Revegetation and Habitat Rehabilitation Plan, Inyanda-Roodeplaat Wind Energy Facility, Eastern Cape, South Africa

LD BIODIVERSITY CONSULTING

Revegetation and Habitat Rehabilitation Plan, Inyanda-Roodeplaat Wind Energy Facility, Eastern Cape, South Africa.

Prepared by

Leigh-Ann de Wet

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

For

SRK

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

www.ldbiodiversity.co.za
leigh-ann@ldbiodiversity.co.za
083 352 1936

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Appointment of Specialist
Leigh-Ann de Wet (LD Biodiversity Consulting) was commissioned by SRK to develop a revegetation and habitat rehabilitation plan. This report thus serves as an addendum to the original Ecological Impact Assessment conducted by CES in 2014, and the Ecological Impact Assessment Update Report completed by LD Biodiversity Consulting in 2016.

Details of Specialist
Leigh-Ann de Wet
LD Biodiversity Consulting

Telephone: 083 352 1936
e-mail: leigh-ann@ldbiodiversity.co.za

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.

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1 Introduction

1.1 Objective of this Plan

The objectives of this plan are as follows:

- To ensure adequate conservation of important species;
- Reduce the impact of the Inyanda-Roodeplaat WEF on the conservation important plant species associated with the WEF; and
- Provide a manageable plan to reduce impacts of the Inyanda-Roodeplaat WEF on vegetation communities.

This plan is part of an adaptive management process and must be updated regularly based on new information. Adaptive management is specifically important for a rehabilitation plan as methods may not be successful and may have to be regularly updated and changed according to literature and field experience. It is recommended that students be encouraged to conduct rehabilitation trials within the study area to determine the best rehabilitation methods for the study site, which can then be integrated into the rehabilitation plan.

Currently there are three options for power line construction for connection to the national grid. This management plan can be applied as far as possible to the power line associated with the WEF, however, as soon as the power line design is finalized. The Revegetation and Habitat Rehabilitation Plan should be updated.

1.2 Vegetation of the Inyanda-Roodeplaat WEF

Nine different vegetation types were described from the study area; these are summarized in

Table 1.1, with an indication of the general vegetation shown in Figure 1-1. A vegetation map is shown in Figure 1-2. A detailed description of the vegetation of the site can be found in the Ecological Impact Assessment Report. The vegetation of the Inyanda-Roodeplaat WEF is sensitive, with several conservation important species. The sensitivity map (Figure 1-3) indicates which areas of the study site are sensitive.

Table 1.1: Summary of the vegetation types mapped for the Inyanda-Roodeplaat WEF study area.

Vegetation type	Brief description
Thicket	Found on rocky outcrops within the fynbos, thicket comprises typical thicket species including *Euclea undulata, Pappea capensis, Brachylaena illicifolia* etc.
Proteaceous fynbos	Occurs on steep south and east facing slopes. Dominated sometimes almost exclusivelty of *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	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	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	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	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	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	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 1-1: General vegetation on the upper slopes of the Inyanda WEF study site.

