Ecological Impact Assessment Update, Roodeplaat Wind Energy Facility, Eastern Cape, South Africa

LD BIODIVERSITY CONSULTING

Ecological Impact Assessment Update, Roodeplaat Wind Energy Facility, Eastern Cape, South Africa.

Prepared by

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(M.Sc., Pri. Sci. Nat)

For

SRK

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Biodiversity Assessments, Baseline surveys and Impact Assessments and Integrated Biodiversity Management Solutions.

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Appointment of Specialist
Leigh-Ann de Wet (LD Biodiversity Consulting) was commissioned by SRK to undertake an updated Ecological Impact Assessment. Terms of reference were to review the existing Ecological Impact Assessment, rate the impacts based on the SRK impact rating scale and address comments made by Interested and Affected parties on the Scoping Report. This report thus serves as an addendum to the original Ecological Impact Assessment conducted by CES in 2014.

Details of Specialist
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Expertise of the specialist
- M.Sc. in Botany from Rhodes University.
- Registered Professional Natural Scientist with the South African Council for Natural Scientific Professionals (Ecological Science).
- Registered with RSPO as a certified High Conservation Value Assessor (Plants), since 2011.
- Founded LD Biodiversity Consulting in 2014.
- Ecological Consultant since 2009.
- Conducted, or have been involved in over 100 Ecological Impact Assessments, Baseline surveys, Biodiversity Action Plans and Offset Plans throughout Africa.
- Published four scientific papers, two popular articles and have three scientific papers in preparation.
- Presented 7 international conference presentations, and at two Botanical Society meetings.
- Lectured methods for specialist assessment for the Rhodes University short course on EIA.

Independence
Leigh-Ann de Wet and LD Biodiversity Consulting have no connection with Inyanda Energy Projects (PTY) LTD, and LD Biodiversity Consulting is not a subsidiary of any kind of Inyanda Energy Projects (PTY) LTD. The remuneration for services by SRK in relation to this report and associated studies is unrelated to approval by decision-making authorities responsible for authorization of any Inyanda Energy Projects (PTY) LTD activity. LD Biodiversity Consulting has no interest in secondary developments as a result of this project. The percentage of work received directly or indirectly from Inyanda Energy Projects (PTY) LTD in the last twelve months is 10%.

Scope and Purpose of Report
The scope and purpose of the report is described in the section on Terms and Reference within this report.

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List of Acronyms and Abbreviations

AoI	Area of Influence
CBA	Critical Biodiversity Area
CES	Coastal and Environmental Services
CITES	Convention on the International Trade in Endangered Species
CSSC	Confirmed Species of Special Concern
CV	Curriculum Vitae
db	Decibels

DEA	Department of Environmental Affairs
ECBCP	Eastern Cape Biodiversity Conservation Plan
Hz	Hertz
IFC	International Finance Corporation
IUCN	International Union for the Conservation of Nature
kHz	Kilohertz
km/h	Kilometres per hour
m	metres
NEMBA	National Environmental Management Biodiversity Act
NPAES	National protected Areas Expansion Strategy
PNCO	Provincial Conservation Ordinance
PSSC	Possible Species of Special Concern
RDB	Red Data Book
SA	South Africa
SACNASP	South African Council for Natural Scientific Professionals
SKEP	Succulent Karoo Ecosystem Plan
SSC	Species of Special Concern
STEP	Subtropical Ecosystem Plan
ToR	Terms of Reference
WEF	Wind Energy Facility

1 Introduction

1.1 Objectives

An updated Ecological Impact Assessment for the proposed Inyanda Wind Energy Facility (WEF) was undertaken to:

- Ground-truth existing information on the vegetation and fauna of the proposed WEF;
- Provide an impact assessment based on the SRK impact rating scale; and
- To address issues of concern raised by Interested and Affected Parties in response to the scoping report.

1.2 Terms of Reference

The Terms of Reference (ToR) for the study are as follows:

1. Address relevant issues raised by Interested and Affected parties during the scoping phase;
2. Assess those areas of the site where changes have been made to the infrastructure layout, concentrating on vegetation and in accordance with the ToR provided in the SRK Scoping Report;
3. Ground truth the results of the original CES report results;
4. Review the original CES report and fill in any gaps identified from the SRK Scoping Report ToR

The ToR provided in the Scoping Report are as follows:

1. A detailed description of the ecological (fauna and flora) environment within and immediately surrounding the footprint of the proposed development and will consider terrestrial fauna and flora. Fauna include mammals, reptiles, amphibians, and insects but not avifauna as these will be the subject of a separate specialist. This aspect of the report will specifically include the identification of:

    - Areas of high biodiversity;
    - The presence of species of special concern, including sensitive, endemic and protected species;
    - Habitat associations and conservation status of the identified fauna and flora;
    - The presence of areas sensitive to invasion by alien species; and
    - The presence of conservation areas and sensitive habitats where disturbance should be avoided or minimised.

2. Review relevant legislation, policies, guidelines and standards, including the Eastern Cape Protected Area Expansion Strategy and the fine scale conservation plan for the Baviaanskloof;
3. An assessment of the potential direct and indirect impacts resulting from the proposed development (including the wind turbines, associated infrastructure, e.g. access roads), both on the footprint and the immediate surrounding area during construction and operation;
4. A detailed description of appropriate mitigation measures that can be adopted to reduce negative impacts for each phase of the project, where required; and
5. Checklists of faunal groups identified in the region to date, highlighting sensitive species and their possible areas of distribution.
6. Specific questions that the ecological assessment must address are as follows:

    - The extent to which biodiversity in the greater planning domain (including current and proposed protected areas or the broader catchment) will be impacted if the development is authorised. It is recognised that a number of planning domains exist and the specialist will be required to select the most appropriate planning domain, motivate that selection, and make an assessment in terms of this;
    - The significance of loss of habitat and habitat fragmentation must be assessed in terms of general biodiversity and in terms of key terrestrial species identified during public consultation (e.g. Leopard, ghost frog, Elandsberg dwarf chameleon, and Smith's dwarf chameleon);
    - Conduct a literature review of the impact of noise on the above-mentioned species (or similar) with the objective of estimating the significance that increased noise during construction and/or operation will have on these species, either in terms of reducing the size of their habitat by more than the physical footprint of the development, or discouraging them to traverse the site (i.e. contribute to habitat fragmentation by more than the physical footprint of the development);
    - Comment on the impact of fencing (if any) on fragmentation of each of these species and on biodiversity in general;
    - Comment on whether, in terms of impacts on terrestrial ecology (such as the occurrence of threatened species on the site), the application should be authorised or not; and
    - Overlay identified vegetation types on a contour map, as per the comment from DEDEAT on the correlation between altitude topography and vegetation type; and
    - Discuss the relevance of fire in the ecological processes of Kouga Grassy Sandstone Fynbos and the implications (if any) to this project.

1.3 Project Team

The project team will comprise Leigh-Ann de Wet, an ecologist, her CV can be found in Appendix 1.

Leigh-Ann is an ecologist with her MSc in Botany from Rhodes University.
She is registered as a Professional Natural Scientist (ecology) with the South African Council for Natural Scientific Professionals (SACNASP), and as a High Conservation Value assessor with the Round Table on Sustainable Palm Oil. Leigh-Ann founded her own biodiversity consulting company in 2014, and has been an ecological consultant since 2009. She has worked on several Ecological Impact Assessments, Baseline Surveys, Biodiversity Action Plans and Offset Plans, among others. She has published several articles, both peer reviewed scientific and popular and presented at 7 international conferences. She has also lectured in methods for specialist assessments for the Rhodes University and CES short course on Environmental Impact Assessment. Leigh-Ann has substantial experience in Wind Energy Facility Ecological Impact Assessments and has completed over 20.

1.4 Assumptions and limitations

- This assessment forms an update of the existing ecological work on the site, rather than an exhaustive study;
- Species of Conservation Concern are present on site, a full list of these species can only be generated through an assessment specifically designed to do so; and
- Impacts are assessed based on the current (52) turbine layout, any changes to this layout will result in a need for an update to this assessment;
- Power line impacts are assessed based on desktop information.

2 Methodology

2.1 Literature Review and Desktop Study

The existing Ecological Impact Assessment conducted by CES in 2014 (Zide & Lubke 2014) was reviewed. In addition, aspects included in the Terms of Reference but not included in this study were researched. These aspects included:

- The impact of noise on species with the objective of estimating the significance that increased noise during construction and/or operation will have on these species, either in terms of reducing the size of their habitat by more than the physical footprint of the development, or discouraging them to traverse the site (i.e. contribute to habitat fragmentation by more than the physical footprint of the development);
- The impact of fencing (if any) on fragmentation of each of these species and on biodiversity in general;
- The relevance of fire in the ecological processes of Kouga Grassy Sandstone Fynbos and the implications (if any) to this project; and
- Recommendations for the power line alternatives being considered.

2.2 Vegetation analysis of the study site

2.2.1 Sample site selection

Sites sampled included 52 different points. These were based along the roads that will form part of the proposed development, as well as additional infrastructure. These points were not chosen randomly, they were chosen to achieve the following:

- Ground-truthing of the CES vegetation and habitat mapping; and
- Vegetation mapping of those areas not visited by CES, primarily along the roads.

Each of the sample points is mapped in Figure 2-1.

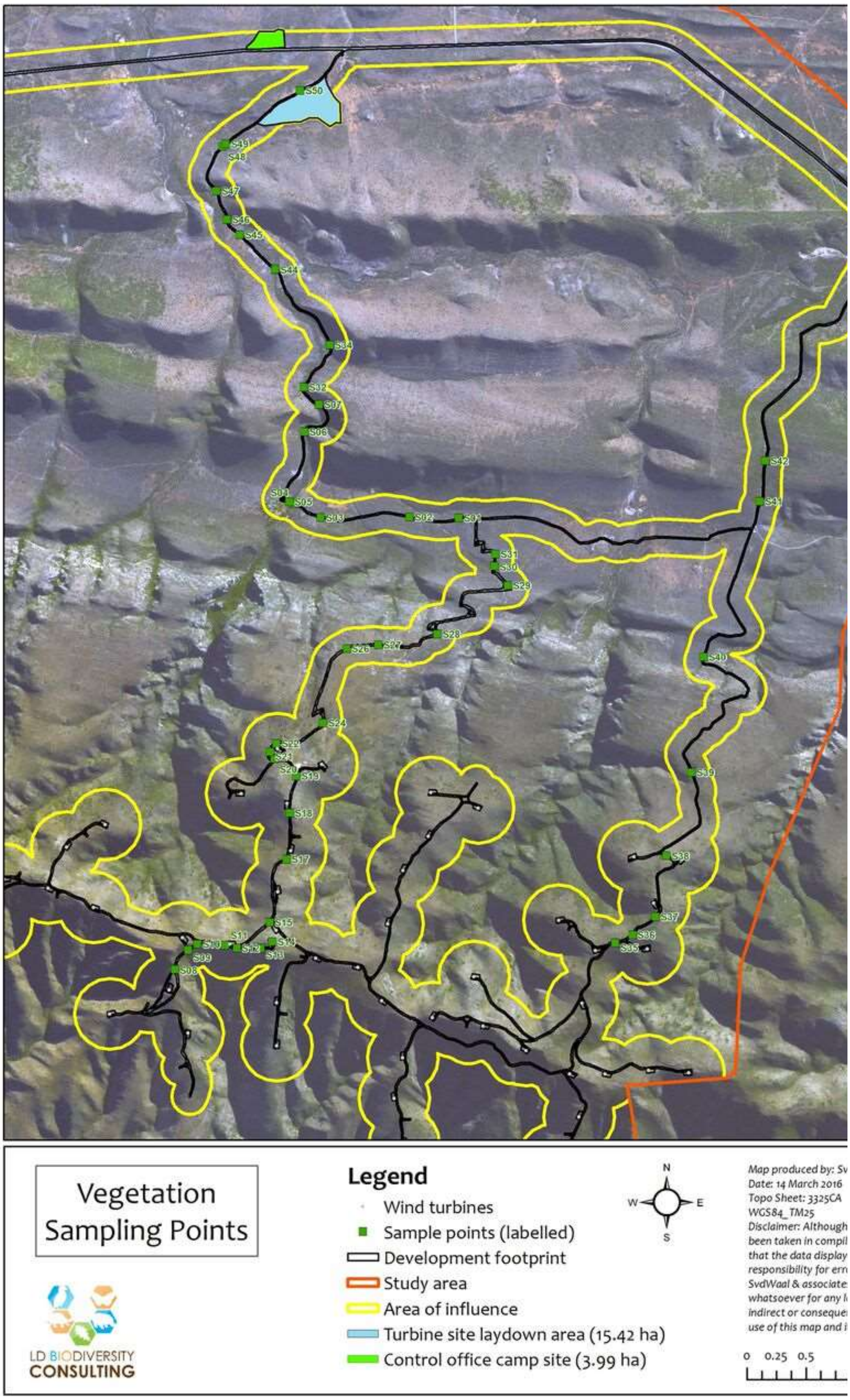

Figure 2-1: Map of the sample points visited to determine the vegetation types of the Inyanda WEF.

2.2.2 Vegetation mapping

The vegetation of the site was mapped based on the findings of CES as well as additional field work. The mapping was done on a fine scale for the Area of Influence (AoI) of the proposed development. The AoI is based on the direct and indirect impacts of the proposed development on the vegetation and habitats of the sample site. The footprint of the development was mapped, including roads, turbines and additional infrastructure as per the ToR. The turbine footprint was based on the design including the laydown areas that will be used in construction of the development (Figure 2-2). Roads are planned to be 6m wide however, due to leveling and cutting required in certain areas (steep slopes) the width is anticipated to be up to 15m. Thus the largest possible footprint of 15m was used.

The AoI included a buffer surrounding each of these aspects. A 300m buffer was applied to the roads, as this is usually the extent to which dust generation from dirt roads affects vegetation. A buffer was also applied to the turbines to account for dust and other potential impacts, as dust is likely to travel 300m from roads (150m each side), this buffer was applied to the turbines as well. The vegetation was then mapped in detail for these areas. This buffer does not taken into account potential noise impacts, as these affect fauna rather than flora and are assessed as such. Overall, there are three zones to the study, all of which are indicated in Figure 2-3. The study area is the larger part of the study site, including all infrastructure, the footprint is that area that will be directly affected by the proposed development and the AoI is that area that will be indirectly affected by the proposed development.

Figure 2-2: An example of a turbine footprint, including the turbine and laydown areas used during construction.

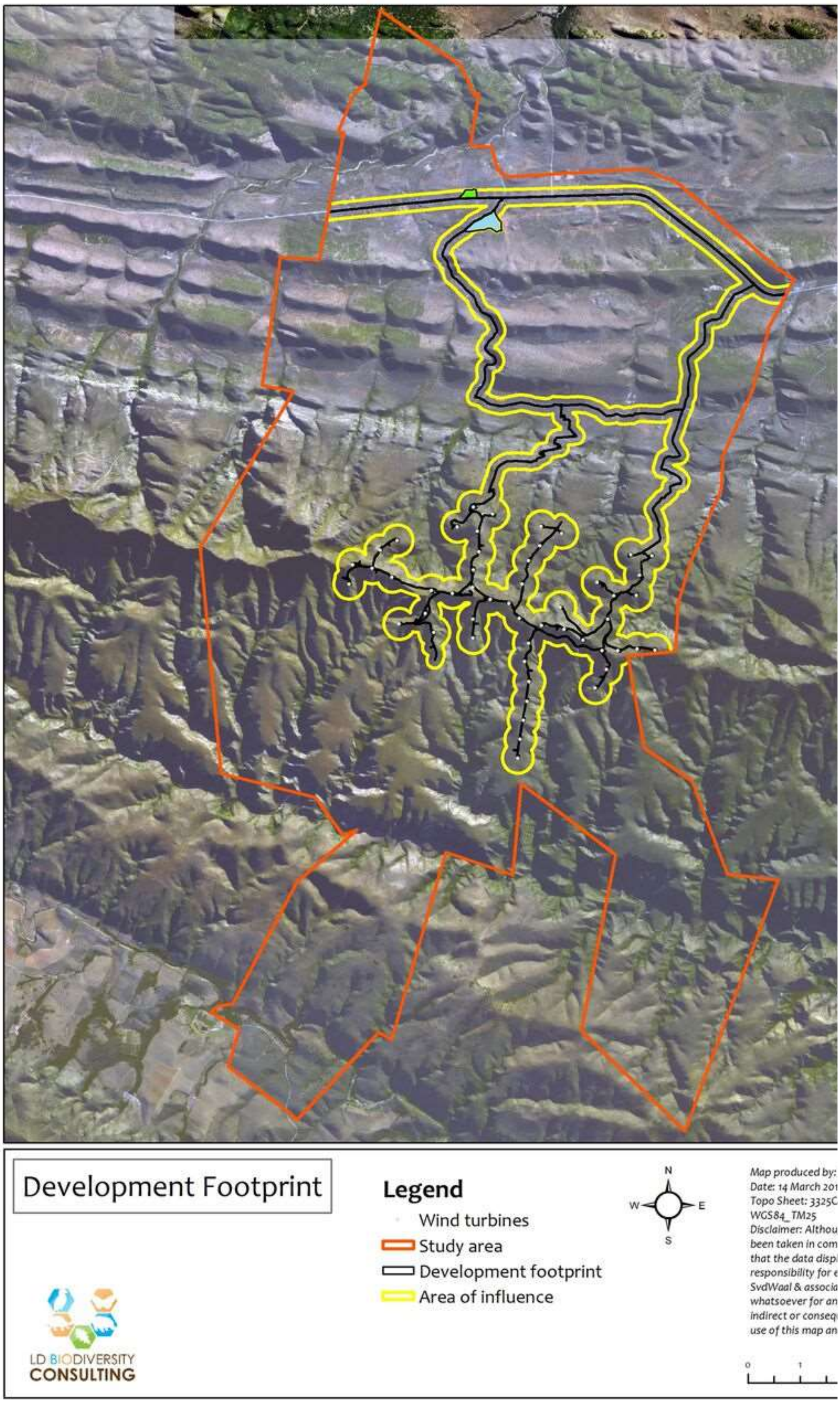

Figure 2-3: Map of the spatial scales of the study for the Inyanda WEF

2.3 Flora

Through the sample plots, several aspects of the flora were identified. These included the species list, list of Species of Special Concern (SSC), and the list of alien and invasive species.

2.3.1 Species list

The species list is compiled mainly from the data gathered from the sample plots. All species occurring in each of the sample plots were identified as far as possible, either during the site visit or afterwards from photographs. In addition, species seen within the study area, but not occurring within specific sample plots were also recorded. This allowed for the production of a species list representative of the entire study area.

2.3.2 Species of Special Concern

From the overall species list, a list of Species of Special Concern can be drawn up. To be as comprehensive as possible, this list includes plants on each of the following lists:

- National Protected Tree List (Government Gazette Vol. 593, 21 November 2014, No. 38215);
- Provincial Protected Species List (Nature Conservation Ordinance No. 19 of 1974);
- National Protected Species List or TOPS (R 1187 of 2007);
- The National Red List (redlist.sanbi.org);
- The International IUCN Red List (www.IUCNredlist.org); and
- CITES (www.cites.org).

An initial list of Species of Special Concern expected to be found within the study area comprises Possible Species of Special Concern (PSSC). If any of these (and any additional species on the above lists) are recorded on site, they are ascribed the status Confirmed Species of Special Concern (CSSC). It is likely that many of the PSSC do occur on site, but were not recorded in this site visit.

According to the IUCN all species are classified in nine groups, set through criteria such as rate of decline, population size, area of geographic distribution, and degree of population and distribution fragmentation (IUCN, 2010). The categories are described in Table 2.1 below.

Table 2.1: Red Data Categories (IUCN, 2010)

Category		Description
Extinct	(EX)	No known individuals remaining.
Extinct in the Wild	(EW)	Known only to survive in captivity.
Critically	(CR)	Extremely high risk of extinction in the wild.
Endangered	(EN)	High risk of extinction in the wild
Vulnerable	(VU)	High risk of endangerment in the wild.
Near Threatened	(NT)	Likely to become endangered in the near future.
Least Concern	(LC)	Lowest risk. Does not qualify for a more at risk category.
Data Deficient	(DD)	Not enough data to make an assessment of its risk of
Not Evaluated	(NE)	Has not yet been evaluated against the criteria.

2.3.3 Alien invasive species

Alien invasive species are recorded from each of the sample plots, as well as through opportunistic sightings throughout the study area. Alien invasive species are those that are not indigenous and can create problems by invading areas that should be open to indigenous species. These plants can reduce habitat size and impact on community structure quite extensively.

