, hence it can be expected that a number of species that may be present on site are not observed.

Vegetation analysis was carried out using the standard TurboVeg phytosociological database (Hennekens and Schaminée 2001) and TWINSPAN classification techniques with JUICE (Tichý 2002). The assessment did not cover an extensive area necessary to fully describe plant communities; hence, the vegetation is simply described in terms of vegetation associations, which are localised associations within plant communities. Extrapolation of vegetation units from survey sites to entire sample area was done by traversing the larger area without doing additional surveys as such and mapping this on Google Earth satellite data.

A species list from POSA (http://posa.sanbi.org, December 2014, Grid reference: 2729) containing the species that might occur in the area was obtained. POSA generated species lists also contain updated Red Data species status according to the Red List of South African Plants 2009 published by SANBI in *Strelitzia* 25 (Raimondo *et al.* 2009, updated 2014).

Plant species nomenclature follows Germishuizen and Meyer (2003), the African Plants Database (GJB), Henderson (2001) and Bromilow (2010).

4.2. Terrestrial Vertebrate Survey

The SANBI SIBIS and ADU database as well as Apps (2000) was queried regarding amphibians, reptiles and mammals historically recorded in the study area and surroundings. A full list of species that could occur in the study area according to these data sources is listed in Appendix C. Species that were sighted or of which relatively recent signs were found are listed under results.

4.3. Sensitivity Analysis and Criteria

Determining ecosystem services and sensitivity of ecosystem components, both biotic and abiotic, is rather complex, and no single overarching criteria 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 amount 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 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 spatio-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:

» **No-Go Areas:** Areas that have irreplaceable biodiversity or important ecosystem function values, which may be lost permanently if these ecosystems are transformed, with a high potential of also affecting adjacent and/or downstream ecosystems negatively.

» **High Sensitivity:** Areas that are relatively undisturbed or pristine and
  - either very species-rich relative to immediate surroundings,
  - or have a very unique and restricted indigenous species composition
  - alternatively, constitute specific habitats or high niche diversity for fauna and/or flora species of conservation concern, and where the total extent of such habitats and associated species of conservation concern remaining in southern Africa is limited.
  - Excessive disturbance of such habitats may lead to ecosystem destabilisation and/or species loss.
  - This would also include areas where the abiotic environment is of such nature that the habitat and its niche-diversity are the main reason for a higher species diversity and cannot be reconstructed or rehabilitated once physically altered in any way.

» **Medium Sensitivity:** Areas where disturbances are at most limited and
  - Areas with a species diversity representative of its natural state, but not exceptionally high or unique compared to its surroundings
  - Areas of which the abiotic or biotic configuration does not constitute a very specific or restricted habitat or very high niche diversity
  - Areas that provide ecosystem services needed for the continued functioning of the ecosystem and the continued use thereof (e.g. grazing or pollinator resources).
  - Although species of conservation concern may occur on the area, these are not restricted to these habitats only.
  - Areas that need to remain intact to ensure the functioning of adjacent ecosystems, or wildlife corridors or portions of land that prevent the excessive fragmentation of natural fauna and flora populations, or areas that will be difficult or impossible to rehabilitate to a functional state after physical alteration

» **Low Sensitivity:** Areas that have been previously transformed, disturbed or
  - Areas that provide limited ecosystem services, or have a low ecological value.
  - Species diversity may be low or all species present have a much wider distribution beyond this habitat or locality.
  - Species of conservation concern may be present on such areas, but these are not restricted to these habitats and can be relocated with ease.
  - Further arguments may include landscapes where the abiotic nature is such that it can be rehabilitated relatively easy to allow the re-establishment of the original species composition, and where the

development will not lead to any unjustified degradation of landscapes or ecosystem services if adequately mitigated.

4.4. Assessment of Impacts for the EIA

The Environmental Impact Assessment methodology assists in the evaluation of the overall effect of a proposed activity on the environment. This includes an assessment of the significant direct, indirect, and cumulative impacts. 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** of the impact refers to the causes of the effect, what will be affected and how it will be affected.

Extent (E) of impact

» Site specific: Rating = 1
» Site and surroundings: Rating = 2
» Site up to provincial extent: Rating = 3
» Site up to national extent: Rating = 4
» Site and beyond national borders: Rating = 5

Duration (D) rating is awarded as follows:
Whether the life-time of the impact will be:

» Very short term – up to 1 year: Rating = 1
» Short term – >1 – 5 years: Rating = 2
» Moderate term - >5 – 15 years: Rating = 3
» Long term – >15 years: Rating = 4
  - The impact will occur during the operational life of the activity, and recovery may occur with mitigation (restoration and rehabilitation).
» Permanent – Rating = 5
  - The impact will destroy the ecosystem functioning and mitigation (restoration and rehabilitation) will not contribute in such a way or in such a time span that the impact can be considered transient.

Magnitude (M) (severity):
A rating is awarded to each impact as follows:

» Small impact – the ecosystem pattern, process and functioning are not affected.
  Rating = 0
» Minor impact - a minor impact on the environment and processes will occur.
  Rating = 2
» Low impact - slight impact on ecosystem pattern, process and functioning.
  Rating = 4

» Moderate intensity – valued, important, sensitive or vulnerable systems or communities are negatively affected, but ecosystem pattern, process and functions can continue albeit in a slightly modified way.
Rating = 6
» High intensity – environment affected to the extent that the ecosystem pattern, process and functions are altered and may even temporarily cease. Valued, important, sensitive or vulnerable systems or communities are substantially affected.
Rating = 8
» Very high intensity – environment affected to the extent that the ecosystem pattern, process and functions are completely destroyed and may permanently cease.
Rating = 10

Probability (P) (certainty) describes the probability or likelihood of the impact actually occurring, and is rated as follows:
» Very improbable – where the impact will not occur, either because of design or because of historic experience.
Rating = 1
» Improbable – where the impact is unlikely to occur (some possibility), either because of design or historic experience.
Rating = 2
» Probable - there is a distinct probability that the impact will occur (<50% chance of occurring).
Rating = 3
» Highly probable - most likely that the impact will occur (50 – 90% chance of occurring).
Rating = 4
» Definite – the impact will occur regardless of any prevention or mitigating measures (>90% chance of occurring).
Rating = 5

Significance (S) - Rating of low, medium or high. Significance is determined through a synthesis of the characteristics described above where:
S = (E+D+M)*P

The **significance weighting** should influence the development project as follows:

» Low significance (significance weighting: <30 points)
If the negative impacts have little real effects, it should not have an influence on the decision to proceed with the project. In such circumstances, there is a significant capacity of the environmental resources in the area to respond to

change and withstand stress and they will be able to return to their pre-impacted state within the short-term.

» Medium significance (significance weighting: 30 – 60 points)

If the impact is negative, it implies that the impact is real and sufficiently important to require mitigation and management measures before the proposed project can be approved. In such circumstances, there is a reduction in the capacity of the environmental resources in the area to withstand stress and to return to their pre-impacted state within the medium to long-term.

» High significance (significance weighting: >60 points)

The environmental resources will be destroyed in the area leading to the collapse of the ecosystem pattern, process and functioning. The impact strongly influences the decision whether or not to proceed with the project. If mitigation cannot be effectively implemented, the proposed activity should be terminated.

5. Results

5.1. Vegetation Survey

A total of 954 indigenous plant species have been recorded in the Majuba Area according to the SANBI database. Of these species recorded in the wider area, only 88 indigenous plant species in total could be identified, which is relatively low for grasslands. Several more alien invasive species have been recorded.

At the time of the vegetation survey, the herbaceous layer overall was reasonably well developed, but additional species may occur in the area that were dormant at the time. Much of the grasslands are still in a state of rehabilitation, thus gradual future changes in species composition can still be expected.

None of the grasslands are considered to be in a pristine or natural condition, but portions of the grassland appear to have been able to regenerate for a longer time and show a considerably higher biodiversity, including a few plants of conservation concern. This small portion of more diverse grasslands is classified by the Mpumalanga Biodiversity Conservation Plan as of Least Concern, whilst the remainder of the area has been recognised as rangelands with no Natural Habitat Remaining (see section 3.3).

Vegetation association identified during this study are based on the overall similarity in species composition, vegetation structure and biophysical attributes that are part of an ecosystem, but smaller phytosociological differences within each vegetation unit are present.

5.2. Description of vegetation units and associated habitats

Three vegetation associations could be identified (Figure 4):

» Association 1(green): *Themeda triandra – Helichrysum pilosellum* Grasslands
  - Sensitivity: Medium
» Association 2 (brown): Semi-natural Grasslands
  - Sensitivity: Low
» Association 3 (red): *Eucalyptus – Pennisetum clandestinum* Depression
  - Sensitivity: Medium

In addition, evidence of several wetlands could be identified – where these were clearly visible they have been mapped as wetlands, but are described in more detail in the wetlands delineation report (Limosella Consulting 2015). Note: The latter report also indicates Association 3 as part of a larger wetland.

The sensitivity of the above associations is shown in Figure 5, with more detail on the sensitivity rating given within the descriptions below.

Figure 4: Vegetation associations identified within the study area.

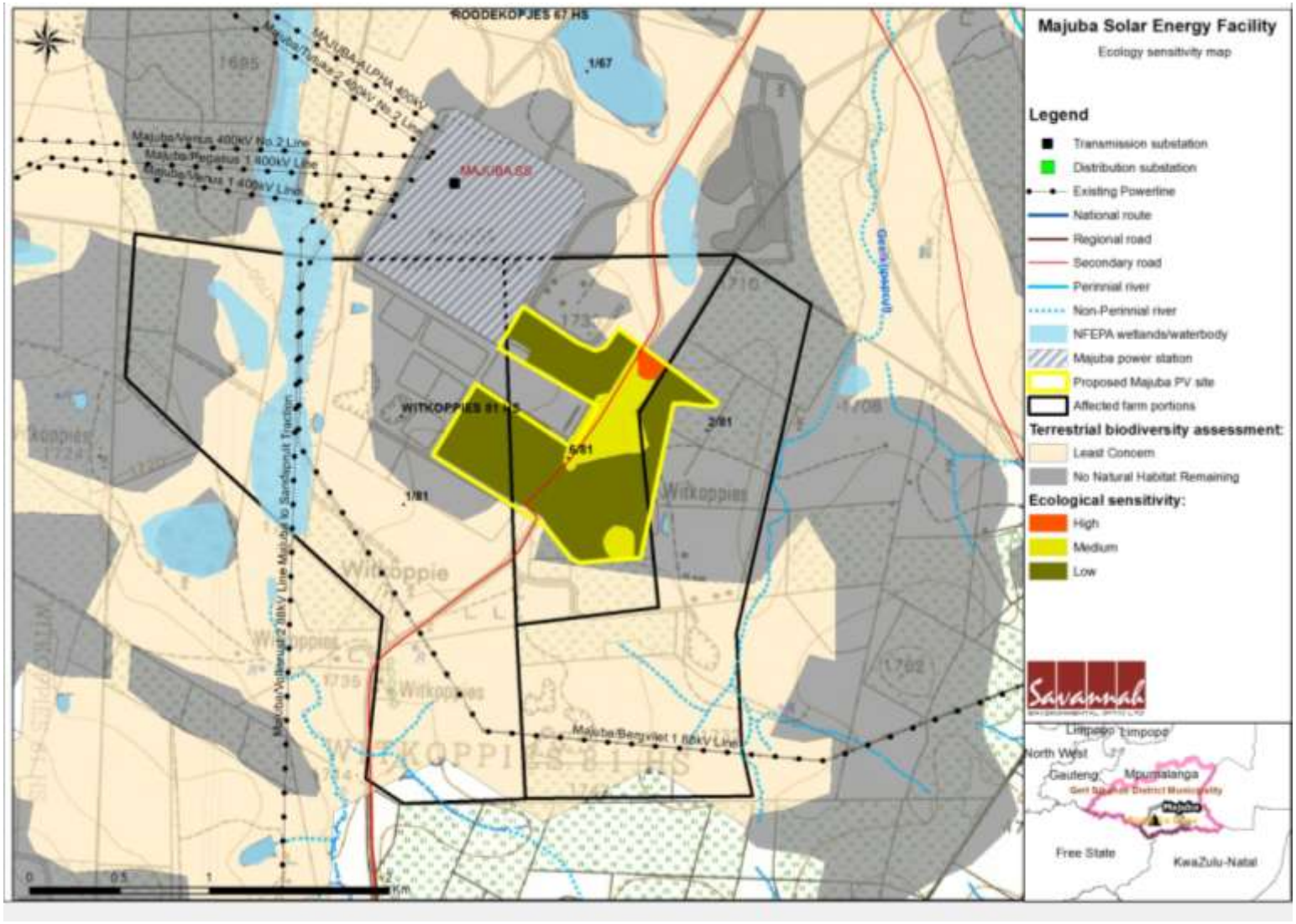

Figure 5: Ecological sensitivity of the study area.

5.2.1. *Themeda triandra - Helichrysum pilosellum* Grasslands

Habitat and Land use			
Substrate	Sandy grey loam on slightly undulating west-facing slopes	**Disturbance**	Past partial transformation, rubble, tracks, coal-dust pollution
Species Richness	62 indigenous species 8 alien invasive species		
Need for rehabilitation	Eradication of alien invasives, reduction of air-borne pollution	**Agricultural potential**	Grazing

Vegetation structure		
Layer	**Height (m)**	**Cover (%)**
Low Shrubs	0.3 – 0.9	1
Grass	0.2 – 1.5	70
Forbs, including geophytes	0.1 – 0.9	20
Dominant species (highest to lowest cover)	*Themeda triandra, Eragrostis curvula, Andropogon chinensis, Helichrysum pilosellum, Heteropogon contortus, Harpochloa falx, Setaria sphacelata, Tristachya leucothrix*	

Conservation status	**Indigenous**	**Weeds (Indigenous)**	**Alien**	**Total**	**Red Data**	**Protected**
Low shrubs	5			**5**		
Succulents	1			**1**		1
Forbs	29	3	8	**40**		
Grasses	14			**14**		
Geophytes	10			**10**		3
Total	**59**	**3**	**8**	**70**	**0**	**4**

The relative dominance by *Themeda triandra* indicates a lower long-term disturbance level of this portion of the study area, accompanied by a higher overall plant diversity as well. The herbaceous layer is relatively dense, consisting largely of perennial species that can adequately bind soils and retain nutrients in the system (Figure 6).