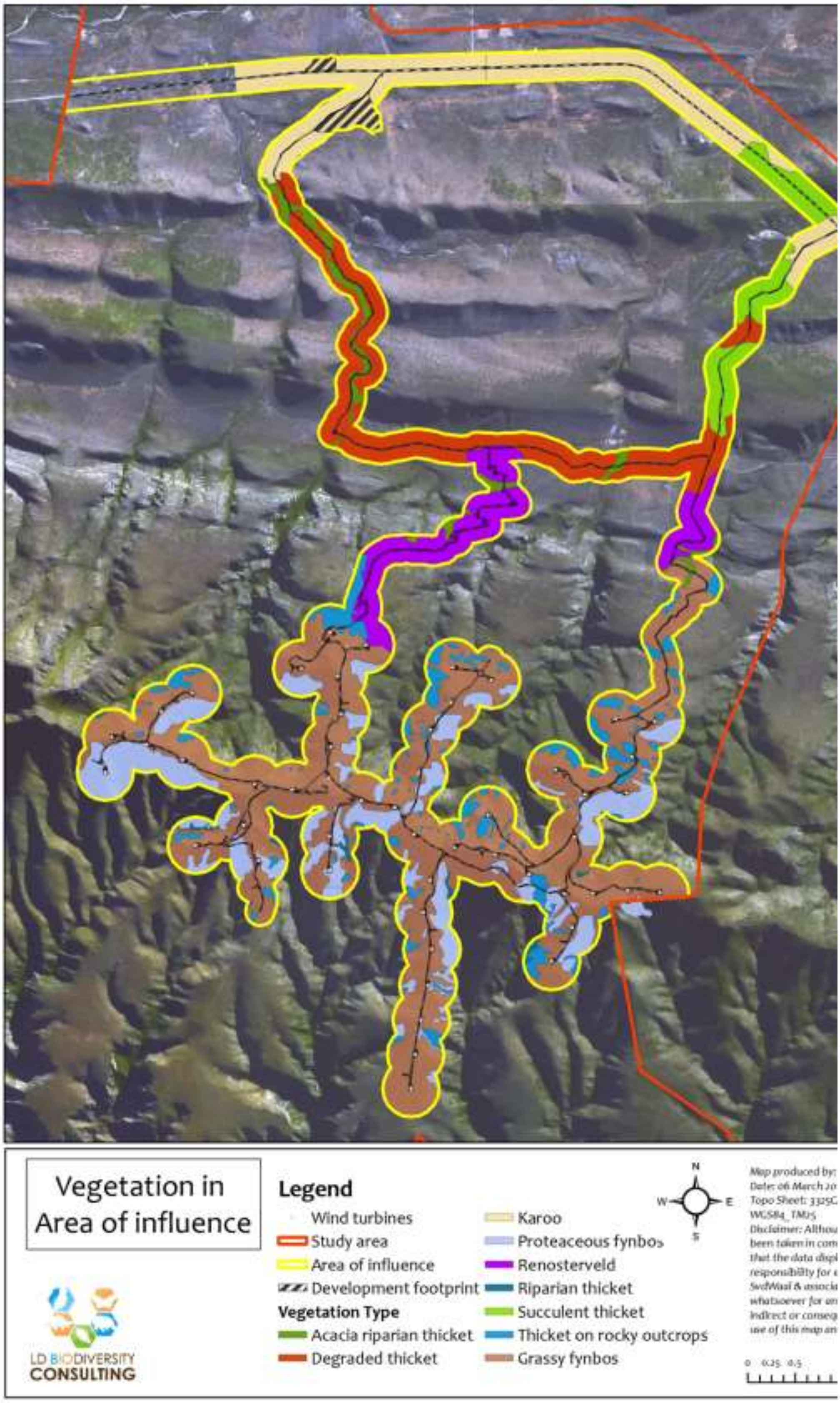

Figure 1-2: Vegetation map of the Inyanda-Roodeplaat WEF.

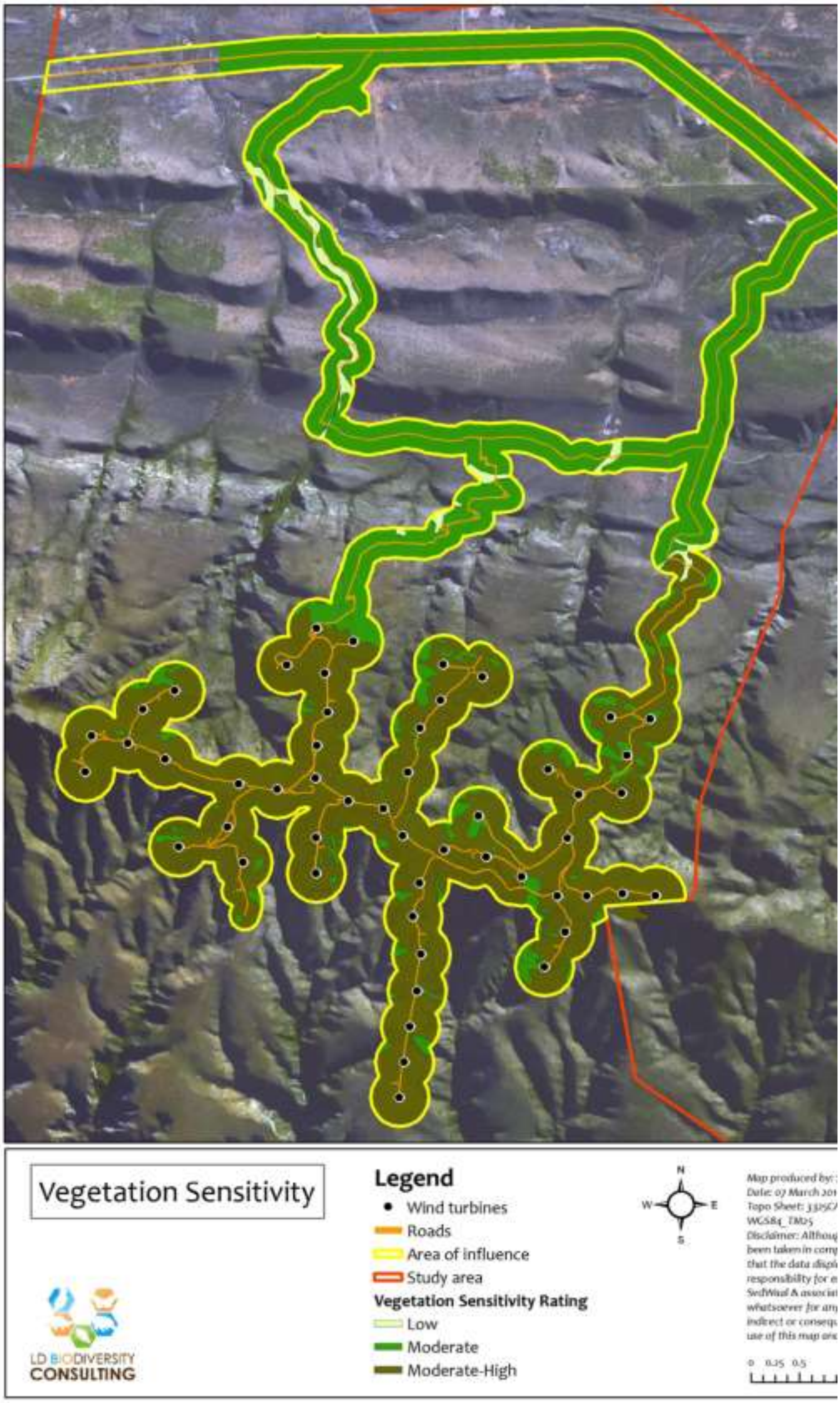

Figure 1-3: Sensitivity of the Inyanda-Roodeplaat WEF.

