



DE CASTRO & BRITS
ECOLOGICAL CONSULTANTS

Baseline Botanical and Faunal Biodiversity Surveys for the footprints of seven Shaft Complexes in the Orkney district belonging to China African Precious Metal: Orkney Gold Mine (North West Province)



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EXECUTIVE SUMMARY

In October of 2014 Shangoni Management Services (Pty) Ltd requested De Castro & Brits Ecological Consultants cc to conduct an once-off ecological survey that briefly describes the vegetation, flora (including alien plant species) and threatened vertebrate fauna (mammals, birds, reptiles and amphibians) of the footprints of seven shaft complexes belonging to the Orkney Gold Mine of China African Precious Metal, North West Province.

The phytosociological and faunal attributes of the study area were investigated during 31 March - 02 April 2015 with the objective to evaluate the structure, composition and conservation value of residing floristic and faunal communities.

Main findings and conclusions include the following:

- Five broad-scale vegetation units were identified from the seven shaft complexes:
 - *Untransformed grassland* - medium to high ecological sensitivity;
 - *Secondary grassland* - low to medium ecological sensitivity;
 - *Secondary hygrophilous (artificial) grassland* - low to medium ecological sensitivity;
 - *Agricultural mosaics* - low ecological sensitivity; and
 - *Infrastructure* - negligible ecological sensitivity.
- The untransformed grassland units showed high floristic richness (mainly in terms of grass and forb species) and were restricted to Shaft #4 and #5;
- The untransformed grassland units provide potential habitat for two near threatened plant species (*c. Drimia sanguinea* and *Pearsonia bracteata*), declining plant taxa (*c. Hypoxis hemerocallidea*) and three species protected by provincial legislation (*c. Gladiolus permeabilis*, *Crinum graminicola* and *Babiana hypogea*);
- A small population of the globally near threatened (and regional endemic) Melodious Lark (*Mirafra cheniana*) persists on the untransformed grassland unit of shaft #4; and
- Alien and invasive plant richness was particularly high on units consisting of secondary grassland and infrastructure.

TABLE OF CONTENTS

EXECUTIVE SUMMARY	I
TABLE OF CONTENTS	II
LIST OF FIGURES.....	III
LIST OF TABLES.....	IV
LIST OF APPENDICES.....	V
DECLARATION OF INDEPENDENCE	VI
1. INTRODUCTION.....	1
1.1 BACKGROUND	1
1.2 TERMS OF REFERENCE	1
2. BACKGROUND INFORMATION.....	2
2.1 LOCATION	2
2.2 LAND COVER AND EXISTING INFRASTRUCTURE	3
2.3 BIOPHYSICAL DESCRIPTION.....	3
2.3.1 Climate.....	3
2.3.2 Geology	3
2.3.3 Regional Vegetation Description	6
2.3.4 North West Province Biodiversity Conservation Assessment	9
2.3.5 Threatened Ecosystems.....	11
2.3.6 Floristic Centres of Endemism.....	11
3. METHODS AND APPROACH.....	12
3.1 VEGETATION SURVEY	12
3.2 VERTEBRATE TAXA OF CONSERVATION CONCERN	13
3.3 ECOLOGICAL SENSITIVITY.....	15
3.4 LIMITATIONS	16
4. RESULTS AND DISCUSSION.....	17
4.1 OCCURRENCE OF PLANT 'SPECIES OF CONSERVATION CONCERN': REGIONAL PERSPECTIVE	17
4.1.1 Plant species of conservation concern	17
4.1.2 Protected plant species.....	18
4.1.3 Declared Weeds and Invader Plants.....	19
4.2 OCCURRENCE OF VERTEBRATE 'SPECIES OF CONSERVATION CONCERN': REGIONAL PERSPECTIVE	25
4.2.1 Mammal species of conservation concern.....	25
4.2.2 Bird species of conservation concern.....	29
4.2.3 Amphibians of conservation concern.....	33
4.2.4 Reptiles of conservation concern	34
4.3 DESCRIPTION OF VEGETATION UNITS AND ECOLOGICAL SENSITIVITY	34
4.3.1 Shaft footprint #1	34
4.3.2 Shaft footprint #2.....	38
4.3.3 Shaft footprint #3.....	41
4.3.4 Shaft footprint #4.....	44
4.3.5 Shaft footprint #5.....	47
4.3.6 Shaft footprint #6.....	51

4.3.7 Shaft footprint #7.....	53
4.4 RECOMMENDATIONS	56
5. REFERENCES.....	58
6. APPENDICES.....	62

LIST OF FIGURES

Figure 1: A locality map illustrating the geographic position of the shaft footprints.....	4
Figure 2: A satellite image illustrating the land cover (2000) corresponding to the shaft footprints (Image courtesy of Google Earth).	5
Figure 3: A satellite image illustrating the land cover classes (2009) corresponding to the shaft footprints.....	6
Figure 4: The spatial position of the proposed study area and the regional vegetation types as defined by Mucina & Rutherford (2006).....	8
Figure 5: A map illustrating the conservation categories based on the North West Province Biodiversity Conservation Assessment, Version 1.2 (2009).	9
Figure 6: A map illustrating the remaining spatial extent of threatened ecosystems on the study area.	11
Figure 7: An example of the broad-scale vegetation units on shaft footprint #1: (a-b) secondary grassland and (c-d) infrastructure.....	36
Figure 8: A map illustrating the broad-scale vegetation units identified on shaft footprint #1.	37
Figure 9: An ecological sensitivity map of shaft footprint #1.....	37
Figure 10: An example of the broad-scale vegetation units on shaft footprint #2: (a-b) secondary grassland and (c-d) infrastructure.....	39
Figure 11: A map illustrating the broad-scale vegetation units identified on shaft footprint #2.	40
Figure 12: An ecological sensitivity map of shaft footprint #2.....	40
Figure 13: An example of the broad-scale vegetation units on shaft footprint #3: (a) secondary hygrophilous grassland, (b-c) secondary grassland and (d) infrastructure.	42
Figure 14: A map illustrating the broad-scale vegetation units identified on shaft footprint #3.	43
Figure 15: An ecological sensitivity map of shaft footprint #3.....	43
Figure 16: An example of the broad-scale vegetation units on shaft footprint #4: (a) untransformed grassland, (b) secondary grassland and (c-d) infrastructure.	46
Figure 17: A map illustrating the broad-scale vegetation units identified on shaft footprint #4.	46
Figure 18: An ecological sensitivity map of shaft footprint #4.....	47
Figure 19: An example of the broad-scale vegetation units on shaft footprint #5: (a) untransformed grassland, (b) secondary grassland, (c) agricultural mosaics and (d) infrastructure.....	49
Figure 20: A map illustrating the broad-scale vegetation units identified on shaft footprint #5.	50
Figure 21: An ecological sensitivity map of shaft footprint #5.....	50

Figure 22: An example of the broad-scale vegetation units on shaft footprint #6: (a-b) infrastructure.	51
Figure 23: A map illustrating the broad-scale vegetation units identified on shaft footprint #6.	52
Figure 24: An ecological sensitivity map of shaft footprint #6.....	52
Figure 25: An example of the broad-scale vegetation units on shaft footprint #7: (a) secondary grassland and (b-d) infrastructure.	54
Figure 26: A map illustrating the broad-scale vegetation units identified on shaft footprint #7.	55
Figure 27: An ecological sensitivity map of shaft footprint #7.....	55

LIST OF TABLES

Table 1: The approximate centre positions of the shaft footprints (WGS 84) and respective surface area.	3
Table 2: A list of the characteristic plant species for each stratum (e.g. grass, forb & woody layer) representing two vegetation types (Mucina & Rutherford, 2006)....	7
Table 3: The biodiversity criteria used to define the Critical Biodiversity Area corresponding to the respective shaft footprints.	10
Table 4: Modified abundance values used during the vegetation survey (adapted and modified as per Kent and Coker, 1993).	13
Table 5: List of all Red and Orange listed plant species (<i>sensu</i> Raimondo <i>et al.</i> , 2009) historically recorded from the quarter degree grid squares sympatric to the study area (2626DC & 2626DD), as well as the grids immediately to the west (2626CD), east (2627CC) and south (2726BA & 2726BB) (http://posa.sanbi.org ., downloaded in April 2015). Conservation status categories were obtained from the latest Red Data List of South African Plants (Raimondo <i>et al.</i> , 2009 and http://redlist.sanbi.org , downloaded April 2015). The lists for six grids sympatric and adjacent to the study area contained only three plant 'species of conservation concern', namely <i>Hypoxis hemerocallidea</i> and <i>Pearsonia bracteata</i> which were recorded from the grid 2626DC and <i>Kniphofia typhoides</i> which was recorded from grid 2627CC. The other species were recorded during previous surveys conducted by De Castro & Brits (2013).	21
Table 6: A list of weeds and invader plant species identified on the study area. * - alien species that are exempted in the Schedule from the provisions of section 65 of the Biodiversity Act of 2004, and include species previously regulated in terms of the Conservation of Agricultural Resources Act, 1983 as weeds and invader plants.....	23
Table 7: A list of threatened, near threatened and conservation important mammal species that could occur on the study area (excluding introduced game) according to historical distribution records and the availability of suitable habitat. The conservation status was based on IUCN Red List (2014) and Friedman & Daly (2004).	26
Table 8: Bird species of 'conservation concern' that could utilise the study area based on their known distribution range (SABAP1 & SABAP2) and the presence of	

suitable habitat. Species highlighted in grey were confirmed on the study area.
Red list categories according to the IUCN (2014) and Taylor (*in press*)..... 29

LIST OF APPENDICES

Appendix 1: A list of plant species recorded within the proposed shaft footprints. * -
refers to exotic species. ** - refers to planted ornamentals..... 62

DECLARATION OF INDEPENDENCE

I, Lukas Niemand declare that:

- I act as the independent specialist in this application for De Castro and Brits Ecological Consultants;
- I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant;
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have no vested financial, personal or any other interest in the application;
- I have no, and will not engage in, conflicting interests in the undertaking of the activity;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the application by the competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority; and
- All the particulars furnished by me in this form are true and correct.



Lukas Niemand (Pr.Sci.Nat)

12 April 2015

Lukas Niemand is registered with The South African Council for Natural Scientific Professionals (400095/06) with more than 12 years of experience in ecological-related assessments. He has conducted numerous ecological, botanical and avifaunal impact assessments including Eskom Transmission projects, hydro-electric schemes, mining related projects in South Africa and other African countries.

1. INTRODUCTION

1.1 Background

In October of 2014 Shangoni Management Services (Pty) Ltd requested De Castro & Brits Ecological Consultants cc to conduct an once-off ecological survey that briefly describes the vegetation, flora (including alien plant species) and threatened vertebrate fauna (mammals, birds, reptiles and amphibians) of the footprints of seven shaft complexes belonging to the Orkney Gold Mine of China African Precious Metal, North West Province.

1.2 Terms of Reference

According to the terms of reference as stipulated in the original proposal, the field surveys will focus on the untransformed habitats situated within the footprints of seven existing shaft complexes. The area within which the shafts are situated will be briefly assessed at a desktop level using existing aerial imagery, provincial conservation planning mapping and threatened species databases and specialist ecological reports compiled for other mines in the area by A. De Castro (see De Castro & Brits, 2013), in order to contextualise the ecosystems, flora and fauna encountered within the shaft complexes.

Priority will be given to plant 'species of conservation concern' (*sensu* Raimondo *et al.*, 2009 and <http://redlist.sanbi.org>), broad-scale habitat and vegetation descriptions, and threatened vertebrate fauna (excluding fish) of the seven shaft footprints.

The terms of reference for the study will focus on the following aspects:

- Determination of the Vegetation Type(s) in accordance with existing national vegetation maps (Mucina & Rutherford 2006) and local vegetation studies, as well as proximity and relationship to any Centre of Endemism (van Wyk and Smith, 2001). A description of the regional biodiversity context using existing information (e.g. North West Province Biodiversity Sector Plan (MBSP) and NPAES mapping) will be provided.
- Mapping of remaining areas of untransformed vegetation and transformed habitats (land-cover types). Brief descriptions of the dominant and typical species identified within the broad-scale plant communities comprising each of these units, will also be provided. These descriptions will be based on visual estimates of cover/abundance and density following established vegetation survey techniques (Kent & Coker, 1993). The number of sites will be limited by the relatively short duration of the fieldwork.

- Each identified vegetation unit / land-cover type will be briefly described in terms of its biodiversity value, sensitivity and conservation importance.
- Compilation of a preliminary species list of indigenous and naturalised plant species (to provide an accurate indication of the floristic diversity) according to latest taxonomic treatments used by the National Herbarium (<http://posa.sanbi.org>). Planted ornamentals that are declared invaders or potentially invasive species will also be listed. Alien invasive species, according to the Alien and Invasive Species Regulation 2014 (under the Biodiversity Act of 2004), will be highlighted and briefly discussed.
- Determination of the occurrence, or possible occurrence, of plant 'species of conservation concern' (Raimondo *et al.*, 2009 and <http://redlist.sanbi.org>), on the basis of the brief field survey (the 'timed meander search' method will be used to briefly search for threatened plants in untransformed habitats), historical distribution records obtained from the PRECIS database of SANBI, and available literature.
- Determination of the occurrence, or possible occurrence, of threatened and / or sensitive vertebrate fauna (mammals, birds, reptiles and amphibians), based on available North West Province threatened vertebrate species databases, habitat characteristics of the study area and coincidental observations compiled whilst conducting the vegetation surveys.
- Further botanical and zoological assessments regarded as necessary will also be identified and a 'Terms of Reference' for these assessments will be recommended. Such further assessments may include additional searches for potentially occurring threatened plant species that were not in flower at the time of the field surveys conducted for this study.
- Where applicable ecological management recommendations (e.g. control of alien invasive plants and identification of areas sensitive to further development) will be provided.

2. BACKGROUND INFORMATION

2.1 Location

The study area is located north-east of the town of Orkney, north of the Vaal River and south-east of the town of Klerksdorp in the North West Province (Figure 1). Shaft #6 is nearest to Orkney town, while Shaft #5 is furthest (c. 10.4 km) from Orkney town. Shaft #6 is the smallest with a surface extent of 1.4 ha, while Shaft #5 is the largest with a surface extent of 40.3 ha (Table 1).

Table 1: The approximate centre positions of the shaft footprints (WGS 84) and respective surface area.

Shaft #	Location (approx. centre position)	Surface area (ha)
1	S26 56 15.8 E26 44 15.3	7.6
2	S26 56 01.5 E26 45 43.4	29.0
3	S26 56 59.0 E26 43 04.0	7.5
4	S26 54 57.3 E26 42 28.1	35.0
5	S26 54 43.4 E26 45 14.4	40.3
6	S26 58 09.9 E26 39 33.4	1.4
7	S26 57 24.5 E26 40 20.4	11.7
		132.5

2.2 Land cover and existing infrastructure

According to the land cover dataset (2000 & 2009) it is evident that the majority of shaft footprints coincide with transformed land (Figure 2 and Figure 3). The prominent land cover categories include mining infrastructure and build-up areas. However, most of the shaft footprints are surrounded by natural untransformed grassland, which are also persisting as fragments on shaft footprints #4 and #5.

2.3 Biophysical Description

2.3.1 Climate

The climate is characterised by summer rainfall with dry winters and frequent occurrences of frost. The mean annual precipitation is approximately 560 mm and the summer temperature is high with an annual mean of 16.8°C (Mucina and Rutherford, 2006).

2.3.2 Geology

The western section of the study area (shaft #6 & #7) is underlain by Rietgat formation andesite of the Platberg Group (Randian Erathem), while the eastern section (shaft #1-#5) is characterised by chert-rich dolomite of the Chuniespoort Formation (Vaalian Erathem). In addition, the western extremity of shaft #4 is underlain by quartzite, conglomerate and slate of the Black Reef Formation (Transvaal Supergroup).

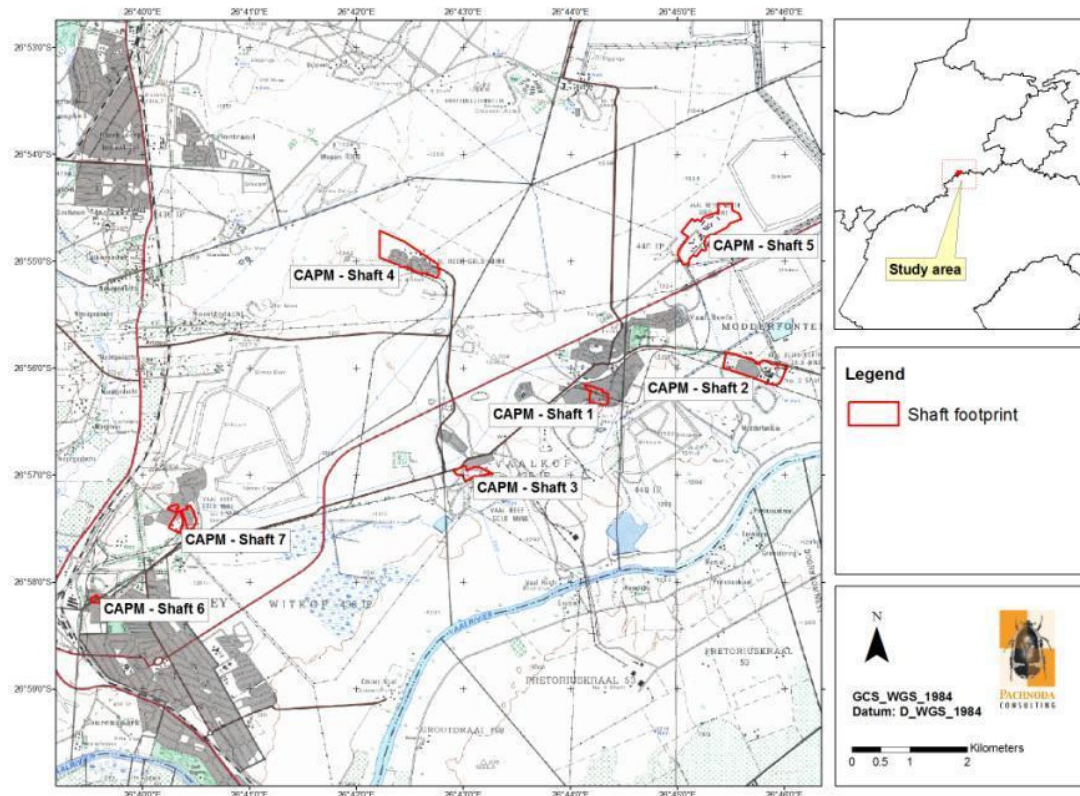


Figure 1: A locality map illustrating the geographic position of the shaft footprints.