Small isolated occurrence of protected geophytes and a succulent species could be found. All of these plants can be relocated if need be. Unfortunately there are already several alien species on this grassland, and the pressure of invasion of more alien species from surrounding areas is very high.

Pollution levels of coal dust from the coal stockpile and the current constant trucking of coal from the stockpile to the power plant on the plants and soils of this vegetation type is very high (Figure 7), and it is desirable that measures be taken to mitigate this.

Figure 6: Vegetation on the less disturbed grasslands.

Figure 7: Coal-dust pollution visible on the leaves of plants

Species composition and typical observed cover percentages:

Species	*Status*	*avg %*	*max %*
Succulents			
Aloe ecklonis	11	0.1	
Low shrubs			
Acalypha angustata		0.1	
Chamaecrista comosa		0.1	
Felicia muricata		0.2	
Hermannia erodioides		0.1	
Pygmaeothamnus chamaedendrum		0.1	
Herbs and forbs			
Berkheya radula		0.3	
Bidens pilosa	AI	0.2	
Bulbostylis hispidula		0.5	
Centella asiatica		0.1	
Commelina africana		1	
Conyza podocephala	W	0.3	
Crepis hypochaeridea	AI	0.5	
Cyperus esculentus	W	0.5	
Euphorbia epicyparissias		0.1	
Gazania krebsiana		0.1	
Haplocarpha lyrata		0.1	
Haplocarpha scaposa		0.1	
Helichrysum appendiculatum		1	
Helichrysum melanacme		0.2	
Helichrysum nudifolium		1	
Helichrysum pilosellum		10	
Helichrysum psilolepis		1	
Helichrysum rugulosum		1	
Hermannia geniculata		0.2	
Hermannia oblongifolia		1	
Hibiscus microcarpus		0.2	
Hibiscus trionum	W	0.1	
Ipomoea crassipes		1	
Kyllinga pulchella		0.2	
Lobelia flaccida		0.2	
Mimulus gracilis		0.1	
Monsonia burkeana		1	

Species	*Status*	*avg %*	*max %*
Oenothera rosea	AI	0.1	
Oenothera tetraptera	AI	0.1	
Plantago lanceolata		0.1	
Plantago virginica	AI	0.3	
Polygala amatymbica		0.1	
Rumex crispus	AI	0.1	
Senecio erubescens		0.1	
Senecio inornatus		0.3	
Verbena bonariensis	AI: 1b	0.2	
Verbena brasiliensis	AI: 1b	0.5	
Vernonia oligocephala		1	
Wahlenbergia virgata		0.5	
Xenostegia tridentata		0.1	
Grasses			
Andropogon chinensis		10	
Aristida congesta		1	
Aristida junciformis		0.1	
Cymbopogon dieterlenii		0.2	
Elionurus muticus		0.5	
Eragrostis capensis		1	
Eragrostis curvula		25	
Eragrostis racemosa		1	
Eragrostis superba		0.5	
Harpochloa falx		2	
Heteropogon contortus		5	
Setaria sphacelata		2	
Themeda triandra		30	
Tristachya leucothrix		2	
Geophytes			
Albuca species		0.1	
Asclepias eminens		0.1	
Chlorophytum fasciculatum		0.1	
Chlorophytum species		0.1	
Eucomis autumnalis	11	0.1	
Gladiolus sericeovillosus s. calvatus	11	0.1	
Habenaria dives	11	0.1	

Species	*Status*	*avg %*	*max %*
Hypoxis rigidula		0.5	
Ledebouria marginata		0.1	
Oxalis obliquifolia		0.1	
Symbols:			

Species	*Status*	*avg %*	*max %*
11 = provincially protected, Schedule 11 AI = Alien Invasive Plant, indicated by category if listed under NEMA:BA W = Indigenous weed that could potentially become invasive			

Sensitivity Rating:

Conservation status	» Medium, only few isolated plants of conservation concern but highest species diversity on the study area
Ecosystem function	» Grazing and soil stabilisation » Nutrient retention to increase landscape functionality » Possible resource for pollinator populations » Reduction of runoff and hence flood attenuation during periods of extreme rainfall
Stability	» Medium to high if indigenous vegetation can be retained
Reversibility of degradation	» Continued improvement to natural grassland should be possible
Rating	» ***Medium sensitivity***

General development recommendations:

Runoff from this portion of the study area is directed into a northerly wetland, which is still relatively functional and still supports a good species diversity. It would thus be desirable that vegetation clearing in this area be kept to the absolute minimum. If the proposed development will be placed on these areas, only PV arrays, preferably high tracking panels that do not shade the vegetation excessively, should be put here, but the placement of roads and any other transformed surfaces should avoid this area as far as possible. Similarly, trenching for cables will have to be done carefully to disturb as little area as possible.

It is further desirable that alien invasive species be controlled and/or cleared.

5.2.2. Semi-natural Grasslands

Habitat and Land use			
Substrate	Sandy grey loam on slightly undulating slopes and plains	**Disturbance**	Previously transformed, rubble, alien invasives, coal-dust pollution
Species Richness	46 indigenous species 10 alien invasive species		
Need for rehabilitation	Eradication of alien invasives	**Agricultural potential**	Grazing

Vegetation structure		
Layer	**Height (m)**	**Cover (%)**
Low Shrubs	0.3 – 0.6	0.1
Grass	0.4 – 1.2	70
Forbs, including geophytes	0.05 – 0.8	10
Dominant species (highest to lowest cover)	*Andropogon chinensis, Eragrostis curvula, Cyperus esculentus, Digitaria eriantha, Hyparrhenia hirta, Helichrysum rugulosum*	

Conservation status	**Indigenous**	**Weeds** (Indigenous)	**Alien**	**Total**	**Red Data**	**Protected**
High shrubs/Trees				**0**		
Low shrubs	4	1		**5**		
Succulents				**0**		
Forbs	26	3	8	**37**		
Grasses	5	1	2	**8**		
Geophytes	6			**6**		
Total	**41**	**5**	**10**	**56**	**0**	**0**

These grasslands have clearly been almost completely transformed in the past – so much so that even some of the wetlands contained within these grassland are hardly distinguishable from a vegetation composition only. Dominance of species varies over the extent of these grasslands, depending on the time since rehabilitation efforts (Figure 8). This will continue to change, and such change may even occur quite rapidly.

Rehabilitation has been moderately successful as a dense perennial grass layer has been established, which stabilises the soil. Small bare patches still do remain, which are prone to erosion, but these are gradually being colonised by

prostrate-growing species, especially of the Genus *Hermannia*. At the time of the survey, levels of invasion by alien plant species was still low, but the area remains susceptible to increased invasion by undesirable species.

A fringe of exotic trees has been planted on most of the periphery of these grasslands, but they have not been included in the survey.

Figure 8: Views of the semi-natural grasslands.

Species composition and typical observed cover percentages:

Species	*Status*	*avg %*	*max %*
Low shrubs			
Felicia muricata		0.1	
Hermannia erodioides		0.1	
Pollichia campestris		0.2	
Seriphium plumosum	W	0.1	
Tephrosia capensis		0.1	
Herbs and forbs			
Anthospermum rigidum		0.2	
Bidens pilosa	AI	1	
Bulbostylis hispidula		0.1	
Cirsium vulgare	AI: 1b	0.1	
Commelina africana		0.1	
Conyza podocephala	W	0.2	
Crepis hypochaeridea	AI	0.1	
Cyperus esculentus	W	5	
Cyperus rigidifolius		0.5	
Euphorbia epicyparissias		0.1	
Haplocarpha scaposa		0.1	
Helichrysum nudifolium		0.2	
Helichrysum pilosellum		0.1	
Helichrysum rugulosum		2	
Hermannia coccocarpa		0.1	
Hermannia depressa		0.1	
Hermannia geniculata		0.1	
Hermannia oblongifolia		0.5	
Hibiscus trionum	W	0.1	
Jamesbrittenia aurantiaca		0.1	
Kohautia amatymbica		0.1	
Kohautia caespitosa		0.1	
Kyllinga pulchella		0.5	
Monopsis decipiens		0.1	
Oenothera rosea	AI	0.2	
Polygala amatymbica		0.1	
Polygala hottentotta		0.1	

Species	*Status*	*avg %*	*max %*
Richardia brasiliensis	AI	0.2	
Rorippa nudiuscula		0.5	
Salvia disermas		0.1	
Scabiosa columbaria		0.1	
Senecio consanguineus		0.1	
Solanum pseudocapsicum	AI: 1b	0.1	
Tagetes minuta	AI	0.3	
Tragopogon dubius		0.1	
Verbena bonariensis	AI: 1b	0.2	
Vernonia oligocephala		0.1	
Grasses			
Andropogon chinensis		40	
Cynodon dactylon		0.5	
Digitaria eriantha		5	
Eragrostis curvula		30	
Eragrostis gummiflua		0.2	
Hyparrhenia hirta	W	5	
Paspalum dilatatum	AI	0.1	
Pennisetum clandestinum	AI	0.5	
Geophytes			
Asclepias eminens		0.1	
Chlorophytum cooperi		0.1	
Hypoxis angustifolia		0.1	
Hypoxis rigidula		0.2	
Oxalis obliquifolia		0.1	
Xysmalobium undulatum		0.1	

Symbols:
AI = Alien Invasive Plant, indicated by category if listed under NEMA:BA
W = Indigenous weed that could potentially become invasive

Sensitivity Rating:

Conservation status	» Low, previously transformed and low species diversity
Ecosystem function	» Vegetation valuable for grazing and stabilisation of soils, maintenance of pollinator populations, increasing infiltration of precipitation
Stability	» High where the lower vegetation layer is dense, medium to low if soils become bare
Reversibility of degradation	» Possible, clearing of invasives needed to improve ecosystem functionality
Rating	» ***Low sensitivity***

General development recommendations:

Listed alien invasive species must be eradicated to prevent further spread of regenerative material into surrounding areas or further downstream. It is recommended that a low natural grass layer be re-instated to suppress ruderal weed and alien invasive species. Regular mowing of this grass layer will ensure it does not pose a fire risk to the proposed development.

5.2.3. *Eucalyptus - Pennisetum clandestinum* Depression

Habitat and Land use			
Substrate	Sandy loam in a slight depression	**Disturbance**	Partial previous transformation, alien invasives, coal-dust pollution
Species Richness	5 indigenous species 8 alien invasive species		
Need for rehabilitation	Eradication of alien invasives	**Agricultural potential**	----

Vegetation structure		
Layer	**Height (m)**	**Cover (%)**
High Shrubs/Trees	3 - 6	2
Grass	0.05 – 1.2	60
Forbs, including geophytes	0.15 – 1.2	30
Dominant species (highest to lowest cover)	*Pennisetum clandestinum, Cosmos bipinnatus, Andropogon chinensis, Eragrostis curvula, Cyperus esculentus, Galinsoga parviflora*	

Conservation status	Indigenous	Weeds (Indigenous)	Alien	Total	Red Data	Protected
High shrubs/Trees			1	**1**		
Low shrubs				**0**		
Succulents				**0**		
Forbs	2	1	6	**9**		
Grasses	2		1	**3**		
Geophytes				**0**		
Total	**4**	**1**	**8**	**13**	**0**	**0**

This small portion of the study area is actually a wetland, but has been included in the vegetation description due to the extremely high level of alien invasives present (Figure 9), which poses a high risk of invasion to the surrounding grasslands, and could also be a major concern to the proposed development.

Eucalyptus trees have become established on this wetland, which has been drained in the past, and the area is dominated by ruderal alien invasive species, of which some are declared invasives that must be eradicated in wetland areas. Despite having been burnt (signs of fire damage still visible on trees and forbs), these alien plants have already displaced the bulk of indigenous species that would naturally occur in such habitats.

Figure 9: The transformed wetland with high alien invasive cover.

Species composition and typical observed cover percentages:

Species	*Status*	*avg %*	*max %*
High shrubs/Trees			
Eucalyptus species	AI: 2	2	
Herbs and forbs			
Chenopodium album	AI	3	
Chenopodium carinatum	AI	1	
Cosmos bipinnatus	AI	15	
Cyperus esculentus	W	5	
Datura stramonium	AI: 1b	0.2	
Galinsoga parviflora	AI	5	
Pycreus cooperi		3	
Solanum pseudocapsicum	AI: 1b	3	

Species	*Status*	*avg %*	*max %*
Withania somnifera		0.5	
Grasses			
Andropogon chinensis		10	
Eragrostis curvula		10	
Pennisetum clandestinum	AI	40	

Symbols:
AI = Alien Invasive Plant, indicated by category if listed under NEMA:BA
W = Indigenous weed that could potentially become invasive

Sensitivity Rating:

Conservation status	»	Low
Ecosystem function	»	**Wetland**: Flood attenuation, filtering of pollutants
Stability	»	Medium in current state
Reversibility of degradation	»	Possible, will require intervention, clearing of invasives needed to improve ecosystem functionality
Rating	»	***Medium sensitivity***

General development recommendations:

Listed alien invasive species must be eradicated to prevent further spread of regenerative material into surrounding areas or further downstream. If the area will be used for the proposed development, it is recommended that a low natural grass layer be re-instated to suppress ruderal weed and alien invasive species. However, given that this is a wetland, it would be more desirable to rehabilitate this area as a functional wetland.

5.3. Amphibians, Reptiles and Mammals

A list of protected vertebrate species (amphibians, reptiles, and mammals) that could occur in the study area according to the ADU and SANBI databases, as well as Apps (2000) is presented in Appendix C. During the survey, no terrestrial vertebrates were sighted, but there are some burrows (left) in the grasslands, indicating the presence of either larger reptiles and/or small rodents. These groups of burrows could be from the Giant Girdled Lizard /Sungazer.

