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Terrestrial Biodiversity EIA Report for the proposed Tshwane Strengthening Project – Phase 1 - Kwagga (Extension) & Phoebes (New) Substations

submitted by

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I Specialist Investigators

The Natural Scientific Professions Act of 2003 aims to 'provide for the establishment of the South African Council of Natural Scientific Professions (SACNASP) and for the registration of professional, candidate and certified natural scientists; and to provide for matters connected therewith'. Quoting the Natural Scientific Professions Act of 2003: 'Only a registered person may practice in a consulting capacity' (20(1) – pg 14).

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II Declaration of Independence

- All specialist investigators, project investigators and members of companies employed for conducting this particular investigation declare that:
- We act as independent specialists for this project.
- We consider ourselves bound to the rules and ethics of the South African Council for Natural Scientific Professions.
- At the time of completing this report, we did not have any interest, hidden or otherwise, in the proposed development as outlined in this document, except for financial compensation for work done in a professional capacity, in terms of the Environmental Impact Assessment Regulations, 2006.
- We will not be affected in any manner by the outcome of the environmental process of which this report forms part of, other than being part of the public.
- We do not have any influence over decisions made by the governing authorities.
- We do not necessarily object to or endorse the proposed development, but aim to present facts and recommendations based on scientific data and relevant professional experience.
- Undertake to disclose to the National Department of Environmental Affairs and Tourism, any material information that have or may have the potential to influence its decision or the objectivity of any report, plan or document required in terms of the Environmental Impact Assessment Regulations, 2006;

- Will provide the National Department of Environmental Affairs and Tourism with access to all information at our disposal regarding the application, whether such information is favourable to the applicant or not.
- Should we consider ourselves to be in conflict with any of the above declarations, we shall formally submit a Notice of Withdrawal to all relevant parties and formally register as an Interested and Affected Party.

III Glossary of Terms

Alternatives: A possible course of action, in place of another, that would meet the same purpose and need but which would avoid or minimize negative impacts or enhance project benefits. These can include alternative locations/sites, routes, layouts, processes, designs, schedules and/or inputs. The "no-go" alternative constitutes the 'without project' option and provides a benchmark against which to evaluate changes; development should result in net benefit to society and should avoid undesirable negative impacts.

Biome: Any major ecological community of organisms, usually characterized by a dominant vegetation type.

Bryophyte: include all embryophytes ('land plants') that are non-vascular, having tissues and enclosed reproductive systems, but lacking vascular tissue that circulates liquids. They neither have flowers nor produce seeds, reproducing via spores.

Cumulative impacts: The combined or additive effects on biodiversity or ecosystem services over time or in space. They may seem to be insignificant when seen in isolation, but collectively they have a significant effect

Direct impacts: Those that take place at the same time and in the same space as the activity, e.g. clearing of natural vegetation for agriculture.

Direct, indirect and cumulative impacts: Decision makers need to know the direct, indirect and cumulative impacts of a proposed activity on the environment, if they are to take informed decisions in line with sustainable development.

Ecologically sensitive ecosystem: One where relatively even minor disturbances may result in substantial and significant changes.

Ecosystems: Include living (e.g. plants, animals) and non-living (e.g. minerals, soil, water) components, which can be defined in terms of distinguishing characteristics (e.g. a wetland ecosystem, a freshwater ecosystem, a terrestrial ecosystem, a forest ecosystem, etc.).

Endemic or range-restricted species or ecosystem: One whose distribution is confined to a particular and often very limited geographical region.

Environment: Broadly covers our surroundings and the characteristics of those surroundings that influence our health and wellbeing. That is, the environment includes all living organisms (plants, animals and other life), the physical environment (land, water and air), as well as social, economic and cultural conditions. Sometimes we speak of 'the natural environment' and 'the built environment', to differentiate between natural and man-made systems.

Epihydate: A plant that grows on another plant but without deriving nourishment from it and not parasitic, as some ferns and orchids growing on trees.

Habitat: The place or type of site where an organism or population naturally occurs.

Helophyte: A biennial or herbaceous plant of which only the buds survive a harsh period, such as winter.

Hydrophyte: A plant that only grows wholly or partly submerged in water.

Indigenous: Native to a particular area.

Impact assessment: A process that is used to identify, predict and assess the potential positive and negative impacts of a proposed project (including reasonable alternatives) on the environment and to propose appropriate management actions and monitoring programmes. Impact assessment is used to inform decision-making by the project proponent, relevant authorities and financing institutions. The process includes some or all of the following components: screening, scoping, impact assessment and decision-making.

Indirect impacts: Occur later in time or at a different place from the activity, e.g. extraction of groundwater for irrigation leads to changes in the water table and affects distant water users.

Irreplaceable loss: When it results in the loss of a resource without substitute, and which cannot be replaced. An impact leading to irreplaceable loss of biodiversity is, by definition, irreversible

Irreversible impact: One that arguably cannot be reversed in time (e.g. decrease in area of a specific vegetation type, loss of genetic diversity through reduction in size of populations of a particular species). Some, but not all, irreversible impacts will lead to irreplaceable loss of biodiversity. They may, or may not, be acceptable to society or stakeholders in terms of their current values

Issue: A context-specific question that asks “what, or how severe, will the impact of some activity/aspect of the development be on some element of the environment?”

Lichen: A lichen is a symbiosis; two or more organisms living together such that both are more successful within the partnership than they would have been if they were living on their own. With lichens the basic components of this partnership are a fungus (mycobiont) and one or more algae and/or cyanobacteria (photobiont).

Natural resources: Include living and non-living materials that can be exploited or used by people. Natural resources form part of ecosystems, and our living natural resources contribute to biodiversity. Some people use ‘natural resources’ to mean the same thing as biodiversity or ecosystem services.

Precautionary Principle: States that “where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation.

Protected area: As defined by National Environmental Management: Protected Areas Act, 2003 (No. 57 of 2003).

Protected species or ecosystem: One that is protected by law from particular activities and land uses.

Red Data Book' or 'Red List': Provides information on threatened species.

Significance: A term used to evaluate how severe an impact would be, taking into account objective or scientific data as well as human values. A specific significance rating should not be confused with the acceptability of the impact (i.e. an impact of low significance is not automatically "acceptable").

Species: A group of plants, animals, micro-organisms or other living organisms that are morphologically similar; that share inheritance from common ancestry; or whose genes are so similar that they can breed together and produce fertile offspring.

Suffrutex: A low-growing woody shrub or perennial with woody base.

Sustainable development: Development that meets the needs of the current generation without compromising the ability of future generations to meet their own needs and aspirations, or improving the quality of human life while living within the carrying capacity of supporting ecosystems".

Threatened species or ecosystem: Species/ Ecosystems that are at risk of going extinct in its natural range. It may be 'critically endangered' at extremely high risk, 'endangered' at very high risk, or 'vulnerable' at high risk. Species or ecosystems at low or no risk are not 'threatened', and fall into the 'near threatened' or 'least concern' categories.

IV Legislation

Compliance with provincial, national and international legislative aspects is strongly advised in the planning, assessment, authorisation and execution of this particular project. In the compilation of this report, the following legislative aspects were taken into consideration, but were not necessarily limited to:

- Biodiversity Act (No. 10 of 2004);
- Conservation of Agricultural Resources Act 43 of 1983;
- Constitution of the Republic of South Africa (Act 108 of 1996);
- Convention on Biological Diversity, 1995;
- Convention on International Trade in Endangered Species of Wild Life and Fauna;
- Environmental Conservation Act (No. 73 of 1989);
- National Environmental Management Act (No. 107 of 1998);
- National Forests Act, 1998 (No 84 of 1998);
- Protected Areas Act (No. 57 of 2003); and
- White Paper on the conservation and sustainable use of South Africa's biological diversity.

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1 Executive Summary

The aim of this report is to provide the reader with an overview of ecological attributes and the inherent terrestrial ecological sensitivity of the study sites. Results of the site investigations are encapsulated in the EIA assessments in order to highlight specific areas or aspects that could potentially be affected significantly by the proposed developments.

1.1 Biophysical Attributes

Only aspects that have a direct bearing on the current status of the terrestrial ecology of a region are discussed and assessed in this document. Sensitivities in the immediate surrounds of the Kwagga Substation site include perennial and non-perennial rivers. These areas were found to be severely compromised by surrounding urban developments. A high biophysical sensitivity is nonetheless ascribed to all wetland habitat types as part of the biophysical sensitivity analysis. No C-PLAN sensitivities are indicated for the Phoebes Substation Site. None of two substation sites are located on a classified ridge area.

Both the Kwagga and Phoebes Sub Station Sites are indicated to be located in a land cover category termed 'Forest and Woodland'. Local areas were however found to be relative degraded. Land transformation is mostly the result of urban developments and nearby settlements.

- Kwagga Substation Site is located within the Marikana Thornveld Vegetation Type (Endangered); and
- Phoebes Substation Site is located within the Central Sandy Bushveld Vegetation Type (Vulnerable).

While a medium-high biophysical status is ascribed to remaining natural habitat around the Kwagga Substation, the current status of untransformed habitat is not adequately captured in available databases. The degraded nature of habitat in the immediate surrounds of Kwagga Substation therefore results in a medium-low status ascribed to remaining natural habitat at the Kwagga Substation site. Aspects of importance in the immediate surrounds include all wetland related habitat. Impacts within these parts should be avoided and the proposed development should therefore be situated towards the west of the existing substation.

A medium status is ascribed to remaining natural habitat at the proposed Phoebes Substation site. Low levels of transformation and degradation are reflected in available databases, but new development affects the status of natural habitat adversely and is not yet captured on available databases.

1.2 Floristic Attributes

The aim of this section is to provide the reader with an overview of floristic attributes of the study areas. Results will ultimately be incorporated into the ecological sensitivity analysis.

Habitat within the immediate surrounds of the existing Kwagga Substation is regarded moderately to severely degraded and little evidence of the regional vegetation type remains. The perennial river to the north and the non-perennial stream to the east are regarded sensitive and it is recommended that the site be extended towards the west of the existing substation where floristic sensitivities are lower.

Habitat at the proposed Phoebes substation site is regarded to be slightly degraded. Although the database of regional vegetation indicates this area as woodland, the vegetation conforms to open grassland, exhibiting a relative high diversity. While the vegetation is regarded to be moderately representative of the regional vegetation (Central Sandy Bushveld, Vulnerable), severe transformation (urban development) is affecting the status of the remaining natural habitat within the proximity to the proposed site. This is not reflected on the Google Earth image. The floristic sensitivity of this site is therefore regarded to be medium. The likelihood of encountering Red Data flora species within this area is regarded medium-low.

No Red Data flora species were observed during the site investigation. Considering the availability of habitat and the status thereof, the likelihood of encountering Red Data species within the proposed areas is regarded low.

The degraded status of available habitat in the immediate surrounds of the existing Kwagga Substation resulted in a medium-low floristic sensitivity of the area. Future and current development of the area surrounding the Phoebes Substation site has resulted in a medium sensitivity ascribed to this site as available natural habitat is being transformed at a high rate.

1.3 Faunal Attributes

The aim of this section is to provide the reader with an overview of faunal attributes and inherent faunal sensitivity of the study areas. Results will ultimately be incorporated into the ecological sensitivity analysis for the study area. The main focus of this assessment is on endangered or sensitive animal species that could be expected to be found in the region of the study area. The likelihood of these animals being present within the region is estimated by comparing these species' (usually) very specific habitat requirements to those present in the study area.

The existing Kwagga Substation is located in a populated urban area that is characterised by high levels of transformation and degradation. Extremely little natural habitat is present for general/ common fauna species. Remaining terrestrial habitat exhibits attributes of frequent and severe impacts, rendering it low in faunal status and also low in suitability for Red Data fauna species.

The proposed Phoebes Substation site is located in a grassland habitat type that exhibits moderate faunal status and Red Data probabilities. However, current and future impacts (urban developments) affect the status of this area adversely. Surrounding urban areas have negated the possibility of encountering any medium and large fauna species (mammals).

The likelihood of encountering any Red Data species within the Kwagga area is regarded medium, at best (4 species). These species are furthermore generalist species, able to inhabit a wide variety of habitat types. The likelihood of encountering any Red Data species within the Phoebes area is regarded medium, at best (12 species). These species are mostly generalist species, able to inhabit a wide variety of habitat types.

None of these sites exhibits faunal attributes of importance. The loss of these portions of habitat is not expected to result in severe impacts on sensitive faunal habitat or species.

1.4 Ecological Interpretation

Results of the respective floristic and faunal sensitivity analysis are combined to present an overview of the ecological sensitivity of the habitat types identified in the assessment. The following ecological sensitivities are ascribed to the respective sites:

Kwagga Substation Site - Medium-Low Ecological Sensitivity; and
Phoebes Substation Site - Medium Ecological Sensitivity.

Results of both the floristic and faunal sensitivity assessments indicate the medium-low sensitivity of the Kwagga substation site, mainly as a result of the high levels of transformation, degradation and isolation of remaining natural habitat at this site.

A medium sensitivity is estimated for the Phoebes substation site, mainly as a result of the presence of moderately pristine terrestrial habitat. However, current and future urban developments will affect the status of this site severely and adversely.

1.5 Impact Assessment

No impacts were identified that could lead to a beneficial impact on the identified habitat type within the study area since the proposed development is largely destructive. Impacts resulting from the construction and operation of a substation on ecological attributes of the study area are largely restricted to the physical impacts on biota or the habitat in which they occur. Potential impacts include the following, but are not necessarily limited to:

- Direct impacts:
  - Destruction of threatened flora & fauna species & associated habitat;
  - Direct impacts on common fauna species;
  - Destruction of sensitive/ pristine regional habitat types;
- Indirect Impacts:
  - Impacts on surrounding habitat/ species;
- Cumulative Impacts:
  - Increase in local and regional fragmentation/ isolation of habitat; and
  - Increase in environmental degradation.

Expected impacts at both the sites are mostly as a result of the physical disturbance of surface areas during the construction period. Since available habitat is not regarded sensitive in terms of biophysical, floristic or faunal attributes, the significance of likely impacts are rated as low. The implementation of generic mitigation measures are expected to prevent any potentially significant impacts within the surrounding areas.

Impacts during the operational phase of the project are mostly restricted to the maintenance procedures on the perimeter of substation sites. Since available habitat is not regarded sensitive in terms of biophysical, floristic or faunal attributes, the significance of likely impacts are rated as low. The implementation of generic mitigation measures are expected to prevent any potentially significant impacts within the surrounding areas.

2 Project Background

The current Eskom transmission network supplies Tshwane Municipality via three points, namely Kwagga, Njala and Verwoerdburg. The contracted reserve capacity at each point is reviewed annually and the latest information indicates that Kwagga's reserve capacity is 840MVA, Njala is 650MVA and Verwoerdburg is 200MVA. Meter measurements at the respective points indicate that the maximum loading has reached 920MVA at Kwagga (2007), 700MVA at Njala (2007) and 208MVA at Verwoerdburg (2007).

Tshwane has subsequently applied for new supply points and a step load increase to Eskom Transmission and Distribution. A number of options were analyzed based on technical and economical benefits to all parties involved and the proposed solution, which is known as the City of Tshwane Electricity Supply Plan Scheme proposed to build four new substations in the Tshwane area. Three will be built by ESKOM and one will be built by Tshwane. These four substations are ESKOM Phoebus 400/275/132kV Substation; ESKOM Verwoerdburg 400/132kV Substation; ESKOM Anderson 400/132kV Substation and Tshwane 400/132kV Wildebees Substation. The proposed solution will meet the Tshwane electricity requirement, representing the less costly option in addition to de-loading the heavily loaded Minerva and Apollo Substations. Phase 1 of this scheme entails the following:

- Construction of 275kV line from Phoebus to Kwagga Substation (30km); and
- Establishment of Phoebus Substation; and
- Extension of the existing Kwagga Substation.

3 Introduction

When natural systems are rezoned for development, indigenous flora are replaced by exotic species and converted to sterile landscapes with no dynamic propensity or ecological value. Additionally, development rarely focus on decisive planning to conserve natural environments, while little thought is normally given to the consequences on the ecological processes of development in highly sensitive areas.

Transformation and fragmentation of natural habitat are not the only results of unplanned or intended developments; loss of ecosystem functioning and ultimately the local extinction of species can also result. Therefore, careful planning will not only preserve rare and endemic species and communities, but also the ecological integrity of ecosystems of the landscape level which is imperative for the continuation of natural resources, such as fossil fuels, water and soils with agricultural potential.

In 1992, the Convention of Biological Diversity, a landmark convention, was signed by more than 90% of all members of the United Nations. The enactment of the National Environmental Management Biodiversity Act, 2004 (Act No. 10 of 2004), together with the abovementioned treaty, focuses on the preservation of all biological diversity in its

totality, including genetic variability, natural populations, communities, ecosystems up to the scale of landscapes. Hence, the local and global focus changed to the sustainable utilisation of biological diversity.

4 Scope of Work

- Compile a report on the regional biodiversity sensitivities of the study area;
- Assess the status of biophysical attributes within the study area that have a bearing on biodiversity of the study area;
- Obtain relevant Red Data flora information and evaluate Red Data taxa probabilities;
- Obtain PRECIS data in order to highlight existing knowledge of the species richness of the region;
- Compile biophysical, floristic, faunal and an integrated ecological sensitivity map that will highlight areas of importance as it relates to the construction and operation of power lines within the natural environment;
- Assess the status of biodiversity attributes in areas identified as sensitive to the construction and operation of power lines;
- Identify any areas that may be considered 'no-go' areas from a biodiversity perspective;
- Provide a description of the general ecological status of recommended corridors and evaluate the status of Red Data flora and fauna habitat and probabilities of occurrence for Red Data species;
- Assess the ecological sensitivity of recommended corridors to the construction and operation of power lines subsequent to the implementation of suitable mitigation measures; and
- Assess the nature and extent of the potential impacts that are likely to result from the construction and operation of power lines on the ecological integrity of recommended corridors during the construction and operational phases;
- Assess and propose potential mitigation measures that can be applied during the construction and operational phases that will minimize impacts on the biodiversity of the recommended corridors.

5 Limitations of this Investigation

- This report is based on a strategic investigation and selective sampling of some parts of the study area.
- No detailed or long-term investigation of biological attributes and biological diversity that may be present in the study area was conducted.
- This company, the consultants and/or specialist investigators do not accept any responsibility for conclusions, suggestions, limitations and recommendations made in good faith, based on the information presented to them, obtained from these strategic assessments or requests made to them for the purpose of this report.

- No definite conclusions may therefore be drawn with regards to biological diversity or conservation strategies as far as this report or the study area is concerned.
- Additional information may come to light during a later stage of the process for which no allowance could have been made at the time of this report.
- BEC withholds the right to amend this report, recommendations and/ or conclusions at any stage of the project should significant or additional information comes to light.
- Information contained in this report cannot be applied to any other area, however similar in appearance or any other aspect, without proper investigation.

6 Approach to the Study

While a proper knowledge of the biodiversity of the region is not negotiable for the ultimate success of this project, an attempt was made to remove subjective opinions that might be held on any part of the study area as far as possible. Inherent characteristics of a project of this nature implies that no method will be foolproof in all instances as a result of the shortcomings in available databases and lack of site specific detail that could be obtained from detailed site investigations in a short period of time.

It is an unfortunate fact that inherent sensitivities of certain areas are likely to exist that could not be captured or illustrated during the process. This is a shortcoming of every scientific study that has ever been conducted; it simply is not humanly possible to know everything or to consider aspects to a level of molecular detail. However, the approach followed in this study is considered effective in presenting objective comments on the comparison of biodiversity sensitivity of parts in the study area that are frequently separated by vast distances.

In order to present an objective opinion of the biodiversity sensitivity of the study area and how this relates to the suitability/ unsuitability of a specific area in terms of the proposed development, all opinions and statements presented in this document are based on three aspects, namely:

- Specialist interpretation of available data, or known sensitivities of certain aspects;
- Augmentation of existing knowledge by means of field surveys and site specific information; and
- An objective mathematical calculation of results obtained from the process.

6.1 Background Information

All species have certain habitat preferences and specific requirements in terms of nutrient/ food requirements, shelter, moisture, etc. in order to successfully live and propagate. For most species on earth, these specific requirements are not known. The ability to withstand changes to the environment in which species occur is generally known as the tolerance levels of species. These tolerance levels have plastic and elastic characteristics species which complicate the process of impact assessments as the long-term reaction of species to forced changes is mostly not known. Common species are generally characterised by high tolerance levels and these species are able to adapt to changing and varying habitat types.

In contrast, most of the threatened species have extremely low tolerance levels to habitat changes and other impacts, which is a main reason for their threatened status. Slight changes to the environment in which these species occur might result in catastrophic impacts on the community. The identification of areas in which these species occurs represent a major objective of this study.

The overall goal of this particular investigation is to therefore to assess the biodiversity sensitivities of the region by means of the Ecosystem Approach or Landscape Ecology. The Ecosystem Approach is advocated by the Convention on Biological Diversity. It recognizes that people and biodiversity are part of the broader ecosystems on which they depend, and that they should thus be assessed in an integrated way is the study of spatial variation in landscapes at a variety of scales. Principles of the Ecosystem Approach include the following:

- The objectives of ecosystem management are a matter of societal choice.
- Ecosystem managers should consider the effects of their activities on adjacent and other systems.
- Conservation of ecosystem structure and functioning, to maintain ecosystem services, should be a priority target.
- Ecosystems must be managed within the limits of their functioning.
- The approach must be undertaken at appropriate spatial and temporal scales.
- Objectives for ecosystem management should be set for the long-term.
- Management must recognise that change is inevitable.
- The approach should seek an appropriate balance between, and integration of, conservation and use of biodiversity.
- All forms of relevant information should be considered.
- All relevant sectors of society and scientific disciplines should be involved

For the purpose of this particular study a local scale was selected as suitable in terms of the size of the study area. The approach of Landscape Ecology includes the assessment of biophysical and societal causes, consequences of landscape heterogeneity and factors that causes disturbance to these attributes. In laymen's terms it implies that if sensitive

habitat types/ ecosystems (frequently associated with biodiversity elements of high sensitivity or conservation importance) are protected, species that are highly sensitive to changes in the environment will ultimately be protected. Species conservation is therefore replaced by the concept of habitat conservation. This approach is regarded effective since the protection of sensitive ecosystems will ultimately filter down to species level.

It is inevitable that the Landscape Ecology Approach will not function effectively in all instances since extremely localised and small areas of sensitivity do occur scattered in the study area, which are not captured on available databases or might have been missed during the regional assessments. A safeguard in this regard is also represented by the final phase of the project that will involve a detailed walkthrough of the selected routes. During this phase these small and localised areas can be avoided by means of localised deviations of sections of the line.

The compilation of exhaustive species lists and the identification and description of localised ecological habitat types were not objectives of this study. It was therefore regarded important to identify areas of sensitivity on a local scale and, where possible, communities or species that are considered sensitive in terms of impacts that are likely to result from the proposed development.

This ecological investigation therefore aims to:

- Determine the sensitivity of the receiving natural environment as it relates to the construction and operation of powerlines in a natural environment;
- Highlight the known level of biodiversity;
- Highlight flora and fauna species of conservation importance that are likely to occur within the study area;
- Estimate the level of potential impacts of the construction and operation of proposed power lines on the biological resources of the study area;
- Make contributions in the route selection in order to prevent unacceptable adverse impacts in the biological environment; and
- Apply the Precautionary Principal throughout the assessment[1].

6.2 Assessment of Biophysical Attributes

6.2.1 Data Selection Process

Available databases of biophysical attributes are implemented to identify regional areas of importance as it relates to biodiversity. Biophysical attributes that are known to be associated with biodiversity aspects of importance, conservation potential or natural status of the environment were implemented to compile the ecological sensitivity analysis of the study area. These attributes include the following:

- Areas of known floristic or faunal importance (C-Plan Version 2);

[1] (www.pprinciple.net/the_precautionary_principle.html).

- Areas of surface water;
- Degradation classes (ENPAT Land Cover Classes);
- Morphological attributes;
- Regional vegetation types (VEGMAP);
- Land cover categories; and
- Ridges (as classified by GIS analysis, slopes exceeding 5° or 8.8%).

The first step in assessing biophysical aspects of importance is the delineation of natural habitat, or exclusion of transformed or degraded habitat. Areas that are transformed as a result of human activities, including agriculture, mining, urban development, etc, constitute parts of the study area where no natural habitat remains and where natural biodiversity is entirely compromised, to the extent that any recovery to a pristine status is regarded impossible. These areas are regarded suitable for the purpose of construction and operation of substations since impacts on important biological resources are regarded unlikely.

Secondly, sensitivity values are ascribed to biophysical attributes based on how these attributes contribute to biological diversity or sensitivity. Ultimately, all biophysical information is compiled to present a holistic picture of the areas where biophysical aspects of importance occur; presenting a map that depicts regional biodiversity sensitivities based on biophysical attributes.

6.2.2 Biophysical Sensitivities - GIS Analysis

The method that is described below is believed to present a holistic view of the biodiversity sensitivity of an area, based on available data as well as the specialist's interpretation of the sensitivity of aspects that are contained in the databases. In specific cases an adjustment of sensitivity of certain areas were made based on information that was obtained from field surveys as well as information that was presented from landowners and interested parties. The GIS analysis of data was compiled in following stages, namely:

- As a first approximation an assessment was compiled during which available databases were assessed for suitability of use in this particular project. Every attempt was made to utilise the most recent available data; databases were replaced as newer information became available even during late stages of the assessment. Each database was separated into different aspects in terms of how it affects biodiversity sensitivity on a local and regional scale:
    - A certain biodiversity sensitivity was ascribed to respective attributes of each database, for example, the 'Land Cover' database was separated into respective classes in the manner in which it affects the local and regional biodiversity sensitivity, i.e. classes such as 'Agricultural', 'Urban Developments' and 'Degradation' was grouped and ascribed a LOW value;

- Care was taken to avoid duplicity between the various databases, for instance, aspects such as 'Woodland' and 'Grassland' was omitted from the 'Land Cover' database as these classes are adequately represented by the VEGMAP database;
- Care was also taken of existing gaps of information in available databases, for example; while the ENPAT database of rivers does reflect larger rivers on a national scale, additional data is available in other databases that are not necessarily captured in the ENPAT database;
- Where a single database contains different classes of sensitivity, these databases were split in the respective classes for layering;
- Available databases were subsequently integrated in order to determine the maximum sensitivity of a particular parcel of land;
- The resultant map provided a basic assessment of the potential sensitivity on a local and regional scale;

- The last step in the analysis represents the calculation of sensitivity classes within the proposed corridors. The compiled raster image of the biodiversity sensitivity map was 'clipped' with each of the corridors and the extent (in hectares) of each sensitivity class (0 – 5) was calculated and subjected to further analysis.

6.3 Assessment of Floristic Attributes

6.3.1 Floristic Patterns & Regional Diversity

In order to obtain an overview of the status of the vegetation within the study area, a selection of sample plots was investigated throughout the study area. Strategic investigation into the status of the vegetation included the following:

- Comments pertaining to general floristic diversity;
- General status of vegetation;
- Presence and status of primary vegetation;
- General land transformation and degradation status; and
- Habitat suitability for Red Data flora species.

6.3.2 Floristic Sensitivity

The floristic sensitivity of the respective sites is a subjective assessment of available natural habitat. Sensitivities are based on the following criteria:

- Delineation of remaining natural vegetation (excluding transformed & degraded habitat);
- A subjective assessment of primary status of the vegetation during the field surveys;
- The likelihood of an area occupying a community of Red Data or protected flora species based on habitat attributes, also considering the list of Red Data species known to occur in the area; and
- General physiognomic attributes.

Remaining natural vegetation occupied within the respective corridors was delineated by GIS analysis and estimated floristic sensitivities ascribed to each site, as follows:

No/ Zero Floristic Sensitivity	0
Low Floristic Sensitivity	1
Medium Floristic Sensitivity	3
Medium-High Floristic Sensitivity	4
High Floristic Sensitivity	5

6.3.3 Red Data Flora Assessment

A list of Red Data flora species that occur within the study area was obtained from E. In most cases very little information is available about the habitat preferences of these species. However, habitat types in which these species normally occur are highlighted in the sensitivity analysis of the study area.

6.4 Assessment of Faunal Attributes

The association of faunal assemblages and vegetation communities is well known and the regional vegetation types are therefore used as an indication of the potential distribution of fauna species, taking the habitat preference and general requirements of fauna species into consideration.

6.4.1 Red Data Fauna Probabilities

Three parameters were used to assess the Probability of Occurrence for Red Data species:

- Habitat requirements (HR) - Most Red Data animals have very specific habitat requirements, the presence of these habitat in the study area is evaluated.
- Habitat status (HS) - The status or ecological condition of available habitat in the study area is assessed. Often, a high level of degradation of a specific habitat type will negate the potential presence of Red Data species (especially wetland-related habitats where water quality plays a major role); and
- Habitat linkage (HL) - Movement between areas used for breeding and feeding purposes forms an essential part of ecological existence of many species. The connectivity of the study area to surrounding habitats and adequacy of these linkages are evaluated for the ecological functioning of Red Data species within the study area.

The estimated Probability of Occurrence is presented in five categories, namely:

- very low;
- low;
- moderate;
- high; and
- very high.

6.5 Impact Evaluation

Direct, indirect and cumulative impacts of issues will be assessed in terms of the following criteria.

6.5.1 Nature of the Impact

A description of what causes the effect, what will be affected and how it will be affected.

6.5.2 Spatial Extent of the Impact

Quantifying the spatial effect of impacts; whether the impact will be local (limited to the immediate area) or regional (having a far-ranging effect).

1 Limited to the site and its immediate surroundings;
2 Local/ Municipal extending only as far as the local community or urban area;
3 Provincial/Regional;
4 National i.e. South Africa; or
5 Across International borders.

6.5.3 Duration of the Impact

Determines the expected duration of the impact in terms of years.

1 Immediate (less than 1 year);
2 Short term (1-5 years);
3 Medium term (5-15 years);
4 Long term (the impact will cease after the operational life span of the project); or
5 Permanent (no mitigation measures of natural process will reduce the impact after construction).

6.5.4 Magnitude of the Impact

Quantified between the scales of small (will have not effect on the environment) and very high (will result in complete destruction of patterns and permanent cessation of processes).

0 None (where the aspect will have no impact on the environment);
1 Minor (where the impact affects the environment in such a way that natural, cultural and social functions and processes are not affected);
2 Low (where the impact affects the environment in such a way that natural, cultural and social functions and processes are slightly affected);
3 Moderate (where the affected environment is altered but natural, cultural and social functions and processes continue albeit in a modified way);
4 High (where natural, cultural or social functions or processes are altered to the extent that it will temporarily cease), or
5 Very high / don't know (where natural, cultural or social functions or processes are altered to the extent that it will permanently cease).