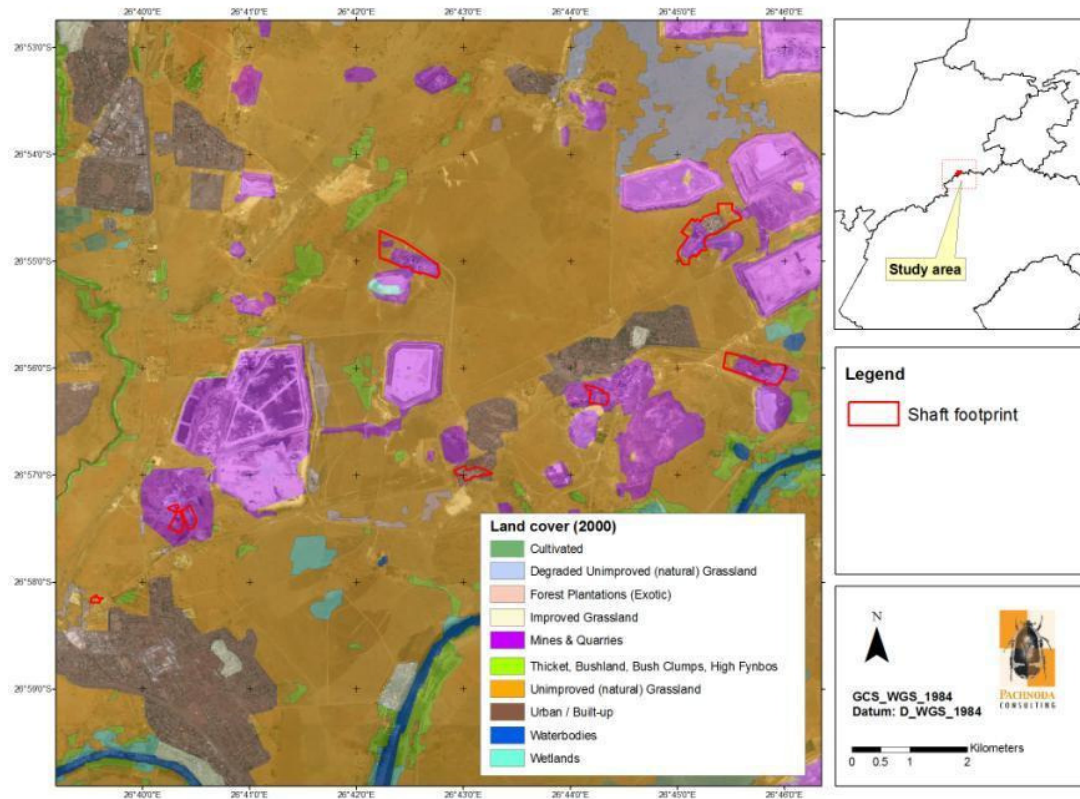


Figure 2: A satellite image illustrating the land cover (2000) corresponding to the shaft footprints (Image courtesy of Google Earth).

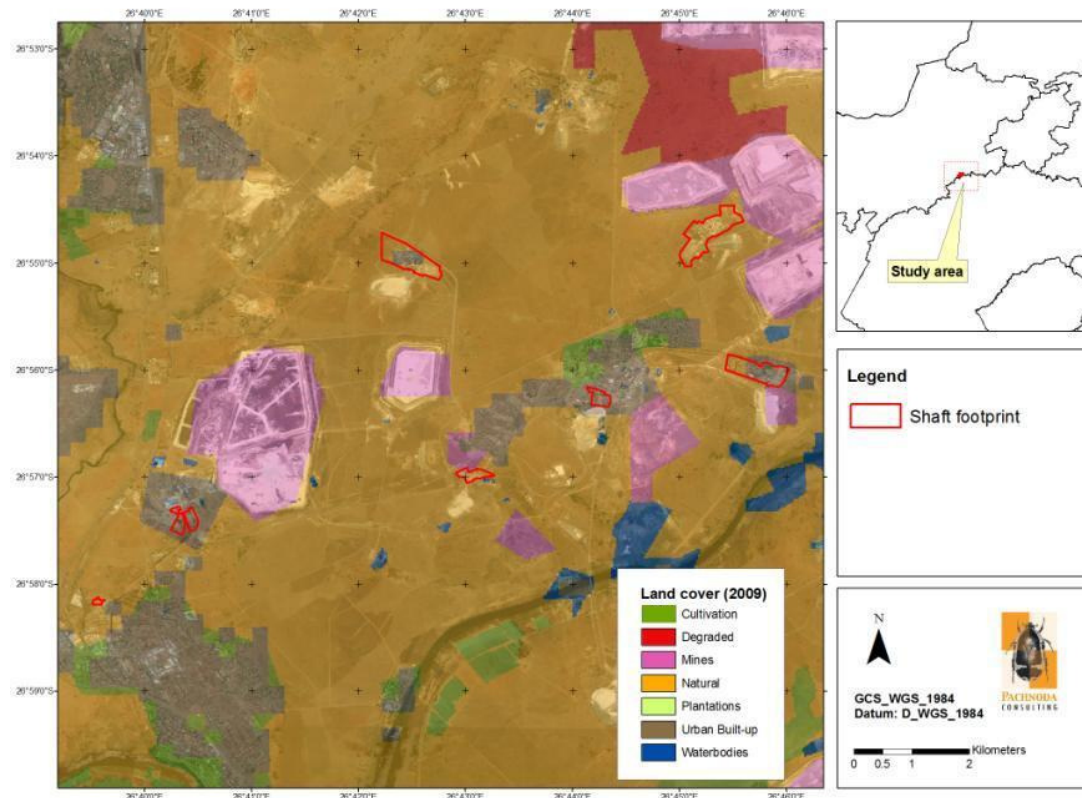


Figure 3: A satellite image illustrating the land cover classes (2009) corresponding to the shaft footprints.

2.3.3 Regional Vegetation Description

The study area corresponds to the Grassland Biome and more particularly to the Dry Highveld Grassland Bioregion as defined by Mucina & Rutherford (2006). It comprehends two ecological types known as the (1) Vaal-Vet Sandy Grassland and (2) Vaal Reefs Dolomite Sinkhole Woodland (Mucina & Rutherford, 2006) (Figure 4).

1. Vaal-Vet Sandy Grassland

This vegetation type is restricted to the North West and Free State Provinces where it is confined to the western section of the study area (only Shaft #6). It typically occurs on plains and consists of a low tussocky-dominated grassland consisting of karroid elements. It is characterised by the dominance of *Themeda triandra*, although the widespread occurrence of *Aristida congesta* and *Cymbopogon pospischilii* are the result of heavy grazing and/or erratic rainfall.

The Vaal-Vet Sandy Grassland is Endangered, and is poorly conserved in the Bloemhof Dam, Faan Meintjies, Schoonspruit, Wolvespruit and Sandveld Nature Reserves. It is transformed by cultivation and inappropriate grazing regimes.

2. Vaal Reefs Dolomite Sinkhole Woodland

This vegetation type is restricted to a small area of dolomite sinkholes near Stilfontein and Orkney with the Vaal River forming its southern boundary. It is associated with chert-rich dolomite ridges, forming a prominent woodland-grassland mosaic, especially near sinkholes and dolomite outcrops.

It is Vulnerable with a small section conserved within the Sterkfontein Caves conservation area (as part of the Cradle of Humankind World Heritage Site). This vegetation type is transformed by mining, cultivation and urban expansion, and contains the highest concentration of mines when compared to the other vegetation types.

Table 2 summarises a list of plant species characteristic of the Vaal-Vet Sandy Grassland and Vaal Reefs Dolomite Sinkhole Woodland.

Table 2: A list of the characteristic plant species for each stratum (e.g. grass, forb & woody layer) representing two vegetation types (Mucina & Rutherford, 2006).

Vaal-Vet Sandy Grassland (Gh10)		
Grassy Layer	Forb Layer	Woody/Shrub Layer
<i>Antheophora pubescens</i> , <i>Aristida congesta</i> , <i>Chloris virgata</i> , <i>Cymbopogon caesius</i> , <i>Cynodon dactylon</i> , <i>Elionurus muticus</i> , <i>Eragrostis chloromelas</i> , <i>E. lehmanniana</i> , <i>E. plana</i> , <i>E. trichophora</i> , <i>Heteropogon contortus</i> , <i>Setaria sphacelata</i> , <i>Themeda triandra</i> , <i>Tragus berteronianus</i> , <i>Brachiaria serrata</i> , <i>Cymbopogon pospischilii</i> , <i>Digitaria eriantha</i> , <i>Eragrostis curvula</i> , <i>E. superba</i> , <i>Pogonarthria squarrosa</i> , <i>Trichoneura grandiglumis</i> , <i>Triraphis andropogonoides</i>	Herbs: <i>Barleria macrostegia</i> , <i>Euphorbia inaequilatera</i> , <i>Helichrysum caespitium</i> , <i>Hermannia depressa</i> , <i>Hibiscus pusillus</i> , <i>Monsonia burkeana</i> , <i>Selago densiflora</i> , <i>Vernonia oligocephala</i> Geophytic herbs: <i>Bulbine narcissifolia</i> , <i>Ledebouria marginata</i> Succulent herbs: <i>Tripteris aghillana</i> <i>var. integrifolia</i>	Low shrubs: <i>Felicia muricata</i> , <i>Anthospermum rigidum subsp. pumilum</i>
Vaal reefs Dolomite Sinkhole Woodland (Gh12)		
Grassy Layer	Forb Layer	Woody/Shrub Layer

<p><i>Aristida congesta</i>, <i>Digitaria eriantha</i>, <i>Eragrostis curvula</i>, <i>Themeda triandra</i>, <i>Antheophora pubescens</i>, <i>Aristida canescens</i>, <i>Bewsia biflora</i>, <i>Brachiaria serrata</i>, <i>Chloris pycnothrix</i>, <i>Cymbopogon caesus</i>, <i>C. pospischillii</i>, <i>Cynodon dactylon</i>, <i>Diheteropogon amplexens</i>, <i>Elionurus muticus</i>, <i>Eragrostis chloromelas</i>, <i>E. lehmanniana</i>, <i>E. subperba</i>, <i>Eustachys paspaloides</i>, <i>Heteropogon contortus</i>, <i>Melinis repens</i>, <i>Setaria sphacelata</i>, <i>Triraphis andropogonoides</i></p>	<p>Non-succulents: <i>Commelina africana</i>, <i>Barleria macrostegia</i>, <i>Euphorbia inaequilatera</i>, <i>Crabbea angustifolia</i>, <i>Dicoma anomala</i>, <i>Hermannia depressa</i>, <i>Ipomoea obscura</i>, <i>Nidorella hottentotica</i>, <i>Osteospermum muricatum</i>, <i>Pollichia campestris</i>, <i>Vernonia oligocephala hottentotica</i></p>	<p>Small trees: <i>Acacia (=Vachellia) karroo</i>, <i>Searsia lancea</i> Tall shrubs: <i>Diospyros lycioides</i> subsp. <i>lycioides</i>, <i>Ehretia rigida</i>, <i>Grewia flava</i> Low shrubs: <i>Asparagus suaveolens</i>, <i>Gymnosporia heterophylla</i>, <i>Sida dregei</i>, <i>Asparagus laricinus</i>, <i>Felicia muricata</i>, <i>Indigofera heterotricha</i>, <i>Triumfetta sonderi</i> Geoxylic suffrutex: <i>Elephanthorrhiza elephantina</i></p>
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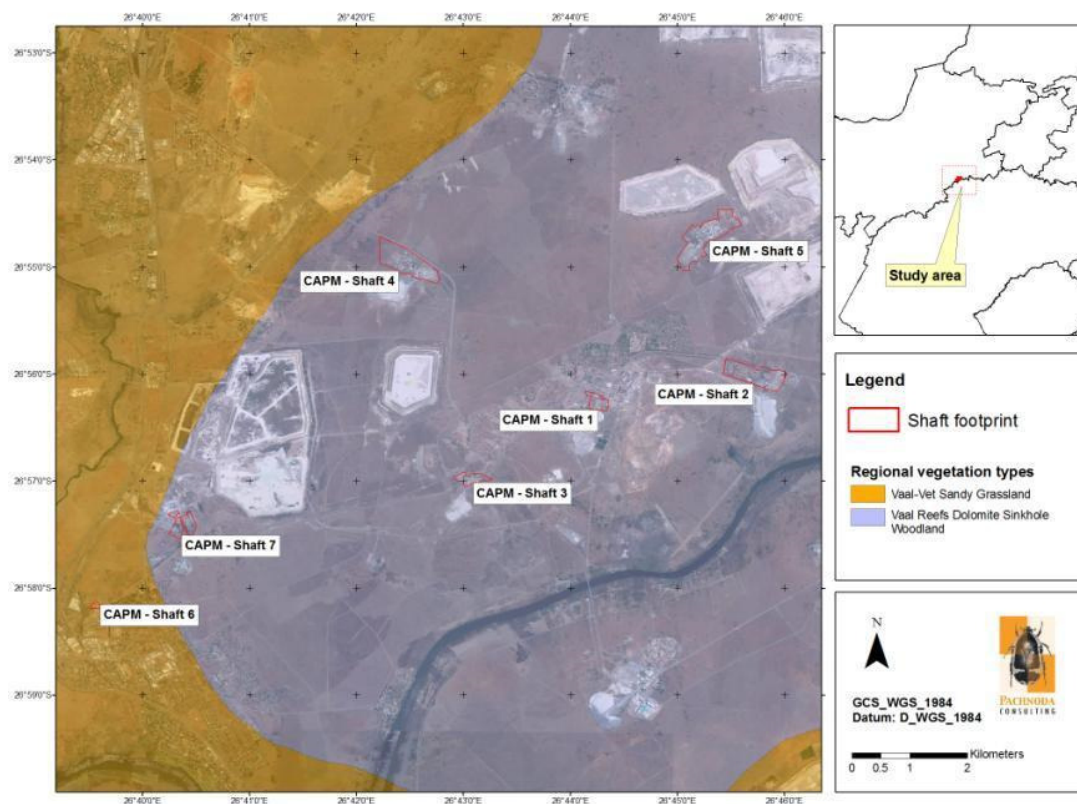


Figure 4: The spatial position of the proposed study area and the regional vegetation types as defined by Mucina & Rutherford (2006).

2.3.4 North West Province Biodiversity Conservation Assessment

According to the North West Province Biodiversity Conservation Assessment Version 1.2 (Desmet *et al.*, 2009), it is evident that the majority of shaft footprints are located in "Critical Biodiversity Areas T2" (Figure 5). These areas sustain either endemic patches of vegetation, important habitat features, natural corridors or the presence of hills or ridges (see Table 3). A "Critical Biodiversity Area T2" (CBA T2) is an area that is "optimal" (as opposed to "irreplaceable") for achieving provincial conservation targets, and represent areas where there are spatial options for achieving targets.

In addition, shaft footprints #6 and #7 has no remaining natural habitat, and are therefore not part of any biodiversity area.