5.4. Species of conservation concern

The following red data species have been recorded from the area (2827) according to the red data species list of SANBI and the ADU database:

Species	RD Status	Suitable Habitat	Possibility of being present	Threat
Plants				
None of the potential red data species have been confirmed on site, or are expected to occur there				
Terrestrial Vertebrates				
Giant Girdled Lizard ***Smaug (Cordylus) giganteus***	VU	Grassland	Possible	Habitat destruction
Spotted Shovel-nosed Frog ***Hemisus guttatus***	VU	Grassland and associated wetlands	Possible	Habitat destruction

The following plants encountered on the study site are protected:

Mpumalanga Nature Conservation Act (Act 10 of 1998):

Aloe ecklonis
Eucomis autumnalis (Figure 10)
Gladiolus sericeovillosus s. calvatus
Habenaria dives (Figure 10)

Figure 10: *Eucomis autumnalis* (left) and *Habenaria dives* (right)

5.5. Invasive Plants

According to the SANBI-POSA species list, over 80 alien invasive plant species have been recorded up to date within the grid representative of Majuba. 20 of these species could be confirmed on the study site already (excluding exotic trees planted on the periphery of the study area).

Regulation 598 under the National Environmental Management: Biodiversity Act (No 10 of 2004), which came into effect on 1 August 2014, groups Alien Invasive Species according to following categories:

Category 1a: Listed Invasive Species

Immediate steps must be taken to combat or eradicate such a species

Category 1b: Listed Invasive Species
Immediate steps must be taken to control such a species

Category 2: Listed Invasive Species
Commercial and utility plants, allowed only by permit holders, else must be eradicated or controlled. Must be considered a category 1b species if found within any riparian area

Category 3: Listed Invasive Species
Commercial and utility plants, allowed only by permit holders, must be considered a category 1b species if found within any riparian area

The following listed alien invasive species have been recorded on the study area:
Category 1b:

Cirsium vulgare
Datura stramonium
Solanum pseudocapsicum
Verbena bonariensis
Verbena brasiliensis

Category 2:

Eucalyptus species

Additional alien invasive species do occur in the surrounding area along major transport routes, which could be accidentally introduced to the project site during construction. Regular monitoring and early eradication should enable a cost-effective control of invasives.

6. Assessment of impacts

6.1. Assumptions

The following is assumed and/or known:

» Existing access roads and tracks will be used and upgraded, whilst new access roads, servitudes, or power lines will coincide as far as possible with existing infrastructure. Access roads will be suitably reinforced, but not covered with tar or concrete
» A thorough ecological investigation of all footprint areas will be conducted to detect and relocate all plant species of conservation concern by a suitably qualified botanist prior to a geotechnical survey and/or commencement of construction
  - Such investigation must be carried out at a time when the maximum amount of species are actively growing and thus visible
» Prior to development and after construction, until decommissioning, the footprint area will be routinely cleared of all listed alien invasive plants
» The construction phase itself will be associated with selective clearing of vegetation and trenching for electrical and other cabling as needed
» All removal of vegetation for construction purposes will be done mechanically, without the use of herbicides

6.2. Fixed and Tracking PV Panels

Impacts on the environment will be influenced by the types of PV panel array to be used. The most important differences that are envisaged to influence the impact on the ecological environment (Tsoutsos *et al*. 2005, Turney and Fthenakis 2011) can be summarised as follows:

Aspect influenced	***Fixed panel***	***Tracking panel***
Size of land needed	smaller	larger
Shading and its associated change of vegetation	More continuous and intense shading Less stable and dense vegetation expected, reduced buffering capacity of extreme weather events by vegetation expected	More variable and less intense overall shading More stable and denser vegetation cover expected, smaller reduction of buffering capacity of extreme weather events expected
Effect on runoff and accelerated erosion	Larger continuous panel area, more concentrated runoff, constant runoff edges potentially create more	Smaller continuous panel areas, runoff more dissipated, moderate variation of runoff edges that are expected to

Aspect influenced	*Fixed panel*	*Tracking panel*
	erosion, especially where vegetation is weakened	create less erosion where vegetation is weakened
Mounting height	PV panels may be as low as 50 cm above ground to allow for higher panels, increasing the limits of permissible vegetation due to maintenance and fire risks	Expected to be more than 1 m off the ground, increasing the possibility of low vegetation establishment and small fauna movement without compromising safety

6.3. Impacts of PV array, access roads and associated infrastructure

1. Activity: Upgrading and/or creation of site access road and internal maintenance tracks *Note: The study area is surrounded by gravel roads, and on-site access will thus be limited to service and construction tracks*		
Environmental Aspect: Removal of vegetation, compaction and disturbance of soils, creation of runoff zone, possible destruction of animal burrows, impact on protected species, alteration of soil surface properties, increased coal-dust pollution		
Environmental impact: Loss of indigenous (-ve) and alien invasive (+ve) vegetation, increase in runoff and erosion, possible increased distribution of alien invasive species, possible disturbance and reduction of habitat or injury to/loss of burrowing vertebrates, possible change of natural runoff and drainage patterns, possible loss of protected species, possible permanent loss of revegetation potential of soil surface		
	Without mitigation	**With mitigation**
Extent (E)	Site specific (1)	Site specific (1)
Duration (D)	Long-term (4)	Long-term (4)
Magnitude (M)	Low (4)	Small (0)
Probability (P)	Definite (5)	Probable (3)
Significance (S = E+D+M)*P	**Medium (45)**	**Low (15)**
Status (positive, neutral or negative)	Negative	*Positive* where aliens will be cleared *Neutral* where roads exist or on transformed areas

Reversibility	Not reversible	Relatively reversible
Irreplaceable loss of resources?	Probable	Not likely
Can impacts be mitigated?	Reasonably well	

Mitigation:

» Avoid wetland areas and high diversity grassland sections
» After the final layout has been approved, conduct a thorough footprint investigation to detect and map any protected plant species and animal burrows
  - Protected plant species: must be relocated
  - Animal burrows: must be monitored by ECO prior to construction for activity/presence of animal species. If detected, such animals must be removed and relocated by a qualified professional/contractor
» During construction: create designated turning areas and strictly prohibit any off-road driving or parking of vehicles and machinery outside designated areas
» Keep the clearing of grasslands to a minimum
» If filling material is to be used, this should be sourced from areas free of invasive species
» Topsoil (the upper 25 cm of soil) is an important natural resource; where it must be stripped, never mix it with subsoil or any other material, store and protect it separately until it can be re-applied, minimise handling of topsoil
» Reinforce portions of existing access routes that are prone to erosion, create structures or low banks to drain the access road rapidly during rainfall events, yet preventing erosion of the track and surrounding areas
» Ensure that runoff from compacted or sealed surfaces is slowed down and dispersed sufficiently to prevent accelerated erosion from being initiated (storm water and erosion management plan required)
» Prevent leakage of oil or other chemicals or any other form of pollution
» Monitor the establishment of (alien) invasive species and remove as soon as detected, whenever possible before regenerative material can be formed
» Reduce the level of air-borne coal-dust pollution by creating a screen between the panel array and the coal stockpile and its supply road
  - Either with a physical screen or by planting a dense row of suitable trees on the periphery
» After decommissioning, if access road or portion thereof will not be of further use to the landowner, remove all foreign material and rip area to facilitate the establishment of vegetation, followed by a suitable revegetation program

Cumulative impacts:

» Possible erosion of areas lower than the access road
» Possible contamination of lower-lying wetlands due to oil or other spillage
» Possible spread and establishment of alien invasive species
» Increased transformation of rangelands in area

Residual impacts:
» Altered vegetation composition and structure
» Altered topsoil conditions
» Potential barren areas
» Potential for erosion and invasion by weed or alien species

2. Activity: Fencing area – may also serve as maintenance track to PV panels		
Environmental Aspect: *(Note: Fencing already exists around the entire power plant area)* Removal of vegetation, compaction of soils, creation of runoff zone, impact on protected species, impact on terrestrial vertebrates		
Environmental impact: Loss of indigenous (-ve) and alien invasive (+ve) vegetation, window of opportunity for the establishment of alien invasive species, altered topsoil characteristics prone to capping, increased runoff and erosion, temporary disturbance of burrowing animals, possible reduction of habitat and forage availability to terrestrial vertebrates by exclusion		
	Without mitigation	**With mitigation**
Extent (E)	Site specific (1)	Site specific (1)
Duration (D)	Long-term (4)	Long term (4)
Magnitude (M)	Minor (2)	Small (0)
Probability (P)	Probable (3)	Probable (3)
Significance (S = E+D+M)*P	**Low (21)**	**Low (15)**
Status (positive, neutral or negative)	Negative	*Positive* where aliens will be cleared *Neutral* where on transformed or highly degraded areas *Minimal new negative impacts expected*
Reversibility	Reversible	Reversible
Irreplaceable loss of resources?	Not likely	Not likely
Can impacts be mitigated?	Reasonably well	

Mitigation:

» Avoid wetland areas
» After the final layout has been approved, conduct a thorough footprint investigation to detect and map (by GPS) any protected plant species and animal burrows
  - Protected plant species: must be relocated
  - Animal burrows: must be monitored by ECO prior to construction for activity/presence of animal species. If detected, such animals must be removed and relocated by a qualified professional/contractor
» As part of the design phase, it must be made clear what vegetation will be permissible and how this will be kept in a state that is suitable for the development, e.g. regular mowing
  - It will be important to maintain a fairly dense, low vegetation layer to protect erodible soils and prevent further wetland degradation
» During the design phase, the possible impact of burrowing vertebrates and rodents on the development must be determined, and fencing must be designed to either exclude such fauna if it will be detrimental or enable occasional migration of smaller vertebrates onto and across the site (which could be beneficial to small vertebrate populations)
» Minimise area affected, especially during construction
» During construction: strictly prohibit any off-road driving or parking of vehicles and machinery outside the footprint areas
» Prevent leakage of oil or other chemicals, strictly prohibit littering of any kind
» Monitor the establishment of alien and indigenous invasive species and remove as soon as detected, whenever possible *before* regenerative material can be formed

Cumulative impacts:

» Possible erosion of cleared areas and associated accelerated erosion from surrounding areas
» Possible loss of ecosystem functioning due to increase in invasive species
» Increased fragmentation of rangelands

Residual impacts:

» Altered vegetation composition (temporary)
» Possibility for erosion and invasion by alien invasives

3. Activity: Construction and operation of PV panels on transformed/low diversity areas

Environmental Aspect: Removal of vegetation, compaction of topsoil, creation

of new or altered runoff zone, redistribution and concentration of runoff from panel surfaces, artificial shading of vegetation, continued displacement of terrestrial vertebrates, reduced buffering capacities of the landscapes during extreme weather events, reduction of alien invasive species (+ve)

Note: tracking panels may occupy more land, but will have smaller sealed surfaces leading to smaller concentrated runoff volumes, which will cause less soil erosion. Also, smaller panels spaced wider allow a denser vegetation layer to re-establish to stabilise the soils and suppress weeds and invasives. Fixed panels may create more erosion which should be adequately mitigated.

Environmental impact: Significant decrease of weeds and alien invasive vegetation (+ve, if properly mitigated), loss of indigenous vegetation, site-specific altered distribution of rainfall and resultant runoff patterns, general increase in runoff from PV and/or bare areas and associated accelerated erosion, reduction of habitat for terrestrial fauna, possible increase of detrimental effects during periods of extreme weather events, e.g. increased severe erosion or dust due to lower buffering capacity if vegetation remains sparse

	Without mitigation	**With mitigation**
Extent (E)	Site specific (1)	Site specific (1)
Duration (D)	Long-term (4)	Long-term (4)
Magnitude (M)	Low (4)	Minor (2)
Probability (P)	Definite (5)	Definite (5)
Significance (S = E+D+M)*P	**Medium (55)**	**Medium (35)**
Status (positive, neutral or negative)	Negative	Negative
Reversibility	Partially reversible	Reversible
Irreplaceable loss of resources?	Highly Probable	Slight Probability
Can impacts be mitigated?	Reasonably	

Mitigation:

» After the final layout has been approved, conduct a thorough footprint investigation to detect and map any protected plant species and active animal burrows
  - Protected plant species: must be relocated
  - Animal burrows: must be monitored by ECO prior to construction for activity/presence of animal species. If detected, such animals must be removed and relocated by a qualified professional/contractor

» Keep areas affected to a minimum, strictly prohibit any disturbance outside the demarcated footprint area

» As part of the design phase, it must be made clear what vegetation will be

permissible and how this will be kept in a state that is suitable for the development, e.g. regular mowing
    - It will be important to maintain a fairly dense, low vegetation layer to protect erodible soils and prevent further wetland degradation
» Remove all rubble and other foreign materials currently on the site, prevent any further pollution
» Weeds and alien invasive species must be eradicated or significantly reduced:
    - This is not only to stop the high reproduction and spreading of alien invasives, but also to reduce maintenance costs of the proposed development
    - Continue monitoring and removing all invasive vegetation after construction up to decommissioning
» After construction, rehabilitate an acceptable vegetation layer according to rehabilitation recommendations of the relevant EMP
    - Use species that were part of the original indigenous species composition similar to the remaining intact natural vegetation as listed in the specialist report, or sow with *Eragrostis curvula*. It is expected that several indigenous species will naturally re-establish due to existing seed banks.
    - A strong grass layer will suppress the re-emergence of weed species from existing seed banks
» If filling material is to be used, this should be sourced from areas free of invasive species
» Topsoil (the upper 25 cm) is an important natural resource; where it must be stripped, never mix it with subsoil or any other material, store and protect it separately until it can be re-applied, minimise handling of topsoil
» Temporarily stored topsoil must be re-applied within 6 months, topsoils stored for longer need to be managed according to a detailed topsoil management plan and must as minimum be freed of weeds and alien invasive plants
» Monitor the area below the PV panels regularly after larger rainfall events to determine where erosion may be initiated and then mitigate by modifying the soil micro-topography and revegetation efforts accordingly
» Prevent leakage of oil or other chemicals, strictly prohibit littering of any kind

Cumulative impacts:

» If mitigation measures are not strictly followed the following could occur:
    - erosion of areas around the panels and continued erosion of the development area with associated siltation and/or degradation of lower-lying wetlands and adjacent natural endangered vegetation
    - contamination of wetlands
    - spread and establishment of invasive species

Residual impacts:

» altered topsoil characteristics
» altered vegetation composition

4. Activity: Construction and operation of any development component(s) on higher diversity grasslands

Environmental Aspect: Removal of or excessive damage to vegetation, compaction of soils, creation of runoff zone, redistribution and concentration of runoff from panel surfaces, artificial shading and resulting decimation of vegetation, displacement of terrestrial vertebrates, reduced buffering capacities of the landscapes during extreme weather events

Note: tracking panels may occupy more land, but will have smaller sealed surfaces leading to smaller concentrated runoff volumes, which will cause less soil erosion. Also, smaller panels spaced wider allow a denser vegetation layer to re-establish to stabilise the soils and suppress weeds and invasives. Fixed panels may create more erosion which should be adequately mitigated.