6.5.5 Reversibility of the Impact

1 Reversible (regenerates naturally);
3 Recoverable (requires human input); or
5 Irreversible

6.5.6 Consequence of the Impact

Derived from the following formula:
Consequence = Severity + Reversibility + Duration + Spatial Scale

6.5.7 Probability of Occurrence

Describes the likelihood of the impact actually occurring.

0 None (impact will not occur);
1 Improbable (the possibility of the impact materialising is very low as a result of design, historic experience or implementation of adequate mitigation measures);
2 Low probability (there is a possibility that the impact will occur);
3 Medium probability (the impact may occur);
4 High probability (it is most likely that the impact will occur); or
5 Definite / do not know (the impact will occur regardless of the implementation of any prevention or corrective actions or it the specialist does not know what the probability will be based on too little published information).

6.5.8 Significance of the Impact

Based on a synthesis of the information contained in the points above and can be described as low, medium or high. Significance is determined using the following formula:
Significance of environmental impact = Consequence X Probability

- More than 60 significance points indicate HIGH environmental significance;
- Between 30 and 60 significance points indicate MODERATE environmental significance; and
- Less than 30 points indicate LOW environmental significance.

Relevant mitigation measures will be considered and impacts will then be ranked again according to the significance results after mitigation.

6.5.9 Status of the Impact

- Negative effect (i.e. at a cost to the environment);
- Positive effect (i.e. at a benefit to the environment); or
- Neutral effect on the environment.

6.5.10 Mitigation of the Impact

The degree to which the impact can be mitigated.

7 Location

- Kwagga Substation is located at S25.75751° & E28.10442°; and
- The proposed Phoebes Substation site is located at S25.56360° & E28.09583°.

The location of these areas is indicated in Figure 1. Google earth images of the sites are presented in Figures 2 and 3. For technical specifications pertaining to the proposed substations, the reader is referred to the main EIA document.

8 Biophysical Habitat Attributes

While many biophysical aspects, such as geology, soils and climate, have an influence on the development of the ecology of a region, it is beyond the scope of this report to present a detailed description of each and every biophysical aspect and how these relate to potential impacts resulting from the construction and operation of substations in a natural environment. Only aspects that have a direct bearing on the current status of the ecology of the sites are therefore discussed and assessed in this document.

8.1 Gauteng Conservation Plan (C-PLAN) Sensitivities)

No C-PLAN sensitivities are indicated for the Phoebes Substation Site. C-PLAN sensitivities for the Kwagga Substation site are illustrated in Figure 4. Sensitivities in the immediate surrounds include perennial and non-perennial rivers. These aspects were ascribed a High biophysical sensitivity value as part of the sensitivity analysis.

8.2 Areas of Surface Water

Areas of surface water that will potentially be affected by the proposed line variants include perennial and non-perennial rivers. The distribution of these areas is illustrated in Figure 4, as part of the C-Plan sensitivities.

Rivers and streams were found to be severely compromised by nearby urban developments. Litter, dumping, infestation by exotic species, poor water quality and erosion are some attributes that are currently affecting the status of wetland habitat types adversely. High biophysical sensitivity was nonetheless ascribed to all wetland habitat types as part of the biophysical sensitivity analysis.

Figure 1: Location of the proposed substation sites

Figure 2: Google Earth image of the Kwagga Substation Site

Figure 3: Google Earth image of the Phoebes Substation Site

Figure 4: Local C-Plan sensitivities of the Kwagga Substation Site

8.3 Ridges & Slopes

None of these two substation sites are located on a classified ridge area.

8.4 Land Cover & Land Use

Both the Kwagga and Phoebes Sub Station Sites are located in a category termed 'Forest and Woodland - Natural'. Local areas were however found to be relative degraded. For the purpose of this biodiversity assessment, land cover are categorised into classes that represent natural habitat and land use categories that contribute to habitat degradation and transformation on a local or regional scale. In terms of the importance for biodiversity the assumption is made that landscapes that exhibit high levels of transformation are normally occupied by plant communities and faunal assemblages that does not reflect the original or pristine status of an area or region. This is particularly important in the case of Red Data species as these plants and animals have extremely low levels of disturbance tolerances, which is one of the main reasons for being threatened. Significant impacts on habitat available to these species are likely to result in similarly significant impacts on these species and their conservation status.

Land transformation is mostly the result of urban developments and settlements.

8.5 Regional Vegetation - VEGMAP

- Kwagga Substation is located within the Marikana Thornveld Vegetation Type; and
- Phoebes Substation Site is located within the Central Sandy Bushveld Vegetation Type.

Table 1: VEGMAP vegetation units conservation status

VEGMAP UNIT	Remaining	Conserved	Target	Ecosystem Status	Protection level
Central Sandy Bushveld	76%	3%	19%	Vulnerable	Poorly Protected
Marikana Thornveld	52%	0%	19%	Endangered	Hardly Protected

8.5.1 Central Sandy Bushveld

It is located in undulating terrain, occurring mainly in a broad arc south of the Springbokvlakte from the Pilanesberg in the west through Hammanskraal and Groblersdal to GaMasemola in the east. The habitat conforms to low undulating areas, sometimes between mountains, and sandy plains and catenas supporting tall, deciduous *Terminalia sericea* and *Burkea africana* woodland on sandy soils (with the former often dominant on the lower slopes of sandy catenas) and low, broadleaved *Combretum* woodland on shallow, rocky or gravely soils. Species of *Acacia, Ziziphus* and *Euclea* are found on flats lower slopes on eutrophic sands and some less sandy soils. *A. tortilis* may dominate some areas along valleys. Grass-dominated herbaceous layer with relatively low basal cover on dystrophic soils are noted frequently.
The Central Bushveld endemic grass species *Mosdenia leptostachys* and herb *Oxygonum dregeanum* subsp. *canescens* var. *dissectum* are present within this unit.

This vegetation type is regarded Vulnerable with less than 3% statutorily conserved, spread thinly across many nature reserved, including the Doorndraai Dam and Skuinsdraai Dam Nature Reserves. An additional 2% is conserved in other reserves including the Wallmansthal SANDF Property and a grouping of the Nylsvlei freshwater wetlands. About 24% is transformed, including 19% cultivated and 4% urban and built-up areas. Much of the unit in the broad arc south of the Springbokvlakte is heavily populated by rural communities. Several alien plants are widely scattered by often at low densities, including *Cereus jamacuru, Eucalyptus* species, *Lantana camara, Melia azedarach, Opuntia ficus-indica* and *Sesbania punicea.*

Acacia sieberiana occurs in the transition zone with grassland in the east, while *A. caffra* and *Faurea saligna* are dominant in the transition zone to the Waterberg Mountain Bushveld in the western parts of this unit. The following species are regarded representative of this particular vegetation type:

- **Tall Trees**

Acacia burkei, A. robusta and *Sclerocarya birrea* subsp. *caffra.*

- **Small Trees**

Burkea africana, *Combretum apiculatum*, C. *zeyheri*, *Terminalia sericea*, *Ochna pulchra, Peltophorum africanum* and *Searsia leptodictya.*

- **Tall Shrubs**

Combretum hereroense, Grewia bicolor, G. *monticola* and *Strychnos pungens.*

- **Low Shrubs**

Agathisanthemum bojeri, *Indigofera filipes*, *Felicia fascicularis, Gnidia sericocephala.*

- **Geoxylic Suffrutex**

Dichapetalum cymosum

- **Woody Climber**

Asparagus buchananii

- **Graminoids**

Brachiaria nigropedata, *Eragrostis pallens*, *E. rigidior*, *Hyperthelia dissoluta*, *Panicum maximum*, *Perotis patens*, *Anthephora pubescens, Aristida scabrivalvis* subsp. *scabrivalvis, Brachiaria serrata, Elionurus muticus, Eragrostis nindensis, Loudetia simplex, Schmidtia pappophoroides, Themeda triandra* and *Trachypogon spicatus.*

- **Herbs**

Dicerocaryum encelioides, *Barleria macrostegia, Blepharis integrifolia, Crabbea angustifolia, Evolvulus alsinoides, Geigeria burkei, Hermannia lancifolia, Indigofera daleoides, Justicia anagalloides, Kyphocarpa angustifolia, Lophiocarpus tenuissimus, Waltheria indica* and *Xerophyta humilis.*

- **Geophytic Herb**

Hypoxis hemerocallidea var. *davyana*

- **Succulent Herb**

Aloe greatheadii

8.5.2 Marikana Thornveld

The northern and southern sections of the study area correspond to a vegetation type known as Marikana Thornveld and were previously classified by Van Rooyen and Bredenkamp as Rocky Highveld Grassland. This ecological type is structurally similar to open *Acacia* savanna woodland, occurring in valleys and slightly undulating plains and some lowland hills. Shrubs are denser along drainage lines, on termitaria and rocky outcrop or in other habitat protected from fire. The Marikana Thornveld is a threatened ("endangered") vegetation type of which less than 1% is formally conserved within reserves and is mainly threatened by cultivation and urbanisation. The following species are regarded representative of the Marikana Thornveld vegetation type.

- **Tall Tree**

Acacia burkei

- **Small Trees**

Acacia caffra, *A. gerrardii*, *A. karroo*, *Combretum molle*, *Searsia lancea*, *Ziziphus mucronata*, *Acacia nilotica, A. tortilis* subsp. *heteracantha, Celtis africana*, *Dombeya rotundifolia, Pappea capensis, Peltophorum africanum* and *Terminalia sericea.*

- **Tall Shrubs**

Euclea crispa subsp. *crispa*, *Olea europaea* subsp. *africana*, *Searsia pyroides* var. *pyroides*, *Diospyros lycioides* subsp. *guerkei, Ehretia rigida* subsp. *rigida, Euclea undulata, Grewia flava* and *Pavetta gardeniifolia.*

- **Low Shrubs**

Asparagus cooperi, Rhynchosia nitens, Indigofera zeyheri and *Justicia flava.*

- **Woody Climbers**

Clematis brachiata and *Helinus integrifolius.*

- **Herbaceous Climbers**

Pentarrhinum insipidum and *Cyphostemma cirrhosum.*

- **Graminoids**

Elionurus muticus, Eragrostis lehmanniana, Setaria sphacelata, Themeda triandra, Aristida scabrivalvis subsp. *scabrivalvis, Fingerhuthia africana, Heteropogon contortus, Hyperthelia dissoluta, Melinis nerviglumis* and *Pogonarthria squarrosa.*

- **Herbs**

Hermannia depressa, Ipomoea obscura, Barleria macrostegia, Dianthus mooiensis subsp*. mooiensis, Ipomoea oblongata* and *Vernonia oligocephala.*

- **Geophytic Herbs**

Ledebouria revoluta, Ornithogalum tenuifolium and *Sansevieria aethiopica.*

8.6 Biophysical Sensitivities - Analysis

Ascribed sensitivities are based on a combination of the likelihood of a specific biophysical attribute being important in terms of biodiversity attributes and the expected reaction of the particular attribute to impacts associated with the construction and operation of substations. Sensitivities are ultimately collated and a biodiversity sensitivity map is produced that presents an overview of the biodiversity sensitivity of the study area on a regional scale. Shortcomings of this approach are that localised and small areas of importance that are not captured in existing databases or that were not observed during the extensive field survey will not be reflected on the sensitivity map.

Biophysical sensitivities of the immediate surrounds of the existing Kwagga Substation are illustrated in Figure 5. While a medium-high status is ascribed to remaining natural habitat around the transformed areas at the Kwagga Substation (based on the Endangered status of the Marikana Thornveld vegetation type), the current status of untransformed habitat is not adequately reflected by available databases. The degraded nature of habitat in the immediate surrounds of Kwagga Substation, as a result of surrounding urban development, roads, littering, etc. therefore results in a medium-low status ascribed to remaining natural habitat at the Kwagga Substation site. Aspects of importance in the immediate surrounds include all wetland related habitat. Impacts within these parts should be avoided and the proposed development should therefore be situated towards the west of the existing substation.

Biophysical sensitivities of the immediate surrounds of the proposed Phoebes Substation are illustrated in Figure 5. A medium status is ascribed to remaining natural habitat. Low levels of transformation and degradation is illustrated on Figure 5, but new development affects the status of natural habitat adversely and is not adequately reflected on available databases.

Figure 5: Biophysical sensitivities in the immediate surrounds of Kwagga Substation

Figure 6: Biophysical sensitivities in the surrounds of proposed Phoebes Substation

9 Floristic Attributes of the Study Area

9.1 Kwagga Substation

Habitat within the immediate surrounds of the existing Kwagga Substation is regarded moderately to severely degraded and little evidence of the regional vegetation type (Marikana Thornveld, Endangered) remains. The location of this substation within an urban area, as well as the proximity to large roads, resulted in the degradation of the original vegetation; aspects that indicate the degraded status include the absence of indigenous trees and shrubs, the proliferation of weeds and exotic species, frequent fires, litter, dumping, etc. However, the perennial river to the north and the non-perennial stream to the east are regarded significant aspects that will be taken into account in the impact assessment of potential impacts and in recommending a suitable site for the proposed development. It is recommended that the site be extended towards the west where sensitivities are lower in significance.

Remaining natural habitat is regarded compromised and does not represent a pristine example of the regional vegetation type. The likelihood of encountering Red Data flora species within this area is regarded low.

9.2 Phoebes Substation

Habitat within the proposed Phoebes substation site is regarded to be slightly degraded. Although the database of regional vegetation indicates this area as woodland, the vegetation conforms to open grassland, exhibiting a relative high species diversity. Species that were encountered include the following:

Grasses: *Themeda triandra, Cynodon dactylon, Elionurus muticus, Hyparrhenia hirta, Heteropogon contortus, Cymbopogon plurinodis, Aristida* species, *Eragrostis curvula, E. chloromelas, E. plana, Panicum* species and *Brachiaria serrata.*

Forbs *Felicia muricata, Albuca* species, *Arctotis arctoides, Helichrysum nudifolium, H. rugulosum, Tagetes minuta, Hypoxis iridifolia, Berkheya setifera, Verbena bonariensis, Conyza podocephala, Indigofera* species and *Conyza bonariensis.*

While the vegetation is regarded to be moderately representative of the regional vegetation (Central Sandy Bushveld, Vulnerable), severe transformation (urban development) is affecting the status of the remaining natural habitat within the proximity to the proposed site (south). This is not reflected on the Google Earth image. The floristic sensitivity of this site is therefore regarded to be medium. The likelihood of encountering Red Data flora species within this area is regarded medium-low.

9.3 Flora Species of Conservation Importance

9.3.1 Kwagga Substation

- Populations of the Red/Orange List plant taxa present on the actual study site or in the near vicinity of the study site: **None**
- Red/Orange List plant taxa recorded from the farm on which the study site is situated / within 5km of the study site: **None**
- Red/Orange List plant taxa have been recorded from the quarter degree grid in which the study site is situated (2528CC):
  - *Andromischus umbraticola* subsp. *umbraticola*
  - *Boophane disticha*
  - *Bowiea volubilis* subsp. *volubilis*
  - *Brachycorythis conica* subsp. *transvaalensis*
  - *Callilepis leptophylla*
  - *Ceropegia decidua* subsp. *pretoriensis*
  - *Cheilanthes deltoidea* subsp. nov. Gauteng form
  - *Cleome conrathii*
  - *Crinum macowanii*
  - *Drimia sanguinea*
  - *Eucomis autumnalis*
  - *Gunnera perpensa*
  - *Habenaria barbertoni*
  - *Habenaria kraenzliniana*
  - *Habenaria mossii*
  - *Holothrix randii*
  - *Hypoxis hemerocallidea*
  - *Ilex mitis* var. *mitis*
  - *Lithops lesliei* subsp. *lesliei*
  - *Melolobium subspicatum*

None of these species were observed during the site investigation. Considering the availability of habitat and the status thereof, the likelihood of encountering any of these species within the proposed area is regarded low.

9.3.2 Phoebes Substation

GDACE database indicate the presence of the following Red Data flora species within the region of the study area is situated:

- Populations of Red/Orange List plant taxa are present on the actual study site or in the near vicinity of the study site: **None**
- Red/Orange List plant taxa recorded from the farm on which the study site is situated / within 5km of the study site: **None**

- Red/Orange List plant taxa recorded from the quarter degree grid in which the study site is situated (2528CA):
  - *Andromischus umbraticola* subsp. *umbraticola*
  - *Aloe peglerae*
  - *Argyrolobium campicola*
  - *Argyrolobium megarrhizum*
  - *Boophane disticha*
  - *Bowiea volubilis* subsp. *volubilis*
  - *Brachycorythis conica* subsp. *transvaalensis*
  - *Callilepis leptophylla*
  - *Ceropegia decidua* subsp. *pretoriensis*
  - *Crinum macowanii*
  - *Cucumis humifructus*
  - *Delosperma gautengense*
  - *Delosperma leendertziae*
  - *Dioscorea sylvatica*
  - *Drimia altissima*
  - *Drimia sanguinea*
  - *Eucomis autumnalis*
  - *Gnaphalium nelsonii*
  - *Gunnera perpensa*
  - *Habenaria bicolor*
  - *Habenaria kraenzliniana*
  - *Holothrix randii*
  - *Hypoxis hemerocallidea*
  - *Ilex mitis* var. *mitis*
  - *Macledium pretoriense*
  - *Searsia gracillima* var. *gracillima*
  - *Stenostelma umbelluliferum*
  - *Trachyandra erythrorrhiza*

None of these species was observed during the site investigation period. Considering the availability of habitat and the status thereof, the likelihood of encountering any of these species within the proposed area is regarded medium-low.

9.4 Floristic Sensitivity Analysis

Floristic sensitivity is based on an analysis of floristic attributes present within the proposed development sites, taking existing impacts and conservation potential into consideration, but also considering the potential significance of impacts resulting from the proposed development. Estimated floristic sensitivities for respective substation sites are presented in Table 3.

9.4.1 Kwagga Substation

The degraded status of available habitat in the immediate surrounds of the existing Kwagga Substation resulted in a medium-low floristic sensitivity of the area. Extremely few floristic attributes are present that reflect the regional vegetation type. A low probability is furthermore estimated for the potential presence of Red Data flora species. The only aspect of importance is the presence of the perennial river to the north and the non-perennial stream to the east of the proposed site. These areas are unlikely to be affected adversely by the proposed development should the site be extended to the west. No attributes of floristic importance were observed or are expected to be present that would affect the recommendation of the portion of land situated to the west of the existing substation for the proposed development.

9.4.2 Phoebes Substation

Future and current development of the area surrounding this site has resulted in a medium sensitivity ascribed to this site as available natural habitat is being transformed. Although the existing habitat at this site is regarded moderately pristine, it is not representative of the regional vegetation type. No attributes of floristic importance were observed or are expected to be present that would affect the recommendation of this portion of land for the proposed development.

Table 2: Floristic sensitivity of the proposed substation sites								
Criteria	**RD species**	**Landscape sensitivity**	**Status / Ecological quality**	**Species composition**	**Functionality / fragmentation**	**TOTAL**	**SENSITIVITY INDEX**	**SENSITIVITY CLASS**
Community	**Criteria Ranking**							
Kwagga Substation Site	2	5	2	4	3	90	29%	**Medium-Low**
Phoebes Substation Site	3	4	5	7	5	128	41%	**Medium**

10 Faunal Attributes of the Study Area

10.1 Kwagga Substation

The existing substation is located in a populated urban area that is characterised by high levels of transformation and degradation. Extremely little natural habitat is present for general/ common fauna species; the only relatively untransformed habitat includes the non-perennial stream located to the east of the existing site. This area is then also the only habitat type that is moderately suitable for the potential presence of Red Data fauna species. Surrounding urban areas have negated the possibility of encountering any medium and large fauna species (mammals). Remaining terrestrial habitat exhibits attributes of frequent and severe impacts, rendering it low in faunal status and also low in suitability for Red Data fauna species.

10.2 Phoebes Substation

The proposed substation site is located in a grassland habitat type that exhibits moderate faunal status and Red Data probabilities. However, current and future impacts (urban developments) affect the status of this area adversely. While the vegetation structure is not representative of the regional vegetation type, the status is regarded suitable for a high diversity of fauna species, particularly invertebrates. Surrounding urban areas have negated the possibility of encountering any medium and large fauna species (mammals).

10.3 Red Data Fauna Probabilities for the Study Area

The World Conservation Organisation (IUCN) has three threatened categories, namely Critically Endangered (CE), Endangered (EN) and Vulnerable (VU). Species that have been evaluated according to the IUCN criteria and do not fall into one of the threatened categories can be classified as Least Concern (LC), Near Threatened (NT) or Data Deficient (DD). Species classified as Least Concern have been evaluated and do not qualify for the Critically Endangered, Endangered, and Vulnerable or Near Threatened categories. Species that are widespread and abundant are normally included in this category.

10.3.1 Red Data Probability Assessment – Kwagga Substation

An assessment of the probabilities of Red Data fauna species occurring at this site is presented in Table 4.

Table 3: Red Data fauna probabilities for Kwagga Substation

Biological Name	English Name	Status	Kwagga
Metisella meninx	Marsh Sylph	VU	moderate-low
Pyxicephalus adspersus	Giant Bullfrog	NT	moderate-low
Homoroselaps dorsalis	Striped Harlequin Snake	NT	low
Amblysomus septentrionalis	Higveld Golden Mole	NT	moderate-low
Atelerix frontalis	South African Hedgehog	NT	moderate
Chrysospalax villosus	Rough-haired Golden Mole	CR	low
Cloeotis percivali	Short-eared Trident Bat	CR	low
Crocidura cyanea	Reddish-grey Musk Shrew	DD	moderate
Crocidura fuscomurina	Tiny Musk Shrew	DD	low
Crocidura hirta	Lesser Red Musk Shrew	DD	moderate
Crocidura maquassiensis	Maquassie Musk Shrew	VU	low
Crocidura mariquensis	Swamp Musk Shrew	DD	moderate-low
Crocidura silacea	Lesser Grey-brown Musk Shrew	DD	low
Dasymys incomtus	Water Rat	NT	low
Elephantulus brachyrhynchus	Short-snouted Elephant Shrew	DD	low
Graphiurus platyops	Rock Dormouse	DD	low
Hyaena brunnea	Brown Hyaena	NT	low
Lemniscomys rosalia	Single-striped Mouse	DD	low
Leptailurus serval	Serval	NT	low
Lutra maculicollis	Spotted-necked Otter	NT	low
Manis temminckii	Pangolin	VU	low
Mellivora capensis	Honey Badger	NT	low
Miniopterus schreibersii	Schreiber's Long-fingered Bat	NT	moderate
Myosorex cafer	Dark-footed Forest Shrew	DD	low
Myosorex varius	Forest Shrew	DD	moderate-low
Myotis tricolor	Temminck's Hairy Bat	NT	moderate-low
Myotis welwitschii	Welwitsch's Hairy Bat	NT	moderate-low
Mystromys albicaudatus	White-tailed Rat	EN	low
Pipistrellus rusticus	Rusty Bat	NT	moderate-low
Poecilogale albinucha	African Weasel	DD	low
Rhinolophus blasii	Peak-saddle Horseshoe Bat	VU	moderate-low
Rhinolophus clivosus	Geoffroy's Horseshoe Bat	NT	moderate-low

Table 3: Red Data fauna probabilities for Kwagga Substation			
Biological Name	**English Name**	**Status**	**Kwagga**
Rhinolophus darlingi	Darling's Horseshoe Bat	NT	moderate-low
Suncus infinitesimus	Least Dwarf Shrew	DD	moderate-low
Suncus lixus	Greater Dwarf Shrew	DD	moderate-low
Suncus varilla	Lesser Dwarf Shrew	DD	low
Tatera leucogaster	Bushveld Gerbil	DD	moderate-low

The likelihood of encountering any Red Data fauna species within this area is regarded medium, at best (4 species). These species are furthermore generalist species, able to inhabit a wide variety of habitat types.

10.3.2 Red Data Probability Assessment – Phoebes Substation

An assessment of the probabilities of Red Data fauna species occurring at this site is presented in Table 5.

Table 4: Red Data fauna probabilities for Phoebes Substation			
Biological Name	**English Name**	**Status**	**Phoebes**
Metisella meninx	Marsh Sylph	VU	low
Pyxicephalus adspersus	Giant Bullfrog	NT	low
Homoroselaps dorsalis	Striped Harlequin Snake	NT	moderate-low
Amblysomus septentrionalis	Higveld Golden Mole	NT	low
Atelerix frontalis	South African Hedgehog	NT	moderate
Chrysospalax villosus	Rough-haired Golden Mole	CR	low
Cloeotis percivali	Short-eared Trident Bat	CR	moderate-low
Crocidura cyanea	Reddish-grey Musk Shrew	DD	moderate-low
Crocidura fuscomurina	Tiny Musk Shrew	DD	low
Crocidura hirta	Lesser Red Musk Shrew	DD	moderate-low
Crocidura maquassiensis	Maquassie Musk Shrew	VU	low
Crocidura mariquensis	Swamp Musk Shrew	DD	low
Crocidura silacea	Lesser Grey-brown Musk Shrew	DD	low
Dasymys incomtus	Water Rat	NT	low
Elephantulus brachyrhynchus	Short-snouted Elephant Shrew	DD	moderate-low
Graphiurus platyops	Rock Dormouse	DD	low
Hyaena brunnea	Brown Hyaena	NT	low
Lemniscomys rosalia	Single-striped Mouse	DD	moderate-low
Leptailurus serval	Serval	NT	low
Lutra maculicollis	Spotted-necked Otter	NT	low
Manis temminckii	Pangolin	VU	low
Mellivora capensis	Honey Badger	NT	low
Miniopterus schreibersii	Schreiber's Long-fingered Bat	NT	moderate
Myosorex cafer	Dark-footed Forest Shrew	DD	low
Myosorex varius	Forest Shrew	DD	low
Myotis tricolor	Temminck's Hairy Bat	NT	moderate
Myotis welwitschii	Welwitsch's Hairy Bat	NT	moderate
Mystromys albicaudatus	White-tailed Rat	EN	low
Pipistrellus rusticus	Rusty Bat	NT	moderate
Poecilogale albinucha	African Weasel	DD	moderate

Table 4: Red Data fauna probabilities for Phoebes Substation			
Biological Name	**English Name**	**Status**	**Phoebes**
Rhinolophus blasii	Peak-saddle Horseshoe Bat	VU	moderate
Rhinolophus clivosus	Geoffroy's Horseshoe Bat	NT	moderate
Rhinolophus darlingi	Darling's Horseshoe Bat	NT	moderate
Suncus infinitesimus	Least Dwarf Shrew	DD	moderate
Suncus lixus	Greater Dwarf Shrew	DD	moderate
Suncus varilla	Lesser Dwarf Shrew	DD	moderate-low
Tatera leucogaster	Bushveld Gerbil	DD	moderate

The likelihood of encountering any Red Data fauna species within this area is regarded medium, at best (12 species). These species are mostly generalist species, able to inhabit a wide variety of habitat types.

10.4 Faunal Habitat Sensitivities

The calculation of faunal sensitivities is presented in Table 6.

Table 5: Faunal Habitat Sensitivities for the study area					
Community	**Status**	**Linkage**	**RD Likelihood**	**Average**	**SENSITIVITY CLASS**
Kwagga Substation Site	3	2	2	23%	**Medium-Low**
Phoebes Substation Site	6	5	4	50%	**Medium**

None of these sites exhibits faunal attributes of importance. The loss of these portions of habitat is not expected to result in severe impacts on sensitive faunal habitat or species.

11 Integrated Biodiversity Sensitivity

Results of the respective floristic and faunal sensitivity analysis are combined to present an overview of the ecological sensitivity of the habitat types identified in the assessment. In order to obtain the ecological sensitivity of the respective communities, the highest sensitivity for each ecological unit is selected as being representative of the ecological sensitivity of the specific ecological unit. Results are determined in Table 6.

Table 6: Ecological Sensitivity of proposed substation sites

Corridor Section	Floristic Sensitivity	Faunal Sensitivity	Ecological Sensitivity
Kwagga Substation Site	Medium-Low	Medium-Low	**Medium-Low**
Phoebes Substation Site	Medium	Medium	**Medium**

Results of both the floristic and faunal sensitivity assessments indicate the medium-low sensitivity of the Kwagga substation site, mainly as a result of the high levels of transformation, degradation and isolation of remaining natural habitat at this site.

A medium sensitivity is estimated for the Phoebes substation site, mainly as a result of the presence of moderately pristine terrestrial habitat. However, current and future urban developments will affect the status of this site severely and adversely.

12 Impact Assessment

Rating of impacts is based on the estimated effect that construction and operation of a substation will have on terrestrial biodiversity and ecological attributes of the study area. Impacts identified in this section are partly based on the Guidance Document on Biodiversity, Impact Assessment and Decision Making in Southern Africa (2006).

12.1 Anticipated Impacts

No impacts were identified that could lead to a beneficial impact on the identified habitat type within the study area since the proposed development is largely destructive.

Impacts resulting from the construction and operation of a substation on ecological attributes of the study area are largely restricted to the physical impacts on habitat in which biota occur. Direct impacts in high sensitivity areas, such as habitat destruction and modifications, are usually regarded immediate, long-term and of high significance. These impacts are mostly measurable and fairly easy to assess as the effects thereof is immediately visible and can be determined to an acceptable level of certainty. In contrast, effects of indirect impacts are not immediately evident and can consequently not be measured to a definite level of certainty. A measure of subjective estimation is therefore necessary in order to evaluate indirect impacts. Lastly, impacts of a cumulative nature places direct and indirect impacts of this projects into a regional and national context, particularly in view of similar or resultant developments and activities. Impacts are rated upon the background of biodiversity sensitivities as determined in previous chapters.

Potential impacts include the following, but are not necessarily limited to:

- Direct impacts:
  - Destruction of threatened flora & fauna species & associated habitat;
  - Direct impacts on common fauna species;
  - Destruction of sensitive/ pristine regional habitat types;

- Indirect Impacts:
  - Impacts on surrounding habitat/ species;

- Cumulative Impacts:
  - Increase in local and regional fragmentation/ isolation of habitat; and
  - Increase in environmental degradation.

Other, more subtle impacts on biological components, such as changes in local, regional and global climate, effects of noise pollution on fauna species, increase in acid rain, ground water deterioration, the effect of EMF on biota, etc. are impacts that cannot be

quantified to an acceptable level of certainty and is mostly subjective in nature as either little literature is available on the topic or contradictory information exist.