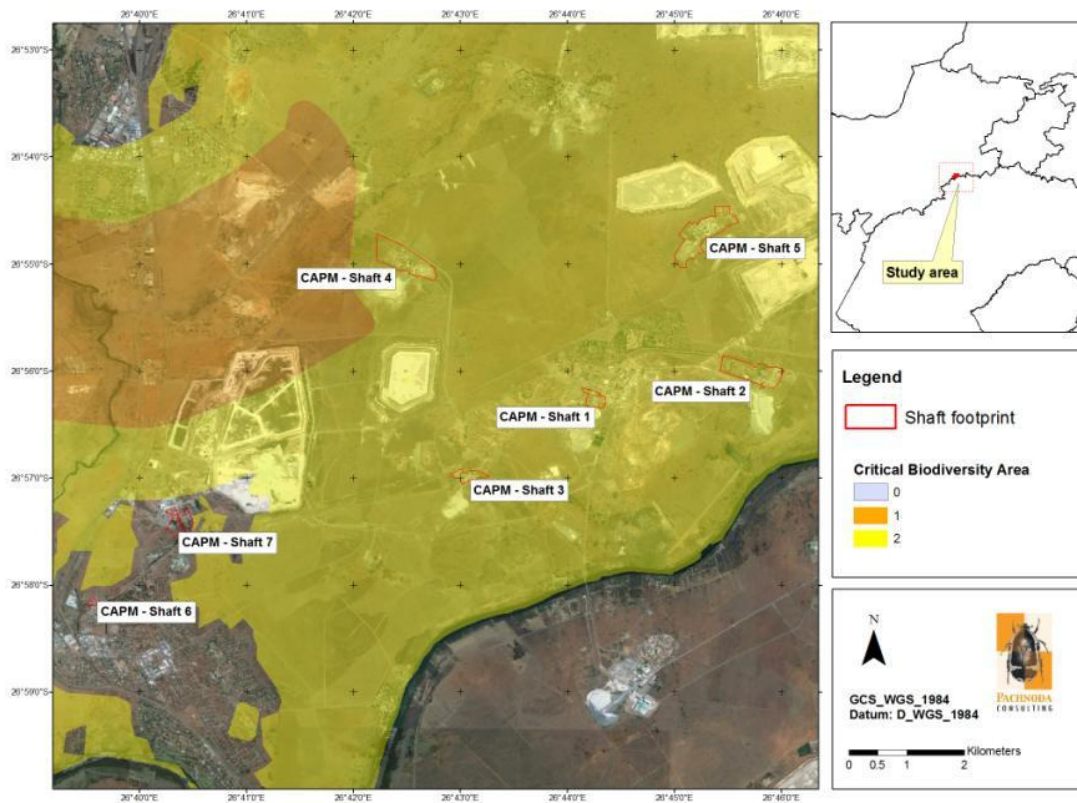


Figure 5: A map illustrating the conservation categories based on the North West Province Biodiversity Conservation Assessment, Version 1.2 (2009).

Table 3: The biodiversity criteria used to define the Critical Biodiversity Area corresponding to the respective shaft footprints.

Shaft #	Sub-category	Description of biodiversity features as per CBA 2 definition
1	Feature/Hill	<p>Containing important natural features (habitats, springs, scenic landscapes)</p> <p>Containing hills and ridges identified as sensitive habitats in the existing provincial SDF dataset</p>
2	Feature/Endemic	<p>Containing important natural features (habitats, springs, scenic landscapes)</p> <p>Containing vegetation patches larger than 10ha of Endemic or Near-Endemic (>80% in province) vegetation types to the province with a global distribution of less than 50 000ha</p>
3	Feature	Containing important natural features (habitats, springs, scenic landscapes)
4	Feature/Endemic/Corridor	<p>Containing important natural features (habitats, springs, scenic landscapes)</p> <p>Containing vegetation patches larger than 10ha of Endemic or Near-Endemic (>80% in province) vegetation types to the province with a global distribution of less than 50 000ha</p> <p>Coincides with provincial-level biodiversity corridor network aimed at retaining connectivity between all geographic areas in the province</p>
5	Feature	Containing important natural features (habitats, springs, scenic landscapes)
6	-	-
7	-	-

2.3.5 Threatened Ecosystems

None of the shaft footprints are located in any threatened ecosystem (Figure 6) as defined by the National Biodiversity Act of 2004. However, It is evident that remnant patches of Vaal-Vet Sandy Grassland, an Endangered ecosystem, are located west of the shaft footprints.

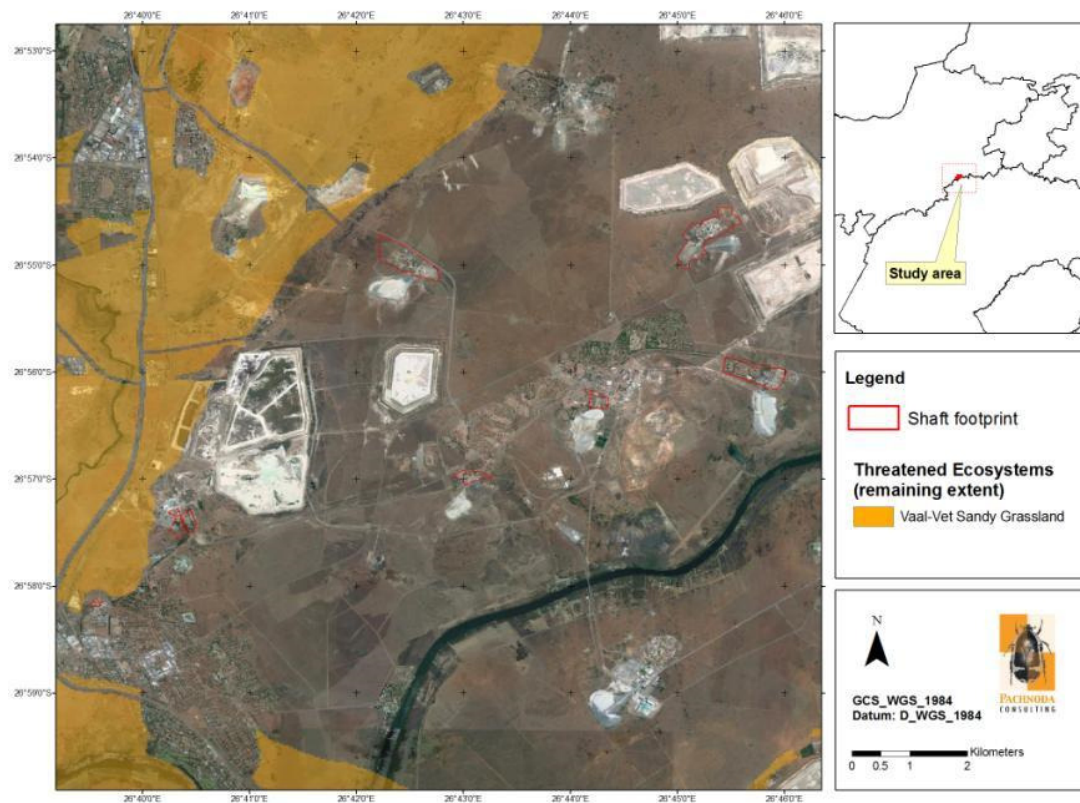


Figure 6: A map illustrating the remaining spatial extent of threatened ecosystems on the study area.

2.3.6 Floristic Centres of Endemism

The study area is not situated within any of the South African centres of endemism recognised by Van Wyk and Smith (2001). The nearest floristic centre of endemism, the Griqualand West Centre, is approximately 190 km west of the study area.

3. METHODS AND APPROACH

The phytosociological and faunal attributes of the study area were investigated during 31 March - 02 April 2015 with the objective to evaluate the structure, composition and conservation value of residing floristic and faunal communities.

3.1 Vegetation Survey

3.1.1 Description and dominance estimation

- 1: 50 000 topographical maps and Google Earth satellite imagery were used to subjectively stratify specific areas of uniform vegetation, structure and land cover (including highly localised and spatially restricted habitats). By using a stratified sampling approach, it is possible to obtain a more accurate species inventory and richness estimate at each of the shaft footprints, rather than using other site selection methods (e.g. random sampling).
- The dominant and characteristic species was based on visual estimates of cover/abundance and density. It entails the compilation of a list of plant taxa, whereby each taxon was assigned an abundance estimate based on its relative cover within a predefined area of approximately 100 m² (see Table 4).
- In order to improve the inventory of plant species and to facilitate the search for plant taxa of conservation concern, the 'timed meander search' method was used. The 'timed meander search' method is a semi-quantitative survey procedure that focuses on the detection of rare vascular plant species or taxa occurring naturally at low densities (Goff *et al.*, 1982; Huebner, 2007). This method is highly effective and time efficient when describing the α -diversity of a particular area (Huebner, 2007).
- Approximately 30 to 120 minutes (depending on habitat diversity and species richness of the site) was spent searching all available habitats at each site situated in untransformed vegetation. However, less effort was expended at sites situated in transformed habitats or secondary vegetation.
- Where possible, all plant taxa were positively identified in the field. Plant names used in Appendix 1 follow Germishuizen *et al.* (2006) with the relevant updates included in the Plants of South Arica web-based database (<http://posa.sanbi.org>).

Table 4: Modified abundance values used during the vegetation survey (adapted and modified as per Kent and Coker, 1993).

Abundance estimate	Relative cover (%)
3	75-100
2	50-75
1	25-50
Common	10-25
Uncommon	<10

3.1.2 Literature review and database acquisition

In addition, the following parameters were also documented to aid the vegetation survey:

- The occurrence of threatened taxa, including near threatened, declining and rare taxa was provided by Raimondo *et al.* (2009). In addition, the potential presence of 'species of conservation concern' in the study area was provided by De Castro and Brits (2013). Prior to the conduction of the field surveys, historical records of plant 'species of conservation concern' within the quarter degree grids within which the study area is situated (2626DC & 2626DD) was obtained from the National Herbarium's PRECIS database (<http://posa.sanbi.org>).
- The prominence of declared weeds and invader species as promulgated under the amended regulations (Regulation 15) of the Conservation of Agricultural Resources Act, 1983 (Act No. 43 of 1983) and the Alien and Invasive species regulations of the National Environmental Management: Biodiversity (NEMBA) Act 10 of 2004 was included; and
- Additional information was also sourced from previous biodiversity surveys conducted in the region, especially the unpublished report compiled by De Castro and Brits (2013).

3.2 Vertebrate Taxa of Conservation Concern

3.2.1 Literature review and database requisition

Mammals

- The potential occurrence and conservation status of mammal taxa were based on the IUCN Red List (2014) and Friedmann & Daly (2004), while mammalian nomenclature was based on Skinner & Chimimba (2005), unless otherwise specified.

Avifauna

- Hockey *et al.* (2005) and Harrison *et al.* (1997) were consulted for general information on the life history attributes of the relevant bird species. They also provide small scale distributional information.
- The conservation status of bird species was categorised according to the global IUCN Red List of threatened species (IUCN, 2014) and a recent regional conservation assessment by Taylor (*in press*).
- Distributional data pertaining to species of conservation concern was sourced from the first South African Bird Atlas Project (SABAP1) and verified against Harrison *et al.* (1997) for species corresponding to the quarter-degree grid cells 2626DC (Klerksdorp) and 2626DD (Stillfontein). The SABAP1 data provides a “snapshot” of the abundance and composition of species recorded within a quarter degree grid cell (QDGC) which was the sampling unit chosen (corresponding to an area of approximately 50x50 km). It should be noted that the atlas data makes use of reporting rates that were calculated from observer cards submitted by the public as well as citizen scientists. It provides an indication of the thoroughness of which the QDGCs were surveyed between 1987 and 1991.
- Additional distributional data was sourced from the second South African Bird Atlas Project (SABAP2; www.sabap2.adu.org.za). Since bird distributions are dynamic (based on landscape changes such as fragmentation and climate change), SABAP2 was born (and launched on 1 July 2007) from SABAP1 with the main difference being that all sampling is done at a finer scale known as pentad grids (5 min lat x 5 min long, equating to 9 pentads within a QDGC). Therefore, the data is more site-specific, recent and more comparable with observations made during the site visit (due to increased standardisation of data collection). The pentad grids relevant to the current project include 2650_2640, 2650_2645, 2655_2635, 2655_2640 and 2655_2645.

Herpetofauna

- Red List categories for potential occurring reptile species were chosen according to the recent conservation assessment conducted by Bates *et al.* (2014);
- Red List categories and listings of potential occurring amphibian taxa follow Measey (2010); and
- The distribution of reptile and amphibian species were verified against the Animal Demography's (ADU) database consisting of ReptileMap and FrogMap.

3.2.2 Field Surveys

Mammals

- Mammals were identified by means of visual sightings during *ad hoc* transect walks. In addition, mammals were also identified by means of spoor, droppings, roosting sites or likely habitat types.

Avifauna

- Birds were identified by means of random transect walks while covering as much of the habitat types as possible.
- Birds were also identified by means of their calls and other signs such as nests, discarded egg shells (Tarboton, 2001) and feathers. Particular attention was paid to suitable roosting, foraging and nesting habitat for species of conservation concern.

Herpetofauna

- Possible burrows, or likely reptile habitat (termitaria, stumps or rocks) were inspected for any inhabitants. Amphibians were identified by their vocalisations (if any) and through likely habitat types (e.g. water features, drainage lines, etc.).

3.3 Ecological Sensitivity

The ecological sensitivity of any piece of land is based on its inherent ecosystem service (e.g. wetlands) and overall preservation of biodiversity. In addition, the sensitivity of any piece of land is a key consideration when identifying impacts.

3.3.1 Ecological function & connectivity

The extent to which a site is ecologically connected to surrounding areas is an important determinant of its sensitivity. Systems with a high degree of landscape connectivity amongst one another are perceived to be more sensitive and will be those contributing to better ecosystem service (e.g. wetlands) or overall preservation of biodiversity.

3.3.2 Biodiversity Importance

Biodiversity importance relates to species diversity, endemism (unique species or unique processes) and the high occurrence of threatened and protected species or ecosystems protected by legislation.

3.3.3 Sensitivity Scale

- *High* – Sensitive and untransformed ecosystems with either low inherent resistance or low resilience towards disturbance factors or highly dynamic systems considered being important for the maintenance of ecosystem integrity. Most of these systems represent ecosystems with high connectivity with other important ecological systems OR with high species diversity and usually provide suitable habitat for a number of threatened, near threatened or rare species.
- *Medium* – These are slightly modified systems which occur along gradients of disturbances of low-medium intensity with some degree of connectivity with other ecological systems OR ecosystems with intermediate levels of species diversity but may include potential ephemeral habitat for threatened species.
- *Low* – Degraded and highly transformed systems with little ecological function and are generally very poor in species diversity (many species are exotic or weeds).
- *Negligible* – Permanently transformed systems with no natural habitat remaining (mainly infrastructure, mining activities or build-up areas).

3.4 Limitations

In order to obtain a comprehensive understanding of the dynamics of the floristic and faunal communities on the study area, as well as the status of endemic, rare or threatened species in any area, ecological surveys should always consider investigations at different time scales (across seasons/years) and through replication. However, due to time constraints such long-term studies were not feasible.

Please note that the inventories listed in this document is by no means complete, and is merely a reflection of the dominant taxa on the study area obtained during series of instantaneous sampling sessions. A comprehensive inventory, irrespective of the taxon or group of taxa could only be achieved during long-term temporal sampling. Therefore a comprehensive species list of the untransformed parts of the footprints cannot be compiled on the basis of a brief, once-off field survey.

The information as presented in this document only has reference to the investigated shaft boundaries and cannot be applied to any other area without prior investigation. This company, the consultants and/or specialist investigators do not accept any responsibility for conclusions, suggestions, limitations and recommendations made in good faith, based on the information presented to them, obtained from the surveys or requests made to them at the time of this report.

4. RESULTS AND DISCUSSION

4.1 Occurrence of plant 'species of conservation concern': Regional perspective

4.1.1 Plant species of conservation concern

South Africa has been recognised globally as having a remarkable plant diversity with high levels of endemism. Almost ten percent of the earth's plants are found within South Africa approximating 23 420 species (Golding, 2002). Of the 948 taxa assessed, 414 species are threatened with extinction, while 270 of these have populations with extremely localised geographic distributions (Golding, 2002).

In terms of conserving biodiversity, there has been a shift towards focussing on ecosystems and landscapes (habitats^{*}) rather than efforts in conserving specific species. This is the case due to the variety of living organisms, which make up ecosystems relying on suitable habitats to which they have become adapted over long periods of time. Habitat degradation is one of the main reasons for species becoming extinct in a particular area. However, it can be viewed that threatened species are seen as indicators of the overall health of an ecosystem and serve, with varying degrees of success, as 'umbrellas' for the protection of other organisms as well as ecosystems (Hilton-Taylor, 1996; 2000). According to Hilton-Taylor (1996), threatened species can be seen as "biodiversity attention grabbers". In addition, Victor & Keith (2004) introduced the concept of an Orange List for plant taxa that warrant conservation measures but do not meet the IUCN criteria. These taxa include those species at risk of becoming threatened (all taxa currently considered "Near threatened" or "Data Deficient") or represent rare or declining populations. These categories were developed to highlight species are not threatened with extinction, but require some conservation effort and monitoring.

Table 5 provides a list of Red and Orange Listed species with known distribution patterns sympatric (QDS: 2626DC and 2626DD, including adjacent grids 2626CD, 2627CC, 2726BA & 2726BB) to the study area, and an indication of their probability of

* Habitats normally comprise several biotopes or areas of uniformity (Davies & Day, 1998).

occurrence. Of these, one declining species (*Hypoxis hemerocallidea*) was recorded on the study area (shaft #2 and #5), while *Boophone disticha* was recorded from untransformed grassland adjacent to one of the shaft footprints (shaft #7). Two near threatened species (*Pearsonia bracteata* and *Drimia sanguinea*) could also occur owing to the presence of suitable habitat (e.g. untransformed Dolomite grassland and open veld with shrubby woodland) (Table 5). Both *H. hemerocallidea* and *B. disticha* are widespread but declining since they are very popular species used for muthi (Raimondo *et al.*, 2009).