2.4 Sensitivity mapping

In order to ensure comparability, the CES sensitivity rating scale was used to determine sensitivity of the vegetation throughout the site, in particular the new areas along the roads that were mapped. A detailed description of this methodology is included in the CES report (Zide & Lubke 2014). The sensitivity scores and corresponding rating is shown in Table 2.2, with the sensitivity rating scale shown in Table 2.3.

Table 2.2: Interpretation of sensitivity scores (Zide & Lubke 2014).

% Score	Sensitivity
0 – 33.3	Low
33.4 – 64.9	Moderate
65 – 85	High
85.1- 100	Very High

Table 2.3: Sensitivity rating scale (Zide & Lubke 2014).

Criteria		Low Sensitivity (1)	Moderate sensitivity (5)	High Sensitivity (10)
1	**Topography**	Level, or even	Undulating, fairly steep slopes	Complex and uneven with steep slopes
2	**Vegetation** – Extent or habitat type in the region	Extensive	Restricted to a particular region/zone	Restricted to a particular locality/site
3	**Conservation status** of fauna/flora or habitats	Well conserved independent of conservation value	Not well conserved, moderate conservation value	Not conserved – has a high conservation value
4	**Species of Special Concern** – Presence and number	None, although occasional regional endemics	No endangered or vulnerable species, some indeterminate or rare endemics	One or more endangered and vulnerable species, or more than 2 endemics or rare species

Criteria		Low Sensitivity (1)	Moderate sensitivity (5)	High Sensitivity (10)
5	**Habitat fragmentation** leading to loss of viable populations	Extensive areas of preferred habitat present elsewhere in region not susceptible to fragmentation	Reasonably extensive areas of preferred habitat elsewhere and habitat susceptible to fragmentation	Limited areas of this habitat, susceptible to fragmentation
6	**Biodiversity** contribution	Low diversity, or species richness	Moderate diversity, and moderately high species richness	High species diversity, complex plant and animal communities
7	**Visibility** of the site or landscape from other vantage points	Site is hidden or barely visible from any vantage points with the exception in some cases from the sea	Site is visible from some or a few vantage points but is not obtrusive or very conspicuous	Site is visible from many or all angles or vantage points
8	**Erosion potential** or instability of the region	Very stable and an area not subjected to erosion	Some possibility of erosion or change due to episodic events	Large possibility of erosion, change to the site or destruction due to climatic or other factors
9	**Rehabilitation** potential of the area or region	Site is easily rehabilitated	There is some degree of difficulty in rehabilitation of the site	Site is difficult to rehabilitate due to the terrain, type of habitat or species required to reintroduce
10	**Disturbance** due to human habitation or other influences (Alien invasive species)	Site is very disturbed or degraded	There is some degree is disturbance of the site	The site is hardly or very slightly impacted upon by human disturbance

2.5 Assessment of the power line alternatives

The power line alternatives were assessed at a desktop level. Each power line was reviewed in Google earth to determine its position in comparison to existing disturbed areas and whether any of the options traversed Greenfield areas. The power line alternatives were then reviewed according to conservation planning tools and vegetation mapping including primarily STEP and the Baviaanskloof mega reserve mapping. These tools provided information on the vegetation of the areas, as well as providing sensitivity information. Impacts were assessed as per the study site.

2.6 Impact rating scale

The assessment of impacts will be based on the professional judgment of specialists at SRK Consulting, fieldwork, and desk-top analysis. The significance of potential impacts that may result from the proposed development will be determined in order to assist the Department of Environmental Affairs (DEA) in making a decision.

The significance of an impact is defined as a combination of the consequence of the impact occurring and the probability that the impact will occur. The criteria used to determine impact consequences are presented in Table 2.4 below.

Table 2.4: Criteria used to determine the Consequence of the Impact

Rating	Definition of Rating	Score
A. Extent– the area over which the impact will be experienced		
None		0
Local	Confined to project or study area or part thereof (e.g. site)	1
Regional	The region, which may be defined in various ways, e.g. cadastral, catchment, topographic	2
(Inter) national	Nationally or beyond	3
B. Intensity– the magnitude of the impact in relation to the sensitivity of the receiving environment		
None		0
Low	Site-specific and wider natural and/or social functions and processes are negligibly altered	1
Medium	Site-specific and wider natural and/or social functions and processes continue albeit in a modified way	2
High	Site-specific and wider natural and/or social functions or processes are severely altered	3
C. Duration– the time frame for which the impact will be experienced		
None		0
Short-term	Up to 2 years	1
Medium-term	2 to 15 years	2
Long-term	More than 15 years	3

The combined score of these three criteria corresponds to a **Consequence Rating**, as follows:

Table 2.5: Method used to determine the Consequence Score

Combined Score (A+B+C)	0 – 2	3 – 4	5	6	7	8 – 9
Consequence Rating	Not significant	Very low	Low	Medium	High	Very high

Once the consequence has been derived, the probability of the impact occurring will be considered using the probability classifications presented in Table 2.6.

Table 2.6: Probability Classification

Probability– the likelihood of the impact occurring	
Improbable	< 40% chance of occurring
Possible	40% - 70% chance of occurring
Probable	> 70% - 90% chance of occurring
Definite	> 90% chance of occurring

The overall **significance** of impacts will be determined by considering consequence and probability using the rating system prescribed in Table 2.7.

Table 2.7: Impact Significance Ratings

Significance Rating	**Possible Impact Combinations**		
	Consequence		**Probability**
Insignificant	Very Low	&	Improbable
	Very Low	&	Possible
Very Low	Very Low	&	Probable
	Very Low	&	Definite
	Low	&	Improbable
	Low	&	Possible
Low	Low	&	Probable
	Low	&	Definite
	Medium	&	Improbable
	Medium	&	Possible
Medium	Medium	&	Probable
	Medium	&	Definite
	High	&	Improbable
	High	&	Possible
High	High	&	Probable
	High	&	Definite
	Very High	&	Improbable
	Very High	&	Possible
Very High	Very High	&	Probable
	Very High	&	Definite

Finally, the impacts will also be considered in terms of their status (positive or negative impact) and the confidence in the ascribed impact significance rating. The system for considering impact status and confidence (in assessment) is laid out in Table 2.8 below.

Table 2.8: Impact status and confidence classification

Status of impact

Indication whether the impact is adverse (negative) or beneficial (positive).	+ ve (positive – a 'benefit')
	– ve (negative – a 'cost')
Confidence of assessment	
The degree of confidence in predictions based on available information, SRK's judgment and/or specialist knowledge.	Low
	Medium
	High

The impact significance rating should be considered by authorities in their decision-making process based on the implications of ratings ascribed below:

- **Insignificant:** the potential impact is negligible and will not have an influence on the decision regarding the proposed activity/development.
- **Very Low:** the potential impact is very small and should not have any meaningful influence on the decision regarding the proposed activity/development.
- **Low:** the potential impact may not have any meaningful influence on the decision regarding the proposed activity/development.
- **Medium:** the potential impact should influence the decision regarding the proposed activity/development.
- **High:** the potential impact will affect the decision regarding the proposed activity/development.
- **Very High:** The proposed activity should only be approved under special circumstances.

Practicable mitigation measures will be recommended and impacts will be rated in the prescribed way both with and without the assumed effective implementation of mitigation measures. Mitigation measures will be classified as either:

- **Essential**: must be implemented and are non-negotiable; or
- **Optional:** must be shown to have been considered and sound reasons provided by the proponent, if not implemented.

3 Description of the Study Area

The study area is described in detail in the CES report (Zide & Lubke 2014) and this description will not be repeated exhaustively here. However, maps of the vegetation are included to provide context. Vegetation descriptions for each of the vegetation types mapped for the region are summarized in Table 3.1. The vegetation type listed is the description given in this report as an amalgamation of the CES vegetation delineations and the delineations determined as a result of additional site visits for this assessment. This is then compared to and categorized according to the available vegetation information, of this information; the most fine scale maps are those of the Baviaanskloof Mega-reserve.

Vegetation was delineated based on the 52 sample points located along the roads of the proposed development and mapped according to field observations. Cognizance was taken of the vegetation map produced by CES and the associated vegetation types. These were delineated in more detail over a smaller area to allow for detailed analysis of the impacts of the proposed development on each of the vegetation types of the site. Sensitivity analyses were further based on these delineations. Photographs showing the different vegetation types delineated for this assessment are included in Figure 3-8 to Figure 3-15**Error! Reference source not found.**. Figure 3-1 shows the variety of different vegetation types including grassy fynbos, Proteaceous fynbos and thicket clumps on rocky outcrops. An additional vegetation type of riparian thicket is delineated but not described, as time did not allow for characterization of this particular vegetation type. The vegetation types were noted to be specifically related to the contours of the study site, with proteaceous fynbos restricted to steep south and east facing slopes (Figure 3-7).

Figure 3-1: General vegetation on the upper slopes of the Inyanda WEF study site.

Table 3.1: Summary of the vegetation types mapped for the Inyanda WEF study area.

Vegetation type (Figure 3-6**)**	**Baviaanskloof Mega-Reserve** (Figure 3-5**)**	**Mucina & Rutherford (2006).** (Figure 3-2**)**	**STEP** (Figure 3-3**)**	**SKEP** **(**Figure 3-4**)**	**Brief description**
Thicket (Figure 3-8)	Elandsberg sour grassland, Kouga mesic fynbos and Elandsberg Grassy fynbos	Kouga Grassy Sandstone fynbos	Cockscomb mountain fynbos complex	Fynbos	Found on rocky outcrops within the fynbos, thicket comprises typical thicket species including *Euclea undulata, Pappea capensis, Brachylaena illicifolia* etc.
Proteaceous fynbos (Figure 3-9)					Occurs on steep south and east facing slopes. Dominated sometimes almost exclusively by *Leucodendron salugnum* but other species may include *Protea munii* and *Metalasia muricata.* This fynbos type includes the Shale fynbos delineated by CES (Zide & Lubke 2014).
Grassy fynbos (Figure 3-10)		Kouga Sandstone Fynbos			On gentle to steep slopes with rocky outcrops containing thicket elements. Dominated by grass species including *Eragrostis curvula, Themeda triandra, Cymbopogon plurinodis* and *Tristcahya rehmanniii.* Other species include geophytes from the Irirdaceae family including *Bobartia orientalis* and Proteacea species including *Protea mundii, Leucodendron salignum* and *Protea nerifolia*.
Succulent thicket (Figure 3-11)	Elands spekboom thicket	Sunday's thicket	Sundays Spekboomveld	Thicket	Succulent thicket occurs on flat areas to the east of the site and is comprised of an almost completely succulent suite of species dominated by *Portulacaria afra* and other Crassulaceae and Mesembryanthemaceae species.

Karoo (Figure 3-12)	Elandsberg mesic fynbos				Karroo is restricted to the very north of the site where it occurs on both sides of the road. A low succulent shrub interspersed with Euphorbia species characterizes it. This vegetation type is fairly degraded within the study site.
Degraded thicket (Figure 3-13)	Perdehoek arid thicket	Groot thicket	Baviaans spekboom thicket		Degraded thicket occurs near the main farmhouse and in areas that have been grazed by livestock or have been used as agricultural land previously. The thicket is open and characterized by typical thicket species that exhibit a browsing growth-form (a clear-cut umbrella tree shape) and include *Pappea capensis* and *Euclea undulala* as dominant species. This vegetation type contains the majority of the alien invasive species recorded from the site.
Renosterveld (Figure 3-14)	Baviaanskloof Sandolienveld				Renosterveld is restricted to a small section of the site and is clearly delineated by the presence of Renosterbos (*Elytropappus rhinoceratis*) where it occasionally forms a monoculture.
Acacia riparian thicket (Figure 3-15)	Groot doringveld	Albany Alluvial Vegetation	Sundays Doringveld	SKEP river corridors	The primary riparian vegetation type on the site has a road running through it and as such, is degraded. The vegetation type is dominated by *Acacia karroo* although in some areas species such as *Salix mucronata, Schotia afra* and *Dondonea angustifolia* are found.

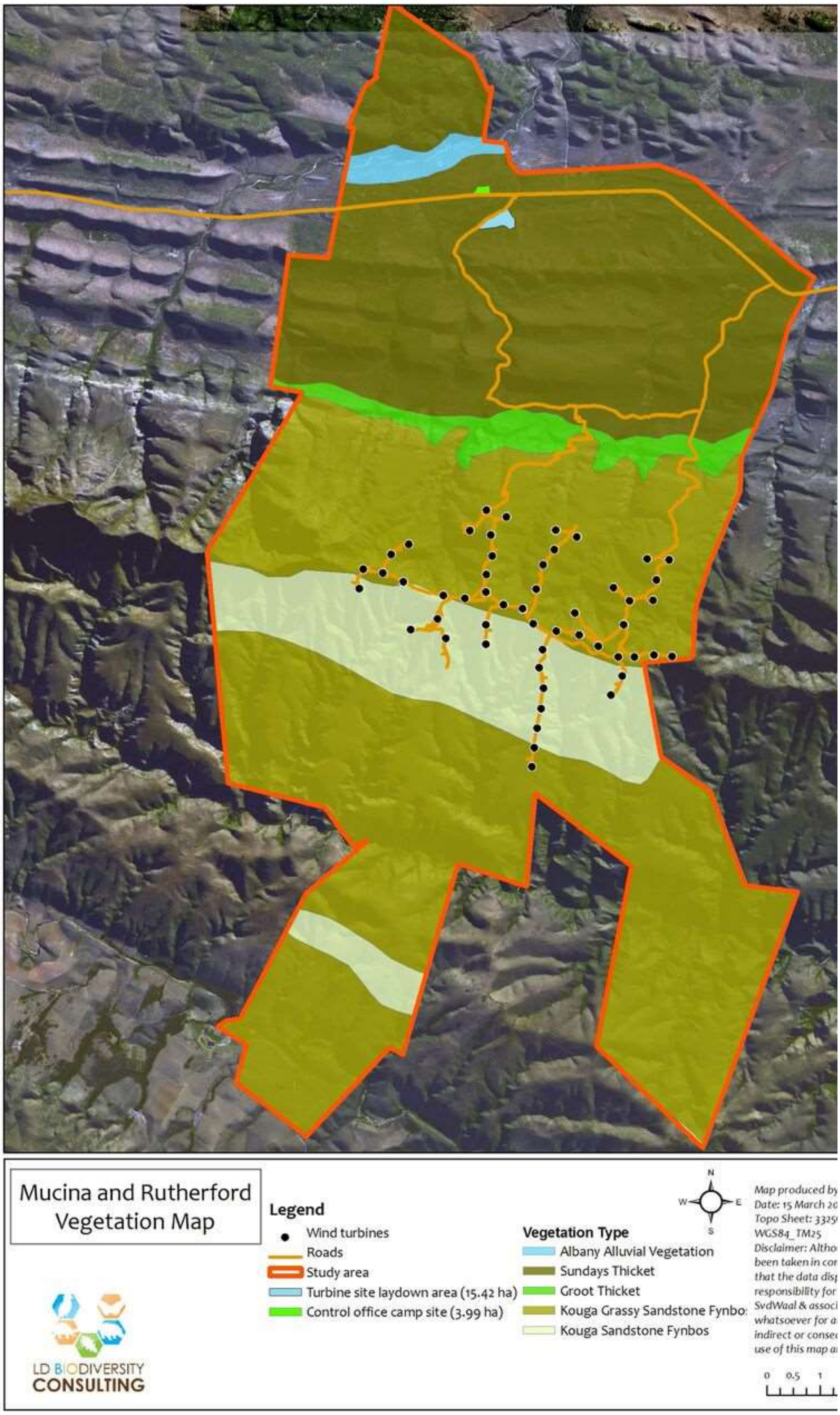

Figure 3-2: Mucina and Rutherford Vegetation map of the Inyanda WEF.

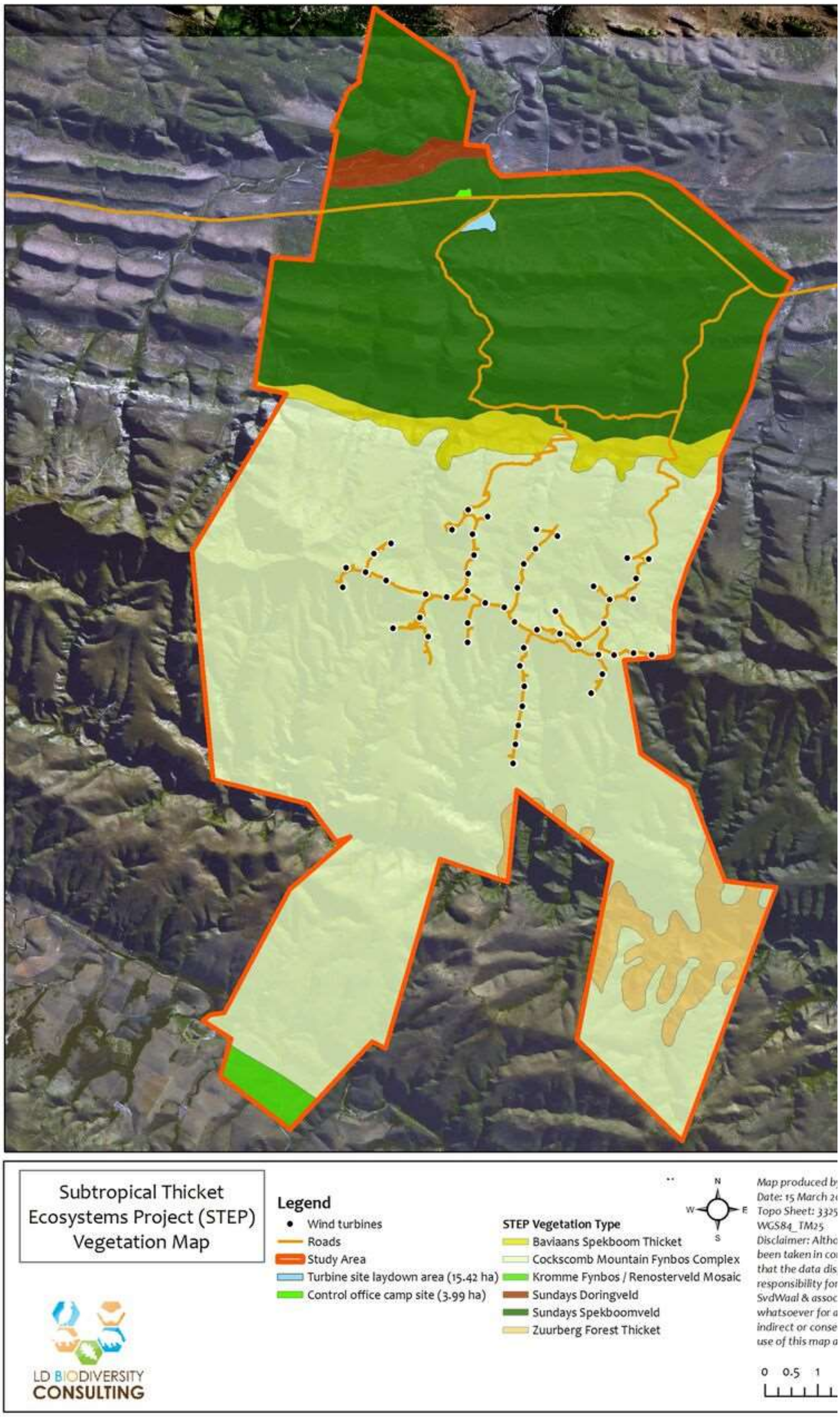

Figure 3-3: STEP Vegetation map of the Inyanda WEF.

