GOD'S WINDOW SKYWALK
PLANT PROTECTION PLAN

SEF Reference No. 505201

Industrial Development Corporation (IDC) (applying on behalf of MTPA)
19 Fredman Drive
Sandown
Tel No.: (011) 447 4888
Fax No.: (011) 447 0355

Prepared by:

Strategic Environmental Focus (Pty) Ltd
P.O. Box 74785
Lynnwood Ridge
0040
Tel. No.: (012) 349-1307
Fax. No.: (012) 349-1229
E-mail: sef@sefsa.co.za

NOVEMBER 2014

Declaration of Independence

I, **Karin van der Walt,** in my capacity as a specialist consultant, hereby declare that I -

- Act as an independent consultant;
- Do not have any financial interest in the undertaking of the activity, other than remuneration for the work performed in terms of the National Environmental Management Act, 1998 (Act No. 107 of 1998);
- Have and will not have vested interest in the proposed activity proceeding;
- Have no, and will not engage in, conflicting interests in the undertaking of the activity;
- Undertake to disclose, to the competent authority, any material information that has or may have the potential to influence the decision of the competent authority or the objectivity of any report, plan or document required in terms of the National Environmental Management Act, 1998 (Act No. 107 of 1998);
- Will provide the competent authority with access to all information at my disposal regarding the application, whether such information is favourable to the applicant or not;
- As a registered member of the South African Council for Natural Scientific Professions, will undertake my profession in accordance with the Code of Conduct of the Council, as well as any other societies to which I am a member
- Based on information provided to me by the project proponent, and in addition to information obtained during the course of this study, have presented the results and conclusion within the associated document to the best of my professional judgement;
- Reserve the right to modify aspects pertaining to the present investigation should additional information become available through ongoing research and/or further work in this field; and
- Undertake to have my work peer reviewed on a regular basis by a competent specialist in the field of study for which I am registered.

16/11/2014

_____ _____

Karin van der Walt *Cert. Sci. Nat.* Date
Terrestrial Ecologist
SACNASP Reg. No. 300028/12

Compiled by:	**Authorised by:**
Karin van der Walt *Cert. Sci. Nat.*	**Byron Grant *Pr. Sci. Nat.***
Terrestrial Ecologist	Principal: Specialist Services
SACNASP Reg. No. 300028/12	SACNASP: Reg. No. 400275/08
	
	Date: 16/11/2014

EXECUTIVE SUMMARY

Strategic Environmental Focus (Pty) Ltd (SEF) has been appointed by the Industrial Development Corporation (IDC) on behalf of the Mpumalanga Tourism and Parks Agency (MTPA) (the applicant) to undertake the Scoping and Environmental Impact Reporting (S&EIR) process in order to obtain the necessary Environmental Authorisation in terms of the Environmental Impact Assessment (EIA) Regulations promulgated in terms of the National Environmental Management Act, 1998 (Act No. 107 of 1998) (NEMA) , as amended.

As part of the review of the Final Scoping Report and an application form submission, the Department of Environmental Affairs (DEA), who is the Competent Authority in this case, has requested a plant rescue and protection plan as well as an alien invasive species management plan to form part of the Environmental Management Programme (EMP) to form part of the Final EIR.

The study area is situated within two Biomes, namely Afrotemperate, Subtropical and Azonal Forests Biome and the Grassland Biome. Biomes can further be divided into smaller units known as vegetation types and according to Mucina and Rutherford (2006), three vegetation types, namely Northern Mistbelt Forest, Northern Escarpment Afromantane Fynbos and Northern Escarpment Quartzite Sourveld, are located within the study area. Further, the present study area is located within the Blyde Quartzite Grassland ecosystem which is currently listed as Endangered in terms of Section 52 of NEMBA. The study area is furthermore located within a protected area according to the latest Mpumalanga Biodiversity Sector Plan, namely Blyde River Canyon Provincial Nature Reserve.

Overarching principles for protection or relocation of thirteen species of conservation concern and/or provincially protected species are described. Only two alien plant species were confirmed in the study area based on ecological studies conducted in October and November 2013. Mechanical control methods are recommended for both species.

TABLE OF CONTENTS

EXECUTIVE SUMMARY iv
LIST OF FIGURES vii
LIST OF PHOTOGRAPHS vii
LIST OF TABLES vii
LIST OF ABBREVIATIONS 8
1. INTRODUCTION 9
1.1 Project Description 9
1.2 Terms of Reference 9
1.3 Methodology 10
1.4 Limitations 10
2. BACKGROUND 10
2.1 Location 10
2.2 Climate 10
2.3 Regional Vegetation 10
2.4 Listed Ecosystems 15
2.5 Mpumalanga Biodiversity Conservation Plan and Biodiversity Sector Plan 15
3. PLANT PROTECTION AND RELOCATION PLAN 16
3.1 Overarching principles for plant protection 16
3.1.1 Protection of species on vertical cliffs 16
3.1.2 Protection and relocation of herbaceous species 16
3.1.3 Protection of woody (tree) species 17
3.2 Plants of Conservation Concern and Provincially Protected species confirmed in the study area 17
3.2.1 Afrocarpus falcatus 18
3.2.2 Agapanthus inapertus 19
3.2.3 Aloe arborescens 19
3.2.4 Aloe nubigena 20
3.2.5 Clivia caulescens 21
3.2.6 Drimia elata 21
3.2.7 Merwilla plumbea 22
3.2.8 Monopsis kowynensis 23
3.2.9 Polystachya transvaalensis 23
3.2.10 Rapanea melanophloeos 24
3.2.11 Scilla nervosa 24
3.2.12 Schizochilus lilacinus 24
3.2.13 Streptocarpus fenestra-dei 25
4. ALIEN INVASIVE SPECIES MANAGEMENT PLAN 26
4.1 Background 26
4.2 Control methods 27

4.2.1 Mechanical control 27
4.2.2 Chemical control 27
4.2.3 Biological control 29
4.3 Control Phases 29
4.4 Alien species recorded in the study area and recommended control methods per species 33
4.4.1 Pinus patula 33
4.4.2 Lilium formosanum 34
5. CONCLUSION 35
REFERENCES 37
GLOSSARY 40

LIST OF FIGURES

Figure 1: Location of the study site 13
Figure 2: Regional vegetation in relation to the study area 14

LIST OF PHOTOGRAPHS

Photograph 1: *Afrocarpus falcatus* on the cliff edges (left) and below vertical cliffs (right) in the study area. 19
Photograph 2: Clumps of *Aloe arborescens* within the study area. 20
Photograph 3: *Aloe nubigena* growing on vertical cliffs in the study area. 20
Photograph 4: Large populations of *Clivia caulescens* was recorded in the study area especially on the vertical cliffs (left) and on the cliff edges (right). 21
Photograph 5: Large numbers of *Drimia elata* was recorded on the cliff edges. 22
Photograph 6: Large numbers of *Drimia elata* was recorded on the cliff edges. 23
Photograph 7: *Monopsis kowynensis* on steep cliffs within the study area. 23
Photograph 8: *Polystachya transvaalensis* was recorded on damp rocks and on branches of trees such as *Afrocarpus falcatus* within the study area. 24
Photograph 9: *Schizochilus lilacinus* growing on vertical cliffs within the study area. 25
Photograph 10: *Streptocarpus fenestra-dei* in the study area 26
Photograph 11: *Pinus patula* seedlings in the study area (left) with a commercial plantation within 150m from the study area (right). 34
Photograph 12: *Pinus patula* seedlings in the study area (left) with a commercial plantation within 150m from the study area (right) (Photo: Early Detection and Rapid Response programme). 35

LIST OF TABLES

Table 1: Plant species of conservation concern and/or provincially protected species in the study area which is likely to be affected by the construction of the proposed Skywalk complex 18
Table 2: Control phases of alien species control programmes 30
Table 3: Initial control methods (adapted from Working for Water, 2007 30
Table 4: Follow-up control methods (adapted from Working for Water, 2007) 33

LIST OF ABBREVIATIONS

ADU	Animal Demographical Unit
CARA	Conservation of Agricultural Resources Act
CBA	Critical Biodiversity Area
CR	Critically Endangered
CWAC	Coordinated Waterbird Counts
DAFF	Department of Agriculture, Forestry and Fisheries
DDD	Data Deficient Distribution
DDT	Data Deficient Taxanomic
EIA	Environmental Impact Assessment
EN	Endangered
ESA	Ecological Support Area
IBA	Important Bird Area
IUCN	International Union for the Conservation of Nature
LC	Least Concern
MTPA	Mpumalanga Tourism and Parks Agency
NEMBA	National Environmental Management Biodiversity Act 2004 (Act No.10 of 2004)
NT	Near Threatened
PA	Protected Area
POSA	Plants of Southern Africa
SABAP	South African Bird Atlas Project
SEF	Strategic Environmental Focus
VM	Virtual Museum
VU	Vulnerable

1. INTRODUCTION

1.1 Project Description

Strategic Environmental Focus (Pty) Ltd (SEF) has been appointed by the Industrial Development Corporation (IDC) on behalf of the Mpumalanga Tourism and Parks Agency (MTPA) (the applicant) to undertake the Scoping and Environmental Impact Reporting (S&EIR) process in order to obtain the necessary Environmental Authorisation in terms of the Environmental Impact Assessment (EIA) Regulations promulgated in terms of the National Environmental Management Act, 1998 (Act No. 107 of 1998) (NEMA) , as amended.