Drimia sanguinea, although widespread, has declined by 20-25 % in the last 60 years due to overharvesting for its medicinal properties¹, especially in Gauteng (Williams *et al.*, 2008). In addition, it has a highly poisonous bulb which has caused widespread mortalities in livestock, thereby resulting in the widespread clearance² of this species by farmers (Williams *et al.*, 2008).

The distribution range of *Pearsonia bracteata* is largely fragmented and is threatened by ongoing habitat loss. However, further examination of this species, especially given the differences in habitat preference between spatially disjunct populations may show that this taxon could consist of two separate species or subspecies. If this is true, then the species is range-restricted and could qualify for a threatened category (von Staden, 2011).

4.1.2 Protected plant species

The following legislation provides protected status to selected indigenous plant species and are of relevance to the study area:

- National Forests Act (Act 84 of 1998),
- NEMA Biodiversity Act (Act 10 of 2004, as amended in 2013), and
- Transvaal Nature Conservation Ordinance (No.12 of 1983).

Schedule A of the National Forests Act (Act 84 of 1998) lists 47 tree species that are Protected in South Africa. In terms of the National Forests Act, a licence should be granted by the Department of Forestry (or a delegated authority) prior to the removal, damage or destruction of any individual tree. Therefore, such activities (as mentioned above) should be directed to the responsible Forestry official in each province or area. The only species that is known to be present in the region is *Acacia (=Vachellia) erioloba* (recorded by De Castro & Brits, 2013). **However, *A. erioloba* was absent from the proposed shaft footprints and none of the remaining 46 tree species listed in Schedule A of the National Forests Act occurs on the proposed study area.**

¹ *Drimia sanguinea* is sold at >70 % muthi markets in 1991, with more than 1 961 bags being sold annually - the equivalent of 380 000 bulbs being sold annually (Williams *et al.*, 2007).

² Up to 400 000 plants were annually removed by a farmer of Wolmaranstad. Certain municipalities (c. Belfast & Heidelberg) have enforced the eradication of *D. sanguinea* after it was declared a noxious weed (Stent & Curson, 1929).

The Biodiversity Act (Act 10 of 2004, as amended in 2013), is intended to protect plant and animal species that are directly threatened by utilisation or illegal trade. The Act assigns four categories (namely Critically Endangered, Endangered, Vulnerable and Protected) to species threatened by utilisation which appears to be similar to those used by the IUCN, although it should be emphasised that these categories are not as rigorously defined as per the IUCN Ver. 3.1 categories (IUCN, 2014). The destruction, collection or trading of any species listed in the Act requires a permit which must be obtained from the relevant authority. **The only protected species that could occur on the study area (in particular areas consisting of open veld with shrubby woodland) is *Drimia sanguinea*.**

A number of plant species occurring in the North West Province are not considered to be threatened or near threatened (*sensu* Raimondo *et al.*, 2009), but are protected under Schedule 11 of the Transvaal Nature Conservation Act (No.12 of 1983). Although old, the Act is still applicable to the province. Only three species, namely *Babiana hypogea*, *Gladiolus permeabilis* and *Crinum graminicola* were recorded from untransformed grassland (corresponding to shaft footprints #4 and #5) on the study area. A permit is required to remove or disturb a protected plant. It is recommended that protected plants in danger of becoming destroyed during any of the planned activities be removed (rescued) prior to the commencement of construction activities and translocated to transformed or degraded habitat of potentially suitable habitat within the study area, or used during the rehabilitation phase

4.1.3 Declared Weeds and Invader Plants

Invaders and weed species are plants that invade natural or semi-natural habitats; especially areas disturbed by humans, and are commonly known as environmental weeds. Weeds that invade severely disturbed areas are known as ruderal and agrestal weeds. Most of these weeds are annuals colonising waste sites and cultivated fields. These weeds only persist on recently disturbed areas and seldom invade established areas (Henderson, 2001).

Declared weeds and invaders have the tendency to dominate or replace the canopy or herbaceous layer of natural ecosystems, thereby transforming the structure, composition and function of natural ecosystems.

The amended Regulations (Regulation 15) of the Conservation of Agricultural Resources Act, 1983 (Act No. 43 of 1983) identify 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.

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 30 m of a 1:50 year floodline and must be prevented from spreading.

In addition, the Alien and Invasive species regulations was published on 1 August 2014 in terms of section 97(1) of the National Environmental Management: Biodiversity (NEMBA) Act 10 of 2004. The Act provides a list of invasive plant species under section 70(1)(A) and identifies four categories:

- Category 1a listed invasive species: Species which must be combatted or eradicated. It basically instructs a person to comply with section 73(2) of the Act. In addition, an authorised official from the Department must be allowed to assist with the eradication of these species.
- Category 1b invasive species: Species that should be controlled as listed by the notice in terms of section 70(1)(a). Any person in control of these species must control these species, and must allow an authorised official from the Department to assist with the control of these species.
- Category 2 invasive species: Species that requires a permit to carry out a restricted activity (e.g. afforestation) on a specified area. A person in possession of a permit or who owns land with Category 2 species must also ensure that these species will not spread outside the land. Unless otherwise specified, if any Category 2 species occurs outside any specified area, it should be treated as a Category 1b species and must be managed accordingly.
- Category 3 invasive species: A species that is subject to exemptions in terms of section 71(3) and prohibitions in terms of section 71A of the Act. If any of these species occur in a riparian area it should be treated as a Category 1b species, and must be managed accordingly.

Table 5: List of all Red and Orange listed plant species (*sensu* Raimondo *et al.*, 2009) historically recorded from the quarter degree grid squares sympatric to the study area (2626DC & 2626DD), as well as the grids immediately to the west (2626CD), east (2627CC) and south (2726BA & 2726BB) (<http://posa.sanbi.org.>, downloaded in April 2015). Conservation status categories were obtained from the latest Red Data List of South African Plants (Raimondo *et al.*, 2009 and <http://redlist.sanbi.org>, downloaded April 2015). The lists for six grids sympatric and adjacent to the study area contained only three plant 'species of conservation concern', namely *Hypoxis hemerocallidea* and *Pearsonia bracteata* which were recorded from the grid 2626DC and *Kniphofia typhoides* which was recorded from grid 2627CC. The other species were recorded during previous surveys conducted by De Castro & Brits (2013).

Taxon	Latest (IUCN version 3.1) Conservation Status Category*	Habitat	Flowering Time	Grid squares from which species is known to occur	Probability of occurrence within the study area and shaft complex
AMARYLLIDACEAE					
<i>Boophone disticha</i> (L. f.) Herb.	Declining	Dry grassland and rocky areas. Widespread in South Africa (known from 9 provinces) and extends up the eastern half of southern Africa to Uganda.	October to January	-	High (recorded adjacent to Shaft #7)
<i>Crinum bulbispermum</i> (Burm.f.) Mile-Redh. & Schweik.	Declining	Along rivers and streams or in damp depressions in black clay or sandy soil. In the authors experience always occurs in areas that are seasonally or at least periodically flooded.	September to November	-	Low
<i>Nerine gracilis</i> R.A. Dyer	Vulnerable [VU B1ab (ii, iii, v)]	Undulating grasslands in damp, moist areas; the plants grow in full sun in damp depressions, near pans or on the edges of streams; grassland, riverbanks, vleis.	February and March	-	Unlikely
ASPHODELACEAE					
<i>Kniphofia typhoides</i> Codd	Near Threatened [NT A2 ac]	Wetland areas dominated by climax <i>Themeda</i> grassland on heavy black clay.	February-March	2627CC	Unlikely
<i>Trachyandra erythrorrhiza</i> (Conrath) Oberm.	Near Threatened [NT B1ab (ii, iii, iv, v)]	Marshy areas, grassland, usually in black turf marshes.	September to November	-	Unlikely
CRASSULACEAE					
<i>Adromischus umbraticola</i> C.A. Sm. subsp. <i>umbraticola</i>	Near Threatened [NT B1ab (ii, iii, v)]	Rock crevices on rocky ridges, usually south-facing, or in shallow gravel on top of rocks, but often in shade of other vegetation.	September to January	-	Low
FABACEAE					
<i>Pearsonia bracteata</i> (Benth.) Polhill	Near Threatened	Plants in Gauteng and North West occur in gently sloping	December to	2626DC	Moderate

Taxon	Latest (IUCN version 3.1) Conservation Status Category*	Habitat	Flowering Time	Grid squares from which species is known to occur	Probability of occurrence within the study area and shaft complex
	[NT B1ab(i,ii,iii,iv,v)]	Highveld grassland, while those in the Wolkberg were collected from steep wooded slopes and cliffs in river valleys. De Castro & Brits (2013) observed this species at West Wits in untransformed Dolomite Grassland and quartzitic grassland.	April (De Castro & Brits, 2013 recorded it flowering in late October at Vaal Reefs in 2006).		(potential habitat observed in untransformed grassland on Shaft complexes #4 and #5, especially on Black Reef formation)
HYACINTHACEAE					
<i>Drimia sanguinea</i> (Schinz) Jessop	Near Threatened [NT A2d]	Open veld and scrubby woodland in a variety of soil types.	August to December	-	High (not recorded although potential habitat observed on Shaft complexes #4 & #5)
HYPOXIDACEAE					
<i>Hypoxis hemerocallidea</i> Fisch. & C.A. Mey.	Declining	Raimondo <i>et al.</i> (2009) state that this species occurs in a wide range of habitats, including sandy hills on the margins of dune forests, open, rocky grassland, dry, stony, grassy slopes, mountain slopes and plateaus. Appears to be drought and fire tolerant. Widespread in the eastern half of southern Africa, where its distribution extends from the Eastern Cape to Botswana and Mozambique. Western Cape to Malawi.	September to March	2626DC	Recorded (recorded in patches of natural grassland corresponding to Shaft complexes #2, #5 & adjacent to #7)
MESEMBRYANTHEMACEAE					
<i>Lithops lesliei</i> (N.E. Br.) N.E. Br. subsp. <i>lesliei</i>	Near Threatened [NT A4acd]	Primary habitat appears to be the arid grasslands in the interior of South Africa where it usually occurs in rocky places, growing under the protection of surrounding forbs and grasses.	March to June	-	Unlikely

Table 6 provides a list of declared weeds and invasive plant species observed on the study area (inclusive of all the shaft footprints). It is evident that the area was historically subjected to a variety of anthropogenic and industrial perturbation events which was responsible for the widespread colonisation of alien and invader plant taxa.

Table 6: A list of weeds and invader plant species identified on the study area. * - alien species that are exempted in the Schedule from the provisions of section 65 of the Biodiversity Act of 2004, and include species previously regulated in terms of the Conservation of Agricultural Resources Act, 1983 as weeds and invader plants.

Species	Vernacular Name	Type	Control Measure	NEMBA Category	CARA Category
<i>Flaveria bidentis</i>	Smelter's Bush	Weed	Control by means of invasive species management programme	1b	1
<i>Malvastrum coromandelianum</i>	Prickly Malvastrum	Weed	Control by means of invasive species management programme	1b	1
<i>Salsola kali</i>	Tumbleweed	Weed	Control by means of invasive species management programme	1b	1
<i>Verbena bonariensis</i>	Wild Verbena	Weed	Control by means of invasive species management programme	1b	-
<i>Acacia melanoxylon</i> *	Australian Blackwood	Invader	Control spread of species	-	2
<i>Argemone ochroleuca</i> *	Mexican Poppy	Weed	Control spread of species	-	1
<i>Arundo donax</i> *	Giant Reed	Weed	Control spread of species	-	1
<i>Canna indica</i> *	Indian Shot	Weed	Control spread of species	-	1
<i>Casuarina cf. cunninghamiana</i> *	Beefwood	Invader	Control spread of species	-	2
<i>Cereus jamacaru</i> *	Queen of the Night	Weed	Eradicate	-	1
<i>Cortaderia selloana</i> *	Pampas Grass	Weed	Control spread of species	-	1
<i>Datura ferox</i> *	Large Thorn Apple	Weed	Control spread of	-	1

Species	Vernacular Name	Type	Control Measure	NEMBA Category	CARA Category
			species		
<i>Eucalyptus camaldulensis</i> *	Red River Gum	Invader	Control spread of species	-	2
<i>Gleditsia triacanthos</i> *	Honey Locust	Invader	Control spread of species	-	2
<i>Grevillea robusta</i> *	Australian Silky Oak	Invader	Control spread of species	-	3
<i>Ipomoea purpurea</i> *	Morning Glory	Invader	Control spread of species	-	3
<i>Jacaranda mimosifolia</i> *	Jacaranda	Invader	Control spread of species	-	3
<i>Ligustrum cf. japonicum</i> *	Liguster	Invader	Control spread of species	1	3
<i>Macfadyena unguis-cati</i> *	Cat's claw Creeper	Weed	Should be eradicated	-	1
<i>Melia azedarach</i> *	Syringa	Invader	Should preferably be eradicated	-	3
<i>Morus alba</i> *	Common Mulberry	Invader	Control spread of species	-	3
<i>Nerium oleander</i> *	Oleander	Weed	Highly poisonous - should be removed	-	1
<i>Nicotiana glauca</i> *	Wild Tobacco	Weed	Control spread of species	-	1
<i>Opuntia ficus-indica</i> *	Sweet Prickly Pear	Weed	Eradicate	-	1
<i>Pennisetum setaceum</i> *	Fountain Grass	Weed	Control spread of species	-	1
<i>Pinus spp.</i> *	Pines	Invader	Control spread of species	-	2
<i>Pyracantha angustifolia</i> *	Yellow Firethorn	Invader	Control spread of species	-	3
<i>Solanum mauritianum</i> *	Bugweed	Weed	Control spread of species	-	1
<i>Tecoma stans</i> *	Yellow Bells	Weed	Should preferably be eradicated	-	1
<i>Tipuana tipu</i> *	Tipu Tree	Invader	Control spread of species	-	3
<i>Xanthium strumarium</i> *	Large Cocklebur	Weed	Control spread of species	-	1

Apart from those species listed under Table 6, many ruderal weeds were observed which include species such as *Conyza* spp., *Tagetes minuta*, *Bidens pilosa* and *B.*

bipinnata. These species are all annuals (they completely die off during the dry season), and are of temporary nature.

4.2 Occurrence of vertebrate 'species of conservation concern': Regional perspective

4.2.1 Mammal species of conservation concern

The study area provides potential habitat for 10 mammal taxa of conservation concern (Table 7), none of which were confirmed during the survey. According to historical records, two species are globally threatened and one globally near threatened (*sensu* IUCN, 2014), while one species is regionally threatened, three are regionally near threatened and five being data deficient (*sensu* Friedmann & Daly, 2004).

Table 7: A list of threatened, near threatened and conservation important mammal species that could occur on the study area (excluding introduced game) according to historical distribution records and the availability of suitable habitat. The conservation status was based on IUCN Red List (2014) and Friedman & Daly (2004).

Scientific Name	Common Name	Global Conservation Status	National Conservation Status	Probability of Occurrence	Habitat
<i>Atelerix frontalis</i>	South African Hedgehog	Least Concern	Near threatened	High, could be present.	A widespread species that prefer dry habitat types and will often utilise urban gardens.
<i>Crocidura cyanea</i>	Reddish-Grey Musk Shrew	Least Concern	Data Deficient	High.	Dry terrain among rocks in dense scrub and grass, in moist places and in hedges.
<i>Crocidura hirta</i>	Lesser Red Musk Shrew	Least Concern	Data Deficient	High.	Wide habitat tolerance.
<i>Crocidura mariquensis</i>	Swamp Musk Shrew	Least Concern	Data Deficient	Moderate.	Moist habitats, e.g. thick grass along riverbanks, reedbeds and in swamps.
<i>Felis nigripes</i>	Black-footed Cat	Vulnerable	Least Concern	Low, habitat regarded as sub-optimal	Varied, partial to short grassland with high prey densities (e.g. small mammals and terrestrial birds) and old burrows/termitaria used for shelter.
<i>Mellivora capensis</i>	Honey Badger	Least Concern	Near threatened	Moderate, regarded as an irregular visitor	Catholic, widespread and tolerant to most habitat types.
<i>Mystromys albicaudatus</i>	White-tailed Rat	Endangered	Endangered	Low (optimal habitat was absent)	A species associated with "climax" or "sub-climax" grassland on black loamy soils with good cover.
<i>Parahyaena brunnea</i>	Brown Hyaena	Near threatened	Near threatened	Moderate (probably displaced by anthropogenic activities and persecution)	Varied and very catholic in habitat preference.
<i>Suncus infinitesimus</i>	Least Dwarf Shrew	Least Concern	Data Deficient	Low.	Varied, although commonly associated with termitaria.
<i>Suncus varilla</i>	Lesser Dwarf Shrew	Least Concern	Data Deficient	Low.	Varied, although commonly associated with termitaria.

The majority of these species, with the exception of the South African Hedgehog (*Atelerix frontalis*) and shrew taxa (c. genus *Crocidura*), are uncommon or absent on the respective shaft footprints owing to anthropogenic displacement and widespread habitat transformation (including loss of habitat due to infrastructure).

A brief annotated account is provided below for those species that *could occur* on the study area:

Brown Hyaena (Parahyaena brunnea)

The Brown Hyaena is listed as near threatened on the global *IUCN Red List* (Wiesel *et al.*, 2008) since it requires extensive areas (sometimes in excess of 1000 km²) to maintain a viable population, especially where inter-specific competition for resources is fierce between other predator taxa. Such massive home ranges often coincide with livestock, human settlement and agricultural areas where they are heavily persecuted by farmers/landowners. Therefore, persecution and the loss of habitat due to agricultural intensification are some of the primary threats faced by this species.