12.2 Nature of Impacts

12.2.1 Destruction of Threatened Flora & Fauna Species & Associated Habitat

The loss of Red Data or Threatened species or areas that are suitable for these species is a significant impact on the biodiversity of a region. Threatened species, in most cases, do not contribute significantly to the biodiversity of an area in terms of sheer numbers as there are generally few of them, but a high ecological value is placed on the presence of such species in an area as they are frequently an indication of pristine habitat conditions. Conversely, the presence of pristine habitat conditions can frequently be accepted as an indication of the potential presence of species of conservation importance.

Red Data species are particularly sensitive to changes in their environment, having adapted to a narrow range of specific habitat requirements. Habitat changes, mostly a result of human interferences and activities, are one of the greatest reasons for these species having a threatened status. Surface transformation activities within habitat types that are occupied by flora or fauna species of conservation importance will definitely result in significant and permanent impacts on these species and their population dynamics. Effects of this impact are usually permanent and recovery or mitigation is generally not perceived as possible.

One of the greatest drawbacks in terms of limiting this particular impact is that extremely little information is available in terms of the presence, distribution patterns, population dynamics and habitat requirements of Red Data species in the study area. In order to assess this impact it is necessary to assess the presence/ distribution of habitats frequently associated with Red Data species. Furthermore, by applying ecosystem conservation principles to this impact assessment and subsequent planning and development phases, resultant impacts will be limited to a large extent.

Direct threats to Red Data fauna species is regarded low in probability, mainly as a result of the ability of fauna species to migrate away from areas where impacts occur. Probably the only exception to this statement will be in the event where extremely localised habitat that are occupied by threatened fauna species are impacted by construction and operational activities to the extent that the habitat no longer satisfy the habitat requirements of the particular species. Considering the type of development, it is however regarded an unlikely probability. To place this aspect into context it is estimated that habitat loss and transformation resulting from non-invasive and often overlooked impacts, such as urban development, overgrazing, infestation by invasive vegetation, littering, dumping and environmental degradation probably contributes more to impacts on threatened fauna species than power developments ever will.

12.2.2 Direct Impacts on Common Flora & Fauna Species

The likelihood of this impact affecting common fauna species is relatively low as a result of the ability of animal species to migrate away from direct impacts. Tolerance levels of common animal species occurring in the study areas are of such a nature that surrounding areas will suffice in habitat requirements of species forced to move from areas of impact.

Similarly, common flora species are widespread and occur abundantly in other, adjacent habitat. The possibility of these proposed developments affecting common flora species to the extent that their conservation status might change is regarded highly unlikely.

12.2.3 Destruction of Sensitive / Pristine Regional Habitat Types

The loss of pristine natural regional habitat represents loss of habitat and biodiversity on a regional scale. Sensitive habitat types include ridges, koppies, wetlands, rivers, streams and localised habitat types of significant physiognomic variation and unique species composition. These areas represent centres of atypical habitat and contain biological attributes that are not frequently encountered in the greater surrounds. A high conservation value is ascribed to floristic communities and faunal assemblages of these areas as they contribute significantly to the biodiversity of a region. Furthermore, these habitat types are generally isolated and are frequently linear in nature, such as rivers and ridges. Impacts that disrupt this continuous linear nature will increase fragmentation and isolation of existing ecological units, affecting the migration potential of some fauna species adversely; pollinator species are important in this regard.

The importance of habitat types is based on the conservation status ascribed to regional vegetation types. However, the actual impact of the construction and operation of power developments is generally low since the total area occupied by the proposed developments are fairly small.

12.2.4 Impacts on Surrounding Habitat / Species

Surrounding areas and species present in the direct vicinity of the study area could potentially be affected by indirect impacts resulting from construction and operation activities. These impacts could include all of the above impacts, depending on the sensitivity and status of surrounding habitat and species as well as the extent of impact activities. This impact also includes the floristic species changes that could potentially occur as a result of the alteration of habitat physiognomy, particularly in woodland areas.

12.2.5 Increase in Local & Regional Fragmentation / Isolation of Habitat

Uninterrupted habitat is a precious commodity for biological attributes in modern times, particularly in areas that are characterised by moderate and high levels of transformation. The loss of natural habitat, even small areas, implies that biological attributes have permanently lost that ability of occupying that space, effectively meaning that a higher premium is placed on available food, water and habitat resources in the immediate surrounds. This, in some instances might mean that the viable population of plants or animals in a region will decrease proportionally with the loss of habitat, eventually decreasing beyond a viable population size. The danger in this type of cumulative impact is that effects are not known, or is not visible; with immediate effect and normally when these effects become visible they are beyond repair. Linear types of developments affect the migratory success of animals in particular.

An important mitigation measure in this regard is to utilise existing causal factors of habitat fragmentation. Existing levels of habitat fragmentation are not expected to increase as the proposed developments will be located to existing substations.

12.2.6 Increase in Environmental Degradation

Impacts associated with this type of development that will lead to initial, incremental or augmentation of existing types of environmental degradation include impacts on the air, soil and water present within available habitat. Pollution of these elements might not always be immediately visible or readily quantifiable, but incremental or fractional increases might rise to levels where biological attributes could be affected adversely on a local or regional scale. In most cases are these effects are not bound and is dispersed, or diluted over an area that is much larger than the actual footprint of the causal factor.

Similarly, developments in untransformed and pristine areas are usually not characterised by visibly significant environmental degradation and these impacts are usually most prevalent in areas where continuous and long-term impacts have been experienced.

12.3 Rating of Impacts

12.3.1 Construction Phase

Impacts are assessed before and after the implementation of all required and recommended mitigation measures in order to indicate the expected efficiency of proposed measures. Significance of impacts is rated as **high**, **medium**, or **low**.

Nature	**Impacts on terrestrial biodiversity during construction of the existing Kwagga Substation Site**	
	Before Mitigation	**After Mitigation**
Extent	1	1
Duration	5	5
Magnitude	1	1
Reversibility	3	3
Consequence	10	10
Probability	2	1
Significance	**20**	**10**
Status	Negative	Negative
Irreplaceable loss of resources?	No	
Can impacts be mitigated	Yes	
Mitigation	High	
Cumulative Impacts	Adding to local transformation, degradation	
Residual Impacts	Local species changes	

Nature	**Impacts on terrestrial biodiversity during construction of the new Phoebes Substation Site**	
	Before Mitigation	**After Mitigation**
Extent	1	1
Duration	5	5
Magnitude	2	1
Reversibility	3	3
Consequence	11	10
Probability	2	1
Significance	**22**	**10**
Status	Negative	Negative
Irreplaceable loss of resources?	No	
Can impacts be mitigated	Yes	
Mitigation	High	
Cumulative Impacts	Adding to local transformation, degradation	
Residual Impacts	Local species changes	

Expected impacts are mostly as a result of the physical disturbance of surface areas during the construction period. Since available habitat is not regarded sensitive in terms of biophysical, floristic or faunal attributes, the significance of likely impacts are rated as low. The implementation of generic mitigation measures are expected to prevent any potentially significant impacts within the surrounding areas.

12.3.2 Operational Phase

Significance of impacts is rated as **high**, **medium**, or **low**.

Nature	**Impacts on terrestrial biodiversity during operation of the existing Kwagga Substation Site**	
	Before Mitigation	**After Mitigation**
Extent	1	1
Duration	2	1
Magnitude	2	1
Reversibility	3	3
Consequence	8	6
Probability	2	1
Significance	**16**	**6**
Status	Negative	Negative
Irreplaceable loss of resources?	No	
Can impacts be mitigated	Yes	
Mitigation	High	
Cumulative Impacts	Adding to local transformation, degradation	
Residual Impacts	Local species changes	

Nature	**Impacts on terrestrial biodiversity during operation of the new Phoebes Substation Site**	
	Before Mitigation	**After Mitigation**
Extent	1	1
Duration	2	1
Magnitude	2	1
Reversibility	3	3
Consequence	8	6
Probability	2	1
Significance	**16**	**6**
Status	Negative	Negative
Irreplaceable loss of resources?	No	
Can impacts be mitigated	Yes	
Mitigation	High	
Cumulative Impacts	Adding to local transformation, degradation	
Residual Impacts	Local species changes	

Impacts during the operational phase of the project are mostly restricted to the maintenance procedures on the perimeter of the substation sites. Since available habitat is not regarded sensitive in terms of biophysical, floristic or faunal attributes, the significance of likely impacts are rated as low. The implementation of generic mitigation measures are expected to prevent any potentially significant impacts within the surrounding areas.

13 Activities Resulting in Impacts

A summation/ elaboration of expected activities are presented, based on generic procedures followed. Activities that will result in adverse impacts on the natural environment will include the following, but are not necessarily limited to:

Activity 1 - surface disturbances in development and surrounding areas;
Activity 2 - surface disturbances in areas used for storage space;
Activity 3 - human movement and use of surrounding areas;
Activity 4 - health and sanitation issues;
Activity 5 - occurrence of open and accidental fires;
Activity 6 - refuelling and vehicle maintenance (spillages and pollution); and
Activity 7 - storage and use of chemicals.

13.1 Surface Disturbances in Development & Surrounding Areas

Importing materials, vehicles, personnel, storage of materials, infrastructure, removal of existing structures, excavation, construction activities include actions that will result in the degradation of the immediate surrounds of pole locations. These effects are usually associated with the decimation of herbaceous and scrubby layers, open soils, erosion and infestation by weeds and pioneer species. Clear and proper demarcation of construction areas should be maintained in order to limit the effect of these activities to a minimum. Proper cleanup and rehabilitation should suffice in limiting impacts associated with this activity. This activity is not expected to result in significant impacts in low sensitivity areas.

13.2 Surface Disturbances in Areas used for Storage Space

Extensive storage areas lead to surface disturbances that contribute to environmental degradation. Accessibility and future rehabilitation need to be considered in the selection of storage areas. Sensitive areas need to be avoided at all costs. Provisions must be made for waste management, temporary ablution facilities, vehicle maintenance areas, erosion control, proper fencing, etc.

13.3 Human Movement & Use of Surrounding Areas

The presence of personnel and the activities in a natural environment will result in localised surface disturbances in and around the construction sites. All vehicle and human movement must be restricted to the servitude area and access roads. Clear demarcation of construction areas must be provided. This is regarded particularly important in order to avoid any contact with animals within conservation areas and game farms. Speed limits must be sufficiently low in order to prevent accidents while periods of vehicular movement should be restricted to periods of light, i.e. no travelling during the night.

Noise levels should be controlled. It is unavoidable that periods of high noise will be experienced, every attempt should be made to limit these periods as far as possible. It is envisaged that this will form part of the responsibilities of the ECO.

Animals usually have a relative high tolerance for noise and disturbances. Most species, when being disturbed, will temporarily evacuate the area and seek suitable shelter, to return at a later stage. However, some animals might be affected to the state where nests or cover is permanently abandoned. The identification of these sites and location of infrastructure and construction facilities as far away as possible should form part of the responsibilities of the ECO. Any unnecessary disturbances, particularly from vehicles and helicopters, should be avoided as far as possible.

13.4 Health, Sanitation and Litter Issues

Drinking of water from streams should not be allowed, drinking water should be provided for on site workers from a trusted source. Temporary sanitation facilities need to be available to site workers at all times. The use thereof should furthermore be advocated.

Aspects pertaining to snakes, scorpions and similar dangerous impacts need to be taken into consideration during the period of maintenance and construction. All health and safety related issues need to be addressed prior to any personnel going on site.

All litter should be contained in suitable storage areas and immediately removed to a suitable disposal facility. Plastic bags, containers, wrapping and insulation material will pose a threat to animals of the area.

13.5 Occurrence of Open & Accidental Fires

The use of fires for cooking purposes or any other purpose may result in accidental spread to adjacent areas. All areas, as a result of high biomass and flammability are regarded prone to the development and spread of accidental fires. Although fire is a natural occurrence, any accidental occurrence should be prevented. Other causes include smoking, discarded cigarettes and matches, overheating vehicles or equipment or faulty electrical equipment or wiring, welding and cutting operations. No firewood may be collected.

13.6 Refuelling & Vehicle Maintenance (spillages and pollution)

Refuelling should be restricted to areas dedicated for this activity, preferably at an existing off-site refuelling facility. On-site refuelling should be done with extreme care, taking all preventative measures against spillages.

Similarly, emergency vehicle maintenance/ repairs should be done in a suitably manner to avoid any spillages or pollution of the environment. Spillages of any nature should be cleaned and rehabilitated by means of appropriate measures.

13.7 Storage & Use of Hazardous Materials & Chemicals

Hazardous materials and chemicals should be stored and use in a manner not to affect the natural environment negatively. Storage should be off site and only be transported to a site when required and then only in an acceptable and safe manner. Mixing of chemicals should be conducted as per manufacturer's label, taking cognisance of all specifications. Appropriate safety measures should implemented by users of all chemicals. By no means should any water be extracted from streams and rivers for the purpose of mixing chemicals. In the event of pollution it must be dealt with in the prescribed manner so that the environment is not damaged.

Chemicals used in the immediate vicinity of rivers, streams and dams should be applied in a manner not to pollute the water. This would probably exclude spraying methods. Pollution of any surface of ground water must be reported to the Department of Water Affairs.

14 Recommended Mitigation Measures

The single most important mitigation measure in the case of line variants that were identified as being unsuitable for the proposed development, in terms of biodiversity and ecological aspects, is the preferred use of an alternative line variant that will result in less significant impacts.

Mitigation Measure 1 - Appoint Environmental Control/ Site Officer. Appointment prior to start of construction, responsibilities should include, but not limited to ensuring adherence to EMP guidelines, guidance of activities, planning, reporting;

Mitigation Measure 2 - Compile and implement environmental monitoring programme, the aim of which should be ensuring long-term success of rehabilitation and prevention of environmental degradation;

Mitigation Measure 3 - Identify areas that will be suitable for access roads, ensuring proper upgrade/ construction/ maintenance in order to limit erosion, proliferation of weeds, etc.;

Mitigation Measure 4 - Limit construction, maintenance and inspection activities to dry periods in order to curb occurrence/ augmentation of erosion in areas of existing erosion, destabilizing of substrate in areas of high slopes, riparian zones, etc;

Mitigation Measure 5 - Demarcate construction areas in order to control movement of personnel, vehicles, providing boundaries for construction sites in order to limit dilution or spread of peripheral impacts;

Mitigation Measure 6 - Remove and store topsoil separately in areas where excavation/ degradation takes place. Topsoil should be used for rehabilitation purposes in order to facilitate regrowth of species that occur naturally in the area;

Mitigation Measure 7 - Compile an education programme for all contractors and subcontractors/ workers to ensure compliance to all aspects of EMP as well as educating personnel in the safe and proper conduct within areas of natural habitat;

Mitigation Measure 8 - Prevent open fires, provide demarcated fire-safe zones, facilities and fire control measures;

Mitigation Measure 9 - Ensure off site storage of hazardous materials, chemicals, fuels, oils, etc. in order to prevent accidental spillage, contamination or pollution;

Mitigation Measure 10 - Develop emergency maintenance operational plan to deal with any event of contamination, pollution or spillages, particularly in sensitive areas;

Mitigation Measure 11 - Provide temporary on-site sanitation, litter and waste management and hazardous materials management facilities;

Mitigation Measure 12 - Ensuring surface restoration and resloping in order to prevent erosion, taking cognisance of local contours and landscaping;

Mitigation Measure 13 - Rehabilitation of disturbed areas subsequent to construction activities, taking cognisance of factors such as topsoil replacement, removal of introduced materials, local environmental factors;

Mitigation Measure 14 - Removal of dismantled structures, rubble, litter, refuse, temporary infrastructures, sanitation equipment, etc. subsequent to construction and rehabilitation; and

Mitigation Measure 15 - Final inspection in order to ensure adherence to EMP guidelines, completion of localised/ remaining areas of impact, monitoring of rehabilitation success, etc.

15 Photographic Records

Photo 1: Example of non-perennial stream to the east of the existing Kwagga Substation

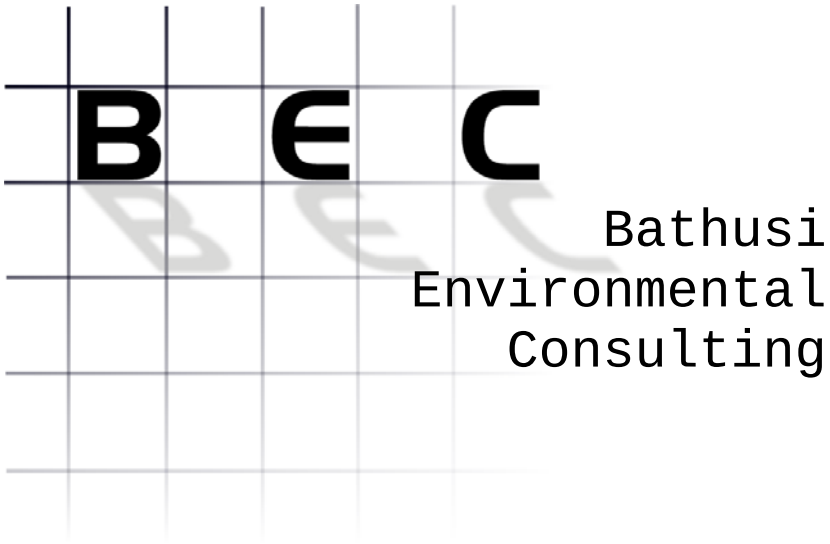
Photo 2: High levels of transformation and degradation around Kwagga Substation

Photo 3: Natural habitat at the Phoebes Substation site

REPORT CODE: SVE – KWP – 2010/13

Terrestrial Biodiversity EIA Report for the proposed Tshwane Strengthening Project – Phase 1 - Kwagga-Phoebus 400kV Line

Submitted by



January 2010

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I Specialist Investigators

The Natural Scientific Professions Act of 2003 aims to 'provide for the establishment of the South African Council of Natural Scientific Professions (SACNASP) and for the registration of professional, candidate and certified natural scientists; and to provide for matters connected therewith'. Quoting the Natural Scientific Professions Act of 2003: 'Only a registered person may practice in a consulting capacity' (20(1) – pg 14).

Investigator: Riaan Robbeson (Pr.Sci.Nat.) (BEC)
Qualification: M.Sc. (Plant Ecology, UP)
Affiliation: South African Council for Natural Scientific Professions
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Fields of expertise: Botanical Scientist & Ecological Scientist.
Affiliation: Grassland Society of Southern Africa
Status: Professional Member

Investigator: Dewald Kamffer (Pr.Sci.Nat.)
Capacity: Faunal Investigator
Qualification: M.Sc. (Conservation Biology)
Affiliation: South African Council for Natural Scientific Professions
Registration number: 400204/05
Fields of expertise: Ecological Scientist & Zoological Scientist.

II Declaration of Independence

- All specialist investigators, project investigators and members of companies employed for conducting this particular investigation declare that:
- We act as independent specialists for this project.
- We consider ourselves bound to the rules and ethics of the South African Council for Natural Scientific Professions.
- At the time of completing this report, we did not have any interest, hidden or otherwise, in the proposed development as outlined in this document, except for financial compensation for work done in a professional capacity, in terms of the Environmental Impact Assessment Regulations, 2006.
- We will not be affected in any manner by the outcome of the environmental process of which this report forms part of, other than being part of the public.
- We do not have any influence over decisions made by the governing authorities.
- We do not necessarily object to or endorse the proposed development, but aim to present facts and recommendations based on scientific data and relevant professional experience.
- Undertake to disclose to the National Department of Environmental Affairs and Tourism, any material information that have or may have the potential to influence its decision or the objectivity of any report, plan or document required in terms of the Environmental Impact Assessment Regulations, 2006;

- Will provide the National Department of Environmental Affairs (DEA) with access to all information at our disposal regarding the application, whether such information is favourable to the applicant or not.
- Should we consider ourselves to be in conflict with any of the above declarations, we shall formally submit a Notice of Withdrawal to all relevant parties and formally register as an Interested and Affected Party.

III Glossary of Terms

Alternatives: A possible course of action, in place of another, that would meet the same purpose and need but which would avoid or minimize negative impacts or enhance project benefits. These can include alternative locations/sites, routes, layouts, processes, designs, schedules and/or inputs. The "no-go" alternative constitutes the 'without project' option and provides a benchmark against which to evaluate changes; development should result in net benefit to society and should avoid undesirable negative impacts.

Biome: Any major ecological community of organisms, usually characterized by a dominant vegetation type.

Bryophyte: include all embryophytes ('land plants') that are non-vascular, having tissues and enclosed reproductive systems, but lacking vascular tissue that circulates liquids. They neither have flowers nor produce seeds, reproducing via spores.

Cumulative impacts: The combined or additive effects on biodiversity or ecosystem services over time or in space. They may seem to be insignificant when seen in isolation, but collectively they have a significant effect

Direct impacts: Those that take place at the same time and in the same space as the activity, e.g. clearing of natural vegetation for agriculture.

Direct, indirect and cumulative impacts: Decision makers need to know the direct, indirect and cumulative impacts of a proposed activity on the environment, if they are to take informed decisions in line with sustainable development.

Ecologically sensitive ecosystem: One where relatively even minor disturbances may result in substantial and significant changes.

Ecosystems: Include living (e.g. plants, animals) and non-living (e.g. minerals, soil, water) components, which can be defined in terms of distinguishing characteristics (e.g. a wetland ecosystem, a freshwater ecosystem, a terrestrial ecosystem, a forest ecosystem, etc.).

Endemic or range-restricted species or ecosystem: One whose distribution is confined to a particular and often very limited geographical region.

Environment: Broadly covers our surroundings and the characteristics of those surroundings that influence our health and wellbeing. That is, the environment includes all living organisms (plants, animals and other life), the physical environment (land, water and air), as well as social, economic and cultural conditions. Sometimes we speak of 'the natural environment' and 'the built environment', to differentiate between natural and man-made systems.

Epihydate: A plant that grows on another plant but without deriving nourishment from it and not parasitic, as some ferns and orchids growing on trees.

Habitat: The place or type of site where an organism or population naturally occurs.

Helophyte: A biennial or herbaceous plant of which only the buds survive a harsh period, such as winter.

Hydrophyte: A plant that only grows wholly or partly submerged in water.

Indigenous: Native to a particular area.

Impact assessment: A process that is used to identify, predict and assess the potential positive and negative impacts of a proposed project (including reasonable alternatives) on the environment and to propose appropriate management actions and monitoring programmes. Impact assessment is used to inform decision-making by the project proponent, relevant authorities and financing institutions. The process includes some or all of the following components: screening, scoping, impact assessment and decision-making.

Indirect impacts: Occur later in time or at a different place from the activity, e.g. extraction of groundwater for irrigation leads to changes in the water table and affects distant water users.

Irreplaceable loss: When it results in the loss of a resource without substitute, and which cannot be replaced. An impact leading to irreplaceable loss of biodiversity is, by definition, irreversible

Irreversible impact: One that arguably cannot be reversed in time (e.g. decrease in area of a specific vegetation type, loss of genetic diversity through reduction in size of populations of a particular species). Some, but not all, irreversible impacts will lead to irreplaceable loss of biodiversity. They may, or may not, be acceptable to society or stakeholders in terms of their current values

Issue: A context-specific question that asks “what, or how severe, will the impact of some activity/aspect of the development be on some element of the environment?”

Lichen: A lichen is a symbiosis; two or more organisms living together such that both are more successful within the partnership than they would have been if they were living on their own. With lichens the basic components of this partnership are a fungus (mycobiont) and one or more algae and/or cyanobacteria (photobiont).

Natural resources: Include living and non-living materials that can be exploited or used by people. Natural resources form part of ecosystems, and our living natural resources contribute to biodiversity. Some people use ‘natural resources’ to mean the same thing as biodiversity or ecosystem services.

Precautionary Principle: States that “where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation.

Protected area: As defined by National Environmental Management: Protected Areas Act, 2003 (No. 57 of 2003).

Protected species or ecosystem: One that is protected by law from particular activities and land uses.

Red Data Book' or 'Red List': Provides information on threatened species.

Significance: A term used to evaluate how severe an impact would be, taking into account objective or scientific data as well as human values. A specific significance rating should not be confused with the acceptability of the impact (i.e. an impact of low significance is not automatically "acceptable").

Species: A group of plants, animals, micro-organisms or other living organisms that are morphologically similar; that share inheritance from common ancestry; or whose genes are so similar that they can breed together and produce fertile offspring.

Suffrutex: A low-growing woody shrub or perennial with woody base.

Sustainable development: Development that meets the needs of the current generation without compromising the ability of future generations to meet their own needs and aspirations, or improving the quality of human life while living within the carrying capacity of supporting ecosystems".

Threatened species or ecosystem: Species/ Ecosystems that are at risk of going extinct in its natural range. It may be 'critically endangered' at extremely high risk, 'endangered' at very high risk, or 'vulnerable' at high risk. Species or ecosystems at low or no risk are not 'threatened', and fall into the 'near threatened' or 'least concern' categories.

IV Legislation

Compliance with provincial, national and international legislative aspects is strongly advised in the planning, assessment, authorisation and execution of this particular project. In the compilation of this report, the following legislative aspects were taken into consideration, but were not necessarily limited to:

- National Environmental Management Biodiversity Act (No. 10 of 2004);
- Conservation of Agricultural Resources Act 43 of 1983;
- Constitution of the Republic of South Africa (Act 108 of 1996);
- Convention on Biological Diversity, 1995;
- Convention on International Trade in Endangered Species of Wild Life and Fauna;
- Environmental Conservation Act (No. 73 of 1989);
- National Environmental Management Act (No. 107 of 1998);
- National Forests Act, 1998 (No 84 of 1998);
- Protected Areas Act (No. 57 of 2003); and
- White Paper on the conservation and sustainable use of South Africa's biological diversity.

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1 Executive Summary

The aim of this report is to provide the reader an overview of ecological attributes and the inherent ecological sensitivity of the study area. Results of the site investigations are encapsulated in the EIA assessment in order to highlight specific areas or aspects that are likely to be affected adversely by the proposed development.

1.1 Biophysical Attributes

Only aspects that have a direct bearing on the current status of the ecology of a region are therefore discussed and assessed in this document. The proposed line variants comprise significant areas of concern in terms of C-PLAN. Environmental aspects that will potentially be affected include the following:

- ridges;
- perennial & non-perennial rivers;
- primary vegetation;
- Red Data invertebrate confirmed location;
- Red Data plant metapopulation;
- Red Data plant confirmed location; and
- Orange plant historic location.

Rivers and streams in the study area were found to be severely compromised be nearby urban developments and settlements in particular. Litter, dumping, infestation by exotic species, poor water quality and erosion are some attributes that are currently affecting the status of wetland habitat types within the study area adversely. A high biophysical sensitivity was nonetheless ascribed to all wetland habitat types as part of the biophysical sensitivity analysis.

Significant ridge areas are present in the southern part of the proposed lines, including Class 1, 2 and 3 Ridges. Major ridges that will be affected by the proposed development include the Daspoortrand and Magaliesberg Range. The proposed corridors are located in areas that comprise extensive areas of natural habitat as well as some transformed areas. Land transformation is mostly the result of urban developments and settlements.

Extensive areas within the study area are transformed and some parts of remaining natural habitat is highly fragmented and isolated. However, the largest extent of the study area comprises natural habitat that is characterised by high continuity, i.e., much of the transformation is nodal in nature and while high levels of transformation is present, a high level of continuity is also noted, implying that organisms are able to migrate extensive distances without having to cross any unnatural borders (moderate habitat isolation). The proposed development is not expected to contribute towards local and regional levels of fragmentation and isolation.

The following VEGMAP vegetation types will be affected by the proposed development

- Central Sandy Bushveld (Vulnerable);
- Gold Reef Mountain Bushveld (Least Threatened);
- Marikana Thornveld (Endangered);
- Moot Plains Bushveld (Vulnerable); and
- Norite Koppies Bushveld (Least Threatened).

For the purpose of the biophysical sensitivity analysis the proposed line was divided into sections (1 – 7) that differentiate between areas where no alternatives are available and sections where alternatives can be compared in terms of likely impacts. Extensive high sensitivity areas are present within the respective corridor sections and mitigation is expected to be effective only in certain sections where alternatives are available.

1.2 Floristic Attributes

The aim of this section is to provide the reader an overview of floristic attributes of the study area. Results will ultimately be incorporated into the ecological sensitivity analysis.

Available data on the SANBI database indicates the presence of approximately 2,232 species within the ¼-degree grid (2528CA) in which the study area is situated. This exceptionally high floristic diversity is the result of highly diverse biophysical attributes, including soils, geology, micro-climatic conditions, moisture regimes, slopes, aspect, rockiness, soil depth, etc. A dissemination of the growth forms revealed the prominence of herbs, shrubs, grasses and geophytes; indicating a high diversity of habitat types that include grassland and savanna physiognomy. A total of 203 plant families are represented in the study area. Prominent families include Poaceae, Fabaceae, Asteraceae, Apocynaceae, Malvaceae, Euphorbiaceae and Cyperaceae.

An analysis of aerial photographs and results of the field surveys revealed the following communities and variations within the proposed corridors:

- Degraded Woodland (Medium-Low Floristic Sensitivity);
- Natural Woodland Community, including:
  - Central Sandy Bushveld Variation (Medium Floristic Sensitivity);
  - Gold Reef Mountain Bushveld Variation (Medium Floristic Sensitivity);
  - Marikana Thornveld Variation (Medium-High Floristic Sensitivity);
  - Norite Koppies Bushveld Variation (Medium Floristic Sensitivity);
- Ridge Habitat Type (High Floristic Sensitivity);
- Transformed Areas (Low Floristic Sensitivity); and
- Wetland Habitat Types (High Floristic Sensitivity).

GDARD database indicate the presence of a total of 34 Red Data flora species within the region of the study area is situated, 16 of which are considered likely to be present, based

on the status of available habitat. Areas of pristine regional vegetation types, particularly the ridge areas, are regarded HIGHLY suitable habitat for some of these species.

1.3 Faunal Attributes

The aim of this section is to provide the reader an overview of faunal attributes and inherent faunal sensitivity of the study area. Results will ultimately be incorporated into the ecological sensitivity analysis for the study area. The main focus is on endangered or sensitive animal species that could be expected to be found in the region of the study area. The likelihood of these animals being present within the region is estimated by using known geographic distributions of these species and comparing these species' usually very specific habitat requirements with those present in the study area.