1.3 Vegetation of the Inyanda-Roodeplaat Power line options

All three power line options go through the same vegetation types, both in Mucina & Rutherford (2006) and STEP (Figure 1-4). These vegetation types are shown in Table 1.2. Of the different options, option 2 traverses the largest area of alluvial vegetation. The vegetation of the Inyanda-Roodeplaat WEF is sensitive, with several conservation important species. The sensitivity map (Figure 1-5) indicates which areas of the study site are sensitive according to STEP.

Table 1.2: 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.

Mucina & Rutherford	Description	STEP	Description
Albany Alluvial	Thornveld and riverine thicket are the two major vegetation types that occur in this vegetation type. It is classified as Endangered with a conservation target of 31%. Only 6% has been statutorily conserved.	Sundays Doringveld	Sundays Doringveld is characterised by a mosaic of thicket clumps and a Nama-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.

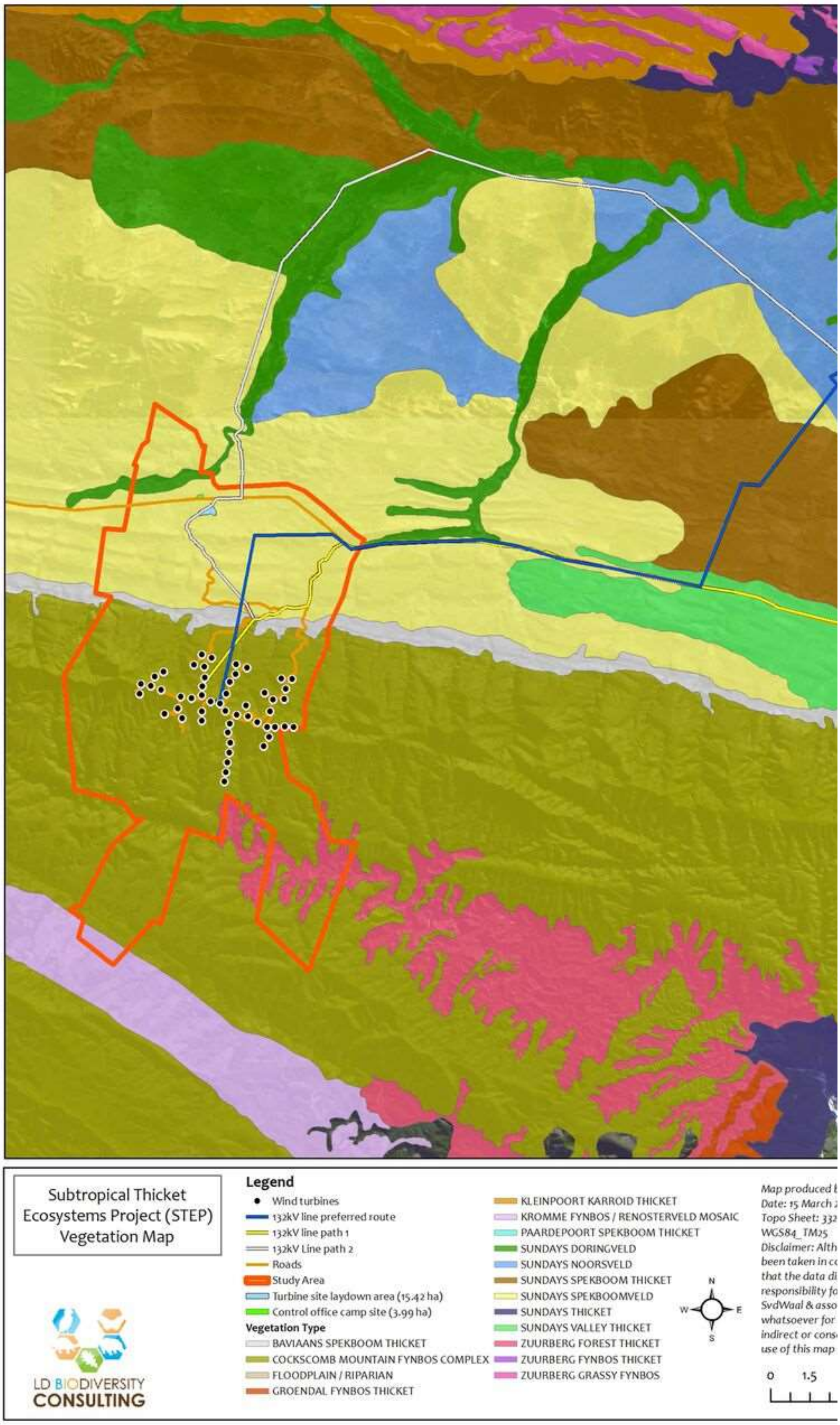

Figure 1-4: STEP vegetation map of the power line alternatives

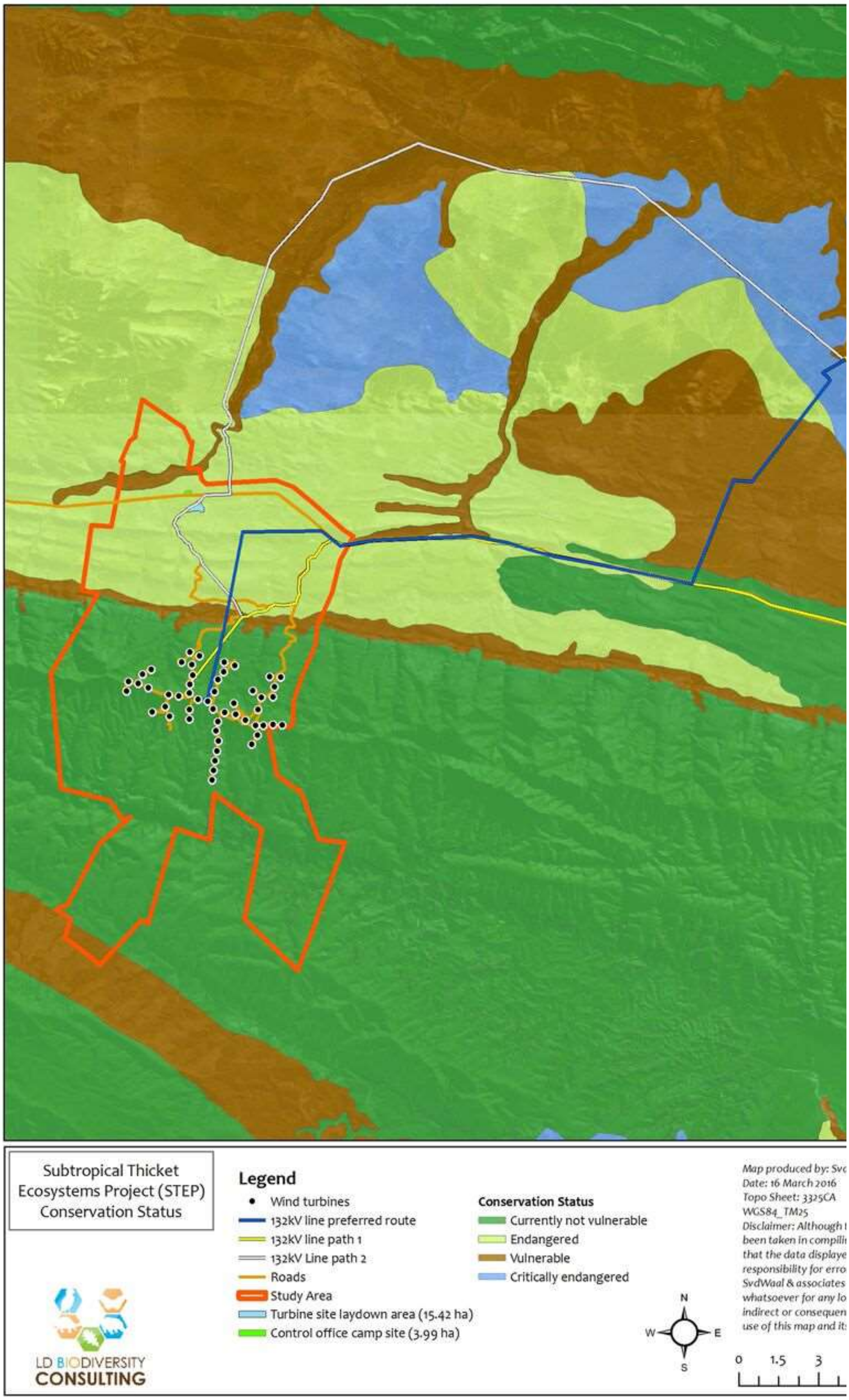

Figure 1-5: STEP Conservation status map indicating the areas traversed by the power line options associated with the Inyanda-Roodeplaat WEF.

2 Rehabilitation

Restoration and rehabilitation of ecosystems is a key component in the long-term sustainability of ecosystems (Aronson & Alexander 2013). Importantly, ecosystem restoration must not be viewed as a substitute for conservation or a rationale for intentionally damaging existing ecosystems. There are a variety of tools and instructions available for ecosystem restoration including a publication by the IUCN Work Commission on Protected Areas called: Ecological restoration for protected area: principles, guidelines and best practices (Aronson & Alexander 2012).

There are several forms of rehabilitation, and the state of the environment and future land use determines which of these is used (Aronson *et al* 1993). The three systems include restoration, rehabilitation or reallocation. Usually restoration is used when the degraded system has not yet passed a degradation threshold, after which only rehabilitation or reallocation can be used. The three different types of rehabilitation with degraded lands are as follows:

- **Restoration**: "the intentional alteration of a site to establish a defined indigenous, historic ecosystem. The goal of this process is to emulate the structure, functioning, diversity, and dynamics of the specified ecosystem".
- **Rehabilitation**: "seeks to repair damaged or blocked ecosystem functions, with the primary goal of raising ecosystem productivity for the benefit of local people. Moreover it attempts to achieve such changes as rapidly as possible. However, a rehabilitation project resembles a restoration attempt in adopting the indigenous ecosystem's structure and functioning as the principal models to be followed, insofar as they can be determined or guessed. That is, they both aim at recreating autonomous or self-sustaining ecosystems, which are characterized by biotic change or succession in plant and animal communities, and the ability to repair themselves following natural or moderate human perturbations"
- **Reallocation:** "part of a landscape, in any state, is assigned a new use that does not necessarily bear an intrinsic relationship with the predisturbance ecosystem's structure or function." (Aronson *et al* 1993).