Based on the high incidence of human activities in the area and the lack of any recent observations by citizen science projects (e.g. MammalMap) it is regarded as an occasional/irregular visitor to the area.

Honey Badger (Mellivora capensis)

The Honey Badger is listed as least concern on the global *IUCN Red List* although Friedmann and Daly (2004) have listed it as near-threatened.

Honey Badgers are widespread and generally very catholic in their habitat requirements. They are predominately nocturnal, solitary, and generally very unobtrusive in behaviour (Skinner & Chimimba, 2005). It is tolerant to modified habitat types, and personal observations from the central Mpumalanga Highveld have shown that it can persist on areas dominated by farming activities (by means of camera trapping, *pers. obs.*). This species is likely to be present on the study area and can occur almost anywhere due to its unobtrusiveness.

The regional conservation status of *M. capensis* is currently under revision, and supporting evidence suggests that it will be downgraded from near threatened to least concern (*pers. comm.*, M. Child of EWT).

South African Hedgehog (Atelerix frontalis)

The South African Hedgehog is listed as least concern on the global *IUCN Red List* although Friedmann and Daly (2004) have listed it as near threatened. This species occurs in a wide variety of habitat types, which makes prediction regarding its habitat requirements very difficult. However, illegal hunting, habitat transformation to make way for agricultural land, and hard-surfaced infrastructure (e.g. road mortalities) are probably the main reasons for its decline.

It readily adapts to urban environments and is frequently encountered in urban gardens (Skinner & Smithers, 1990). Therefore it will colonise new developments, if emphases is placed on preserving the natural function of the receiving natural habitat types while minimising the unnecessary use of exotic plant species and fragmentation of grassland habitat (e.g. the construction of roads). It is considered a resident on areas consisting of untransformed vegetation on the study area.

Data Deficient Taxa

All shrew species (genera *Crocidura* and *Suncus*) are Data Deficient and many of these taxa could occur on the study area. Most of these species are perceived to be relatively widespread and abundant, but current modifications of suitable habitats and the paucity of scientific information on meta-population demographics place these species under the Data Deficient category.

The regional conservation status of these taxa is currently under revision, and supporting evidence suggests that many taxa will be downgraded to least concern (*pers. comm.*, M. Child of EWT).

Black-footed Cat (Felis nigripes)

The localised and patchy distribution range of the Black-footed Cat is responsible for the upgrading of its conservation status from Least Concern to Vulnerable (Sliwa, 2008). According to a recent conservation assessment by the IUCN, the effective population size of Black-footed Cats may be less than 10 000 adult individuals (with subpopulations containing less than 1000 individuals). Reasons for its decline include the eminent loss of prey, genetic contamination with feral cats and human exploitation for its pelt. Its rarity is further exacerbated by the low density of adults found in suitable habitat (c. 0.17/km² or 8 adults/60 km²) (Sliwa, 2004; 2008).

The Black-footed Cat is a stenotopic species of open, short grassland sustaining high densities of small murid prey (especially *Malacothrix typica* – an important prey item

during the reproductive season) and ground-roosting birds (e.g. larks; Sliwa, 1994; 2008). It was included in the analysis since its distribution range appears to be peripheral to the study area. However, *F. nigripes* is considered to be irregular in occurrence based on the following observations:

- Most of the shaft footprint sites are transformed and the presence of humans in the areas will attract feral cats which could interbreed with *F. nigripes* (resulting in genetic contamination of the population);
- *F. nigripes* often takes refuge in disused termite mounds or springhare burrows - these habitat features provide critical shelter for *F. nigripes* (c. 98 % of 184 shelters were confined to abandoned springhare burrows (in Wilson & Mittermeyer, 2009). These habitat features were rarely encountered and were patchy in occurrence;
- Anecdotal evidence based on observations from the natural grassland habitat revealed that murid activity (e.g. burrows) was uncommon.

4.2.2 Bird species of conservation concern

Table 8 provides an overview of bird species of 'conservation concern' recorded in the study area, including those previously recorded in the area based on their known distribution range (SABAP1 and SABAP2) and the presence of suitable habitat. According to Table 8, 26 species are sympatric to the study area, of the Melodious Lark (*Mirafra cheniana*) was confirmed during the survey. In addition, the only other two bird species likely to occur regularly on the study area are the near threatened Abdim's Stork (*Ciconia abdimii*) and the vulnerable Lanner Falcon (*Falco biarmicus*). The remaining taxa are either (1) irregular foraging visitors or are (2) unlikely to be present on the study area due to the absence of suitable habitat (although they could utilise suitable habitat on adjacent properties, e.g. nearby Vaal River, impoundments and pans).

Table 8: Bird species of 'conservation concern' that could utilise the study area based on their known distribution range (SABAP1 & SABAP2) and the presence of suitable habitat. Species highlighted in grey were confirmed on the study area. Red list categories according to the IUCN (2014) and Taylor (*in press*).

Species	Global Conservation Status*	National Conservation Status**	Average SABAP1 reporting rate (n=441 cards)	Average SABAP2 Reporting rate (n=315 cards)	Preferred Habitat	Potential Likelihood of Occurrence on study area (shaft footprints)
<i>Alcedo semitorquata</i> (Half-collared Kingfisher)	-	Near threatened	0.45	-	Prefers fast-flowing and well-vegetated streams.	Unlikely to occur.

Species	Global Conservation Status*	National Conservation Status**	Average SABAP1 reporting rate (n=441 cards)	Average SABAP2 Reporting rate (n=315 cards)	Preferred Habitat	Potential Likelihood of Occurrence on study area (shaft footprints)
<i>Anthropoides paradiseus</i> (Blue Crane)	Vulnerable	Near threatened	2.27	-	Prefers open grasslands. Also forages in wetlands, pastures and agricultural land.	Vagrant to study area.
<i>Charadrius pallidus</i> (Chestnut-banded Plover)	Near threatened	Near threatened	1.36	-	Large ephemeral saline pans and depressions.	Unlikely to occur.
<i>Ciconia abdimii</i> (Abdim's Stork)	-	Near threatened	15.86	3.76	Open stunted grassland, fallow land and agricultural fields.	A fairly common summer foraging visitor to the area.
<i>Ciconia nigra</i> (Black Stork)	-	Vulnerable	2.26	-	Breeds on steep cliffs within mountain ranges; forages on ephemeral wetlands.	Unlikely to occur.
<i>Circus maurus</i> (Black Harrier)	Near threatened	Near threatened	1.82	-	Generally confined to the clay grasslands on the south-western parts of Mpumalanga.	Highly irregular and rare foraging visitor to untransformed grassland patches.
<i>Circus ranivorus</i> (African Marsh Harrier)	-	Endangered	1.36	-	Restricted to permanent wetlands with extensive reedbeds.	Unlikely to occur.
<i>Coracias garrulous</i> (European Roller)	Near threatened	Near threatened	2.0	-	Open woodland and bushveld.	An irregular to rare summer (non-breeding) visitor.
<i>Eupodotis senegalensis</i> (White-bellied Korhaan)	-	Vulnerable	1.13	-	Prefers transitional habitat between grassland and savanna (e.g. Bankenveld).	Unlikely to occur.
<i>Falco biarmicus</i> (Lanner Falcon)	-	Vulnerable	5.67	3.9	Varied, but prefers to breed in mountainous areas.	A regular foraging visitor to the area.
<i>Glareola nordmanni</i>	Near threatened	Near threatened	0.91	-	A species preferring extensive open	An uncommon to rare summer

Species	Global Conservation Status*	National Conservation Status**	Average SABAP1 reporting rate (n=441 cards)	Average SABAP2 Reporting rate (n=315 cards)	Preferred Habitat	Potential Likelihood of Occurrence on study area (shaft footprints)
(Black-winged Pratincole)					grassland, usually near wetlands. Often forages over agricultural land and pastures.	foraging visitor.
<i>Gyps africanus</i> (White-backed Vulture)	Endangered	Endangered	1.13	-	Breeds on tall, flat-topped trees. Mainly restricted to large rural or game farming areas.	Vagrant to study area.
<i>Leptoptilos crumeniferus</i> (Marabou Stork)	-	Near threatened	6.36	-	Varied, from savanna to wetlands, pans and floodplains – dependant of game farming areas.	Vagrant to the study area.
<i>Mirafrā cheniana</i> (Melodious Lark)	Near threatened	(Delisted)	-	1.64	A species with a preference for open dry “climax” <i>Themeda triandra</i> grassland or open primary grassland dominated by sour wiry grasses such as <i>Loudetia simplex</i> , <i>Tristachya rehmannii</i> and <i>Trachypogon spicatus</i> on well drained sandy substrates. Also secondary <i>Eragrostis</i> -dominated grassland.	Recorded from untransformed grassland (Shaft complex #4)
<i>Mycteria ibis</i> (Yellow-billed Stork)	-	Endangered	1.36	-	Prefers shoreline habitat bordering large impoundments and extensive wetland systems.	Unlikely to occur.
<i>Oxyura maccoa</i> (Maccoa Duck)	Near threatened	Near threatened	4.09	-	Large saline pans and shallow impoundments.	Unlikely to occur.

Species	Global Conservation Status*	National Conservation Status**	Average SABAP1 reporting rate (n=441 cards)	Average SABAP2 Reporting rate (n=315 cards)	Preferred Habitat	Potential Likelihood of Occurrence on study area (shaft footprints)
<i>Pelecanus onocrotalus</i> (Great White Pelican)	-	Vulnerable	0.91	-	Forages on large impoundments, lakes and estuaries.	Unlikely to occur.
<i>Pelecanus rufescens</i> (Pink-backed Pelican)	-	Vulnerable	1.36	-	Forages on large impoundments, lakes and estuaries.	Unlikely to occur.
<i>Phoeniconaias minor</i> (Lesser Flamingo)	Near threatened	Near threatened	2.95	1.64	Restricted to large alkaline pans and other inland water bodies.	Unlikely to occur.
<i>Phoenicopterus ruber</i> (Greater Flamingo)	-	Near threatened	5.9	1.35	Restricted to large saline pans and other inland water bodies.	Unlikely to occur.
<i>Polemaetus bellicosus</i> (Martial Eagle)	Near threatened	Endangered	0.45	4.76	Varied, from open karroid shrub to lowland savanna.	Vagrant to study site.
<i>Rhinoptilus africanus</i> (Double-banded Courser)	-	Near threatened	2.5	-	Arid, open grassland and stunted karroid veld or open gravel plains.	Very rare to uncommon resident - probably absent.
<i>Rostratula benghalensis</i> (Greater Painted Snipe)	-	Vulnerable	0.45	2.7	Inundated grassland bordering seasonal wetlands and pans.	Unlikely to occur.
<i>Sagittarius serpentarius</i> (Secretarybird)	Vulnerable	Vulnerable	7.26	-	Prefers open grassland or lightly wooded habitat.	An irregular foraging visitor.
<i>Sterna caspia</i> (Caspian Tern)	-	Vulnerable	-	33.3	Large impoundments, large rivers and coastal (marine) habitat.	Unlikely to occur.
<i>Tyto capensis</i> (African Grass-owl)	-	Vulnerable	0.91	-	Prefers rank moist grassland that borders drainage lines or wetlands.	Highly irregular foraging visitor.

A brief annotated account is provided below for those species *with a high probability to occur* on the study area:

Lanner Falcon (Falco biarmicus)

F. biarmicus is currently classified as regionally Vulnerable (Taylor, *in press*). It breeds mainly in mountainous areas and prefers ravines and vertical cliffs for nesting purposes. Although fairly common within its distribution range with approximately 1 400 pairs located in the eastern part of South Africa (Tarboton & Allen 1984), it is at risk due to persistent loss of open habitat to make way for agricultural land.

Although not observed during the survey period, *F. biarmicus* is predicted to be a fairly regular foraging visitor as indicated by the high reporting rates for this species (SABAP1 & SABAP2; Harrison *et al.*, 1997). The shaft structures on the study area (including the electricity pylons) provide potential breeding and roosting habitat for this species.

Melodious Lark (Mirafra cheniana)

Mirafra cheniana is an endemic species to southern Africa and globally listed as near threatened owing to rapid population declines caused by habitat alteration (BirdLife International, 2012). However, a recent conservation assessment has downlisted the species from regionally near threatened to Least Concern (Taylor, *in press*) since the proposed conservation targets set for this species were met in South Africa. It prefers fairly short grassland (<50 cm) with a low basal cover, especially on siliceous soils. It was previously thought to occur almost exclusively in grassland dominated by dry *Themeda triandra* (Harrison *et al.*, 1997). However, recent observations from Gauteng and Mpumalanga showed that this species have a high preference for open grassland on sandy, siliceous soils dominated by sour, wiry grasses such as *Loudetia simplex*, *Tristachya rehmannii*, *Trachypogon spicatus* and *Diheteropogon amplexans*. It will even colonise tall secondary *Hyparrhenia hirta* grassland provided that patches of short open grassland persist (*pers. obs.*).

The Melodious Lark was observed from the untransformed grassland on shaft complex #4, but is also predicted to be present on similar patches of grassland coinciding with shaft complex #5.

4.2.3 Amphibians of conservation concern

Currently, none of the frog species with distribution ranges sympatric to the study area are threatened or near threatened (Measey, 2010). It is worth mentioning that the Giant Bullfrog (*Pyxicephalus adspersus*), a species which shares its distribution range with the study area (2626DC), was historically listed as near threatened (Minter *et al.*, 2004), but

was recently downgraded to the category of Least Concern due to its wide distribution range and broad habitat tolerance. According to Channing *et. al.* (2004), its global population size is presumably large enough to buffer current declines and the alteration of its breeding habitat, which disqualifies this species for listing in a threatened category.

4.2.4 Reptiles of conservation concern

According to a recent conservation assessment (*sensu* Bates *et al.*, 2014), no reptile species present on the study are that are threatened or near threatened.

4.3. Description of vegetation units and ecological sensitivity

Appendix 1 provides a preliminary list of plant species observed on each of the shaft footprints.

4.3.1 Shaft footprint #1

Approximately 85 % of the total surface area of shaft #1 is transformed by infrastructure and build-up land cover. The remaining 15 % consists of secondary grassland.

Secondary Grassland

The extent of this unit within shaft footprint #1 is 1.13 ha (or 14.97% of the shaft footprint). It consists of two discrete grassland communities restricted to the north-western (c. 0.68 ha) and south-eastern (c. 0.45 ha) sections of the shaft complex (Figure 7 & Figure 8). Both grassland communities are located on areas that were historically severely disturbed, and is representative of a grassland sere that is at an early successional stage. The vegetation composition of the two grassland communities varies somewhat in accordance to the frequency of past disturbances. Therefore, grassland communities exposed to low levels of disturbances showed higher floristic richness values and retained some of its pre-disturbed composition (e.g. late successional graminoid taxa). For example, the grassland community pertaining to the south-eastern corner of the shaft footprint consists of small relict (pre-disturbed) stands of *Diheteropogon amplexans* and *Schizachyrium sanguineum* (both species were absent or uncommon on the other shaft footprints). In general, both grassland communities are dominated by the genera *Eragrostis*, *Enneapogon* and *Aristida*. The vegetation unit displays comparatively low species richness and the unit does not provide suitable habitat for any plant or vertebrate 'species of conservation concern'.

The vegetation unit is strongly dominated by grasses, while forb diversity is low. The dominant species are the grasses *Eragrostis curvula* and *Enneapogon cenchroides*. The grasses *Hyparrhenia hirta*, *Aristida congesta* subsp. *barbicollis* and *Cynodon dactylon* are common and localised sub-dominants. Other common grasses include *Aristida*

congesta subsp. *congesta*, *Melinis repens*, *Eragrostis lehmanniana* var. *lehmanniana*, *E. trichophora*, *Urochloa mosambicensis*, *Pogonarthria squarrosa* and *Heteropogon contortus*. Forbs include *Tagetes minuta**, *Bidens bipinnata**, *Sida rhombifolia*, *Alternanthera pungens**, *Guilleminea densa**, *Vernonia* cf. *staehelinoides*, *Verbena officinalis** and *Helichrysum nudifolium*.

This unit comprises of secondary vegetation confined to previously transformed habitats. It has a low species richness in terms of indigenous species and is not representative of untransformed regional vegetation types (as defined by Mucina & Rutherford 2006). Most of the species richness is made up of alien ruderal weeds and indigenous pioneer species, which is typical of secondary grassland. Furthermore, no 'species of conservation concern' (*sensu* Raimondo *et al.*, 2009) was recorded from the unit. However, the unit has a **low-medium** ecological sensitivity due to the presence of relict stands of late-successional taxa (Figure 9).

Infrastructure

The extent of this unit within shaft complex #1 is 6.41 ha (or 85.03 % of the shaft footprint). This unit comprises of completely transformed habitat and inclines a shaft complex, abandoned residential units and derelict buildings (Figure 7 & Figure 8).

