FAUNAL, AVIFAUNAL, FLORAL AND WETLAND ECOLOGICAL ASSESSMENT AS PART OF THE ENVIRONMENTAL IMPACT ASSESSMENT AND AUTHORISATION PROCESS FOR THE PROPOSED SOLAR PHOTOVOLTAIC POWER PLANT WITH ASSOCIATED INFRASTRUCTURE AT THE ARNOT COAL FIRED POWER STATION, MPUMALANGA PROVINCE

Prepared for

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SECTION B

Floral Assessment

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1 INTRODUCTION

1.1 Background

Scientific Aquatic Services (SAS) was appointed to conduct a faunal, avifaunal, floral and wetland assessment as part of environmental impact assessment for the proposed solar photovoltaic power plant with associated infrastructure at the Arnot Coal Fired Power Station, Mpumalanga Province (hereafter referred to as “study area”). The study area is situated around and within the Arnot Power Station that is located in Arnot suburb in the Middelburg District in Mpumalanga.

2 GENERAL SITE SURVEY

Field assessments were undertaken during November and December 2014, in order to determine the ecological status of the study area. A reconnaissance ‘walkabout’ was initially undertaken to determine the general habitat types found throughout the study area and, following this, specific study sites were selected that were considered to be representative of the habitats found within the area, with special emphasis being placed on areas that may potentially support Red Data Listed (RDL) species. Sites were investigated on foot in order identify the occurrence of the dominant plant species and habitat diversities.

3 FLORAL ASSESSMENT METHODOLOGY

3.1 Vegetation Surveys

Vegetation surveys were undertaken by first identifying different habitat units and then analysing the floral species composition that were recorded during detailed flora assessments using the step point vegetation assessment methodology. Different transect lines were chosen within areas that were perceived to best represent the various plant communities. Floral species were recorded and a species list was compiled for each habitat unit. These species lists were also compared with the vegetation expected to be found within the relevant vegetation types as described in Section 4, which serves to provide an accurate indication of the ecological integrity and conservation value of each habitat unit (Evans & Love, 1957; Owensby, 1973).

3.2 Vegetation Index Score

The Vegetation Index Score (VIS) was designed to determine the ecological state of each habitat unit defined within an assessment site. This enables an accurate and consistent description of the PES concerning the study area in question. The information gathered during the assessment also contributes towards the sensitivity mapping, leading to a more truthful representation of ecological value and sensitive habitats.

Each defined habitat unit is assessed using separate data sheets (Appendix B) and all the information gathered then contributes to the final VIS score. The VIS is derived using the following formulas:

VIS = [(EVC) + (SI x PVC) + (RIS)]

Where:

1. **EVC** is extent of vegetation cover;
2. **SI** is structural intactness;
3. **PVC** is percentage cover of indigenous species and
4. **RIS** is recruitment of indigenous species.

Each of these contributing factors is individually calculated as discussed below. All scores and tables indicated in blue are used in the final score calculation for each contributing factor.

1. EVC=[(EVC1+EVC2)/2]

EVC 1 - Percentage natural vegetation cover						
Vegetation cover %	**0%**	**1-5%**	**6-25%**	**26-50%**	**51-75%**	**76-100%**
Site score						
EVC 1 score	0	1	2	3	4	5

EVC 2 – Total site disturbance						
Disturbance score	**0**	**Very low**	**Low**	**Moderate**	**High**	**Very high**
Site score						
EVC 2 score	5	4	3	2	1	0

2. SI=(SI1+SI2+SI3+SI4)/4)

	Trees (S1)		Shrubs (S2)		Forbs (S3)		Grasses (S4)	
Score	*Present state	**Perceived reference state	Present state	Perceived reference state	Present state	Perceived reference state	Present state	Perceived reference state
Continuous								
Clumped								
Scattered								
Sparse								

*Present State (P/S) = currently applicable for each habitat unit

**Perceived Reference State (PRS) = if in pristine condition

Each SI score is determined with reference to the following scoring table of vegetation distribution for present state versus perceived reference state.

	Present state (P/S)			
Perceived reference state (PRS)	**Continuous**	**Clumped**	**Scattered**	**Sparse**
Continuous	3	2	1	0
Clumped	2	3	2	1
Scattered	1	2	3	2
Sparse	0	1	2	3

3. ***PVC=[(EVC)-(exotic x 0.7) + (bare ground x 0.3)]***

Percentage vegetation cover (exotic)						
	0%	**1-5%**	**6-25%**	**26-50%**	**51-75%**	**76-100%**
Vegetation cover %						
PVC score	0	1	2	3	4	5
Percentage vegetation cover (bare ground)						
	0%	**1-5%**	**6-25%**	**26-50%**	**51-75%**	**76-100%**
Vegetation cover %						
PVC score	0	1	2	3	4	5

4. ***RIS***

Extent of indigenous species recruitment	**0**	**Very low**	**Low**	**Moderate**	**High**	**Very high**
RIS						
RIS Score	0	1	2	3	4	5

The final VIS scores for each habitat unit are then categorised as follows:

Vegetation Index Score	Assessment Class	Description
22 to 25	**A**	Unmodified, natural
18 to 22	**B**	Largely natural with few modifications
14 to 18	**C**	Moderately modified
10 to 14	**D**	Largely modified
5 to 10	**E**	The loss of natural habitat extensive
<5	**F**	Modified completely

3.3 Red Data Species Assessment

Prior to the field visit, a record of Red Data Listed (RDL) floral species and their habitat requirements was acquired from the South African National Biodiversity Institute (SANBI) for the Quarter Degree Squares (QDS) 2529DD (Appendix A). Throughout the floral assessment, special attention was paid to the identification of any of these RDL species as well as identification of suitable habitat that could potentially sustain these species.

The Probability of Occurrence (POC) for each floral species of concern (within the QDS 2529DD) was determined using the following calculations wherein the habitat requirements and habitat disturbance were considered. The accuracy of the calculation is based on the available knowledge about the species in question, with many of the species lacking in-depth

habitat research. Therefore, it is important that the literature available is also considered during the calculation.

Each factor contributes an equal value to the calculation.

Literature availability						
	No literature available					**Literature available**
Site score						
EVC 1 score	0	1	2	3	4	5
Habitat availability						
	No habitat available					**Habitat available**
Site score						
EVC 1 score	0	1	2	3	4	5
Habitat disturbance						
	0	**Very low**	**Low**	**Moderate**	**High**	**Very high**
Site score						
EVC 1 score	5	4	3	2	1	0

[Literature availability + Habitat availability + Habitat disturbance] / 15 x 100 = POC%

4 FLORAL DESCRIPTION

4.1 Biome and bioregion

Biomes are broad ecological units that represent major life zones extending over large natural areas (Rutherford, 1997). The study area falls within the Grassland biome (Rutherford and Westfall, 1994) (Figure 1). Biomes are further divided into bioregions, which are spatial terrestrial units possessing similar biotic and physical features, and processes at a regional scale. The study area is situated within the Mesic Highveld Grassland Bioregion (Mucina and Rutherford, 2006) (Figure 2).