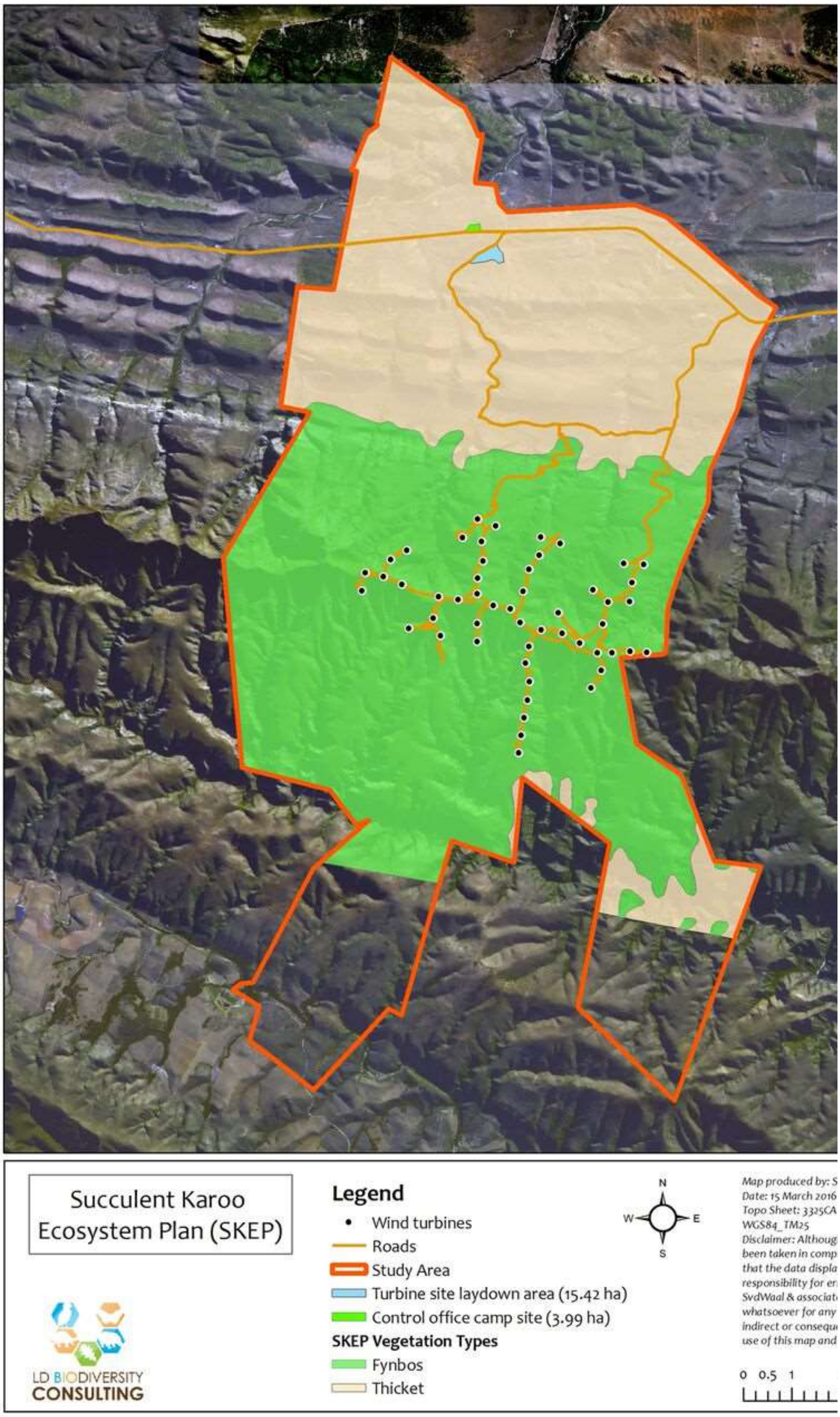

Figure 3-4: SKEP Vegetation map of the Inyanda WEF.

Figure 3-5: Baviaanskloof Mega-reserve Vegetation Types

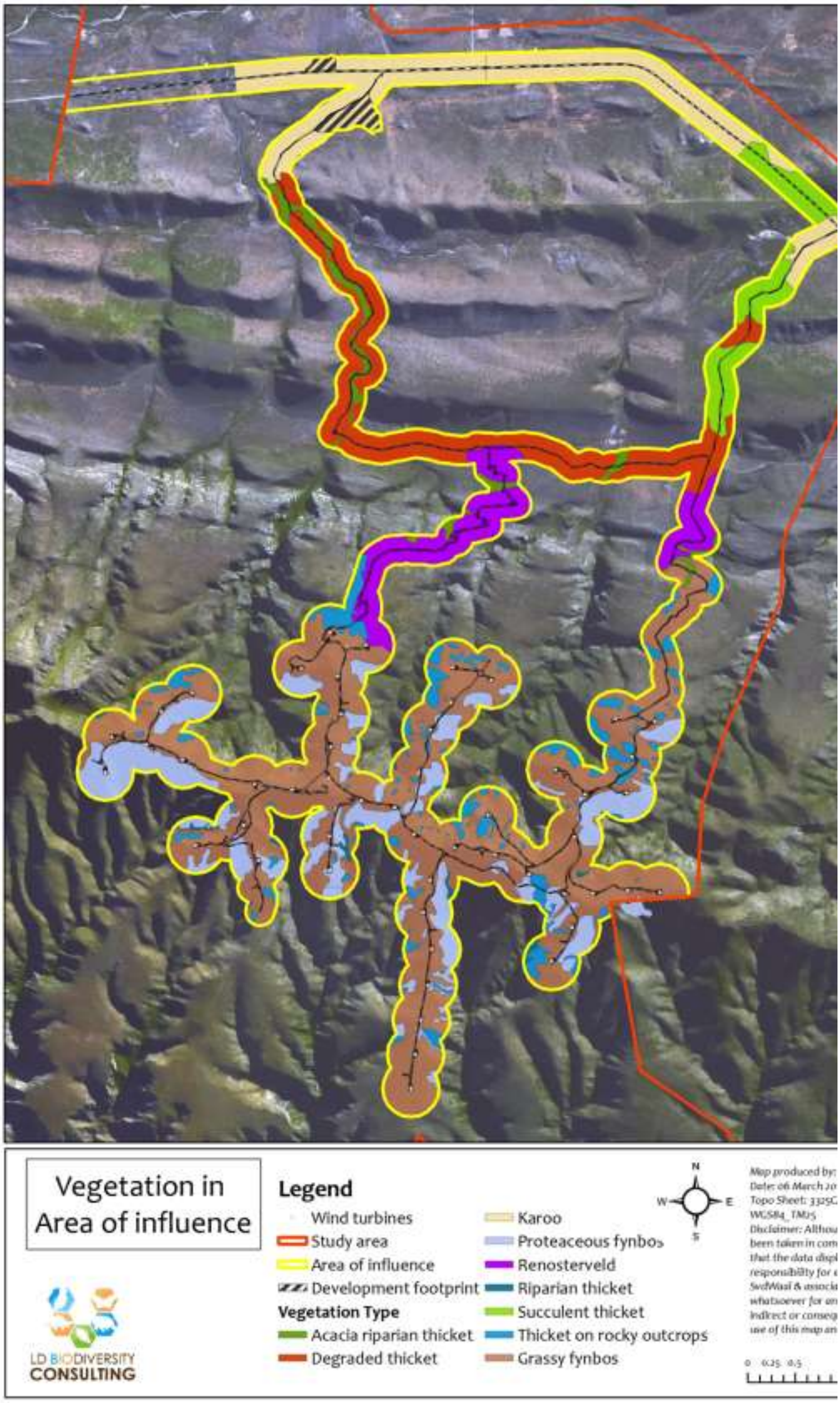

Figure 3-6: Vegetation map of the Inyanda WEF within the Area of Influence.

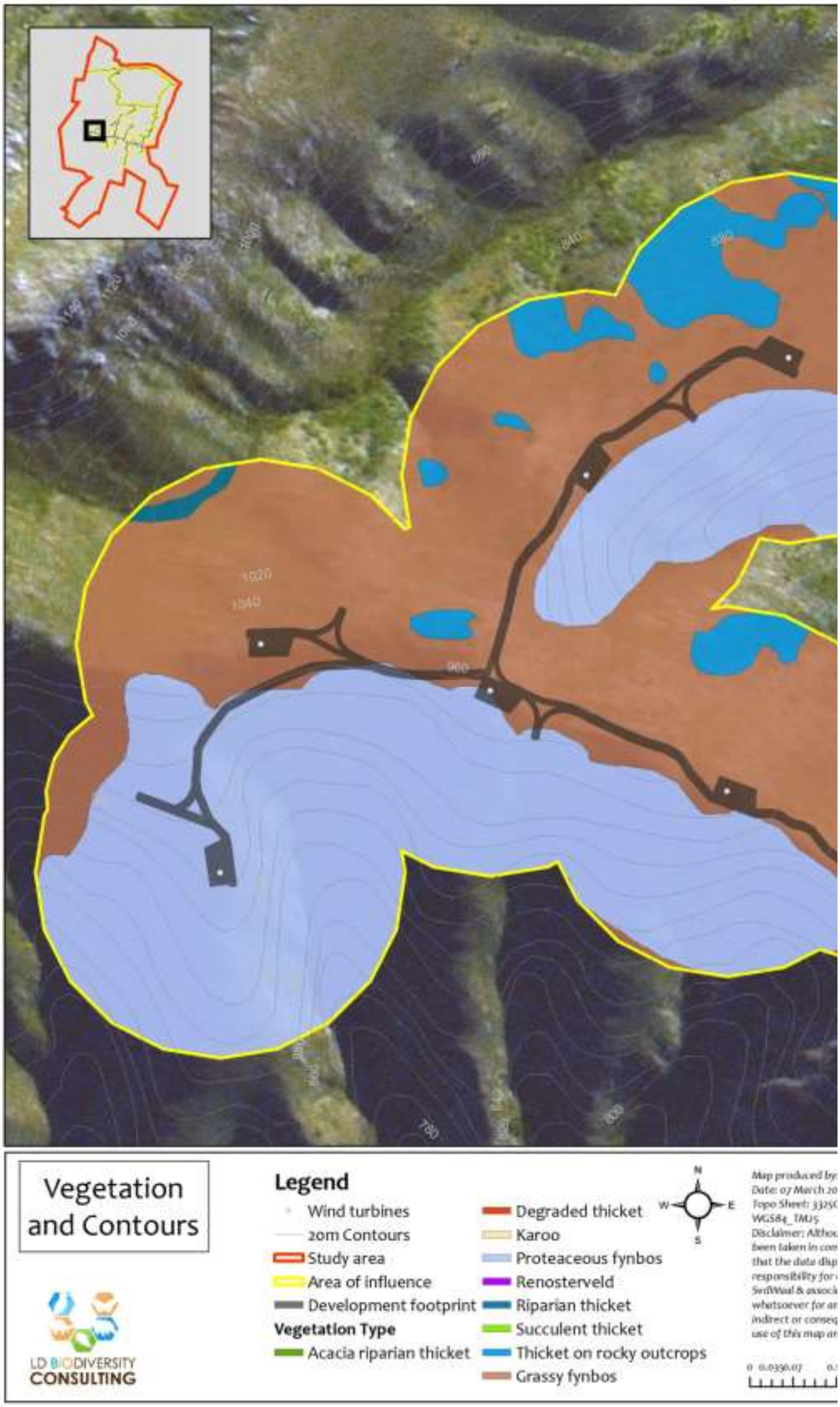

Figure 3-7: Vegetation types related to contours .

Figure 3-8: Thicket (on rocky outcrops)

Figure 3-9: Proteaceous fynbos

Figure 3-10: Grassy fynbos

Figure 3-11: Succulent thicket

Figure 3-12: Karoo

Figure 3-13: Degraded thicket

Figure 3-14: Renosterveld

Figure 3-15: *Acacia* riparian thicket

3.1 Fire and the Inyanda WEF

Fire is a part of the ecology of the study site, with the site burning on average once a year in sections through uncontrolled means (they were not set as part of a management plan). Regular fires may change vegetation composition. Evidence of fires at the site was found (Figure 3-16), with areas recently burnt allowing for little elucidation of vegetation communities. These areas tend to be dominated by grass species, which form a short sparse grassy fynbos community (Figure 3-17).

It is clear that fires play a role in the development of the vegetation communities on site, and may be a driving factor in the different fynbos community types – producing grassy fynbos where there are regular fires, and proteaceous fynbos where there are not such regular fires. However, this theory should be tested. It is recommended that a fire monitoring protocol be put into place to try to understand the effect of fire in the vegetation and habitats of the site. Fire will certainly affect slow-moving animals that may not be able to move out of the way in time such as tortoises and chameleons. These taxa and the vegetation should be monitored to determine the impacts of fire on the site. Care should be taken that the development does not result in the starting of any fires.

Figure 3-16: Fire damaged vegetation at the Inyanda WEF site

Figure 3-17: Fire creating a short grass-dominated fynbos system

3.2 Flora

The flora of the site has been extensively described by CES in the original Ecological Impact Assessment Report, a summary is thus provided here, with the addition of some newly recorded alien invasive species.

3.2.1 Species of Special Concern

SSC that have been recorded from the site are shown in Table 3.2 as per Zide and Lubke (2014). It should be noted that a ground-truthing site visit would produce a comprehensive list of SSC for the entire site, which is required for the permitting process for the removal, or destruction of such species. Such a comprehensive ground-truthing study was not part of the scope of this assessment. Figure 3-18 shows an *Encephalartos longifolius* individual recorded from the site.

Blanket protected families and genera (PNCO) occurring on site include all *Aloe* species, all *Amaryllidaceae* species, all *Encephalartos* species, all Ericaceae, all Iridaceae, all *Haworthia* species, all Mesembryanthemaceae species, all Proteaceae species. The site is rich with many of these groups, all of which will require permits to remove or destroy.

Table 3.2: SSC recorded from the study site (Zide & Lubke 2014).

Scientific name	IUCN	SA Red data list	CITES appendix	NEMBA protection status	PNCO Schedule
Agathosma gonaquensis		CR			
Encephalartos longifolius	NT	NT	II	Protected	3
Kniphofia triangularis		R			
Loxostylis alata		D			
Pelargonium reniforme		NT			
Aloe ferox			II		3
Bobartia orientalis					4
Carpobrotus edulis					4
Diascia capsularis					4
Erica cerinthoides					4
Erica cf chamissonis					4
Erica cf copiosa					4
Erica imbricate					4
Geissorhiza heterostyla					4
Kniphofia triangularis					4
Lampranthus spectabilis					4
Leucadendron salignum					4
Leucospermum cuneiforme					4
Protea foliosa					4

Scientific name	IUCN	SA Red data list	CITES appendix	NEMBA protection status	PNCO Schedule
Protea lanuginosa subs. Intermedia					4
Protea mundii					4
Protea nerifolia					4
Protea nitida					4

Figure 3-18: *Encephalartos longifolius* in its typical habitat of a rocky outcrop amongst the fynbos.

3.2.2 Alien invasive species

CES (Zide & Lubke 2014) recorded three invasive species on site including *Acacia mearnsii*, *Cuscuta campestris* and a *Pinus* species. Additional species recorded from the site visit conducted as part of this study include those listed in Table 3.3, with pictures of some of these species shown in Figure 3-19 and Figure 3-20. Control measures are prescribed for each category, with category 1 and 2 species requiring to be managed by law through an invasive plant management plan.

Table 3.3: Alien invasive species recorded from the proposed Inyanda WEF study site

Scientific name	Common name	Category

Scientific name	Common name	Category
Acacia mearnsii	Black wattle	2
Cuscuta campestris	Dodder	1b
Pinus sp.	Pine	2
Opuntia aurantiaca	Jointed prickly pear	1b
Opuntia ficus-indica	Sweet prickly pear	1b
Agave americana	Century plant	1b
Agave sisalana	Sisal	2
Echinopsis spachiana	Torch cactus	1b

Figure 3-19: *Opuntia ficus-indica*, an invasive species found in the proposed Inyanda WEF site.

Figure 3-20: Right: *Agave sisalana*, and Left: *Echinopsis spachiana* both alien invasive species recorded from the proposed Inyanda WEF site.

3.3 Fauna

Faunal species are discussed within the CES report, for which a desktop study was done (Zide & Lubke 2014) and are thus not repeated here. A summary is provided for the species of concern in Table 3.4, with

Figure 3-21 showing a pair of fighting angulate tortoises found on site. It is recommended that a full faunal survey be conducted to determine the presence of faunal species. As most of these species can move away from the development, it is recommended that this be done as part of research projects that may be done by students on the site.

Table 3.4: Summary of faunal SSC within the proposed Inyanda WEF site derived from Zide & Lubke (2014)

Scientific name	Common name	Recorded on site	Habitat present
Heleophryne hewitii[1]	Hewitt's Ghost Frog	No	Yes
Brachypodion sp. "sp.4"	Groendal Dwarf Chameleon[2]	No	Yes
Afroedura sp. "Kouga"	Baviaanskloof Flaat Gecko[3]	No	Yes
Bradypodion taeniabronchum	Elandsberg chameleon[4]	No	Yes
Bradypodion ventrale	Eastern Cape Dwarf Chameleon	No	Yes
Chersina angulata	Angulate Tortoise	Yes	Yes
Cordylus cordylus	Cape Girdle Lizard	No	Yes
Homopus areolatus	Parrot-beaked Dwarf Tortoise	No	Yes
Karusasaurus polyzonus	Karoo Girdle Lizard	No	Yes
Psammobates tentorius	Tented Tortoise	No	Yes
Stigmochelys pardalis	Leopard Tortoise	No	Yes
Varanus albigularis	Rock Monitor	No	Yes
Varanus niloticus	Water Monitor	No	Yes
Atelerix frontalis	South African hedgehog	No	Yes
Mystromys albicaudatus	White-tailed mouse	No	Yes
Panthera pardus	Leopard	No	Yes
Mellivora capensis	Honey Badger	No	Yes
Vulpes chama	Cape Fox	No	Yes

[1] An Endangered species known from two locations, with only one location confirmed recently. Expected to occur in the WEF region but no confirmation of occurrence.

[2] Part of a complex of three species as yet unresolved. Morphology and landscaping techniques are required to properly define these three species.

[3] A new species recently described, with little information available.

[4] Forming part of the complex of unresolved species also containing the Groendal dwarf chameleon.

Figure 3-21: Angulate tortoise pair fighting on the proposed Inyanda WEF site

4 Sensitivity

The sensitivity of the site is based on various factors as described in Section 2.4. Several conservation assessments have been completed for the area and include the conservation importance of the site as a whole. Table 4.2 describes the factors taken into consideration for each of the 10 criteria for the sensitivity assessment. Sensitivity rating is necessarily subjective, and takes into consideration the experience and knowledge of the specialist applying the scale. CES (Zide & Lubke 2014) have described the conservation and planning tools available for the area in detail. These maps are reproduced here to aid elucidation of the sensitivity assessment and are presented in

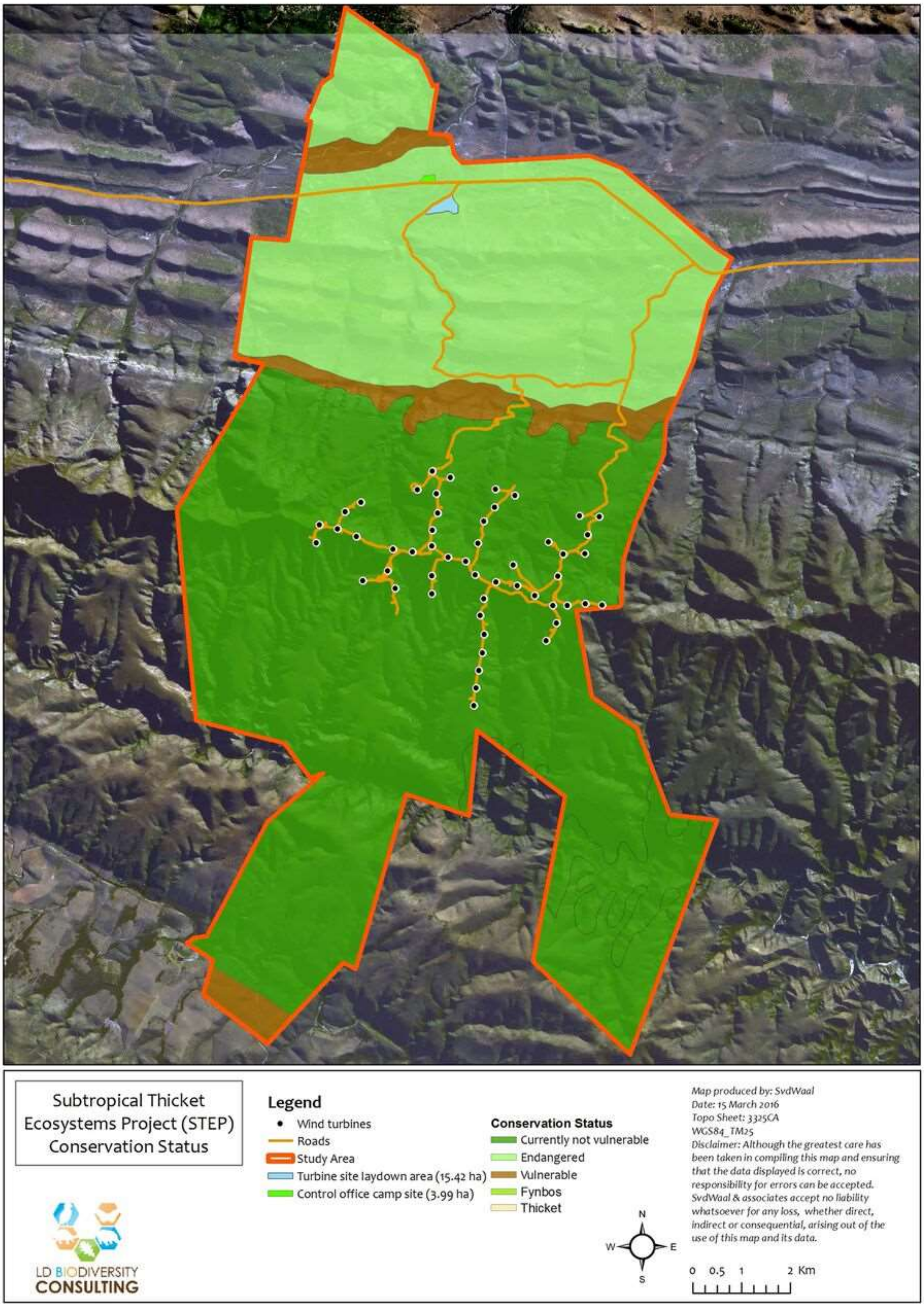

Figure 4-1 to Figure 4-4. Table 4.3 describes the sensitivity rating process for each of the community types identified within the study area, with a map of the sensitive areas shown in Figure 4-5.