As part of the review of the Final Scoping Report and an application form submission, the Department of Environmental Affairs (DEA), who is the Competent Authority in this case, has requested a plant rescue and protection plan as well as an alien invasive species management plan to form part of the Environmental Management Programme (EMP) to form part of the Final EIR.

1.2 Terms of Reference

The plant rescue and protection plan will outline the activities associated with the relevant plans and include the following:

- Detailed description of all the plant species of conservation concern, provincially protected species and / nationally protected species confirmed within the study area;
- Recommend species-specific mitigation measures aimed at protection of species *in situ*;
- Recommend relocation methods best suited for each species; and
- Recommend rehabilitation of areas containing protected species which were disturbed during construction.

Terms of reference during the implementation phase include the following:

- Indigenous plant species which are of conservation concern or nationally or provincially protected will be identified and physically marked during the summer months;
- All herbaceous species identified for relocation will be removed and relocated, by a suitably qualified botanist (the timing of the relocation will depend on the species);
- Where applicable, all national and provincial permits will be applied for before any relocation is conducted;
- Where possible, any large indigenous trees will be protected from construction through physical barriers. (Relocation of trees is largely unsuccessful and cost intensive and it is not recommended).

The terms of reference for the alien invasive species management plan were as follows:

- Description of all alien and exotic species recorded within the study area including the current invasive status according to the Conservation of Agricultural Resources Act, 1983 (Act No.43 of 1983) (CARA);
- Identify and map all areas where exotic species occur;
- Compile an alien/invasive species management plan tailored to the study area which indicates priority species for control, recommended control methods and a monitoring plan; and
- Draw up the re-vegetation and rehabilitation plan together with the alien/invasive management plans as these will talk to each other and has to be implemented simultaneously.

1.3 Methodology

The plant protection and relocation plan as well as the alien invasive species management plan were largely be based on ecological studies conducted by SEF in October and November 2013.

1.4 Limitations

The final site layout for the proposed project was not available at the time of compilation of this report and reference was therefore made to the entire site. Species-specific recommendations will need to be revised once the final layout and construction methods are available.

2. BACKGROUND

2.1 Location

The study area is located at God's Window in the Mpumalanga Province approximately 7km north-east of Graskop and falls in Quarter Degree Grid Cell (QDGC) 2430DD between 24°52'31.5" – 24°52'42.7" south and 30°53'19.0" – 30°53'14.3" east (Figure 1).

2.2 Climate

The study area experiences a strong seasonal summer rainfall although orographic effects enhance precipitation (mean annual precipitation is 1176mm). Mist is common along the escarpment although frost is experienced infrequently. Mean annual temperature is 16.6ºC (Mucina and Rutherford, 2006). The area received a total of 30.6mm of rain between the 1st of October 2013 and the 15th of October 2013 (worldweatheronline.com).

2.3 Regional Vegetation

The study area is situated within two Biomes, namely Afrotemperate, Subtropical and Azonal Forests Biome and the Grassland Biome. The Afrotemperate, Subtropical and Azonal Forests Biome is defined as miltilayered vegegtation which is dominated by trees

with overlapping crown cover and the graminoids in the herbaceous layer are generally rare (Mucina & Rutherford, 2006). These forests are limited to regions with high water availability and persist in areas with mean annual rainfall of more than 725mm per annum during summer. The Grassland Biome is characterized by high summer rainfall and dry winters. Frequent frost during the winter nights as well as marked diurnal temperature variations is unfavourable for tree growth resulting in the Grassland Biome consisting mainly of grasses and plants with perennial underground storage organs, such as bulbs and tubers. A large number of Rare and Threatened plant species in the summer rainfall regions of South Africa is restricted to high-rainfall grassland, making this the vegetation type in most urgent need of conservation.

Biomes can further be divided into smaller units known as vegetation types and according to Mucina and Rutherford (2006), three vegetation types namely Northern Mistbelt Forest, Northern Escarpment Afromantane Fynbos and Northern Escarpment Quartzite Sourveld are located within the study area (Figure 2).

Northern Mistbelt Forest occurs in Limpopo, Mpumalanga and Swaziland along the Soutpansberg from Blouberg in the northwest to the Samadou Plateau in the northeast as well as along the Abel Erasmus Pass to Badplaas and Baberton. This vegetation type is also known as the Mpumalanga Afromontane Forest (Ferrar and Lotter, 2007). The vegetation consists of tall, evergreen afrotemperate mistbelt forests on east facing cliffs and sheltered kloofs. The most common canooy trees include *Xymalos monospora, Podocarpus latifolius, Combretum kraussii, Cryptocarya transvaalensis* and *Pterocelastrus galpinii.* The understory consists of species such as *Psycotria zombamontana, Canthium kuntzeanum, Gymnosporia harveyana, Peddiea Africana, Mackaya bella* and *Sclerochiton harveyanus.* Northern Mistbelt Forest is classified as Least threatnened with about 10% statutorily conserved in the Blyde River Canyon, Lekgalameetse, Songimvelo, Barberton and Starvation Creek Nature Reserves.

Northern Escarpment Afromontane Fynbos is located in the Limpopo and Mpumalanga Provinces where it is restricted to the peaks of Thabakgolo Mountains above Penge, southwards along the highest peaks to Mariepskop and Graskop. The dominant vegetation structure is shrubland which consists of sclerophyllous shrubs and herbs. Important taxa include small trees such as *Protea caffra, P.roupelliae,* succulent species such as *Aloe arborescens* and herbaceous species such as *Erica natalitia, Hypericum revolutum, Passerina montana, Cliffortia linearifolia, Erica revoluta, Erica simii, Euryops pedunculatus* and various *Helichrysum* species. Northern Escarpment Afromontane Fynbos is classified as Least Threatened with more than 56% of this vegetation type protected.

Northern Escarpment Quartzite Sourveld occurs in Limpopo and Mpumalanga Provinces where it occurs along the high-altitude crests of the Northern Escarpment from Haenertsburg to Blyde River Canyon and Kaapsehoop. The landscape is

characteristically very rugged with steep east-facing cliffs which are dominated by species such as *Protea roupelliae, Faurea galpinii, Faurea rochetiana, Syzygium cordatum, Cyathea dregai, Vernonia myriantha.* Low shrub species includes *Athrixia phylicoides, Clutia monticola, Crotalaria doidgeae, Erica woodii, Euryops pedunculatus, Aloe arborescens, Crassula sarcocaulis* while the diverse herbaceous layer consists of species such as *Berkheya echinacea, Dicoma anomala, Eriosema angustifolium, Gerbera ambigua, Monsonia attenuate* and *Pearsonia sessilifolia.* Northern Escarpment Quartzite Sourveld is classified as Vulnerable with more than 38% transformed mainly by plantations. It is furthermore noted that this vegetation type coincides with the Wolkberg Centre of Endemism and is rich in endemic plants.