- Six Red Data butterflies are known from Gauteng, none of which has been observed in the 2528CA Q-degree grid. These species are therefore not considered likely inhabitants of the area investigated.
- Only one Red Data frog is known from within the boundaries of Gauteng, namely *Pyxicephalus adspersus* (Giant Bullfrog, NT). The study area is located in a region where this species is observed sporadically.
- Only one Red Data reptile is known from Gauteng, namely the Striped Harlequin Snake (*Homoroselaps dorsalis*, NT). Land transformation due to wide-scale commercial agriculture is thought to pose a significant threat to the species, since ploughing destroys suitable termitaria.
- Fifteen mammal species listed as Data Deficient (DD) are listed for the region of the study area. The two Critically Endangered (CR) species are estimated to have a low and moderate probability of occurring in the study area respectively, namely *Chrysospalax villosus* and *Cloeotis percivali*.

Habitat types that are pristine are regarded as high quality faunal habitat and the likelihood of Red Data species occurring within these areas is generally high. These habitat types are often associated with environmental features that are also regarded as sensitive, such as riparian zones aquatic regions and rocky outcrops.

The four faunal groups investigated (invertebrates, frogs, reptiles and mammals) are mostly earthbound (with the exception of bats which is not known to collide with power lines) and unlikely to be directly influenced by the operation of a power line as is proposed for the study area. The most significant impacts are likely to be related to the construction phase of the proposed power line. Habitat loss, habitat degradation and –fragmentation are the most likely and most significant anticipated impacts. Degradation of wetlands, loss of moribund termitaria and the creation of "barriers" (such as construction roads resulting, over time, in large ditches as a result of soil erosion) are some of the potential adverse impacts that might be expected to influence the current status of the faunal communities, assemblages and species currently found in the study

area. However, careful planning in the construction phase (including placements of construction roads and construction camps) and best environmental practice could mitigate such potential impacts successfully.
Because of the similarity between floristic and faunal habitat types, the extent of faunal habitat types per corridor section is similar to that of the floristic habitat types (Table 7). The extent of faunal habitat sensitivities per corridor section is presented in Table 12.

1.4 Ecological Interpretation

Results of the respective floristic and faunal sensitivity analysis are combined to present an overview of the ecological sensitivity of the habitat types identified in the assessment. The following ecological sensitivities are ascribed to habitat types:

- Degraded Woodland (Medium-Low Ecological Sensitivity);
- Central Sandy Bushveld Variation (Medium Ecological Sensitivity);
- Gold Reef Mountain Bushveld Variation (Medium Ecological Sensitivity);
- Marikana Thornveld Variation (Medium-High Ecological Sensitivity);
- Norite Koppies Bushveld Variation (Medium-High Ecological Sensitivity);
- Ridge Habitat Type (High Ecological Sensitivity);
- Transformed Areas (Low Ecological Sensitivity); and
- Wetland Habitat Types (High Ecological Sensitivity).

Comparing Corridor Sections 2 and 3, it is evident that Section 2 has less high sensitivity habitat than Section 3. Extensive medium-high sensitivity habitat is however present in Section 2. Impacts within these areas are regarded to be less significant while impacts within the high sensitivity areas can be effectively mitigated.

The use of Corridor Section 6 is recommended as the proposed corridor can be deviated around high sensitivity areas in order to avoid impact for an extensive section of the proposed corridor.

1.5 Impact Assessment

Rating of impacts is based on the estimated effect that construction and operation of powerlines will have on sensitive terrestrial biodiversity attributes of the study area. No impacts were identified that could lead to a beneficial impact on the identified habitat type within the study area since the proposed development is largely destructive. Potential impacts include the following, but are not necessarily limited to:

- Direct impacts:
  - Destruction of threatened flora & fauna species & associated habitat;
  - Direct impacts on common fauna species;
  - Destruction of sensitive/ pristine regional habitat types;
- Indirect Impacts:
  - Faunal interactions with structures, servitudes and personnel;

  - Impacts on surrounding habitat/ species;
- Cumulative Impacts:
  - Impacts on local and national conservation obligations & targets;
  - Increase in local and regional fragmentation/ isolation of habitat; and
  - Increase in environmental degradation.

Expected impacts are mostly as a result of the physical disturbance of surface areas and clearance of servitudes during the construction period. Impacts within the ridge habitat type is regarded to be highly significant and severe mitigation measures need to be put into practice in areas where unavoidable impacts will occur in order to minimize adverse impacts on sensitive biodiversity attributes. Impacts within the remainder of the area are regarded to be of moderate nature and the implementation of generic mitigation measures is expected to minimize likely impacts within these environments.

Impacts during the operational phase of the project are mostly restricted to the maintenance procedures within the servitudes as well as latent effects of habitat alteration, particularly in the woodland areas. Impacts are generally regarded to be of a moderate nature and the implementation of generic mitigation measures are expected to decrease the significance of impacts to a benign status.

Nine High Impact Areas were identified, mostly related to riparian and ridge habitat types. Avoidance of impacts within the ridge habitat, where possible, is regarded the most significant mitigation measure. Where deviations are not possible it is recommended that the proposed corridor be aligned with existing lines of transformation and degradation (existing servitudes and roads).

Mitigation measures are divided into two groups, namely:

- generic mitigation measures (measures that is required/ recommended for the entire line and during the maintenance/ construction process); and
- site/ action specific mitigation measures (measures that is required/ recommended for specific sites, or in the event of specific activities or impacts).

2 Project Background

The current Eskom transmission network supplies Tshwane Municipality via three points, namely Kwagga, Njala and Verwoerdburg. The contracted reserve capacity at each point is reviewed annually and the latest information indicates that Kwagga's reserve capacity is 840MVA, Njala is 650MVA and Verwoerdburg is 200MVA. Meter measurements at the respective points indicate that the maximum loading has reached 920MVA at Kwagga (2007), 700MVA at Njala (2007) and 208MVA at Verwoerdburg (2007).

Tshwane has subsequently applied for new supply points and a step load increase to Eskom Transmission and Distribution. A number of options were analyzed based on technical and economical benefits to all parties involved and the proposed solution, which is known as the City of Tshwane Electricity Supply Plan Scheme proposed to build four new substations in the Tshwane area. Three will be built by ESKOM and one will be built by Tshwane. These four substations are ESKOM Phoebus 400/275/132kV Substation; ESKOM Verwoerdburg 400/132kV Substation; ESKOM Anderson 400/132kV Substation and Tshwane 400/132kV Wildebees Substation. The proposed solution will meet the Tshwane electricity requirement, representing the less costly option in addition to de-loading the heavily loaded Minerva and Apollo Substations. Phase 1 of this scheme entails the following:

- Construction of 275kV line from Phoebus to Kwagga Substation (30km); and
- Establishment of Phoebus Substation; and
- Extension of the existing Kwagga Substation.

3 Introduction

When natural systems are rezoned for development, indigenous flora are replaced by exotic species and converted to sterile landscapes with no dynamic propensity or ecological value. Additionally, development rarely focus on decisive planning to conserve natural environments, while little thought is normally given to the consequences on the ecological processes of development in highly sensitive areas.

Transformation and fragmentation of natural habitat are not the only results of unplanned or intended developments; loss of ecosystem functioning and ultimately the local extinction of species can also result. Therefore, careful planning will not only preserve rare and endemic species and communities, but also the ecological integrity of ecosystems of the landscape level which is imperative for the continuation of natural resources, such as fossil fuels, water and soils with agricultural potential.

In 1992, the Convention of Biological Diversity, a landmark convention, was signed by more than 90% of all members of the United Nations. The enactment of the National Environmental Management Biodiversity Act, 2004 (Act No. 10 of 2004), together with the abovementioned treaty, focuses on the preservation of all biological diversity in its

totality, including genetic variability, natural populations, communities, ecosystems up to the scale of landscapes. Hence, the local and global focus changed to the sustainable utilisation of biological diversity.

4 Scope of Work

- Compile a report on the regional biodiversity sensitivities of the study area;
- Assess the status of biophysical attributes within the study area that have a bearing on biodiversity of the study area;
- Obtain relevant Red Data flora information and evaluate Red Data taxa probabilities;
- Obtain PRECIS data in order to highlight existing knowledge of the species richness of the region;
- Compile biophysical, floristic, faunal and an integrated ecological sensitivity map that will highlight areas of importance as it relates to the construction and operation of power lines within the natural environment;
- Assess the status of biodiversity attributes in areas identified as sensitive to the construction and operation of power lines;
- Identify any areas that may be considered 'no-go' areas from a biodiversity perspective;
- Provide a description of the general ecological status of recommended corridors and evaluate the status of Red Data flora and fauna habitat and probabilities of occurrence for Red Data species;
- Assess the ecological sensitivity of recommended corridors to the construction and operation of power lines subsequent to the implementation of suitable mitigation measures; and
- Assess the nature and extent of the potential impacts that are likely to result from the construction and operation of power lines on the ecological integrity of recommended corridors during the construction and operational phases;
- Assess and propose potential mitigation measures that can be applied during the construction and operational phases that will minimize impacts on the biodiversity of the recommended corridors.

5 Limitations of this Investigation

- This report is based on a strategic investigation and selective sampling of some parts of the study area.
- No detailed or long-term investigation of biological attributes and biological diversity that may be present in the study area was conducted.
- This company, the consultants and/or specialist investigators do not accept any responsibility for conclusions, suggestions, limitations and recommendations made in good faith, based on the information presented to them, obtained from these strategic assessments or requests made to them for the purpose of this report.

- No definite conclusions may therefore be drawn with regards to biological diversity or conservation strategies as far as this report or the study area is concerned.
- Additional information may come to light during a later stage of the process for which no allowance could have been made at the time of this report.
- BEC withholds the right to amend this report, recommendations and/ or conclusions at any stage of the project should significant or additional information comes to light.
- Information contained in this report cannot be applied to any other area, however similar in appearance or any other aspect, without proper investigation.

6 Approach to the Study

While a proper knowledge of the biodiversity of the region is not negotiable for the ultimate success of this project, an attempt was made to remove subjective opinions that might be held on any part of the study area as far as possible. Inherent characteristics of a project of this nature implies that no method will be foolproof in all instances as a result of the shortcomings in available databases and lack of site specific detail that could be obtained from detailed site investigations in a short period of time.

It is an unfortunate fact that inherent sensitivities of certain areas are likely to exist that could not be captured or illustrated during the process. This is a shortcoming of every scientific study that has ever been conducted; it simply is not humanly possible to know everything or to consider aspects to a level of molecular detail. However, the approach followed in this study is considered effective in presenting objective comments on the comparison of biodiversity sensitivity of parts in the study area that are frequently separated by vast distances.

In order to present an objective opinion of the biodiversity sensitivity of the study area and how this relates to the suitability/ unsuitability of a specific area in terms of the proposed development, all opinions and statements presented in this document are based on three aspects, namely:

- Specialist interpretation of available data, or known sensitivities of certain aspects;
- Augmentation of existing knowledge by means of field surveys and site specific information; and
- An objective mathematical calculation of results obtained from the process.

6.1 Background Information

All species have certain habitat preferences and specific requirements in terms of nutrient/ food requirements, shelter, moisture, etc. in order to successfully live and propagate. For most species on earth, these specific requirements are not known. The ability to withstand changes to the environment in which species occur is generally known as the tolerance levels of species. These tolerance levels have plastic and elastic characteristics species which complicate the process of impact assessments as the long-term reaction of species to forced changes is mostly not known. Common species are generally characterised by high tolerance levels and these species are able to adapt to changing and varying habitat types.

In contrast, most of the threatened species have extremely low tolerance levels to habitat changes and other impacts, which is a main reason for their threatened status. Slight changes to the environment in which these species occur might result in catastrophic impacts on the community. The identification of areas in which these species occurs represent a major objective of this study.

The overall goal of this particular investigation is to therefore to assess the biodiversity sensitivities of the region by means of the Ecosystem Approach or Landscape Ecology. The Ecosystem Approach is advocated by the Convention on Biological Diversity. It recognizes that people and biodiversity are part of the broader ecosystems on which they depend, and that they should thus be assessed in an integrated way is the study of spatial variation in landscapes at a variety of scales. Principles of the Ecosystem Approach include the following:

- The objectives of ecosystem management are a matter of societal choice.
- Ecosystem managers should consider the effects of their activities on adjacent and other systems.
- Conservation of ecosystem structure and functioning, to maintain ecosystem services, should be a priority target.
- Ecosystems must be managed within the limits of their functioning.
- The approach must be undertaken at appropriate spatial and temporal scales.
- Objectives for ecosystem management should be set for the long-term.
- Management must recognise that change is inevitable.
- The approach should seek an appropriate balance between, and integration of, conservation and use of biodiversity.
- All forms of relevant information should be considered.
- All relevant sectors of society and scientific disciplines should be involved

For the purpose of this particular study a local scale was selected as suitable in terms of the size of the study area. The approach of Landscape Ecology includes the assessment of biophysical and societal causes, consequences of landscape heterogeneity and factors that causes disturbance to these attributes. In laymen's terms it implies that if sensitive

habitat types/ ecosystems (frequently associated with biodiversity elements of high sensitivity or conservation importance) are protected, species that are highly sensitive to changes in the environment will ultimately be protected. Species conservation is therefore replaced by the concept of habitat conservation. This approach is regarded effective since the protection of sensitive ecosystems will ultimately filter down to species level.

It is inevitable that the Landscape Ecology Approach will not function effectively in all instances since extremely localised and small areas of sensitivity do occur scattered in the study area, which are not captured on available databases or might have been missed during the regional assessments. A safeguard in this regard is also represented by the final phase of the project that will involve a detailed walkthrough of the selected routes. During this phase these small and localised areas can be avoided by means of localised deviations of sections of the line.

The compilation of exhaustive species lists and the identification and description of localised ecological habitat types were not objectives of this study. It was therefore regarded important to identify areas of sensitivity on a local scale and, where possible, communities or species that are considered sensitive in terms of impacts that are likely to result from the proposed development.

This ecological investigation therefore aims to:

- Determine the sensitivity of the receiving natural environment as it relates to the construction and operation of powerlines in a natural environment;
- Highlight the known level of biodiversity;
- Highlight flora and fauna species of conservation importance that are likely to occur within the study area;
- Estimate the level of potential impacts of the construction and operation of proposed power lines on the biological resources of the study area;
- Make contributions in the route selection in order to prevent unacceptable adverse impacts in the biological environment; and
- Apply the Precautionary Principal throughout the assessment[1].

6.2 Assessment of Biophysical Attributes

6.2.1 Data Selection Process

Available databases of biophysical attributes are implemented to identify regional areas of importance as it relates to biodiversity. Biophysical attributes that are known to be associated with biodiversity aspects of importance, conservation potential or natural status of the environment were implemented to compile the ecological sensitivity analysis of the study area. These attributes include the following:

- Areas of known floristic or faunal importance (C-Plan Version 2);

[1] (www.pprinciple.net/the_precautionary_principle.html).

- Areas of surface water;
- Degradation classes (ENPAT Land Cover Classes);
- Morphological attributes;
- Regional vegetation types (VEGMAP);
- Land cover categories; and
- Ridges (as classified by GIS analysis, slopes exceeding 5° or 8.8%).

The first step in assessing the biophysical aspects of importance is the delineation of natural habitat, or the exclusion of transformed or degraded habitat. Areas that are transformed as a result of human activities, including agriculture, mining, urban development, etc, constitute parts of the study area where no natural habitat remains and where natural biodiversity is entirely compromised, to the extent that any recovery to a previous, pristine status is regarded as being impossible. These areas are regarded most suitable for the purpose of construction and operation of power lines and substation since any impact on important biological resources is regarded unlikely. Ultimately, areas that are characterised by high levels of transformation or degradation or which are characterised by low occurrences of biophysical aspects of biodiversity importance, will be considered more suitable for the proposed development than areas constituting large tracts of untransformed and sensitive habitat types.

Secondly, sensitivity values are ascribed to biophysical attributes based on how these contribute to biological diversity or sensitivity. Ultimately all the information is compiled to present a holistic picture of the areas where biophysical aspects of importance occur, presenting a map that depicts regional biodiversity sensitivities based on biophysical attributes.

6.2.2 Biophysical Sensitivities - GIS Analysis

The method that is described below is believed to present a holistic view of the biodiversity sensitivity of an area, based on available data as well as the specialist's interpretation of the sensitivity of aspects that are contained in the databases. In specific cases an adjustment of sensitivity of certain areas were made based on information that was obtained from field surveys as well as information that was presented from landowners and interested parties.

The GIS analysis of data was compiled in following stages, namely:

- As a first approximation an assessment was compiled during which available databases were assessed for suitability of use in this particular project. Every attempt was made to utilise the most recent available data; databases were replaced as newer information became available even during late stages of the assessment. Each database was separated into different aspects in terms of how it affects biodiversity sensitivity on a local and regional scale:

- A certain biodiversity sensitivity was ascribed to respective attributes of each database, for example, the 'Land Cover' database was separated into respective classes in the manner in which it affects the local and regional biodiversity sensitivity, i.e. classes such as 'Agricultural', 'Urban Developments' and 'Degradation' was grouped and ascribed a LOW value;
- Care was taken to avoid duplicity between the various databases, for instance, aspects such as 'Woodland' and 'Grassland' was omitted from the 'Land Cover' database as these classes are adequately represented by the VEGMAP database;
- Care was also taken of existing gaps of information in available databases, for example; while the ENPAT database of rivers does reflect larger rivers on a national scale, additional data is available in other databases that are not necessarily captured in the ENPAT database;
- Where a single database contains different classes of sensitivity, these databases were split in the respective classes for layering;
- Available databases were subsequently integrated in order to determine the maximum sensitivity of a particular parcel of land;
- The resultant map provided a basic assessment of the potential sensitivity on a local and regional scale;

- The last step in the analysis represents the calculation of sensitivity classes within the proposed corridors. The compiled raster image of the biodiversity sensitivity map was 'clipped' with each of the corridors and the extent (in hectares) of each sensitivity class (0 – 5) was calculated and subjected to further analysis (please refer Section 15 of this document, for calculation procedures).

6.3 Assessment of Floristic Attributes

6.3.1 Floristic Patterns & Regional Diversity

In order to obtain an overview of the status of the vegetation within the study area, a selection of sample plots was investigated throughout the study area. Strategic investigation into the status of the vegetation included the following:

- Comments pertaining to general floristic diversity;
- General status of vegetation;
- Presence and status of primary vegetation;
- General land transformation and degradation status;
- Habitat suitability for Red Data flora species;
- General sensitivity pertaining to the construction and operation of power lines;
- Baseline PRECIS data obtained from SANBI was obtained to present an overview of the regional diversity of plants; and
- Data and information obtained from landowners during interviews as well as information presented during the public participation process.

6.3.2 Floristic Sensitivity

The floristic sensitivity of the respective corridors is a subjective assessment of habitat types, implementing the regional vegetation types, as described in the VEGMAP database. Sensitivities are based on the following criteria:

- Delineation of all remaining natural vegetation (exclusion of all transformed and degraded habitat);
- A subjective assessment of the primary status of the vegetation during the field surveys;
- The likelihood of an area occupying a community of Red Data or protected flora species based on habitat attributes, also considering the list of Red Data species known to occur in the area; and
- General physiognomic attributes.

The total area of remaining natural vegetation occupied within the respective corridors was calculated by GIS analysis and estimated floristic sensitivities ascribed to each vegetation type, as follows:

No/ Zero Floristic Sensitivity	0
Low Floristic Sensitivity	1
Medium Floristic Sensitivity	3
Medium-High Floristic Sensitivity	4
High Floristic Sensitivity	5

6.3.3 Red Data Flora Assessment

A list of Red Data flora species that occur within the study area was obtained from GDACE. In most cases very little information is available about the habitat preferences of these species. However, habitat types in which these species normally occur are highlighted in the sensitivity analysis of the study area.

6.4 Assessment of Faunal Attributes

The association of faunal assemblages and vegetation communities is well known and the regional vegetation types are therefore used as an indication of the potential distribution of fauna species, taking the habitat preference and general requirements of fauna species into consideration.

6.4.1 General Faunal Diversity

Available databases are used in order to obtain an overview of the distribution patterns of fauna species in the study area. It should be noted that, because extremely limited information is available in terms of the true faunal composition of extensive parts of the study area, the species composition is by no means considered to be comprehensive. It is

however presented in order to indicate the variety of fauna species that could be encountered in the range of habitat types in the study area. Information supplied by land owners in this regard is regarded important and all information that was obtained during the environmental process is captured in the database.

Furthermore, the association of fauna species of conservation importance with certain regional habitat types will provide a good indication of the sensitivity of specific regions, highlighting areas of concern.

It should also be noted that specific disciplines, particularly invertebrates, are generally poorly sampled and little information is available on the diversity of species in most regions.

6.4.2 Red Data Fauna Probabilities

Three parameters were used to assess the Probability of Occurrence for Red Data species:

- Habitat requirements (HR) - Most Red Data animals have very specific habitat requirements and the presence of these habitat characteristics in the study area is evaluated.
- Habitat status (HS) - The status or ecological condition of available habitat in the study area is assessed. Often, a high level of degradation of a specific habitat type will negate the potential presence of Red Data species (especially wetland-related habitats where water quality plays a major role); and
- Habitat linkage (HL) - Movement between areas used for breeding and feeding purposes forms an essential part of ecological existence of many species. The connectivity of the study area to surrounding habitats and adequacy of these linkages are evaluated for the ecological functioning of Red Data species within the study area.

The estimated Probability of Occurrence is presented in five categories, namely:

- very low;
- low;
- moderate;
- high; and
- very high.

6.5 Impact Evaluation

Direct, indirect and cumulative impacts of issues will be assessed in terms of the following criteria.

6.5.1 Nature of the Impact

A description of what causes the effect, what will be affected and how it will be affected.

6.5.2 Spatial Extent of the Impact

Quantifying the spatial effect of impacts; whether the impact will be local (limited to the immediate area) or regional (having a far-ranging effect).

1 Limited to the site and its immediate surroundings;
2 Local/ Municipal extending only as far as the local community or urban area;
3 Provincial/Regional;
4 National i.e. South Africa; or
5 Across International borders.

6.5.3 Duration of the Impact

Determines the expected duration of the impact in terms of years.

1 Immediate (less than 1 year);
2 Short term (1-5 years);
3 Medium term (5-15 years);
4 Long term (the impact will cease after the operational life span of the project); or
5 Permanent (no mitigation measures of natural process will reduce the impact after construction).

6.5.4 Magnitude of the Impact

Quantified between the scales of small (will have not effect on the environment) and very high (will result in complete destruction of patterns and permanent cessation of processes).

0 None (where the aspect will have no impact on the environment);
1 Minor (where the impact affects the environment in such a way that natural, cultural and social functions and processes are not affected);
2 Low (where the impact affects the environment in such a way that natural, cultural and social functions and processes are slightly affected);

3 Moderate (where the affected environment is altered but natural, cultural and social functions and processes continue albeit in a modified way);
4 High (where natural, cultural or social functions or processes are altered to the extent that it will temporarily cease), or
5 Very high / don't know (where natural, cultural or social functions or processes are altered to the extent that it will permanently cease).

6.5.5 Reversibility of the Impact

1 Reversible (regenerates naturally);
3 Recoverable (requires human input); or
5 Irreversible

6.5.6 Consequence of the Impact

Derived from the following formula:
Consequence = Severity + Reversibility + Duration + Spatial Scale

6.5.7 Probability of Occurrence

Describes the likelihood of the impact actually occurring.

0 None (impact will not occur);
1 Improbable (the possibility of the impact materialising is very low as a result of design, historic experience or implementation of adequate mitigation measures);
2 Low probability (there is a possibility that the impact will occur);
3 Medium probability (the impact may occur);
4 High probability (it is most likely that the impact will occur); or
5 Definite / do not know (the impact will occur regardless of the implementation of any prevention or corrective actions or it the specialist does not know what the probability will be based on too little published information).

6.5.8 Significance of the Impact

Based on a synthesis of the information contained in the points above and can be described as low, medium or high. Significance is determined using the following formula:
Significance of environmental impact = Consequence X Probability

- More than 60 significance points indicate HIGH environmental significance;
- Between 30 and 60 significance points indicate MODERATE environmental significance; and
- Less than 30 points indicate LOW environmental significance.

Relevant mitigation measures will be considered and impacts will then be ranked again according to the significance results after mitigation.

6.5.9 Status of the Impact

- Negative effect (i.e. at a cost to the environment);
- Positive effect (i.e. at a benefit to the environment); or
- Neutral effect on the environment.

6.5.10 Mitigation of the Impact

The degree to which the impact can be mitigated.

7 Location

The proposed 400kV line will be located between the existing Kwagga Substation (S25.75751° & E2810442°) and the proposed Phoebes Substation (S25.56360° & E28.09583°) in the City of Tshwane Metropolitan Municipality (CTMM), Gauteng Province, covering a distance of approximately 30km (Figure 1) A Google earth image of the region is presented in Figure 2.

For technical specifications pertaining to the proposed lines, the reader is referred to the main document.

8 Biophysical Habitat Attributes

While many biophysical aspects, such as geology, soils and climate, have an influence on the development of the ecology of a region, it is beyond the scope of this report to present a detailed description of each and every biophysical aspect and how these relate to potential impacts resulting from the construction and operation of power lines in a grassland environment. Only aspects that have a direct bearing on the current status of the ecology of a region are therefore discussed and assessed in this document.

8.1 Gauteng Conservation Plan (C-PLAN) Sensitivities)

C-PLAN sensitivities are illustrated in Figure 3. The proposed line variants comprise significant areas of concern in terms of C-PLAN. Environmental aspects that will potentially be affected include the following:

- ridges;
- perennial rivers;
- non-perennial rivers;
- primary vegetation;
- Red Data invertebrate confirmed location;
- Red Data plant metapopulation;
- Red Data plant confirmed location; and
- Orange plant historic location.

All of these aspects were ascribed a High biophysical sensitivity value as part of the sensitivity analysis.

Figure 1: Location of the study area

Figure 2: Google Earth image of the general region

Figure 3: C-Plan sensitivities of the general region

8.2 Areas of Surface Water

Areas of surface water that will potentially be affected by the proposed line variants include perennial and non-perennial rivers. The distribution of these areas is illustrated in Figure 3, as part of the C-Plan sensitivities.

Areas of surface water contribute significantly towards the local and regional biodiversity of an area due to the atypical habitat that is present within the interface of terrestrial and aquatic habitat types. These ecotones (areas or zones of transition between different habitat types) are frequently occupied by species that occur in both the bordering habitat types, and is therefore generally rich in species. In addition, many flora and fauna species is specifically adapted to exploit the temporal or seasonal fluctuation in moisture levels in these areas and exhibits extremely narrow habitat variation tolerance levels. In addition, these areas are also visited on a frequent basis by all terrestrial animals that utilise water sources on a frequent basis. Ecotonal interface areas form extremely narrow bands around areas of surface water and they constitute extremely small portions when calculated on a purely mathematical basis. However, considering the high species richness, these areas are extremely important on a local and regional scale.

Rivers also represent important linear migration routes for a number of fauna species as well as a distribution method for plant seeds. This method of seed distribution is extremely evident in the case of several invasive alien tree species that occur extensively in many of the rivers and streams. The morphology of a region can also be loosely associated with the presence and diversity of aquatic habitat types. Topographically heterogeneous regions are usually associated with the presence of numerous smaller rivers and streams caused by increased run-off and slopes. Plains and areas where low slopes prevail are usually characterised by the presence of few, but large, rivers and pans, comprising extensive surface areas.

Rivers and streams in the study area were found to be severely compromised be nearby urban developments and settlements in particular. Litter, dumping, infestation by exotic species, poor water quality and erosion are some attributes that are currently affecting the status of wetland habitat types within the study area adversely. A high biophysical sensitivity was nonetheless ascribed to all wetland habitat types as part of the biophysical sensitivity analysis.

8.3 Ridges & Slopes

Varied topography is recognised as one of the most powerful influences contributing to the high biodiversity of southern Africa. The interplay between topography and climate over a long period has led to the evolution of a rich biodiversity. Landscapes composed of spatially heterogeneous abiotic conditions provide a greater diversity of potential niches for plants and animals than do homogeneous landscapes. The richness and diversity of flora has been found to be significantly higher in sites with high geomorphological heterogeneity and it can reasonably be assumed that associated faunal communities will also be significantly more diverse in spatially heterogeneous environments.

Ridges are characterised by high spatial heterogeneity due to the range of differing aspects (north, south, east, west and variations thereof), slopes and altitudes, all resulting in differing soil (e.g. depth, moisture, temperature, drainage, nutrient content), light and hydrological conditions. The temperature and humidity regimes of microsites vary on both a seasonal and daily basis. Moist cool aspects are more conducive to leaching of nutrients than warmer drier slopes. Variation in aspect, soil drainage and elevation/altitude has been found to be especially important predictors of biodiversity. It follows that ridges will be characterized by a particularly high biodiversity; as such their protection will contribute significantly to the conservation of biodiversity in Gauteng.

Many Red Data/ threatened species of plants and animals inhabit ridges. Due to their threatened status, Red Data species require priority conservation efforts in order to ensure their future survival. As such, the conservation of ridges in Gauteng will contribute significantly to the future persistence of these species.

At least three threatened mammal species that occur within Gauteng utilise habitat provided by ridges environment including Juliana's Golden mole (*Amblysomus julianae*), which is perhaps the most threatened small mammal in Africa. Several bird species occurring in Gauteng that are on the South African or international Red Data lists or are considered to be of conservation concern are dependent on ridges, koppies and hills. Similarly, three rare reptile species that occur in Gauteng utilise rocky habitats such as those provided by ridges. The Northern Pygmy Toad (*Bufo fenoulheti*) and the Common River Frog (*Rana angolensis*) are found in kloofs. Many Red Data butterflies (especially those belonging to the lycaenid group) occur on the southern slopes of ridges, e.g. the Heidelberg copper butterfly (*Chrysoritis aureus*) is restricted to the rocky southern slopes of the Alice Glockner Nature Reserve. *Metisella meninx* is a Vulnerable butterfly species that occurs at altitudes above 1,600m and as such, these butterflies are often present on ridge systems. Invertebrates are reliant on hilltops as thermal refugia from winter cold air drainage.

Natural corridors, which are present in unfragmented landscapes, such as rivers, riparian zones and topographic features should be retained following fragmentation. Such

corridors may remain relatively self-sustaining after fragmentation as they continue to be essentially isolated in a larger matrix, unlike remnant corridors that require substantial management to counteract the external effects of the surrounding matrix. Remnant corridors only become corridors when the surrounding landscape is fragmented and until that time had been part of the overall matrix.