The Baviaanskloof Mega-reserve CBA map was mostly taken into account as the vegetation mapping for this area is of the finest scale of all the assessments consulted. This assessment describes three CBAs, the recommendations for which are described in Table 4.1. Of the development, a small portion of existing road falls in CBA 1 and CBA 2, with the majority of the development falling into CBA 3 and the rest into CBA 2.

Table 4.1: Baviaanskloof Mega-reserve CBAs

CBA	Description	Development Guidance
CBA1a	100% irreplaceable habitats; restricted RDB plant species; all remaining Critically Endangered habitats; selected river reaches	Natural Landscapes – Maintain biodiversity in as natural a state as possible. Manage for no biodiversity loss. Land use = conservation.
CBA1b	Best design site (meeting balance of patter targets); RDB plant species; restricted animal habitats	
CBA2	All remaining Endangered habitats; all remaining forest and wetland habitats; remaining coastal corridor; river reaches supporting selected river reaches; landscape linkages	Near Natural Landscapes – maintain biodiversity in a near natural state with minimal loss of ecosystem integrity. No transformation on natural habitat should be permitted. Land use = game farming, Conservation, Limited livestock
CBA3	Sub-quaternary catchments od selected river reaches, Key Biodiversity Support Area, Important Natural Area	Functional Landscapes – Manage for sustainable development, keeping natural habitat intact in wetlands (including buffers) and riparian zones. Environmental authorizations should support ecosystem integrity. Land use = Conservation, Game farming, livestock, limited dryland crops, limited irrigated crops, limited dairy, limited timber, limited settlement.

Table 4.2: Factors taken into consideration for the sensitivity assessment

Criteria		Factors considered	Data sets analysed
1	**Topography**	As slopes, especially steep rocky slopes can form refugia for SSC, these are important. Slopes also provide a variety of habitats that may be used by a number of different species.	• Google earth imagery • Contours • Site inspection

Criteria		Factors considered	Data sets analysed
2	**Vegetation** – Extent or habitat type in the region	The extent of the vegetation in the region determines whether it is rare, which increases conservation value or widespread, which decreases conservation value.	• Baviaanskloof Megareserve • Mucina & Rutherford (2006) • STEP • SKEP • CES vegetation map • LD Biodiversity Vegetation map
3	**Conservation status** of fauna/flora or habitats	The conservation status of the vegetation and faunal habitats is important. For example none of the vegetation type may be conserved, or most of it may be.	• Baviaanskloof Megareserve • Mucina & Rutherford (2006) • STEP • SKEP • NPAES • Protected areas
4	**Species of Special Concern** – Presence and number	The number of SSC will help to determine the sensitivity of the site. Large numbers of SSC raise the sensitivity rating.	• CES species list • PNCO • Protected trees • NEMBA • National Red List • International Red List • CITES
5	**Habitat fragmentation** leading to loss of viable populations	This aspect of the sensitivity rating scale is based on the level of fragmentation of the vegetation type. Fragmentation includes development, disturbance and other anthropogenic effects.	• Baviaanskloof Megareserve • Mucina and Rutherford (2006) • Google earth imagery
6	**Biodiversity** contribution	Each of the different vegetation communities found within the site may form habitat for large numbers of species or smaller numbers of species. The large the number of species (diversity) the higher the sensitivity of the site.	• CES species list
7	**Visibility** of the site or landscape from other vantage points	Some areas are highly visible, such as those on the top of high ridges, while others are not visible. Visibility increases the sensitivity of the site.	• Contours • Google earth imagery • Site inspection

Criteria		Factors considered	Data sets analysed
8	**Erosion potential** or instability of the region	Erosion potential is an aspect of how the natural environment will respond to disturbance. A low erosion potential indicates a robust site that will be able to buffer disturbance, particularly from clearing. Sites with high erosion potential (low robustness) are more sensitive than those with low erosion potential (high robustness).	• Site inspection
9	**Rehabilitation** potential of the area or region	Rehabilitation potential is also a sensitivity indicator. Areas that are easy to rehabilitate back to the natural state are less sensitive than areas that are not easy to rehabilitate. It should be noted that restoration – or the rehabilitation of a site back to a completely natural state – is not often successful.	• Site inspection • Vegetation classification • CES species list
10	**Disturbance** due to human habitation or other influences (Alien invasive species)	The greater the amount of disturbance, the less sensitive a site is. Disturbance results in the invasion of alien species and the loss of SSC.	• Site inspection • Google earth imagery

Table 4.3: Sensitivity assessment of the Inyanda WEF site

Vegetation Community	Sensitivity	Total % Score	Sensitivity criteria									
			1	2	3	4	5	6	7	8	9	10
Thicket on rocky outcrops	Moderate	59	10	5	1	10	1	5	10	1	7	9
Proteaceous fynbos	Moderate-high	64	5	5	1	10	5	7	10	3	9	9
Grassy fynbos	Moderate-high	62	5	5	1	8	5	7	10	3	9	9
Succulent thicket	Moderate	52	2	2	3	10	5	9	5	6	5	5
Karoo	Moderate	49	2	4	5	10	5	4	5	8	4	2
Degraded thicket	Moderate	42	4	2	1	8	5	5	5	6	4	2
Renosterveld	Moderate	44	5	5	4	6	5	3	5	6	3	2
Acacia riparian thicket	Low	29	2	2	5	2	2	3	3	4	4	2
Riparian thicket	Moderate	60	10	5	5	7	5	5	1	5	8	9