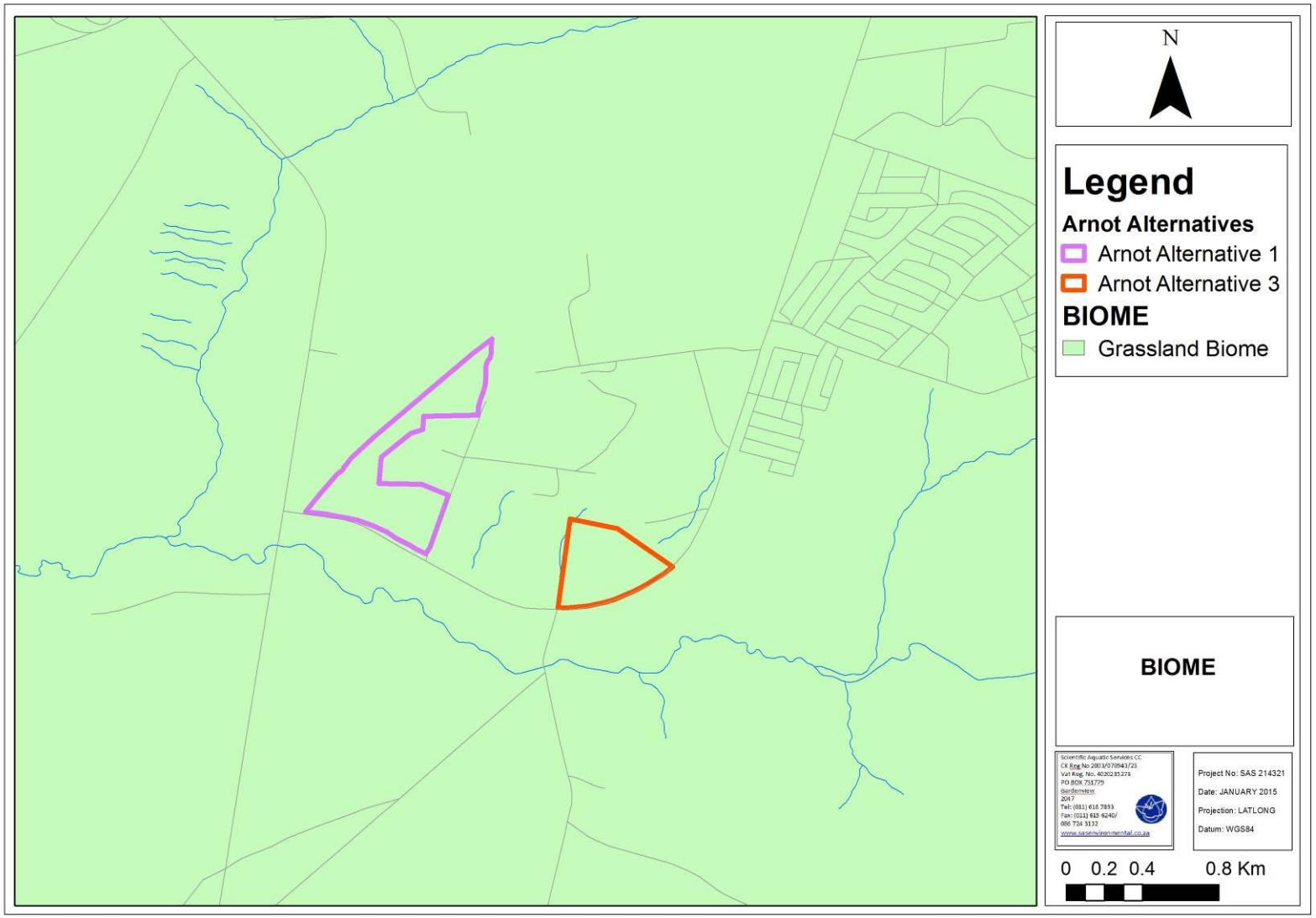

Figure 1: Biome associated with the study area (Mucina and Rutherford, 2006).

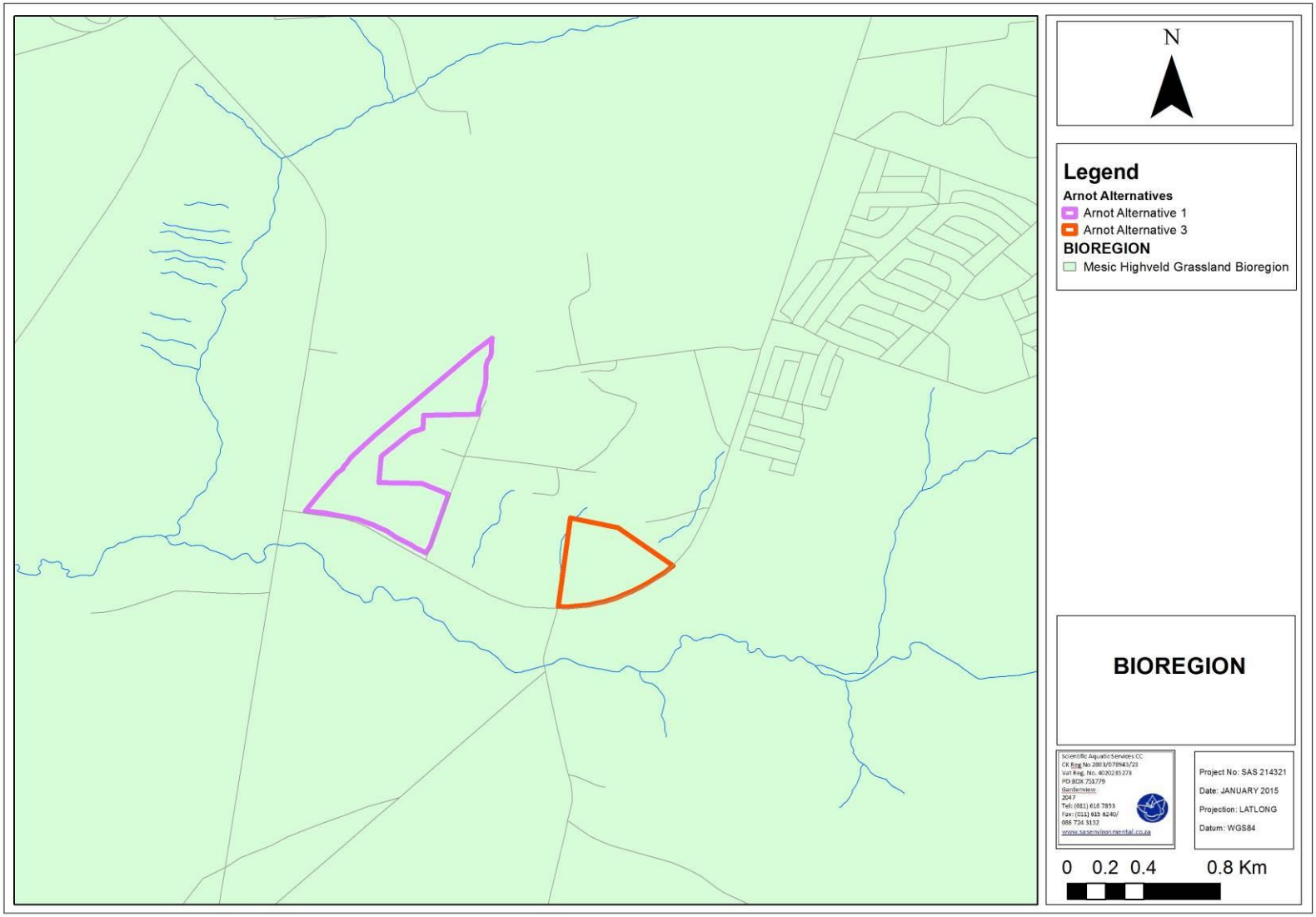

Figure 2: Bioregion associated with the study area (Mucina & Rutherford, 2006).

4.2 Vegetation Type and Landscape Characteristics

While biomes and bioregions are valuable as they describe broad ecological patterns, they provide limited information on the actual species that are expected to be found in an area. Knowing which vegetation type an area belongs to provides an indication of the floral composition that would be found if the assessment site was in a pristine condition, which can then be compared to the observed floral list and so give an accurate and timely description of the ecological integrity of the assessment site. When the boundary of the assessment site is superimposed on the vegetation types of the surrounding area (Figure 3), it is evident that the study area falls within the Eastern Highveld Grassland vegetation type (Mucina and Rutherford, 2006). The characteristics of this vegetation type are discussed below.