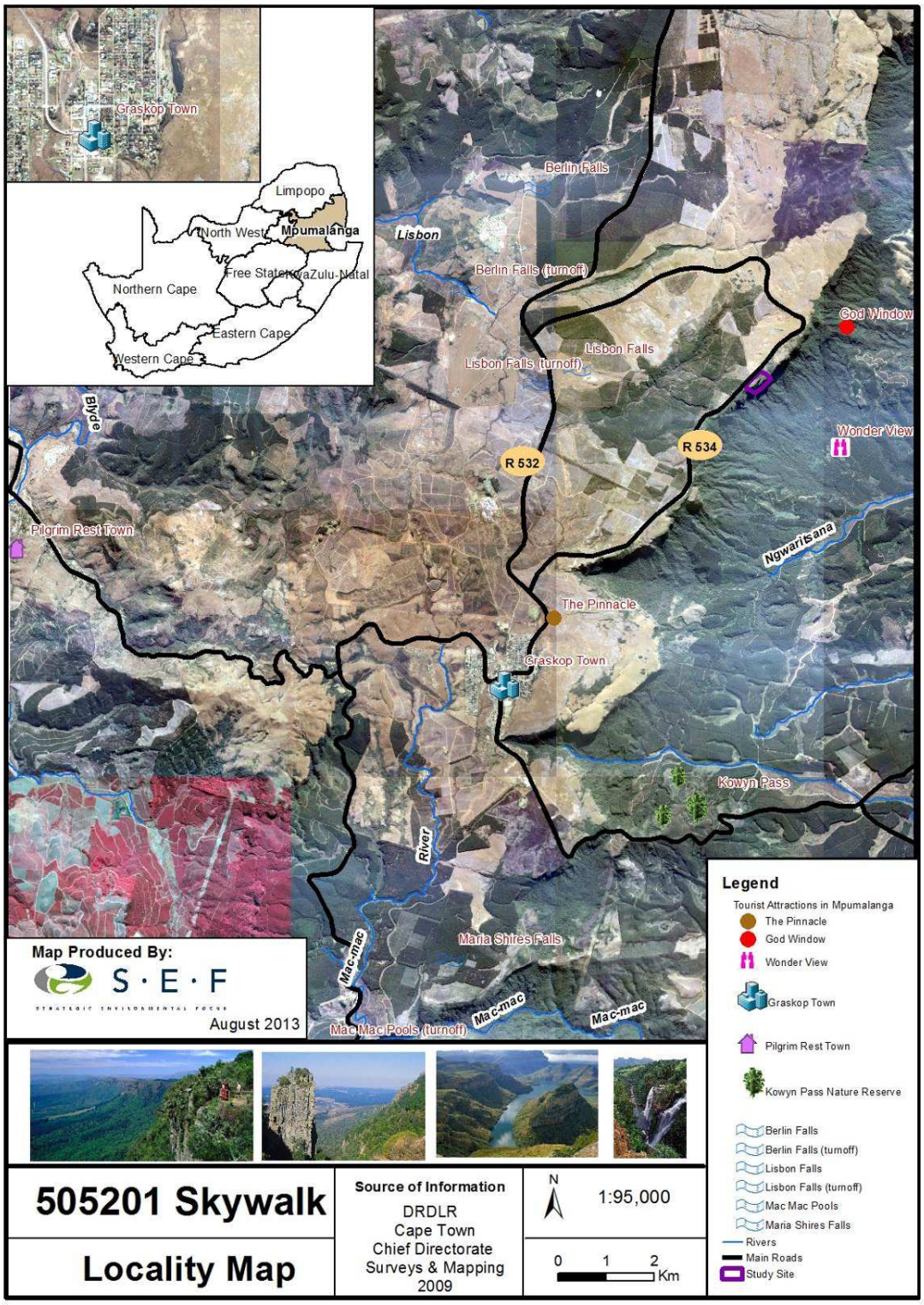


Figure 1: Location of the study site

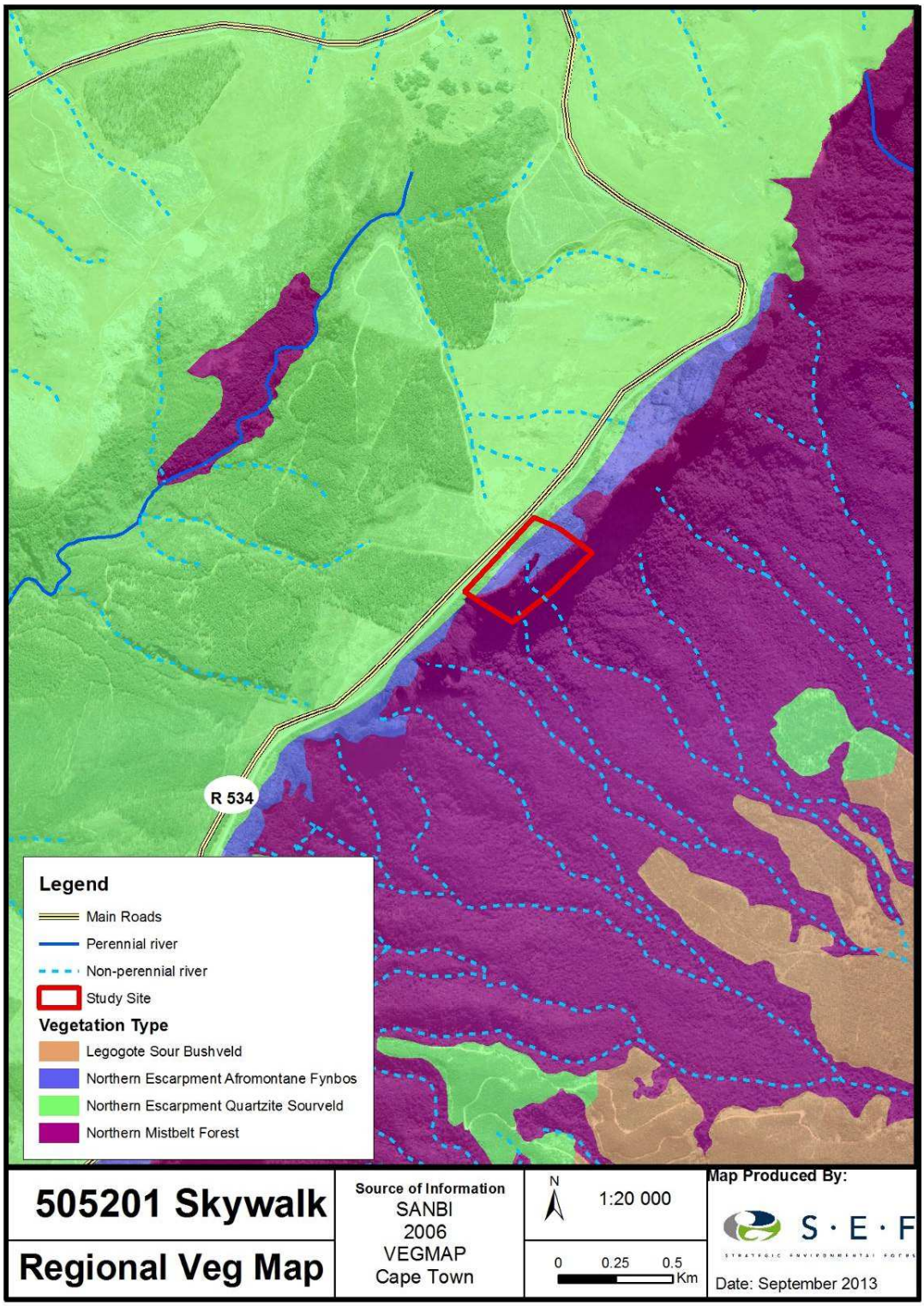


Figure 2: Regional vegetation in relation to the study area

2.4 Listed Ecosystems

The National Environmental Management: Biodiversity Act (Act 10 of 2004) provides for listing threatened or protected ecosystems, in one of four categories: Critically Endangered (CR), Endangered (EN), Vulnerable (VU) or Protected (Government Gazette, 2011). The main purpose of listing threatened ecosystems is to reduce the rate of ecosystem and species extinction and includes the prevention of further degradation and loss of structure, function and composition of threatened ecosystems.
Threatened terrestrial ecosystems have been delineated based on the following:

- The South African Vegetation Map;
- National forest types;
- Priority areas identified in a provincial systematic biodiversity plan (in this case the Mpumalanga Conservation Plan); or
- High irreplaceability forest patches and clusters.

The present study area is located within the Blyde Quartzite Grassland ecosystem which is currently listed as Endangered in terms of Section 52 of NEMBA (Government Gazette, 2011) under Criterion F. Originally the Blyde Quartzite Grassland ecosystem covered about 33 000ha and currently 63% of the natural habitat remains. Furthermore, at least 28 threatened or endemic plant and animal species occur within this ecosystem and includes the following: four mammals, three reptiles, five birds and 16 plants. Five vegetation types are represented in this ecosystem and include Northern Escarpment Afromontane Fynbos, Northern Escarpment Quartzite Sourveld, Northern Escarpment Dolomite Grassland, Mpumalanga Afromontane Forest and Subtropical Afromontane forest.

2.5 Mpumalanga Biodiversity Conservation Plan and Biodiversity Sector Plan

A Provincial Conservation Plan aims to build on national plans at the provincial level. It is intended to be used by all who are involved in land-use and development planning, most particularly those specialists who need a comprehensive source of biodiversity information. The plan, and resulting land-use guidelines, are intended to supplement other spatial planning tools such as municipal Integrated Development Plans and Spatial Development Frameworks.

The Mpumalanga Biodiversity Sector Plan (MBSP) is an updated version of The Mpumalanga Biodiversity Conservation Plan (MBCP) and consists of a comprehensive environmental inventory and spatial plan that is intended to guide conservation and land use decisions in support of sustainable development. However, both the Mpumalanga Biodiversity Conservation Plan (MBCP) as well as the updated Mpumalanga Biodiversity Sector Plan (MBSP) have been created using spatial data and in many cases have not been ground-truthed. According to the latest Mpumalanga Biodiversity Sector Plan, the study area falls within the Blyde River Canyon Provincial Nature Reserve.

3. PLANT PROTECTION AND RELOCATION PLAN

3.1 Overarching principles for plant protection

The following overarching principles are applicable to all species described below:

3.1.1 Protection of species on vertical cliffs

Plant species growing on vertical cliff faces have highly evolved mechanisms to cope with weather extremes. The lack of soil means that most of the vegetation on vertical cliffs are lightly attached to the rock face, usually in small crevices and pockets and are therefore vulnerable to any form of disturbance such as falling rocks and strong winds which can dislodge plants. These vulnerable vegetation communities were present on the vertical cliffs within the study area. In order to protect the numerous threatened, rare and provincially protected species growing on the sheer cliffs the following measurements should be implemented:

- No building rubble or building materials should be dropped down the cliff edges as falling objects are likely to dislodge plant communities on the cliffs;
- The alien tree species *Pinus patula* which was confirmed on the vertical cliffs should be removed and it is recommended that these removals are conducted or supervised by a suitably qualified botanist or ecologist to ensure sensitive plants are not disturbed;
- Mitigation measures recommended by the wetland report (SEF, 2014) should be implemented to ensure that the hydrology of the cliffs are not impacted on. Species such as *Streptocarpus fenestra-dei* requires moist habitats to grow and it is likely that the disturbance of the hydrology on top of the cliffs could lead to the desiccation of the cliffs;
- Since the final layout plan and detailed construction activities were not available at the time of the compilation of this report, it is recommended that a suitably qualified botanist or ecologist is consulted to review the final plans.