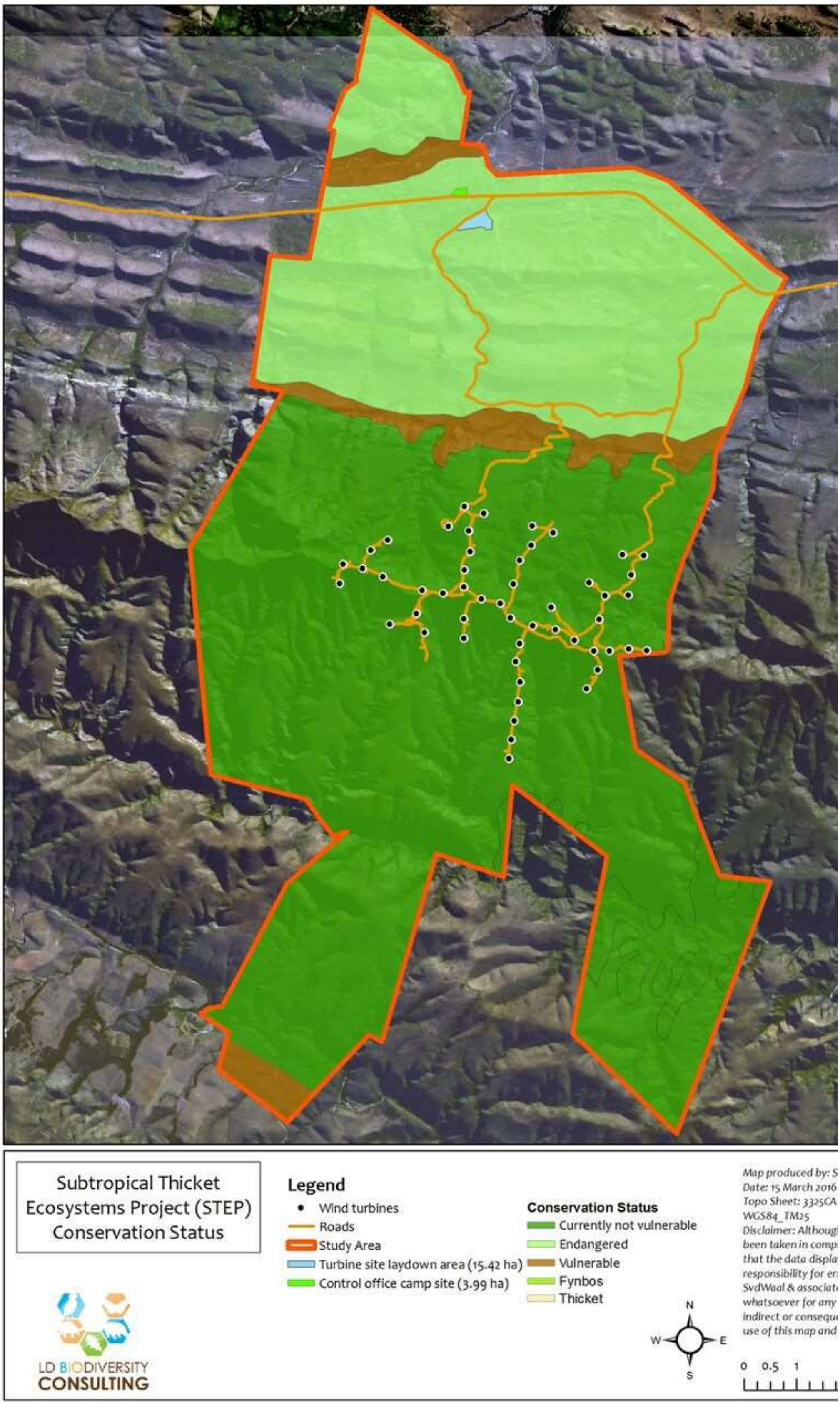

Figure 4-1: STEP Conservation Status

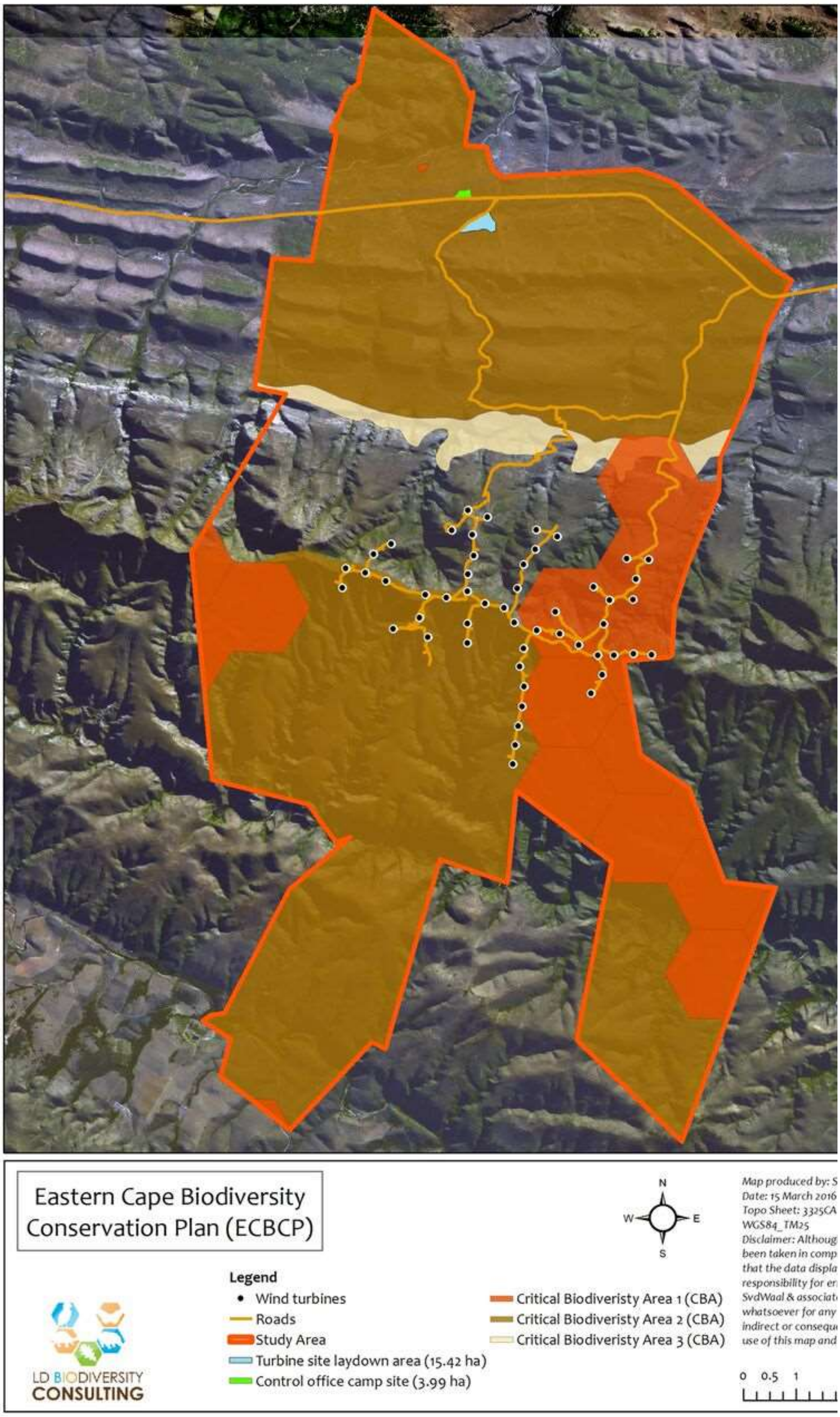

Figure 4-2: ECBCP Critical Biodiversity Areas

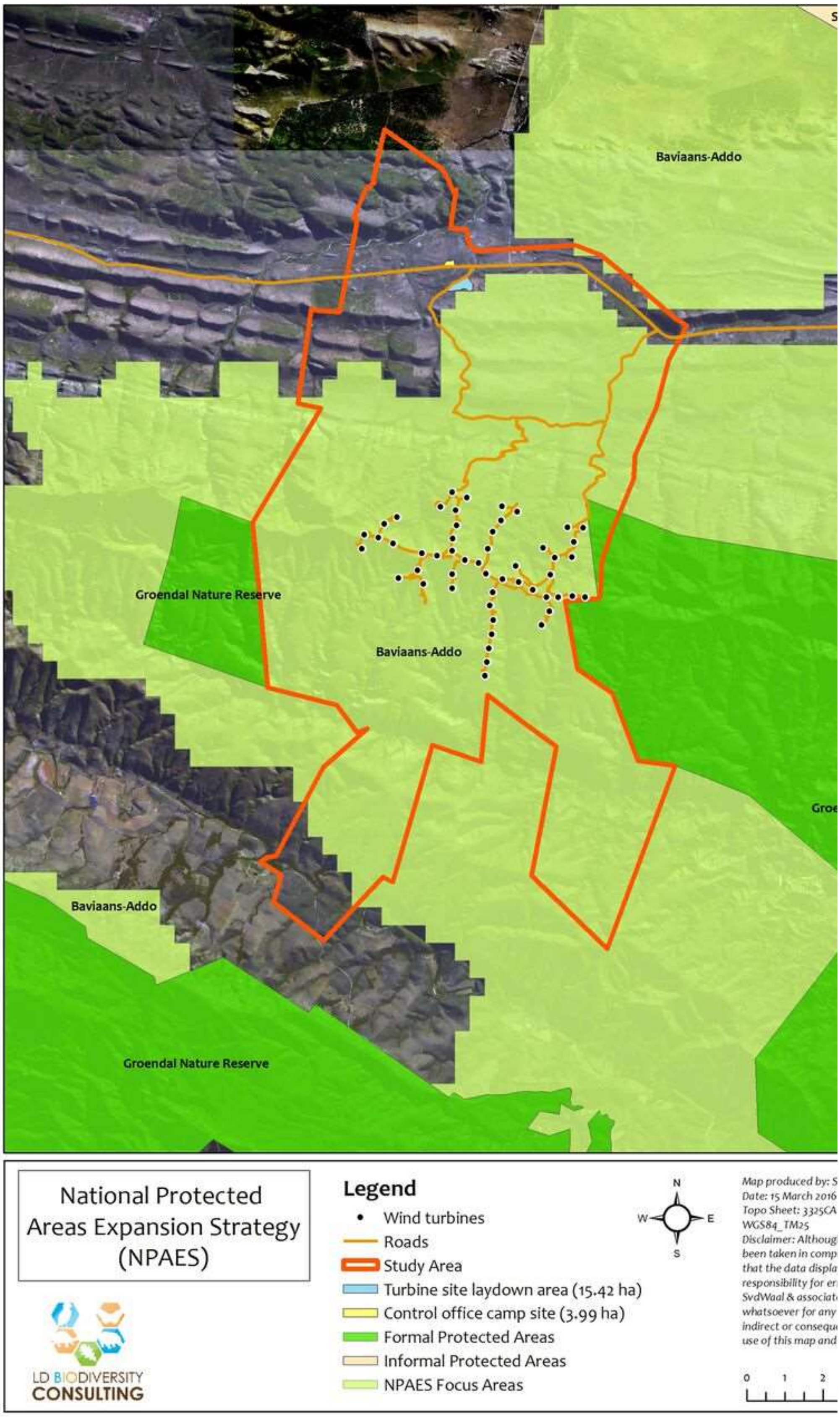

Figure 4-3: National Protected Areas Expansion Strategy

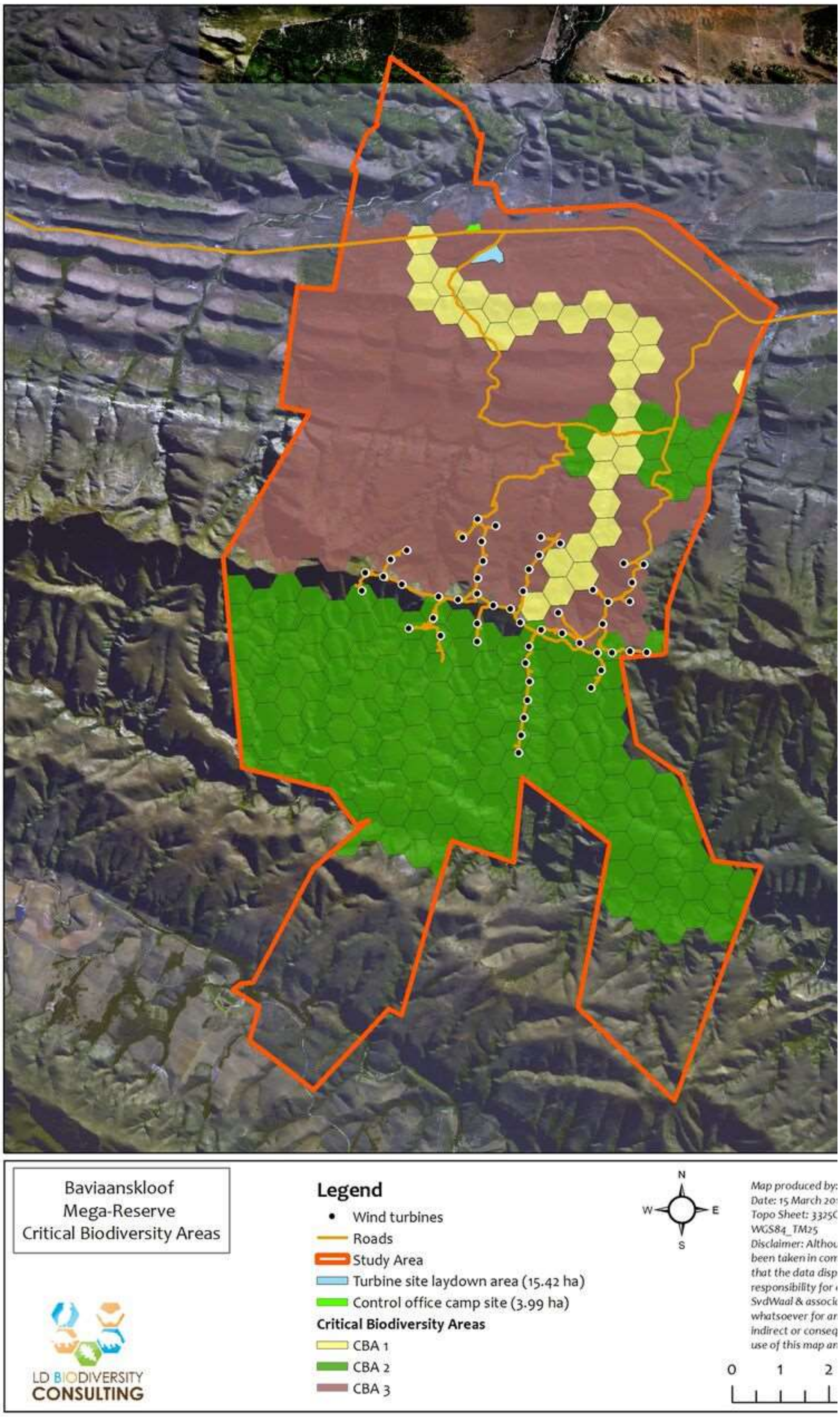

Figure 4-4: Baviaanskloof Mega-reserve Critical Biodiversity Areas

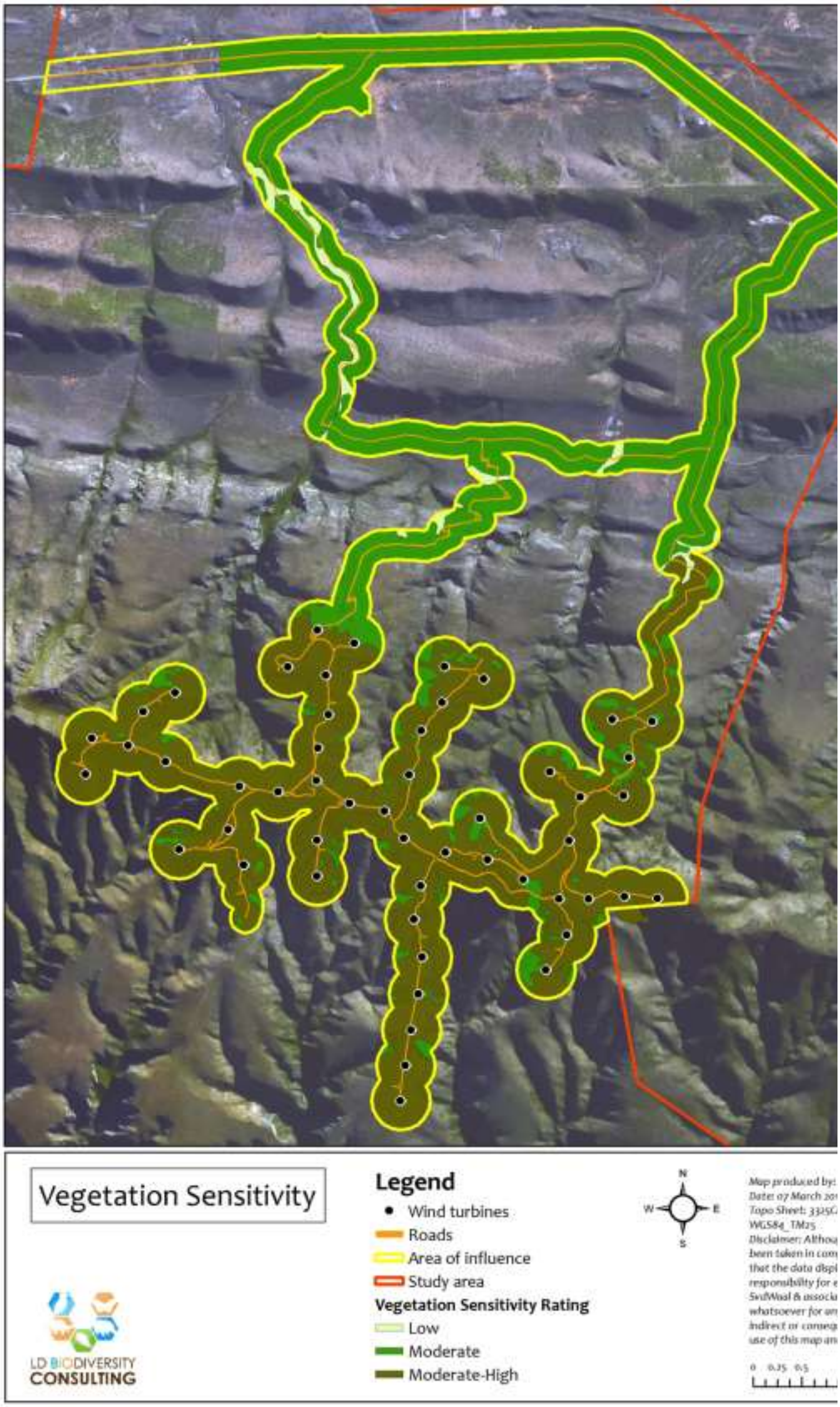

Figure 4-5: Sensitivity map of the Area of Influence

5 Description and sensitivity of three power line options

There are three power line options for the proposed development, these are mapped extensively within the CES report (Zide & Lubke, 2014) and are not repeated here. The most fine-scale and detailed map of the vegetation types and conservation areas are included here to allow for context.

5.1 Vegetation

All three power line options go through the same vegetation types, both in Mucina & Rutherford (2006) and STEP (Figure 5-1). These vegetation types are shown in Table 5.1. Of the different options, option 2 traverses the largest area of alluvial vegetation.

Table 5.1: Vegetation types of the three power line options (adapted from Zide and Lubke (2014).

Mucina & Rutherford	Description	STEP	Description
Sundays Thicket	Characterised by undulating plains and low mountains and foothills covered with tall dense thicket. The Sundays Thicket is composed of a mosaic of predominantly spinescent species that include trees, shrubs and succulents. It is classified as Least Threatened with a conservation target of 19%. 6% has been transformed by cultivation and urban development.	Sundays Spekboomveld	This vegetation type is dominated by *Pappea capensis* and *Portulacaria afra* while *Euphorbia coerulescens* and *Crassula ovata* are abundant succulent plants that characterize this vegetation type. This spekboomveld is distinguished from adjacent noorsveld by the relatively high cover of *Portulacaria afra*, *Pappea capensis* and *Schotia afra*. This vegetation type is listed as Endangered.
		Sundays Spekboom Thicket	The tree component of this vegetation type is dominated by *Portulacaria afra* and *Pappea capensis*. Other common species include *Euphorbia ledienii* and *Rhigozum obovatum*. This vegetation type is listed as Vulnerable.
Albany Alluvial	Thornveld and riverine thicket are the two major vegetation types that occur	Sundays Doringveld	Sundays Doringveld is characterised by a mosaic of thicket clumps and a Nama-

	in this vegetation type. It is classified as Endangered with a conservation target of 31%. Only 6% has been statutorily conserved.		karoo matrix. Thicket clumps often have low species diversity with species that are typical of the Sundays Valley Thicket. Dominant species in the Nama-karoo matrix comprise of *Acacia karoo, Lycium sp.* And *Cynodon dactylon* and include a suite of succulents, some of which are rare endemics such as *Haworthia sordida*. This vegetation type is listed as Vulnerable..
Sundays Noorsveld	The Sundays Noorsveld occurs along flat lowlands. It is characterised by succulent thicket consisting of a mosaic of *Euphobia caerulescens* and low karoo shrub vegetation (dominated by *Pentzia incana* and *Rhigozum obovayum*). This vegetation type is classified as Least Threatened with a conservation target of 19%. About 15% is statutorily conserved in the Greater Addo Elephant National Park and some 3% in private game ranches. Approximately 4% of this vegetation type has been transformed by cultivation.	Sundays Noorsveld	The domiant species of this vegetation type is *Euphorbia coerulescens*. Presence of witgat trees (*Boscia oleoides*) and wildegranaat (*Rhigozum obovatum)* is diagnostic. Spekboom (*Portulacaria afra)*, only found in the better-preserved veld, was never a dominant component. Palatable grasses (*Cenchrus ciliata, Fingerhuthia africana* and *Panicum maximum*) used to be abundant, but are now sparse.

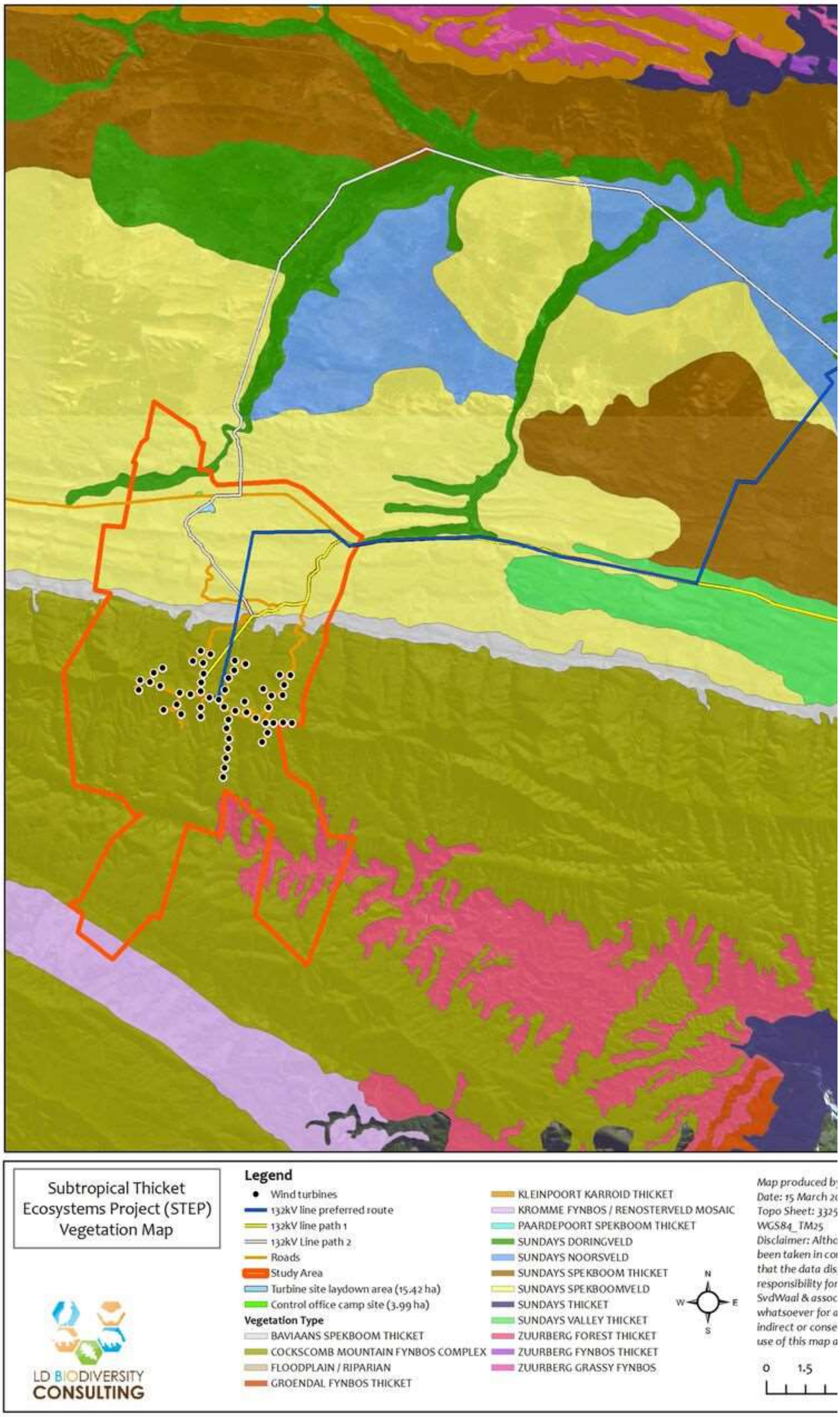

Figure 5-1: STEP vegetation map of the power line alternatives

5.2 Sensitivity

STEP, the finest scale conservation-planning tool that covers the entire power line footprint reflects that each of the options traverse areas considered Critically Endangered, Endangered and Vulnerable, with small portions of the preferred option and Option 1 traversing areas that are Currently Not Vulnerable. These areas are shown in Figure 5-2. These conservation statuses are described in full in Zide and Lubke (2014) however, a brief table is included here in Table 5.2. These sensitivity ratings in addition to other factors, have been used to determine the overall sensitivity for each of the routes, this assessment can be seen in Table 5.3.

Table 5.2: STEP conservation priorities (Pierce, 2003)

Classification	Conservation priority	Brief Description	General rule
Critically Endangered	I – highest priority	Ecosystems whose original extent has been so reduced that they are under threat of collapse or disappearance. Included here are special ecosystems such as wetlands and natural forests	This Class I land can NOT withstand loss of natural area through disturbance or development. Any further impacts on these areas must be avoided. Only biodiversity friendly activities must be permitted.
Endangered	II	Ecosystems whose original extent has been severely reduced, and whose health, functioning and existence is endangered	This land can withstand minimal loss of natural area through disturbance or development
Vulnerable	III	Ecosystems which cover much of their original extent but where further disturbance or destruction could harm their health and functioning	This land can withstand limited loss of area through disturbance or development
Currently not Vulnerable	IV	Ecosystems which cover most of their original extent and which are mostly intact, healthy and functioning	Depending on other factors, this land can withstand loss of natural area through disturbance or development

Table 5.3: Sensitivity assessment for each power line route

Power line option	STEP conservation status	Area traversing through Critically Endangered areas	Area traversing green fields areas	Overall comparative sensitivity of the route (1 being the most sensitive, 3 being the least)
Preferred option	Traverses Critically Endangered, Endangered and Vulnerable areas, with a small area of Currently Not vulnerable.	The smallest area of Critically Endangered habitat will be traversed by this option.	None, this option is located next to existing roads and fence lines.	3
Option 1	Traverses Critically Endangered, Endangered and Vulnerable areas.	The largest area of Critically Endangered habitat is traversed by this option.	None, this option is located next to existing roads and fence lines.	2
Option 2	Traverses Critically Endangered, Endangered and Vulnerable areas, with a small area of Currently Not vulnerable.	Critically Endangered habitat will be traversed by this option, less than Option 1 but more than the preferred option.	Yes, this option traverses areas without existing fence lines and roads for a section.	1

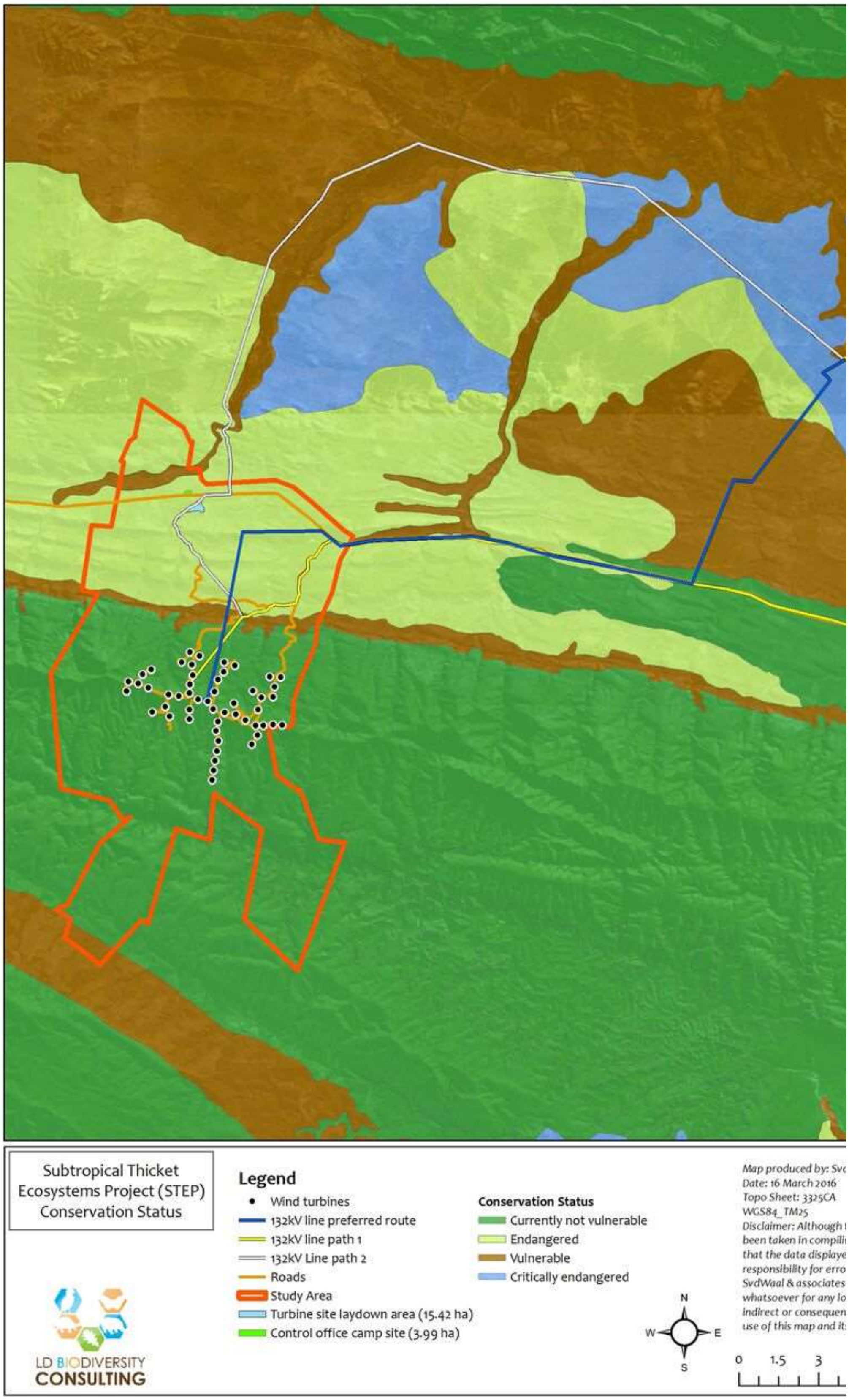

Figure 5-2: STEP Conservation status map indicating the areas traversed by the power line options associated with the Inyanda WEF.

6 Impacts of the WEF

Impacts have been identified by CES in the previous ecological assessment report (Zide & Lubke 2014). These impacts are assessed here using the SRK impact rating scale. Additional impacts are also assessed as per the Terms of Reference (see Section 1.2). These include:

- The impacts on key terrestrial species identified during public consultation (e.g. Leopard, ghost frog, Elandsberg dwarf chameleon, and Smith's dwarf chameleon);
- The impact of noise on faunal species; and
- The impact of fencing (if any) on fragmentation of faunal species and on biodiversity in general.

A complete discussion of the impacts identified by CES can be found in that report, with impact tables produced here in the same order for comparison purposes.

6.1 Loss of vegetation communities

The impacts differ only in the description of particular vegetation types, where metrics are used to determine the impacts associated with the loss of each of these vegetation types. Metrics are used to contextualize the loss of habitat. Should the development footprint change in any way, these metrics will have to be recalculated based on the new layout. The metrics are based on the definition of the footprint of the development (Figure 6-1), which is defined based on drawings for each of the 52 turbines and the laydown areas, and a road width of 15m (which accounts for cut and fill required for roads on steep slopes for an drivable road width of 6m – see Figure 6-2). It is important to note that most of the roads included in the development footprint are not new, and thus the loss of vegetation for the footprint of these areas is conservatively calculated.