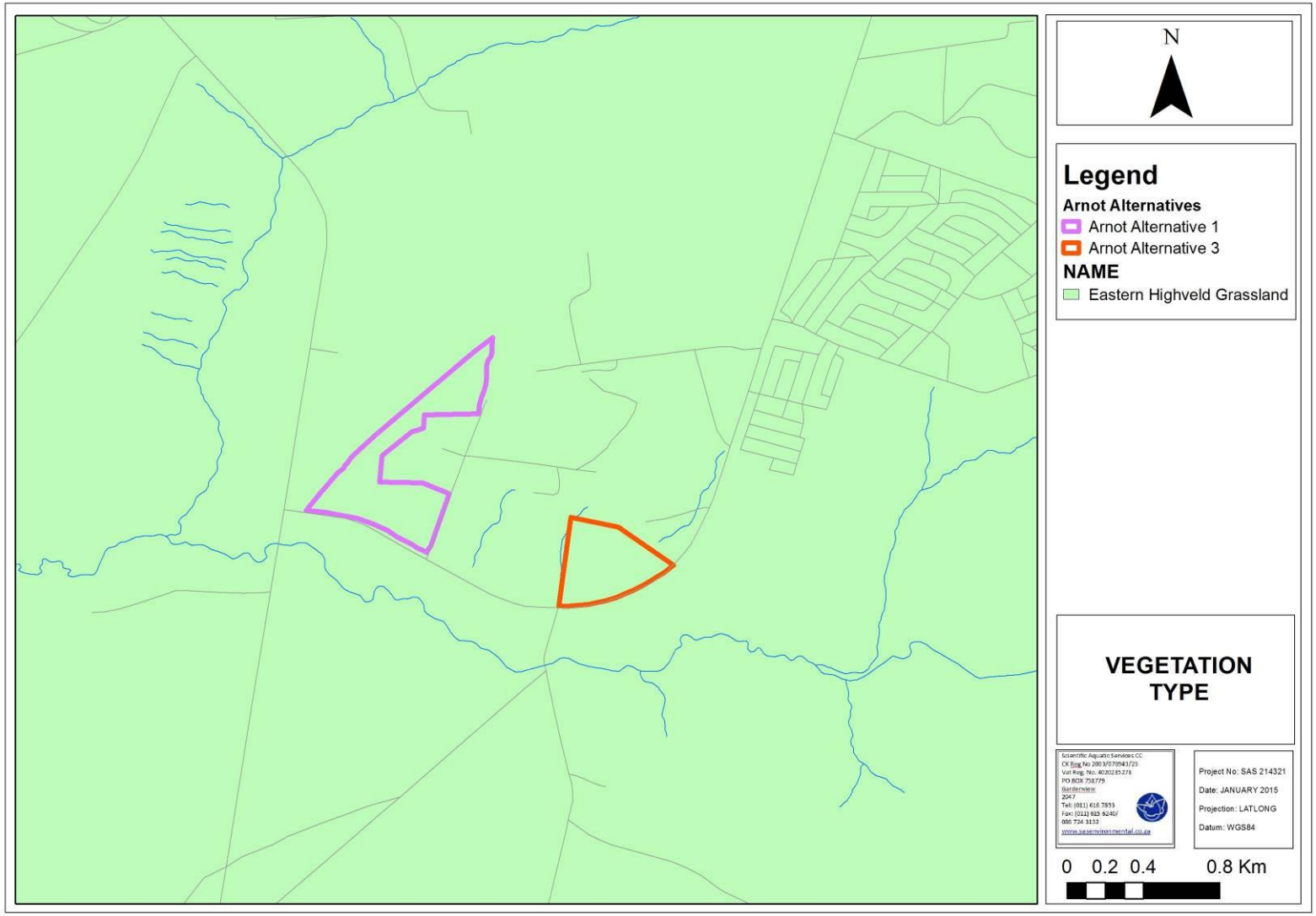

Figure 3: Vegetation types associated with the study area (Mucina and Rutherford, 2006).

4.3. Eastern Highveld Grassland

4.3.1. Distribution

Eastern Highveld Grassland occurs in the Mpumalanga and Gauteng Provinces: It occurs in the plains between Belfast in the east and the eastern side of Johannesburg in the west and extending southwards to Bethal, Ermelo and west of Piet Retief. Altitude ranges from 1520m to 1780m, but also declines as low as 1300m (Mucina & Rutherford, 2006).

4.3.2. Climate

Eastern Highveld Grassland is characterised by strongly seasonal summer rainfall, with very dry winters. The Mean Annual Precipitation (MAP) is between 650-900 mm (overall average: 726 mm), MAP is relatively uniform across most of this unit, but increases significantly in the extreme southeast. The coefficient of variation in MAP is 25% across most of the unit, but drops to 21% in the east and southeast. Incidences of frost form (13-42 days) have been recorded, but increase at higher elevations (Mucina & Rutherford, 2006).

The Mean Annual Soil Moisture Stress (MASMS) value for the region is 73%. These values, when compared to the MAT and MAPE averages of 14.7°C and 1,926mm, respectively, show the region to be a relatively water-stressed area. Conservation of surface (and ground) water resources is therefore imperative to biodiversity conservation within the region.

Table 1: General climatic information for the *Eastern Highveld Grassland* (Mucina & Rutherford, 2006).

Bioregion	Vegetation types	Altitude (m)	MAP* (mm)	MAT* (°C)	MAPE* (mm)	MASMS* (%)
Mesic Highveld Grassland	*Eastern Highveld Grassland*	1520 - 1780	726	14.7	1926	73

**MAP – Mean annual precipitation; MAT – Mean annual temperature; MAPE – Mean annual potential evaporation; MASMS – Mean annual soil moisture stress (% of days when evaporative demand was more than double the soil moisture supply).*

4.3.3. Geology and soils

The area is characterised by red to yellow sandy soils of Ba and Bb land types found on shale's and sandstones of Madzaringwe formation (Karoo Super group), which are prominent throughout the *Eastern Highveld Grassland* (Mucina & Rutherford, 2006).

4.3.4. Conservation

Eastern Highveld Grassland is considered *Endangered.* Only a very small fraction is conserved in statutory reserves (Nooitgedacht Dam and Jericho Dam Nature Reserves) and in private reserves (Holkranse, Kransbank, Morgenstond). Some 44% is transformed primarily by cultivation, plantations, mines, and urbanisation and by building of dams. Cultivation may have had a more extensive impact, indicated by land-cover data. No serious alien invasions are reported, but *Acacia mearnsii* can become dominant in disturbed areas. Erosion is very low (Mucina & Rutherford, 2006).

4.3.5 Dominant Floral Taxa

In terms of recent vegetation classifications, the assessed area occurs within the *Eastern Highveld Grassland* vegetation type (Mucina & Rutherford, 2006). This vegetation occurs in slightly too moderately undulating plains including some low hills and pan depressions. The vegetation is short dense grassland dominated by the usual Highveld grass composition (*Aristida, Digitaria, Eragrostis, Themeda, Tristachya* etc.) with small, scattered rocky outcrops with wiry, sour grasses and some woody species (*Acacia caffra, Celtis africana, Diospyros lyciodes* subsp *lyciodes, Parinari capensis, Protea caffra, P. welwitschii and Rhus magalismontanum*).

Table 2: Dominant and typical floristic species of *Eastern Highveld Grassland* (Mucina & Rutherford, 2006).

Grass species	Forb species	Tree/Shrub species
Aristida aequiglumis	*Aloe ecklonis*	*Anthospermum rigidium* subsp. *pumilum*
A. congesta	*Gladiolus crassifolius*	*Stoebe plumosa*
A. junciformis subsp. galpinii	*Haemanthus humilis subsp. hirsutus*	
Brachiaria serrata	*Hypoxis rigidula var. pilosissima*	
Cynodon dactylon	*Ledebouria ovatifolia*	
Digitaria monodactyla	*Berkheya setifera*	
D. tricholaenoides	*Haplocarpha scaposa*	
Elionurus muticus	*Justicia anagalloides*	
Eragrostis chloromelas	*Pelargonium luridum*	
E. curvula	*Acalypha angustata*	
E. plana	*Chamaecrista mimosoides*	
E. racemosa	*Dicoma anomala*	
E. sclerantha	*Euryops gilfillanii*	
Heteropogon contortus	*E. transvaalensis subsp. setilobus*	
Loudetia simplex	*Helichrysum aureonitens*	
Microchloa caffra	*H. caespititium*	
Monocymbium ceresiiforme	*H. callicomum*	
Setaria sphacelata	*H. oreophilum*	
Sporobolus africanus	*H. rugulosum*	
Sporobolus pectinatus	*Ipomoea crassipes*	
Themeda triandra	*Pentanisia prunelloides subsp. latifolia*	
Trachypogon spicatus	*Selago densiflora*	
Tristachya leucothrix		
T. rehmannii		

Grass species	Forb species	Tree/Shrub species
Alloteropsis semialata subsp. eckloniana *Andropogon appendiculatus* *A. schirensis* *Bewsia biflora* *Ctenium concinnum* *Diheteropogon amplectens* *Harpochloa falx* *Panicum natalense* *Rendlia altera* *Schizachyrium sanguineum* *Setaria nigrirostris* *Urelytrum agropyroides*	*Senecio coronatus* *Vernonia oligocephala* *Wahlenbergia undulata.*	

5 RESULTS OF FLORAL INVESTIGATION

The vegetation assessment was performed within the study area. As the floral characteristics of all alternatives were similar, the floral ecology of the alternatives is discussed together. Two main habitat units/vegetation types were identified during the assessment, which are defined below:

- Habitat considered to be transformed due to agricultural activities and alien/weed encroachment; and
- Wetland habitat.

The following sections describe the habitat units in more detail.