The objective at the Inyanda-Roodeplaat WEF is to rehabilitation of disturbed areas, with a view to restoration of ecosystems. There are three primary sections that will need to be rehabilitated following the construction of the WEF, these are the thicket, the fynbos and the riparian areas of the site. Some of the thicket and riparian zones of the study area in general are disturbed as a result of past land use. These too should be rehabilitated.

2.1 Rehabilitation of riparian areas

Riparian areas are the areas of transition from aquatic to terrestrial habitats; these areas generally have plant communities different from the surrounding vegetation (Gashaw *et al* 2015). Degradation of these systems occurs through anthropogenic activities such as farming, road construction and grazing, among others. "Riparian rehabilitation and restoration in repairing and re-establishing of the riparian functions and related physical, chemical, and biological linkages between terrestrial and aquatic ecosystems. It is important to restore and rehabilitate riparian zones as well as conserve those that are intact to maintain ecosystem integrity. Rehabilitation techniques include the following:

- **Riparian silviculture:** replanting of trees and other vegetation along with protection from loss of plants and further degradation to the area.
- **Fencing and grazing reduction:** grazing management to reduce the pressure on riparian zones including the erection of protection fences and the control of grazers.
- **Passive restoration:** cessation of anthropogenic activities causing degradation and preventing recovery, and leaving the ecosystem to recover on its own.
- **Active restoration:** planting species that will aid in restoration, this requires a high level of site management and maintenance (Gashaw *et al* 2015).

2.2 Rehabilitation of thicket

Work has been done on thicket restoration in the region of the study site in both the Baviaanskloof Nature Reserve and Addo Elephant National Park (Sigwela *et al* 2014). Restoration of thicket allows for an increase in plant biomass therefore in carbon sequestration and improved water retention and infiltration. Restoration activities in this vegetation type are expected to result in a species assemblage approximating natural within 30 to 50 years. Successful rehabilitation of thicket has resulted from the transplanting of *Portulacaria afra* (spekboom) as an ecosystem engineer with good results. This species can grow vegetatively and is easily transplanted and harvested. It also has excellent carbon sequestration properties with the potential for carbon credits in the market once it has stabilized. After successful planting of the species, other thicket species colonize the area as well, approximating natural species richness (Sigwela *et al* 2014).

2.3 Rehabilitation of fynbos

Rehabilitation methods used for fynbos include the following:

- "Sowing of native species to re-establish a functional native community and increase biodiversity.
- Soil restoration treatments to restore soil to its natural nutrient content.
- Passive restoration from the existing seed bank and natural seed dispersal (Gaertner *et al* 2012).
- Active restoration through planting cultivated fynbos species.

3 Rehabilitation of the Inyanda-Roodeplaat WEF

Rehabilitation of the Inyanda-Roodeplaat WEF should be concentrated around those areas cleared for construction that will not be used in operation. This rehabilitation will be restricted to the footprint of the development, and include such areas as road edges (Figure 3-5), and turbine platforms. Rehabilitation sections are indicated in Figure 3-5. The footprint of the development comprises section 1 and is the rehabilitation priority.

Figure 3-1: Road edges to be rehabilitated

There are, however, additional areas within the study site that have been degraded as a result of past land use including agriculture and grazing. Examples of degraded areas are shown in Figure 3-2 and include areas of erosion and gaps created in vegetation from livestock. These areas form parts of section 2 and 3. Section 2 is the second priority and Section 3, the last priority for rehabilitation (Figure 3-5).