3.1.2 Protection and relocation of herbaceous species

Herbaceous species within the footprint of the development should be protected *in situ* as far as possible. Where this proves not to be possible, the following principles should be applied:

- Herbaceous species which are of conservation concern, rare or provincially protected should be removed prior to any construction activities. Removal should be conducted or overseen by a suitably qualified experienced botanist or ecologist with relevant experience;
- Plants which have been removed should be planted in bags or pots with appropriate growing media within the property and maintained by a suitably qualified horticulturist or botanist. Once the construction phase is concluded these

species should be used for rehabilitation and landscaping around the Skywalk complex;

- Seed should be collected from dominant species such as *Aloe arborescens* and *Clivia caulescens* and used to rehabilitate areas disturbed during construction (A permit might be required from MTPA to collect seed from protected species);
- It is highly recommended that plant species which occur naturally in the area are used for rehabilitation and landscaping. Under no circumstances should any *Aloe* species be purchased from nurseries or other sources. Extensive hybridization occurs in *Aloe* species with overlapping flowering periods and this will result in a loss of genetic purity of rare and protected *Aloe* occurring in the study area; and
- Landscaping and rehabilitation should be overseen by a suitably qualified ecologist of botanist.

3.1.3 Protection of woody (tree) species

Three tree species, *Rapanea melanophloeos, Afrocarpus falcatus* and *Faurea galpinii* were confirmed in the study area, although *F. galpinii* was recorded close to the viewpoint and therefore unlikely to be impacted on by the construction of the Skywalk complex. The relocation of tree species are rarely successful, especially where these trees are rooted in deep rock crevices. It is therefore recommended that these trees are protected from construction activities and incorporated into landscaping around the Skywalk complex. A permit will be required for trees that will be destroyed.

3.2 Plants of Conservation Concern and Provincially Protected species confirmed in the study area

Plants of conservation concern are those plants that are important for South Africa's conservation decision making processes. Species of conservation concern include the International Union for the Conservation of Nature (IUCN) categories of Extinct (EX), Extinct in the Wild (EW), Critically Endangered (CR), Endangered (EN), Vulnerable (VU), Near Threatened (NT), Data deficient (DD) as well as the South African categories of Critically Rare, Rare and Declining (Raimondo et al., 2009). Many of these plants are nationally protected by the National Environmental Management: Biodiversity Act, 2004 (Act No. 10 of 2004).

Rare and Endangered species are mostly small, very localized and visible for only a few weeks in the year when they flower (Ferrar and Lötter, 2007). As these plants might not have been visible at the time of the field survey, the probabilities of occurrence for these plants were based on distribution data and information gathered concerning the area. A minimum of 39 plant species of conservation concern have been recorded from QDGC 2430DD (Raimondo *et al.,* 2009; POSA, 2011), eight of which were confirmed during the field survey mostly on cliff edges and on vertical cliffs. Some indigenous plant species are protected under Schedule 11 of the Mpumalanga Nature Conservation Act, 1998 (Act No.

10 of 1998). The plant species of conservation concern, as well as provincially protected species which have been confirmed in the study area are summarized in Table 2 while recommended protections measures and relocation principles are described below for each species. Two species which are provincially protected, namely *Cyathea capensis* and *Faurea galpinii,* were confirmed in the areas surrounding the study area and are therefore not described in this report.

Table 1: Plant species of conservation concern and/or provincially protected species in the study area which is likely to be affected by the construction of the proposed Skywalk complex

Species	IUCN Conservation Status	Provincially Protected
Afrocarpus falcatus	LC	Genus protected in Mpumalanga
Agapanthus inapertus	LC	Genus protected in Mpumalanga
Aloe arborescens	LC	All Aloe species naturally occurring in Mpumalanga
Aloe nubigena	LC	All Aloe species naturally occurring in Mpumalanga
Cliva caulescens	NT	Genus protected in Mpumalanga
Drimia elata	DDT	Genus protected in Mpumalanga
Merwilla plumbea	LC	Species protected in Mpumalanga
Monopsis kowynensis	VU	Not protected in Mpumalanga
Polystachya transvaalensis	LC	All Orchidaceae are protected in Mpumalanga
Rapanea melanophloeos	Declining	Not protected in Mpumalanga
Schizochilus lilacinus	Rare	All Orchidaceae are protected in Mpumalanga
Scilla nervosa	LC	Genus protected in Mpumalanga
Streptocarpus fenestra-dei	VU	Not protected in Mpumalanga

3.2.1 Afrocarpus falcatus

Afrocarpus falcatus is a medium to large tree growing in Afromontane forests along the escarpment. The bark is traditionally burnt in kraals and although wood is prized for furniture it is not as popular as *Podocarpus latifolius*. *Afrocarpus falcatus* is nationally protected in terms of the National Forests Act of 1998 (Act 84 of 1998) and it is also protected in Mpumalanga.

Within the study area, *A. falcatus* was recorded on the cliff edges as well as below the vertical cliffs (Photograph 1). Large trees seldom relocate successfully and within the study area, *A. falcatus* was growing amongst large boulders with roots wedged into cracks making relocation impossible. In addition to this, the provincially protected orchid *Polystachya transvaalensis* was also recorded growing on the branches of *Afrocarpus falcatus* in the study area. It is essential that the trees within the study area are conserved *in situ* and incorporated into the general landscape. It is furthermore recommended that this species is propagated from seed collected from the study area and seedlings used for additional landscaping and rehabilitation. A permit will be required from the Department of Agriculture, Forestry and Fisheries (DAFF) as well as MTPA to destroy individuals.

Photograph 1: *Afrocarpus falcatus* on the cliff edges (left) and below vertical cliffs (right) in the study area.

3.2.2 Agapanthus inapertus

Agapanthus inapertus is a deciduous species growing on forest margins, in grasslands and in mountains. It is fairly widespread and common in Mpumalanga and Limpopo and although there is some harvesting for medicinal purposes it is not considered threatened at this stage. It is however protected in Mpumalanga.

Within the study area, *A. inapertus* was recorded amongst the rocks on cliff edges and the overarching principles as described in section 3.1.2 should be applied.

3.2.3 Aloe arborescens

Aloe arborescens is a large branched *Aloe* growing on cliffs and rocky slopes in cool areas. It is widespread occurring from the Western Cape, through Kwazulu-Natal, Mpumalanga and Limpopo provinces. *Aloe* species are considered one of the keystone species in many landscapes with their flowers providing essential food to invertebrates and birds during dry winter months while dense leaves provide shelter to bat and rodent species. This was also the case for *A. arborescens* within the study area with the flowers of this species providing an important food source in May and June. Although this species is not currently considered to be threatened, all *Aloe* species are protected in Mpumalanga.

Aloe arborescens was very common throughout the study area and clumps were dense and well established (Photograph 2). Where possible these clumps should be protected from the development and incorporated into the landscaping around the Skywalk complex. Where this is not possible, seed should be harvested from the plants and used during rehabilitation of the disturbed areas and overarching principals described in section 3.1.1 and 3.1.2 should be applied to *A. arborescens.*

Photograph 2: Clumps of *Aloe arborescens* within the study area.

3.2.4 Aloe nubigena

Aloe nubigena is a small grass *Aloe* which is restricted to Mpumalanga where it has highly specific habitat requirements growing on rocky outcrops or vertical cliff faces. Although its distribution is limited, it could be common in areas where suitable habitat is found. However, less than 10% of the population occurs on top of cliffs, the remainder being found on steep cliff faces. Plants which are located on top of cliffs have been declining in the recent past due to habitat degradation and collecting of plants for horticultural purposes. This species is considered to be highly vulnerable to invasion of its habitat by pine seedlings (IUCN, 2014). Due to these threats and highly specialized habitat requirements, *A. nubigena* is listed as VU by the IUCN and is protected in Mpumalanga.

Within the study area, *A. nubigena* was recorded on vertical cliffs (Photograph 3) with isolated individuals located on the cliff edges and overarching principles described in section 3.1.1 and 3.1.2 are applicable to *A. nubigena.*

Photograph 3: *Aloe nubigena* growing on vertical cliffs in the study area.

3.2.5 Clivia caulescens

Clivia caulescens is an evergreen, bulbous plant and produces rhizomes which tend to sucker and in time, grows into a large plant. The stem develops to a height of 0.5-2.0 m and 30-40 mm in diameter. The leaves are dark green, 400-900 x 50 mm while the inflorescence consists of 15-20 orange to cream-coloured, pendulous flowers. *Clivia caulescens* flowers in summer (October to November). The light yellow to almost purple berries vary from round to oblong and ripen after nine months. This species is fairly common in the Mpumalanga and northern provinces, occurring at Sabie, Mount Sheba, God`s Window and Soutpansberg in the north (www.plantzafrica.com).