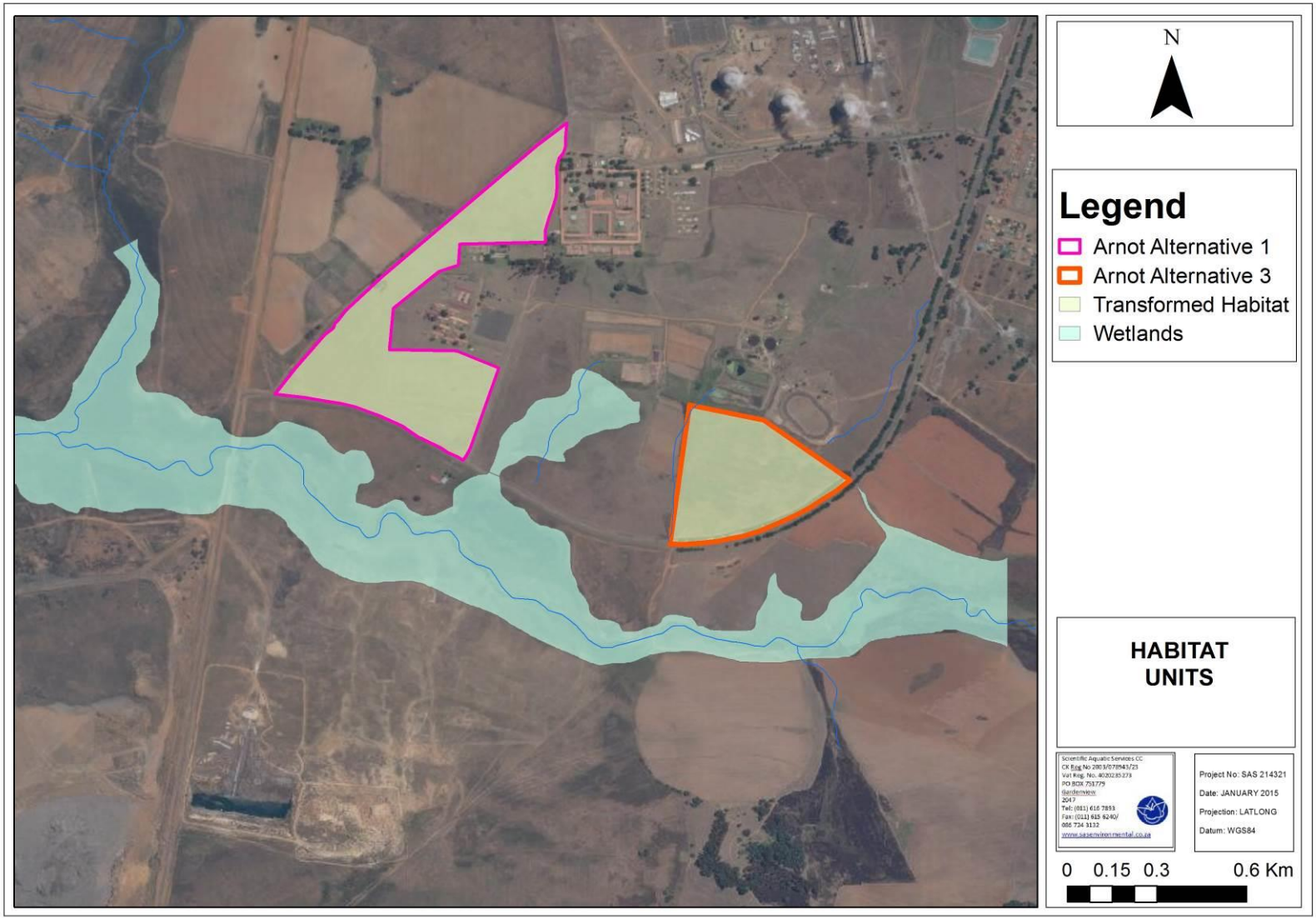

Figure 4: Habitat units identified within the study area.

5.1 Habitat Unit 1: Transformed Habitat Unit

The transformed habitat unit comprises areas where historical agricultural activities have occurred and where vegetation has been cleared/mowed as part of maintenance activities around the powerstation. Additional vegetation transformation has also taken place due to the establishment of alien and invasive floral communities, and overgrazing. This habitat unit covers the majority of the study area.

Figure 5: Representative photographs of the transformed habitat unit.

This habitat unit has been transformed by edge effects associated with historic agricultural activities, alien floral invasion and edge effects from roads and powerstation infrastructure, vegetation clearing and woody encroachment by *Seriphium plumosum*. This has led to the alteration of the floral community structure and the establishment of a sub-climax grass community. Ecological functioning, although not completely absent, was found to be low in most areas. Dominant grass species included *Hyparrhenia hirta, Eragrostis curvula* and *E. chloromelas*. These species are associated with transformation and usually grow in disturbed places such as old cultivated lands and along roadsides. Additionally, these areas have a significant build-up of moribund material due to the natural burning regime being altered, which significantly reduces forb diversity.

The likelihood of floral SCC occurring within this habitat unit is considered to be low, and none were encountered. Furthermore, the ecological functionality and habitat integrity of the transformed habitat unit is regarded as being moderate to low, and development within this habitat unit is supported. However, edge effects from any activities occurring in this habitat

unit must be effectively mitigated in order to prevent adverse impacts on the surrounding wetland habitat unit.

Table 3: Dominant species encountered in the transformed habitat unit. Alien species are indicated with an asterisk.

Grass/sedge/reed species	Forb species	Tree/Shrub Species
Aristida bipartata	*Acalypha angustata*	*Seriphium plumosum*
Aristida congesta subsp. barbicollis	**Tagetes minuta*	**Acacia mearnsii*
Aristida congesta subsp. congesta	*Berkheya radula*	
Cynodon dactylon	**Bidens pilosa*	
Digitaria tricholaenoides	**Bidens formosa*	
Eragrostis curvula	**Plantago lanceolata*	
Eragrostis chloromelas	*Pelargonium luridum*	
Hyparrhenia hirta	*Helichrysum kraussii*	
Themeda triandra	*Monopsis decipiens*	
Tristachya leucothrix	*Senecio coronatus*	
Pogonarthria squarrosa	*Hypoxis angustifolia*	
Imperata cylindrica	*Hypoxis acuminata*	
	**Taraxacum officinale*	
	Ledebouria cooperii	
	Ledebouria ovatifolia	

5.2 Habitat Unit 2: Wetland Habitat Unit

Several wetland features were identified around the proposed alternative footprint areas. However, no natural wetlands were encountered within the footprint areas of any of the alternative footprints.

All of the natural wetlands have been affected to varying degrees by edge effects from the powerstation, road construction, historic agriculture and general anthropogenic activities, which has negatively affected the habitat integrity of these systems.

Figure 6: Typical view of the wetland habitat unit

Table 4: Dominant species encountered in the wetland habitat unit, invader species are marked with an asterisk (*)

Terrestrial zone	Temporary / Seasonal Zone	Permanent Zone
Hyparrhenia hirta	**Verbena bonariensis*	*Mariscus congestus*
Eragrostis curvula	*Sporobolus africanus*	*Imperata cylindrica*
Eragrostis chloromelas	*Juncus effusus*	*Kylinga alba*
Harpochloa falx	*Schoenoplectus corymbosus*	*Cyperus rupestris*
**Asclepias fruticosa*	*Imperata cylindrica*	*Typha capensis*
Cymbopogon plurinodis	*Helichrysum* species	*Juncus effusus*
**Cosmos bipinnata*	*Habenaria nyikana*	*Schoenoplectus corymbosus*
**Conyza bonariensis*	*Eragrostis plana*	*Phragmites australis*
Eragrostis plana		*Leersia hexandra*

Dominant floral species within the wetlands include *Typha capensis, Juncus effusus, Cyperus rupestris, Leersia hexandra, Imperata cylindrica, Eragrostis plana, Schoenoplectus paludicola, Hyparrhenia tamba* and *Persicaria lapathifolia*. The majority of the wetland areas were still connected to wetland resources adjacent to the study area, and as such provide migratory corridors for faunal species in an area which is extensively transformed by agriculture.

The wetlands are considered to be in a moderately modified state, and a moderate change in ecosystem processes and loss of natural habitats has taken place, but the natural habitat

remains predominantly intact. Therefore, although some wetland areas are more transformed than others, the wetland habitat unit as a whole is considered to be of increased conservational importance from a floral perspective in relation to the surrounding terrestrial areas.

Thus, where any activities or edge effects associated with the proposed project or infrastructure are likely to affect wetlands, it must be ensured that the disturbance footprint is minimised and that the duration of disturbance is limited. Connectivity of the wetland features in the systems need to be maintained in order to ensure linear protection of water quality within these systems as well as ensuring the continuity of the habitats and resources.