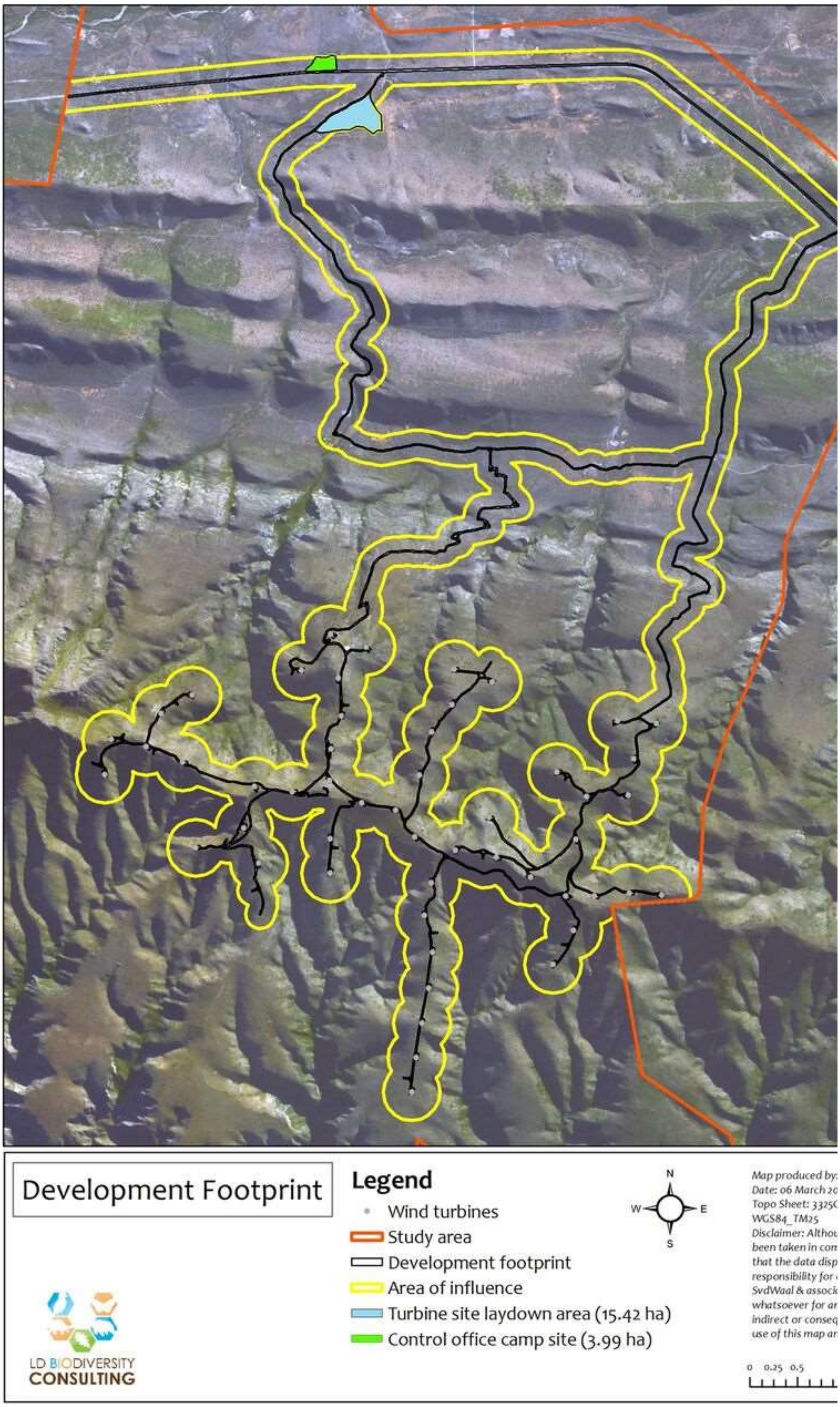

Figure 6-1: Footprint of the Inyanda WEF

Figure 6-2: A cut and fill road, with a footprint extending further than the 6m road width.

Table 6.1: Loss of each of the vegetation types as a result of the proposed development

Vegetation type	Sensitivity	Total area within the AoI (ha)	Area lost during construction (ha)	Percentage of AoI lost (%)
Thicket on rocky outcrops	Moderate	123,00	1,99	1,62
Proteaceous fynbos	Moderate-high	266,95	5,24	1,96
Grassy fynbos	Moderate-high	829,87	50,56	6,09
Succulent thicket	Moderate	86,27	4,65	5,39
Karoo	Moderate	269,57	34,78	12,9
Degraded thicket	Moderate	217,47	10,01	4,6
Renosterveld	Moderate	131,11	8,68	6,62
Acacia riparian thicket	Low	45,44	2,35	5,17
Riparian thicket	Moderate	8,68	0	0
Total		**1978,36**	**118,26**	**5,98**

Mitigation measures for the direct loss of the different vegetation types include the following, which are taken into consideration in the “with mitigation” impact rating:

Essential mitigation measures
Keep the footprint of the development as small as possible and ensure that the maximum road width (15m) is not exceeded.
Rehabilitate areas that will not need to remain cleared in the operational phase, especially remaining areas of turbine platforms that will not be used during the operational phases.
Optional mitigation measures
Move individual turbines out of highly sensitive areas and into less sensitive areas on a small scale.
Reduce the number of turbines in the development, thus also reducing the total area of roads required to reach all of the turbines. It is anticipated that recent changes in the design of the turbines to be used for the proposed development may reduce the number of turbines from 52 (assessed here) to approximately 45 turbines, thus reducing the direct impact on vegetation types.
Enter into a conservation management agreement with the relevant authority will allow for assurance of the conservation of the site. This mitigation measure is already underway, with some discussion regarding a trust that will be set aside for conservation goals for the general area in place.

6.1.1 Loss of Thicket on rocky outcrops

Loss of some of these thicket clumps is definite, from both roads and turbine platforms during the construction phase. Some of the turbine construction phase area can be rehabilitated to mitigate the loss of a small area of this vegetation type. Overall, 1,99ha of this vegetation type will be lost, which forms 1,62% of the vegetation type within the Area of Influence. Individual turbines can be moved slightly to avoid this vegetation type completely or mostly; this may be practical considering the rocky nature of this vegetation type. Confidence rating for this impact is high.

Impact	Consequence			Consequence score	Probability	Impact significance
	Extent	Intensity	Duration			
Without mitigation	Local	Low	Long-term	Low	Definite	Low -
With mitigation	None	None	None	Not significant	Improbable	Insignificant -

6.1.2 Loss of Proteaceous fynbos

Proteaceous fynbos occurs primarily on south and east facing slopes, and as such, will be lost as a result of road and turbine construction. 5,24ha within the Area of Influence will be lost, a total of 1,96% of the vegetation type within the AoI. Areas that are used in the construction phase may be rehabilitated in the operational phase to mitigate the loss of this vegetation type. Confidence rating for this impact is high.

Impact	Consequence	Consequence	Probability	Impact

	Extent	Intensity	Duration	score		significance
Without mitigation	Local	Low	Long-term	Low	Definite	Low -
With mitigation	Local	Low	Long-term	Low	Probable	Low -

6.1.3 Loss of Grassy fynbos

Grassy fynbos is the most extensive vegetation type on the ridges of the Study Area and, as such, is the vegetation type that will lose the greatest area: 50,56ha as a result of the proposed development. This area constitutes 6.09% of the area of grassy fynbos within the Area of Influence. Confidence rating for this impact is high.

Impact	Consequence			Consequence score	Probability	Impact significance
	Extent	Intensity	Duration			
Without mitigation	Local	Low	Long-term	Low	Definite	Low -
With mitigation	Local	Low	Long-term	Low	Probable	Low -

6.1.4 Loss of Succulent thicket

Succulent thicket is present along the roads of the site. Where succulent thicket is present, all roads are already constructed as existing farm roads. As a result, it is anticipated that no additional succulent thicket will be lost during the construction of the proposed development. However, to remain conservative, this impact is rated as though the roads would be newly constructed through the thicket. If this were the case, 4.65ha of the succulent thicket would be lost, a total of 5.39% of the total area of succulent thicket within the Area of Influence. Confidence rating for this impact is high.

Impact	Consequence			Consequence score	Probability	Impact significance
	Extent	Intensity	Duration			
Without mitigation	Local	Low	Long-term	Low	Definite	Low -
With mitigation	N/A					

6.1.5 Loss of Karoo vegetation

The karoo areas will be lost through the construction of the turbine laydown area as well as the camp and roads (already existing as farm roads or roads built for the construction of the met masts). As a result, some of the area used to calculate this impact has already been lost due to previous development and is included here to provide a conservative estimation of the impact to this vegetation type. A total of 34.78ha of the karoo vegetation type will be lost (forming 12.9% of the total area of karoo within the Area of Influence), mainly due to the construction of the laydown area required for the construction of the proposed development. This area must be rehabilitated after the construction of the development, resulting in a decrease in the total area of this vegetation type lost during construction. Rehabilitation of the area may not comprise restoration, but may include rehabilitation including other functional use of the land, such as use as a nursery for the rehabilitation of the site. Confidence rating for this impact is high.

It is also noted that the area planned as a laydown area is within an alluvial plain with evidence of a large amount of water likely passing through seasonally. A hydrologist should investigate this, with a wetland specialist also looking at the impacts associated with construction in an area that may form part of a seasonal wetland or flood zone.

Impact	Consequence			Consequence score	Probability	Impact significance
	Extent	Intensity	Duration			
Without mitigation	Local	Low	Long-term	Low	Definite	Low -
With mitigation	Local	Low	Long-term	Low	Possible	Very Low -

6.1.6 Loss of Degraded thicket

Degraded thicket will be lost through the construction of roads for the proposed development. All roads traversing this vegetation type have previously been constructed as farm roads or for access to the met masts on the farm. As a result, impacts on this vegetation type are based on conservative estimates assuming that the roads have yet to be constructed. 10.01ha of degraded thicket will be lost as a result of road construction, 4,6% of the total area of degraded thicket within the Area of Influence. Confidence rating for this impact is high.

Impact	Consequence			Consequence score	Probability	Impact significance
	Extent	Intensity	Duration			
Without mitigation	Local	Low	Long-term	Low	Definite	Low -
With mitigation	N/A					

6.1.7 Loss of Rensoterveld

Renosterveld will be lost as a result of the construction of roads for the proposed development. As these roads have previously been constructed as farm roads or tracks, this is a conservative estimate of the impact of the construction of the proposed development. A total of 8.68ha of the Renosterveld will be lost as a result of road construction, forming 6.62% of the total area of Renosterveld within the Area of Influence. Confidence rating for this impact is high.

Impact	Consequence			Consequence score	Probability	Impact significance
	Extent	Intensity	Duration			
Without mitigation	Local	Low	Long-term	Low	Definite	Low -
With mitigation	N/A					

6.1.8 Loss of Acacia Riparian thicket

The road passes through an area of riparian thicket in the low-lying areas. This thicket is very degraded and, as the roads already are constructed, the impact is rated as a conservative estimate as though they had not yet been constructed. A total area of 2.35ha, forming 5.17% of the total area of acacia riparian thicket will be lost as a result of the roads. Confidence rating for this impact is high.

It should be noted that roads should not be built through riparian areas, as usually these are highly sensitive. However, these have already been constructed, it is thus recommended that a wetland specialist determine the impacts of existing roads on these wetland areas.

Impact	Consequence			Consequence score	Probability	Impact significance
	Extent	Intensity	Duration			
Without mitigation	Local	Low	Long-term	Low	Definite	Low -
With mitigation	N/A					

6.1.9 Loss of Riparian thicket

Riparian thicket is restricted to areas along the sides of streams in the valleys and will not be impacted by the development footprint. Confidence rating for this impact is high.

Impact	Consequence			Consequence score	Probability	Impact significance
	Extent	Intensity	Duration			
Without mitigation	None	None	None	Not significant	Improbable	Insignificant -
With mitigation	N/A					

6.2 Issue 2: Loss of species of special concern and biodiversity

6.2.1 Loss of plant species of special concern

In the site overall, there is a high number of SSC as well as an expected increase in the SSC recorded should a ground-truthing study be done for permit applications to remove or destroy SSC on site. As a result, the loss of SSC is one of the highest negative impacts of the proposed development. The area of each vegetation type lost is very small, with a total area of 118.26ha that will be lost as a result of the proposed development (an area which does include roads that have already been constructed.). SSC include members of the Proteaceae family, Mesembyanthemaceae family and others and specifically an *Encephalartos longifolius*, which are protected through various pieces of legislation.

Essential mitigation measures
Keep the footprint of the development as small as possible and ensure that the maximum road width (15m) is not exceeded.
Ground-truth the SSC for the entire footprint of the proposed development with the development of a full and complete list of all SSC.
Search and rescue of any SSC within the footprint of the development prior to construction. (Application of permits for the removal for destruction or transplantation of SSC (depending on what is most practical for each group)
Rehabilitation of any areas that were cleared for construction but not required for operation using rescued plants.
Optional mitigation measures
Move individual turbines away from particular SSC, such as *Encephalartos longifolius*.
Reduce the number of turbines in the development, thus also reducing the total area of roads required to reach all of the turbines. It is anticipated that recent changes in the design of the turbines to be used for the proposed development may reduce the number of turbines from 52 (assessed here) to approximately 45 turbines, thus reducing the direct impact on vegetation types.
Enter into a conservation management agreement with the relevant authority will allow for assurance of the conservation of the site. This mitigation measure is already underway, with some discussion regarding a trust that will be set aside for conservation goals for the general area in place.

If search and rescue and rehabilitation is done effectively in conjunction with propagation trials, the numbers of individuals of each SSC will not be reduced and can be increased, resulting in an overall positive impact on the numbers of these species. Confidence rating for this impact is medium.

Impact	**Consequence**			**Consequence score**	**Probability**	**Impact significance**
	Extent	**Intensity**	**Duration**			
Without mitigation	Local	High	Long-term	High	Definite	High -
With mitigation	Local	Medium	Long-term	Medium	Possible	Low +

6.2.2 Loss of animal species of conservation concern

There are several factors at play for rating the impact of the loss of animal SSC. In this section only direct losses will be taken into account, with other factors affecting faunal species dealt with in Sections 5.5 and 5.6 below. Direct loss of species would include slow-moving animals that may be run over by vehicles, specifically tortoises and chameleons. In addition, loss of animals may occur during construction when these are killed as a result of vegetation clearing. Construction personnel may trap animals. Confidence rating for this impact is low. Mitigation measures to avoid these impacts on animals such as amphibians and reptiles (including the ghost frog, Elandsberg dwarf chameleon, and Smith's dwarf chameleon – none of which were recorded from the site) include:

Essential mitigation measures
A search and rescue must be undertaken during construction to ensure that any of these species are relocated prior to vegetation removal.
The speed limit on roads within the proposed development should not exceed 40km/h to avoid road fatalities. Any road fatalities should be monitored and mitigation measures adapted to reduce these.
Workers must not be allowed to trap any animals on site and must be trained in the value of biodiversity.
Optional mitigation measures
The majority of the large earthworks involved in construction should take place in a season where faunal SSC are not active (such as the dry season) to avoid fatalities.
Reduce the number of turbines in the development, thus also reducing the total area of roads required to reach all of the turbines. It is anticipated that recent changes in the design of the turbines to be used for the proposed development may reduce the number of turbines from 52 (assessed here) to approximately 45 turbines, thus reducing the direct impact on vegetation types.
Enter into a conservation management agreement with the relevant authority will allow for assurance of the conservation of the site. This mitigation measure is already underway, with some discussion regarding a trust that will be set aside for conservation goals for the general area in place.

Impact	**Consequence**			**Consequence score**	**Probability**	**Impact significance**
	Extent	**Intensity**	**Duration**			
Without mitigation	Local	Low	Short-term	Very low	Probable	Very Low -
With mitigation	Local	Low	Short-term	Very low	Improbable	Insignificant -

6.2.3 Loss of biodiversity (general)

Biodiversity loss will result from the clearance of vegetation for the construction of the proposed development. As a result, individuals of many species will be lost over the total 118.26ha that will be removed for construction. Species richness and diversity is high for the site, especially considering the range of different vegetation types recorded on site. The confidence rating for this impact is medium. Mitigation measures to reduce the loss of biodiversity should include:

Essential mitigation measures
Keep the footprint of the development as small as possible.
Collect and propagate species other than the SSC for use in rehabilitation.
Optional mitigation measures
Reduce the number of turbines in the development, thus also reducing the total area of roads required to reach all of the turbines. It is anticipated that recent changes in the design of the turbines to be used for the proposed development may reduce the number of turbines from 52 (assessed here) to approximately 45 turbines, thus reducing the direct impact on vegetation types.
Enter into a conservation management agreement with the relevant authority will allow for assurance of the conservation of the site. This mitigation measure is already underway, with some discussion regarding a trust that will be set aside for conservation goals for the general area in place.

Impact	Consequence			Consequence score	Probability	Impact significance
	Extent	Intensity	Duration			
Without mitigation	Local	Medium	Long-term	Medium	Definite	Medium -
With mitigation	Local	Low	Medium-term	Very low	Probable	Very Low -

6.3 Issue 3: Disruption of ecosystem function and process

6.3.1 Fragmentation and edge effects

In a site with the roads reaching 15m at their widest and the turbine construction platforms taking up very little space, fragmentation is unlikely to be a large impact. The roads are narrow enough to allow for the crossing of small animals such as tortoises and chameleons as well as large animals such as leopards. In addition, such road widths are unlikely to affect seed dispersal and pollination. Thus the proposed development does not pose a fragmentation problem.

Impact	Consequence			Consequence score	Probability	Impact significance
	Extent	Intensity	Duration			
Without mitigation	Local	Low	Long-term	Low	Improbable	Very low -
With mitigation	N/A					

6.3.2 Invasion of alien species

Several alien pant species were recorded from the site, some of which are concerning. A *Pinus* species has invaded the fynbos, a large concern considering the sensitivity of this vegetation. In addition various succulent species (including prickly pear and jointed cactus) have invaded the thicket and Acacia riparian areas that can be a major problem in these vegetation types. Currently, the invasion level is low however; the activity associated with the construction of the proposed development will result in the spread of these species and could result in a very large detrimental impact. Confidence rating for this impact is medium. Mitigation measures are essential and include the following:

Essential mitigation measures
Removal and control of all alien species continually throughout the lifespan of the proposed development.
Ensure trucks entering the site do not bring alien invasive species in. This can be done by visually scanning each vehicle and ensuring no jointed cactus or prickly pear are attached.
Implementation of an alien invasive management plan.
Optional mitigation measures
Enter into a conservation management agreement with the relevant authority will allow for assurance of the conservation of the site. This mitigation measure is already underway, with some discussion regarding a trust that will be set aside for conservation goals for the general area in place.

Impact	**Consequence**			**Consequence score**	**Probability**	**Impact significance**
	Extent	**Intensity**	**Duration**			
Without mitigation	Local	Medium	Long-term	Medium	Definite	Medium -
With mitigation	Local	Low	Short-term	Very Low	Possible	Insignificant -

6.4 Issue 4: Impacts of dust generation on vegetation

The impacts of dust on the vegetation, especially during the construction phase, were used to calculate the Area of Influence of the study site and are thus important. Impacts of dust are treated as a separate issue here as a result of that importance. Impact rating confidence is medium.

Fugitive, or airborne, dust is classified as particulate matter which is one of the of the six principal air pollutants, as identified by the United States Environmental Protection Agency (EPA). Sources of fugitive dust include construction sites, agricultural land and roads. Both paved and unpaved roads release dust into the atmosphere, but unpaved roads (also known as unsealed, or dirt, roads) are responsible for the majority of vehicle-induced dust generation and are by far the largest source of particulate matter. Jones (2000) estimated that the total dust generated on the c. 500 000 km of unpaved roads in South Africa was c. 3 million tonnes per annum, but this estimate was later increased to 4 million tonnes by the Ministry of Transport after the estimate of total unpaved road length was increased to 600 000 km (Greening, 2011). All vehicles travelling on unpaved roads result in the emission of dust into the atmosphere. This occurs as the tyres of the vehicle loosen the road's surface and the turbulence caused by the vehicle's movement transports the resultant loose material into the air. This often results in dust clouds, which may also contain other pollutants, such as fuel products. The amount of dust that is generated and how far its impacts are felt depends on many factors, such as road conditions, the size of the dust particles, rainfall, wind speed and direction, and vehicle weight and speed. Coarse dust particles have greater negative environmental impacts but travel shorter distances, while finer particles are not as harmful to the environment but can travel great distances. Very coarse material usually re-settles on the road surface where it is further sheared and grinded by passing vehicles into finer fractions (Greening, 2011). With regards to the effect of vehicle type: the heavier the vehicle, and the higher the vehicle's speed, the greater the amount of dust generation. In general the higher the wind speed, the farther the impacts of the dust are felt. In New Zealand it was shown that, depending on wind and terrain, crops accumulated dust from unpaved road use between 25 m and 250 m from the road (McCrae, 1984), while in South Africa the effects of dust has been recorded up to 300 m from the road (Jones, 2001).

Most of the research on the impacts of dust on vegetation has been of an agricultural nature, focusing on crops and other commercial plants and the possible economic losses associated with dust generation (e.g. McCrea, 1984). We can however glean, from the body of research, that dust generated from the use of unpaved roads may affect the photosynthesis, respiration and transpiration of adjacent plants and could also allow the penetration of phytotoxic gaseous pollutants (Farmer, 1993; Prajapati, 2012).