The vegetation occurring within this unit is all secondary in nature and comprises of planted trees (both indigenous and exotic ornamentals such as *Searsia pendulina*) and ruderal weed communities. This vegetation has very low species richness in terms of indigenous species. It does not contain suitable habitat for any plant or vertebrate 'species of conservation concern' (*sensu* Raimondo *et al.*, 2009). This unit is therefore **negligible** in terms of its ecological importance and function (Figure 9).



Figure 7: An example of the broad-scale vegetation units on shaft footprint #1: (a-b) secondary grassland and (c-d) infrastructure.

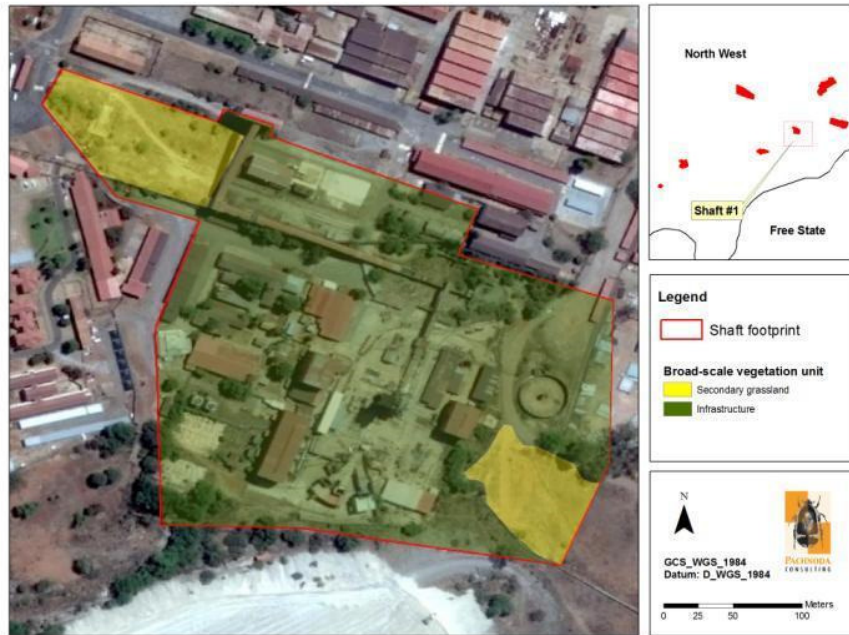


Figure 8: A map illustrating the broad-scale vegetation units identified on shaft footprint #1.

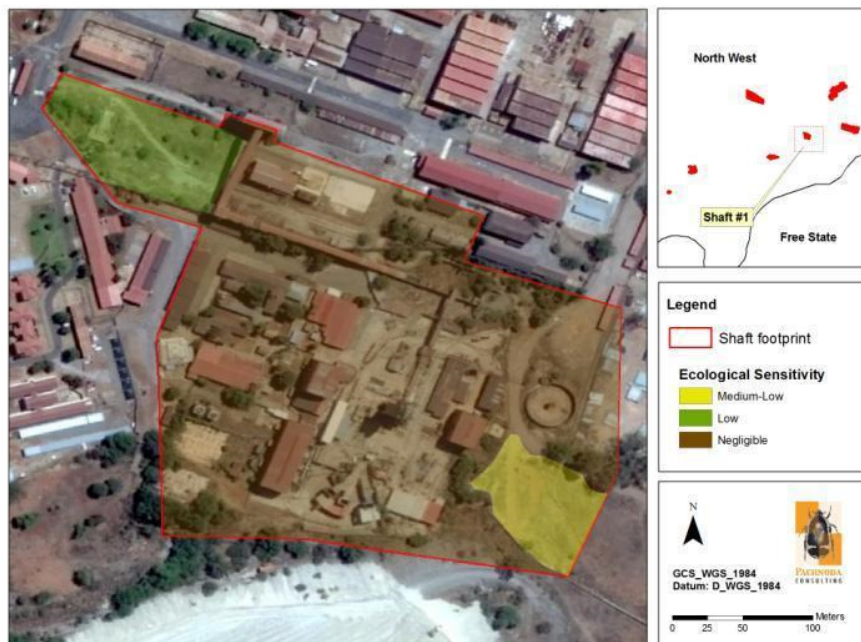


Figure 9: An ecological sensitivity map of shaft footprint #1.

4.3.2 Shaft footprint #2

Approximately 86 % of shaft footprint #2 is transformed by infrastructure. The remaining 14 % consists of secondary grassland.

Secondary Grassland

The extent of this unit within shaft footprint #2 is 4.01 ha (or 13.91 % of the shaft footprint). It consists of two discrete grassland communities restricted to the western extremity (c. 2.45 ha) and northern (c. 1.47 ha) part of the shaft complex (Figure 10 & Figure 11). These communities were historically disturbed and are characterised by a grassland sere consisting of secondary and pioneer graminoid taxa. The forb layer is almost entirely composed of annual ruderal weed species, and typifies a floristic composition at an early successional stage. Current disturbance regimes will prohibit the successional progression of the communities. The grassland community on the northern section of the shaft footprint provides suitable habitat for *Hypoxis hemerocallidea*, a declining species.

The vegetation is primarily dominated by graminoid species, and forb richness is low. The dominant grass is *Cynodon dactylon*. Sub-dominant grasses include *Hyparrhenia hirta* and *Urochloa mossambicensis*, while the dominant forb species include *Schkuhria pinnata**. Other noteworthy plant species include *Tagetes minuta**, *Guilleminea densa**, *Bidens bipinnata**, *Verbena bonariense**, *Felicia muricata* and relict populations of *Indigofera heterotricha*, *Sida chrysantha*, *Hypoxis hemerocallidea* and *Ledebouria revoluta* (these taxa are prominent on untransformed grassland communities).

This unit comprises of secondary vegetation confined to previously transformed habitats. Species richness is low and the composition is not representative of untransformed regional vegetation types (as defined by Mucina & Rutherford 2006). Most of the species richness is made up of alien ruderal weeds and indigenous pioneer species, which is typical of such secondary grassland. Furthermore, no 'species of conservation concern' (*sensu* Raimondo *et al.*, 2009), apart from scattered individuals of the declining geophyte *H. hemerocallidea*, was recorded from the unit. Therefore, this unit has a **low-medium** ecological sensitivity (Figure 12).

Infrastructure

The extent of this unit within shaft complex #2 is 24.8 ha (or 86.09 % of the shaft footprint). It comprises of completely transformed habitat and includes a shaft complex, abandoned residential units and concrete slabs. It also comprehends a derelict soccer field located on the western part of the shaft footprint (Figure 10 & Figure 11).

The vegetation occurring within this unit is all secondary in nature and comprises of planted trees (both indigenous and exotic ornamentals, in particular *Tipuana tipu**, *Melia azedarach**, *Olea europaea* subsp. *africana*, *Combretum erythrophyllum* and *Searsia pendulina*) and ruderal weed communities. The derelict soccer field is dominated by *Cynodon dactylon* and *Urochloa mossambicensis*, while prominent forb species include *Tagetes minuta** and *Bidens bipinnata**. This vegetation has very low species richness in terms of indigenous species. It does not contain suitable habitat for any plant 'species of conservation concern' (*sensu* Raimondo *et al.*, 2009) and is **negligible** in terms of its ecological importance and function (Figure 12).



Figure 10: An example of the broad-scale vegetation units on shaft footprint #2: (a-b) secondary grassland and (c-d) infrastructure.

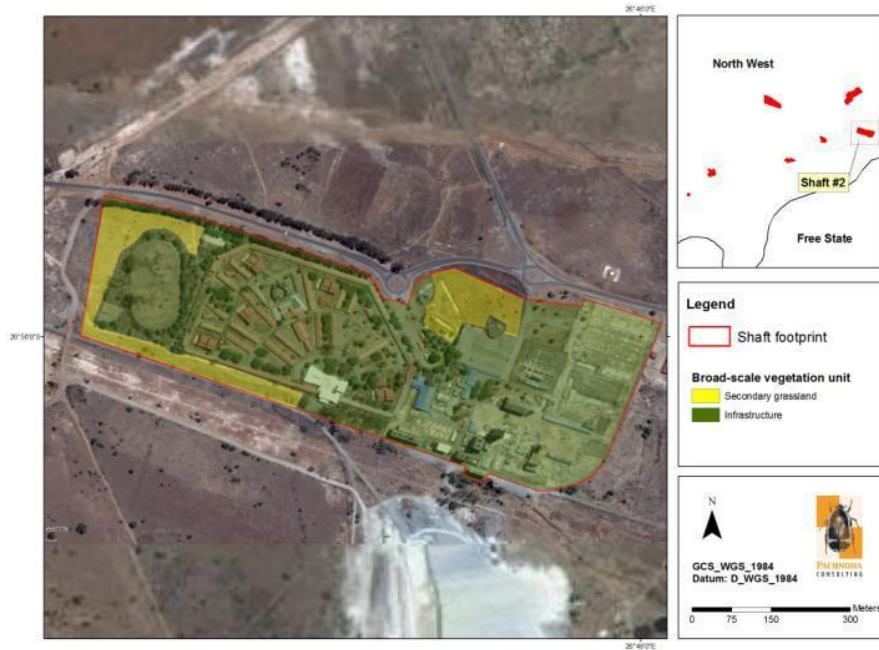


Figure 11: A map illustrating the broad-scale vegetation units identified on shaft footprint #2.

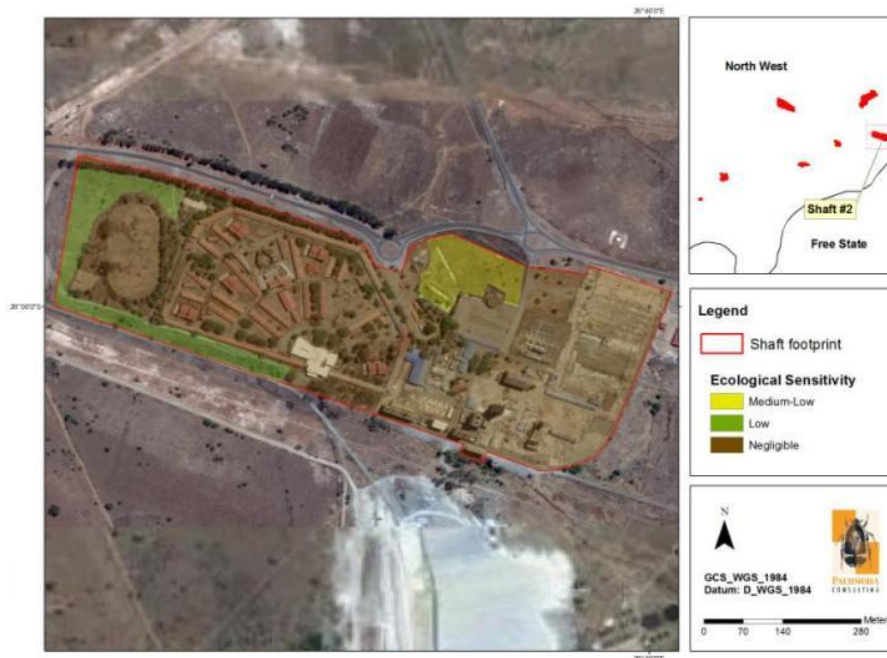


Figure 12: An ecological sensitivity map of shaft footprint #2.

4.3.3 Shaft footprint #3

Approximately 86 % of shaft footprint #3 is transformed by infrastructure. The remaining section of the shaft footprint consists of secondary grassland and secondary hygrophilous grassland.

Secondary Grassland

The extent of this unit within shaft footprint #3 is approximately 1.03 ha (or 15.55 % of the shaft footprint). It occurs on the eastern and western extremities of the shaft footprint on land that is reminiscent of past disturbances and mining activities (Figure 13 & Figure 14). The western section of the shaft footprint consists of a "plagioclimax" of *Hyparrhenia hirta*, while the grassland on the eastern section is structurally interspersed by exotic (and naturalised) bush clumps. Typical canopy constituents (pertaining to the bush clumps) include *Celtis australis**, *Tipuana tipu**, *Morus alba** along with indigenous species such as *Ziziphus mucronata*, *Searsia pyroides* and *Diospyros lycioides*.

The community is primarily composed of graminoid species while forb richness is low. The dominant grass species include *Hyparrhenia hirta*, along with sub-dominants such as *Cynodon dactylon* and *Enneapogon cenchroides*. The dominant forb species include *Tagetes minuta** and *Verbena bonariense**. In addition, no 'species of conservation concern' (*sensu* Raimondo *et al.*, 2009) was recorded from this unit.

This unit comprises of secondary vegetation confined to previously transformed habitats with a low species richness. The dominant composition includes alien ruderal weeds and indigenous pioneer species, which is typical of secondary grassland. Therefore, this unit has a **low** ecological sensitivity (Figure 15).

Infrastructure

The extent of this unit within the shaft complex #3 is 6.44 ha (or 86.15 % of the total shaft footprint). It comprises of transformed habitat and includes a shaft complex and abandoned residential buildings (Figure 13 & Figure 14).

The vegetation is secondary in nature and comprises of planted trees (both indigenous and exotic ornamentals as well as declared invader taxa) and ruderal weed communities. This vegetation has very low α - diversity while β - diversity (e.g. species richness along spatial gradients) is also low. It does not contain suitable habitat for any plant 'species of conservation concern' (*sensu* Raimondo *et al.*, 2009). This unit is **negligible** in terms of its ecological importance and function (Figure 15).

Secondary Hygrophilous Grassland

The southern section of the shaft footprint consists of a small artificial drainage line which periodically receives storm water from the nearby shaft complex. The moist conditions have facilitated the colonisation of facultative wetland plant taxa such as *Phragmites australis* and *Verbena bonariense**. Other sub-dominants include *Pennisetum clandestinum**. This unit does not contain suitable habitat for 'species of conservation concern' (*sensu* Raimondo *et al.*, 2009) although it is likely to facilitate the dispersal of small mammal taxa. Therefore, this unit has a **low-medium** ecological sensitivity (Figure 15).



Figure 13: An example of the broad-scale vegetation units on shaft footprint #3: (a) secondary hygrophilous grassland, (b-c) secondary grassland and (d) infrastructure.

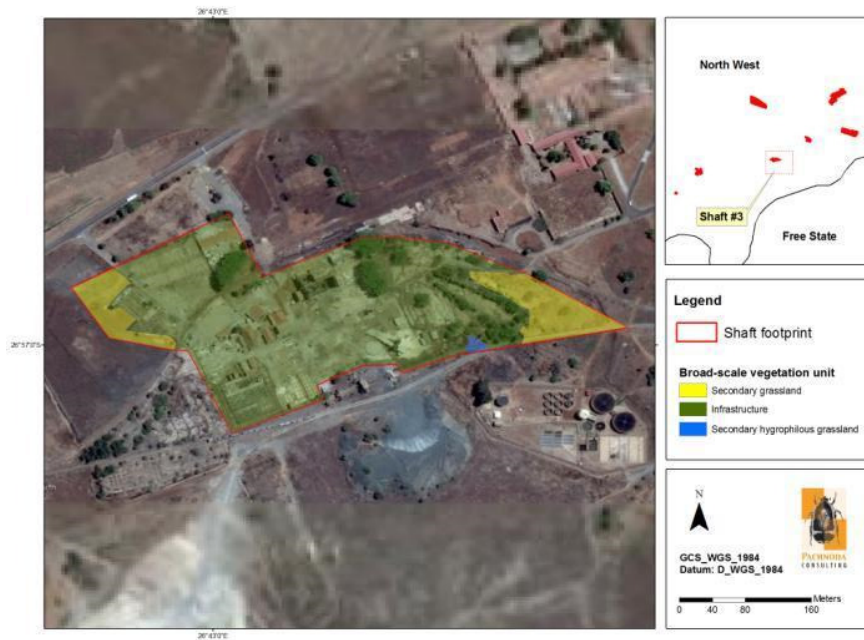


Figure 14: A map illustrating the broad-scale vegetation units identified on shaft footprint #3.

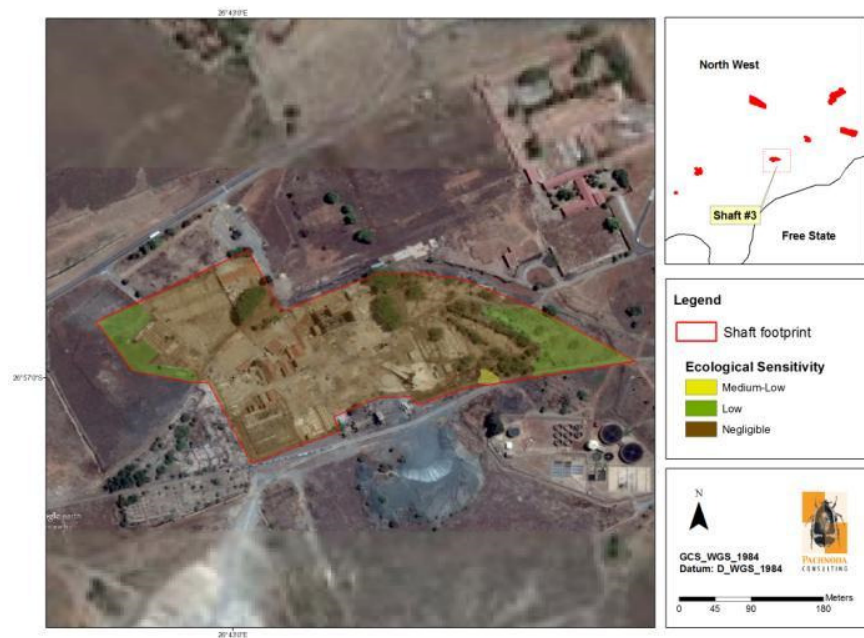


Figure 15: An ecological sensitivity map of shaft footprint #3.