Clivia caulescens is currently listed as Near Threatened by the IUCN and is threatened by harvesting, mostly for the traditional medicine trade with the volume purchased annually by traders in Faraday estimated to be at least 200 bags. Surveys in 2004 revealed that none of the traders were able to acquire stock and although *C. caulescens* is more widespread than other South African *Clivia* species it is expected to decline by at least 25% in the next 60 years (IUCN, 2014). *Clivia caulescens* is also protected in Mpumalanga.

Within the study area, *Clivia caulescens* was considered to be very common, especially along the cliff edges and on the vertical cliffs (Photograph 4). The overarching principles for species on vertical cliffs (3.1.1) and herbaceous species (3.1.2) should be applied to *C. caulescens* in the study area.

Photograph 4: Large populations of *Clivia caulescens* were recorded in the study area, especially on the vertical cliffs (left) and on the cliff edges (right).

3.2.6 Drimia elata

All *Drimia* species have large underground storage bulbs. The flowers are tubular with the tips of petals reflexed and the stamens fused into a narrow tube. Currently there is some confusion between *Drimia* and *Urginia* and attempts to unite the two genera has resulted in the species conservation status being listed as Data Deficient Taxonomic (DDT) (van Wyk et al. 2005).

Large populations of *Drimia elata* were recorded on the cliff edges (Photograph 5) and the overarching principles described in 3.1.2 should be applied to *D. elata.*

Photograph 5: Large numbers of *Drimia elata* was recorded on the cliff edges.

3.2.7 Merwilla plumbea

Merwilla plumbea is the name given for several species which include *Scilla kraussii, S. natalensis* and *S. plumbea*. *Merwilla plumbea* occurs solitary or in large colonies in a variety of habitats including grassland, cliffs and rocky slopes. The inflorescence are borne on stalks of up to 1m tall between September and December.

Merwilla plumbea is currently listed as Near Threatened and is protected in Mpumalanga. *Merwilla plumbea* is a highly sought after medicinal plant throughout most of its range and is threatened by the high volumes traded. *Merwilla plumbea* can be locally abundant if it is not exploited although the population is declining with some populations becoming extinct.

Merwilla plumbea was recorded in fairly large numbers of the cliff edges and vertical cliffs (Photograph 6) but also sporadically in the area between the current parking area and cliff edge. The overarching principles described in section 3.1.1 and 3.1.2 should be applied to *M. plumbea.*

Photograph 6: Large numbers of *Drimia elata* was recorded on the cliff edges (left) and vertical cliffs (right).

3.2.8 Monopsis kowynensis

Monopsis kowynensis is a slender herb growing in mistbelt grasslands in Mpumalanga where it is known from three localities. *Pinus* plantations within the mistbelt area of Mpumalanga has resulted in large scale habitat destruction and it is also considered to be threat for *M. kowynensis.*

Within the study area *M. kowynensis* was recorded on the vertical cliffs in small clumps (Photograph 7) and overarching principles described in section 3.1.1 should be applied to protect *M. kowynensis* on the cliffs.

Photograph 7: *Monopsis kowynensis* on steep cliffs within the study area.

3.2.9 Polystachya transvaalensis

Polystachya transvaalensis is a slender orchid which grows in trees especially *Afrocarpus* (*Podocarpus*) *latifolius* and on rocks in cooler escarpment forests. This species is not currently threatened and is locally common in many localities but all orchid species are protected in Mpumalanga.

Within the study area, *P. transvaalensis* was very common within the study area where it was recorded in *Afrocarpus* (*Podocarpus*) *falcatus* and on rocks in damp areas (Photograph 8). This species rarely survives relocation and it is therefore recommended that the species is conserved *in situ*. A permit from MTPA will be needed to destroy specimens which can't be conserved.

Photograph 8: *Polystachya transvaalensis* was recorded on damp rocks and on branches of trees such as *Afrocarpus falcatus* within the study area.

3.2.10 Rapanea melanophloeos

Rapanea melanophloeos is a small to large evergreen tree which grows on exposed rocky areas, in thickets and Afromontane forests throughout South Africa. The bark is very popular in traditional medicine and is considered to the Declining by the IUCN.

Within the study area *R. melanophloeos* was recorded on the rocky cliff edges and since large trees seldom relocate successfully it is essential that *R. melanophloeos* is protected and incorporated into the landscape. In addition to this it is recommended that this species is propagated from seed collected from the study area and seedlings used for landscaping and rehabilitation.

3.2.11 Scilla nervosa

Scilla nervosa grows in clumps in grasslands from the coast up to 2 000 meters above sea level. The underground tubers are used in traditional medicine while grasslands are generally threatened by plantations and habitat degradation, the genus is protected in Mpumalanga. *Scilla nervosa* was recorded on the plateau between the current parking area and cliff edges and the overarching principles described in section 3.1.2 should be applied to *S. nervosa.*

3.2.12 Schizochilus lilacinus

Schizochilus lilacinus is a terrestrial orchid growing exclusively on ledges and vertical cliffs and is known from extremely few localities within a restricted distribution range between

Lydenburg and Graskop in Mpumalanga. The vertical cliffs on which *S. lilacinus* grows protects it from impacts such as plant collectors, fires, grazing and plantations and it is therefore listed as Rare. It is also protected in Mpumalanga.

Within the study area, *S. lilacinus* was frequently recorded on the vertical cliffs and it was found amongst grasses and other vegetation communities which helped to secure *S. lilacinus* to the cliffs (Photograph 9). Overarching principles for protection of species on cliffs as described in section 3.1.1 should be applied to ensure no *S. lilacinus* is destroyed by falling objects.

Photograph 9: *Schizochilus lilacinus* growing on vertical cliffs within the study area.

3.2.13 Streptocarpus fenestra-dei

Streptocarpus fenestra-dei grows in shallow soils in rocky areas and in forested gullies between God's Window and Burke's Luck Potholes. Plants in both localities are threatened by collection for horticultural purposes as well as trampeling by tourists and *S. fenestra-dei* is therefore listed as VU by the IUCN and it is protected in Mpumalanga.

Within the study area *S. fenestra-dei* was recorded on cliff edges as well as on crevices on the vertical cliffs (Photograph 10). Since *Streptocarpus* species rarely transplant successfully, the individuals on the cliff edges should be protected from the development while overarching principles for species on vertical cliffs as described in section 3.1.1 should be applied.

Photograph 10: *Streptocarpus fenestra-dei* in the study area

4. ALIEN INVASIVE SPECIES MANAGEMENT PLAN

4.1 Background

Infestations by alien plants, mainly trees and shrubs, are estimated at over 10 million ha (Le Maitre et al. 2000). Declared weeds and invaders have the tendency to dominate or replace the herbaceous layer of natural ecosystems, thereby transforming the structure, composition and function of natural ecosystems. Therefore, it is important that all these transformers (as defined above) be eradicated and controlled by means of an eradication and monitoring programme. Some invader plants may also degrade ecosystems through superior competitive capabilities to exclude native plant species (Henderson, 2001).

The amended Regulations (Regulation 15) of the Conservation of Agricultural Resources Act (CARA), 1983 (Act No. 43 of 1983) identifies three categories of problem plants:

- **Category 1** plants may not occur on any land other than a biological control reserve and must be controlled or eradicated. Therefore, no person shall establish, plant, maintain, propagate or sell/import any category 1 plant species;
- **Category 2** plants are plants with commercial application and may only be cultivated in demarcated areas (such as biological control reserves) otherwise they must be controlled; and
- **Category 3** plants are ornamentally used plants and may no longer be planted, except those species already in existence at the time of the commencement of the regulations (30 March 2001), unless they occur within 30m of a 1:50 year flood line and must be prevented from spreading.

The following categories are proposed on the revised Conservation of Agriculture Resource act (CARA) and the National Environmental Management Biodiversity Act (NEMBA), and are thus included within the present assessment:

- **Category 1a** plants are high-priority emerging species requiring compulsory control. All breeding, growing, moving and selling are banned.

- **Category 1b** plants are widespread invasive species controlled by a management programme.
- **Category 2** plants are invasive species controlled by area. Can be grown under permit conditions in demarcated areas. All breeding, growing, moving, and selling are banned without a permit.
- **Category 3** plants are ornamental and other species that are permitted on a property but may no longer be planted or sold.

Only two alien plant species, *Pinus patula* and *Lilium formosanum,* were recorded in the study area.

4.2 Control methods

There are three commonly used methods of alien plant removal, namely mechanical, chemical and biological control. An effective approach often entails a combination of these methodologies.

4.2.1 Mechanical control

This involves tree felling and a 'hands on' removal approach often paired with the use of fire. Mechanical and chemical methods are seen to have short-medium term effectiveness follow-up removals are needed periodically to prevent the re-colonization of alien invasive plants. Mechanical control methods are often expensive and applicable to dense infestations.