Environmental impact: Loss and further fragmentation of species of conservation concern, altered vegetation cover, window of opportunity for the establishment of alien invasive species, site-specific altered distribution of rainfall and resultant runoff patterns, increase in runoff from PV panels and/or bare areas and accelerated erosion, loss of habitat and resource availability for terrestrial fauna, possible increase of detrimental effects during periods of extreme weather events, e.g. severe erosion or dust due to lower buffering capacity of sparser vegetation

	Without mitigation	**With mitigation**
Extent (E)	Site specific (1)	Site specific (1)
Duration (D)	Long-term (4)	Long-term (4)
Magnitude (M)	High (8)	Moderate (6)
Probability (P)	Definite (5)	Definite (5)
Significance (S = E+D+M)*P	**High (65)**	**Medium (55)**
Status (positive, neutral or negative)	Negative	Negative
Reversibility	Partially reversible	Partially reversible
Irreplaceable loss of resources?	Highly Probable	Probable
Can impacts be mitigated?	Reasonably	

Mitigation:

» After the final layout of permissible development components has been approved, conduct a thorough footprint investigation to detect and map any protected plant species and active animal burrows
  - Protected plant species: must be relocated
  - Animal burrows: must be monitored by ECO prior to construction for

activity/presence of animal species. If detected, such animals must be removed and relocated by a qualified professional/contractor

» Keep areas affected to a minimum, strictly prohibit any disturbance outside the demarcated footprint area
» Clear as little grassland vegetation as possible, aim to maintain vegetation where it will not interfere with the construction or operation of the development, rehabilitate an acceptable vegetation layer according to rehabilitation recommendations of the relevant EMP
    - use only species that were part of the original indigenous species composition as listed in the specialist report
» As part of the design phase, it must be made clear what vegetation will be permissible and how this will be kept in a state that is suitable for the development, e.g. regular mowing
    - It will be important to maintain a fairly dense, low vegetation layer to protect erodible soils and prevent further wetland degradation
» Remove all rubble and other foreign materials currently on the site, prevent any further pollution
» Weeds and alien invasive species must be eradicated or significantly reduced:
    - This is not only to stop the high reproduction and spreading of alien invasives, but also to reduce maintenance costs of the proposed development
    - Continue monitoring and removing all invasive vegetation after construction up to decommissioning
» After construction, rehabilitate an acceptable vegetation layer according to rehabilitation recommendations of the relevant EMP
    - Use species that were part of the original indigenous species composition similar to the remaining intact natural vegetation as listed in the specialist report, or sow with *Eragrostis curvula*. It is expected that several indigenous species will naturally re-establish due to existing seed banks.
    - A strong grass layer will suppress the re-emergence of weed species from existing seed banks
» If filling material is to be used, this should be sourced from areas free of invasive species
» Topsoil (the upper 25 cm of soil) is an important natural resource; where it must be stripped, never mix it with subsoil or any other material, store and protect it separately until it can be re-applied, minimise handling of topsoil
» Temporarily stored topsoil must be re-applied within 6 months, topsoils stored for longer need to be managed according to a detailed topsoil management plan
» The rehabilitation plan for all temporarily affected areas and for the development area after decommissioning must aim to re-introduce all non-weed indigenous species listed in the specialist report as a minimum, taking the observed original cover percentages as a guideline of acceptable vegetation cover
» Prevent leakage of oil or other chemicals, strictly prohibit littering of any kind

» Remove all alien invasive vegetation prior to construction » Monitor the establishment of all invasive species and remove as soon as detected, whenever possible before regenerative material can be formed
Cumulative impacts: » If mitigation measures are not strictly e the following could occur: o Loss of and further fragmentation of remaining portions of natural grassland and associated ecosystem services such as pollination o Alteration of occupancy by terrestrial fauna, possible reduction of available habitat and food availability to terrestrial fauna o Spread and establishment of invasive species, and further associated degradation of remaining endangered vegetation
Residual impacts: » altered topsoil characteristics » altered vegetation composition » fragmentation and loss of diversity of endangered vegetation

5. Activity: Construction of a short power line as part of the grid connection (see also impacts and mitigations under activity 4 above)		
Environmental Aspect: Limited removal of vegetation, compaction of soils, temporary or permanent damage to animal burrows		
Environmental impact: Loss of vegetation, increase in runoff and erosion, disturbance of burrowing animals		
	Without mitigation	**With mitigation**
Extent (E)	Site and surroundings (2)	Site specific (1)
Duration (D)	Long-term (4)	Long-term (4)
Magnitude (M)	Minor (2)	Small (0)
Probability (P)	Probable (3)	Probable (3)
Significance (S = E+D+M)*P	**Low (24)**	**Low (15)**
Status (positive, neutral or negative)	Negative	Slightly negative
Reversibility	Reversible	Reversible
Irreplaceable loss of resources?	Not likely	Not likely
Can impacts be mitigated?	Reasonably	
Mitigation:		

» During the design phase, aim to have connection routes coinciding with existing tracks or fence lines to reduce the disturbance to vegetation and avoid creating new tracks and areas of compaction by construction and maintenance machinery
  o Avoid crossing wetland areas as far as possible
» After the final layout has been approved, conduct a thorough footprint investigation to detect and map any protected plant species and animal burrows
  o Protected plant species: must be relocated where affected by pylons, maintenance tracks or construction
  o Animal burrows: must be monitored by ECO prior to construction for activity/presence of animal species. If detected, such animals must be removed and relocated by a qualified professional/contractor
» During construction: create designated servitude areas and strictly prohibit any off-road driving or parking of vehicles and machinery outside designated areas
» Limit clearing of indigenous vegetation to pylon positions only
» Prevent spillage of construction material, oils or other chemicals, strictly prohibit other pollution
» Monitor the establishment of invasive species and remove as soon as detected, whenever possible before regenerative material can be formed

Cumulative impacts: » Possible erosion of surrounding areas if no mitigation is implemented, no major cumulative impact on flora or fauna expected (excluding avifauna)
Residual impacts: » Very localised alteration of soil surface characteristics » Very localised alteration of species composition

6. Activity: Construction of substation and other electricity-related buildings, workshops, offices, guardhouses, etc. on *transformed areas*		
Environmental Aspect: Removal of vegetation, compaction and alteration of topsoils, creation of runoff zone, redistribution and concentration of runoff from sealed surfaces, displacement of terrestrial vertebrates		
Environmental impact: Loss of vegetation and/or species of conservation concern, significant decrease and possible eradication of weeds and alien invasive plants (+ve), loss of microhabitats, altered and reduced vegetation cover, altered distribution of rainfall and resultant runoff patterns, increase in *concentrated* runoff from sealed surfaces and possibly higher accelerated erosion, reduction of habitat and resource availability for terrestrial fauna		
	Without mitigation	**With mitigation**
Extent (E)	Site specific (2)	Site specific (1)

Duration (D)	Long-term (4)	Long-term (4)
Magnitude (M)	Minor (2)	Small (0)
Probability (P)	Definite (5)	Definite (5)
Significance (S = E+D+M)*P	**Medium (40)**	**Low (25)**
Status (positive, neutral or negative)	Negative	Neutral on transformed or severely degraded grassland areas *(Negative on high diversity grassland areas – see under activity 4)*
Reversibility	Partially reversible	Reversible
Irreplaceable loss of resources?	Probable	Not likely
Can impacts be mitigated?	Reasonably	

Mitigation:

» During the design phase, ensure that none of these development components are situated outside transformed areas, or degraded grassland areas adjacent to existing infrastructure
  - Avoidhigher diversity grasslands and wetlands for these development components

» After the final layout has been approved, conduct a thorough footprint investigation to detect and map any protected plant species and animal burrows
  - Protected plant species: must be relocated
  - Animal burrows: must be monitored by ECO prior to construction for activity/presence of animal species. If detected, such animals must be removed and relocated by a qualified professional/contractor

» Weeds and alien invasive species must be eradicated or significantly reduced:
  - Continue monitoring and removing all invasive vegetation after construction up to decommissioning

» Limit disturbance to footprint area as far as practically possible

» During construction: stay within demarcated footprint areas and strictly prohibit any off-road driving or parking of vehicles and machinery outside designated areas

» Prevent spillage of construction material and other pollutants, contain and treat any spillages immediately

» Topsoil (the upper 25 cm) is an important natural resource; where it must be stripped, never mix it with subsoil or any other material, store and protect it separately until it can be re-applied, minimise handling of topsoil

» Temporarily stored topsoil must be re-applied within 6 months, topsoils stored

for longer need to be managed according to a detailed topsoil management plan
» If filling material is to be used, this should be sourced from areas free of invasive species
» Rehabilitate and revegetate all areas outside the footprint area that have been disturbed
» After decommissioning, remove all foreign material prior to starting the rehabilitation
» The rehabilitation plan for all temporarily affected areas and for the development area after decommissioning must aim to re-introduce non-weed indigenous species listed for the natural remaining grasslands as described in the specialist, taking the observed original cover percentages of intact grasslands as a guideline of acceptable vegetation cover
» Monitor the establishment of invasive species and remove as soon as detected, whenever possible before regenerative material can be formed

Cumulative impacts:
» If mitigation measures are not strictly followed the following could occur:
  - erosion of areas around sealed surfaces and continued erosion or degradation of the development area with associated degradation of lower-lying wetlands
  - contamination of wetlands
  - spread and establishment of invasive species

Residual impacts:
» altered topsoil characteristics
» possible removal of existing foreign materials from the environment (which would be desirable and positive)
» altered vegetation composition (which can be positive if invasives are replaced by indigenous species)

7. Activity: Temporary construction camps and sites where materials, machinery and temporary staff facilities are kept during construction

Environmental Aspect: Removal of vegetation, compaction of soils, creation of runoff zone, displacement of terrestrial vertebrates, possible contamination of topsoil and groundwater by chemicals or oils
Note: within the power plant area are already transformed areas that could possibly be utilised for construction equipment

Environmental impact: Loss of vegetation and/or species of conservation concern, loss of microhabitats, altered vegetation cover, altered distribution of rainfall and resultant runoff patterns, increase in *concentrated* runoff from sealed or compacted surfaces and possibly higher accelerated erosion, reduction of habitat and resource availability for terrestrial fauna, possible contaminated topsoil, possible contaminated ground water or wetlands

	Without mitigation	**With mitigation**
Extent (E)	Site specific (1)	Site specific (1)
Duration (D)	Moderate-term (3)	Short-term (2)
Magnitude (M)	Low (4)	Small (0)
Probability (P)	Highly Probable (4)	Probable (3)
Significance (S = E+D+M)*P	**Medium (32)**	**Low (9)**
Status (positive, neutral or negative)	Negative	Negative
Reversibility	Reversible	Reversible
Irreplaceable loss of resources?	Not likely	Not likely
Can impacts be mitigated?	Reasonably	

Mitigation:

» Exclude wetlands from this activity
» After the final layout has been approved, conduct a thorough footprint investigation to detect and map any protected plant species and animal burrows
  - Protected plant species: must be relocated
  - Animal burrows: must be monitored by ECO prior to construction for activity/presence of animal species. If detected, such animals must be removed and relocated by a qualified professional/contractor
» Stay within demarcated temporary construction areas and strictly prohibit any off-road driving or parking of vehicles and machinery outside designated areas
» Prevent spillage of construction material and other pollutants, contain and treat any spillages immediately, strictly prohibit any pollution/littering according to the relevant EMP
» No fires may be lit for cooking or any other purposes
» Facilities may not be used as staff accommodation
» Topsoil (the upper 25 cm of soil) is an important natural resource; where it must be stripped, never mix it with subsoil or any other material, store and protect it separately until it can be re-applied, minimise handling of topsoil
» Temporarily stored topsoil must be re-applied within 6 months, topsoils stored for longer need to be managed according to a detailed topsoil management plan
» After construction remove all foreign material prior to starting the rehabilitation
» The rehabilitation plan for all temporarily affected areas must aim to re-introduce all non-weed indigenous species listed in the specialist report as a

minimum, taking the observed original cover percentages of intact grasslands as a guideline of acceptable vegetation cover » Monitor the establishment of invasive species and remove as soon as detected, whenever possible before regenerative material can be formed
Cumulative impacts: » If mitigation measures are not strictly followed the following could occur: o erosion of the development area with associated siltation and/or erosion of lower-lying wetlands o contamination of drainage lines, lower-lying rivers, wetlands and ground water o spread and establishment of invasive species
Residual impacts: » altered topsoil characteristics » altered vegetation composition

8. Activity: Borrow-pits and/or topsoil stockpiles that might be required during construction		
Environmental Aspect: Removal of vegetation, compaction of soils, creation of runoff zone, displacement of terrestrial vertebrates		
Environmental impact: Loss of vegetation and/or species of conservation concern, loss of microhabitats, altered vegetation cover, altered distribution of rainfall and resultant runoff patterns, possibly higher accelerated erosion, possible loss of topsoil resources, reduction of habitat and resource availability for terrestrial fauna		
	Without mitigation	**With mitigation**
Extent (E)	Local (2)	Local (1)
Duration (D)	Long-term (4)	Short-term (2)
Magnitude (M)	Low (4)	Minor (2)
Probability (P)	Highly Probable (4)	Probable (3)
Significance (S = E+D+M)*P	**Medium (40)**	**Low (15)**
Status (positive, neutral or negative)	Negative	Neutral to slightly negative
Reversibility	Partially reversible	Reversible
Irreplaceable loss of resources?	Probable	Not likely
Can impacts be mitigated?	Reasonably	

Mitigation:

» Exclude high diversity grasslands and wetlands from this activity
» After the final layout has been approved, conduct a thorough footprint investigation to detect and map any protected plant species and animal burrows
  - Protected plant species: must be relocated
  - Animal burrows: must be monitored by ECO prior to construction for activity/presence of animal species. If detected, such animals must be removed and relocated by a qualified professional/contractor
» Stay within demarcated areas and access routes for extraction and/or movement of materials
» Strictly prohibit any off-road driving or parking of vehicles and machinery outside designated areas
» Prevent spillage of pollutants, contain and treat any spillages immediately, strictly prohibit any pollution
» Topsoil (the upper 25 cm of soil) is an important natural resource; where it must be stripped, never mix it with subsoil or any other material, store and protect it separately until it can be re-applied, minimise handling of topsoil, manage stored topsoil according to a dedicated topsoil management plan
» Temporarily stored topsoil must be re-applied within 6 months, topsoils stored for longer need to be managed according to a detailed topsoil management plan
» Monitor erosion of areas and control where necessary
» After construction remove all foreign material prior to starting the rehabilitation
» Fill up borrow pits that may be created first with overburden or subsoils, covered with topsoils, following to a detailed rehabilitation plan
» The rehabilitation plan for all temporarily affected areas must aim to re-introduce all non-weed indigenous species listed in the specialist report as a minimum, taking the observed original cover percentages as a guideline of acceptable vegetation cover
» Monitor the establishment of invasive species and remove as soon as detected, whenever possible before regenerative material can be formed

Cumulative impacts:

» If mitigation measures are not strictly followed the following could occur:
  - continued erosion of the altered surfaces with associated siltation and/or erosion of lower-lying wetlands
  - contamination of drainage lines, lower-lying rivers or wetlands
  - spread and establishment of invasive species

Residual impacts:

» altered topsoil characteristics
» altered vegetation composition

9. Activity: PV array *components* and their continued maintenance and eventual decommissioning: regular washing and possible breakage of panels		
Environmental Aspect: altered runoff and associated vegetation and erosion patterns, contamination of the environment by possible toxic substances and glass		
Environmental impact: localised increase in runoff and accelerated erosion, possible release of toxic substances and/or heavy metals and associated contamination of soil and groundwater, possible contamination and damage to terrestrial fauna by broken glass		
	Without mitigation	**With mitigation**
Extent (E)	Site and surroundings (2)	Site specific (1)
Duration (D)	Long-term (4)	Long-term (4)
Magnitude (M)	Low (4)	Small (0)
Probability (P)	Definite (5)	Probable (3)
Significance (S = E+D+M)*P	**Medium (50)**	**Low (15)**
Status (positive, neutral or negative)	Negative	Neutral
Reversibility	Partially reversible	Reversible
Irreplaceable loss of resources?	Probable	Not likely
Can impacts be mitigated?	Reasonably	

Mitigation:

» Where panels need to be washed, no polluting chemicals may be used, and the use of water should be minimal as well

» Where water is used for washing, monitor areas around the PV arrays for signs of accelerated erosion and establishment of weeds or alien invasive species and manage according to the erosion- and invasive species management plan

» Prior to construction and up to decommissioning, clear instructions must be drafted and at all times available on site on how any breakages of PV panels will be dealt with, including:

- A list of possible toxic substances, heavy metals or other potentially harmful substances that could be released during breakage
- How to contain and mitigate the release of such substances
- Correct salvage, disposal and preferably also recycling methods (or possibilities) for any broken materials

Cumulative impacts: » Possible pollution of surrounding areas if no mitigation is implemented » Possible increase in and spread of alien invasive species beyond the site if no mitigation is implemented
Residual impacts: » None expected if mitigation measures are implemented

Implications of the anticipated impacts for the development:

» The proposed photovoltaic facility development on the site will not have significant impacts on the above-ground ecology of the site if all mitigation measures are followed, especially if listed alien invasives can be reduced. If such currently present disturbances can be sufficiently mitigated, the impact may be to some extent beneficial for more sensitive surrounding areas. The low ecological sensitivity of the larger portion of the study area is due to the past land-use history, during which these areas were transformed or degraded.

» The impact on fauna is expected to be small to negligent. Presence of indigenous terrestrial vertebrates within the study area is low due to current land use. Animals that may be permanently present can be relocated or will move away during construction, and may resettle after construction, depending on safety specifications necessitated by the development. No restricted or specific habitat of vertebrates exists on the study area and will be affected by the proposed development; especially if the proposed development remains outside the recommended buffers around wetland and seepage areas.

7. Limitations of study

There is a key difference between the approach of the ecological consultant and that of the ecological researcher. In consultancy, judgements have to be made and advice provided that is based on the best available evidence, combined with collective experience and professional opinion. The available evidence may not be especially good, potentially leading to over-simplification of ecological systems and responses, and do contain a considerable deal of uncertainty. This is opposed to ecological research, where evidence needs to be compelling before conclusions are reached and research is published (Hill & Arnold 2012). The best option available to the consulting industry is to push for more research to be conducted to address its questions. However, such research is often of a baseline nature and thus attracts little interest by larger institutions that need to do innovative research to be able to publish and attract the necessary funding.

Clients in need of ecological assessments are used to funding such assessments, but are seldom willing to fund further research to monitor the effects of developments. Furthermore, a review to test the accuracy of the predictions of an ecologist following completion of the development is very rarely undertaken, which means the capacity to predict the future is not tested and therefore remains unknown (Hill & Arnold 2012).

Predictions on future changes on ecosystems and populations once a development has happened are seldom straightforward, except in cases of such as the total loss of a habitat to development. However, most development impacts are indirect, subtle, and cumulative or unfold over several years following construction or commencement of the operation of the development. Whilst a possible mechanism for an impact to occur can usually be identified, the actual likelihood of occurrence and its severity are much harder to describe (Hill & Arnold 2012).

A closely related issue is that of the effectiveness of ecological mitigation which stems from ecological assessments, as well as in response to legal and planning policy requirements for development. Many recommendations may be incorporated into planning conditions or become conditions of protected species licences, but these recommendations are implemented to varying degrees, with most compliance being for the latter category, protected species, because there is a regulatory framework for implementation. What is often missing is the follow-up monitoring and assessment of the mitigation with sufficient scientific rigour or duration to determine whether the mitigation, compensation or enhancement measure has actually worked in the way intended (Hill & Arnold 2012).

8. Discussion and Conclusion

The selected property falls within the original extent of the Amersfoort Highveld Clay Grassland (Unit Gm13) as defined by Mucina and Rutherford (2006), undulating plains with small scattered patches of dolerite outcrops. The vegetation consists of a short closed grass cover, in its natural state largely dominated by a dense *Themeda triandra* layer, with a relatively high diversity of grasses, herbs and geophytes (Mucina and Rutherford 2006). Many of the herbs resprout every year from below-ground storage tubers, usually early in the growing season before the grasses reach their full cover. Mucina and Rutherford (2006) regard this vegetation type as Vulnerable. Although it is not currently listed under NEMA:BA, none is currently protected, with some 25% already permanently transformed.

The Mpumalanga Biodiversity Conservation Plan classified a small central portion of the study area as of Least Concern, whilst the remainder has been classified as having no natural habitat remaining. This was confirmed during the field study – with a small area of relatively diverse grassland remaining, whilst the largest portion of the study area consists of rehabilitated (semi-natural) grasslands.

Overall, the species diversity of the study area is low, comprising less than 10% of the floral diversity recorded in the greater area. Nevertheless, a few species of conservation concern observed as well as wetlands on the area should be taken into account during the design of the layout and the future environmental management of the proposed development.

Small groups of burrows have been found, which must be monitored prior to construction to ensure that no harm comes to amphibians, reptiles or small mammals living in these burrows.

Several alien invasive plants have been observed on the study site, with more species in close proximity. For all species, there is a very high risk of spread throughout the project area following disturbance. This implies that a detailed Invasive Plant Management Plan will have to be in place prior to commencement of activity and be diligently followed and updated throughout the project cycle up to the decommissioning phase.

It is not expected that the development will compromise the survival of or significantly impact any flora or terrestrial vertebrate species on the study area or beyond. The most significant impacts are expected to be on ecosystem health and functionality, which should remain relatively intact if all mitigation recommendations are implemented; and the associated integrity of surrounding wetlands.

The most pressing issues identified by this study are:

- Existing high levels of air-borne coal dust that is polluting plants and soils
- All listed alien invasives and potential invasives within the development footprint area will have to be entirely cleared prior to development, not only to prevent spread of these species but also to ensure efficient maintenance of the proposed development
- An ongoing monitoring program will be necessary to control and/or eradicate newly emerging invasives
- Newly cleared soils will have to be revegetated and stabilised as soon as construction has been completed

- Soils are prone to capping and erosion and need to be stabilised by a permanent grass or suitable indigenous vegetation layer.
- Locally occurring grass species become moribund and die off if not grazed or burnt regularly. It is thus recommended to allow either seasonal sheep grazing to reduce dead biomass accumulation on grass tufts or implement a regular mowing program (possibly twice a year). This will also greatly reduce the risk of fire, which is a natural component of grassland dynamics.

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10. Appendix A: Declaration of Independence

DETAILS OF SPECIALIST AND DECLARATION OF INTEREST

	(For official use only)
File Reference Number:	
NEAS Reference Number:	DEAT/EIA/
Date Received:	

Application for authorisation in terms of the National Environmental Management Act, 1998 (Act No. 107 of 1998), as amended and the Environmental Impact Assessment Regulations, 2010

PROJECT TITLE

Majuba Solar Energy Facility

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Project Consultant:	Savannah Environmental (Pty) Ltd		
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E-mail:	Joanne@savannahsa.com		

4.2 The specialist appointed in terms of the Regulations_

I, Marianne Strohbach , declare that --

General declaration:

- I act as the independent specialists 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 form are true and correct; and**
- **I realise that a false declaration is an offence in terms of Regulation 71 and is punishable in terms of section 24F of the Act.**

Signature of the specialist:

Savannah Environmental (Pty) Ltd

Name of company (if applicable):

20 March 2015

Date:

11. Appendix B: Curriculum Vitae of Specialist

CURRICULUM VITAE

MARIANNE STROHBACH
SAVANNAH ENVIRONMENTAL (PTY) LTD

Profession : Specialist Scientist
Specialisation: Plant Ecology and Botany, with special reference to vegetation mapping, vegetation state assessment, dynamics of arid and semi-arid vegetation and population dynamics of harvested plants, conservation planning
Work experience: Twenty (20) years active in Plant Ecology

SKILLS BASE AND CORE COMPETENCIES

- Four years Plant Conservation (Namibia)
- 16 years active research in vegetation mapping, vegetation state assessment, vegetation and plant population dynamics, long-term vegetation monitoring
- Advisory to International Standards for plant species that are harvested for commercial purposes
- Research Project Management
- Ecological assessments for developmental purposes (BAR, EIA)
- Working knowledge of environmental planning policies, regulatory frameworks and legislation
- Identification and assessment of potential environmental impacts and benefits
- Development of practical and achievable mitigation measures and management plans and evaluation of risk to project execution
- Experienced in environmental monitoring and research
- Working knowledge of GIS applications and analysis of satellite imagery data
- Completed projects in several Provinces of South Africa, as well as Zimbabwe and Namibia
- Several publications in peer-reviewed journals, book chapters, scientific conference presentations and popular articles

EDUCATION AND PROFESSIONAL STATUS

Degrees:
2003: M.Sc. in Botany, University of Pretoria, Pretoria, RSA
1991: B.Sc. Hons in Botany, Nelson Mandela Metropolitan University, Port Elizabeth, RSA
1990: B.Sc. in Biological Sciences, Nelson Mandela Metropolitan University, Port Elizabeth

Short Courses:
2008: Landscape Functional Analysis for vegetation condition and restoration monitoring
2002: Satellite Image Analysis for Vegetation Mapping, German Aerospace Centre (DLR) in

Cologne/Würzburg, Germany
1994: Methods and Techniques of Environmental Management, Deutsche Stiftung für Internationale Entwicklung, Berlin, Germany
1993: Conservation Law Enforcement, Ministry of Environment and Tourism, Namibia

Professional Society Affiliations:

- South African Association for Botanists
- Association of Desert Net International
- The South African Council for Natural Scientific Professions: Pr. Sci. Nat. Reg. No. 400079/10 (Botany and Ecology)

Publications:

- 7 Articles in peer-reviewed scientific journals
- 5 Book-chapters in scientific publications
- 10 Popular articles
- 9 presentations at scientific conferences
- 2 contributions to TV documentaries on nature

Ongoing outputs:

- Project-specific specialist reports for Ecological Screening Studies, Basic Assessments, Environmental Scoping and Impact Assessments and Ecological Footprint Investigations
- Compilation of Environmental Management Plans: Invasive Plant management, Plant Search and Rescue, Revegetation, Erosion Control

EMPLOYMENT

- **Current**: Ecologist, Savannah Environmental (Pty) Ltd
- 2011: Lecturer, Plant Ecology, University of Pretoria
- 1997 onwards: working as vegetation ecologist on a freelance basis, involved in part-time positions and contractual research as outlined below
- 1995 to 1996: Agricultural Researcher at the National Botanical Research Institute, Windhoek, Namibia
- 1992 to 1995: Vegetation ecologist at the Ministry of Environment and Tourism, Namibia, Directorate of Scientific Services

Past Affiliations and Research

2001 – 2010: contractual work with BIOTA (BIOdiversity Transect analysis in Africa) as affiliate to the National Botanical Research Institute, Namibia.
Deliverables:

Project management, including research proposal, financial management and project implementation.