4.3.4 Shaft footprint #4

The majority of shaft footprint #4 is transformed by infrastructure (c. approx. 70 % of the total surface area). The remaining section of the shaft footprint consists of secondary grassland (6.34 %) and untransformed grassland (23.47 %).

Untransformed Grassland

This unit is confined to the western section of the shaft footprint, and represents approximately 8.18 ha of the total surface area where it is prominent on brown sandy/loamy soils underlain by dolomite (Figure 16 and Figure 17). It is described as an untransformed grassland community with high richness values for both graminoid and forb species. It shows high affinities to an open *Themeda triandra* - *Indigofera heterotricha* grassland alliance, of which the herbaceous layer represents approximately 80 % of the total vegetation cover. This unit was occasionally subjected to perturbation events and low levels of disturbances (including grazing frequency) as evidenced by the high incidence of late successional taxa in the composition. Therefore, the community is not entirely at "climax" state since a number of secondary species were also detected (e.g. genera *Eragrostis* and *Aristida*). However, their presence (or dominance) is localised and contributes towards increased levels of spatial heterogeneity (e.g. as explained by the intermediate disturbance hypothesis). In fact, the evenness value for the graminoid composition was high and very few of the taxa attained high dominance values when subjective methods were applied. In addition, the floristic composition provides habitat for *Gladiolus permeabilis*, a protected species. The community also provides potential suitable habitat for two near threatened plant species (*Pearsonia bracteata* and *Drimia sanguinea*) and a small population of the globally near threatened Melodious Lark (*Mirafra cheniana*).

The graminoid composition is diverse (n=28 spp.) and is dominated by *Themeda triandra*, *Setaria sphacelata* and *Aristida congesta*. Other common grass species include *Aristida canescens*, *Eragrostis curvula*, *E. gummiflua*, *Cymbopogon pospischilii*, *Brachiaria serrata*, *Digitaria tricholaenoides*, *Aristida diffusa* and *Antheophora pubescens*. Forb richness is very high and represents approximately 70 % of the total floristic richness, with prominent taxa such as *Indigofera heterotricha*, *Vernonia oligocephala*, *Blepharis integrifolia* and *Barleria macrostegia*. Dominant shrubs include *Lippia* cf. *scaberrima*.

This unit is floristically diverse and untransformed. It provides habitat for two plant species and one bird species of 'conservation concern', and therefore has a **high** ecological sensitivity (Figure 18).

Secondary Grassland

The extent of this unit within shaft footprint #4 is approximately 2.21 ha (or 6.34 % of the shaft footprint) and is restricted to a derelict soccer field (Figure 16 and Figure 17). It is characterised by many secondary graminoid taxa and agrestal weed species. However, the unit is located within an untransformed grassland community, which increased the successional potential of the community (even though it was historically disturbed).

The dominant grass species include *Urochloa mossambicensis*, while sub-dominants include *Eragrostis chloromelas* and *Cynodon dactylon*. No 'species of conservation concern' (*sensu* Raimondo *et al.*, 2009) were recorded from this unit.

This unit comprises of secondary vegetation confined to previously transformed habitats with a low species richness in terms of indigenous species. The dominant richness is composed of ruderal weeds and indigenous pioneer species. Therefore, this unit has a **low** ecological sensitivity (Figure 18).

Infrastructure

The extent of this unit within shaft complex #4 is 24.46 ha (or 70.19 % of the total shaft footprint). It comprises of transformed habitat and includes a shaft complex and abandoned residential units (Figure 16 & Figure 17).

The vegetation occurring within this unit is all secondary in nature and comprises of neglected gardens and ruderal weed communities. It does not contain suitable habitat for any plant 'species of conservation concern' (*sensu* Raimondo *et al.*, 2009). This unit is **negligible** in terms of its ecological importance and function (Figure 18).



d



Figure 16: An example of the broad-scale vegetation units on shaft footprint #4: (a) untransformed grassland, (b) secondary grassland and (c-d) infrastructure.

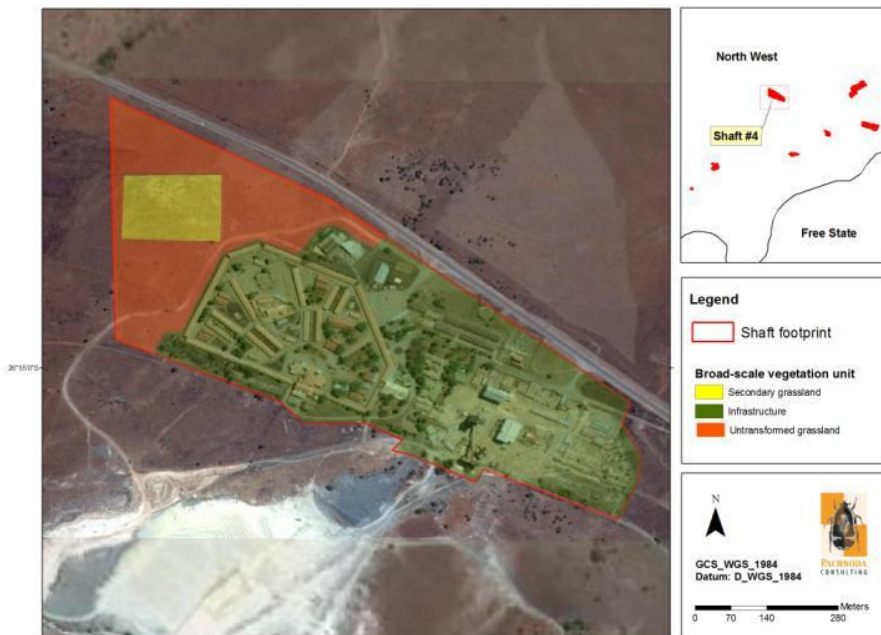


Figure 17: A map illustrating the broad-scale vegetation units identified on shaft footprint #4.

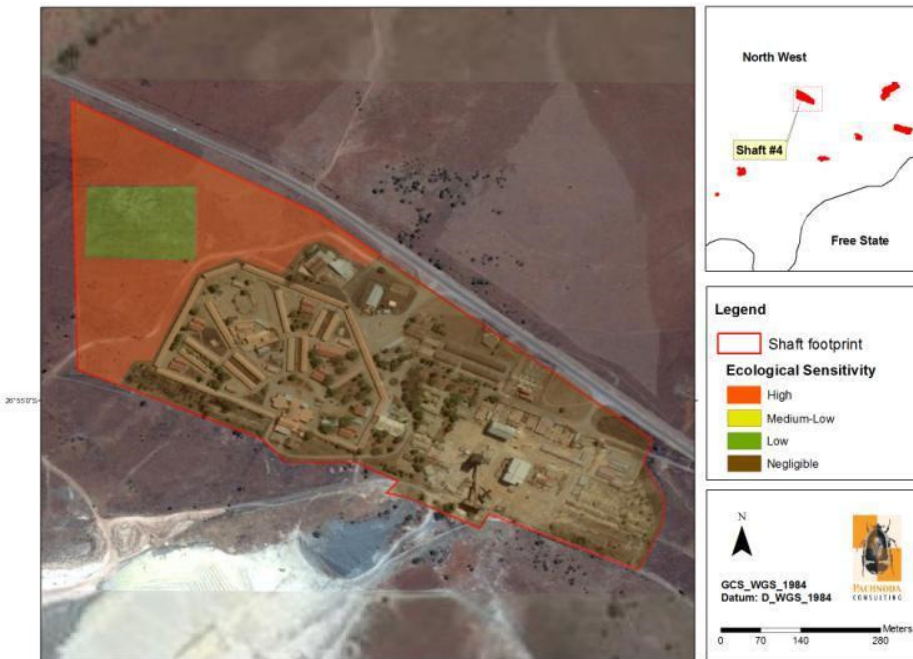


Figure 18: An ecological sensitivity map of shaft footprint #4.

4.3.5 Shaft footprint #5

Approximately 77 % of shaft footprint #5 is transformed by infrastructure. The remaining section consists of untransformed grassland (10 %), secondary grassland (10 %) and agricultural mosaics (c. 3.2 %).

Untransformed Grassland

This unit is confined to a series of fragmented grassland seres located along the edge of the shaft boundary. Cumulatively it represents approximately 4 ha, where it is prominent on brown clay/loamy soils underlain by dolomite (Figure 19 and Figure 20). Similar to the untransformed grasslands on shaft footprint #4, the graminoid and forb species richness is high. It is described as a short to medium (50-60 mm) *Themeda triandra* - *Indigofera heterotricha* - *Ledebouria revoluta* grassland alliance, of which the herbaceous layer represents approximately 70 % of the total vegetation cover. This unit was often subjected to low levels of disturbance events which resulted in the colonisation of secondary grass taxa (mainly species of the genera *Eragrostis* and *Hyparrhenia*), apart from the persistence of late-successional taxa (e.g. *Diheteropogon amplectens*, *Triraphis andropogonoides*, *Eustachys paspaloides*, *Brachiaria serrata* and *Themeda triandra*). In addition, it provides habitat for two provincial protected plant species (*Babiana hypogea*

and *Crinum graminicola*) and on declining species (*Hypoxis hemerocallidea*). It also provides potential habitat for two near threatened plant species (*Pearsonia bracteata* and *Drimia sanguinea*), and the globally near threatened Melodious Lark (*Mirafra cheniana*).

The graminoid species richness is high (n>30 spp.) and dominated by *Themeda triandra* and *Antheophora pubescens*. Other common grass species include *Triraphis andropogonoides*, *Sporobolus pyramidalis*, *Aristida canescens*, *Eragrostis trichophora*, *Digitaria argyrograpta* and *Diheteropogon amplexans*. Forb richness is very high with prominent taxa such as *Indigofera heterotricha*, *Ledebouria revoluta* and *Vernonia oligocephala*. Dominant shrubs include *Grewia flava* and *Acacia tortilis*, while the tree layer is dominated by *Searsia lancea*. Other noteworthy woody elements include *Ziziphus mucronata*, *Acacia hereroensis* and *A. karroo*.

This unit is floristically diverse even though the graminoid layer is composed of many secondary graminoid taxa. However, it provides potential habitat for protected and declining plant taxa. It therefore has a **medium-high** ecological sensitivity (Figure 21).

Secondary Grassland

The extent of this unit within shaft footprint #4 is approximately 4 ha (or 10 % of the shaft footprint) and is primarily confined to old soccer fields and agricultural land (Figure 19 and Figure 20). It is characterised by secondary graminoid species and agrestal weed communities.

The dominant plant species include *Urochloa mossambicensis*, *Cynodon dactylon* and *Schkuhria pinnata**. No 'species of conservation concern' (*sensu* Raimondo *et al.*, 2009) was recorded from this unit.

This unit comprises of secondary vegetation confined to previously transformed habitats with a low species richness. The dominant richness is composed of ruderal weeds and indigenous pioneer species. Therefore, this unit has a **low** ecological sensitivity (Figure 21).

Agricultural mosaics

This unit include 1.29 ha of subsistence farmland that is utilised for the production of *Zea mays* (maize) (Figure 19 and Figure 20). However, when the soil is tilled it is rapidly colonised by agrestal weeds such as *Tagetes minuta**, *Bidens pilosa** and the pioneer grass *Urochloa mossambicensis*. This unit has a **low** ecological sensitivity (Figure 21).

Infrastructure

The extent of this unit within shaft complex #4 is 30.73 ha (or 76.82 % of the total shaft footprint). It comprises of transformed habitat including a shaft complex and abandoned residential units (Figure 19 & Figure 20).

The vegetation occurring within this unit is all secondary in nature and comprises of neglected gardens and ruderal weed communities. It does not contain suitable habitat for any plant 'species of conservation concern' (*sensu* Raimondo *et al.*, 2009). This unit is **negligible** in terms of its ecological importance and function (Figure 21).

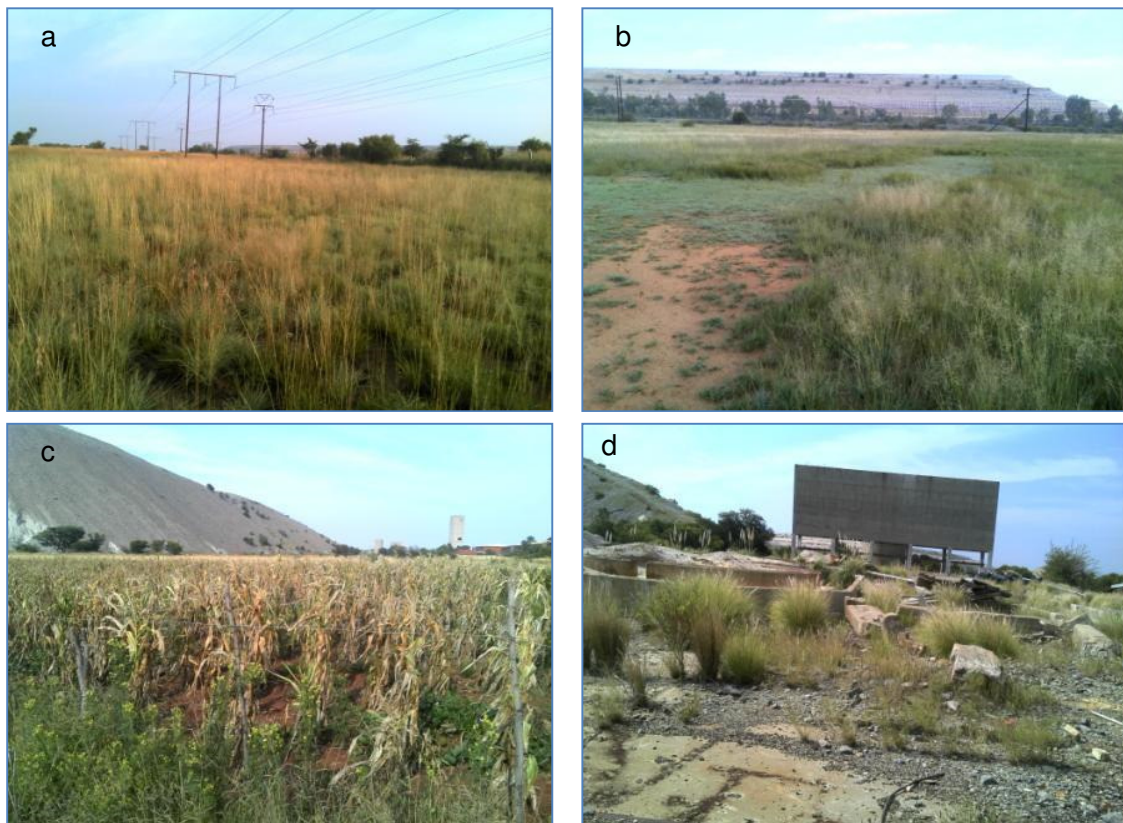


Figure 19: An example of the broad-scale vegetation units on shaft footprint #5: (a) untransformed grassland, (b) secondary grassland, (c) agricultural mosaics and (d) infrastructure.

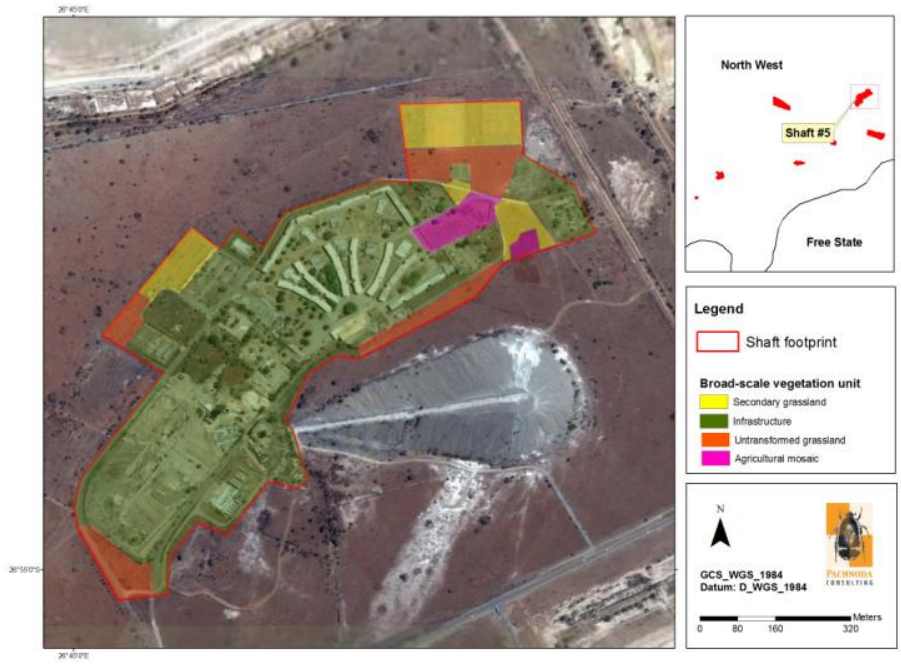


Figure 20: A map illustrating the broad-scale vegetation units identified on shaft footprint #5.