4.2.2 Chemical control

Chemicals have been used for weed control for more than 100 years and in the beginning chemical weed control was mainly done on industrial sites, railway tracks ect. These chemicals included crushed arsenical ores, oil wastes and creosote, all of which are toxic and highly detrimental to the environment (Brimlow, 2010). It should be noted that all person(s) / contractors appointed to apply herbicides should be registered in terms of the Fertilizers, Farm Feeds, Agricultural Remedies and Stock Remedies Act (Act 36 of 1947), as amended. Herbicides application shall be done by suitably trained personnel in possession of an appropriate course certificate, or under the direction of a qualified pest control operator, registered under the Fertilizers, Farm Feeds, Agricultural Remedies Act. Registration with the Pest Control Service Industry Board (PCSIB) is also preferred. The following chemicals are currently available:

Herbicides

Herbicides are substances with are either natural or man-made which alters the metabolic processes of a plant so that the plant is suppressed, killed or its growth is altered so it becomes less of a problem. Herbicides can be divided into the following groups:

- Non- selective and selective herbicides: Non-selective herbicides will affect any plant that it comes into contact with while selective herbicides kill a weed without harming other species (such as a crop);
- Contact and systemic herbicides: Contact herbicides act by affecting only the plant tissue which they come into contact with and plants are often only susceptible to contact herbicides during an early age. Systemic chemicals are transported throughout the plant from the initial site of application (usually through the roots);
- Pre-emergence and post-emergence herbicides: Pre-emergence herbicides are applied to the soil before the weeds emerge while post-emergence herbicides are applied after the weeds have emerged and are usually taken up through the leaves; and
- Long and short residual action herbicides: Some herbicides can remain active in the soil for months or even years after application, while others have a relatively short life.

Modern chemical groups

Important chemical groups which are currently in use include:

- Triazines and ureas: These are usually applied on the soil and inhibit photosynthesis. It does not affect germination since it is taken up by the developing roots;
- Acetanelides (amines): This group is usually used to prevent germination but will also inhibit root and overall growth and is mostly used for grass species;
- Phenoxy compounds: This group acts as artificial hormones causing an imbalance which lead to uncontrolled cell division and enlargement in the growth point of the plant. It furthermore induces a large number of biochemical and metabolic changes that lead to abnormal plant development and are mostly killers of broadleaf weeds;
- Thiocarbamates: These chemicals are volatile and must be incorporated into the soil to prevent its loss through evaporation. It is highly selective and has long residual actions. It is mainly active on grasses and sedges;
- Dinitroanalines: These chemicals are less volatile than thiocarbamates but also has a long residual action;
- Sulphonyl ureas: This group was developed in the 1980's and are highly active at very low dosages. It includes a wide range of herbicidal actions;
- Phosphorous herbicides: This group is typified by glyphosates and its salts and currently makes up the largest volume of usage of any group of herbicides. This group is post-emergence, non-selective and systemic and act by inhibiting the formation of amino acids; and
- Bipyridylium compounds: This is a small group of herbicides which is non-selective, post-emergence and contact herbicides which are rapidly absorbed by green plant tissue. It deactivates once it comes into contact with the soil.

All forms of chemical control entails the use of environmentally safe herbicides, while adhering to all relevant health and safety regulations pertaining to the use of hazardous chemicals. When controlling weeds and invaders, damage to the environment must be limited or prevented. Mechanical and chemical methods are often combined. The following damage to the environment could occur if the chemical control is applied without caution and cognisance of the law:

- the removal of or herbicidal damage to non-target plants;
- the chemical pollution of soil or water or any other threat to non-target organisms;
- the creation of a fire hazard by allowing flammable material to accumulate in fire-sensitive areas;
- unnecessary or irresponsible disturbance of the soil, especially on riverbanks or slopes;
- failure to rehabilitate denuded areas so as to prevent soil erosion and invasion by other undesirable species; and
- upset the ecological balance of the environment.

Note: herbicides should be applied directly to the plant(s) that needs to be eradicated. Herbicides are generally not plant specific and will kill most plants it comes in contact with. Therefore, do not spray during windy periods as drift from the spray will kill non-targeted plants and species of conservation concern.

4.2.3 Biological control

This method involves introducing species-specific insects and diseases that would control the alien plant in its country of origin. Biological control involves the use of host-specific natural enemies of weeds or invaders from the plant's country of origin, to either kill or remove the invasive potential of these plants. It may only be initiated by and carried out under the supervision of an academic or research institute or organisation established by legislation, which practises and researches biological control of weeds and invader plants (Agricultural Research Council, 2011). Biological control is seen to be an effective long-term approach to controlling alien plants. However, an ethical issue arises with trying to control an alien plant with an alien insect or pathogen. Specialist knowledge is crucial to guide biological control measures. Biological control of weeds is subject to rigorous regulations, and will be recognised by CARA as a valid control method only if it is practised in accordance with all these regulations.

4.3 Control Phases

An alien control program should ideally include three phases as listed in Table 2. Each stage is equally important in removing and controlling the spread of alien plants. The aim of control is to reach a point where, ideally, the plants concerned no longer occur in that particular area or, at least, where the plants can no longer grow, produce viable seeds or spores, coppice, sprout or produce root suckers, reproduce vegetatively, propagate themselves in any other way, or spread into other areas. If this is not possible, the plants have to be contained and their multiplication limited as far as possible.

In general, the situation should be monitored during spring, mid summer and autumn each year to avoid alien plant re-infestation, spread and densification and to thereby avoid increased control costs.

Table 2: Control phases of alien species control programmes

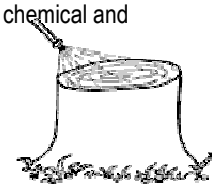
Phase	Actions
1. Initial Control	Drastic reduction of the existing populations
2. Follow-up Control	Control of seedlings, root suckers and coppice re-growth
3. Maintenance Control	Sustain low (or no) alien plant numbers/density with low annual control costs. At this phase, alien plants are no longer considered a problem. However, regular monitoring to ensure that no new infestation take place is essential.

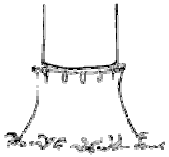
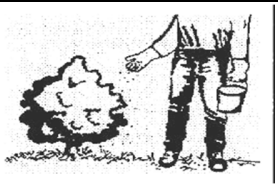
The initial control in most cases, involves mechanical methods and in the case of heavy infestations, machinery. The initial control aims to drastically reduce the number of adult and often large individuals of invasive plants.

After initial clearance, tree stumps can readily coppice and in the absence of follow-up treatments, the infestation will proliferate and negate the initial control efforts. In addition, some plant species produce large numbers of seeds that can lie dormant in the soil for a number of years. Soil disturbance and the removal of large trees that shaded the soil, often result in the copious germination of weedy plant species, which can easily be removed or sprayed when young. Follow-up control of alien seedlings and coppice re-growth is thus essential to achieve and sustain the progress made with initial control work.

Once the invasion is maintained, regular monitoring followed by maintenance control where needed, should prevent the re-colonisation of alien plants species or the infestation by newly introduced alien species. If monitoring does not take place timeously, new infestations might not be noticed until the infestation becomes severe. Subsequently, initial control might again have to be undertaken which is both costly and detrimental to rehabilitation efforts. Table 3 and Table 4 list the various initial and follow-up control methods that could be implemented

Table 3: Initial control methods (adapted from Working for Water, 2007

Initial control	Method	Methodology
Hand Pull Method	Mechanical	Gripping the young plant low down and pulling it out by hand (using gloves).
Tree felling	Mechanical	Trees can be felled and removed with the use of chainsaws, bow saws, brush cutters or cane knives
Cut stump treatment	Combination of chemical and mechanical 	Stems should be cut as low as possible. Apply the recommended herbicide mixed in water to the cut surface of stumps. *NB: Do not spray the sides of the stumps*. Apply herbicide mix within 1 hour after felling or the cut wound will seal.