Modelling of Savanna Dynamics:
Collating and summarising available phytosociological data for ecological modellers to use in creating a generic savanna model for the Namibian savannas
Defining plant functional types to simplify vegetation data and to use as indicators in monitoring techniques by livestock farmers

Vegetation Patterns and Processes in Namibian Savannas:
Small scale monitoring of vegetation dynamics over a range of soil conditions and seasons
Determine ecological barriers to and best practice for rangeland restoration

Vegetation classification and mapping in Central Namibia:
Collection and analysis of phytosociological baseline data for the central Thornbush Savanna in Namibia, delineation of vegetation types with the aid of satellite imagery

2006: German Scientific Authority to CITES, Plants, Federal Agency for Nature Conservation
International Standard for the Sustainable Wild Collection of Medicinal & Aromatic Plants
Assisting in the compilation of a reference guide for minimum research standards necessary to ensure sustainable use of economically utilised plants (updated in FairWild Standard Version 2, 2010)

2004: contractual work for Desert Research Foundation of Namibia
Vegetation description and mapping of the Namibian Eastern Communal Areas and assess possible development options using indigenous plant resources

1997 to 2010: contractual work with CRIAA-SADC as ecologist.
Deliverables:

The Sustainably Harvested Devil's Claw Project:
Annual surveys of *Harpagophytum* populations to determine harvesting quotas for rural communities
Determine and monitor impact of harvesting frequency and techniques on survival of *Harpagophytum procumbens*
Educate harvester communities on issues of resource management
In collaboration with the German Federal Agency for Nature Conservation
This work was extended in 2006 to the Hwange Area, NW Zimbabwe, together with Africa Now

Pilot Devil's Claw cultivation trials:

Increase available resources of *Harpagophytum procumbens*
Give communities ownership and better access of their resources to improve their income

Namibian National Devil's Claw Situation Analysis:
Design and implement a country-wide survey of *Harpagophytum* species to assess resource availability compared to annual export figure

1999 to 2001: Assistant curator at the Swakopmund Museum (part-time position)
Help maintain existing collections and exhibits , design and create new exhibits for the museum in collaboration with the Museum Hannover, Germany

Specialist Scientist Vegetation Surveys and related Impact Assessments were done for following clients:
Langer Heinrich Uranium Pty (Ltd): Central Namib Desert, Namibia
University of Namibia, Hentiesbay Research Centre: West Coast, Namibia
Sasol – Limpopo Province
EcoAgent – Northern Cape, Eastern Cape, Limpopo and Mpumalanga
Namwater – Karst aquifers, north-central Namibia
ENVASS (for AfriDevo) – Northern Cape
Savannah Environmental – Northern Cape, Eastern Cape, Free State, North-West Province, Western Cape, Limpopo

12. Appendix C: Terrestrial Vertebrate species previously recorded in the area

Species Name	Common Name	Threat Status
Amphibians		
Hemisus guttatus	**Spotted Shovel-nosed Frog**	**Vulnerable**
Reptiles - Geckos		
Pachydactylus capensis	Cape Gecko	p
Pachydactylus vansoni	Van Son's Gecko	p
Reptiles - Agamas		
Agama aculeata subsp. distanti	Distant's Ground Agama	p
Agama atra	Southern Rock Agama	p
Reptiles - Chamaeleons		
Bradypodion dracomontanum	Drakensberg Dwarf Chameleon	Near Threatened, p
Chamaeleo dilepis subsp. dilepis	Common Flap-neck Chameleon	p
Reptiles – Lizards and skinks		
Cordylus vittifer	Common Girdled Lizard	p
Pseudocordylus melanotus subsp. melanotus	Common Crag Lizard	p
Smaug giganteus	**Giant Girdled Lizard**	**p, Vulnerable**
Gerrhosaurus flavigularis	Yellow-throated Plated Lizard	p
Nucras lalandii	Delalande's Sandveld Lizard	p
Pedioplanis burchelli	Burchell's Sand Lizard	p
Acontias gracilicauda	Thin-tailed Legless Skink	p
Trachylepis capensis	Cape Skink	p
Trachylepis homalocephala	Red-sided Skink	p
Trachylepis punctatissima	Speckled Rock Skink	p
Trachylepis varia	Variable Skink	p
Reptiles - Tortoises		
Pelomedusa subrufa	Central Marsh Terrapin	p
Chiroptera - Bats		
Rhinolophus clivosus	Geoffrey's Horseshoe Bat	Near Threatened
Cistugo lesueuri	Lesueur's Wing-gland Bat	Near Threatened

Species Name	Common Name	Threat Status
Insectivora - Insectivores		
Lemniscomys rosalia	Single-Striped Grass Mouse	Data Deficient
Crocidura mariquensis	Swamp Musk Shrew	Data Deficient
Artiodactyla – even-toed ungulates		
Raphicerus campestris	Steenbok	p
Carnivora - Carnivores		
Proteles cristata	Aardwolf	p
P = Protected species Red data listed plants are indicated by their status		

13. Appendix D: Ecological Environmental Management Program

13.1. Design Phase

13.1.1. Optimal design and pre-commencement activities

OBJECTIVE 1: Ensure the selection of the best environmental option for the alignment of the power lines, development areas and access roads

OBJECTIVE 2: Ensure all environmental sensitivities and possible impacts are fully accounted for and methods in place for mitigation prior to commencement of activity

The selected property falls within the original extent of the Amersfoort Highveld Clay Grassland. The vegetation consists of a short closed grass cover, largely dominated by a dense *Themeda triandra* layer, and in its natural state a relatively high diversity of grasses, herbs and geophytes (Mucina and Rutherford 2006). Mucina and Rutherford (2006) regard this vegetation type as Vulnerable. Although it is not currently listed under NEMA:BA, none is currently protected, with some 25% already permanently transformed.

The Mpumalanga Biodiversity Conservation Plan classified a small central portion of the study area as of Least Concern, whilst the remainder has been classified as having no natural habitat remaining. This was confirmed during the field study – with a small area of relatively diverse grassland remaining, whilst the largest portion of the study area consists of rehabilitated (semi-natural) grasslands.

Overall, the species diversity of the study area is low, comprising less than 10% of the floral diversity recorded in the greater area. Nevertheless, a few species of conservation concern observed as well as wetlands on the area should be taken into account during the design of the layout and the future environmental management of the proposed development.

Opportunities to mitigate the negative impacts of large-scale PV developments largely arise during the planning and design stages. The correct choice of footprint location and layout is paramount, thus ecosystem components such as biodiversity and ecosystem function should be given full consideration during the design phase, as determined by the Ecological Studies and related Impact Assessments. The exact design of PV arrays (panel size, height, spacing, and nature of panels – tracking or fixed) can be equally important. The timing of pre-

commencement, construction, maintenance and decommissioning activities also provides opportunities to reduce negative impacts on biodiversity.

Once the layout has been designed, a detailed investigation of the footprint area during the optimal growing season and as described below must be conducted before the layout is finalised, followed by a species search and rescue operation before activity commences.

Project Component/s	» PV Array » Grid connection and associated servitudes » Access roads » Workshop, guardhouses, substation and other related infrastructure » Temporary construction camps » Protective fencing around development » Potential topsoil stockpiles and/or borrow pits
Potential Impact	» Placement that degrades the environment unnecessarily, particularly with respect to habitat destruction, loss of indigenous flora, damage to wetlands, establishment and persistence of alien invasive plants, and erosion.
Activities/Risk Sources	» Positioning of solar components and internal access routes » Positioning of workshop, guardhouses, substation and other related infrastructure » Alignment of power lines and servitudes » Alignment of access roads to development » Positioning of temporary sites
Mitigation: Target/Objective	» To ensure selection of best environmental option for positioning alignment of proposed infrastructure » Environmental sensitivities are taken into consideration and avoided as far as possible, thereby mitigating potential impacts

Mitigation: Action/Control	**Responsibility**	**Timeframe**
Avoid remaining high diversity grasslands and functional wetland areas as far as possible.	Developer	Design phase
Undertake pre-construction walk-through footprint investigations for protected flora and burrowing terrestrial vertebrates: The final footprint investigation (walkthrough) is aimed to fully inform the developer, responsible	Developer, carried out by Specialist	Design review phase

Mitigation: Action/Control	Responsibility	Timeframe
conservation authority (that will issue the relevant permits and authorisations), contractors, EO and ECO about: » Protected species that will be affected by the development » Location of protected plant species within the footprint area – approximate mapping of areas of occurrence (alternatively, for linear structures, between which structures or other markers) » Identification of the affected species by providing a representative photo record that enables ECOs and contractors to identify such plants » How many specimens per species will be affected – relatively accurate estimate to the nearest 50, more accurate if less than 50 » Which species can be successfully relocated, which and how many will have to be destroyed » Location and nature of any nesting sites or active burrows of vertebrate species (birds, amphibians, reptiles and mammals), mapped by GPS, that will have to be inspected and cleared/relocated prior to construction by the contractor or duly appointed person(s) » Nature of alien invasive species that will have to be cleared by the contractor » Location and nature of any other significant environmental concerns, e.g. extreme gully erosion, that will need to be addressed by the contractor to prevent any unnecessary (further) degradation of the development footprint		
The above pre-construction footprint investigations will be used together with results from the ecological specialist report to draft the following: » A comprehensive search and rescue program for plants and possible burrowing animals » A comprehensive alien invasive species eradication and management plan o Basic requirements of these are listed under the Construction and operational Phase EMPr	Developer, drafted by Specialist	Design review phase
Obtain permits for protected plant removal and	Developer	Pre-

Mitigation: Action/Control	Responsibility	Timeframe
relocation prior to commencement of any activity related to this development		commencement
Use design-level mitigation measures recommended in respect of habitat and ecosystem intactness and prevention of species loss as detailed within the EIA Report » This includes positioning components of the development as close as possible together and in close proximity to other existing or planned developments in the area » Strictly adhere to existing tracks/roads where ever possible to gain access to the site » Sites for storing, mixing, and handling topsoil piles (if necessary) or any introduced materials, including all machinery or processing implements, must be placed in an ecologically least sensitive area and at least 500 m from any type of wetland. Such sites must be clearly indicated in site plans and the drafting of relevant detailed method statements and/or management plans requested from the relevant contractor or environmental firm.	Developer	Prior to submission of final construction layout plan
Access roads and machinery turning points must be planned to minimise the impacted area, avoid the initiation of accelerated soil erosion and prevent unnecessary compaction and disturbance of topsoils, prevent obstruction or alteration of natural water flow	Developer	Design phase
Compile a comprehensive storm water management and erosion control plan for the footprint area as part of the final design of the project » Basic requirements of these are listed under the Construction and operational Phase EMPr	Developer and relevant specialist	Design phase
Permissible biodiversity: » Depending on the final PV array and mechanism developed and taking all potential impacts, fire risks and maintenance requirements into consideration, it has to be decided upon and made clear: o Permissible vegetation: maximum height, desirable density and composition o Maintenance of this vegetation – mowing, or	Developer and relevant specialist	Design phase

Mitigation: Action/Control	Responsibility	Timeframe
other means Note: due to the hydrogeology of the area, there should be no application of herbicides		
After the permissible biodiversity has been determined, compile a comprehensive vegetation rehabilitation management plan. » Basic requirements of these are listed under the Construction and operational Phase EMPr	Developer and relevant specialist	Design phase
Depending on the type of PV panels selected for the development, a plan must be put in place to deal with accidental breakages and potential release of harmful substances. This plan must include as a minimum: » Specifications of harmful substances that could be released from accidental breakages of PV panels » How such harmful substances can best be salvaged and removed as soon as an accidental breakage has occurred » How and where broken components and potential harmful substances can be disposed of – it must also be indicated if any material can be recycled, and where materials must then be taken for recycling o The above will have to be incorporated into the waste management plan	Developer and relevant waste management specialist	Design phase

Performance Indicator	» Grid connection and road alignments meet environmental objectives. » Solar components and all associated temporary and permanent infrastructure and access road alignments meet environmental objectives » Ecosystem fragmentation is kept to a minimum » Ecosystem functionality is retained and any degradation prevented
Monitoring	» Ensure that the design implemented meets the objectives and mitigation measures in the EIA Report through review of the design by the Project Manager, and the ECO prior to the commencement of activity.

13.2. Construction and Operational Phase

The expected lifetime of the development ranges between 25 to 30 years after construction. After that, the development will either be decommissioned or, more likely, upgraded with newer available technology to remain functional and economical. These timeframes are sufficient to cause an irreversible negative shift in natural biodiversity composition and associated loss of ecosystem functionality if impacts are not maximally mitigated and any degradation of the environment prevented from the start and continuously monitored and mitigated until decommissioning.

The management options below specify the minimum requirements to mitigate the impacts of the proposed development on the biodiversity and overall ecology of the area to be developed. More specific management options will need to be created once the exact layout and type of PV and construction plans are known.

For the optimal implementation and updating of the management plans, it is recommended that the ecological specialist who is familiar with the site or at least did the pre-commencement footprint investigation, visit the site soon after construction has started or immediately after all site preparation earthworks have been completed, and at least once when rehabilitation work is under way. This would be not only to support the ECO, but to ensure that minimum requirements of the mitigation plans are sufficient to retain a basic functionality of the ecosystem that will prevent any undue further degradation of the development site and beyond.

The ECO will most likely only be present on site for the duration of construction activities. Where continued monitoring and possible mitigation will be required during the operational phase, an EO or suitable staff must be appointed. It is recommended that the current EMP be revised after completion of the design, again after construction and then as necessary, and a new set of EMPs be drafted for the decommissioning phase to continue with mitigations and prevention of all related environmental impacts.

13.2.1. Species search and rescue

OBJECTIVE: Minimise loss of indigenous biodiversity, including plants of conservation concern

Prior to commencement of any activity, including earthworks (grading, road construction, etc.), a plant Search and Rescue program should be developed and implemented, preceded by a meticulous investigation of all footprint areas by a suitably qualified botanist, conducted during the optimal growing season (January to April) along the entire footprint area as specified in 13.1.1.