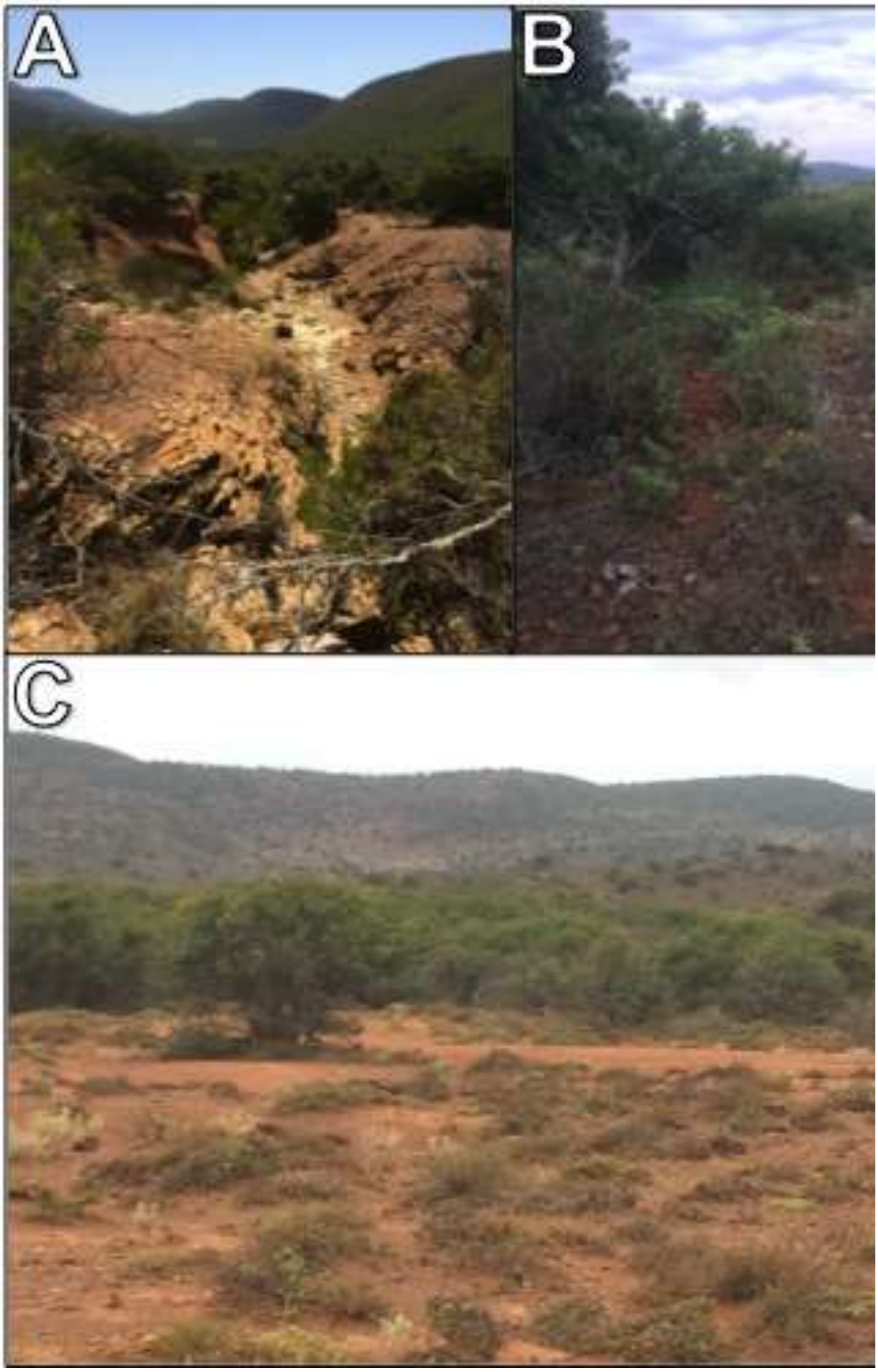

Figure 3-2: Areas within the study site that are degraded. A: An erosion gully. B: Pathways created in thicket by livestock. C: sheet erosion.

There are two vegetation types on site that are already degraded. These will need to be rehabilitated within both the Area of Influence and the Study Site. Descriptions of these vegetation types are provided in Table 3.1, with photographs showing degradation in Figure 3-3 and Figure 3-4.

Table 3.1: Vegetation types within the study area requiring rehabilitation

Vegetation type	Brief description
Acacia riparian thicket	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.
Degraded 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.

Figure 3-3: A Degraded riparian zone.