The accumulation of dust on the leaves of plants reduces the total leaf area exposed to direct sunlight, essentially "shading" the plant and causing a decrease in photosynthetic ability. Thomson *et al.* (1984) showed that road dust applied to the upper surface of *Viburnum tinus* leaves reduced photosynthesis due to shading, while the application of dust to the lower surface reduced photosynthesis due to the hindrance of diffusion. A reduction in photosynthesis results in a lower supply of carbohydrates, which decreases the plant's overall productivity (i.e. its growth, the number of buds formed and its fruit set). The transpiration rate can also be impacted, depending on the amount, colour and particle size of the dust that accumulates on the leaves (Prajapati, 2012). If large amounts of dark-coloured dust cover the leaves, leaf temperature can rise significantly (due to the absorption of heat), increasing water loss. Road dust can also increase a plant's susceptibility to insects, fungi and disease. Studies have shown that conditions conducive to the growth of bacteria and fungi are created when dust accumulates in crevices on plant surfaces and fruit (Greening, 2001). Insects that eat the fruit of plants are protected from eradication in two ways when sufficient dust is present (Jones *et al.*, 2008). Firstly, dust reduces the activity of beneficial insects, which prey on those insects that eat the fruit, enabling them to escape predation. Secondly, dust reduces the contact of insecticides, reducing its effect. Dust also diminishes the effect of fungicides, weed control sprays and fertilisers by the same mechanism. It has also been suggested that dust may hinder pollination too which would impede fruit formation and yield (McCrea, 1984).

The adverse effects of vehicle-generated dust were clearly shown in a model study conducted in South Africa using infra-red aerial photography (HKS, 1992). The study seems to be used as a point of reference in many reports and related research (Jones, 2000; Jones 2001; Greening 2011). It showed that trees in fruit orchards immediately adjacent to unpaved roads were smaller and less productive than those that were progressively further away from the road. Between 80% and 90% of the trees in the three rows closest to the road were less productive and smaller than the average for the whole orchard. Tree size and productivity increased progressively as one moved further away from the road until trees were unaffected in the eighth row. The study also showed that the presence of dust protects fruit-eating insects to some extent in that additional insecticide applications were required on the trees nearest to the road in order to counter the hindrance of the dust to the contact of the insecticides and the negative impact the dust has on beneficial insects.

The impacts of vehicle-generated dust on the vegetation also have consequences for nearby grazing livestock and wildlife, in that dust accumulation reduces the palatability of vegetation. It has been observed in the national parks of South Africa that animals tend to avoid grazing on the dust-covered grass next to unpaved roads and rather graze on grass further away (Jones, 2001), while other work has even showed that animals that graze next to unpaved roads may even experience accelerated tooth wear (McCrea, 1984). An indirect impact of vehicle-generated dust on the vegetation results due to the loss of gravel from unpaved roads and the resultant requirement for maintenance and construction. The ministry of transport has estimated that 150 million tonnes of gravel lost from South African dirt roads each year. More quarries need to be opened as unpaved roads degrade (a process which is continual and speeds up with use) and these quarries contribute their own negative impacts on vegetation through the dust that they release.

It is anticipated that dust will have an impact on the vegetation up to 300m surrounding the roads of the site. These impacts will reduce the productivity and photosynthesis of the plants adjacent to the roads and reduce the palatability for herbivores. Mitigation measures used to reduce or control dust effects on vegetation include dust suppression models such as (from Jones, 2000; Addo *et al*., 2004; Jones *et al*., 2008):

- The roads could be sealed, reducing the dust generation as well as potential erosion of the road surfaces on site. This may be beneficial considering the steep slopes of the site that will be subject to erosion as exposed surfaces;
- Mechanical stabilization options are available: that is using specific materials for road construction. This option may be prohibitively expensive;
- Water can be used to suppress dust and is often recommended as a spray to reduce dust generation during high traffic periods (for example the construction phase of the development). However, considering the arid nature of the site and the current drought being experienced, this is not considered a reasonable mitigation measure for dust suppression;
- Calcium chloride sprays may be used to absorb atmospheric moisture and bind particles together, reducing dust generation, ligno-suphonates may also be used in a similar manner;

Essential mitigation measures

Reduction of the speed of vehicular traffic, it is recommended that the speed limit for the roads within the study area be no more than 40km/h with a recommended speed of 20km/h which will not only reduce dust generation but also reduce faunal road fatalities.
Dust suppression options must be researched and the best method both functionally and cost-effectively should be chosen for the site to ensure reduction of dust generation as well as the reduction of the erosion potential of roads on the site.

Impact	Consequence			Consequence score	Probability	Impact significance
	Extent	Intensity	Duration			
Without mitigation	Local	Medium	Long-term	Medium	Definite	Medium -
With mitigation	Local	Low	Long-term	Low	Possible	Very low -

6.5 Issue 5: Impacts of noise generation on fauna

Noise generation during construction will include the traffic noise of construction vehicles and associated construction noises. Operational noise is restricted primarily to the noise and vibrations of the turbines themselves. Noise is likely to have an impact on animal species, particularly SSC.

Wind turbines generate two types of noise (Kikuchi, 2008; Marmo et al., 2013):

- Aerodynamic: generated by the blades when they collide with air masses.
- Mechanical: generated by the machinery within the turbine.

The aerodynamic noise is audible noise, with the mechanical noise forming vibrations. Vibrations are produced by two different sources: the gear meshing and electromagnetic interactions. Audible noise is at very low frequencies usually lower than 50Hz, with vibrations ranging between 50Hz to 2kHz. Although most impacts studied related to the noise of turbines are associated with volant (able to fly) fauna, this noise does have an impact on non-volant fauna (Lovich and Ennen, 2013, Rabin et al., 2006).

Non-volant animals can also be affected by anthropological activities during the construction as well as the operation and maintenance of the WEF including road noise (Helldin et al. 2012). No work has been done on the impact of wind turbine noise on fauna of South Africa, and wind facilities currently in operation will provide an opportunity to achieve this. Until then, impacts can be inferred from studies done on WEFs in other countries. Due to lack of knowledge in this area, impacts are assessed with a low level of confidence.

6.5.1 Impact of noise on mammals

Helldin et al. (2012) have reported some impacts on reindeers, squirrels (Kikuchi, 2008; Rabin et al. 2006) and some other mammals naturally found within WEF sites. Studies have shown that mammals tend to get used to the noise associated with turbines if they are unable to relocate to other locations. Small mammals may be more susceptible to volant predators as they are alarmed by turbine noises, which may flush them into the open. Larger mammals are less affected by the noise and avoid open roads and get used to the noise if there are no other unaffected habitat locations. If communication between animals is related to sound, this may be affected by the turbine noise. The confidence rating for this impact is low.

Impact	Consequence			Consequence score	Probability	Impact significance
	Extent	Intensity	Duration			
Without mitigation	Local	Low	Long-term	Low	Definite	Low -
With mitigation	N/A					

6.5.2 Impact of noise on reptiles

No studies could be found that determine the effect of wind turbine noise on reptiles, however, studies have been done on the response of reptiles to other noise generators and these impacts are extrapolated here. Noise disturbs reptile activity (Andrews *et al.* 2008), as it affects behavior related to hearing acuity. However, no large detrimental effects have been found to occur on reptile populations as a result of noise generation. The confidence rating for this impact is low.

Impact	Consequence			Consequence score	Probability	Impact significance
	Extent	Intensity	Duration			
Without mitigation	Local	Low	Long-term	Low	Definite	Low -
With mitigation	N/A					

6.5.3 Impact of noise on amphibians

As with reptiles, little information exists on the effects of wind turbine noise on amphibians. Impacts are inferred from studies related to the impact of noise in general on amphibians. Amphibians tend to be heavily impacted by noise generated by anthropogenic activities (Bergevin et al., 2010; Kaiser et al., 2010). Amphibians are reliant on calls to ensure mates, and additional noise created by developments can detrimentally affect the communication of amphibian species, mainly resulting in mis-orientation of the amphibians. As a result, the amphibians can be exposed to predators and breeding can be decreased with a resultant decrease in the population of the amphibians.

Some studies have reported that some amphibians have the ability to adjust their hearing acuity in order to adapt to the noise generated by the road traffic (Cunnington & Fahrig, 2010; Narin, 2013). Kaiser et al. (2010), Narin (2013) and Cunnington & Fahrin (2010) show that amphibians have a wide range of tolerance towards the noise and vibration produced by the wind turbines; they are able to adjust they sensory membranes to adapt to lower frequencies. The damages will be irreversible (tympanic loss) if the vibrations are at high frequencies and reaching 120 db of intensity.

It is important to note that no populations of the ghost frog were found within the site. In addition, no suitable habitat for the frog species was located within the Area of Influence. However, despite this, it may still be present on the site. It is recommended that a comprehensive amphibian survey be done for the site, potentially as part of a student research project, allowing for the clearer elucidation of the impacts on turbine generated noise on amphibian populations. The confidence rating for this impact is low.

Impact	Consequence			Consequence score	Probability	Impact significance
	Extent	Intensity	Duration			
Without mitigation	Regional	Medium	Long-term	High	Possible	Medium -
With mitigation	N/A					

6.6 Issue 6: Impacts of fencing on fauna

The use of fencing for either wildlife or livestock has many benefits, such as increasing the safety of the animals (in the case of human- wildlife conflicts) and controlling the movement/ migration of wildlife or livestock (beneficial for the surrounding vegetation, especially crops) (Boone and Hobbs, 2009). Use in conservation, however limits movement of animals (Hayward and Kerley, 2009). Physically structured fences such as barbed or poly wire, tape and electrified fencing have been observed to entangle, electrocute large herbivores such as kudus (*Tragelaphus sterpsiceros)*, and also pose a threat to smaller animals such as tortoises (*Geochelone pardalis*) and ducklings, (Hayward and Kerley, 2009). Metaphorical fences, comprised of less harmful materials such as hedges, cacti, thorn, stones, noise barriers, guard dogs, scent (faeces from territorial animals, or garden chillies- *Capsicum spp)* are also employed and just as effective in containing animals within their restricted areas. (Hayward and Kerley, 2009, Boone and Hobbs, 2009).

The act of containing wildlife/ livestock within confined areas, especially in South African farms, has been observed to have negative impacts on their genetic structures, thus raising concerns for inbreeding and founder's effect. (Boone and Hobbs, 2009). Other evolutionary/ behavioural changes are also of major concern, with buffalos (*Syncerus caffer*), in captivity thought to be in danger of losing their anti- predator behaviour. Blocking migratory routes for migratory animals has been observed to also impact animals on a major scale, with the example of the altitudinal migratory Cape zebra (*Equus equus*) and the eland- *Tragelaphus oryx*, which migrate from SA during unfavourable seasons. Fencing along their migratory routes forces them to occupy places unfavorable to their needs at certain seasons (Hayward and Kerly, 2009).

Less negative effects however seem to be experienced by carnivores with a study on lions (*Panthera leo),* spotted hyenas (*Crocuta crocuta*) and leopards *(Panthera pardus*) fenced within on the Addo Elephant Park. By observing the ranges at which they occupy, a study by

(Hayward, Kerley et al, 2008) showed that the use of fences did not restrict their movement, rather, the abundance of prey within their vicinity being the determining factor for their population sizes.

Fencing on site has been reduced to a large extent to allow for free movement of wildlife in the area. The confidence rating for this impact is medium. Should fencing be required, the following mitigation measures are recommended:

Essential mitigation measures
Mesh sizes should allow for the passage of small animals.
Electrical bottom-wires should be avoided as these can lead to the death of small animals, in particular tortoises.
Flags and other methods of ensuring fence visibility to animals such as Kudu should be employed where fences are erected to avoid animals being caught in fences.
Fences not required should be removed to allow for free movement of animals.
Optional mitigation measures
Use of metaphorical fences where appropriate – some research may need to be done depending on which animal species need to be excluded from certain areas.

Impact	**Consequence**			**Consequence score**	**Probability**	**Impact significance**
	Extent	**Intensity**	**Duration**			
Without mitigation	Regional	Low	Long-term	Medium	Probable	Medium -
With mitigation	Local	Low	Long-term	Low	Possible	Very low -

7 Impacts of the power line alternatives

Impacts of the power line alternatives are rated together so that comparisons can be made as to which alternative has the least impact for each of the issues and impacts. All impacts are rated based on desktop information and Google earth imagery. Each was surveyed according to where it was placed (alongside existing linear developments such as roads or fences or through green fields areas), which was also taken into account.

7.1 Issue 1: Loss of vegetation

The loss of vegetation is determined based on Google earth images and vegetation maps of the area. For the purposes of this study, community types were not elucidated. Confidence rating for this impact assessment is low. For the impact ratings without mitigation, it is assumed that good condition indigenous vegetation will be removed, that is, undisturbed areas will be affected. Mitigation measures for the direct loss of the different vegetation types include the following, which are taken into consideration in the "with mitigation" impact rating:

Essential mitigation measures
Keep the footprint of the development as small as possible and ensure that the maximum servitude width (31m) is not exceeded.
Rehabilitate areas that will not need to remain cleared in the operational phase.
Mow or flatten vegetation, rather than clear it wherever possible.
Ensure that as far as possible servitudes are placed in areas of already existing disturbance, for example along the edges of roads.

Impact	**Consequence**			**Consequence score**	**Probability**	**Impact significance**
	Extent	**Intensity**	**Duration**			
Preferred option						
Without mitigation	Regional	Low	Long-term	Medium	Definite	Medium -
With mitigation	Local	Low	Long-term	Low	Definite	Low -
Option 1						
Without mitigation	Regional	Medium	Long-term	High	Definite	High -
With mitigation	Local	Low	Long-term	Low	Definite	Low -
Option 2						
Without mitigation	Regional	Medium	Long-term	High	Definite	High -
With mitigation	Local	Low	Long-term	Low	Definite	Low -

7.2 Issue 2: Loss of species of special concern and biodiversity

7.2.1 Loss of plant species of special concern

Considering the vegetation of the area, a high number of SSC is anticipated. As a result, the loss of SSC is one of the highest negative impacts of the proposed development. However, no field studies have been done to determine the SSC for each of the options and the SSC are inferred from what is already known of the region. The confidence for this impact rating is low.

Essential mitigation measures
Keep the footprint of the development as small as possible and ensure that the maximum servitude width (31m) is not exceeded.
Ground-truth the SSC for the entire footprint of the proposed development with the development of a full and complete list of all SSC.
Search and rescue of any SSC within the footprint of the development prior to construction. (Application of permits for the removal for destruction or transplantation of SSC (depending on what is most practical for each group)
Rehabilitation of any areas that were cleared for construction but not required for operation using rescued plants.
Ensure that as far as possible servitudes are placed in areas of already existing disturbance, for example along the edges of roads.

Impact	**Consequence**			**Consequence score**	**Probability**	**Impact significance**
	Extent	**Intensity**	**Duration**			
Preferred option						
Without mitigation	Regional	Medium	Long-term	Medium	Definite	Medium -
With mitigation	Local	Low	Long-term	Low	Definite	Low -
Option 1						
Without mitigation	Regional	Medium	Long-term	High	Definite	High -
With mitigation	Local	Low	Long-term	Low	Definite	Low -
Option 2						
Without mitigation	Regional	Medium	Long-term	High	Definite	High -
With mitigation	Local	Low	Long-term	Low	Definite	Low -

7.2.2 Loss of animal species of conservation concern

There are several factors at play for rating the impact of the loss of animal SSC. In this section only direct losses will be taken into account. Direct loss of species would include slow-moving animals that may be run over by vehicles, specifically tortoises and chameleons. In addition, loss of animals may occur during construction when these are killed as a result of vegetation clearing. Construction personnel may trap animals. Confidence rating for this impact is low. Mitigation measures to avoid these impacts on animals such as amphibians and reptiles include:

Essential mitigation measures
A search and rescue must be undertaken during construction to ensure that any of these species are relocated prior to vegetation removal.
The speed limit on roads within the proposed development should not exceed 40km/h to avoid road fatalities. Any road fatalities should be monitored and mitigation measures adapted to reduce these.
Workers must not be allowed to trap any animals on site and must be trained in the value of biodiversity.
Optional mitigation measures
The majority of the large earthworks involved in construction should take place in a season where faunal SSC are not active (such as the dry season) to avoid fatalities.

Impact	**Consequence**			**Consequence score**	**Probability**	**Impact significance**
	Extent	**Intensity**	**Duration**			
Preferred option						
Without mitigation	Regional	Medium	Long-term	Medium	Possible	Low -
With mitigation	Local	Low	Long-term	Low	Possible	Very Low -
Option 1						
Without mitigation	Regional	Medium	Long-term	High	Possible	Medium -
With mitigation	Local	Low	Long-term	Low	Possible	Very Low -
Option 2						
Without mitigation	Regional	Medium	Long-term	High	Possible	Medium -
With mitigation	Local	Low	Long-term	Low	Possible	Very Low -

7.2.3 Loss of biodiversity (general)

Biodiversity loss will result from the clearance of vegetation for the construction of the proposed development. As a result, individuals of many species will be lost over the total area that will be removed for construction. The confidence rating for this impact is low. Mitigation measures to reduce the loss of biodiversity should include:

Essential mitigation measures
Keep the footprint of the development as small as possible.
Collect and propagate species other than the SSC for use in rehabilitation.

Impact	Consequence			Consequence score	Probability	Impact significance
	Extent	Intensity	Duration			
Preferred option						
Without mitigation	Regional	Medium	Long-term	Medium	Definite	Medium -
With mitigation	Local	Low	Long-term	Low	Definite	Low -
Option 1						
Without mitigation	Regional	Medium	Long-term	High	Definite	High -
With mitigation	Local	Low	Long-term	Low	Definite	Low -
Option 2						
Without mitigation	Regional	Medium	Long-term	High	Definite	High -
With mitigation	Local	Low	Long-term	Low	Definite	Low -

7.3 Issue 3: Disruption of ecosystem function and process

7.3.1 Fragmentation and edge effects

Although a linear development, primarily located along pre-existing linear developments (roads) such servitude widths are unlikely to affect seed dispersal and pollination. Thus the proposed development does not pose a fragmentation problem.

7.3.2 Invasion of alien species

Several alien pant species were recorded from the study site, most of which can occur throughout all powerline alternatives. Confidence rating for this impact is low. Mitigation measures are essential and include the following:

Essential mitigation measures
Removal and control of all alien species continually throughout the lifespan of the proposed development.
Ensure trucks entering the site do not bring alien invasive species in. This can be done by visually scanning each vehicle and ensuring no jointed cactus or prickly pear are attached.
Development of an alien invasive management plan.

Impact	Consequence	Consequence	Probability	Impact

	Extent	Intensity	Duration	score		significance
Preferred option						
Without mitigation	Regional	Medium	Long-term	High	Definite	High -
With mitigation	Local	Low	Long-term	Low	Definite	Low -
Option 1						
Without mitigation	Regional	Medium	Long-term	High	Definite	High -
With mitigation	Local	Low	Long-term	Low	Definite	Low -
Option 2						
Without mitigation	Regional	Medium	Long-term	High	Definite	High -
With mitigation	Local	Low	Long-term	Low	Definite	Low -

8 Conclusions and recommendations

8.1 Impacts

Overall, the impacts of the proposed development on biodiversity are relatively low. A summary of the impacts of the proposed Inyanda WEF is shown in Table 8.1, with impacts of the power line alternatives in Table 8.2. The presence of a large number of plant SSC mean that the impact to these species is high. However, with the proper mitigation measures in place, these impacts can be avoided and an increase in the number of these species achieved, resulting in a positive impact on plant SSC. In terms of internationally accepted best practice, the mitigation hierarchy should be followed to ensure that no net loss of biodiversity is achieved for a development. This is further explained with reference to recommended mitigation measures in Section 8.2 below.

Table 8.1: Summary of impacts associated with the proposed Inyanda WEF

Impact	Without mitigation	With Mitigation
Loss of thicket on rocky outcrops	Low -	Insignificant
Loss of proteaceous fynbos	Low -	Low -
Loss of grassy fynbos	Low -	Low -
Loss of succulent thicket	Low -	N/A
Loss of karoo	Low -	Very low -
Loss of degraded thicket	Low -	N/A
Loss of renosterveld	Low -	N/A
Loss of acacia riparian thicket	Low -	N/A
Loss of riparian thicket	Insignificant	N/A
Loss of plant SSC	High -	Low +
Loss of animal SSC	Very low -	Insignificant
Loss of biodiversity	Medium -	Very low -
Fragmentation and edge effects	Very low -	N/A
Spread of Invasive alien species	Medium -	Insignificant
Impacts of dust	Medium -	Very low -
Noise on mammals	Low -	N/A
Noise on reptiles	Low -	N/A
Noise on amphibians	Medium -	N/A
Fencing on fauna	Medium -	Very low -

Table 8.2: Summary of impacts associated with the powerline alternatives

Impact	Preferred Option		Option 1		Option 2	
	Without mitigation	With Mitigation	Without mitigation	With Mitigation	Without mitigation	With Mitigation
Loss of	Medium -	Low -	High -	Low -	High -	Low -

vegetation						
Loss of plant SSC	Medium -	Low -	High -	Low -	High -	Low -
Loss of animal SSC	Low -	Very Low -	Medium -	Very Low -	Medium -	Very Low -
Loss of biodiversity	Medium -	Low -	High -	Low -	High -	Low -
Spread of Invasive alien species	High -	Low -	High -	Low -	High -	Low -

8.2 Cumulative impacts

Cumulative impacts of the power lines and the WEF are low overall (with mitigation). This is due to the comparatively small amount of natural vegetation that will be lost and the development of the power line (the preferred alternative is recommended) along existing linear developments (roads and fence lines) thus reducing the impact of a new linear development. It is anticipated that due to the narrow roads and the power line servitudes left as natural vegetation (perhaps mown), fragmentation will be negligible overall. The development will allow for the movement of fauna as well as the pollination and seed dispersal of flora.