Total Stump Treatment	Combination of chemical and mechanical	Apply the recommended herbicide mixed in diesel to the cut surface, down the sides of the stumps and to any exposed roots. Diesel carries the herbicide through the bark to the cambium. The herbicide mix can be applied even several days after felling. *Not all herbicides can be mixed with diesel – the label should be checked for the recommended carrier*.
Basal Bark Method	Combination of mechanical and chemical	The application of a suitable herbicide with diesel can be applied to the bottom 250 mm of the stem. Diesel carries the herbicide through the bark to the cambium. Applications should be by means of a low pressure, coarse droplet spray from a narrow angle solid cone nozzle. Stems with a diameter up to 50 mm should be treated to a height of 250 mm and stems above 50m diameter to a height of 500 mm. This method is only suitable for stems up to 100 mm in diameter.
Ring Barking Method	Mechanical and possibly also chemical 	Bark must be removed from the bottom of the stem to a height of 0.75-1.0m. All bark must be removed to below ground level for good results. Where clean de-barking is not possible due to crevices in the stem or where exposed roots are present, a combination of bark removal and basal stem treatments should be carried out. Bush knives or hatchets should be used for debarking.
Frill Method	Mechanical 	Use an axe or bush knife and make angled cuts downward into the cambium layer through the bark in a ring. Cuts should be distributed around the entire stem and herbicide applied into the cuts.
Herbicide Plugs	Combination of chemical and mechanical	After felling, holes should be made in the stump and plugs inserted to contain the herbicide. The herbicide will be released into the stumps.
Strip Bark	Mechanical	Bark should be stripped away from the tree from waist down into the soil. Bark comes away readily in the rainy season. Cambium is stripped with the bark. This cuts off the supply of food from the leaves to the roots, which slowly die. Bush knives are more effective than hand axes. No herbicide is used.
Burning Stem Bases		Branches are stacked around the base of stems and the wood is burned. This will control most of the trees. Spray any coppice re-growth.
Soil Applied herbicide	Chemical 	Certain herbicides are taken up by the trees and plants through the roots. Such herbicides are applied to the soil surface, leach into the target plant root zone and taken up by the plant, which will then die.
Shrubs smaller than 1m		Where possible hand pull. Foliar application of a registered herbicide is required where shrubs cannot be hand pulled. Where grass is present, use selective broadleaf herbicides that do not harm the grass. Where dense seedling growth of uniform height is present, use knapsack sprayers with flat nozzles. Use solid cone nozzles of seedling of uneven height, coppice growth, root sucker and short saplings.

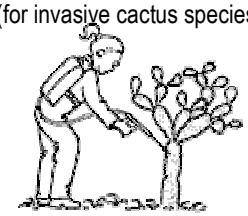
Shrubs taller than 1m		Where shrubs are taller than 1.5m the height must be controlled by cutting, using sharpened hoes, cane knives or motorized brush cutters. For large areas of dense growth, use a tractor-mounted gyro-mover. After slashing or cutting plants, treat the freshly cut stumps or allow re-growth to knee height and then spray with a suitable registered herbicide.
Mechanical uprooting		Uprooting of large volumes of shrubs promotes soil disturbance and erosion. This result in exposure of weed seeds. Germination of these seeds re-infests the cleared areas. Mechanical uprooting should be applied where the soil can be stabilized, e.g. by dense grass cover. When soil has been disturbed, it is advisable to sow grass seed immediately after uprooting and soil levelling has been completed.
Stem injection	Chemical (for invasive cactus species) 	Stem injection: Punch downward slanting holes into the main stem using a sharpened metal spike. Space holes around entire circumference of lower stems. Inject the herbicide directly into the plant – ensuring to inject around the stem. Follow label recommendations -

Table 4: Follow-up control methods (adapted from Working for Water, 2007)

Follow-up control	Method	Methodology
Burning	Mechanical	• Fire can destroy the seedling of invader species and increases the competitive ability of the grass sward. • Burning can also stimulate even growth of seedlings so that follow-up control measures are easier.
Cutting of coppice	Mechanical and chemical For re-sprouting or re-growth	• This is suitable for medium – high density infestations. Slash plants at a convenient height, e.g. knee height. Cutting dense plants is good winter work but it is tiring and must be well-organized. • Spray coppice re-growth during the active growing season, when there is enough leaf cover to absorb the herbicide.
Seedlings and saplings	Mechanical and chemical For re-sprouting or re-growth	• Hand pull seedlings when soil is wet, using gloves to protect the hands. • Burn grass to control saplings – the controlled burning of high grass fuel loads is another option in an integrated control program. NB: Any burning must be done in a controlled safe manner, and according to local burning regulations. Protect neighbouring veld during burning. Contact your local extension office for burning guidelines. • Fire can destroy the seedling of invader species and increases the competitive ability of the grass sward. • Many shrubs and trees coppice after burning. Treat any coppice growth with herbicide. If this is not done, the coppice will form multi stemmed plants. • Cut the plant with a brush cutter and treat the stumps. • Untreated plants can be controlled with foliar herbicide application during follow-up work.
Removal of flowers and seeds	Mechanical	• If for any reason follow up control cannot be initiated, remove the flowers and seeds from the alien invasive plants. • Although this will not eradicate the plants, it will limit seed dispersal and thus the spread of invasive plants.

4.4 Alien species recorded in the study area and recommended control methods per species

Only two alien plant species were recorded in the study area during the ecological surveys in October and November 2013 (SEF, 2013) and are described below:

4.4.1 Pinus patula

Pinus patula occurs naturally in Mexico where it is generally restricted to moist temperate to sub humid climates, but it has been recorded from subtropical climates as well. *Pinus patula* was introduced into South Africa in 1907 as a plantation species. In 2001 the area covered by *P. patula* in South Africa was over 337 000 ha making South Africa the largest area planted with *P. patula* in the world (Nyoka 2003). It is predominantly planted in cool, mist-belt areas at high altitudes in Mpumalanga and Kwazulu-Natal provinces.

Pinus patula can flower from as early as two to three years with viable seed produced from five years. An abundance of cones are produced from eight years old and seed may remain in the cones for up to seven years without a major loss of viability. The seed is winged, extremely light and can be blown by wind for several kilometres (Nyoka 2003). These reproductive traits make *P. patula* an aggressive invader in medium to high altitude areas where it invades afromontane forests and grasslands, it is considered as one of the most invasive or potentially invasive *Pinus* species in southern Africa and is currently listed as Category 2 in terms of CARA. *Pinus patula* was declared as an invader and transformer species in South Africa (Government Gazette, 2001) and according to these regulations, growers of the species are expected to follow published regulations to minimize further infestations and control existing infestations. Within the study area,

Impact and location in study area

Pinus patula was recorded as isolated, young individuals which at this stage can easily be controlled by mechanical removal. However, there is a *Pinus patula* commercial plantation within 150m from the study area and this species will have to be removed on annual basis to prevent the species form becoming established in the study area. *Pinus patula* was recorded on the plateau close to the current parking area, as well as on the vertical cliffs (Photograph 11). Removal of *Pinus patula* seedlings from vertical cliffs should be overseen by a qualified ecologist or botanist to ensure activities associated with the removal do not impact on highly sensitive vegetation communities on these cliff edges.

Photograph 11: *Pinus patula* seedlings in the study area (left) with a commercial plantation within 150m from the study area (right).

4.4.2 Lilium formosanum

Lilium formosanum is a bulbous species with a stem of up to 2.5m high. Leaves are narrow, dark green and shiny while flowers are funnel shaped white with red-purple flashes. Flowers are produced between January and March and fruits are borne in capsules of up to 90mm long (Photograph 12).

Lilium formosanum occurs naturally in Taiwan and was introduced into South Africa as an ornamental species. It is commonly found on forest edges and roadsides where it is

tolerant to infertile, dry and sandy soils and out-competes indigenous vegetation. It is furthermore seen as a serious contributor to the degradation of the Grassland Biome (Bromilow 2010).

Impact and location in study area

Lilium formosanum was sporadically recorded on the plateau between the current parking area and cliff edge and although infestations were not extensive at the time of the survey, this species only flowers from January to March and could therefore have been overlooked. There is currently no herbicides registered for this species and unwanted plants should therefore be dug out. The bulb and small bulbils forming around the old bulb should be carefully removed and burnt.

Photograph 12: *Lilium formosanum* (Photo: Early Detection and Rapid Response, 2014)

5. CONCLUSION

The study area is situated within two Biomes, namely Afrotemperate, Subtropical and Azonal Forests Biome and the Grassland Biome. Biomes can further be divided into smaller units known as vegetation types and according to Mucina and Rutherford (2006), three vegetation types, namely Northern Mistbelt Forest, Northern Escarpment Afromantane Fynbos and Northern Escarpment Quartzite Sourveld, are located within the study area. Further, the present study area is located within the Blyde Quartzite Grassland ecosystem which is currently listed as Endangered in terms of Section 52 of NEMBA. The study area is furthermore located within a protected area according to the latest

Mpumalanga Biodiversity Sector Plan, namely Blyde River Canyon Provincial Nature Reserve.

Overarching principles for protection or relocation of thirteen species of conservation concern and/or provincially protected species are described. Only two alien plant species were confirmed in the study area based on ecological studies conducted in October and November 2013. Mechanical control methods are recommended for both species.

REFERENCES

Department of Environmental Affairs and Tourism (2007): NEMBA 2004 (Act 10 of 2004): *Critically Endangered, Endangered, Vulnerable and Protected Species*, Regulation No. 151, Government Gazette No. 29657, 23 February 2007, Pretoria: DEAT.

Emery, A. J., Lotter M. and Williamson, S.D. (2002): *Determining the conservation value of land in Mpumalanga*, DWAF (Department of Water Affairs) / DFID (Department for International Development) Strategic Environmental Assessment, Department: Water Affairs and Forestry, Republic of South Africa.

Ferrar, A.A. and Lötter, M.C. (2007): *Mpumalanga Conservation Plan Handbook*, Nelspruit: Mpumalanga Tourism and Parks Agency.

Government Gazette No 32689, (2009): *Draft National List of Threatened Ecosystems in terms of the National Environmental Management Act, 2004 (Act No. 10 of 2004)*. Department of Environmental Affairs Notice 1477 of 2009 in Government Gazette No. 32689, 6 November 2009.