5.3 Vegetation Index Score

The information gathered during the assessment of the study area was used to determine the Vegetation Index Score (VIS) - see Appendix B for calculations. Due to variation between the different habitat units within each site, all habitat units were assessed separately. The table below lists the results of each habitat unit.

Table 5: Scoring for the Vegetation Index Score

Vegetation Index Score	Assessment Class	Description
22 to 25	**A**	Unmodified, natural
18 to 22	**B**	Largely natural with few modifications.
14 to 18	**C**	Moderately modified
10 to 14	**D**	Largely modified
5 to 10	**E**	The extensive loss of natural habitat
<5	**F**	Modified completely

Table 6: Vegetation Index Score for each habitat unit assessed

Habitat unit	Score	Class	Motivation
Transformed habitat	13	**D – Largely modified**	Transformation has occurred within this habitat unit to the degree that secondary grassland conditions prevail and alien and invader species abundance is high. Therefore, this habitat unit is classified as largely modified.
Wetland habitat	15	**C – Moderately modified**	Transformation of the wetland systems include draining of wetlands for agriculture, erosion, vegetation transformation and sedimentation. The wetland systems have an important ecological function in terms of habitat provision for faunal and floral species.

5.4 Floral SCC Assessments

An assessment considering the presence of any plant species of concern, as well as suitable habitat to support any such species was undertaken. The complete PRECIS (Pretoria Computer Information Systems) red data plant lists for the grid reference 2529DD was acquired from SANBI (South African National Biodiversity Institute).

The PRECIS plant list for the grid reference (2529DD) indicated that no RDL or floral SCC occur in this grid. Past disturbance such as crop cultivation activities and overgrazing in the area have led to degradation in overall natural habitat throughout most of the study area. No floral SCC were encountered. However, the most likely habitat for any floral SCC, should they be present, will be the wetlands. Thus by conserving the wetland areas, possible habitat for floral SCC will also be conserved.

5.5 Alien and Invasive Floral Species

Alien invaders are plants that are of exotic origin and are invading previously pristine areas or ecological niches (Bromilow, 2001). Not all weeds are exotic in origin but, as these exotic plant species have very limited natural “check” mechanisms within the natural environment, they are often the most opportunistic and aggressively growing species within the ecosystem. Therefore, they are often the most dominant and noticeable within an area. Disturbances of the ground through trampling, excavations or landscaping often leads to the dominance of exotic pioneer species that rapidly dominate the area. Under natural conditions, these pioneer species are overtaken by sub-climax and climax species through natural veld succession. This process however takes many years to occur, with the natural vegetation never reaching the balanced, pristine species composition prior to the disturbance. There are many species of indigenous pioneer plants, but very few indigenous species can out-compete their more aggressively growing exotic counterparts.

Alien vegetation invasion causes degradation of the ecological integrity of an area, causing (Bromilow, 2001):

- A decline in species diversity;
- Local extinction of indigenous species;
- Ecological imbalance;
- Decreased productivity of grazing pastures and
- Increased agricultural input costs.

Table 7: Exotic or invasive identified or from literature? species within the study area.

Species	English name	Type or Origin	Category*
	Tress/ shrubs		
Salix babylonica	Weeping willow	Invader	2
Acacia mearnsii	Black wattle	Native to Australia	2
Eucalyptus camuldulensis	Red river gum	Invader	2
Melia azederach	Syringa	Native to India	3
	Forbs		
Bidens pilosa	Common blackjack	Native to S America	NA
Bidens formosa	Cosmos	Native to Central America	NA
Rumex acetosella	Sheep sorrel	Native to Europe	NA
Conyza albida	Tall fleabane	Native to America	NA
Conyza Canadensis	Horseweed fleabane	Native to America	NA
Datura stramonium	Common thornapple	Native to N America	1
Schkuhria pinnata	Dwarf marigold	Native to S America	NA
Tagetes minuta	Tall khakiweed	Native to S America	NA
Verbena bonariensis	Purple top	Native to S America	NA
Trifolium repens	White clover	Native to Europe	NA
Solanum elaeagnifolium	Silverleaf bitter apple	Native to America	1
Solanum sisymbrifolium	Dense thorned bitter apple	Weed	1
Hibiscus trionum	Wild stockrose	Native to Asia	NA
Datura ferox	Large thorn apple	Native to N America	1
Bidens formosa	Cosmos	Native to Central America	NA
Asclepias fruticosa	Shrubby milkweed	Weed	Na
	Reeds/Grasses		
Cyperus esculentis	Yellow nut sedge	Unknown origin	
Bromus catharticus	Rescue grass	Native to S. America	

Category 1 – Declared weeds. Prohibited plants, which must be controlled or eradicated.

Category 2 – Declared invader plants with a value. "Invaders" with certain useful qualities (i.e. commercial). Only allowed in controlled, demarcated areas.

Category 3 – Mostly ornamental plants. Alien plants presently growing in, or having escaped from, areas such as gardens, but are proven invaders. No further planting or trade in propagative material is allowed (Bromilow, 2001).

From the table above it is clear that a moderate to high diversity of alien species occurs within the study area, especially within the transformed areas. Alien species located on the study area need to be removed on a regular basis as part of maintenance activities according to the Conservation of Agricultural Resources Act (Act No. 43 of 1983) (CARA).

5.6 Medicinal Plant Species

Medicinal plant species are not necessarily indigenous species, with many of them regarded as alien invasive weeds. The medicinal species are all commonly occurring species and are not confined to the study area.

The table below presents a list of plant species with traditional medicinal value, plant parts traditionally used and their main applications, which were identified during the field assessment. All of the medicinal species identified are considered to be common and widespread species and were not confined to any specific habitat unit. Therefore, the proposed development is not likely to have a significant impact on medicinal flora species conservation.

Table 8: Traditional medicinal plants identified during the field assessment. Medicinal applications and application methods are also presented (van Wyk, et al., 1997; van Wyk and Gericke, 2000; van Wyk and Wink, 2004; van Wyk, Oudtshoorn, Gericke, 2009).

Species	Name	Plant parts used	Medicinal uses
Gnidia kraussiana	Yellow head	Rootstock and roots	There are many medicinal uses for this highly toxic plant, ranging from the topical treatment of burns and snake bites to enemas for stomach complains and decoctions used to ensure and easy childbirth
Helichrysum nudifolium	Everlasting	Leaves and twigs	Mainly ailments are treated, including coughs, cold, fever, infections, headache and menstrual pains. It is a popular ingredient for wound dressing.
Vernonia oligocephala	Bitterbossie	Leaves and twigs	Abdominal pain and colic. Rheumatism, dysentery, and diabetes.
Asclepias fruticosa	Milkweed	Mainly leaves, sometimes roots.	Snuff is prepared from ground leaves and used for treatment of headaches, tuberculosis and a general emetic to strengthen body.
Datura stramonium	Thornapple	Leaves and rarely the green fruit.	Generally as asthma treatment and pain reduction.
Leonotis microphylla	Wild dagga	Leaves and stems, sometimes roots.	Dried parts smoked for relief of epilepsy. Leaves and roots widely used for a remedy for snake bite and other stings and bites. External decoctions used as a treatment for boils, eczema, skin diseases, itching and muscular cramps. Internal decoctions used for coughs, colds and influenza, bronchitis, high blood pressure and headaches. Leaf infusions have been used for asthma and viral hepatitis.
Plantago lanceolata	Ribwort plantain	Leaves	Anti-inflammatory and expectorant. Used to treat wounds, inflammation of skin and against catarrhs of the respiratory tract and inflammation of mouth and throat.
Conyza canadensis	Horseweed fleabane	Herb	Astringent, diarrhoea, diuretic, colds, insect repellent

6 SENSITIVITY MAPPING

The figure below conceptually illustrates the areas considered to be of increased ecological sensitivity in relation to the proposed project. The areas are depicted according to their sensitivity in terms of faunal and floral habitat integrity and their suitability to provide habitat to faunal and floral communities. The wetlands are considered to be sensitive, as they provide faunal and floral habitat in an area characterised by transformation due to agriculture and also provide migratory corridors for faunal species. The National Environmental Management Act (Act 107 of 1998) stipulates that no activity can take place within 32m of a wetland without the relevant authorisation. In addition, the National Water Act (Act 36 of 1998) states that no diversion, alteration of bed and banks or impeding of flow in watercourses (which includes wetlands) may occur without obtaining a water use licence authorising the proponent to do so. Furthermore, General Notice (GN) 1199 as published in the Government Gazette 32805 of 2009 as it relates to the NWA, 1998 (Act 36 of 1998) states that any activities occurring within 500m of watercourses must be authorised by the DWS.