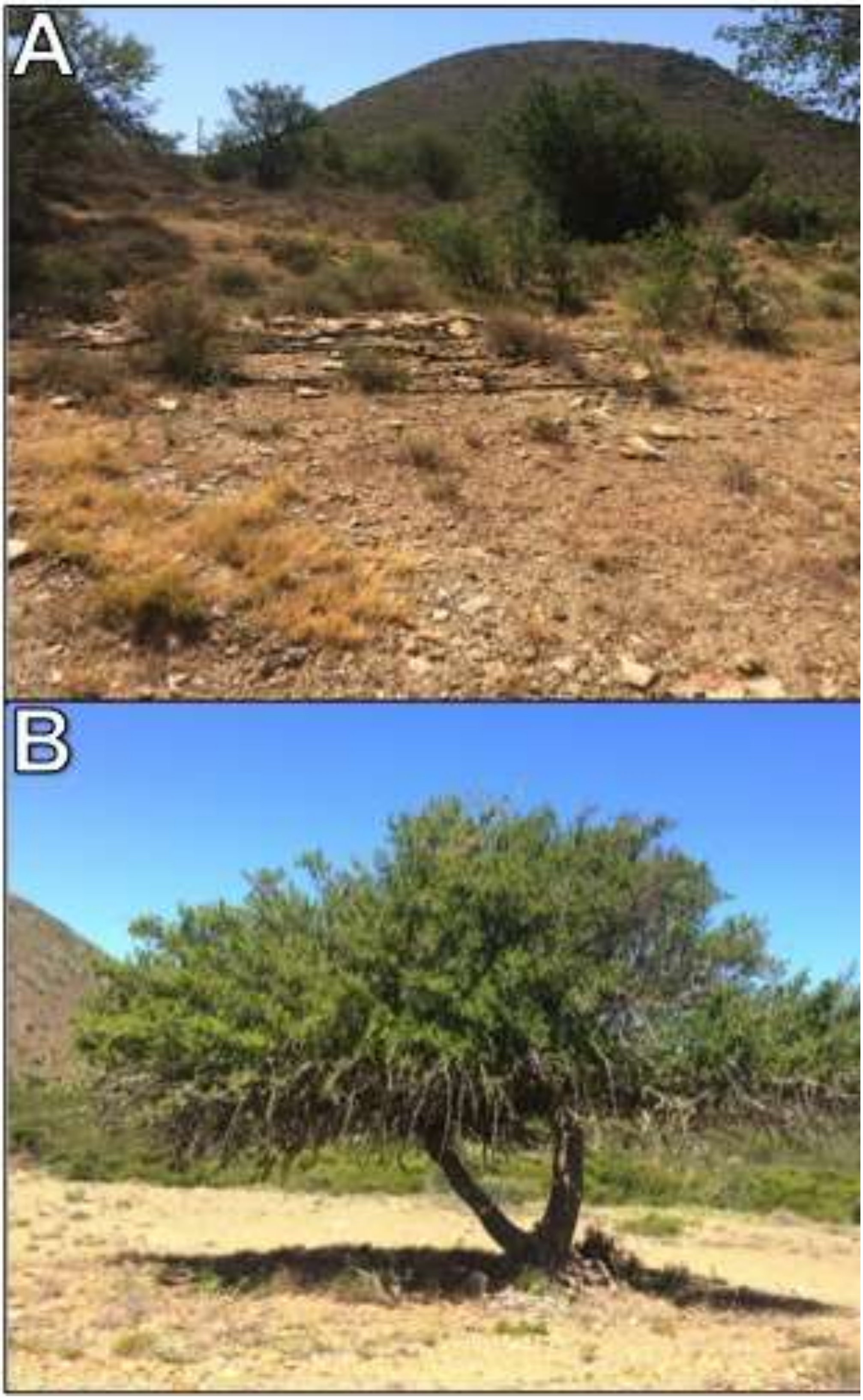

Figure 3-4: Degraded thicket. A: loss of thicket species. B: an umbrella-shaped tree indicative of browsing by livestock.

Figure 3-5: Areas to be rehabilitated in the Inyanda-Roodeplaat WEF

4 Monitoring and Management Plan

The site comprises three spatial zones:

- The footprint of the study area
- The Area of Influence, which is the area most likely to receive the majority of the impacts of the development and
- The Study Area, comprising the farms containing the development.

As described in Section 3, there are three rehabilitation sections, with section 1 the priority for rehabilitation. These are outlined in Table 4.1.

Table 4.1: Rehabilitation sections and priorities

Section (Figure 3-5)	**Priority**	**Part of study area**	**Rehabilitation goal**
Section 1	High	Footprint	Rehabilitate areas disturbed during construction but not used in operation with a view to restoration to a natural suite of species and natural functioning.
Section 2	Medium	Area of Influence	Restore areas already disturbed through prior land use.
Section 3	Low	Study Area	Restore areas already disturbed through prior land use (optional depending on conservation goals)

This plan is formed as an adaptive management plan, which must be reviewed on a regular basis and adjusted according to new information. In addition, it is to be utilized as part of a suite of management plans produced for the Inyanda-Roodeplaat WEF including, but not limited to:

- Environmental Management Plan – SRK (2016);
- Alien Vegetation Management Plan – L. de Wet (2016);
- Plant Rescue and protection Plan – L. de Wet (2016); and
- Rehabilitation Plan – L. de Wet (2016).

In addition to these plans, background information can be obtained from the two Ecological Impact Assessment Reports (full references available in the reference list, Section 5).

- Zide, A and Lubke, R (2014). Inyanda-Roodeplaat Wind Energy Project Environmental Impact Assessment, Eastern Cape. Ecological Specialist Report.
- L. de Wet (2016). Ecological Impact Assessment Update, Roodeplaat Wind Energy Facility.

The Re-vegetation and Habitat Rehabilitation Plan follows: these tables are designed to be freestanding (with reference to the maps) and to be utilized in the field by the responsible parties.

Inyanda-Roodeplaat WEF Revegetation and Habitat Rehabilitation Plan					
Vegetation clearing					
Number	Task	Responsible Party	Frequency		
			Footprint	Area of Influence	Study Site
1.1	Vegetation clearing should be done at the development front, and large areas should not be cleared unless they are surfaced or used immediately following.	Contractor	Daily	N/A	N/A
1.2	Alien vegetation must be removed from site prior to clearing.	Contractor	According to the Alien Vegetation Management Plan		
1.3	Cleared vegetation must be properly dumped in a designated area, and not in intact vegetation, even temporarily. This vegetation can be used for mulch.	Contractor	Daily	N/A	N/A
1.4	Vegetation should be cleared independently of the topsoil to allow for topsoil collection and stockpiling,	Contractor	Daily	N/A	N/A
1.5	Use of herbicides should not be allowed for vegetation clearing unless required for specific application to invasive species.	Contractor	Daily	N/A	N/A
1.6	A Standard Operating Procedure (SOP) must be developed for clearing that outlines the stages of clearing and how the cleared vegetation will be dealt with.	Contractor	Preconstruction	N/A	N/A
Topsoil clearing					
Number	Task	Responsible Party	Frequency		
			Footprint	Area of Influence	Study Site
2.1	Topsoil should be cleared separately at a depth of 100 to 150 mm depending on the depth of the soil over rocky areas.	Contractor	Daily	N/A	N/A
2.2	Topsoil should be safely stockpiled separately from other stockpiles in demarcated areas in piles not exceeding 2m high	Contractor	Daily	N/A	N/A