Henderson, L., (2001): *Alien Weeds and Invasive Plants. A complete guide to declared weeds and invaders in South Africa*, Plant Protection Research Institute Handbook No. 12, Agricultural Research Council, South Africa.

Le Maitre, D.C., Versfled, D.C., and Chapman, R.A. (2000): *The impact of invading alien plants on surface water resources in South Africa: A preliminary assessment.* Water SA, Vol. 26 No. 3.

Lötter, M.C., and Ferrar, A.A. (2006): *Mpumalanga Biodiversity Conservation Plan Map*, Nelspruit: Mpumalanga Parks and Tourism Agency.

Manning, J., (2009): *Field Guide to Wild Flowers of South Africa*, Cape Town: Random House Struik (Pty) Ltd.

Mpumalanga Tourism and Parks Agency (2008): *Requirements for assessing and mitigating environmental impacts of development applications*, Nelspruit: MTPA.

Mucina, L. and Rutherford, M.C. (2006): The vegetation of South Africa, Lesotho and Swaziland, *Strelitzia 19*, Pretoria: South African National Biodiversity Institute.

Nyoka, B.I. (2003): *Biosecurity in Forestry: A case study on the status of Invasive Forest tree species in Southern Africa.* Forest Biosecurity Working Papers.

Pooley, E., (1998): *Guide to the Wildflowers of KwaZulu-Natal and the Eastern Region.* Durban: Natal Flora Publications.

Raimondo, D., von Staden, L., Foden, W., Victor, J.E., Helme, N.A., Turner, R.C., Kamundi, D.A. and Manyama P.A., (eds) (2009): *Red List of South African plants* 2009, Strelitzia *25*, Nelspruit: South African National Biodiversity Institute.

Rutherford, M. C. and Westfall, R. H. (1994): *Biomes of Southern Africa: an objective categorisation*, Pretoria: National Botanical Institute.

Strategic Environmental Focus (SEF): (2013): *God's Window Skywalk Ecological Assessment*. Project code: 505201.

Van Wyk, B. and Malan, S. (1997): *Field Guide to the Wild Flowers of the Highveld*, Cape Town: Struik Publishers.

Van Wyk, B. and Smith, G. (2005): *Guide to the Aloes of South Africa*, Pretoria: Briza Publications.

Van Wyk, B-E, Van Oudtshoorn, B. and Gericke, N: (2005): *Medicinal Plants of South Africa.* Cape Town: Struik.

Van Wyk, B. and Van Wyk, P. (1997): *Field Guide to Trees of Southern Africa*, Cape Town: Struik.

DIGITAL REFERENCES

Animal Demography Unit: FrogMAP – South African Frog Atlas Project (SAFAP) (2012): http://vmus.adu.org.za

Animal Demography Unit: ReptileMAP – South African Reptile Conservation Assessment (SARCA) (2012): http://sarca.adu.org.za

Animal Demography Unit: Southern African Butterfly Conservation Assessment (SABCA) (2012): http://sabca.adu.org.za

IUCN (2012): IUCN Red List of Threatened Species, Version 2012.2: www.iucnredlist.org

Plants of Southern Africa (POSA) (2009): http://posa.sanbi.org/searchspp.php

South African National Red List (2012): http://redlist.sanbi.org

Southern African Birding cc. (2011): Roberts VII Multimedia, Birds of Southern Africa, Computer Software.

GLOSSARY

Alien species	Plant taxa in a given area, whose presence there, is due to the intentional or accidental introduction as a result of human activity.
Biodiversity	Biodiversity is the variability among living organisms from all sources including *inter alia* terrestrial, marine and other aquatic ecosystems and ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems.
Biome	A major biotic unit consisting of plant and animal communities having similarities in form and environmental conditions, but not including the abiotic portion of the environment.
Buffer zone	A collar of land that filters edge effects.
Climax community	The presumed end point of successional sequence; a community that has reached a steady state, the most mature and fully developed vegetation that an ecosystem can achieve under the prevailing conditions. It is reached after a sequence of changes in the ecosystem, known as succession. Once climax vegetation develops, the changes are at a minimum and the vegetation is in dynamic equilibrium with its environment. Very few places show a true climax because physical environments are constantly changing so that ecosystems are always seeking to adjust to the new conditions through the process of succession.
Conservation	The management of the biosphere so that it may yield the greatest sustainable benefit to present generation while maintaining its potential to meet the needs and aspirations of future generations. The wise use of natural resources to prevent loss of ecosystems function and integrity.
Conservation concern	Plants of conservation concern are those plants that are important for South Africa's conservation decision making processes and include all plants that are Threatened (see **Threatened**), Extinct in the wild, Data deficient, **Near threatened**, Critically rare, Rare and **Declining**. These plants are nationally protected by the National Environmental Management: Biodiversity Act. Within the context of these reports, plants that are Declining are also discussed under this heading.
Conservation status	An indicator of the likelihood of that species remaining extant either in the present day or the near future. Many factors are taken into account when assessing the conservation status of a species: not simply the number remaining, but the overall increase or decrease in the population over time, breeding success rates, known threats, and so on.
Community	Assemblage of populations living in a prescribed area or physical habitat, inhabiting some common environment.
Correspondence Analysis	Correspondence Analysis simultaneously ordinates species and samples.

Critically Endangered	A taxon is Critically Endangered when it is facing an extremely high risk of extinction in the wild in the immediate future.
Data Deficient	There is inadequate information to make a direct, or indirect, assessment of its risk of extinction based on its distribution and/or population status. However, "data deficient" is therefore not a category of threat. Listing of taxa in this category indicates that more information is required and acknowledges the possibility that future research will show that threatened classification is appropriate.
Declining	A taxon is declining when it does not meet any of the five IUCN criteria and does not qualify for the categories Threatened or Near Threatened, but there are threatening processes causing a continuous decline in the population (Raimondo *et al.*, 2009).
Ecological Corridors	Corridors are roadways of natural habitat providing connectivity of various patches of native habitats along or through which faunal species may travel without any obstructions where other solutions are not feasible.
Edge effect	Inappropriate influences from surrounding activities, which physically degrade habitat, endanger resident biota and reduce the functional size of remnant fragments including, for example, the effects of invasive plant and animal species, physical damage and soil compaction caused through trampling and harvesting, abiotic habitat alterations and pollution.
Endangered	A taxon is Endangered when it is not Critically Endangered but is facing a very high risk of extinction in the wild in the near future.
Fauna	The animal life of a region.
Flora	The plant life of a region.
Forb	A herbaceous plant other than grasses.
Habitat	Type of environment in which plants and animals live.
Indigenous	Any species of plant, shrub or tree that occurs naturally in South Africa.
Invasive species	Naturalised alien plants that have the ability to reproduce, often in large numbers. Aggressive invaders can spread and invade large areas.
Least Concern	A taxon is Least Concern when it has been evaluated against five IUCN criteria and does not qualify for the Threatened or Near threatened Categories (Raimondo *et al.*, 2009).
Mitigation	The implementation of practical measures to reduce adverse impacts.
Near Threatened	A Taxon is Near Threatened when available evidence indicates that that it nearly meets any of the five IUCN criteria for Vulnerable, and is therefore likely to qualify for a threatened category in the near future (Raimondo *et al.*, 2009).

Plant community	A collection of plant species within a designated geographical unit, which forms a relatively uniform patch, distinguishable from neighbouring patches of different vegetation types. The components of each plant community are influenced by soil type, topography, climate and human disturbance.
Protected Plant	According to Provincial Nature Conservation Ordinances, no one is allowed to sell, buy, transport, or remove this plant without a permit from the responsible authority. These plants are protected by provincial legislation.
Threatened	Species that have naturally small populations and species which have been reduced to small (often unsustainable) population by man's activities.
Red Data	A list of species, fauna and flora that require environmental protection - based on the IUCN definitions. Now termed Plants of Conservation Concern.
Species diversity	A measure of the number and relative abundance of species.
Species richness	The number of species in an area or habitat.
Succession	Progressive change in the composition of a community of plants, e.g. from the initial colonisation of a bare area, or of an already established community towards a largely stable climax. The complete process of succession may take hundreds or thousands of years and entails a number of intermediate communities - each called a seral community. The replacement of one seral community by another in most cases leads to the eventual formation of a climax community, a relatively stable community of plants and animals.
Vegetation Unit	A complex of plant communities ecologically and historically (both in spatial and temporal terms) occupying habitat complexes at the landscape scale. Mucina and Rutherford (2006) state: "Our vegetation units are the obvious vegetation complexes that share some general ecological properties such as position on major ecological gradients and nutrient levels, and appear similar in vegetation structure and especially floristic composition".
Threatened	Threatened Species are those that are facing a high risk of extinction, indicated by placing in the categories Critically Endangered (CR), Endangered (E) and Vulnerable (VU) (Raimondo *et al.*, 2009).
Vulnerable	A taxon is Vulnerable when it is not Critically Endangered or Endangered but meets any of the five IUCN criteria for Vulnerable and is therefore facing a high risk of extinction in the wild in the future (Raimondo *et al.*, 2009).