Ridges may have a direct effect on temperature/radiation, surface airflow/wind, humidity and soil types. Ridges also influence fire in the landscape, offering protection for those species that can be described as "fire-avoiders". Because of the influence of topography on rainfall, many streams in Gauteng originate on ridges and control water inputs into wetlands. The protection of the ridges in Gauteng in a natural state will thus ensure the normal functioning of ecosystem processes. In contrast, development of a ridge will alter these major landscape processes. For example, water runoff into streams and wetlands will increase. The proposed line variants will potentially affect Class 1, Class 2 and Class 3 ridges. Significant ridge areas are present in the southern part of the proposed lines (Figure 7).

8.3.1 Class 1 Ridges

Figure 4 provides an example of a Class 1 ridge, being classified as any ridge on which less than 5% of the ridge is transformed. No further development should be allowed in these areas; a strict no-go policy should be exercised. No further subdivisions will be allowed and consolidation of subdivisions is encouraged. If developer should wish government to deviate from strict no-go policy, a full EIA is required with full set of specialist reports including, but not limited to the following:

- An ecological study, including both functional and compositional (biodiversity) aspects;
- A Red Data study for both fauna and flora;
- An invertebrate study;
- All specialist studies to examine cumulative impacts; and
- A 200m buffer zone of low impact development is required around Class 1 ridges.

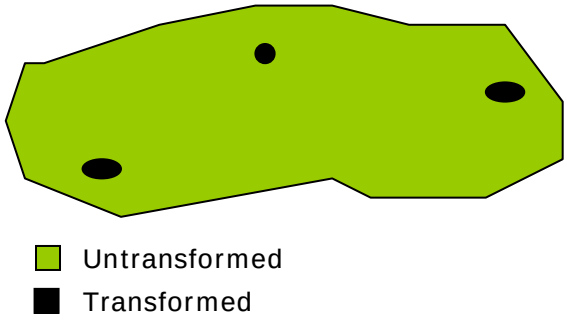

Figure 4: Example of Class 1 Ridge

8.3.2 Class 2 Ridges

Figure 5 provides an example of a Class 2 ridge, being classified as any ridge on which between 5% and 35% of the ridge is transformed. No further subdivisions will be allowed and consolidation of subdivisions is encouraged. No-go development policy should be enforced and only low impact (e.g. tourism developments) will be considered requiring full EIA with full set of specialist reports including, but not limited to the following:

- An ecological study, including both functional and compositional (biodiversity) aspects;
- A Red Data study for both fauna and flora;
- An invertebrate study;
- All specialist studies to examine cumulative impacts;
- Ecological footprint of low impact developments to cover no more than 5% of a property. All impacts for these developments must be sufficiently mitigated;
- A management plan to maintain the ecological integrity of remaining property is required and implementation is the responsibility of the developer; and
- A 200m buffer zone of low impact development is required around Class 2 ridges.

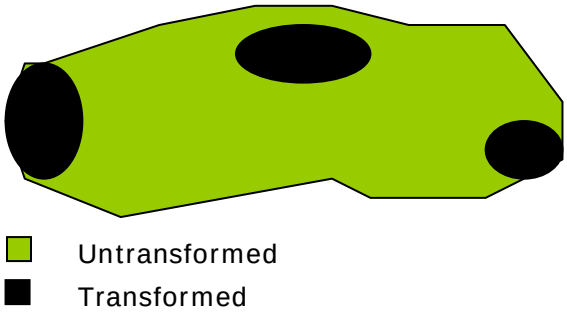

Figure 5: Example of Class 2 Ridge

8.3.3 Class 3 Ridges

Figure 4 provides an example of a Class 3 ridge, with BLACK indication the transformed areas and GREEN indicating the untransformed parts. A Class 3 ridge is classified as any ridge on which 35% to 65% of the ridge is transformed. Ridges in this class are to be designated as low impact development areas (A) and high impact development areas (B). Development should be contained within areas that are already transformed (B).

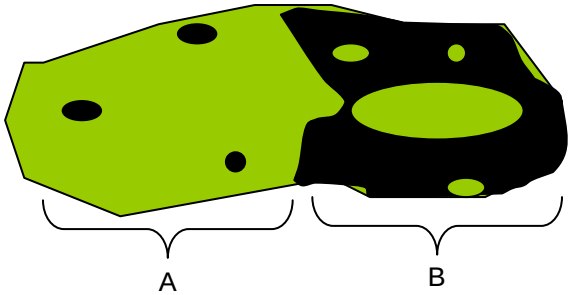

Figure 6: Example of Class 3 ridge

- **Untransformed areas:**

No further subdivisions will be allowed and consolidation of subdivisions will be encouraged. Low impact developments will be considered requiring full EIA with full set of specialist reports including, but not limited to the following:

- An ecological study, including both functional and compositional aspects;
- A Red Data study for both fauna and flora;
- An invertebrate study;
- All specialist studies to examine cumulative impacts.
- Ecological footprint of low impact developments to cover no more than 5% of a property;
- All impacts for these developments must be sufficiently mitigated;
- A management plan to maintain the ecological integrity of remaining property is required and implementation is the responsibility of the developer; and
- A 200m buffer zone of low impact development is required around class 3(A) ridges.

- **Transformed areas**

Exempt from EIA process unless:

- A Red Data species is recorded for the ridge – implementation of Red Data policy is required.
- The open space is 4ha or larger. EIA with all specialist reports (see above) is required. All policy guidelines as listed for (Untransformed areas) above are applicable.
- Surrounding community / landowners object. A scoping report is then required with specialist reports identified in accordance with public objections but should at least include a social study, including cultural, historical and open space value aspects

Major ridges that will be affected by the proposed development include:

- Daspoortrand; and
- Magaliesberg Range.

Figure 7: Distribution of ridges in the study area

8.4 Land Cover & Land Use

Land cover categories are presented in Figure 8.

For the purpose of this biodiversity assessment, land cover are categorised into classes that represent natural habitat and land use categories that contribute to habitat degradation and transformation on a local or regional scale. In terms of the importance for biodiversity the assumption is made that landscapes that exhibit high levels of transformation are normally occupied by plant communities and faunal assemblages that does not reflect the original or pristine status of an area or region. This is particularly important in the case of Red Data species as these plants and animals have extremely low levels of disturbance tolerances, which is one of the main reasons for being threatened. Any significant changes to the status of habitat available to these species are likely to result in similarly significant impacts on these species and their conservation status.

Three important aspects are associated with habitat changes that accompany certain land uses. Permanent transformation of natural habitat by land uses such as agriculture, mining and urbanisation results in the permanent decimation of available habitat for flora and fauna species as these areas will not return to the original pristine status. A second aspect of habitat transformation or degradation is that it affects species directly, namely a change in species composition of an area results from an exodus of some species that are no longer able to exist in changed habitat conditions, the decrease in abundance of certain species as a result of decreased habitat or an influx of species that are not normally associated with the original or pristine habitat, but is suitably adapted to the changed environment. While some, or most, of the species that occupy these changed habitat conditions might be indigenous to a region, they are not endemic to an area. Lastly a larger threat to the natural biodiversity of a region is represented by the influx of invasive exotic species and weeds that can effectively sterilise large tracts of remaining natural habitat.

The proposed corridors are located in areas that comprise extensive areas of natural habitat as well as some transformed areas. Land transformation is mostly the result of urban developments and settlements.

Figure 8: Land cover categories of the study area

8.5 Land Transformation Effects

Figure 9 provides an indication of the remaining untransformed areas within the general surrounds. It is evident that the region is relatively transformed, with only some areas of remaining natural habitat remaining in the region. Urbanisation and limited agriculture represents the major land transformation effects within the region.

8.5.1 Habitat Fragmentation

Habitat fragmentation is the emergence of discontinuities (fragmentation) in an organism's preferred environment/ habitat and can be caused by geological processes that slowly alter the layout of the physical environment or by human activity such as land conversion, which can alter the environment on a much faster time scale. The former is thought to be one of the major causes of speciation, while the latter is causative in extinctions of many species.

Habitat fragmentation caused by humans occurs when native vegetation is cleared for human activities such as agriculture, rural development or urbanization. Remaining habitat fragments are therefore rarely representative samples of the initial landscape. Habitats which were once continuous become divided into separate fragments. After intensive clearing, the remaining fragments tend to be small islands isolated from each other by crop land, pasture, roads, pavement or even barren land. The term habitat fragmentation includes six discrete phenomena:

- Reduction in the total area of the habitat;
- Increase in the amount of edge;
- Decrease in the amount of interior habitat;
- Isolation of one habitat fragment from other areas of habitat;
- Breaking up of one patch of habitat into several smaller patches; and
- Decrease in the average size of each patch of habitat.

One of the major ways that habitat fragmentation affects biodiversity is by reduction in the amount of available habitat for plants and animals. Plants and other sessile organisms in these areas are usually directly destroyed while mobile animals (especially birds and mammals) retreat into remnant patches of habitat, leading to crowding effects and increased competition.

Figure 9: Isolation & fragmentation of untransformed habitat in the region

Species that can move between fragments may use more than one fragment while others must make do with what is available in the single fragment in which they ended up. Area is the primary determinant of the number of species in a fragment. The size of the fragment will influence the number of species which are present when the fragment was initially created, and will influence the ability of these species to persist in the fragment. Small fragments of habitat can only support small populations of plants and animals and small populations are more vulnerable to extinction. Minor fluctuations in climate, resources or other factors, that would be unremarkable and quickly corrected in large populations can be catastrophic in small, isolated populations. Fragmentation of habitat is therefore an important cause of species extinction.

Population dynamics of subdivided populations tend to vary asynchronously. In an unfragmented landscape a declining population can be "rescued" by immigration from a nearby expanding population, but in fragmented landscapes the distance between fragments may prevent this from happening. Additionally, unoccupied fragments of habitat that are separated from a source of colonists by some barrier are less likely to be repopulated than adjoining fragments.

Additionally, habitat fragmentation leads to edge effects. Microclimatic changes in light, temperature, and wind can alter the ecology around the fragment, and in the interior and exterior portions of the fragment. Fires become more likely in the area as humidity drops and temperature and wind levels rise. Exotic and pest species may establish themselves easily in such disturbed environments, and the proximity of domestic animals often upsets the natural ecology. Also, habitat along the edge of a fragment has a different climate and favours different species from the interior habitat.

The existence of viable habitat is critical to the survival of any species, and in many cases the fragmentation of any remaining habitat can lead to difficult decisions for conservation biologists. Given a limited amount of resources available for conservation is it preferable to protect the existing isolated patches of habitat or to buy back land to get the largest possible continuous piece of land. It is however an ongoing debate and is often referred to as SLOSS (Single Large or Several Small).

8.5.2 Habitat Isolation

Habitat isolation is defined as the extent to which a parcel of land or habitat of a certain species, or community of species, is separated from other similar habitat, species or communities, where the distance of separation might be larger than what is acceptable for species that occupy an area in order to successfully navigate in order to feed, propagate or inhabit.

The degree of habitat isolation experienced by individuals of a given species depends on many factors. For example, above a particular level of habitat loss the physical distances

between habitats patches increase exponentially. For many species, rate of movement between patches of suitable habitat can be reduced as a result. Spatial scale, mobility and mode of movement (e.g. flying versus crawling) are key issues associated with considerations of the impacts of habitat subdivision and habitat isolation. The spatial scales of which a species moves and over which it perceives its environment will strongly influence the extent to which a given modified landscape is, or is not, negatively subdivided or isolated for that taxon. For example, for some small mammal and flightless insect species, a road may effectively subdivide and isolate the populations on either side of it, whereas such a road would have very limited or no impact on more mobile species.

Many of the warnings associated with the themes of habitat loss and habitat degradation are also relevant to considerations of habitat subdivision and habitat isolation. This is because, like habitat loss, what constitutes habitat subdivision and habitat isolation will be species specific. For example, the isolation of vegetation patches defined from a human perspective may not lead to habitat isolation from the perspective of some species. Even in a landscape that is extensively modified by humans, the matrix may be highly permeable for some species. Hence, actual levels of habitat isolation might therefore actually be relatively low for these taxa and recolonization rates of patches can be high. For other species, the same matrix may be 'hostile', meaning that neighbouring patches, although being located relatively close together, are actually very isolated for the specific species.

The spatial isolation of habitat can impair dispersal movements between the natural territory and suitable habitat patches, which are typically made by juvenile or sub-adult animals attempting to establish new territories. This interruption to dispersal can reduce the genetic size of populations through impaired patterns of gene flow. Importantly, effective dispersal involves not only the movement of an individual, but also its successful reproduction in the receiving population. In some cases, males and females of a given species do not respond in the same way to habitat isolation. In addition, the recolonization of vacant territories in some habitat patches by individuals originating from other habitat patches is critical for maintaining the overall demographic size of a given species population. By affecting patterns of dispersal between patches, habitat isolation can have significant effects on the occupancy of otherwise suitable habitat patches, including protected areas like nature reserves. For example, population recovery after disturbance may be imparts by habitat isolation.

Habitat isolation may shift a formerly contiguous and interacting population into a series of loosely connected subpopulations (i.e. metapopulation). A metapopulation is defined as a set of local populations which interact via individuals moving between local populations. However, patchily distribution of populations of a species does not always conform to a true metapopulation structure.

8.5.3 Biodiversity Sensitivities

In order to compile a map of biodiversity sensitivities the assumption is made that areas of transformation no longer contain any natural habitat and are therefore placed in a low biophysical sensitivity category. These areas are regarded suitable for development purposes and the assumption is also made that expected impacts within these areas will be of a less significant nature than in areas where natural habitat are still present.

It is evident that extensive areas within the study area are transformed and some parts of remaining natural habitat is highly fragmented and isolated. However, the largest extent of the study area comprises natural habitat that is characterised by high continuity, i.e., much of the transformation is nodal in nature and while high levels of transformation is present, a high level of continuity is also noted, implying that organisms are able to migrate extensive distances without having to cross any unnatural borders (moderate habitat isolation). The proposed development is not expected to contribute towards local and regional levels of fragmentation and isolation.

8.6 Regional Vegetation - VEGMAP

The following VEGMAP vegetation types will be affected by the proposed development (Figure 10):

Table 2: VEGMAP vegetation units conservation status

VEGMAP UNIT	Remaining	Conserved	Target	Ecosystem Status	Protection level
Central Sandy Bushveld	76%	3%	19%	Vulnerable	Poorly Protected
Gold Reef Mountain Bushveld	85%	21%	24%	Least Threatened	Moderately Protected
Marikana Thornveld	52%	0%	19%	Endangered	Hardly Protected
Moot Plains Bushveld	72%	6%	19%	Vulnerable	Poorly Protected
Norite Koppies Bushveld	89%	0%	24%	Least Threatened	Not Protected

8.6.1 Central Sandy Bushveld

It is located in undulating terrain, occurring mainly in a broad arc south of the Springbokvlakte from the Pilanesberg in the west through Hammanskraal and Groblersdal to GaMasemola in the east. The habitat conforms to low undulating areas, sometimes between mountains, and sandy plains and catenas supporting tall, deciduous *Terminalia sericea* and *Burkea africana* woodland on sandy soils (with the former often dominant on the lower slopes of sandy catenas) and low, broadleaved *Combretum* woodland on shallow, rocky or gravely soils. Species of *Acacia, Ziziphus* and *Euclea* are found on flats lower slopes on eutrophic sands and some less sandy soils. *A. tortilis* may dominate some areas along valleys. Grass-dominated herbaceous layer with relatively low basal cover on dystrophic soils are noted frequently.

The Central Bushveld endemic grass species *Mosdenia leptostachys* and herb *Oxygonum dregeanum* subsp. *canescens* var. *dissectum* are present within this unit.

This vegetation type is regarded Vulnerable with less than 3% statutorily conserved, spread thinly across many nature reserved, including the Doorndraai Dam and Skuinsdraai Dam Nature Reserves. An additional 2% is conserved in other reserves including the Wallmansthal SANDF Property and a grouping of the Nylsvlei freshwater wetlands. About 24% is transformed, including 19% cultivated and 4% urban and built-up areas. Much of the unit in the broad arc south of the Springbokvlakte is heavily populated by rural communities. Several alien plants are widely scattered by often at low densities, including *Cereus jamacuru, Eucalyptus* species, *Lantana camara, Melia azedarach, Opuntia ficus-indica* and *Sesbania punicea.*

Acacia sieberiana occurs in the transition zone with grassland in the east, while *A. caffra* and *Faurea saligna* are dominant in the transition zone to the Waterberg Mountain Bushveld in the western parts of this unit. The following species are regarded representative of this particular vegetation type:

- **Tall Trees**

Acacia burkei, A. robusta and *Sclerocarya birrea* subsp. *caffra.*

- **Small Trees**

Burkea africana, *Combretum apiculatum*, C. *zeyheri*, *Terminalia sericea*, *Ochna pulchra, Peltophorum africanum* and *Searsia leptodictya.*

- **Tall Shrubs**

Combretum hereroense, Grewia bicolor, G. *monticola* and *Strychnos pungens.*

- **Low Shrubs**

Agathisanthemum bojeri, *Indigofera filipes*, *Felicia fascicularis, Gnidia sericocephala.*

- **Geoxylic Suffrutex**

Dichapetalum cymosum

- **Woody Climber**

Asparagus buchananii

- **Graminoids**

Brachiaria nigropedata, *Eragrostis pallens*, *E. rigidior*, *Hyperthelia dissoluta*, *Panicum maximum*, *Perotis patens*, *Anthephora pubescens, Aristida scabrivalvis* subsp. *scabrivalvis, Brachiaria serrata, Elionurus muticus, Eragrostis nindensis, Loudetia simplex, Schmidtia pappophoroides, Themeda triandra* and *Trachypogon spicatus.*

- **Herbs**

Dicerocaryum encelioides, *Barleria macrostegia, Blepharis integrifolia, Crabbea angustifolia, Evolvulus alsinoides, Geigeria burkei, Hermannia lancifolia, Indigofera daleoides, Justicia anagalloides, Kyphocarpa angustifolia, Lophiocarpus tenuissimus, Waltheria indica* and *Xerophyta humilis.*

- **Geophytic Herb**

Hypoxis hemerocallidea var. *davyana*

- **Succulent Herb**

Aloe greatheadii

8.6.2 Gold Reef Mountain Bushveld

This vegetation type is situated on rocky hills and ridges often west-east facing slopes associated with distinct florist differences (e.g. preponderance of *Acacia caffra* on the southern slopes). Tree cover elsewhere is variable. Tree and shrub layers are often continuous and the herbaceous layer is dominated by grasses. This vegetation type is regarded Least Threatened with a target of 24%. Some 22% is statutorily conserved mainly in the Rustenberg, Wonderboom and Suikerbosrand Nature Reserves. At least and additional 1% is conserved in other reserves, brining the total conserved very close to target. About 15% is transformed mainly be cultivation and urban and built-up areas. Some areas occur with dense stands of the alien tree species *Melia azedarach,* which is often associated with drainage lines or alluvia (i.e. azonal vegetation), are embedded within this unit. The endemic succulent shrub *Aloe peglerae* and the succulent herb *Frithia pulchra* are present in this vegetation type. The following species are regarded representative of the Gold Reef Mountain Bushveld vegetation type.

- **Small Trees**

Acacia caffra, Combretum molle, Protea caffra, Celtis africana, Dombeya rotundifolia, Englerophytum magalismontanum, Ochna pretoriensis, *Searsia leptodictya, Vangueria infausta, V. parvifolia* and *Ziziphus mucronata.*

- **Tall Shrubs**

Canthium gilfillanii, Ehretia rigida, Grewia occidentalis, Gymnosporia buxifolia and *Mystroxylon aethiopicum.*

- **Low Shrubs**

Athrixia elata, Pearsonia cajanifolia, Searsia magalismontana and *S. rigida.*

- **Woody Climber**

Ancylobotrys capensis

- **Graminoids**

Loudetia simplex, Panicum natalense, Schizachyrium sanguineum, Trachypogon spicatus, Alloteropsis semialata, Bewsia biflora, Digitaria tricholaenoides, Diheteropogon amplectens, Sporobolus pectinatus, Tristachya leucothrix and *T. biseriata.*

- **Herbs**

Helichrysum nudifolium, H. rugulosum, Pentanisia angustifolia, Senecio venosus and *Xerophyta retinervis.*

- **Geophytic Herbs**

Cheilanthes hirta, Hypoxis hemerocallidea and *Pellaea calomelanos.*

8.6.3 Marikana Thornveld

The northern and southern sections of the study area correspond to a vegetation type known as Marikana Thornveld and were previously classified by Van Rooyen and Bredenkamp as Rocky Highveld Grassland. This ecological type is structurally similar to open *Acacia* savanna woodland, occurring in valleys and slightly undulating plains and some lowland hills. Shrubs are denser along drainage lines, on termitaria and rocky outcrop or in other habitat protected from fire. The Marikana Thornveld is a threatened ("endangered") vegetation type of which less than 1% is formally conserved within reserves and is mainly threatened by cultivation and urbanisation. The following species are regarded representative of the Marikana Thornveld vegetation type.

- **Tall Tree**

Acacia burkei

- **Small Trees**

Acacia caffra, *A. gerrardii*, *A. karroo*, *Combretum molle*, *Searsia lancea*, *Ziziphus mucronata*, *Acacia nilotica, A. tortilis* subsp. *heteracantha, Celtis africana*, *Dombeya rotundifolia, Pappea capensis, Peltophorum africanum* and *Terminalia sericea.*

- **Tall Shrubs**

Euclea crispa subsp. *crispa*, *Olea europaea* subsp. *africana*, *Searsia pyroides* var. *pyroides*, *Diospyros lycioides* subsp. *guerkei, Ehretia rigida* subsp. *rigida, Euclea undulata, Grewia flava* and *Pavetta gardeniifolia.*

- **Low Shrubs**

Asparagus cooperi, Rhynchosia nitens, Indigofera zeyheri and *Justicia flava.*

- **Woody Climbers**

Clematis brachiata and *Helinus integrifolius.*

- **Herbaceous Climbers**

Pentarrhinum insipidum and *Cyphostemma cirrhosum.*

- **Graminoids**

Elionurus muticus, Eragrostis lehmanniana, Setaria sphacelata, Themeda triandra, Aristida scabrivalvis subsp. *scabrivalvis, Fingerhuthia africana, Heteropogon contortus, Hyperthelia dissoluta, Melinis nerviglumis* and *Pogonarthria squarrosa.*

- **Herbs**

Hermannia depressa, Ipomoea obscura, Barleria macrostegia, Dianthus mooiensis subsp*. mooiensis, Ipomoea oblongata* and *Vernonia oligocephala.*

- **Geophytic Herbs**

Ledebouria revoluta, Ornithogalum tenuifolium and *Sansevieria aethiopica.*

8.6.4 Moot Plains Bushveld

This vegetation type occurs immediately to the south of both the Dwarsberg-Swatruggens Mountain Bushveld and Gold Reef Mountain Bushveld, consisting of an open to closed *Acacia* savanna with a well-developed herbaceous layer dominated by grasses. This vegetation type is Vulnerable of which only 13% is conserved, mainly in the Magaliesberg Nature Area. About 28% is transformed mainly by cultivation and urban and built-up areas. Are scattered occurrences to sometimes dense patched in places of various alien plains occur, including *Cereus jamacuru, Eucalyptus* species, *Jacaranda mimosifolia, Lantana camara, Melia azedarach* and *Schinus molle.* The following species are regarded representative of the Moot Plains Bushveld vegetation type.

- **Small Trees**

Acacia nilotica, *A. tortilis* subsp. *heteracantha* and *Searsia lancea*.

- **Tall Shrubs**

Buddleja saligna, *Euclea undulata*, *Olea europaea* subsp. *africana*, *Grewia occidentalis, Gymnosporia polyacantha* and *Mystroxylon aethiopicum* subsp. *burkeanum.*

- **Low Shrubs**

Aptosimum elongatum, Felicia fascicularis, Lantana rugosa and *Teucrium trifidum.*

- **Succulent Shrub**

Kalanchoe paniculata

- **Woody Climber**

Jasminum breviflorum

- **Herbaceous Climber**

Lotononis bainesii

- **Graminoids**

Heteropogon contortus, *Setaria sphacelata*, *Themeda triandra*, *Aristida congesta, Chloris virgata, Cynodon dactylon, Sporobolus nitens* and *Tragus racemosus.*

- **Herbs**

Achyropsis avicularis, Corchorus asplenifolius, Evolvulus alsinoides, Helichrysum nudifolium, H. undulatum, Hermannia depressa, Osteospermum muricatum and *Phyllanthus maderaspatensis.*

8.6.5 Norite Koppies Bushveld

This vegetation type is encapsulated in the central part of the study area, corresponding to low, semi-open to closed woodland up to 5m tall, consisting of dense deciduous shrubs and trees with very sparse undergrowth on shallow soil, with large areas not covered by vegetation. Tree and shrub layers are continuous. The stands of this unit are found on noritic outcrops and koppies, many appearing as inselbergs above the surrounding plains.

The conservation status is regarded Least Threatened according to remote sensing data, but ground truthing suggests that it is rather susceptible. None is conserved in statutory reserves, but 4% is conserved in De Onderstepoort Nature Reserve. Mining, urban and built-up developments as well as agriculture represent the main threats to this vegetation type. Areas close to human settlements are often severely disturbed and many woody species in these areas have been harvested for fuel and building materials.

Vegetation patterns on norite koppies are primarily determined by the amount of rockiness and aspect, warmer north-facing sloes and cooler south-facing slopes bearing floristically distinct vegetation. A number of the woody species are typical chasmophytes, penetrating the rocks with their roots. The vegetation unit is transitional between xeric lowland bushveld and mesophyllous woodland in cooler more moist upland areas associated with the Magaliesberg and may be considered a more xeric phase of these upland areas. The following species are regarded representative of the Norite Koppies Bushveld vegetation type.

- **Tall Tree**

Sclerocarya birrea subsp. *caffra*

- **Small Trees**

Combretum molle, *Croton gratissimus*, *Ficus abutilifolia*, *Pappea capensis*, *Acacia caffra, Bridelia mollis, Combretum apiculatum, Cussonia paniculata, Dombeya rotundifolia*, *Faurea saligna, Ficus glumosa, Lannea discolor, Obetia tenax, Peltophorum africanum, Searsia leptodictya, Vangueria infausta* and *Ziziphus mucronata.*

- **Succulent Tree**

Euphorbia cooperi

- **Shrubs**

Triaspis glaucophylla, *Canthium gilfillanii, Clerodendrum glabrum, Diplorhynchus condylocarpon, Euclea natalensis, Grewia flavescens,* G. *monticola, Gymnosporia nemorosa,* G. *polyacantha, Pavetta eylesii, Pouzolzia mixta, Psydrax livida, Vitex zeyheri, Jatropha latifolia* var. *latifolia*, *Abutilon austro-africanum, Hermannia floribunda, Hibiscus subreniformis* and *Searsia zeyheri.*

- **Succulent Shrub**

Tetradenia brevispicata

- **Semiparasitic Shrub**

Osyris lanceolata

- **Woody Climbers**

Helinus integrifolius, Rhoicissus tridentata and *Turraea obtusifolia.*

- **Woody Succulent Climber**

Sarcostemma viminale

- **Herbaceous Climber**

Cyphostemma lanigerum

- **Graminoids**

Chrysopogon serrulatus, *Setaria lindenbergiana*, *Aristida congesta, Bulbostylis humilis, Eustachys paspaloides, Heteropogon contortus, Loudetia simplex, Melinis nerviglumis, Panicum maximum* and *Themeda triandra.*

- **Herb**

Hibiscus sidiformis

- **Geophytic Herbs**

Pellaea calomelanos, P viridis and *Scadoxus puniceus.*

Figure 10: VEGMAP vegetation types in the region of the study area

8.7 Biophysical Sensitivities - Analysis

Ascribed sensitivities are based on a combination of the likelihood of a specific biophysical attribute being important in terms of biodiversity attributes and the expected reaction of the particular attribute to impacts associated with the construction and operation of powerlines as perceived relevant to this particular project. Sensitivities are ultimately collated and a biodiversity sensitivity map is produced that presents an overview of the biodiversity sensitivity of the study area on a regional scale.

Shortcomings of this approach are that localised and small areas of importance that are not captured in existing databases or that were not observed during the extensive field survey will not be reflected on the sensitivity map. It should be noted that areas of a small extent will be identified and appropriately avoided during the final walk-through of the project.

For the purpose of the sensitivity analysis the proposed line was divided into sections (1 – 7) that differentiate between areas where no alternatives are available and sections where alternatives can be compared in terms of likely impacts. Comparative sections are indicated in a similar colour.

Table 3: Extent of habitat sensitivities within respective sections

Section	Low / No Sensitivity	Medium Sensitivity	Medium high Sensitivity	High Sensitivity
1	60.9 ha	25.6 ha	0.0 ha	1.4 ha
2	25.6 ha	15.9 ha	81.7 ha	17.8 ha
3	70.3 ha	22.0 ha	10.6 ha	30.1 ha
4	16.6 ha	0.1 ha	50.8 ha	36.1 ha
5	6.3 ha	1.5 ha	0.2 ha	41.7 ha
6	2.4 ha	2.6 ha	1.3 ha	62.9 ha
7	99.9 ha	5.0 ha	48.9 ha	37.7 ha

Figure 11: Biophysical sensitivities of the region

9 Floristic Attributes of the Study Area

9.1 Regional Diversity

The compilation of detailed species lists for specific regions was not perceived as part of the scope of this environmental impact assessment and only general observations of the floristic diversity was made during the field surveys. Available data on the SANBI database indicates the presence of approximately 2,232 species within the ¼-degree grid (2528CA) in which the study area is situated. This exceptionally high floristic diversity is the result of highly diverse biophysical attributes, including soils, geology, micro-climatic conditions, moisture regimes, slopes, aspect, rockiness, soil depth, etc. A dissemination of the growth forms that occur in the region is presented in Table 3. The prominence of herbs (819 species, 36.7%), shrubs (483 species, 21.6%), grasses (286 species, 12.8%) and geophytes (165 species, 7.4%) indicates a high diversity of habitat types that include grassland and savanna physiognomy. The high diversity of species also provides indication that extensive parts of the study area comprises habitat of a pristine nature in which the natural diversity of the region is reflected. The contribution of weeds and invasive species is also noted and numerous invasive and exotic species were observed during the site investigation period, particularly in close proximity to urban and settlement areas and wetland habitat types.