Project Component/s	Project components affecting the objective: » PV Array » Grid connection and associated servitudes » Access roads » Workshop, guardhouses, substation and other related infrastructure » Temporary construction camps » Protective fencing around development » Potential topsoil stockpiles and/or borrow pits
Potential Impact	» Substantially increased loss of species of conservation concern and other natural vegetation at construction phase, waste of on-site plant resources, lack of locally sourced material for rehabilitation of disturbed areas » Increased cost of rehabilitation
Activities/Risk Sources	» Construction related loss and damage to remaining natural and semi-natural vegetation
Mitigation: Target/Objective	» Rescue, maintenance and subsequent replanting of at least all bulbous protected plant species within the specific land portion

Mitigation: Action/Control	Responsibility	Timeframe
Ecological footprint investigation and recording by GPS of localities of species of conservation concern as described in 13.1.1 (Design Phase)	Ecologist	Prior to commencement of activity
» Search and Rescue (S&R) of all protected plants that will be affected by the development, especially species occurring in long term and permanent, hard surface development footprints (i.e. all buildings, new roads and tracks, laydown areas, and panel positions) should take place » All development footprints must be surveyed and pegged out as soon as possible, after which a local horticulturist with Search and Rescue	Horticultural Contractor, monitored and approved by ECO	Prior to construction

Mitigation: Action/Control	Responsibility	Timeframe
experience should be appointed to undertake the S&R » All rescued species should be either replanted as soon as possible or bagged and kept in the horticulturist's or a designated on-site nursery, and should be returned to site or land portion once all construction is completed and rehabilitation of disturbed areas is required » Replanting should occur in spring to early summer once sufficient rains have fallen, in order to facilitate establishment		
In line with specifications regarding permissible biodiversity and the rehabilitation plan (see 13.1.1), a minimum percentage cover of vegetation must be established and permanently maintained post construction	Developer and horticultural contractor	Prior to and after construc-tion, throughout operational phase
All cable trenches, excavations, etc. should be excavated carefully in order to minimise damage to surrounding areas and biodiversity: » The trenches must be checked on a daily basis for the presence of trapped animals » Any animals found must be removed in a safe manner, unharmed, and placed in an area where the animal will be comfortable » If the ECO or contractor is unable to assist in the movement of a fauna species, ensure a member of the conservation authorities assists with the translocation » All mammal, large reptiles and avifauna species found injured during construction will be taken to a suitably qualified veterinarian or rehabilitation centre to either be put down in a humane manner or cared for until it can be released again	Contractor / ECO	Duration of construction

Performance Indicator	» Rescue of species of conservation concern » No damage or injury to fauna » Re-establishment of rescued species
Monitoring	» ECO to monitor Search and Rescue, continue search and rescue operations during the construction process where it becomes necessary after the initial S&R » It may be possible that geophytic species may emerge during construction that were not accounted for in the original S&R plan –

	once observed the ECO should consult the botanists on the identification and possible S&R for those plant species

13.2.2. Management of temporary construction sites

OBJECTIVE1: Environmentally sensitive location of construction equipment camps and all other temporary structures on site to limit impacts

OBJECTIVE2: Environmentally sensitive movement of equipment, machinery, vehicles and materials to, on and from site to limit impacts

It is expected that all construction staff will reside within existing accommodation in nearby townships. No staff should be accommodated on site. Construction equipment and machinery may need to be stored at an appropriate location on the site for the duration of the construction period, and temporary staff facilities will have to be made available.

Project Component/s	Project components affecting the objective: » Construction equipment camps » Facilities for storing, mixing and general handling of materials » Temporary staff facilities » Access roads
Potential Impact	» Damage to indigenous natural vegetation » Damage to and/or loss of topsoil » Initiation of accelerated erosion » Compacting of ground » Pollution of the surrounding environment due to inadequate or inappropriate facilities or procedures
Activities/Risk Sources	» Vegetation clearing and levelling of temporary construction or storage area/s » Transport to and from the temporary construction or storage area/s » Types of materials or equipment and the manner in which they are stored or handled
Mitigation: Target/Objective	» To minimise impacts on the biophysical environment » To prevent any residual or cumulative impacts arising from temporary construction or storage areas

Mitigation: Action/Control	Responsibility	Timeframe

Mitigation: Action/Control	Responsibility	Timeframe
» The location of the construction equipment camp and all access routes will take cognisance of any ecologically sensitive areas identified. » The location of this construction equipment camp shall be approved by the project ECO or the specialist doing the pre-commencement footprint investigation	Contractor/ECO	Pre-construction
As far as possible, minimise natural vegetation clearing for equipment storage areas » Aim to locate the temporary construction camps on already degraded and/or heavily disturbed areas	Contractor, monitored by ECO	During site establishment
Staff shall be supplied with adequate facilities aimed at preventing any kind of pollution » Cooking on open fires must be prohibited, if staff need cooking/kitchen facilities on site, such should be provided by the contractor	Contractor, monitored by ECO	Construction, Operational phase
Identify and demarcate construction areas, servitudes, and access for general construction work and restrict construction activity to these areas. » Prevent unnecessary destructive activity within construction areas (prevent over-excavations and double handling) » Create specific turning points and parking areas for vehicles and heavy machinery as needed » Strictly prohibit any driving outside designated areas and roads	Contractor, ECO to control	Before and during construction, operational phase
To limit the possible distribution of undesirable species and possible pollutants onto site: » Regularly check clothing and vehicles for mud and seed and clear in an appropriate manner (see invasive plant management for more details) » Do not wash down any machinery or vehicle within the farm portion, including the footprint area » All materials moved onto the development site must be free of weeds or any other undesirable organisms or pollutants » It is recommended that fuels, lubricants and	Contractor, ECO to control	Before and during construction, operational phase

Mitigation: Action/Control	Responsibility	Timeframe
other chemicals only be stored on site if absolutely necessary, and then in a manner that prevents any accidental spillage		
Rehabilitate and revegetate all disturbed areas at the construction equipment camp as soon as construction is complete within an area, and mitigate erosion where required as per specific management plans	Contractor, rehabilitation contractor, monitored by ECO	Construction, operational phase

Performance Indicator	» No visible erosion scars or any pollution once construction in an area is completed » All damaged areas successfully rehabilitated one year after completion » No damage to wetland areas » Appropriate waste management
Monitoring	» Regular monitoring and audits of the construction camps and temporary structures on site by the ECO » A photographic record must be established before, during and after mitigation » An incident reporting system should be used to record non-conformances to the EMP, followed by the necessary action from the developer to ensure full compliance

13.2.3. Topsoil management

OBJECTIVE: Minimisation of disturbance to and loss of topsoil

Topsoil conservation is an integral part of rehabilitation efforts and helps to maintain the productive capability and ecological functionality of rangelands.

Removal of topsoil should be done where:

- Areas will be excavated
- Areas will be severely compacted
- Areas will be buried with excavated material
- Areas will be permanently covered with altered surfaces

Topsoil must at all times be treated as a valuable natural resources, and may thus not be discarded or degraded.

Project Component/s	Project components affecting the objective: » PV Array supports and trenching » Grid connection and associated servitudes » Access roads » Workshop, guardhouses, substation and other related infrastructure » Potential topsoil stockpiles and/or borrow pits
Potential Impact	» Loss of topsoil and natural resources and biological activity within the topsoil » Loss of natural regeneration potential of soils » Loss of agricultural potential of soils.
Activity/Risk Source	» Site preparation and earthworks » Excavation of foundations and trenches » Construction of site access road » Power line construction activities » PV array construction activities » Stockpiling of topsoil, subsoil and spoil material.
Mitigation: Target/Objective	» To retain full biological activity and functionality of topsoil » To retain desirable natural vegetation, where possible » To minimise footprints of disturbance of vegetation/habitats » Remove and store all topsoil on areas that are to be excavated; and use this topsoil in subsequent rehabilitation of disturbed areas » Minimise spoil material

Mitigation: Action/Control	Responsibility	Timeframe
Areas to be cleared must be clearly marked on-site to eliminate the potential for unnecessary clearing.	Contractor in consultation with Specialist	Pre-construction
Construction activities must be restricted to demarcated areas so that impact on topsoil is restricted.	Contractor, ECO to control	Before and during construction, operational phase
Salvaging topsoil: » Topsoil must always be salvaged and stored separately from subsoil and lower-lying parent rock or other spoil material. o Topsoil stripping removes up to 30 cm or less of the upper soils. o In cultivated areas, depth of topsoil may increase and needs to be confirmed with the	Contractor, ECO to control	Before and during construction

Mitigation: Action/Control	Responsibility	Timeframe
land owner » Prior to salvaging topsoil, the depth, quality and characteristics of topsoil should be known for every habitat type. o This will give an indication of total volumes of topsoil that need to be stored to enable the proper planning and placement of topsoil storage. o Different types of topsoil – rocky soils and sands must be stored separately » Topsoils should be removed (and stored) under dry conditions to avoid excessive compaction whenever topsoil will have to be stored for longer than one year.		
Storing topsoil: » Viability of stored topsoil depends on moisture, temperature, oxygen, nutrients and time stored. » Rapid decomposition of organic material in warm, moist topsoils rapidly decreases microbial activity necessary for nutrient cycling, and reduces the amount of beneficial micro-organisms in the soil. » Stockpile location if not adjacent to a linear development: o At least 50 m from any natural wetlands o Ideally a disturbed area cleared of weeds and invasives » *Topsoil is typically stored in berms with a width of 150 – 200 cm, and a maximum height of 100 cm, preferably lower* o Place berms along contours or perpendicular to the prevailing wind direction o Adhere to the following general rule: the larger the pile of topsoil storage needs to be, the shorter should be the time it is stored » Topsoil handling should be reduced to stripping, piling (once), and re-application. Between the piling and reapplication, stored topsoils should not undergo any further handling except control of erosion and (alien) invasive vegetation » Where topsoil can be reapplied within six months to one year after excavation, it will be useful to store the topsoil as close as possible to the area of excavation and re-application, e.g. next to cabling trenches	Contractor, ECO to control	Before and during construction

Mitigation: Action/Control	Responsibility	Timeframe
○ In such case, use one side of the linear development for machinery and access only ○ Place topsoil on the other/far side of this development, followed by the subsoil ○ If there will be a need for long-term storage of topsoil in specified stockpiles, this must be indicated in the design phase already and accompanied by a detailed topsoil stockpile management plan » In cases where topsoil has to be stored longer than 6 months or during the rainy season, soils should be kept as dry as possible and protected from erosion and degradation by: ○ Preventing puddling on or between heaps of topsoil ○ Or covering topsoil berms ○ Preventing all forms of contamination or pollution ○ Preventing any form of compaction ○ Monitoring establishment of all invasive vegetation and removing such if it appears ○ Keeping slopes of topsoil at a maximal 2:1 ratio ○ Monitoring and mitigating erosion where it appears ○ Where topsoil needs to be stored in excess of one year, it is recommended to either cover the topsoil or allow an indigenous grass cover to grow on it – if this does not happen spontaneously, seeding should be considered		
Reapplying topsoils: » Spoil materials and subsoil must be back-filled first, then covered with topsoil » Generally, topsoils should be re-applied to a depth equal to or slightly greater to the topsoil horizon of a pre-selected undisturbed reference site » The minimum depth of topsoil needed for revegetation to be successful is approximately 20 cm » If the amount of topsoil available is limited, a strategy must be worked to out to optimise revegetation efforts with the topsoil available » Reapplied topsoils should be landscaped in a way that creates a variable micro topography of small ridges and valleys that run parallel to existing	Contractor, ECO to control	Before and during construction

Mitigation: Action/Control	Responsibility	Timeframe
contours of the landscape. The valleys become catch-basins for seeds and act as run-on zones for rainfall, increasing moisture levels where the seeds are likely to be more concentrated. This greatly improves the success rate of revegetation efforts. » To stabilise reapplied topsoils and minimise raindrop impact and erosion: o Use organic material from cleared vegetation where possible o Alternatively, suitable geotextiles or organic erosion mats can be used as necessary » Continued monitoring will be necessary to detect any sign of erosion early enough to allow timeous mitigation		
Re-applied topsoils need to be re-vegetated as soon as possible, following the revegetation and rehabilitation plan.	Contractor, ECO to control	Before and during construction, monitored during operational phase

Performance Indicator	» Minimal disturbance outside of designated work areas. » Topsoil appropriately stored, managed, and rehabilitated.
Monitoring	» Monitoring of appropriate methods of vegetation clearing and soil management activities by ECO throughout construction phase. » An incident reporting system will be used to record non-conformances to the EMP. » Regular monitoring of topsoil after construction by developer until such topsoil can be regarded as fully rehabilitated, stable and no longer prone to accelerated erosion

13.2.4. Erosion management

OBJECTIVE: Prevention and early mitigation of all erosion and loss of topsoil and ecosystem integrity

Compacted and/or denuded and disturbed soils are usually prone to surface capping – even more so if the soils are dispersive or have a fine texture due to higher clay or loam contents. Such capped soils are prone to ever increasing

erosion, creating a dysfunctional landscape and ecosystem that rapidly loses soil, nutrients and seeds from the ecosystem.

Naturally occurring grassland vegetation that historically covered the entire proposed development area not only protects the soil surface from direct raindrop impact, but high portion of biomass in the upper 20 – 50 cm of the soil significantly increases rapid infiltration of rainwater, whilst also binding soil particles and thus preventing erosion. A highly disturbed or reduced vegetation layer will thus naturally be accompanied by higher runoff levels and accelerated erosion, especially during extreme weather events.

The measures below indicate the minimum mitigation that will be required for erosion and storm water control. A more specific erosion management plan will be possible after the final layouts and choice of PV array components are known.