After consideration of findings during the wetland assessment, a suitable buffer zone was considered for the proposed development. A 32m buffer was prescribed and all non-essential activities should be situated outside of wetland areas and the development footprint and activity footprint in the wetland and associated buffer should be prevented as far as possible. This buffer zone is deemed sufficient to maintain the Present Ecological State, limit any further impact that the proposed development could have and ultimately support the REC. A 500m buffer around the wetlands is also indicated in the figure below in terms of GN1199.

The transformed habitat unit is considered to be of low ecological sensitivity, and any activities situated in these areas, provided that they are implemented responsibly and the mitigation measures contained in this report are adhered to, are expected to have an insignificant impact on the receiving environment.

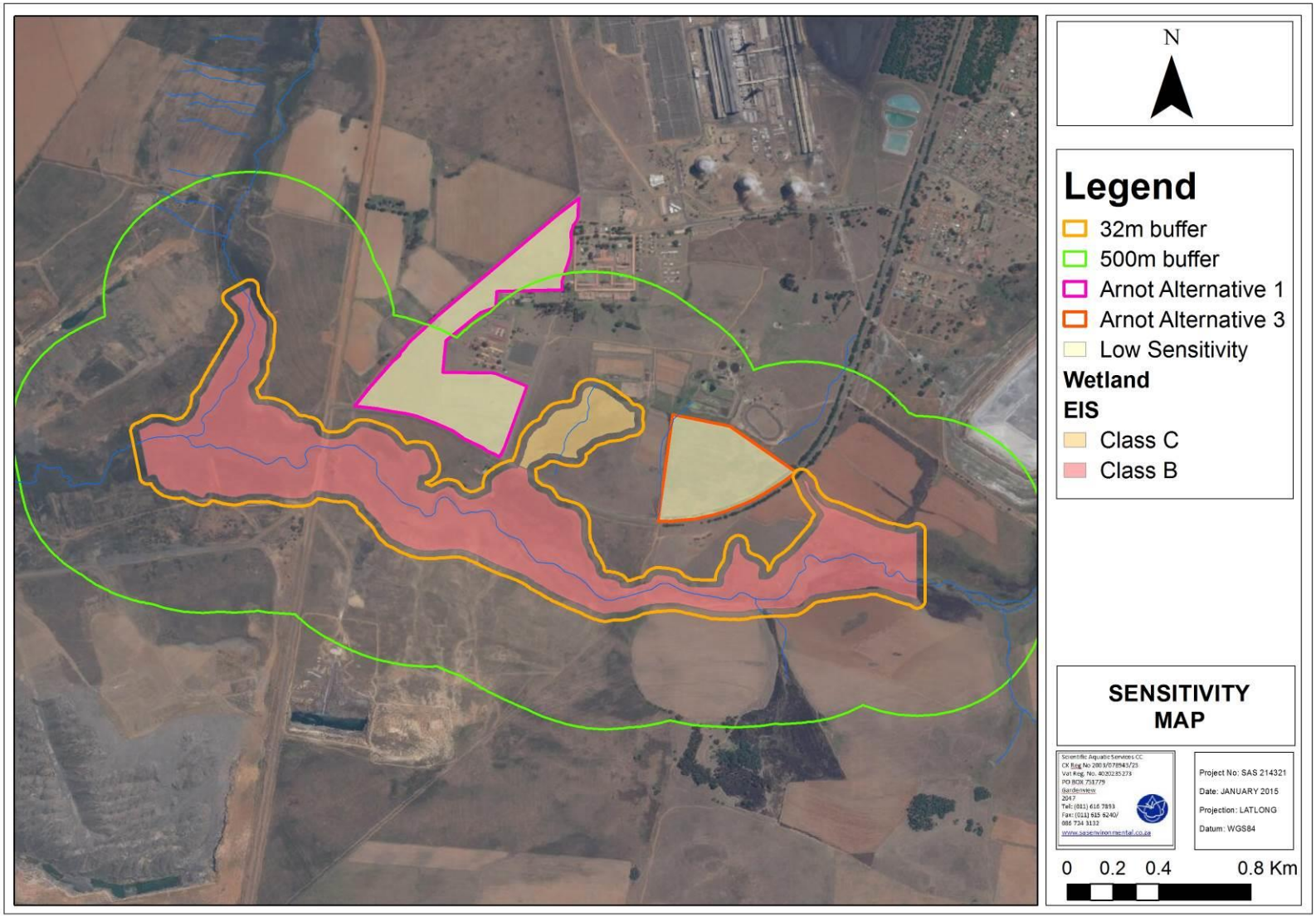

Figure 7: Sensitivity Map for the study area.

7 IMPACT ASSESSMENT

The tables below serve to summarise the significance of potential impacts on floral species and habitat that may result due to the proposed activities. A summary of all potential pre-construction, construction, operational and decommissioning and closure phase impacts is provided after the impact discussion. The sections below present the impact assessment according to the method described in Section A.

In addition, it also indicates the required mitigatory and management measures needed to minimise potential ecological impacts and presents an assessment of the significance of the impacts taking into consideration the available mitigatory measures, assuming that they are fully implemented.

Latent and general everyday impacts which may impact on the floral ecosystem will include any activities which take place within the study area that may impact on the receiving environment. These impacts are highlighted below and are relevant for all sensitive floral related areas identified in this report:

- Appropriate sanitary facilities must be provided for the construction phase and all waste removed to an appropriate waste facility.
- All soils compacted as a result of construction activities falling outside of the project footprint areas should be ripped and profiled. Special attention should be paid to alien and invasive control within these areas. Alien and invasive vegetation control should take place throughout all phases to prevent loss of floral habitat.
- To prevent the erosion of top soils, management measures may include berms, soil traps, hessian curtains and storm water diversion away from areas susceptible to erosion. It must be ensured that topsoil stockpiles are located outside of any drainage lines and areas susceptible to erosion. Stockpiles should be placed away from areas known to contain hazardous substances such as fuel and if any soils are contaminated, it should be stripped and disposed of at a registered hazardous waste dumping site.
- All areas of disturbed and compacted soils need to be ripped and reprofiled.
- No dumping of waste should take place. If any spills occur, they should be immediately cleaned up.
- In the event of a breakdown, maintenance of vehicles must take place with care and the recollection of spillage should be practiced to prevent the ingress of hydrocarbons into the topsoil.

- It must be ensured that all roads and construction areas are regularly sprayed with water in order to curb dust generation. This is particularly necessary during the dry season when increased levels of dust generation can be expected. These areas should not be over-sprayed causing water run-off and subsequent sediment loss in the vicinity of the study area.
- Ensure that all hazardous storage containers and storage areas comply with the relevant SABS standards to prevent leakage. Regularly inspect all vehicles for leaks. Re-fuelling must take place on a sealed surface area to prevent ingress of hydrocarbons into topsoil.

7.1 Impact 1: Impact on Habitat for Floral Species

Activities and aspect registry

Pre-Construction	Construction	Operational
Poor planning of infrastructure placement and design	Site clearing and the removal of vegetation	On-going disturbance of soils due to general operational activities leading to altered floral habitat
Inadequate design of infrastructure	Loss of floral biodiversity through invasion of alien species	Increased introduction and proliferation of alien plant species and further transformation of natural habitat
	Erosion as a result of infrastructure development and storm water runoff	Maintenance activities such as vegetation clearing resulting in ongoing impact on floral habitat.
	Movement of construction vehicles and access road construction	
	Dumping of material outside designated areas leading to loss of floral habitat	
	Compaction of soils reducing floral re-establishment	

Placement of infrastructure within the wetland habitat will result in permanent removal of vegetation considered to be of increased ecological importance and sensitivity. Although the vegetation within this habitat unit has been disturbed as a result of surrounding agricultural activities and grazing of livestock, these areas still provide habitat to support a high diversity of indigenous floral species. Development or placement of infrastructure within the wetland habitat will result in permanent removal of indigenous vegetation and will result in a low to medium-low impact significance.

The transformed habitat unit has been significantly disturbed as a result of historic and on-going agricultural activities and overgrazing of veld. The floral habitat within this habitat unit is therefore largely transformed and placement of infrastructure within this habitat unit will most likely have a low impact significance.

As the proposed infrastructure is situated outside of any wetland areas, any significant impacts are unlikely, and with implementation of mitigation measures the impact significance may be reduced to low levels.