Table 4: Growth forms in the general region

Growth Form	Number	Percentage
Bryophyte	97	4.3%
Carnivore	7	0.3%
Climber	128	5.7%
Creeper	4	0.2%
Cyperoid	59	2.6%
Epihydate	5	0.2%
Geophyte	165	7.4%
Graminoid	286	12.8%
Helophyte	13	0.6%
Herb	819	36.7%
Hydrophyte	2	0.1%
Lichen	19	0.9%
Parasite	31	1.4%
Scrambler	7	0.3%
Shrub	483	21.6%
Succulent	48	2.2%
Suffrutex	5	0.2%
Tree	54	2.4%
Total	**2,232**	

A total of 203 plant families are represented in the study area. Prominent families include Poaceae (286 species, 12.8%), Fabaceae (235 species, 10.5%), Asteraceae (219 species,

9.8%), Apocynaceae (118 species, 5.3%), Malvaceae (68 species, 3.0%), Euphorbiaceae (59 species, 2.6%) and Cyperaceae (59 species, 2.6%).

9.2 Floristic Habitat Types of the Study Area

An analysis of aerial photographs and results of the field surveys revealed the following communities and variations within the proposed corridors (Figure 12):

- Degraded Woodland;
- Natural Woodland Community, including:
  - Central Sandy Bushveld Variation;
  - Gold Reef Mountain Bushveld Variation;
  - Marikana Thornveld Variation;
  - Norite Koppies Bushveld Variation;
- Ridge Habitat Type;
- Transformed Areas; and
- Wetland Habitat Types.

The extent of habitat types within the proposed corridors is presented in Table 4. The extent of habitat types within the respective sections of the corridors is presented in Table 5

Table 5: Extent of habitat types in proposed corridors

Habitat Type	Extent	Percentage
Degraded Woodland	269.7 ha	37.2%
Natural Woodland - Central Sandy Bushveld	21.7 ha	3.0%
Natural Woodland - Gold Reef Mountain Bushveld	24.1 ha	3.3%
Natural Woodland - Marikana Thornveld	92.8 ha	12.8%
Natural Woodland - Norite Koppies Bushveld	13.0 ha	1.8%
Ridge Habitat Types	121.0 ha	16.7%
Transformed Areas	99.3 ha	13.7%
Wetland Habitat Types	83.1 ha	11.5%
Total	**724.6 ha**	

Table 6: Extent of habitat types within corridor sections

Habitat Type	Sec 1	Sec 2	Sec 3	Sec 4	Sec 5	Sec 6	Sec 7
Degraded Woodland	47.9 ha	40.3 ha	63.1 ha	43.9 ha	2.8 ha	4.7 ha	67.0 ha
Central Sandy Bushveld	21.7 ha	0.0 ha	0.0 ha	0.0 ha	0.0 ha	0.0 ha	0.0 ha
Gold Reef Mountain Bushveld	0.0 ha	0.0 ha	0.0 ha	0.0 ha	9.6 ha	0.0 ha	14.4 ha
Marikana Thornveld	0.0 ha	62.5 ha	8.3 ha	16.7 ha	0.0 ha	0.0 ha	5.3 ha
Norite Koppies Bushveld	0.0 ha	13.0 ha	0.0 ha	0.0 ha	0.0 ha	0.0 ha	0.0 ha
Ridge Habitat Types	0.0 ha	12.2 ha	0.0 ha	0.0 ha	27.3 ha	41.0 ha	40.5 ha
Transformed Areas	7.6 ha	9.4 ha	6.5 ha	11.1 ha	2.4 ha	5.6 ha	56.7 ha
Wetland Habitat Types	10.7 ha	3.4 ha	55.0 ha	5.4 ha	2.7 ha	0.8 ha	5.0 ha
Total	**88.0 ha**	**140.9 ha**	**132.9 ha**	**77.1 ha**	**44.8 ha**	**52.0 ha**	**188.9 ha**

9.2.1 Degraded Woodland Habitat

As a result of historic disturbances, including agriculture, high grazing pressure, poor management principles, destruction of the woody layer through wood gathering, frequent fires, etc., extensive parts of the natural woodland areas of the study area constitute secondary climax vegetation. This community is confined to the floodplains of the study area where characteristically flat (slopes >5°), or slightly undulating areas, predominate and surface rocks are generally absent. Soils may be stony in some areas, but the percentage cover of rock or stones are generally below 5%. Soils in this community are generally deep and the clay content is high, hence the relative high cover abundance values noted for *Acacia* species. The physiognomy of this community is typical of open savanna, with a dominant grass sward and scattered *Acacia* trees, or clumps of trees occurring in varying densities.

The species diversity of this community is not particularly high. The shrub/ tree layer, where present, appears stunted and comprises mostly *Acacia* species in the 1.0 to 1,5m class, including *Acacia nilotica, A. tortilis, A. karroo* and *A. caffra,* but other tree species also occur at lower densities, such as *Searsia leptodictya, Ziziphus mucronata, Searsia lancea* and *Euclea crispa.*

The grass sward is well developed, with a relative high diversity. No singular dominant species is present and grass species are present as co-dominants. Prominent grass species occurring in this community are characteristic of soils with high clay content and include *Ischaemum afrum, Sehima galpinii, Bothriochloa insculpta, Themeda triandra, Heteropogon contortus, Elionurus muticus, Eragrostis rigidior, Aristida bipartita, Setaria nigrirostris* and *Brachiaria eruciformis*

The herb component, similar to the grass sward, is relative diverse and most species provide indication of the relative high degradation factor. Common species include *Clematis brachiata, Vernonia oligocephala, Bidens pilosa, Araujia sericifera, Lippia javanica, Teucrium trifidum, Pseudognaphalium luteo-album, Aloe greatheadii, Asparagus suaveolens* and *Vernonia poskeana*.

A medium-low in floristic sensitivity and a low likelihood of encountering Red Data flora species within this habitat type is estimated.

9.2.2 Natural Woodland Community

This community includes relative pristine variations of the regional vegetation types, including:

- Central Sandy Bushveld Variation;
- Gold Reef Mountain Bushveld Variation;
- Marikana Thornveld Variation; and
- Norite Koppies Bushveld Variation.

The main characteristic of these variations is the prominence of the woody layer, which is, to a lager or lesser extent, unaffected by impacts noted in the general surrounds. These areas are normally contained within private property where access is not readily available and few continued pressure effects are present. The woody layer is diverse and dominant and a well-developed substratum is noted in these parts. Some parts, particularly the Marikana Thornveld (Endangered) and Central Sandy Bushveld (Vulnerable) Variations, have a threatened status. Biophysical habitat attributes are similar to the Degraded Woodland Community.

The physiognomy is characterised by a high cover of woody species, including *Searsia lancea, S. pyroides, Ziziphus mucronata, Acacia karroo, Maytenus heterophylla, Pappea capensis, Combretum molle* and *Vitex zeyheri.* Woody species that occur at lower densities include *Dombeya rotundifolia, Ehretia rigida, Celtis africana, Dichrostachys cinerea, Tarchonanthus camphoratus, Acacia robusta, Berchemia zeyheri, Clerodendrum glabrum* and *Ximenia americana.*

The principal forb species are *Aloe greatheadii, A. pretoriensis, Clematis brachiata, Lippia javanica, Tagetes minuta, Teucrium trifidum, Vernonia oligocephala, Achyranthes aspera, Stachys* species and *Araujia sericifera*. The grass sward is diverse and dominant species include *Bothriochloa insculpta, Themeda triandra, Heteropogon contortus, Aristida canescens, Hyparrhenia hirta, Ischaemum afrum, Setaria verticillata, Panicum maximum, Eragrostis chloromelas, Brachiaria eruciformis, Setaria nigrirostris* and *Aristida bipartita.*

The floristic status of this community is considered moderate low due to increased cover abundance of woody species resulting from high grazing pressure. This effect is not considered permanent and could be reversed within a relative short time span with the application of a proper management programme and burning strategy.

9.2.3 Riparian Habitat

Perennial and non-perennial drainage lines are present in the study area. The vegetation within the drainage lines were found to be highly degraded, consisting of a variety of weeds and exotic species. *Phragmites australis* and *Typha capensis* stands is characteristic of large sections of this habitat type. Extremely little of the original, pristine wetland habitat types remain in the study area.

Impacts that compromise this habitat type include effects of nearby urban developments and settlements, such as litter, dumping, infestation by exotic species, as well as poor water quality resulting from effluents from industrial areas and erosion. A medium floristic status is estimated for this habitat type, mainly as a result of the moderately degraded status of the vegetation, but a medium-high likelihood of encountering Red Data flora species in this habitat type is estimated in some of the less affected areas. The relative narrow ecotonal areas that are created by variance in soil moisture are rich in species. In spite of the high level of degradation that is noted in this community, a high floristic sensitivity is nonetheless ascribed, mainly as a result of the environmental importance of this habitat type.

9.2.4 Ridge Habitat Type

This habitat type includes all areas of natural/ pristine vegetation that are situated within ridge areas as captured in the Gauteng Ridges Policy. Common characteristics of this habitat type include high rockiness and slopes that exceed 5° (8.8%). Several variations are noted that vary between grassland and open savanna to closed woodland, all of these are included in this community as a result of a similar sensitivity and importance on a local and regional scale.

A high diversity of plant species is noted throughout these parts and the vegetation was found to be in a prime condition, mostly as a result of inaccessibility for cattle that could potentially impact adversely on the vegetation.

Closed woodland variations, such as the smaller ridges comprise a woody layer that consists of trees with average heights between 3.0 and 4.0m tall. Co-dominant species include *Croton gratissimus, Dichrostachys cinerea, Ehretia rigida, Combretum molle, C. apiculatum, Searsia leptodictya, S. lancea, Ziziphus mucronata, Tarchonanthus camphoratus, Maytenus heterophylla, Pappea capensis, Vitex zeyheri, Acacia caffra, A. nilotica, Euclea crispa* and *Clerodendrum glabrum.* The shrub layer is well developed but no species were found to dominate exclusively. The adaptations of climbers and other forb species these species to shaded undergrowth conditions is evident. Species commonly found include *Pouzolzia mixta, Grewia flava, G. monticola, Lippia javanica, Zanthoxylon capense, Aloe marlothii, Sarcostemma viminale, Searsia zeyheri* and *Vangueria infausta.* Due to the limited availability of soil and the shaded conditions that

prevail in this community, the grass sward is poorly developed. Few species were noted and these were present in localised areas where the slope is not as severe as is commonly the case, resulting in the presence of relatively deeper soils. *Themeda triandra, Aristida canescens*, *Heteropogon contortus, Panicum maximum, Bothriochloa insculpta,* and *Hyparrhenia hirta* represent the prominent grass species in this community. The herbaceous layer is adapted to shaded conditions and relative dry condition underneath the dominant woody canopy in shallow soils. The diversity of the herbaceous layer is relative poor and species usually occur at low cover values. Forb species of this community include *Vernonia poskeana, Lippia javanica, Pellaea calomelanos, Clerodendrum triphyllum, Vernonia oligocephala, Clutia pulchella* and *Rhoicissus tridentata.*

Open ridge woodland, such as on the larger ridges comprise an herbaceous dominated physiognomy with scatter trees and shrubs. The vegetation is dominated by grass species, including *Trachypogon spicatus, Panicum maximum, Tristachya leucothrix, Cymbopogon plurinodis, Digitaria eriantha, Aristida sciurus, Melinis repens, Schizachyrium jeffreysii, Themeda triandra, Urelytrum agropyroides* and *Diheteropogon amplectens* as well as the forbs *Euphorbia schinzii, Xerophyta retinervis, Anacampseros subnuda, Parinari capensis, Elephantorrhiza elephantina, Achyranthes aspera, Hibiscus calyphyllus, Kalanchoe rotundifolia, K. thyrsiflora, Aloe greatheadii* and *Helichrysum pallidum.* Characteristic of the steeper slopes are the tree species *Combretum molle, C. zeyheri, Strychnos pungens, Burkea africana, Englerophytum magalismontana, Ehretia rigida* and *Euclea crispa*.

Several Red Data species are known to occur in this habitat type, particularly on the Daspoort and Magaliesberg ranges, which represents the main ridge areas within the proposed corridors. Impacts within these areas are expected to be unavoidable, unless severe and extensive realignments to the west are considered, which was indicated not to be feasible. Smaller ridge areas are present in the northern sections of the proposed corridors and avoiding these areas with localised realignments appears to be possible.

This community is regarded highly suitable for the potential presence of Red Data flora species. A high floristic status and sensitivity is ascribed to this community.

9.2.5 Transformed Habitat

Transformed areas represent parts where historical or recent human activities led to the total transformation of the natural vegetation. No natural vegetation remains in these areas and the floristic status of these areas is therefore regarded low because of the presence of secondary vegetation or the entire absence of any vegetation. The likelihood of encountering Red Data flora species within these areas are regarded low and a low floristic status is ascribed to this habitat type.

Stands of Wattle (*Acacia mearnsii*) and *Eucalyptus* are present in the study area (south) and are included in the Transformed Habitat Type. The species composition and physiognomy is dominated by the exotic trees and a poorly developed herbaceous layer is noted in most cases. In stands where the density of trees is not particularly high, a well developed grass layer may be present, consisting almost exclusively of *Hyparrhenia hirta, Eragrostis chloromelas, E. curvula* and *E. gummiflua*.

The significance of floristic attributes of this vegetation unit is considered low. Attributes that contribute to this status include:

- being infested with declared exotic tree species;
- low species diversity; and
- low coverage of species generally associated with pristine grassland.

This vegetation unit is considered suitable for the proposed development. The removal and control of alien and exotic species is recommended and should be included in the EMP for the proposed development. The likelihood of encountering Red Data flora species within these parts are regarded low and a low floristic status is ascribed to this habitat type.

Figure 12: Floristic habitat types of the study area

9.3 Flora Species of Conservation Importance

GDACE database indicate the presence of the following Red Data flora species within the region of the study area is situated:

- Populations of Red/Orange List plant taxa are present on the actual study site or in the near vicinity of the study site: **None**
- Red/Orange List plant taxa recorded from the farm on which the study site is situated / within 5km of the study site: **None**
- Red/Orange List plant taxa recorded from the quarter degree grid in which the study site is situated:
  - ***Andromischus umbraticola* subsp. *umbraticola*** (Near Threatened);
  - ***Aloe peglerae*** (Endangered);
  - *Argyrolobium campicola* (Near Threatened);
  - *Argyrolobium megarrhizum* (Near Threatened);
  - ***Boophane disticha*** (Declining);
  - ***Bowiea volubilis* subsp. *volubilis*** (Vulnerable);
  - ***Brachycorythis conica* subsp. *transvaalensis*** (Vulnerable);
  - ***Callilepis leptophylla*** (Declining);
  - ***Ceropegia decidua* subsp. *pretoriensis*** (Vulnerable);
  - *Cheilanthes deltoidea* subsp. nov. Gauteng form (Vulnerable);
  - *Cleome conrathii* (Near Threatened);
  - ***Crinum macowanii*** (Declining);
  - *Cucumis humifructus* (Vulnerable);
  - ***Delosperma gautengense*** (Vulnerable);
  - ***Delosperma leendertziae*** (Near Threatened);
  - *Dioscorea sylvatica* (Vulnerable);
  - ***Drimia altissima*** (Declining);
  - ***Drimia sanguinea*** (Near Threatened);
  - ***Eucomis autumnalis*** (Declining);
  - *Gnaphalium nelsonii* (Rare/ Sparse);
  - *Gunnera perpensa* (Declining);
  - *Habenaria barbertoni* (Near Threatened);
  - *Habenaria kraenzliniana* (Near Threatened);
  - *Habenaria mossii* (Endangered);
  - *Habenaria bicolor* (Near Threatened);
  - *Holothrix randii* (Near Threatened);
  - ***Hypoxis hemerocallidea*** (Declining);
  - *Ilex mitis* var. *mitis* (Declining);
  - *Lithops lesliei* subsp. *lesliei* (Near Threatened); and
  - *Macledium pretoriense* (Extinct);
  - *Melolobium subspicatum* (Vulnerable).
  - *Searsia gracillima* var. *gracillima* (Near Threatened);
  - ***Stenostelma umbelluliferum*** (Near Threatened); and

- ***Trachyandra erythrorrhiza*** (Near Threatened).

None of these species was observed during the site investigation period. Species indicated in **bold** are regarded likely to be present within the study area, based on the status of available habitat. Areas of pristine regional vegetation types, particularly the ridge areas, are regarded HIGHLY suitable habitat for some of these species.

9.4 Floristic Sensitivity Analysis

Floristic sensitivity is based on an analysis of floristic attributes, taking existing impacts and conservation potential into consideration, but also considering the potential significance of impacts resulting from the proposed development. The following floristic sensitivities are estimated for respective habitat types (Table 6) and are illustrated in Figure 13. A calculation of the area extent of floristic habitat sensitivities within the respective corridor sections is presented in Table 7 with a calculation of the extent of habitat sensitivities per corridor sections presented in Table 8.

9.4.1 Discussion

- **Section 1 –** Some high sensitivity areas (wetland habitat types) are present within this section. Mitigation is expected to minimize impacts to an acceptable level. No alternative to this section is available.
- **Section 2 –** Some high- and extensive medium-high sensitivity areas are present within this section. The use of this section is preferred to Section 3, in spite of the presence of more medium sensitivity areas. Effective mitigation and localised realignments will minimise impacts to an acceptable level.
- **Section 3 –** Extensive high- and some medium-high sensitivity areas are present within this section. The use of this section is not preferred as a result of potential impacts within wetland areas.
- **Section 4 –** Some high and medium-high sensitivity areas are present within this section. Effective mitigation is expected to minimise impacts to an acceptable level. No alternative to this section is available.
- **Section 5 –** Extensive high impact areas are present within this section. The use of this section is not preferred as mitigation of impacts within Section 6 is expected to be more effective.
- **Section 6 –** Extensive high sensitivity areas are present within this section. The use of this section is preferred to Section 5, in spite of the presence of more high sensitivity areas. Localised realignments will minimise impacts to an acceptable level.
- **Section 7 -** Extensive high sensitivity areas are present within this section. Effective mitigation will be required. No alternative to this section is available.

Table 7: Floristic sensitivity of habitat types in the proposed corridors								
Criteria	**RD species**	**Landscape sensitivity**	**Status / Ecological quality**	**Species composition**	**Functionality / fragmentation**	**TOTAL**	**SENSITIVITY INDEX**	**SENSITIVITY CLASS**
Community	**Criteria Ranking**							
Degraded Woodland	2	4	4	6	6	108	35%	**Medium-Low**
Central Sandy Bushveld	4	6	6	7	4	157	51%	**Medium**
Gold Reef Mountain Bushveld	4	5	6	7	6	152	49%	**Medium**
Marikana Thornveld	5	8	7	8	6	194	63%	**Medium-High**
Norite Koppies Bushveld	4	6	8	8	6	176	57%	**Medium**
Ridge Habitat Types	9	10	10	10	10	280	90%	**High**
Transformed Areas	0	2	2	2	3	39	13%	**Low**
Wetland Habitat Types	9	10	7	7	10	247	80%	**High**

Table 8: Extent of floristic habitat types per corridor sections							
Habitat Type	**Section 1**	**Section 2**	**Section 3**	**Section 4**	**Section 5**	**Section 6**	**Section 7**
Degraded Woodland	47.9 ha	40.3 ha	63.1 ha	43.9 ha	2.8 ha	4.7 ha	67.0 ha
Central Sandy Bushveld Variation	21.7 ha	0.0 ha	0.0 ha	0.0 ha	0.0 ha	0.0 ha	0.0 ha
Gold Reef Mountain Bushveld Variation	0.0 ha	0.0 ha	0.0 ha	0.0 ha	9.6 ha	0.0 ha	14.4 ha
Marikana Thornveld Variation	0.0 ha	62.5 ha	8.3 ha	16.7 ha	0.0 ha	0.0 ha	5.3 ha
Norite Koppies Bushveld Variation	0.0 ha	13.0 ha	0.0 ha	0.0 ha	0.0 ha	0.0 ha	0.0 ha
Ridge Habitat Types	0.0 ha	12.2 ha	0.0 ha	0.0 ha	27.3 ha	41.0 ha	40.5 ha
Transformed Areas	7.6 ha	9.4 ha	6.5 ha	11.1 ha	2.4 ha	5.6 ha	56.7 ha
Wetland Habitat Types	**10.7 ha**	**3.4 ha**	**55.0 ha**	**5.4 ha**	**2.7 ha**	**0.8 ha**	**5.0 ha**

Table 9: Extent of floristic habitat sensitivities per corridor section					
Corridor Section	**Low Sensitivity**	**Medium-Low Sensitivity**	**Medium Sensitivity**	**Medium-High Sensitivity**	**High Sensitivity**
Section 1	7.6 ha	47.9 ha	21.7 ha	0.0 ha	10.7 ha
Section 2	9.4 ha	40.3 ha	13.0 ha	62.5 ha	15.6 ha
Section 3	6.5 ha	63.1 ha	0.0 ha	8.3 ha	55.0 ha
Section 4	11.1 ha	43.9 ha	0.0 ha	16.7 ha	5.4 ha
Section 5	2.4 ha	2.8 ha	9.6 ha	0.0 ha	30.0 ha
Section 6	5.6 ha	4.7 ha	0.0 ha	0.0 ha	41.8 ha
Section 7	56.7 ha	67.0 ha	14.4 ha	5.3 ha	45.5 ha

Figure 13: Floristic sensitivity of habitat types

10 Faunal Attributes of the Study Area

10.1 General Diversity

Due to project limitations, only limited sampling was conducted. Available habitat was scrutinised for attributes that are deemed suitable for high faunal diversity, sensitive and Red Listed fauna species. The following disciplines were included in the investigation:

- Invertebrates;
- Frogs;
- Reptiles; and
- Mammals.

Please note that the avifaunal component is addressed in a separate document and are therefore not included in this assessment. The known diversity of the general region is presented in Table 9.

Table 10: Known faunal diversity of the region

Biological Name	English Name	Status	Probability
Invertebrates			
Danaus chrysippus	African Monarch	LT	confirmed
Melanitis leda	Evening Brown	LT	moderate-high
Heteropsis perspicua	Eyed Bush Brown	LT	moderate
Physacaeneura panda	Dark-webbed Ringlet	LT	high
Paternympha narycia	Spotted-eye Brown	LT	high
Stygionympha wichgrafi	Wichgraf's Hillside Brown	LT	high
Acraea horta	Garden Acraea	LT	moderate-high
Acraea neobule	Wandering Donkey Acraea	LT	high
Acraea natalica	Natal Acraea	LT	high
Charaxes jasius	Foxy Charaxes	LT	moderate
Byblia ilithyia	Spotted Joker	LT	high
Hypolimnas misippus	Common Diadem	LT	moderate-low
Catacroptera cloanthe	Pirate	LT	moderate
Precis archesia	Garden Commodore	LT	moderate
Junonia hierta	Yellow Pansy	LT	high
Junonia oenone	Blue Pansy	LT	high
Junonia madagascariensis	Eyed Pansy	LT	high
Vanessa cardui	Painted Lady	LT	high
Leptomyrina henningi	Henning's Black-eye	LT	high
Deudorix antalus	Brown Playboy	LT	high
Myrina silenus	Common Fig-tree Blue	LT	moderate-low
Cigaritis mozambica	Mozambique Bar	LT	moderate
Axiocerses tjoane	Eastern Scarlet	LT	high
Aloeides henningi	Henning's Copper	LT	high
Aloeides molomo	Molomo Copper	LT	high
Aloeides taikosama	Dusky Copper	LT	high
Uranothauma nubifer	Black Heart	LT	moderate
Cacyreus marshalli	Common Geranium Bronze	LT	moderate-high
Leptotes pirithous	Common Zebra Blue	LT	high

Table 10: Known faunal diversity of the region			
Biological Name	**English Name**	**Status**	**Probability**
Lampides boeticus	Pea Blue	LT	high
Taurucus sybaris	Dotted Blue	LT	confirmed
Lepidochrysops letsea	Free State Blue	LT	moderate
Lepidochrysops procera	Potchefstroom Blue	LT	moderate
Lepidochrysops patricia	Patricia Blue	LT	moderate-high
Cupidopsis jobates	Tailed Meadow Blue	LT	high
Actizera lucida	Rayed Blue	LT	high
Zizeeria knysna	African Grass Blue	LT	high
Chilades trochylus	Grass Jewel	LT	high
Zizula hylax	Gaika Blue	LT	high
Pinacopteryx eriphia	Zebra White	LT	high
Belenois aurota	Brown-veined White	LT	confirmed
Pontia helice	Common Meadow White	LT	confirmed
Mylothris agathina	Common Dotted Border	LT	high
Colias electo	African Clouded Yellow	LT	high
Catopsilla florella	African Migrant	LT	high
Eurema brigitta	Broad-bordered Grass Yellow	LT	confirmed
Papilio demodocus	Citrus Swallowtail	LT	high
Papilio nireus	Green-banded Swallowtail	LT	moderate-high
Eretis umbra	Small Marbled Elf	LT	moderate-low
Spialia mafa	Mafa Sandman	LT	high
Spialia diomus	Common Sandman	LT	high
Metisella willemi	Netted Sylph	LT	moderate-low
Metisella meninx	Marsh Sylph	VU	moderate-low
Tsitana tsita	Dismal Sylph	LT	high
Kedestes nerva	Scarce Ranger	LT	low
Platylesches ayresii	Peppered Hopper	LT	high
Platylesches neba	Flower-girl Hopper	LT	moderate-high
Gegenes pumilio	Dark Hottentot	LT	high
Gegenes niso	Common Hottentot	LT	high
Amphibians			
Amietophrynus gutturalis	Gutttural Toad	LT	high
Amietophrynus rangeri	Raucous Toad	LT	high
Schismaderma carens	Red Toad	LT	high
Kassina senegalensis	Bubbling Kassina	LT	high
Cacosternum boettgeri	Boettger's Caco	LT	high
Phrynobatrachus natalensis	Snoring Puddle Frog	LT	moderate
Xenopus laevis	Common Platanna	LT	moderate
Amietia angolensis	Common River Frog	LT	high
Amietia fuscigula	Cape River Frog	LT	moderate
Pyxicephalus adspersus	Giant Bullfrog	NT	moderate-high
Tomopterna cryptotis	Tremelo Sand Frog	LT	moderate-low
Tomopterna natalensis	Natal Sand Frog	LT	moderate
Reptiles			
Kinixys lobatsiana	Lobatse Hinged Tortoise	LT	low
Pelomedusa subrufa	Marsh Terrapin	LT	moderate-high
Rhinotyphlops lalandei	Delalande's Beaked Blind Snake	LT	moderate-high
Leptotyphlops scutifrons	Eastern Cape Thread Snake	LT	moderate-high

Table 10: Known faunal diversity of the region			
Biological Name	**English Name**	**Status**	**Probability**
Python natalensis	Southern African Python	LT	moderate-low
Atractaspis bibronii	Bibron's Stiletto Snake	LT	moderate-low
Atractaspis duerdeni	Duerden's Stiletto Snake	LT	low
Aparallactus capensis	Black-headed Centipede-eater	LT	high
Amblyodipsas polylepis	Common Purple-glossed Snake	LT	low
Lycodonomorphus rufulus	Brown Water Snake	LT	low
Lamprophis capensis	Brown House Snake	LT	moderate
Lamprophis inornatus	Olive House Snake	LT	moderate-low
Lamprophis aurora	Aurora House Snake	LT	moderate
Lycophidion capense	Cape Wolf Snake	LT	moderate-low
Mehelya capensis	Common File Snake	LT	moderate-low
Duberria lutrix	South African Slug-eater	LT	moderate-low
Pseudaspis cana	Mole Snake	LT	moderate
Prosymna sundevallii	Sundevall's Shovel-snout	LT	moderate-low
Psammophylax rhombeatus	Spotted Grass Snake	LT	moderate
Psammophylax tritaeniatus	Striped Grass Snake	LT	moderate
Psammophis trinasalis	Fork-marked Sand Snake	LT	moderate-low
Psammophis brevirostris	Short-snouted Grass Snake	LT	moderate
Psammophis crucifer	Cross-marked Grass Snake	LT	moderate
Philothamnus semivariegatus	Spotted Bush Snake	LT	moderate
Philothamnus hoplogaster	South Eastern Green Snake	LT	moderate-low
Philothamnus natalensis	Western Natal Green Snake	LT	moderate-low
Dasypeltis scabra	Rhombic Egg-eater	LT	high
Crotophopeltis hotamboeia	Red-lipped Snake	LT	high
Telescopus semiannulatus	Eastern Tiger Snake	LT	low
Homoroselaps lacteus	Spotted Harlequin Snake	LT	moderate-low
Homoroselaps dorsalis	Striped Harlequin Snake	NT	moderate
Elapsoidea sundevallii	Highveld Garter Snake	LT	moderate-low
Naja mossambica	Mozambique Spitting Cobra	LT	moderate
Hemachatus haemachatus	Rinkhals	LT	high
Causus rhombeatus	Rhombic Night Adder	LT	high
Bitis arietans	Puff Adder	LT	moderate-high
Trachylepis capensis	Cape Skink	LT	high
Trachylepis punctatissima	Speckled Rock Skink	LT	high
Trachylepis varia	Variable Skink	LT	high
Panaspis walbergii	Wahlberg's Snake-eyed Skink	LT	moderate-low
Nucras ornata	Ornate Sandveld Lizard	LT	moderate-low
Pedioplanis lineoocellata	Spotted Sand Lizard	LT	moderate-low
Gerrhosaurus flavigularis	Yellow-throated Plated Lizard	LT	moderate
Chamaesaura aenea	Coppery Grass Lizard	LT	moderate-low
Chamaesaura anguina	Cape Grass Lizard	LT	moderate-low
Cordylus vittifer	Common Girdled Lizard	LT	moderate
Varanus albigularis	Rock Monitor	LT	moderate
Varanus niloticus	Water Monitor	LT	moderate
Agama aculeata	Distant's Ground Agama	LT	moderate
Agama atra	Southern Rock Agama	LT	moderate-high
Chamaleo dilepis	Common Flap-neck Chamaleon	LT	moderate
Hemidactylus mabouia	Common Tropical House Gecko	LT	high