High impacts of concern include the removal and/or destruction of flora SSC. This needs to be carefully managed to ensure the proper permitting is in place and that plants that can be transplanted are housed in a nursery and used for rehabilitation. The loss of faunal species may also be relatively high, and all slow-moving reptiles should be rescued and relocated during construction to ensure no losses.

8.3 The Mitigation Hierarchy and recommended mitigation measures

The mitigation hierarchy is international best practice for managing risks and impacts, and is listed by the International Finance Corporation (IFC) as the primary objective of Performance Standard 1 as follows: “To adopt a mitigation hierarchy to anticipate and avoid, or where avoidance is not possible, minimize, and, where residual impacts remain, compensate/offset for risks and impacts to workers, Affected Communities, and the environment.” This mitigation hierarchy is represented in Figure 8-1.

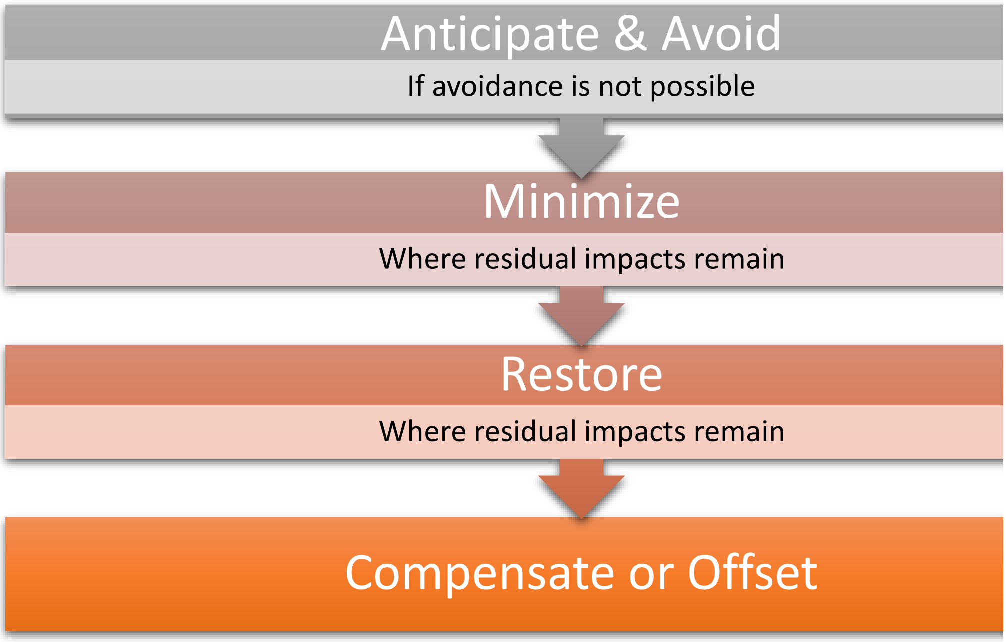

Figure 8-1: The Mitigation Hierarchy as defined by the IFC

The IFC further mentions the Mitigation Hierarchy in Performance Standard 6, in the context of natural or critical habitat and states that "biodiversity offsets may only be considered after appropriate avoidance, minimization and restoration measures have been applied" (IFC. 2012). The Hierarchy follows a strict progression of best practice for dealing with impacts; these are explained in Table 8.3 below:

Table 8.3: The different levels of the Mitigation Hierarchy defined

Avoidance	If impacts on the natural environment can be avoided, this is the best possible way of reducing impacts. Avoidance can involve changes in the location of infrastructure, in this case, turbines may be relocated to avoid impacts on certain areas of vegetation or SSC.
Minimization	If impacts cannot be avoided, it is important that these are minimized. This is where mitigation measures usually described in an EIA fall. Minimization may include reducing the footprint of the development as far as possible,, or utilising already existing infrastructure.
Restore	If there are still residual impacts, restoration or rehabilitation may be employed to increase the biodiversity value of the site after development activities. Such mitigation measures include rehabilitation of areas of the site cleared for construction, but not used for operation of the development.
Offset	If residual impacts remain after all efforts to avoid, minimize and restore have been taken into consideration, offsets may be needed. These include the setting aside of areas within the project area as corridors and conservation areas, as well as the setting aside of other areas for conservation. Offsets are difficult to determine and manage, and a separate study is often needed in order to identify the best options and those which compensate identical (or as close as possible) biodiversity to that which was

	impacted by the development.

Mitigation measures for the proposed development are thus categorized according to the mitigation hierarchy as follows:

8.3.1 Avoidance

Some of the impacts can be avoided this may be achieved by, for example:

- Moving turbines to avoid *Encephalartos longifolius* individuals;
- Reducing the overall number of turbines – this is already being considered, with changes to the turbine design resulting in an updated layout of 45 turbines.

8.3.2 Minimization

Impacts that cannot be avoided can be minimized; such mitigation measures include the following, for example:

- Control of alien invasive plant species; and
- Maintaining as small a footprint as possible.

8.3.3 Restoration

Areas that are cleared for construction, but not required for operation of the development can be rehabilitated. This should be done using plant SSC rescued and propagated, as well as other species that are propagated for rehabilitation purposes.

8.3.4 Offsets

Considering that areas will be lost as a direct result of the development, as well as the noise impacts of the turbines on fauna, it is recommended that offsets be considered. Offsets will ensure Net Positive Impact on Biodiversity for the project. As discussions are underway for the development of a trust that will ensure conservation of the site, offsets have effectively been taken into consideration. This could potentially result in an overall positive impact on biodiversity as a result of the development.

8.4 Mitigation measures for the WEF

The following mitigation measures have been recommended throughout the document, and are consolidated here:

Essential mitigation measures
Keep the footprint of the development as small as possible and ensure that the maximum road width (15m) or servitude width (31m) is not exceeded.
Ensure that as far as possible power line servitudes are placed in areas of already existing disturbance, for example along the edges of roads.
Rehabilitate areas that will not need to remain cleared in the operational phase, especially

remaining areas of turbine platforms that will not be used during the operational phases.
Ground-truth the flora SSC for the entire footprint of the proposed development with the development of a full and complete list of all SSC.
Search and rescue of any flora SSC within the footprint of the development prior to construction. (Application of permits for the removal for destruction or transplantation of SSC (depending on what is most practical for each group)
Rehabilitation of any areas that were cleared for construction but not required for operation using rescued plants.
A search and rescue for fauna must be undertaken during construction to ensure that any of these species are relocated prior to vegetation removal.
The speed limit on roads within the proposed development should not exceed 40km/h to avoid road fatalities. Any road fatalities should be monitored and mitigation measures adapted to reduce these.
Workers must not be allowed to trap any animals on site and must be trained in the value of biodiversity.
Collect and propagate species other than the SSC for use in rehabilitation.
Removal and control of all alien species continually throughout the lifespan of the proposed development.
Ensure trucks entering the site do not bring alien invasive species in. This can be done by visually scanning each vehicle and ensuring no jointed cactus or prickly pear are attached.
Development of an alien invasive management plan.
Reduction of the speed of vehicular traffic, it is recommended that the speed limit for the roads within the study area be no more than 40km/h with a recommended speed of 20km/h which will not only reduce dust generation but also reduce faunal road fatalities.
Dust suppression options must be researched and the best method both functionally and cost-effectively should be chosen for the site to ensure reduction of dust generation as well as the reduction of the erosion potential of roads on the site.
Mesh sizes should allow for the passage of small animals.
Electrical bottom-wires should be avoided as these can lead to the death of small animals, in particular tortoises.
Flags and other methods of ensuring fence visibility to animals such as Kudu should be employed where fences are erected to avoid animals being caught in fences.
Fences not required should be removed to allow for free movement of animals.
Optional mitigation measures
Move individual turbines out of highly sensitive areas and into less sensitive areas on a small scale.
Move individual turbines away from particular SSC, such as *Encephalartos longifolius*.
The majority of the large earthworks involved in construction should take place in a season where faunal SSC are not active (such as the dry season) to avoid fatalities.
Use of metaphorical fences where appropriate – some research may need to be done depending on which animal species need to be excluded from certain areas.
Reduce the number of turbines in the development, thus also reducing the total area of roads required to reach all of the turbines. It is anticipated that recent changes in the design of the turbines to be used for the proposed development may reduce the number of turbines from 52 (assessed here) to approximately 45 turbines, thus reducing the direct impact on vegetation types.

Enter into a conservation management agreement with the relevant authority will allow for assurance of the conservation of the site. This mitigation measure is already underway, with some discussion regarding a trust that will be set aside for conservation goals for the general area in place.

8.5 Recommendations for ensuring application of mitigation measures

It is vital that mitigation measures are applied as recommended (based on practicality and cost effectiveness). This can be achieved with a series of plans assuring the process to be followed for monitoring and application of mitigation measures. Plans recommended for this proposed development are as follows:

- An alien invasive management plan;
- A comprehensive assessment of all plant SSC within the footprint of the development and corresponding permit applications for removal of these species (removal includes both transplantation and destruction of these species);
- A search and rescue plan for both plant and animal SSC to be applied before construction (plants) and during construction (animals);
- A rehabilitation plan detailing the methods used for the rehabilitation of areas cleared for construction but not required for operation of the development;
- An offset plan should be developed should the proponent wish to demonstrate a net gain of biodiversity for the proposed project.

It is further recommended that all such plans be included in an overall Biodiversity Action Plan or BAP (optional) as is usually required for IFC projects to meet international best practice. Such a plan will allow for centralization of biodiversity-related mitigation actions with associated responsibility assignations and monitoring.

8.6 Recommendations for further studies

It is clear from research that little is known about the impacts of wind energy facilities in South Africa, in particular their impact on fauna. Should this potential development go ahead, it provides a unique opportunity to allow for the study of these impacts to inform future developments, as well as allow for the continued adaptation of mitigation measures during the life of the proposed development. In addition, there are some gaps in the knowledge of fauna from the WEF site and gaps in knowledge of flora and fauna for the power line options, which would allow for clearer elucidation of impacts of these aspects on the flora and fauna. As such, additional studies are recommended but are optional; these include:

- A comprehensive herpetological study, of the WEF site focusing on the presence of SSC in this group;
- A comprehensive small mammal survey of the WEF site, focusing on the presence of SSC in this group;

- A flora and fauna study on the three power line alternatives including a field visit and vegetation community mapping.

Recommendations for further studies that are required for this development by law include:

- A ground-truthing site visit of both the WEF study site and the powerline alternatives to identify all species of special concern and map these where appropriate within the footprint of the proposed development. This study will inform the permitting process for removal or destruction of these plants, depending on the species;
- The set up and running of a nursery to house plants for rehabilitation and housing for rescued plants or propagation of other plants.

8.7 Recommendation of the specialist

In terms of the power line alternatives, it is the recommendation of the specialist that the preferred option be used. This is recommended, as this option is the shortest, therefore having the least overall impact, it is aligned with existing linear aspects (fences and roads) and traverses the smallest area of sensitive vegetation.

Considering the following:

- the limited area of the footprint of the proposed WEF development;
- the limited extent of impact of the WEF on biodiversity as a whole; and
- the intention to provide a trust with a conservation function for the site effectively providing offsets for the proposed development,

It is the opinion of the specialist that the development be allowed to go ahead provided adherence to mitigation measures.

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10 APPENDIX 1: Specialist CV

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Profile

A biodiversity specialist with a history in botanical research, biodiversity assessments and associated planning in developing countries. Possesses experience in classification of ecosystems and development of management and monitoring plans for a variety of ecosystems from the spiny thicket of Madagascar to the Rainforests of West and Central Africa. Experience also includes Biodiversity Assessments (comprising classification and mapping of ecosystems and habitats) of ecosystems and vegetation types throughout Southern Africa including grasslands, forests, thicket, bushveld and fynbos with associated conservation and management recommendations.

Key Expertise

Ecological research methodology development	Report and paper writing
Ecological research	Synthesis of specialist work into integrated assessments
Habitat and vegetation mapping	Ecological statistics
Habitat and vegetation classification	Environmental Management and Monitoring

Education

2005 - 2007	**MSc** in Botany – Rhodes University
2005	**BSc Honours** in Botany (with Distinction) – Rhodes University
2001 - 2004	**BSc** (Botany and Entomology) – Rhodes University

Courses

2013	Wetland Management: Introduction to Law – University of the Free State
2013	Wetland Management: Introduction and Delineation Short Course – University of the Free State
2011	Land Degradation Short Course – Rhodes University
2009	EIA Short Course – Rhodes University and Coastal and Environmental Services

Membership

2012 – Present	Professional Natural Scientist with SACNASP: Ecological Science (No. 400233/12)
2012 – Present	High Conservation Value Assessor (plants) with the Round Table of Sustainable Biofuels.
2013 – Present	South African Association of Botanists

2013 – Present Botanical Society of South Africa
2013 – Present Wildlife and Environment Society of South Africa
2013 Grasslands Society of Southern Africa

Professional experience

2014 - Current Owner of LD Biodiversity Consulting – Biodiversity Specialist
Started own company (Sole Proprietor) to focus on Ecological Assessments including baseline assessments (habitat and ecosystem classification) as well as Management and Monitoring for large projects. Responsibilities include:

- Ecological Surveys including Baseline Assessments, Biodiversity Management and Monitoring Plans and Spatial Planning for biodiversity goals to meet international standards
- Offset design
- Strategic Environmental Planning
- Mapping (QGIS)
- Research
- Financial Management

2012 - 2014 Digby Wells Environmental – Unity Manager: Biophysical
Management of the Biophysical Department, specifically Flora and Fauna although included the overseeing and review of both Freshwater Ecology and Wetlands as well.
Responsibilities includeed:

- Conducting and management of Ecological Baseline and Impact Assessments to meet international standards
- Biodiversity Management and Monitoring Plans
- Management of a team of between four and seven colleugues and specialists

2009 – 2012 Coastal and Environmental Services – Senior Environmental Consultant and Ecological Specialist
Ecological specialist responsible for conducting ecological assessments including baseline and impact assessments for Fauna and Flora. Later in this time for overseeing junior ecologists and training. Key responsibilities included:

- Conducting Ecological Baseline and Impact Assessments to international standards
- Strategic environmental planning
- Managing teams of specialists
- Mapping (Arc)
- Research

2007 - 2009 Rhodes University (South Africa) and Sheffield University (England) – NERC Research Assistant
Design and conducting of a large common or garden experiement looking at the effects of global climate change on grassland compoisition. Key responsibilities included:

- Experimental design
- Experiment implementation

- Data analyses

Awards

2005	Best Young Botanist second prize for a presentation entitled: "Population biology and effects of harvesting on *Pelargonoium reniforme* (Geraniaceae) in Grahamstown and surrounding areas" at the SAAB conference. Dean's list, Academic Colours, Masters Scholarship.
2004	Putterill Prize for conservation in the Eastern Cape, Dean's list, Academic Half Colours, Honours Scholarship.
2001 - 2003	Dean's List

Publications

de Wet, L., Downsborough, L., Reimers, B., and Weah, C. (in prep). Traditional ecological knowledge and social survey as a proxy for large mammal scientific survey in Liberia.

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Presentations

2013	**LR de Wet** – Biodiversity Actions Plans for existing mines: Making them Work for Grassland Conservation - Grassland Society of Southern Africa Congress, Limpopo
2011	**LR de Wet** - Finding Ecological Benefits of Windfarms – Thicket Forum, Grahamstown
2010	Lubke, RA, N Davenport, **LR de Wet** and C Fordham – The ecology and distribution of endorheic pans in the subtropical thicket vegetation near Port Elizabeth, Eastern Cape, South Africa – International Association for Vegetation Science, 53rd Annual Symposium, Ensenada, Mexico.
2006	**LR de Wet,** Barker, N and Peter, C – Pollinator-mediated selection in *Pelargonium reniforme* as described by Inter Simple Sequence Repeat markers. – South African Association of Botanists (SAAB) conference.
2006	**LR de Wet**, Barker, N and Peter, C– Pollinator-mediated selection of *Pelargonium reniforme* and two floral morphs described by inter simple sequence repeat markers – Southern African Society for Systematic Biology (SASSB) conference.
2005	**LR de Wet** and Vetter, S – Population biology and effects of harvesting on *Pelargonium reniforme* (Geraniaceae) in Grahamstown and surrounding areas, Eastern Cape, South Africa – South African Association of Botanists (SAAB) conference.
2005	**LR de Wet** and Vetter, S – Harvesting of *Pelargonium reniforme* in Grahamstown; what are the implications for populations of the plant? – Thicket Forum
2005	**LR de Wet** – Harvesting of *Pelargonium reniforme* in Grahamstown; what are the implications for populations of the plant? – Annual general meeting. Botanical Society of South Africa, Albany Branch.
2004	**LR de Wet** – Population biology of *Pelargonium reniforme* – Annual general meeting. Botanical Society of South Africa, Albany Branch.

11 APPENDIX 2: Field notes for each sample point

Sample Point	Description
1	Thicket along the road. Some evidence of grazing but not particularly disturbed. Typical thicket species including *Euclea undulata, Pappea capensis* etc.
2	Thicket as in 1
3	Thicket as in 1
4	Riparian zone. Dominated by *Acacia*. Very disturbed.
5	Same as 4
6	Same as 4
7	Same as 4
8	Grassy fynbos on ridge tops
9	Proteaceous Fynbos
10	Grassy Fynbos with *Agapanthus*
11	Grassy Fynbos
12	Proteaceous fynbos on steep slopes
13	Proteaceous fynbos on steep south-facing slopes, Grassy fynbos on north-facing slopes. Grassy fynbos has thicket clumps restricted to rocky outcrops.
14	Grassy fynbos on ridge top with proteaceous fynbos on steep slope.
15	Grassy fynbos with thicket clumps
16	Grassy fynbos. Restricted area of proteaceous fynbos may be as a result of fires however it clearly is a pattern of steep south to east facing slopes have dense proteaceous fynbos with grassy fynbos comprising the rest.
17	Grassy fynbos with thicket clumps on rocky outcrops.
18	Grassy Fynbos
19	Grassy fynbos with thicket clumps
20	Grassy fynbos
21	Grassy fynbos on gentle north-facing slope
22	Bush clumps becoming more prolific on slopes (N – NE facing) forming grassy fynbos/ thicket matrix
23	Transition zone between bush clumps and rensoterveld
24	Transition between grassy fynbos/ bush clumps/ renosterveld
25	Transition between grassy fynbos/ bush clumps/ renosterveld
26	Low shrubs and grasses
27	Low shrubs and grasses
28	Low shrubs and grasses
29	Renosterveld
30	Riparian patch with *Protulacaria afra, Euclea undulata, Pappea capensis*
31	Renosterveld monoculture
32	River and riparian

33	River and riparian surrounded by dry and degraded thicket
34	Degraded thicket extending onto slopes
35	Grassy fynbos on hilltop. Lots of thicket on rocky outcrops in the area
36	Grassy fynbos that extends into a shrub/thicket matrix on a rocky outcrop. Cycads present.
37	Thickety scrubland on rocky outcrops, adjacent to grassy fynbos.
38	Grassy fynbos and thicket matrix
39	Grassy fynbos and thicket matrix. Lots of cycads and large proteas with vegetation starting to resemble renosterveld on lower slopes.
40	Renosterveld
41	Open thicket with succulents
42	Succulent thicket
43	Dry karoo *Euphorbia* veld
44	River and riparian
45	Matrix of riparian and degraded thicket
46	River and riparian
47	Open degraded thicket
48	Open degraded thicket changing to karoo
49	*Euphorbia* karoo
50	*Euphorbia* karoo
51	*Euphorbia* karoo
52	*Euphorbia* karoo