Unmanaged	Probability of Impact	Sensitivity of receiving environment	Severity	Spatial scale	Duration of impact	Likelihood	Consequence	Significance
Construction phase	2	3	3	3	4	5	10	50 (Low)
Operational phase	2	3	3	3	4	5	10	50 (Low)

Essential construction phase mitigation measures:

- Keep the proposed infrastructure within designated low sensitivity areas as far as possible.
- If possible, avoid placement of infrastructure in the sensitive wetland habitat units.
- Restrict vehicles to travelling only on designated roadways to limit the ecological footprint of the proposed development activities.
- All soils compacted as a result of construction activities falling outside of the development footprint areas should be ripped and profiled.

Recommended construction phase mitigation measures:

- During the construction phases erosion berms should be installed to prevent gully formation and siltation of the wetland resources. The following points should serve to guide the placement of erosion berms:
    - Where the track has a slope of less than 2%, berms every 50m should be installed;
    - Where the track slopes between 2% and 10%, berms every 25m should be installed;
    - Where the track slopes between 10%-15%, berms every 20m should be installed; and
    - Where the track has a slope greater than 15%, berms every 10m should be installed.
- Ensure that the proposed development footprint areas remain as small as possible

Essential operation phase mitigation measures:

- Ensure that operational activities are kept strictly within the development footprint.
- Alien and invasive vegetation control should take place throughout the operational phase of the development.
- In the event of a breakdown, maintenance of vehicles must take place with care and the recollection of spillage should be practiced to prevent the ingress of hydrocarbons into the topsoil.
- Restrict vehicles to travelling only on designated roadways to limit the ecological footprint of the proposed development activities.

Recommended operational phase mitigation measures:

- N/A

Managed	Probability of Impact	Sensitivity of receiving environment	Severity	Spatial scale	Duration of impact	Likelihood	Consequence	Significance
Construction phase	1	3	2	2	3	4	7	28 (Low)
Operational phase	1	3	2	3	3	4	8	32 (Low)

Probable latent impacts

- Loss of floral habitat may lead to altered floral biodiversity.
- Ineffective rehabilitation may lead to permanent transformation of floral habitat and species composition.

7.2 Impact 2: Impact on Floral Diversity

Activities and aspects registry

Pre-Construction	Construction	Operational
Poor planning of infrastructure placement and design	Site clearance and removal of vegetation	An increase in alien plant species leading to altered plant community structure and composition
	Construction of infrastructure and access roads through natural areas leading to a loss of plant species diversity	Erosion and sedimentation as a result of operational activities leading to a loss of floral species diversity
	Increased fire frequency and intensity, as well as uncontrolled fires due to increased human activity may impact on plant communities	Maintenance activities such as vegetation clearing resulting in ongoing impact on floral diversity
	Increased anthropogenic activity and an increase in the collection of medicinal floral species	

Floral diversity within both habitat units has been decreased as a result of historic and on-going disturbances. The species diversity is however higher within the wetland areas than that associated with the transformed habitat unit. The impact significance associated with the loss of species diversity is considered to be low to medium low prior to the implementation of mitigation measures.

As the proposed infrastructure is situated outside of any wetland areas, any significant impacts are unlikely, and with implementation of mitigation measures the impact significance may be reduced to low levels.

Unmanaged	Probability of Impact	Sensitivity of receiving environment	Severity	Spatial scale	Duration of impact	Likelihood	Consequence	Significance
Construction phase	2	3	3	3	4	5	10	50 (Low)
Operational phase	2	3	3	3	4	5	10	50 (Low)

Essential construction mitigation measures:

- Keep the proposed infrastructure within designated low sensitivity areas as far as possible.
- Planning of temporary roads and access routes should take the site sensitivity plan into consideration. If possible, such roads should be constructed a distance from the more sensitive wetland areas and not directly adjacent thereto.
- Prohibit the collection of plant material for firewood or for medicinal purposes.
- Species specific and area specific eradication recommendations:
    - Care should be taken with the choice of herbicide to ensure that no additional impact and loss of indigenous plant species occurs due to the herbicide used;
    - Footprint areas should be kept as small as possible when removing alien plant species; and
    - No vehicles should be allowed to drive through designated sensitive wetland areas during the eradication of alien and weed species.

Recommended construction mitigation measures:

- N/A

Essential operation mitigation measures:

- An alien vegetation control plan has to be implemented in order to manage alien plant species occurring within the study area.
- Removal of the alien and weed species encountered within the operational footprint area must take place in order to comply with existing legislation (amendments to the regulations under the Conservation of Agricultural Resources Act, 1983 and Section 28 of the National Environmental Management Act, 1998). Removal of species should take place throughout the operational phase.
- Restrict vehicles to travelling only on designated roadways to limit the ecological footprint of the proposed development activities.
- To prevent the erosion of top soils, management measures may include berms, soil traps, hessian curtains and storm water diversion away from areas susceptible to erosion. It must be ensured that topsoil stockpiles are located outside of any drainage lines and areas susceptible to erosion. Stockpiles should be placed away from areas known to contain hazardous substances such as fuel and if any soils are contaminated, it should be stripped and disposed of at a registered hazardous waste dumping site.

Recommended operational mitigation measures:

- Prohibit the collection of plant material for firewood or for medicinal purposes.

Managed	Probability of Impact	Sensitivity of receiving environment	Severity	Spatial scale	Duration of impact	Likelihood	Consequence	Significance
Construction phase	1	3	2	2	2	4	6	24 (Very Low)
Operational phase	1	3	2	2	3	4	7	28 (Low)

Probable latent impacts

- Permanent loss of floral diversity within areas where construction has taken place.
- Alien and invasive species proliferation and bush encroachment into disturbed areas.
- Ineffective rehabilitation may lead to permanent loss of floral biodiversity.

7.3 Impact 3: Impact on Important Species

Activities and aspects registry

Pre-Construction	Construction	Operational
Poor planning of infrastructure placement and design	Site clearance and removal of important/ indigenous vegetation within wetland habitat	An increase in alien plant species leading to loss of medicinal plant species by outcompeting these species
	Construction of infrastructure and access roads through natural areas	Collection of medicinal floral species
	Increased anthropogenic activity and an increase in the collection of plant material for medicinal purposes	Maintenance activities such as vegetation clearing resulting in ongoing impact on floral SCC
	Increased fire frequency and intensity, as well as uncontrolled fires due to increased human activity may impact on plant communities	

No floral SCC were recorded nor are any likely to occur within the study area. However, the most likely habitat for any floral SCC, should they be present, will be the wetlands. Thus by conserving the wetland areas, possible habitat for floral SCC will also be conserved. The impact on floral SCC is considered to be of low significance prior to the implementation of mitigation measures. As the proposed infrastructure is situated outside of any wetland areas, any significant impacts are unlikely, and with implementation of mitigation measures the impact significance may be reduced to low levels.

Unmanaged	Probability of Impact	Sensitivity of receiving environment	Severity	Spatial scale	Duration of impact	Likelihood	Consequence	Significance
Construction phase	2	3	3	3	4	5	10	50 (Low)
Operational phase	2	3	3	3	4	5	10	50 (Low)

Essential construction mitigation measures:

- If possible, avoid placement of infrastructure in the wetland habitat unit.
- Prohibit the collection of plant material for medicinal purposes.
- The existing integrity of flora surrounding the proposed footprint areas should be upheld and no activities be carried out outside the footprint of the construction areas.
- Edge effect control needs to be implemented to ensure no further degradation outside of the proposed footprint area.

Recommended construction mitigation measures:

- Should any floral SCC or other protected plant species be encountered within the study area in the future, the following should be ensured:
    - If any threatened species will be disturbed, ensure effective relocation of individuals to suitable offset areas; and
    - All rescue and relocation plans should be overseen by a suitably qualified specialist.

Essential operational phase mitigation measures:

- Ensure that operational related activities are kept strictly within the development footprint.
- Restrict vehicles to travelling only on designated roadways to limit the ecological footprint of the proposed development activities.
- Prohibit the collection of plant material for medicinal purposes.

Recommended operational mitigation measures:

- N/A

Managed	Probability of Impact	Sensitivity of receiving environment	Severity	Spatial scale	Duration of impact	Likelihood	Consequence	Significance
Construction phase	1	3	2	2	3	4	7	28 (Low)
Operational phase	1	3	2	2	4	4	8	32 (Low)

Probable latent impacts

- A decrease in medicinal floral species diversity may lead to a loss of species richness over time within the region.

7.4 Impact Assessment Conclusion

Based on the above assessment it is evident that there are three possible impacts which may affect the floral ecology within the study area. The tables below summarise the findings indicating the significance of the impacts before mitigation takes place as well as the significance of the impacts if appropriate management and mitigation takes place. Table 9 presents the summary for the construction phase of the project and Table 10 present the summary for the operational phase impacts.