Table 10: Known faunal diversity of the region			
Biological Name	**English Name**	**Status**	**Probability**
Lygodactylus capensis	Common Dwarf Gecko	LT	moderate-high
Pachydactylus affinins	Transvaal Gecko	LT	moderate-high
Pachydactylus capensis	Cape Gecko	LT	high
Mammals			
Aethomys chrysophilus	Red Veld Rat	LC	moderate-high
Aethomys namaquensis	Namaqua Rock Mouse	LC	high
Amblysomus septentrionalis	Higveld Golden Mole	NT	moderate-low
Aonyx capensis	Cape Clawless Otter	LC	low
Atelerix frontalis	South African Hedgehog	NT	moderate-high
Atilax paludinosus	Water Mongoose	LC	moderate-high
Canis mesomelas	Black-backed Jackal	LC	confirmed
Caracal caracal	Caracal	LC	low
Cercopithecus aethiops	Vervet Monkey	LC	moderate
Chrysospalax villosus	Rough-haired Golden Mole	CR	low
Civettictis civetta	African Civet	LC	low
Cloeotis percivali	Short-eared Trident Bat	CR	moderate
Connachaetus gnou	Black Wildebeest	LC	low
Crocidura cyanea	Reddish-grey Musk Shrew	DD	moderate-high
Crocidura fuscomurina	Tiny Musk Shrew	DD	low
Crocidura hirta	Lesser Red Musk Shrew	DD	moderate-high
Crocidura maquassiensis	Maquassie Musk Shrew	VU	low
Crocidura mariquensis	Swamp Musk Shrew	DD	moderate-low
Crocidura silacea	Lesser Grey-brown Musk Shrew	DD	low
Cryptomys hottentotus	Common Mole-rat	LC	confirmed
Cynictis penicillata	Yellow Mongoose	LC	confirmed
Damaliscus pygargus phillipsi	Blesbok	LC	low
Dasymys incomtus	Water Rat	NT	low
Dendromus melanotis	Grey Climbing Mouse	LC	low
Dendromus mystacalis	Chestnut Climbing Mouse	LC	low
Desmodillus auricularis	Short-tailed Gerbil	LC	low
Elephantulus brachyrhynchus	Short-snouted Elephant Shrew	DD	moderate-low
Elephantulus myurus	Rock Elephant Shrew	LC	low
Felis nigripes	Black-footed Cat	LC	low
Felis silvestris	African Wild Cat	LC	low
Galago moholi	Southern Lesser Galago	LC	low
Galerella sanguinea	Slender Mongoose	LC	high
Genetta genetta	Small-spotted Genet	LC	low
Genetta tigrina	Large-spotted Genet	LC	low
Graphiurus murinus	Woodland Dormouse	LC	low
Graphiurus platyops	Rock Dormouse	DD	moderate-low
Hyaena brunnea	Brown Hyaena	NT	moderate-low
Hystrix africaeaustralis	Porcupine	LC	moderate-low
Ichneumia albicauda	White-tailed Mongoose	LC	low
Ictonyx striatus	Striped Polecat	LC	moderate-low
Lemniscomys rosalia	Single-striped Mouse	DD	moderate-high
Leptailurus serval	Serval	NT	low
Lepus saxatilis	Scrub Hare	LC	confirmed
Lutra maculicollis	Spotted-necked Otter	NT	low

Table 10: Known faunal diversity of the region			
Biological Name	**English Name**	**Status**	**Probability**
Malacothrix typica	Large-eared Mouse	LC	moderate-low
Manis temminckii	Pangolin	VU	low
Mastomys coucha	Multimammate Mouse	LC	moderate
Mastomys natalensis	Natal Multimammate Mouse	LC	moderate
Mellivora capensis	Honey Badger	NT	low
Miniopterus schreibersii	Schreiber's Long-fingered Bat	NT	moderate
Mus minutoides	Pygmy Mouse	LC	moderate
Mus musculus	House Mouse	LC	moderate-high
Myosorex cafer	Dark-footed Forest Shrew	DD	low
Myosorex varius	Forest Shrew	DD	moderate
Myotis tricolor	Temminck's Hairy Bat	NT	moderate
Myotis welwitschii	Welwitsch's Hairy Bat	NT	moderate
Mystromys albicaudatus	White-tailed Rat	EN	low
Nycteris thebaica	Egyptian Slit-faced Bat	LC	moderate
Oreotragus oreotragus	Klipspringer	LC	low
Orycteropus afer	Aardvark	LC	low
Otomys angoniensis	Angoni Vlei Rat	LC	moderate
Otomys irroratus	Vlei Rat	LC	moderate
Panthera pardus	Leopard	LC	moderate-low
Papio ursinus	Chacma Baboon	LC	moderate-low
Paraxerus cepapi	Tree Squirrel	LC	low
Pedetes capensis	Springhare	LC	moderate-low
Pipistrellus kuhlii	Kuhl's Pipistrelle	LC	moderate
Pipistrellus rusticus	Rusty Bat	NT	moderate
Poecilogale albinucha	African Weasel	DD	moderate
Pronolagus randensis	Jameson's Red Rock Rabbit	LC	moderate
Proteles cristatus	Aardwolf	LC	low
Raphicerus campestris	Steenbok	LC	moderate-low
Rattus rattus	House Rat	LC	moderate
Rhabdomys pumilio	Striped Mouse	LC	high
Rhinolophus blasii	Peak-saddle Horseshoe Bat	VU	moderate
Rhinolophus clivosus	Geoffroy's Horseshoe Bat	NT	moderate
Rhinolophus darlingi	Darling's Horseshoe Bat	NT	moderate
Rhinolophus simulator	Bushveld Horseshoe Bat	LC	moderate-low
Saccostomys campestris	Pouched Mouse	LC	moderate
Sauromys petrophilus	Flat-headed Free-tailed Bat	LC	low
Scotophilus viridis	Lesser Yellow House Bat	LC	low
Suncus infinitesimus	Least Dwarf Shrew	DD	moderate
Suncus lixus	Greater Dwarf Shrew	DD	moderate
Suncus varilla	Lesser Dwarf Shrew	DD	moderate-low
Suricata suricatta	Suricate	LC	low
Sylvicapra grimmia	Common Duiker	LC	moderate
Tadarida aegyptiaca	Egyptian Free-tailed Bat	LC	moderate-low
Taphozous mauritianus	Mauritian Tomb Bat	LC	moderate-low
Tatera brantsii	Highveld Gerbil	LC	moderate
Tatera leucogaster	Bushveld Gerbil	DD	moderate
Thallomys nigricauda	Black-tailed Tree Rat	LC	low
Thallomys paedulcus	Tree Rat	LC	low

Table 10: Known faunal diversity of the region			
Biological Name	**English Name**	**Status**	**Probability**
Thryonomys swinderianus	Greater Cane Rat	LC	low
Vulpes chama	Cape Fox	LC	low
Xerus inauris	Cape Ground Squirrel	LC	moderate-low

10.1.1 Invertebrates

At least 59 of the butterfly species known from South Africa have been observed in the Q-degree grid of the study area, 2528CA (South African Butterfly Conservation Assessment, SABCA – http://sabca.adu.org.za). A significant number of these species have large home ranges and are commonly found in large portions of the country; this group includes species such as *Danaus chrysippus, Acraea horta, Byblia ilithyia, Hypolimnas missipus, Catacroptera cloanthe, Junonia hierta, Juonia oenone, Vanessa cardui, Leptotes pirithous, Lampides boeticus, Actizera lucida, Belenois aurota, Pontia helice, Catopsilla florella, Eurema brigitta* and *Papilio demodocus*. Other species, such as *Melanitis leda, Leptomyrina henningi, Aloeides taikosama, Lepidochrysops procera, Platylesches ayresii* and *Gegenes pumilio* are not quite as widespread or commonly found, but are still not considered to be under threat (based upon the threat categories and criteria listed for each under the IUCN red data list principles).

One Red Data butterfly has been observed in the 2528CA Q-degree grid, namely *Metisella meninx*. One of the 59 species listed for the region, one is estimated to have a low probability of occurring in the study area, five are ascribed a moderate-low, eight a moderate, six a moderate-high and thirty-four a high probability of occurring in the study area. Estimations are based on the quality, status and diversity of the untransformed butterfly habitat (feeding, egg-laying sites etc.) of the study area. Five species are confirmed for the study area (observed during the field assessment).

10.1.2 Amphibians

Twelve of the frog species known from South Africa have been observed in the 2528CA Q-degree grid (Atlas and Red Data Book of the Frogs of South Africa, Lesotho and Swaziland). Species that occur over a large area and are commonly found in a variety of habitat types in South Africa, including *Amietophrynus gutturalis, Amietophrynus rangeri, Schismaderma carens, Kassina senegalensis, Phrynobatrachus natalensis, Cacosternum boettgeri, Xenopus laevis, Amieta angolensis, Amieta fuscigula, Tomopterna cryptotis* and *Tomopterna natalensis*.

Pyxicephalus adspersus (Giant Bullfrog, NT) is well known from the 2528CA Q-degree grid. One of the twelve species listed for the region is estimated to have a moderate-low probability of occurring in the study area, four a moderate, one a moderate-high and six species are ascribed a high probability of occurring in the study area. These estimations

are based on the quality, status and diversity of the untransformed terrestrial and wetland habitat of the study area.

10.1.3 Reptiles

At least 55 of the reptile species known from South Africa have been observed in the 2528CA Q-degree grid (South African Reptile Conservation Assessment, SARCA – http://vmus.adu.org.za). A significant number of these species have large home ranges and are commonly found in large portions of the country; this group includes species such as *Lamprophis capensis, Pseudaspis cana, Psammophylax rhombeatus, Philothamnus semivariegatus, Dasypeltis scabra, Crotophopeltis hotamboeia, Naja mossambica, Hemachatus haemachatus, Causus rhombeatus, Bitis arietans, Trachylepis capensis, Trachylepis varia, Nucras ornata, Cordylus vittifer, Varanus albigularis, Varanus niloticus, Agama atra, Chamaleo dilepis, Lygodactylus capensis, Pachydactylus affinis* and *Pachydactylus capensis*. Other species, such as *Rhinotyphlops lalandei, Atractaspis duerdeni, Psammophis trinasalis, Agama distanti* and *Trachylepis punctatissima* are not quite as widespread or commonly found, but are still not considered to be under threat (based upon the threat categories and criteria listed for each under the IUCN red data list principles).

One Red Data reptile has been observed in the 2528CA Q-degree grid, namely *Homoroselaps dorsalis*. Five of the 55 species listed are estimated to have a low probability of occurring in the study area, seventeen species are ascribed a moderate-low, sixteen a moderate, seven a moderate-high and ten a high probability of occurring in the study area.

These estimations are based on the quality, status and diversity of the untransformed reptile habitat of the study area.

10.1.4 Mammals

An estimated 95 mammal species are known to occur in the region of the study area (EWT mammal conservation Assessment 2004). A significant number of these species have large home ranges and are commonly found in large portions of the country; this group includes species such as *Aethomys chrysophlius, Aethomys namaquensis, Canis mesomelas, Caracal caracal, Cercopithecus aethiops, Crocidura cyaena, Cryptomys hottentotus, Cynictis pencillata, Felis sylvestris, Galago moholi, Galarella sanguinea, Genetta genetta, Hystrix africaeaustralis, Lepus saxatilis, Mastomys coucha, Mastomys natalensis, Orycteropus afer, Panthera pardus, Papio ursinus, Paraxerus cepapi, Pedetes capensis, Poecilogale albinucha, Proteles cristatus, Raphicerus campestris, Rhabdomys pumilio, Suricata suricatta, Sylvicapra grimmia, Tatera brantsi, Tatera leucogaster* and *Xerus inauris*.

Other species, such as *Aonyx capensis, Dendromus melanotis, Felis nigripes, Genetta tigrina, Mus minutoides, Oreotragus oreotragus, Pipistrellus kuhlii, Pronolagus randensis, Saccostomys campestris, Thallomys nigricauda* and *Thryonomys swinderianus* are not quite as widespread or commonly found, but are still not considered to be under threat (based upon the threat categories and criteria listed for each under the IUCN red data list principles).

Thirty-four Red Data mammals have been observed from the region of the study area. Thirty-eight of the ninety-five species listed are estimated to have a low probability of occurring in the study area, seventeen species are ascribed a moderate-low, twenty-six a moderate, seven a moderate-high and three species have a high probability of occurring in the study area.

Four species were confirmed for the study area (observed during the field assessment or confirmed as being present by land-owners). These estimations are based on the quality, status and diversity of the untransformed mammal habitat of the study area.

10.2 Faunal Habitat Types

The close relationship between vegetation units and specific faunal composition has been noted in several scientific studies. For the purpose of this investigation the habitat types identified in the floristic assessment are therefore considered representative of the faunal assemblages. The following units were identified:

- Degraded Woodland;
- Natural Woodland Community, including:
  - Central Sandy Bushveld Variation;
  - Gold Reef Mountain Bushveld Variation;
  - Marikana Thornveld Variation;
  - Norite Koppies Bushveld Variation;
- Ridge Habitat Type;
- Transformed Areas; and
- Wetland Habitat Types.

The distribution of these habitat types are illustrated in Figure 12.

The study area is located in the Central Bushveld Bioregion, including five regional vegetation types. Specific plant communities and variations, such as listed above provide habitat for specific animal communities and –assemblages. At the level of regional vegetation communities it might not be significantly different for mammals, reptiles and frogs (e.g. Central Sandy Bushveld vs. Moot Plains Bushveld) but provide significantly different faunal habitat for invertebrate communities. Very little is however known about the ecology and diversity of invertebrates of the highveld grasslands and savannas of Gauteng; many species remain undescribed and consequently the status (threatened,

common, widespread etc.) of many species remain a mystery. Although some groups such as the Lepidoptera (butterflies & moths) have been studies at length, many of the other groups (such as Diptera – flies, Hemiptera – bugs and Hymenoptera – bees, wasps and relatives) are poorly known. Based on faunal habitat value (unique habitat characteristics, intrinsic habitat value, status and condition), three major faunal habitat variations were identified within the study area, namely:

10.2.1 Transformed areas

Areas that are considered transformed have little value as faunal habitat. Such areas are usually "beyond restoration" (as opposed to degraded areas) and are unlikely to sustain any natural faunal community or red data species – such areas have low faunal sensitivities.

10.2.2 Natural woodland

Natural savanna areas in the study area include untransformed habitat retaining a significant number of the original habitat characteristics found historically in highveld grasslands. These areas are typified by the flatlands of the highveld grasslands that do not include any significantly unique habitat characteristics, as are found in sensitive faunal habitat (below); these areas have moderate faunal sensitivities. This habitat type includes the regional vegetation type variations.

10.2.3 Sensitive Habitat (wetlands, ridges)

Sensitive faunal habitat includes all untransformed areas within the study area that are characterized by relatively unique habitat characteristics or known sensitive or threatened taxa or populations thereof. Included in this category are wetlands, ridges and sensitive areas as indicated in C-plan (Gauteng Nature Conservation: GDACE). High faunal sensitivities are ascribed to these areas.

10.3 Red Data Fauna Probabilities for the Study Area

The World Conservation Organisation (IUCN) has three threatened categories, namely Critically Endangered (CE), Endangered (EN) and Vulnerable (VU). Species that have been evaluated according to the IUCN criteria and do not fall into one of the threatened categories can be classified as Least Concern (LC), Near Threatened (NT) or Data Deficient (DD). Species classified as Least Concern have been evaluated and do not qualify for the Critically Endangered, Endangered, and Vulnerable or Near Threatened categories. Species that are widespread and abundant are normally included in this category.

10.3.1 Red Data Probability Assessment

An assessment of the probabilities of Red Data fauna species occurring in the study area is presented in Table 10.

Table 11: Red Data animals of the study area

Biological Name	English Name	STATUS	Probability
INVERTEBRATES			
Metisella meninx	Marsh Sylph	Vulnerable	moderate-low
AMPHIBIANS			
Pyxicephalus adspersus	Giant Bullfrog	Near Threatened	moderate-high
REPTILES			
Homoroselaps dorsalis	Striped Harlequin Snake	Near Threatened	moderate
MAMMALS			
Amblysomus septentrionalis	Higveld Golden Mole	Near Threatened	moderate-low
Atelerix frontalis	South African Hedgehog	Near Threatened	moderate-high
Chrysospalax villosus	Rough-haired Golden Mole	Critically Rare	low
Cloeotis percivali	Short-eared Trident Bat	Critically Rare	moderate
Crocidura cyanea	Reddish-grey Musk Shrew	Data Deficient	moderate-high
Crocidura fuscomurina	Tiny Musk Shrew	Data Deficient	low
Crocidura hirta	Lesser Red Musk Shrew	Data Deficient	moderate-high
Crocidura maquassiensis	Maquassie Musk Shrew	Vulnerable	low
Crocidura mariquensis	Swamp Musk Shrew	Data Deficient	moderate-low
Crocidura silacea	Lesser Grey-brown Musk Shrew	Data Deficient	low
Dasymys incomtus	Water Rat	Near Threatened	low
Elephantulus brachyrhynchus	Short-snouted Elephant Shrew	Data Deficient	moderate-low
Graphiurus platyops	Rock Dormouse	Data Deficient	moderate-low
Hyaena brunnea	Brown Hyaena	Near Threatened	moderate-low
Lemniscomys rosalia	Single-striped Mouse	Data Deficient	moderate-high
Leptailurus serval	Serval	Near Threatened	low
Lutra maculicollis	Spotted-necked Otter	Near Threatened	low
Manis temminckii	Pangolin	Vulnerable	low
Mellivora capensis	Honey Badger	Near Threatened	low
Miniopterus schreibersii	Schreiber's Long-fingered Bat	Near Threatened	moderate
Myosorex cafer	Dark-footed Forest Shrew	Data Deficient	low
Myosorex varius	Forest Shrew	Data Deficient	moderate
Myotis tricolor	Temminck's Hairy Bat	Near Threatened	moderate
Myotis welwitschii	Welwitsch's Hairy Bat	Near Threatened	moderate
Mystromys albicaudatus	White-tailed Rat	Endangered	low
Pipistrellus rusticus	Rusty Bat	Near Threatened	moderate
Poecilogale albinucha	African Weasel	Data Deficient	moderate
Rhinolophus blasii	Peak-saddle Horseshoe Bat	Vulnerable	moderate
Rhinolophus clivosus	Geoffroy's Horseshoe Bat	Near Threatened	moderate
Rhinolophus darlingi	Darling's Horseshoe Bat	Near Threatened	moderate
Suncus infinitesimus	Least Dwarf Shrew	Data Deficient	moderate
Suncus lixus	Greater Dwarf Shrew	Data Deficient	moderate
Suncus varilla	Lesser Dwarf Shrew	Data Deficient	moderate-low
Tatera leucogaster	Bushveld Gerbil	Data Deficient	moderate

10.3.2 Discussion

Six Red Data butterflies are known from Gauteng, none of which has been observed in the 2528CA Q-degree grid. These species are therefore not considered likely inhabitants of the area investigated.

- *Platylesches dolomitica* (Hilltop Hopper, VU) have been observed in one Q-degree grid in Gauteng (2627BC).
- *Aloeides dentatis dentatis* (Roodepoort Copper, VU) have been observed from four Q-degree grids in Gauteng (2627BB, 2628AC, 2628BC, 2628CA).
- *Chrysoritis aureus* (Heidelberg Opal, NT) are known from three Q-degree grids in Gauteng (2628AD, 2628CB, 2628DA).
- *Lepidocrhysops praeterita* (Highveld Blue, VU) are known from one Q-degree grid in the North-West Province (2627CA) and three Q-degree grids in Gauteng (2627AD, 2627BC, 2628AA).
- *Orachrysops mijburgi* (Mijburg's Blue, VU) have been observed in three Q-degree grids, namely two in the Free State (2727BB, 2727BD) and one in Gauteng (2627BD).
- The Marsh Sylph, *Metisella meninx,* is the only Red Data butterfly known from the bordering Q-grid (to the South) 2528CC. It is found in areas bordering streams or small wetlands where larvae feed on aquatic grasses. It is considered to have a moderate-low probability of occurring in the study area due to a lack of appropriate and significantly unfragmented wetland habitat.

Only one Red Data frog is known from within the boundaries of Gauteng, namely *Pyxicephalus adspersus* (Giant Bullfrog, NT), known from 174 grid cells, ten of which are located in Gauteng (2528BC, 2528CA, 2528CB, 2528CC, 2528DA, 2528DC, 2628AA, 2628AB, 2628AD, 2628BC). The study area is located in a region where the species is observed sporadically. It is known from the region of the study area and therefore not be discounted as a potential inhabitant.

Only one Red Data reptile is known from Gauteng, namely the Striped Harlequin Snake (*Homoroselaps dorsalis*, NT). The species is known from 44 grid cells (Q-degree) of which ten are located in Gauteng (2527DC, 2527DD, 2528CA, 2528CB, 2528CC, 2627BD, 2627DB, 2628AA, 2628AC, 2628CA). The Striped Harlequin Snake has a patchy distribution in the highveld grasslands of Gauteng and Free State. It is a grassland specialist; most recorded specimens have been found in moribund termitaria. Land transformation due to wide-scale commercial agriculture is thought to pose a significant threat to the species, since ploughing destroys suitable termitaria.

Fifteen mammal species listed as Data Deficient (DD) are listed for the region of the study area; three are estimated to have a low probability of occurrence, four a moderate-low and five a moderate probability. Fifteen Near Threatened (NT) mammal species are listed; four with an estimated low probability of occurrence, two with a moderate-low and

seven with a moderate probability. Only four Vulnerable (VU) species are listed; two with a low, one with a moderate-low and one with a moderate probability of occurrence. The only Endangered (EN) mammal species known from the region is estimated to have a low probability of occurrence (*Mystromys albicaudatus*). The two Critically Endangered (CR) species are estimated to have a low and moderate probability of occurring in the study area respectively, namely *Chrysospalax villosus* and *Cloeotis percivali*.

The four groups investigated (invertebrates, frogs, reptiles and mammals) are mostly earthbound (with the exception of bats which is not known to collide with power lines) and unlikely to be directly influenced by the operation of a power line as is proposed for the study area. The most significant impacts are likely to be related to the construction phase of the proposed power line. Habitat loss, habitat degradation and –fragmentation are the most likely and most significant anticipated impacts. Degradation of wetlands, loss of moribund termitaria and the creation of "barriers" (such as construction roads resulting, over time, in large ditches as a result of soil erosion) are some of the potential adverse impacts that might be expected to influence the current status of the faunal communities, assemblages and species currently found in the study area. However, careful planning in the construction phase (including placements of construction roads and construction camps) and best environmental practice could mitigate such potential impacts successfully.

10.4 Faunal Habitat Sensitivities

Faunal sensitivities are based on the assessment of the following habitat attributes:

- Biophysical habitat status
- Red Data probabilities
- Ecological linkages

The association of faunal species and assemblages with the floristic and physical environment has been proven. The assessment and discussion of faunal sensitivity issues are therefore based on the distribution of floristic communities and variations.

The calculation of faunal sensitivities are presented in Table 11 and visually presented in Figure 14.

Table 12: Faunal Habitat Sensitivities for the study area

Community	Status	Linkage	RD Likelihood	Average	SENSITIVITY CLASS
Degraded Woodland	2	5	2	30%	**Medium-Low**
Central Sandy Bushveld	6	3	2	37%	**Medium-Low**
Gold Reef Mountain Bushveld	7	4	3	47%	**Medium**
Marikana Thornveld	5	3	2	33%	**Medium-Low**
Norite Koppies Bushveld	7	4	8	63%	**Medium-High**
Ridge Habitat Types	9	9	9	90%	**High**
Transformed Areas	1	3	1	17%	**Low**
Wetland Habitat Types	6	9	9	80%	**High**

Habitat types that are pristine are regarded as high quality faunal habitat and the likelihood of Red Data species occurring within these areas is generally high. These habitat types are often associated with environmental features that are also regarded as sensitive, such as riparian zones aquatic regions and rocky outcrops. Because of the similarity between floristic and faunal habitat types, the extent of faunal habitat types per corridor section is similar to that of the floristic habitat types (Table 7). The extent of faunal habitat sensitivities per corridor section is presented in Table 12.

Table 13: Extent of faunal habitat sensitivities per corridor section

Corridor Section	Low Sensitivity	Medium-Low Sensitivity	Medium Sensitivity	Medium-High Sensitivity	High Sensitivity
Section 1	7.6 ha	69.6 ha	0.0 ha	0.0 ha	10.7 ha
Section 2	9.4 ha	102.9 ha	0.0 ha	13.0 ha	15.6 ha
Section 3	6.5 ha	71.4 ha	0.0 ha	0.0 ha	55.0 ha
Section 4	11.1 ha	60.6 ha	0.0 ha	0.0 ha	5.4 ha
Section 5	2.4 ha	2.8 ha	9.6 ha	0.0 ha	30.0 ha
Section 6	5.6 ha	4.7 ha	0.0 ha	0.0 ha	41.8 ha
Section 7	56.7 ha	72.3v	14.4 ha	0.0 ha	45.5 ha

Figure 14: Faunal habitat sensitivities of the proposed servitudes

11 Integrated Biodiversity Sensitivity

Results of the respective floristic and faunal sensitivity analysis are combined to present an overview of the ecological sensitivity of the habitat types identified in the assessment. In order to obtain the ecological sensitivity of the respective communities, the highest sensitivity for each ecological unit is selected as being representative of the ecological sensitivity of the specific ecological unit. Results are determined in Table 13 and visually presented in Figure 15.

Table 14: Ecological Sensitivity of respective habitat types

Corridor Section	Floristic Sensitivity	Faunal Sensitivity	Ecological Sensitivity
Degraded Woodland	Medium-Low	Medium-Low	**Medium-Low**
Central Sandy Bushveld	Medium	Medium-Low	**Medium**
Gold Reef Mountain Bushveld	Medium	Medium	**Medium**
Marikana Thornveld	Medium-High	Medium-Low	**Medium-High**
Norite Koppies Bushveld	Medium	Medium-High	**Medium-High**
Ridge Habitat Types	High	High	**High**
Transformed Areas	Low	Low	**Low**
Wetland Habitat Types	High	High	**High**

The extent of habitat sensitivities per corridor section is presented in Table 14.

Table 15: Extent of ecological habitat sensitivities per corridor section

Corridor Section	Low Sensitivity	Medium-Low Sensitivity	Medium Sensitivity	Medium-High Sensitivity	High Sensitivity
Section 1	7.6 ha	47.9 ha	21.7 ha	0.0 ha	10.7 ha
Section 2	9.4 ha	40.3 ha	0.0 ha	75.6 ha	15.6 ha
Section 3	6.5 ha	63.1 ha	0.0 ha	8.3 ha	55.0 ha
Section 4	11.1 ha	43.9 ha	0.0 ha	16.7 ha	5.4 ha
Section 5	2.4 ha	2.8 ha	9.6 ha	0.0 ha	30.0 ha
Section 6	5.6 ha	4.7 ha	0.0 ha	0.0 ha	41.8 ha
Section 7	56.7 ha	67.0 ha	14.4 ha	5.3 ha	45.5 ha

Comparing Corridor Sections 2 and 3, it is evident that Section 2 has less high sensitivity habitat than Section 3. Extensive medium-high sensitivity habitat is however present in Section 2. Impacts within these areas are regarded to be less significant while impacts within the high sensitivity areas can be effectively mitigated.

The use of Corridor Section 6 is recommended as the proposed corridor can be deviated around high sensitivity areas in order to avoid impact for an extensive section of the proposed corridor.

Figure 15: Ecological habitat sensitivities of the proposed corridors

12 Impact Assessment

Rating of impacts is based on the estimated effect that construction and operation of powerlines will have on terrestrial biodiversity and ecological attributes of the study area. Impacts identified in this section are partly based on the Guidance Document on Biodiversity, Impact Assessment and Decision Making in Southern Africa (2006). Impacts are assessed as it relates to the construction and operation of powerlines within a specific habitat type.

Please note that impacts will only be assessed in habitat types that were ascribed an ecological sensitivity of Medium or higher. These habitat types include:

- Natural Woodland - Central Sandy Bushveld;
- Natural Woodland - Gold Reef Mountain Bushveld;
- Natural Woodland - Marikana Thornveld;
- Natural Woodland - Norite Koppies Bushveld;
- Ridge Habitat Types; and
- Wetland Habitat Types.

12.1 Anticipated Impacts

No impacts were identified that could lead to a beneficial impact on the identified habitat type within the study area since the proposed development is largely destructive.

Impacts resulting from the construction and operation of powerlines on ecological attributes of the study area are largely restricted to the physical impacts on biota or the habitat in which they occur. Direct impacts, such as habitat destruction and modifications, are usually regarded immediate, long-term and of high significance, particularly in high sensitivity areas. These impacts are mostly measurable and fairly easy to assess as the effects thereof is immediately visible and can be determined to an acceptable level of certainty. In contrast, effects of indirect impacts are not immediately evident and can consequently not be measured to an acceptable level of certainty. A measure of subjective estimation is therefore necessary in order to evaluate this type of impact. Lastly, impacts of a cumulative nature places direct and indirect impacts of this projects into a regional and national context, particularly in view of similar or resultant developments and activities. Impacts are rated upon the background of biodiversity sensitivities as determined in previous chapters.

Potential impacts include the following, but are not necessarily limited to:

- Direct impacts:
  - Destruction of threatened flora & fauna species & associated habitat;
  - Direct impacts on common fauna species;
  - Destruction of sensitive/ pristine regional habitat types;

- Indirect Impacts:
  - Faunal interactions with structures, servitudes and personnel;
  - Impacts on surrounding habitat/ species;

- Cumulative Impacts:
  - Impacts on local and national conservation obligations & targets;
  - Increase in local and regional fragmentation/ isolation of habitat; and
  - Increase in environmental degradation.

Other, more subtle impacts on biological components, such as changes in local, regional and global climate, effects of noise pollution on fauna species, increase in acid rain, ground water deterioration, the effect of EMF on fauna species, etc. are impacts that cannot be quantified to an acceptable level of certainty and is mostly subjective in nature as either little literature is available on the topic or contradictory information exist.

12.2 Nature of Impacts

12.2.1 Destruction of Threatened Flora & Fauna Species & Associated Habitat

The loss of Red Data or Threatened species or areas that are suitable for these species is a significant impact on the biodiversity of a region. Threatened species, in most cases, do not contribute significantly to the biodiversity of an area in terms of sheer numbers as there are generally few of them, but a high ecological value is placed on the presence of such species in an area as they are frequently an indication of pristine habitat conditions. Conversely, the presence of pristine habitat conditions can frequently be accepted as an indication of the potential presence of species of conservation importance.

Red Data species are particularly sensitive to changes in their environment, having adapted to a narrow range of specific habitat requirements. Habitat changes, mostly a result of human interferences and activities, are one of the greatest reasons for these species having a threatened status. Surface transformation activities within habitat types that are occupied by flora species of conservation importance will definitely result in significant and permanent impacts on these species and their population dynamics. Effects of this impact are usually permanent and recovery or mitigation is generally not perceived as possible.