Definitions:
Accelerated soil erosion: Soil erosion induced by human activities and ultimately leading to irreversible degradation of the ecosystem and loss of ecosystem functionality

Project Component/s	Project components affecting the objective: » PV Array » Grid connection and associated servitudes » Access roads » Workshop, guardhouses, substation and other related infrastructure » Potential topsoil stockpiles and/or borrow pits
Potential Impact	» Loss of topsoil and natural resources and biological activity within the topsoil » Loss of natural regeneration potential of soils » Loss of agricultural potential of soils.
Activity/Risk Source	» Rainfall and wind erosion of disturbed areas » Excavation, stockpiling and compaction of soil » Concentrated discharge of water from construction activity and new infrastructure, including PV panels » Storm water run-off from sealed, altered or bare surfaces » Construction equipment and vehicle movement on site » Cabling and road construction activities » Power line construction activities » River/stream/drainage line road crossings » Roadside drainage ditches » Premature abandonment of follow-up monitoring and adaptive

	management of rehabilitation
Mitigation: Target/Objective	» To minimise erosion of soil from site during construction » To minimise deposition of soil into drainage lines » To minimise damage to vegetation by erosion or deposition » To minimise damage to rock, soil, animals and vegetation by construction activity » No accelerated overland flow related surface erosion as a result of a loss of vegetation cover » No reduction in the surface area of natural drainage lines and other wetland areas as a result of the establishment of infrastructure » Minimal loss of vegetation cover due to construction related activities » No increase in runoff into drainage lines as a result of construction of project related infrastructure » No increase in runoff into drainage lines as a result of road construction

Mitigation: Action/Control	**Responsibility**	**Timeframe**
Identify and demarcate construction areas for general construction work and restrict construction activity to these areas. Prevent unnecessary destructive activity within construction areas (prevent over-excavations and double handling)	Contractor, ECO to control	Before and during construction
New access roads and other servitudes to be carefully planned and constructed to minimise the impacted area and prevent unnecessary excavation, placement, and compaction of soil. Special attention to be given to roads that may cross drainage lines.	Contractor, ECO to control	Before and during construction
Rehabilitate disturbance areas as soon as construction in an area is completed as per the rehabilitation plan.	Contractor, ECO to control	Immediately after construction, monitored during operational phase
General Erosion control measures: » Runoff control and attenuation can be achieved by using any or a combination of sand bags, silt fences, storm water channels and catch-pits, shade nets, geofabrics, seeding or mulching as needed on and around cleared and disturbed areas o Ensure that all soil surfaces are protected by vegetation or a covering to avoid the surface	Contractor, ECO to control	Construction, operational phase

Mitigation: Action/Control	Responsibility	Timeframe
being eroded by wind or water. » Ensure that heavy machinery does not compact areas that are not meant to be compacted as this will result in sealed hydrophobic, water repellent soils that increase the erosion potential of the area. » Prevent the concentration or flow of surface water or storm water down cut or fill slopes or along pipeline routes or roads and ensure measures to prevent erosion are in place prior to construction. » Storm water and any runoff generated by hard impervious surfaces should be discharged into retention swales or areas with rock rip-rap. These areas should be grassed with indigenous vegetation. These energy dissipation structures should be placed in a manner that flows are managed prior to being discharged. » Minimise and restrict site clearing to areas required for construction purposes only and restrict disturbance to adjacent undisturbed natural vegetation. » Vegetation clearing should occur in parallel with the construction progress to minimise erosion and/or run-off. Large tracts of bare soil will either cause dust pollution or quickly erode and then cause sedimentation in the lower portions of the catchment » If implementing dust control measures, prevent over-wetting, saturation, and run-off that may cause erosion and sedimentation		
Control depth of excavations and stability of cut faces/sidewalls	Contractor, to be monitored by ECO	Site establishment & duration of contract
Compile a comprehensive storm water management method statement, as part of the final design of the project and implement during construction and operation.	Developer, Contractor, to be monitored by ECO	Site establishment & duration of contract
All vehicles on site must be appropriate to access the site. No off-road driving is permitted unless authorised by the ECO.	Contractor, to be monitored by ECO	Pre-construction, Construction & operation
4x4's or diff lock vehicles must be used in wet slippery conditions to reduce the erosion on the roads and the	Contractor, to be monitored by	Pre-construction,

Mitigation: Action/Control	Responsibility	Timeframe
surrounding area.	ECO	Construction & operation

Performance Indicator	» Minimal level of soil erosion around site » No signs of accelerated soil erosion » Minimal level of soil degradation » Acceptable state of excavations, as determined by EO & ECO » Progressive return of disturbed and rehabilitated areas to the desired end state (Refer also to the Plant Rescue and Rehabilitation Plan)
Monitoring	» Fortnightly inspections of the site by ECO » Fortnightly inspections of sediment control devices by ECO » Fortnightly inspections of surroundings, including drainage lines by ECO » Immediate reporting of ineffective sediment control systems » An incident reporting system must record non-conformances according to the EMP.

13.2.5. Rehabilitation and revegetation

OBJECTIVE: Minimisation of disturbance to and loss of topsoil and ecosystem functionality

Immediately after clearing of vegetation, the soil surface must be inspected for signs of erosion and stabilised as soon as possible. After completion of construction, such erosion stabilisation should preferably be with a cover of vegetation. A dense initial grass or other perennial cover will be desirable.

The aim of the first vegetation cover is to form a protective, relatively dense indigenous layer to slow runoff, increase moisture infiltration into the soil, and gradually change the soil nutrient status in order for it to be more favourable for other desirable indigenous vegetation to become established.

The first vegetation layer must be developed further until a desirable end state, as determined during the design phase and taking the original vegetation description of existing natural vegetation in close proximity of the proposed development site as guideline, is established.

Project	Project components affecting the objective:

Component/s	» PV Array supports and trenching » Grid connection and associated servitudes » Access roads » Workshop, guardhouses, substation and other related infrastructure » Potential topsoil stockpiles and/or borrow pits
Potential Impact	» Within the footprint, a change of plant species composition with lower productivity can be expected due to removal, disturbance and continued long-term shading of vegetation » A largely reduced vegetation cover will render the ecosystem more prone to erosion and irreversible degradation » Disturbance of indigenous vegetation creates opportunities for the establishment of invasive vegetation or creation of surfaces that do not support the permanent (re-) establishment of vegetation » Loss of natural regeneration potential of soils
Activity/Risk Source	» Site preparation and earthworks » Excavation of foundations and trenches » Construction of site access road » Power line construction activities » PV array construction activities » Stockpiling of topsoil, subsoil and spoil material.
Mitigation: Target/Objective	» Recreate a non-invasive, acceptable vegetation cover that will facilitate the establishment of desirable and/or indigenous species » Prevent and accelerated erosion of ecosystem degradation

Mitigation: Action/Control	**Responsibility**	**Timeframe**
Rehabilitation of surface		
Prior to the application of topsoil » subsoil shall be shaped and trimmed to blend in with the surrounding landscape or used for erosion mitigation measures » ground surface or shaped subsoil shall be ripped or scarified with a mechanical ripper or by hand to a depth of 15 – 20 cm » compacted soil shall be ripped to a depth greater than 25 cm and the trimmed by hand to prevent re-compacting the soil » any foreign objects, concrete remnants, steel remnants or other objects introduced to the site during the construction process shall be cleared before ripping, or shaping and trimming of any	Contractor, ECO to control	During and after construction

Mitigation: Action/Control	Responsibility	Timeframe
landscapes to be rehabilitated takes place » shaping will be to roughly round off cuts and fills and any other earthworks to stable forms, sympathetic to the natural surrounding landscapes		
Application of topsoil » topsoils shall be spread evenly over the ripped or trimmed surface, if possible not deeper than the topsoil originally removed » the final prepared surface shall not be smooth but furrowed to follow the natural contours of the land » the final prepared surface shall be free of any pollution or any kind of contamination » care shall be taken to prevent the compaction of topsoil	Contractor, ECO to control	During and after construction
Soil stabilisation » mulch, if available from shredded vegetation, shall be applied by hand to achieve a layer of uniform thickness » mulch shall be rotovated into the upper 10 cm layer of soil o this operation shall not be attempted if the wind strength is such as to remove the mulch before it can be incorporated into the topsoil » measures shall be taken to protect all areas susceptible to erosion by installing temporary and permanent drainage work as soon as possible where required o where natural water flow-paths can be identified, subsurface drains or suitable surface drains and chutes should be installed » additional measures shall be taken to prevent surface water from being concentrated in streams and from scouring slopes, banks or other areas » runnels or erosion channels developing shall be back-filled and restored to a proper condition o such measures shall be effected immediately before erosion develops at a large scale » where erosion cannot be remedied with available mulch or rocks, geojute or other geotextiles shall be used to curtail erosion	Contractor, ECO to control	Construction phase Operational phase, followed up until desired end state is reached
Borrow-pits (if required) » shall be shaped to have undulating, low-gradient	Contractor, ECO to control	After construction

Mitigation: Action/Control	Responsibility	Timeframe
slopes and surfaces that are rough and irregular, suitable for trapping sediments and facilitation of plant growth » upon completion of rehabilitation these reshaped and revegetated areas shall blend into the natural terrain		
Revegetation		
» revegetation of the final prepared area is expected to occur spontaneously to some degree where topsoils could be re-applied within 6 months » revegetation will be done according to an approved planting/landscaping plan according to the desirable end states and permissible vegetation	Contractor, ECO to control	Construction phase Operational phase, followed up until desired end state is reached
Re-seeding » revegetation can be increased where necessary by hand- seeding indigenous species o previously collected and stored seeds shall be sown evenly over the designated areas, and be covered by means of rakes or other hand tools o commercially available seed of grass species naturally occurring on site can be used as alternative » re-seeding shall occur at the recommended time to take advantage of the growing season » in the absence of sufficient follow-up rains after seeds started germinating, irrigation of the new vegetation cover until it is established shall become necessary to avoid loss of this vegetative cover and the associated seed bank	Contractor, ECO to control	Construction phase Operational phase, followed up until desired end state is reached
Planting of species » the composition of the final acceptable vegetation will be based on the vegetation descriptions of the original ecological investigation, and will include rescued plant material » geophytic plants shall be planted in groups or as features in selected areas » during transplanting care shall be taken to limit or prevent damage to roots » plants should be watered immediately after transplanting to help bind soil particles to the roots (or	Contractor, ECO to control	Construction phase Operational phase, followed up until desired end state is reached

Mitigation: Action/Control	Responsibility	Timeframe
soil-ball around rooted plants) and so facilitate the new growth and functioning of roots		
Traffic on revegetated areas » designated tracks shall be created for pedestrian of vehicle traffic where necessary » Disturbance of vegetation and topsoil must be kept to a practical minimum, no unauthorised off road driving will be allowed » All livestock shall be excluded from newly revegetated areas, until vegetation is well established	Contractor, ECO to control	Construction phase Operational phase
Establishment » The establishment and new growth of revegetated and replanted species shall be closely monitored o Where necessary, reseeding or replanting will have to be done if no acceptable plant cover has been created	Contractor, ECO to control	Construction phase Operational phase, followed up until desired end state is reached
Monitoring and follow-up treatments		
Monitor success of rehabilitation and revegetation and take remedial actions as needed according to the respective plan » Erosion shall be monitored at all times and measures taken as soon as detected » Where necessary, reseeding or replanting will have to be done if no acceptable plant cover has been created	ECO during construction, suitable designated person / contractor after that	Construction phase Operational phase
Weeding » It can be anticipated that invasive species and weeds will germinate on rehabilitated soils o These need to be hand-pulled before they are fully established and/or reaching a mature stage where they can regenerate o Where invasive shrubs re-grow, they will have to be eradicated according to the Working for Water specifications	Contractor	Construction phase Operational phase

Performance Indicator	» No activity in identified no-go areas » Natural configuration of habitats as part of ecosystems or cultivated land is retained or recreated, thus ensuring a diverse but stable

	hydrology, substrate and general environment for species to be able to become established and persist » The structural integrity and diversity of natural plant communities is recreated or maintained » Indigenous biodiversity continually improves according to the pre-determined desirable end state o This end state, if healthy, will be dynamic and able to recover by itself after occasional natural disturbances without returning to a degraded state » Ecosystem function of natural landscapes and their associated vegetation is improved or maintained » No signs of accelerated soil erosion
Monitoring	» Fortnightly inspections of the site by ECO during construction » An incident reporting system must record non-conformances to the EMP. » Quarterly inspections and monitoring of the site by the ECO or personnel designated to the rehabilitation process until 80% of the desired plant species have become established o These inspections should be according to the monitoring protocol set out in the rehabilitation plan » Thereafter annual inspections according to the minimal monitoring protocol

13.2.6. Invasive plant management

OBJECTIVE: Manage and reduce the impact of invasive vegetation

Within the project area invasive species – indigenous and alien - occur, which all have a potential of reproducing to such an extent that the ecosystem within and beyond the project area could be impaired. Additional alien species grow along major transport routes to the area and thus could be potentially spread there as well.

Project Component/s	» Permanent and temporary infrastructure » Access roads
Potential Impact	» Displacement of indigenous vegetation » Degradation of soils » Degradation of faunal habitats » Increase in source of regenerative material of undesirable species that may negatively affect the site and surrounding

	agricultural lands
Activity/Risk Source	» Transport of construction materials to site » Movement of construction machinery and personnel » Site preparation and earthworks causing disturbance to indigenous vegetation » Construction of site access road » Stockpiling of topsoil, subsoil and spoil material » Routine maintenance work – especially vehicle movement
Mitigation: Target/Objective	» To significantly reduce the presence of weeds and eradicate alien invasive species » To avoid the introduction of additional alien invasive plants to the project control area » To avoid further distribution and thickening of existing alien plants on the project area » To complement existing alien plant eradication programs in gradually causing a significant reduction of alien plant species throughout the project control area

Mitigation: Action/Control	**Responsibility**	**Timeframe**
» Compile a detailed invasive plant management and monitoring method statement for the construction phase. » Regularly update the invasive plant management and monitoring programme as needed for the entire construction, operational and decommissioning phase o This plan must contain WfW-accepted species-specific eradication methods o It must also provide for a continuous monitoring programme to detect new infestations	Specialist	Pre-construction
Avoid creating conditions in which invasive plants may become established: » Keep disturbance of indigenous vegetation to a minimum » Rehabilitate disturbed areas as quickly as possible » Shred all non-seeding material from cleared invasive shrubs and other vegetation an use as mulch as part of the rehabilitation and revegetation plan » Where possible, destroy seeding material of weeds and invasives by piling burning (in designated areas or suitable containers) » Do not import soil from areas with alien plants	Contractor, monitored by ECO	Construction phase Operational phase
» Eradicate all invasive plants that occur within the development's temporary and permanent footprint	Contractor, monitored by	Construction phase

Mitigation: Action/Control	Responsibility	Timeframe
areas » Ensure that material from invasive plants that can regenerate – seeds, suckers, plant parts are adequately destroyed and not further distributed	ECO	Operational phase
» Immediately control any alien plants that become newly established using registered control measures	Contractor, monitored by ECO	Construction phase Operational phase
Risks from alien invasives do not only arise from invasives present within the footprint area, but also from alien invasives along the verges of the major transport routes, especially invasive grasses and smaller weeds. Similarly, invasives can be spread by construction processes to surrounding areas. To avoid the distribution of weeds and invasive plants, establish a routine amongst contractors/all staff to regularly check: » that clothing and shoes are free of mud and seeds » that foot wells inside vehicles and mats are cleared of weed seed » radiator and grill, along wheel trims, around wheels, mud flaps, undercarriage of vehicle or other moving machinery for mud and seed »	Contractor, monitored by ECO	Construction phase Operational phase

Performance Indicator	» Visible reduction of number and cover of alien invasive plants within the project area. » Improvement of vegetation cover from current dominance of invasive shrubs to dominance of perennial grasses and dwarf shrubs » No establishment of additional alien invasive species.
Monitoring	» Ongoing monitoring of area by ECO during construction. » Ongoing monitoring of area by EO during operation » Audit every two to three years by a suitably qualified botanist to assess the status of infestation and success of eradication measures » If new infestations are noted these must be recorded. A comprehensive eradication programme with the assistance of the WfW (Working for Water) Programme is advisable.