As the proposed infrastructure is situated outside of any wetland areas, any significant impacts are unlikely, and the spatial scale is anticipated to be small. This lowers the impact significance throughput all phases. However, mitigation measures must still be responsibly implemented in order to further minimise the anticipated impact.

Table 9: A summary of the impact significance of the construction phase.

Impact	Unmanaged	Managed
1: Impact on habitat for floral species	Low	Low
2: Impact on floral diversity	Low	Low
3: Impact on important species	Medium-Low	Low

Table 10: A summary of the impact significance of the operational phase.

Impact	Unmanaged	Managed
1: Impact on habitat for floral species	Low	Very Low
2: Impact on floral diversity	Low	Low
3: Impact on important species	Medium-Low	Low

8 RECOMMENDATIONS

After the conclusion of this assessment, it is the opinion of the ecologists that the proposed activities on the study area be considered favourably, provided that the recommendations below are adhered to:

Development footprint

- A sensitivity map has been developed for the study area, indicating wetlands and an associated 32m buffer zone, which are considered to be of increased ecological importance. It is recommended that this sensitivity map be considered during all development phases to aid in the conservation of floral habitat within the study area.
- No activities are to infringe upon these sensitive areas or associated buffer zones.
- In this regard, Alternative 1 is recommended as the preferred alternative from an ecological perspective.
- All development footprint areas should remain as small as possible.
- All areas of increased ecological sensitivity should be designated as No-Go areas and be off limits to all unauthorised vehicles and personnel. Vehicles should be restricted to travelling only on designated roadways to limit the ecological footprint of the proposed development activities.
- It must be ensured that waste or spillage and effluent do not affect the sensitive habitat boundaries and associated buffer zones.

Alien floral species

- Removal of the alien and weed species encountered on the property must take place in order to comply with existing legislation (amendments to the regulations under the Conservation of Agricultural Resources Act, 1983 and Section 28 of the National Environmental Management Act, 1998). Removal of species should take place throughout the construction and operational phases.
- Species specific and area specific eradication recommendations:
    - Care should be taken with the choice of herbicide to ensure that no additional impact and loss of indigenous plant species occurs due to the herbicide used.
    - Footprint areas should be kept as small as possible when removing alien plant species.
    - No vehicles should be allowed to drive through designated sensitive wetland areas during the eradication of alien and weed species.

Soils

- It must be ensured that the pollution control system is managed in such a way as to prevent discharge to the receiving environment.

Rehabilitation

- All disturbed habitat areas must be rehabilitated as soon as possible to ensure that floral ecology is re-instated.
- Reseeding with indigenous grasses should be implemented in all affected areas and strategic planting of grassland species should take place to re-establish microclimates and niche habitats.

Fires

- Informal fires should be prohibited during all development phases.

Floral SCC

- Sensitive floral species, if encountered, must be rescued and relocated and are to be handled with care and the relocation of sensitive plant species is to be overseen by a botanist.
- Should any floral SCC be encountered within the proposed development footprint areas, the following should be ensured:
    - If any threatened species, or nationally or provincially protected floral will be disturbed, ensure effective relocation of individuals to suitable similar habitat.
    - All rescue and relocation plans should be overseen by a suitably qualified specialist.

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APPENDIX A

Expected floral species list for QDS 2529DD

(CAN BE PROVIDED UPON REQUEST)

APPENDIX B

Vegetation Index Score

Vegetation Index Score –Transformed

1. *EVC=[(EVC1+EVC2)/2]*

EVC 1 - Percentage natural vegetation cover:

Vegetation cover %	0%	1-5%	6-25%	26-50%	51-75%	76-100%
Site score					X	
EVC 1 score	0	1	2	3	4	5

EVC2 - Total site disturbance score:

Disturbance score	0	Very Low	Low	Moderately	High	Very High
Site score					X	
EVC 2 score	5	4	3	2	1	0

2. *SI=(SI1+SI2+SI3+SI4)/4)*

	Trees (SI1)		Shrubs (SI2)		Forbs (SI3)		Grasses (SI4)	
Score:	Present State	Perceived Reference State	Present State	Perceived Reference State	Present State	Perceived Reference State	Present State	Perceived Reference State
Continuous								
Clumped					X	X	X	X
Scattered		X	X	X				
Sparse	X							

Present State (P/S) = Currently applicable for each habitat unit

Perceived Reference State (PRS) = If in pristine condition

Each SI score is determined with reference to the following scoring table of vegetation distribution for present state versus perceived reference state.

	Present state (P/S)			
Perceived Reference state (PRS)	Continuous	Clumped	Scattered	Sparse
Continuous	3	2	1	0
Clumped	2	3	2	1
Scattered	1	2	3	2
Sparse	0	1	2	3

3. *PVC=[(EVC)-(exotic x 0.7) + (bare ground x 0.3)]*

Percentage vegetation cover (exotic):

	0%	1-5%	6-25%	26-50%	51-75%	76-100%
Vegetation cover %		X				
PVC Score	0	1	2	3	4	5

Percentage vegetation cover (bare ground):

	0%	1-5%	6-25%	26-50%	51-75%	76-100%
Vegetation cover %		X				
PVC Score	0	1	2	3	4	5

4. RIS

Extent of indigenous species recruitment	**0**	**Very Low**	**Low**	**Moderate**	**High**	**Very High**
				X		
RIS	**0**	**1**	**2**	**3**	**4**	**5**

VIS = [(EVC) + (SI x PVC)+(RIS)] = 13

The final VIS scores for each habitat unit are then categorised as follows:

Vegetation Index Score	Assessment Class	Description
22 to 25	**A**	Unmodified, natural
18 to 22	**B**	Largely natural with few modifications.
14 to 18	**C**	Moderately modified
10 to 14	**D**	Largely modified
5 to 10	**E**	The loss of natural habitat extensive
<5	**F**	Modified completely

Vegetation Index Score –Wetland habitat

1. *EVC=[(EVC1+EVC2)/2]*

EVC 1 - Percentage natural vegetation cover:						
Vegetation cover %	**0%**	**1-5%**	**6-25%**	**26-50%**	**51-75%**	**76-100%**
Site score				X		
EVC 1 score	0	1	2	3	4	5
EVC2 - Total site disturbance score:						
Disturbance score	**0**	**Very Low**	**Low**	**Moderately**	**High**	**Very High**
Site score			x			
EVC 2 score	5	4	3	2	1	0

2. *SI=(SI1+SI2+SI3+SI4)/4)*

	Trees (SI1)		**Shrubs (SI2)**		**Forbs (SI3)**		**Grasses (SI4)**	
Score:	**Present State**	**Perceived Reference State**	**Present State**	**Perceived Reference State**	**Present State**	**Perceived Reference State**	**Present State**	**Perceived Reference State**
Continuous								
Clumped					X	X	X	X
Scattered		X	X	X				
Sparse	X							

Present State (P/S) = Currently applicable for each habitat unit

Perceived Reference State (PRS) = If in pristine condition

Each SI score is determined with reference to the following scoring table of vegetation distribution for present state versus perceived reference state.

	Present state (P/S)			
Perceived Reference state (PRS)	**Continuous**	**Clumped**	**Scattered**	**Sparse**
Continuous	3	2	1	0
Clumped	2	3	2	1
Scattered	1	2	3	2
Sparse	0	1	2	3

3. PVC=[(EVC)-(exotic x 0.7) + (bare ground x 0.3)]

Percentage vegetation cover (exotic):						
	0%	1-5%	6-25%	26-50%	51-75%	76-100%
Vegetation cover %		x				
PVC Score	0	1	2	3	4	5
Percentage vegetation cover (bare ground):						
	0%	1-5%	6-25%	26-50%	51-75%	76-100%
Vegetation cover %		x				
PVC Score	0	1	2	3	4	5

4. RIS

Extent of indigenous species recruitment	**0**	**Very Low**	**Low**	**Moderate**	**High**	**Very High**
						X
RIS	**0**	**1**	**2**	**3**	**4**	**5**

VIS = [(EVC)+(SI x PVC)+(RIS)] = 15

The final VIS scores for each habitat unit are then categorised as follows:

Vegetation Index Score	Assessment Class	Description
22 to 25	**A**	Unmodified, natural
18 to 22	**B**	Largely natural with few modifications.
14 to 18	**C**	Moderately modified
10 to 14	**D**	Largely modified
5 to 10	**E**	The loss of natural habitat extensive
<5	**F**	Modified completely