One of the greatest drawbacks in terms of limiting this particular impact is that extremely little information is available in terms of the presence, distribution patterns, population dynamics and habitat requirements of Red Data flora species in the study area. In order to assess this impact an approach it is therefore necessary to assess the presence/ distribution of habitats frequently associated with these species. Furthermore, by

applying ecosystem conservation principles to this impact assessment and subsequent planning and development phases, resultant impacts will be limited to a large extent.
Direct threats to threatened fauna species is regarded low in probability, mainly as a result of the ability of fauna species to migrate away from areas where impacts occur. Probably the only exception to this statement will be in the event where extremely localised habitat that are occupied by threatened fauna species are impacted by construction and operational activities to the extent that the habitat no longer satisfy the habitat requirements of the particular species. It should also be noted that threatened fauna species potentially occurring in the study area have relatively wide habitat preferences and ample suitable habitat is presently available throughout the study area. To place this aspect into context it is estimated that habitat loss and transformation resulting from non-invasive and often overlooked impacts, such as overgrazing, infestation by invasive shrubs and selective hunting probably contributes more to impacts on certain threatened fauna species than powerline developments ever will.

12.2.2 Direct Impacts on Common Flora & Fauna Species

The likelihood of this impact affecting common fauna species is relatively low as a result of the ability of animal species to migrate away from direct impacts. The tolerance levels of common animal species occurring in the study area is of such a nature that surrounding areas will suffice in habitat requirements of species forced to move from areas of impact.

Likely, common flora species are widespread and occur abundantly in other, adjacent habitat. The possibility of this proposed powerline affecting common flora species to the extent that their conservation status might change is regarded highly unlikely.

12.2.3 Destruction of Sensitive / Pristine Regional Habitat Types

The loss of pristine natural regional habitat represents loss of habitat and biodiversity on a regional scale. Sensitive habitat types include ridges, koppies, wetlands, rivers, streams and localised habitat types of significant physiognomic variation and unique species composition. These areas represent centres of atypical habitat and contain biological attributes that are not frequently encountered in the greater surrounds. A high conservation value is attributed to the floristic communities and faunal assemblages of these areas as they contribute significantly to the biodiversity of a region. Furthermore, these habitat types are generally isolated and are frequently linear in nature, such as rivers and ridges. Any impact that disrupts this continuous linear nature will risk fragmentation and isolation of existing ecological units, affecting the migration potential of some fauna species adversely, pollinator species in particular.

The importance of regional habitat types is based on the conservation status ascribed to vegetation types. However, the actual impact of the construction and operation of powerlines in grassland habitat is generally low since extremely little impacts result on the

structure of the vegetation. Impacts within grassland habitat are mostly restricted to the footprint areas of the pole structures, which is extremely small. Visual observations within existing servitudes revealed very little variation in the species composition between areas in- and outside the powerline servitude.

12.2.4 Faunal Interactions with Structures, Servitudes & Personnel

It should be noted that animals generally avoid contact with human structures, but do grow accustomed to structures after a period. While the structures are usually visible as a result of clearance around tower footprints, injuries and death of animals do occur sporadically as a result of accidental contact. Large mammals are mostly prone to this type of impact. In particular, primate species such as baboons and monkeys are known to climb pole structures. Alteration of habitat conditions within the servitudes does not necessarily imply a decrease in faunal habitation. These areas are frequently preferred by certain fauna species. The establishment of a dominant grass layer generally results in increased presence of grazer species, which might lead to an unlikely, but similar increase in predation within these areas.

The presence of personnel within the servitude during construction and maintenance periods will inevitably result in contact with animals. While most of the larger animal species are likely to move away from human contact, dangerous encounters with snakes, scorpions and possibly larger predators always remain likely. Similarly, the presence of humans within areas of natural habitat could potentially result in killing of animals by means of snaring, poaching, road kills, poisoning, trapping, etc.

12.2.5 Impacts on Surrounding Habitat / Species

Surrounding areas and species present in the direct vicinity of the study area could be affected by indirect impacts resulting from construction and operation activities. These impacts could include all of the above impacts, depending on the sensitivity and status of surrounding habitat and species as well as the extent of impact activities. This impact also includes the floristic species changes that could potentially occur as a result of the alteration of habitat physiognomy, particularly in woodland areas.

12.2.6 Impacts on Local and National Conservation Obligations & Targets

This impact is regarded a cumulative impact since it affects the status of conservation strategies and targets on a local as well as national level and is viewed in conjunction with other types of local and regional impacts that affects conservation areas. Impacts that could potentially affect the status of protected areas are regarded unacceptable and should be avoided at all costs. Also, aligning the servitudes in proximity to conservation areas as a mitigation measure against impacting on the conservation areas is not always a good solution as it places a limitation on the future expansion of conservation areas. This

will only be a solution in selected cases where extensive transformed habitat is available for the use of servitudes. Natural habitat in the general surrounds of conservation areas do act as a buffer for these areas, also as a potential source of genetic variability, particularly in the case of relative small conservation areas.

12.2.7 Increase in Local & Regional Fragmentation / Isolation of Habitat

Uninterrupted habitat is a precious commodity for biological attributes in modern times, particularly in areas that are characterised by moderate and high levels of transformation. The loss of natural habitat, even small areas, implies that biological attributes have permanently lost that ability of occupying that space, effectively meaning that a higher premium is placed on available food, water and habitat resources in the immediate surrounds. This, in some instances might mean that the viable population of plants or animals in a region will decrease proportionally with the loss of habitat, eventually decreasing beyond a viable population size. The danger in this type of cumulative impact is that effects are not known, or is not visible; with immediate effect and normally when these effects become visible they are beyond repair. Lineare types of developments affect the migratory success of animals in particular.

An important mitigation measure in this regard is to utilise existing causal factors of habitat fragmentation. One factor that will be taken into consideration is the presence of existing powerlines in the study area. Habitat fragmentation will not be increased significantly when new powerlines are placed adjacent to existing lines or other types of linear structures, such as roads. In contrast, constructing new powerlines through areas of unfragmented habitat, the adverse effects of habitat fragmentation and isolation will be maximised. Therefore, where potential servitudes are presented with similar sensitivities, a potential alignment with an existing servitude might result in one being more suitable for the proposed development than an option affecting an area of largely untransformed habitat. Unfortunately this is not always a clear-cut case as it is heavily dependent on the local and regional sensitivity of the existing line, which might be located in areas of high sensitivity, while a line going through untransformed habitat might represent impacts of lower significance in terms of other types of impacts.

12.2.8 Increase in Environmental Degradation

Impacts associated with this type of development that will lead to initial, incremental or augmentation of existing types of environmental degradation include impacts on the air, soil and water present within available habitat. Pollution of these elements might not always be immediately visible or readily quantifiable, but incremental or fractional increases might rise to levels where biological attributes could be affected adversely on a local or regional scale. In most cases are these effects are not bound and is dispersed, or diluted over an area that is much larger than the actual footprint of the causal factor.

Similarly, developments in untransformed and pristine areas are usually not characterised by visibly significant environmental degradation and these impacts are usually most prevalent in areas where continuous and long-term impacts have been experienced.

12.3 Construction Phase

12.3.1 Rating of Impacts

Impacts are assessed prior to the implementation of any mitigation measures as well as subsequent to the implementation of all required and recommended mitigation measures in order to indicate the expected efficiency of proposed measures. Significance of impacts is rated as **high**, **medium**, or **low**.

Nature	**Impacts of powerlines within the Central Sandy Bushveld Variation**	
	Before Mitigation	**After Mitigation**
Extent	2	1
Duration	4	3
Magnitude	2	1
Reversibility	3	1
Consequence	11	6
Probability	2	1
Significance	**22**	**6**
Status	Negative	Negative
Irreplaceable loss of resources?	No	
Can impacts be mitigated	Yes	
Mitigation	Medium-high	
Cumulative Impacts	Increase in habitat degradation	
Residual Impacts	Species changes, degraded habitat	

Nature	**Impacts of powerlines within the Gold Reef Mountain Bushveld Variation**	
	Before Mitigation	**After Mitigation**
Extent	1	1
Duration	3	2
Magnitude	3	2
Reversibility	3	3
Consequence	10	8
Probability	3	2
Significance	**30**	**16**
Status	Negative	Negative
Irreplaceable loss of resources?	No	
Can impacts be mitigated	Yes	
Mitigation	Medium-high	
Cumulative Impacts	Increase in habitat degradation, habitat fragmentation, habitat isolation	
Residual Impacts	Species changes, degraded habitat	

Nature	**Impacts of powerlines within the Marikana Thornveld Variation**	
	Before Mitigation	**After Mitigation**
Extent	2	1
Duration	3	2
Magnitude	3	2
Reversibility	3	3
Consequence	11	8
Probability	3	2
Significance	**33**	**16**
Status	Negative	Negative
Irreplaceable loss of resources?	No	
Can impacts be mitigated	Yes	
Mitigation	Medium	
Cumulative Impacts	Increase in habitat degradation, habitat fragmentation, habitat isolation, conservation targets	
Residual Impacts	Species changes, degraded habitat	

Nature	**Impacts of powerlines within the Norite Koppies Bushveld Variation**	
	Before Mitigation	**After Mitigation**
Extent	1	1
Duration	3	2
Magnitude	2	1
Reversibility	3	3
Consequence	9	7
Probability	3	2
Significance	**27**	**14**
Status	Negative	Negative
Irreplaceable loss of resources?	No	
Can impacts be mitigated	Yes	
Mitigation	Medium	
Cumulative Impacts	Increase in habitat degradation, habitat fragmentation, habitat isolation	
Residual Impacts	Species changes, degraded habitat	

Nature	Impacts of powerlines within the Ridge Habitat Type	
	Before Mitigation	**After Mitigation**
Extent	3	3
Duration	5	4
Magnitude	4	3
Reversibility	5	3
Consequence	17	13
Probability	4	3
Significance	**68**	**39**
Status	Negative	Negative
Irreplaceable loss of resources?	Yes	
Can impacts be mitigated	No	
Mitigation	Low	
Cumulative Impacts	Increase in habitat degradation, habitat fragmentation, habitat isolation, conservation targets	
Residual Impacts	Species changes, degraded habitat	

Nature	Impacts of powerlines within Wetland Habitat Types	
	Before Mitigation	**After Mitigation**
Extent	3	3
Duration	4	3
Magnitude	3	2
Reversibility	3	3
Consequence	13	11
Probability	3	2
Significance	**39**	**22**
Status	Negative	Negative
Irreplaceable loss of resources?	No	
Can impacts be mitigated	Yes	
Mitigation	Medium	
Cumulative Impacts	Increase in habitat degradation, habitat fragmentation, habitat isolation	
Residual Impacts	Species changes, degraded habitat	

12.3.2 Discussion

Expected impacts are mostly as a result of the physical disturbance of surface areas and clearance of servitudes during the construction period. Impacts within the ridge habitat type is regarded to be highly significant and severe mitigation measures need to be put into practice in areas where unavoidable impacts will occur in order to minimize adverse impacts on sensitive biodiversity attributes.

Impacts within the remainder of the area are regarded to be of moderate nature and the implementation of generic mitigation measures is expected to minimize likely impacts within these environments.

12.4 Impact Assessment Rating – Operational Phase

Significance of impacts is rated as **high**, **medium**, or **low**.

12.4.1 Rating

Nature	**Impacts of powerlines within the Central Sandy Bushveld Variation**	
	Before Mitigation	**After Mitigation**
Extent	1	1
Duration	4	4
Magnitude	2	1
Reversibility	3	1
Consequence	10	7
Probability	2	1
Significance	**20**	**7**
Status	Negative	Negative
Irreplaceable loss of resources?	No	
Can impacts be mitigated	Yes	
Mitigation	Medium-high	
Cumulative Impacts	Increase in habitat degradation	
Residual Impacts	Species changes, degraded habitat	

Nature	**Impacts of powerlines within the Gold Reef Mountain Bushveld Variation**	
	Before Mitigation	**After Mitigation**
Extent	1	1
Duration	4	3
Magnitude	2	1
Reversibility	3	1
Consequence	10	6
Probability	3	2
Significance	**30**	**12**
Status	Negative	Negative
Irreplaceable loss of resources?	No	
Can impacts be mitigated	Yes	
Mitigation	Medium-high	
Cumulative Impacts	Increase in habitat degradation, habitat fragmentation, habitat isolation	
Residual Impacts	Species changes, degraded habitat	

Nature	**Impacts of powerlines within the Marikana Thornveld Variation**	
	Before Mitigation	**After Mitigation**
Extent	1	1
Duration	4	3
Magnitude	2	1
Reversibility	3	3
Consequence	10	8
Probability	3	2
Significance	**30**	**16**
Status	Negative	Negative
Irreplaceable loss of resources?	No	
Can impacts be mitigated	Yes	
Mitigation	Medium	
Cumulative Impacts	Increase in habitat degradation, habitat fragmentation, habitat isolation, conservation targets	
Residual Impacts	Species changes, degraded habitat	

Nature	**Impacts of powerlines within the Norite Koppies Bushveld Variation**	
	Before Mitigation	**After Mitigation**
Extent	1	1
Duration	3	2
Magnitude	3	2
Reversibility	3	2
Consequence	10	7
Probability	3	2
Significance	**30**	**14**
Status	Negative	Negative
No	No	
Yes	Yes	
Mitigation	Medium	
Increase in habitat degradation, habitat fragmentation, habitat isolation	Increase in habitat degradation, habitat fragmentation, habitat isolation	
Species changes, degraded habitat	Species changes, degraded habitat	

Nature	Impacts of powerlines within the Ridge Habitat Type	
	Before Mitigation	**After Mitigation**
Extent	2	2
Duration	4	3
Magnitude	3	2
Reversibility	3	3
Consequence	12	10
Probability	3	2
Significance	**36**	**20**
Status	Negative	Negative
Irreplaceable loss of resources?	Yes	
Can impacts be mitigated	No	
Mitigation	Low	
Cumulative Impacts	Increase in habitat degradation, habitat fragmentation, habitat isolation, conservation targets	
Residual Impacts	Species changes, degraded habitat	

Nature	Impacts of powerlines within Wetland Habitat Types	
	Before Mitigation	**After Mitigation**
Extent	2	2
Duration	4	3
Magnitude	3	2
Reversibility	3	3
Consequence	12	10
Probability	3	2
Significance	**36**	**20**
Status	Negative	Negative
Irreplaceable loss of resources?	No	
Can impacts be mitigated	Yes	
Mitigation	Medium	
Cumulative Impacts	Increase in habitat degradation, habitat fragmentation, habitat isolation	
Residual Impacts	Species changes, degraded habitat	

12.4.2 Discussion

Impacts during the operational phase of the project are mostly restricted to the maintenance procedures within the servitudes as well as latent effects of habitat alteration, particularly in the woodland areas. Impacts are generally regarded to be of a moderate nature and the implementation of generic mitigation measures are expected to decrease the significance of impacts to a benign status.

12.5 High Impact Areas

High impact areas and recommended realignments are indicated in Figure 16.

High Impact Area 1	Localised riparian habitat. Habitat within this part of the study area is relative degraded and the implementation of generic mitigation measures is recommended. No geographic alternative to this part of the corridor is available. Footprints should be placed outside delineated wetland habitat, limit clearance of woody vegetation to a minimum.
High Impact Area 2	Extensive wetland areas. This corridor section is indicated to run parallel to the perennial river for an extensive distance, which is not ideal. Although the vegetation within these parts is not regarded pristine, a relative high probability of impacts on Red Data species could occur. Mitigation of impacts is expected to result only in limited success. The use of Section 2 is preferred.
High Impact Area 3	Localised ridge habitat. A relative high probability of impacts on Red Data species and sensitive habitat types is estimated. Deviate proposed corridor around the ridge habitat, preferably to the west alongside the road. It should be noted that extensive ridge areas are also located to the west and east of this high impact area, impacts within these areas should be avoided at all costs.
High Impact Area 4	Localised riparian habitat. Habitat within this part of the study area is relative degraded and the implementation of generic mitigation measures is recommended. No geographic alternative to this part of the corridor is available. Footprints should be placed outside delineated wetland habitat, limit clearance of woody vegetation to a minimum.
High Impact Area 5	Extensive ridge habitat. Deviate proposed corridor around this habitat, align proposed corridor with existing powerline servitudes and low sensitivity areas, this will ultimately reduce the significance of impacts within this part of the corridor extensively.
High Impact Area 6	Extensive ridge habitat. The use of this section (6) is not recommended; 1) impacts are of low mitigation potential, 2) mitigation of impacts in section 5 is regarded mitigatable and will ultimately be of lower significance, and 3) impacts within this section is regarded to be of higher significance than section 6.
High Impact Area 7	Extensive ridge habitat. Impacts within this part of the corridor are unavoidable. Align proposed corridor with existing lines of

	transformation and degradation (existing servitudes and roads).
High Impact Area 8	Extensive ridge habitat. Impacts within this part of the corridor are unavoidable. Align proposed corridor with existing lines of transformation and degradation (existing servitudes and roads).
High Impact Area 9	Localised riparian habitat. No geographic alternative to this part of the corridor is available. Footprints should be placed outside delineated wetland habitat, limit clearance of woody vegetation to a minimum. Lines should cross riparian habitat perpendicular to the stream.

Figure 16: High impact areas & recommended deviations

13 Activities Resulting in Impacts

A summation/ elaboration of expected activities are presented, based on generic procedures followed (Section 21). Activities that will result in adverse impacts on the natural environment will include the following, but are not necessarily limited to:

Activity 1 - construction and use of access roads;
Activity 2 - clearing of vegetation for construction and access purposes where required;
Activity 3 - surface disturbances surrounding footprint areas;
Activity 4 - surface disturbances in areas used for storage space;
Activity 5 - excavation of footprints;
Activity 6 - human movement and use of surrounding areas;
Activity 7 - health and sanitation issues;
Activity 8 - occurrence of open and accidental fires;
Activity 9 - refuelling and vehicle maintenance (spillages and pollution);
Activity 10 - poaching/trapping/ illegal hunting;
Activity 11 - storage and use of chemicals; and
Activity 12 - clearing of vegetation for servitude maintenance (removing, cutting, trimming of trees), including physical clearance and use of chemicals.

13.1 Access Roads - Construction & Use

For much of the grassland areas, this activity does not constitute a significant impact and the loss of biodiversity attributes are not expected to affect the status or sensitivity of habitat or species on a local or regional scale. However, sensitive areas, including rivers, streams and mountainous parts in particular, are regarded extremely vulnerable for related impacts and significant impacts is expected to occur as a result of the construction and use of access roads. Adverse effects of this activity include increased erosion, destabilisation of the substrate, prevalence of weeds and invasive species, damage to pristine and sensitive environments.

The rehabilitation and use of existing roads is recommended for the proposed operations. Construction of new access roads in the mountainous areas is regarded a prohibited activity and should be considered only when all other alternatives have been exhausted. The construction process should be undertaken with extreme care and under the implementation of all necessary mitigation measures.

13.2 Surface Disturbances Surrounding Footprint Areas

Importing materials, vehicles, personnel, storage of materials, infrastructure, removal of existing structures, excavation, construction activities include actions that will result in the degradation of the immediate surrounds of pole locations. These effects are usually associated with the decimation of herbaceous and scrubby layers, open soils, erosion and infestation by weeds and pioneer species. Clear and proper demarcation of construction areas should be maintained in order to limit the effect of these activities to a minimum.

Proper cleanup and rehabilitation should suffice in limiting impacts associated with this activity. This activity is not expected to result in significant impacts in low sensitivity areas, but high sensitivity areas will be affected adversely.

13.3 Surface Disturbances in Areas used for Storage Space

Extensive storage areas lead to surface disturbances that contribute to environmental degradation. Accessibility and future rehabilitation need to be considered in the selection of storage areas. Sensitive areas need to be avoided at all costs. Provisions must be made for waste management, temporary ablution facilities, vehicle maintenance areas, erosion control, proper fencing, etc.

13.4 Excavation of Footprints

Areas need to be excavated in order for the substrate anchoring of pole structures. Fortunately these areas are small in size and associated activities and movement of vehicles and personnel is regarded to represent a more severe risk to the environment than the actual footprint excavation. It is cautioned that the loss of topsoil, infestation with weeds and pioneer species, increased erosion and localised impacts on flora are some of the impacts associated with this activity that need to be monitored.

This activity is not expected to result in significant impacts in low sensitivity areas, but high sensitivity areas will be affected adversely.

13.5 Human Movement & Use of Surrounding Areas

The presence of personnel and the activities in a natural environment will result in localised surface disturbances in and around the construction sites. All vehicle and human movement must be restricted to the servitude area and access roads. Clear demarcation of construction areas must be provided. This is regarded particularly important in order to avoid any contact with animals within conservation areas and game farms. Speed limits must be sufficiently low in order to prevent accidents while periods of vehicular movement should be restricted to periods of light, i.e. no travelling during the night.

Noise levels should be controlled. It is unavoidable that periods of high noise will be experienced, every attempt should be made to limit these periods as far as possible. It is envisaged that this will form part of the responsibilities of the ECO.

Animals usually have a relative high tolerance for noise and disturbances. Most species, when being disturbed, will temporarily evacuate the area and seek suitable shelter, to return at a later stage. However, some animals might be affected to the state where nests or cover is permanently abandoned. The identification of these sites and location of infrastructure and construction facilities as far away as possible should form part of the

responsibilities of the ECO. Any unnecessary disturbances, particularly from vehicles and helicopters, should be avoided as far as possible.

13.6 Health, Sanitation and Litter Issues

Drinking of water from streams should not be allowed, drinking water should be provided for on site workers from a trusted source. Temporary sanitation facilities need to be available to site workers at all times. The use thereof should furthermore be advocated.

Aspects pertaining to snakes, scorpions and similar dangerous impacts need to be taken into consideration during the period of maintenance and construction. All health and safety related issues need to be addressed prior to any personnel going on site.

All litter should be contained in suitable storage areas and immediately removed to a suitable disposal facility. Plastic bags, containers, wrapping and insulation material will pose a threat to animals of the area.

13.7 Occurrence of Open & Accidental Fires

The use of fires for cooking purposes or any other purpose may result in accidental spread to adjacent areas. All areas, as a result of high biomass and flammability are regarded prone to the development and spread of accidental fires. Although fire is a natural occurrence, any accidental occurrence should be prevented. Other causes include smoking, discarded cigarettes and matches, overheating vehicles or equipment or faulty electrical equipment or wiring, welding and cutting operations. No firewood may be collected.

13.8 Refuelling & Vehicle Maintenance (spillages and pollution)

Refuelling should be restricted to areas dedicated for this activity, preferably at an existing off-site refuelling facility. On-site refuelling should be done with extreme care, taking all preventative measures against spillages.

Similarly, emergency vehicle maintenance/ repairs should be done in a suitably manner to avoid any spillages or pollution of the environment. Spillages of any nature should be cleaned and rehabilitated by means of appropriate measures.

13.9 Poaching/ Trapping/ Illegal Hunting

Any interaction with wild animals should be prevented and all wild animals should be treated as dangerous, particularly snakes, scorpions, large mammals and predators. The trapping, poaching or capturing of any animal is regarded an illegal activity. Any contact with wild animals should be avoided as far as possible. Should the presence of wild animals happen to interfere with construction, safety or operational procedures a responsible person should be contacted to deal with the problem or remove the animals. It is strongly advised that a herpetologist/ snake capturer be on permanent stand-by for the specialised capturing, removing and relocating of reptiles. Proper medical procedures/ treatment should also be available on-site in the event of injuries or incidents, particularly for snake-bites.

13.10 Clearing of Vegetation for Construction & Access Purposes

Clearance of vegetation should be done in accordance to standards as available in Eskom documentation.

13.11 Storage & Use of Hazardous Materials & Chemicals

Hazardous materials and chemicals should be stored and use in a manner not to affect the natural environment negatively. Storage should be off site and only be transported to a site when required and then only in an acceptable and safe manner. Mixing of chemicals should be conducted as per manufacturer's label, taking cognisance of all specifications. Appropriate safety measures should implemented by users of all chemicals. By no means should any water be extracted from streams and rivers for the purpose of mixing chemicals. In the event of pollution it must be dealt with in the prescribed manner so that the environment is not damaged.

Chemicals used in the immediate vicinity of rivers, streams and dams should be applied in a manner not to pollute the water. This would probably exclude spraying methods. Pollution of any surface of ground water must be reported to the Department of Water Affairs.

13.12 Clearing of Vegetation for Servitude Maintenance

Clearance levels between the conductor and vegetation need to be maintained in the interest of effective line performance and for safety purposes. Pruning of indigenous trees is preferred to complete removal. Pruning must be according to set standards as available in Eskom documentation.

Alien vegetation is mostly associated with the rivers and old agricultural fields. All alien vegetation should be removed from the servitude area. Accepted removal and treatment

methods should be implemented with extreme caution not to contaminate aquatic systems. Herbicide application to be conducted according to manufacturer's label. Clearance of vegetation should be done in accordance to standards as available in Eskom documentation.

Grass buildup around structures should be hoed/ slashed to required levels. The implementation of a fire management strategy is recommended to prevent grass buildup within the servitude areas. This is preferred to large scale mowing.

14 Recommended Mitigation Measures

The single most important mitigation measure in the case of line variants that were identified as being unsuitable for the proposed development, in terms of biodiversity and ecological aspects, is the preferred use of an alternative line variant that will result in less significant impacts.

Mitigation measures are divided into two groups, namely:

- generic mitigation measures (measures that is required/ recommended for the entire line and during the maintenance/ construction process); and
- site/ action specific mitigation measures (measures that is required/ recommended for specific sites, or in the event of specific activities or impacts).

14.1 Generic Mitigation Measures

Mitigation Measure 1 - Appoint Environmental Control/ Site Officer. Appointment prior to start of construction, responsibilities should include, but not limited to ensuring adherence to EMP guidelines, guidance of activities, planning, reporting;

Mitigation Measure 2 - Compile and implement environmental monitoring programme, the aim of which should be ensuring long-term success of rehabilitation and prevention of environmental degradation;

Mitigation Measure 3 - Conduct a final walkthrough prior to commencement of construction activities. This should be the responsibility of ECO/ ecologist. Responsibilities should be ensuring absence of Red Data species from construction sites, identification of localised areas of significance;

Mitigation Measure 4 - Identify areas of high ecological sensitivity during final walk-through and recommend localised deviations in the alignment;

Mitigation Measure 5 - Identify areas that will be suitable for access roads, ensuring proper upgrade/ construction/ maintenance in order to limit erosion, proliferation of weeds, etc.;

Mitigation Measure 6 - Limit construction, maintenance and inspection activities to dry periods in order to curb occurrence/ augmentation of erosion in

areas of existing erosion, destabilizing of substrate in areas of high slopes, riparian zones, etc;

Mitigation Measure 7 - Demarcate construction areas in order to control movement of personnel, vehicles, providing boundaries for construction sites in order to limit dilution or spread of peripheral impacts;

Mitigation Measure 8 - Remove and store topsoil separately in areas where excavation/ degradation takes place. Topsoil should be used for rehabilitation purposes in order to facilitate regrowth of species that occur naturally in the area;

Mitigation Measure 9 - Compile an education programme for all contractors and subcontractors/ workers to ensure compliance to all aspects of EMP as well as educating personnel in the safe and proper conduct within areas of natural habitat;

Mitigation Measure 10 - Prevent open fires, provide demarcated fire-safe zones, facilities and fire control measures;

Mitigation Measure 11 - Limit damage/ pruning/ cutting of indigenous trees to a minimum in accordance to Eskom guidelines;

Mitigation Measure 12 - The pruning of the woody layer is recommended instead of complete removal of all woody plants. Leaving a significant portion of the woody structure intact will prevent the establishment of an atypical habitat, limiting adverse impacts to a large extent;

Mitigation Measure 13 - Ensure off site storage of hazardous materials, chemicals, fuels, oils, etc. in order to prevent accidental spillage, contamination or pollution;

Mitigation Measure 14 - Develop emergency maintenance operational plan to deal with any event of contamination, pollution or spillages, particularly in sensitive areas;

Mitigation Measure 15 - Provide temporary on-site sanitation, litter and waste management and hazardous materials management facilities;

Mitigation Measure 16 - Ensuring surface restoration and resloping in order to prevent erosion, taking cognisance of local contours and landscaping;

Mitigation Measure 17 - Rehabilitation of disturbed areas subsequent to construction activities, taking cognisance of factors such as topsoil replacement, removal of introduced materials, local environmental factors;

Mitigation Measure 18 - Removal of dismantled structures, rubble, litter, refuse, temporary infrastructures, sanitation equipment, etc. subsequent to construction and rehabilitation; and

Mitigation Measure 19 - Final inspection in order to ensure adherence to EMP guidelines, completion of localised/ remaining areas of impact, monitoring of rehabilitation success, etc.

14.2 Site Specific Mitigation Measures

Some of the site specific mitigation measures are indicated in Figure 16. These site specific mitigation measures are in addition to the recommended realignments presented in Section 12.5.

The following site/ action specific mitigation measures are recommended:

Mitigation Measure 20 - Conduct on-foot inspections in areas where access for vehicles are not possible/ feasible;

Mitigation Measure 21 - Prohibit construction of new access roads in areas of high environmental sensitivity. Use should be made of existing roads, ensuring proper maintenance/ upgrade. Alternative methods of construction/ access to sensitive areas is recommended;

Mitigation Measure 22 - Construction of new/ temporary bridges as part of access roads across non-perennial streams and larger rivers is regarded a prohibited activity, use should be made of existing crossings, ensuring proper maintenance/ upgrade;

Mitigation Measure 23 - Ensure proper substrate anchorage, provide 'dummy pole' in order to prevent damage/ injury of mammals as a result of direct contact with pole structures;

Mitigation Measure 24 - Ensure that riparian areas are spanned/ pole structures are not placed within proximity to rivers, streams. Ensure placement of footprints outside 1:100 year floodlines. Crossing of riparian systems is only permitted at existing/ approved crossing points, taking due care to prevent additional/ new impacts;

Mitigation Measure 25 - Prevent impacts on any surface water as a result of hazardous materials, contamination, unnecessary crossing by vehicles or personnel, extraction, drinking or other human uses, construction and maintenance activities; and

Mitigation Measure 26 - Remove invasive and alien vegetation, particularly in vicinity of riparian zones where alien and invasive trees are known to occur. The implementation of a monitoring programme in this regard is recommended, being the responsibility of the ECO/ ecologist.

15 Photographic Records

Photo 1: Example of Ridge Habitat

Photo 2: Example of non-perennial stream (moderately degraded)

Photo 3: Example of natural woodland habitat

Photo 4: Example of localised koppies (ridge habitat, Norite Koppies Bushveld)

Photo 5: Example of non-perennial stream (degraded)

Photo 6: Example of ridge habitat (Gold Reef Mountain Bushveld)