2.3	Germination of alien species on stockpiles should be monitored and controlled.	Contractor	According to the Alien Vegetation Management Plan		
2.4	Stockpiles should be protected from soil loss and erosion through a method agreed upon by the contractor and the ECO, which allows for the maintenance of the topsoil seed bank (no plastic materials will be used)	Contractor	Daily	N/A	N/A
2.5	A Standard Operating Procedure (SOP) must be developed for clearing that outlines the stages of clearing and how the cleared topsoil will be dealt with.	Contractor	Preconstruction	N/A	N/A
Revegetation					
Number	Task	Responsible Party	Frequency		
			Footprint	Area of Influence	Study Site
3.1	A list of indigenous plants for use in revegetation should be developed and only plants from this used to revegetate areas.	Botanical Specialist	Pre-construction		
3.2	Areas to be rehabilitated should be ripped and stockpiled topsoil applied prior to revegetation.	Contractor	Daily	Monthly	Annually
3.3	Nursery SSC must be used for revegetation where they are likely to naturally occur	Botanical Specialist	See Plant Rescue and Protection Plan		
3.4	Cleared indigenous vegetation must be used as mulch (chipped) where possible to allow for soil stabilization and addition to the natural seed bank. Vegetation used should be that removed for construction, with no additional areas outside the footprint cleared for this purpose.	Contractor	Daily	Monthly	N/A
3.5	Initial vegetation should be done using nursery plants and mulch. Nursery plants should be planted with required nutrients in a density determined for each area. For thicket, *Portulacaria afra* truncheons can be planted directly from the field as well as from the nursery.	Botanical specialist	Daily	Monthly	Annually

3.6	Seed harvested prior to clearing can also be broadcast in areas to be rehabilitated.	Contractor	Daily	Monthly	Annually
3.7	Rehabilitated areas will need to be watered, water should be free of chemical additives.	Contractor	Weekly	Weekly in areas rehabilitated	
Soil stabilization					
Number	Task	Responsible Party	Frequency		
			Footprint	Area of Influence	Study Site
4.1	Exposed areas of soil must be stabilized as soon as possible either through surfacing (in the case of roads), or through landscaping.	Contractor	Daily	N/A	N/A
4.2	Erosion should be ameliorated as soon as it is recorded using gabions, soil stabilizer (jute) pegged into place or other methods.	Contractor	Weekly	N/A	N/A
4.3	Stabilized areas should be out of bounds and any damage to these areas repaired.	Contractor	Weekly	N/A	N/A
Rehabilitation of riparian areas					
Number	Task	Responsible Party	Frequency		
			Footprint	Area of Influence	Study Site
5.1	Ensure that all river crossings allow for the natural movement of water and aquatic fauna throughout all seasons.	Contractor	When necessary		
5.2	Sediment traps must be used downstream during construction to ensure no change in water quality and river functioning as a result of construction activities.	Contractor	When necessary	N/A	N/A
5.3	Riverbanks should be stabilized and erosion control measures taken where appropriate.	Contractor	When necessary	N/A	N/A
5.4	Where riverbanks are disturbed, these should be sloped to allow for easy erosion control and river access.	Contractor	When necessary	N/A	N/A
5.5	Areas cleared of vegetation should be revegetated using nursery plants and mulch; with broadcasting of collected seed, additional	Botanical Specialist	Post construction	Monthly	Annually

	slope stabilization may be required to maintain mulch in place.				

Inyanda-Roodeplaat WEF Revegetation and Habitat Rehabilitation Monitoring Plan							
1: Construction Phase							
Number	Task	Method	Outcome	Responsible Party	Frequency		
					Footprint	Area of Influence	Study Site
1.1	Investigation of area to be rehabilitated	• Characterize the vegetation community of the site • List species occurring.	• Description of the vegetation community • Species list	Botanical Specialist	Prior to clearing	Prior to rehabilitation	
1.2	Development and implementation of a planting plan	• Use species list and community information to determine planting density and species • Instruct contractors on rehabilitation for the site • Mark all planted individuals to allow for easy monitoring	• Rehabilitated site	Botanical Specialist	Post clearing	Initial rehabilitation	
1.3	Record species survival	• Record which planted species are dead or alive	• A list of surviving planted species	Botanical Specialist	Monthly		
1.4	Record natural regeneration	• Record all species not planted in the	• A list of naturally occurring species	Botanical Specialist	Every 6 months		

		rehabilitation site			
1.5	Record cover	• Estimations of cover should be taken as a percentage of the total area	• Cover percentages for rehabilitated areas	Botanical Specialist	Monthly
1.6	Compile rehabilitation report	• Compile data	• Report indicating the success of rehabilitation in each of the rehabilitated areas	Botanical Specialist	Every 6 months
1.7	Adapt rehabilitation Plan	• Collate data gathered during rehabilitation and any rehabilitation trial conducted.	• An updated Rehabilitation Plan using the most successful rehabilitation treatment for each site	Botanical Specialist	Every 6 months Initially, then annually, and every 5 years after a successful rehabilitation plan is determined.

5 References

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