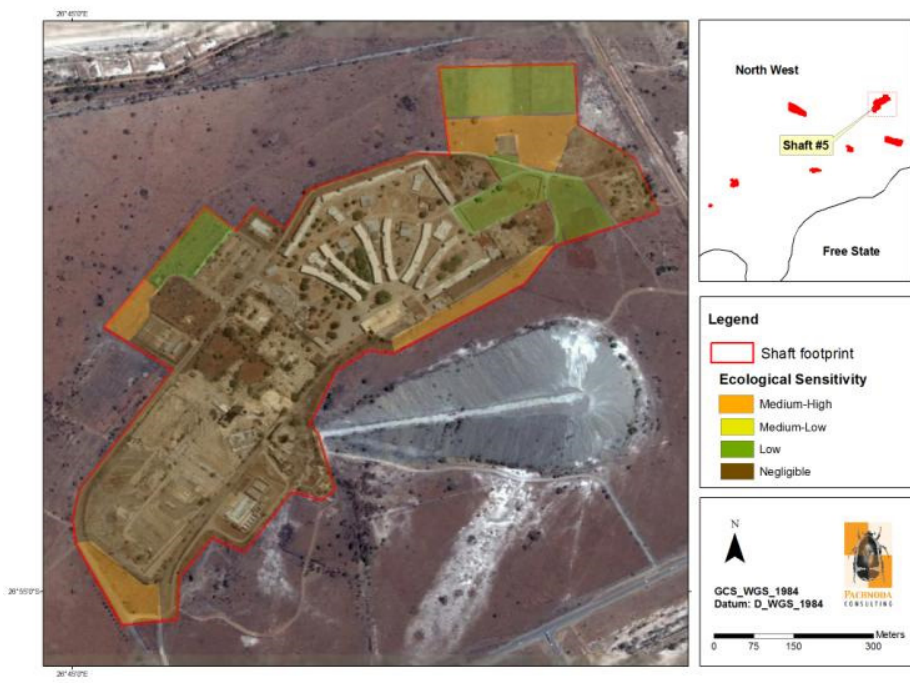


Figure 21: An ecological sensitivity map of shaft footprint #5.

4.3.6 Shaft footprint #6

The entire surface area of shaft footprint #6 is transformed by infrastructure (c. 1.37 ha).

Infrastructure

This unit comprises of transformed habitat including a shaft complex, abandoned residential units and derelict office buildings (Figure 22 & Figure 23).

The vegetation occurring within this unit is all secondary in nature and comprises of neglected gardens and ruderal weed communities. It does not contain suitable habitat for any plant 'species of conservation concern' (*sensu* Raimondo *et al.*, 2009). This unit is **negligible** in terms of its ecological importance and function (Figure 24).



Figure 22: An example of the broad-scale vegetation units on shaft footprint #6: (a-b) infrastructure.

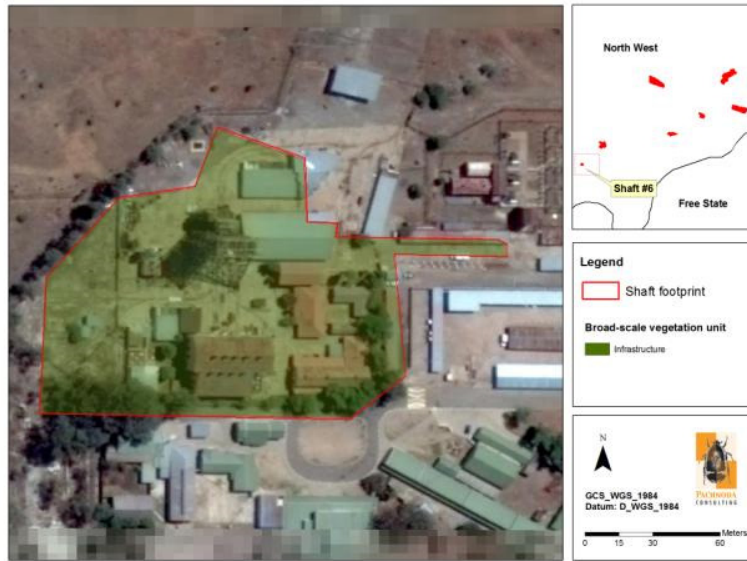


Figure 23: A map illustrating the broad-scale vegetation units identified on shaft footprint #6.



Figure 24: An ecological sensitivity map of shaft footprint #6.

4.3.7 Shaft footprint #7

Approximately 85 % of shaft footprint #7 is transformed by infrastructure. The remaining section of the shaft footprint consists of secondary grassland (15 %).

Secondary Grassland

The extent of this unit within shaft footprint #7 is approximately 1.77 ha (or 15.10 % of the shaft footprint) and is located on the southern parts of the complex (Figure 25 and Figure 26). It is characterised by severely degraded grassland and ruderal weed species among tall stands of *Eucalyptus* cf. *camaldulensis**.

The dominant plant species include *Melinis repens*, *Enneapogon cenchroides* and *Tagetes minuta**. No 'species of conservation concern' (*sensu* Raimondo *et al.*, 2009) was recorded from this unit.

This unit comprises of degraded secondary vegetation confined to previously transformed habitats with a low species richness. Therefore, this unit has a **low** ecological sensitivity (Figure 27).

It is worth mentioning that this unit is located in close proximity to untransformed grassland where declining species such as *Boophone disticha* and *Hypoxis hemerocallidea* were recorded. Therefore, it is imperative to prevent an overspill of construction and operational activities into areas consisting of untransformed grassland.

Infrastructure

The extent of this unit within shaft complex #7 is 9.93 ha (or 84.90 % of the total shaft footprint). It comprises of transformed habitat consisting of a shaft complex, abandoned office buildings and residential buildings (Figure 25 & Figure 26).

The vegetation occurring within this unit is all secondary in nature and comprises of neglected gardens, extensive stands of *Eucalyptus* spp.* and ruderal weed communities. It does not contain suitable habitat for any plant 'species of conservation concern' (*sensu* Raimondo *et al.*, 2009). This unit is **negligible** in terms of its ecological importance and function (Figure 27).



Figure 25: An example of the broad-scale vegetation units on shaft footprint #7: (a) secondary grassland and (b-d) infrastructure.

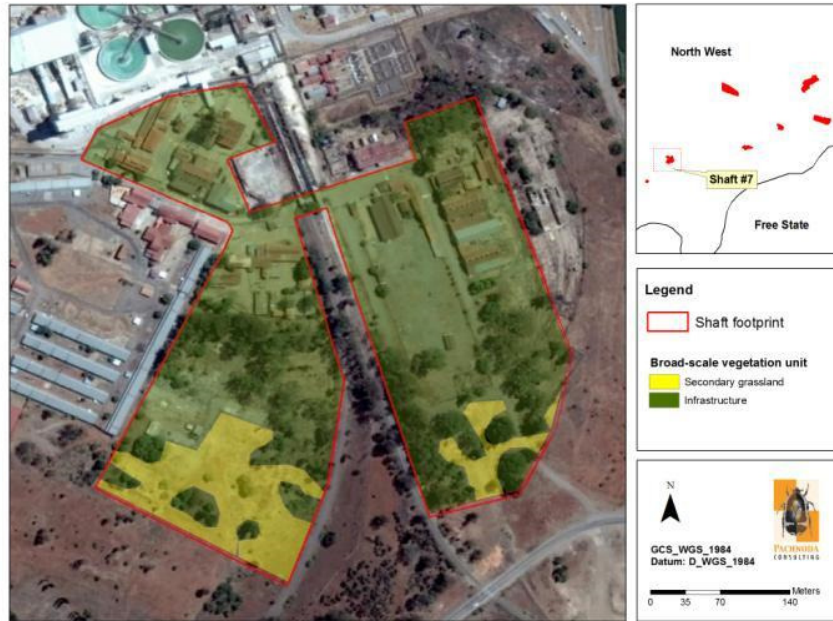


Figure 26: A map illustrating the broad-scale vegetation units identified on shaft footprint #7.

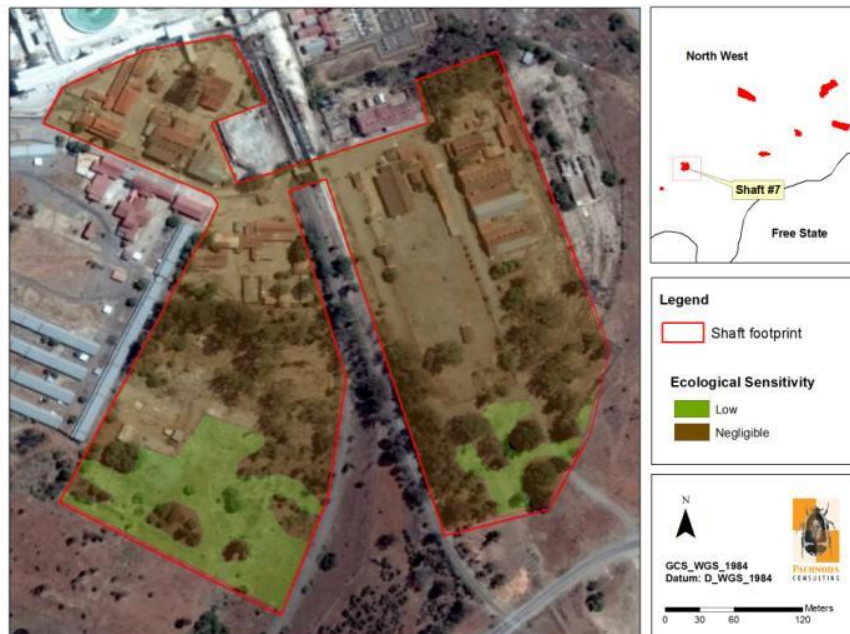


Figure 27: An ecological sensitivity map of shaft footprint #7.

4.4 Recommendations

Based on the findings of the current survey, and the guidelines and recommendations contained in all available biodiversity conservation planning tools and legislation, the majority of the study area is suitable for the proposed development from an ecological perspective, although special care should be taken not to disrupt the ecological integrity or species composition of the untransformed grassland units (communities with medium-high or high ecological sensitivity). The following recommendations are proposed:

- The attached sensitivity maps should be used to guide the layout design. Construction and operational activities should preferably be restricted to areas identified with **negligible or low conservation importance**. Construction and operation activities on areas of **high or medium-high conservation importance** and/or **untransformed grassland** should be avoided;
- An overspill of construction and operational activities into areas consisting of untransformed grassland should be prohibited, unless environmental authorisation has been obtained. The extent of the construction site/laydown areas should be demarcated on site layout plans (restricted to areas identified with low conservation importance), and no construction personnel or vehicles may leave the demarcated area except those authorised to do so. Those areas surrounding the construction site that are not part of the demarcated development area should be considered as “no-go” areas for employees, machinery or even visitors;
- In order to confirm the presence of Near Threatened species, it is recommended that prior to any development, additional brief follow-up surveys should be conducted focusing on searching the untransformed portions of the study area for *Drimia sanguinea*. These should be done in September/October. The brief additional surveys will serve to fill in seasonal gaps in the field surveys conducted for the current study, expand the species list provided in Appendix 1 and confirm the absence of any additional threatened plant species within the study area. In the event of any ‘species of conservation concern’ being recorded during such follow-up surveys, appropriate *in situ* and / or *ex situ* conservation measures should be developed and implemented;
- In the event that the development of the study area is approved, permission for the removal of Declining species should be obtained from the relevant authority, and if necessary appropriate *in situ* and / or *ex situ* conservation measures should be developed and implemented. Illegal harvesting of Declining medicinal plants should be monitored and discouraged through control of access to the study area;
- It is recommended that where untransformed habitats are to be affected by any approved development, protected/declining species are to be rescued and placed in a nursery or donated to a research institute (e.g. SANBI or regional botanical

garden) prior to development. Where possible, viable sub-populations of such species can also be translocated to transformed or degraded areas within the study area which provide potentially suitable habitats and which are not earmarked for development (translocations will have to be carried out in a manner that ensures that no ecological degradation of the host habitat occurs), and will have to be evaluated by a botanist for each species and each potential host area. A permit must be obtained prior to removal or destruction of any protected plant species.

- An alien and invasive plant eradication and control programme must be implemented along with a follow-up programme. The programme must be compiled by a qualified botanist/ecologist and the implementation thereof should be supervised by a qualified botanist/ecologist.
- To ensure the long-term viability and to promote species diversity of the untransformed grassland units (including adjacent grassland seres that are not part of the shaft footprints), a basic fire and grazing management plan should be drafted and implemented (along with monitoring).

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6. APPENDICES

Appendix 1: A list of plant species recorded on the proposed shaft footprints. * - refers to exotic species. ** - refers to planted ornamentals.

FAMILY & Species	#1	#2	#3	#4	#5	#6	#7
Pteridophytes							
OPHIOGLOSSACEAE							
<i>Ophioglossum polyphyllum</i> var. <i>polyphyllum</i>				1	1		
Monocotyledons							
AMARYLLIDACEAE							
<i>Crinum graminicola</i>					1		
ANTHERICACEAE							
<i>Chlorophytum cooperi</i>					1		
<i>Chlorophytum fasciculatum</i>				1	1		
ASPARAGACEAE							
<i>Asparagus africanus</i>				1			
<i>Asparagus cooperi</i>				1			
<i>Asparagus laricinus</i>		1	1		1	1	
<i>Asparagus</i> cf. <i>setaceus</i>		1					
<i>Asparagus suaveolens</i>				1	1		
ASPHODELACEAE							
<i>Aloe greatheadii</i> var. <i>davyana</i>	1	1	1		1		
<i>Bulbine capitata</i>					1		
CANNACEAE							
* <i>Canna italica</i>	1						
COMMELINACEAE							
<i>Commelina africana</i>				1	1		
<i>Commelina benghalensis</i>	1	1	1			1	
<i>Commelina</i> cf. <i>eckloniana</i>				1	1		
<i>Cyanotis speciosa</i>				1	1		
CYPERACEAE							
<i>Bulbostylis burchellii</i>				1	1		
* <i>Cyperus esculentus</i>		1					
<i>Kyllinga alba</i>				1			
HYACINTHACEAE							
<i>Ledebouria marginata</i>				1	1		
<i>Ledebouria revoluta</i>		1	1	1	1		1
<i>Ornithogalum</i> sp.		1		1	1		
HYPOXIDACEAE							

FAMILY & Species	#1	#2	#3	#4	#5	#6	#7
<i>Hypoxis hemerocallidea</i>		1			1		
IRIDACEAE							
<i>Babiana hypogea</i>					1		
<i>Gladiolus permeabilis</i>				1			
POACEAE							
<i>Andropogon schirensis</i>					1		
<i>Anthephora pubescens</i>				1	1		
<i>Aristida bipartita</i>	1	1	1	1		1	1
<i>Aristida canescens</i>				1	1		
<i>Aristida congesta</i> subsp. <i>congesta</i>	1	1	1	1	1	1	1
<i>Aristida congesta</i> subsp. <i>barbicollis</i>	1	1	1	1	1		
<i>Aristida diffusa</i>	1	1	1	1	1		1
<i>Aristida</i> cf. <i>meridionalis</i>					1		
<i>Aristida stipitata</i> var. <i>graciliflora</i>			1	1	1		
* <i>Arundo donax</i>							1
<i>Bewisia biflora</i>				1			
<i>Brachiaria serrata</i>				1	1		
<i>Chloris pycnothrix</i>	1	1	1	1	1		1
<i>Chloris virgata</i>	1	1	1		1		1
* <i>Cortaderia selloana</i>		1			1		
<i>Cymbopogon caesius</i>		1	1	1	1		
<i>Cymbopogon pospischilii</i>				1	1		
<i>Cynodon dactylon</i>	1	1	1	1	1	1	1
<i>Digitaria argyrograpta</i>				1	1		
<i>Digitaria eriantha</i>	1			1	1		
<i>Digitaria sanguinalis</i>		1		1			
<i>Digitaria ternata</i>		1					
<i>Digitaria tricholaenoides</i>	1			1	1		
<i>Diheteropogon amplexens</i>	1				1		
<i>Echinochloa holubii</i>			1				
<i>Eleusine coracana</i> subsp. <i>africana</i>	1			1	1		
<i>Elionurus muticus</i>		1	1	1	1		
<i>Enneapogon cenchroides</i>	1	1	1	1	1	1	1
<i>Eragrostis biflora</i>			1				
<i>Eragrostis chloromelas</i>	1	1	1	1	1		
<i>Eragrostis curvula</i>	1		1	1	1	1	1
<i>Eragrostis gummiflua</i>				1	1		
<i>Eragrostis lehmanniana</i> var. <i>lehmanniana</i>	1		1	1	1	1	
<i>Eragrostis plana</i>					1		

FAMILY & Species	#1	#2	#3	#4	#5	#6	#7
<i>Eragrostis X pseudo-obtusa</i>		1					
<i>Eragrostis pseudosclerantha</i>	1	1	1	1	1		
<i>Eragrostis rigidior</i>				1			
<i>Eragrostis trichophora</i>	1	1	1	1	1	1	1
<i>Eragrostis superba</i>				1	1		
* <i>Eragrostis tef</i>						1	
<i>Eustachys paspaloides</i>				1	1		
<i>Heteropogon contortus</i>	1		1	1	1		
<i>Hyparrhenia hirta</i>	1	1	1	1	1	1	1
<i>Hyparrhenia cf. dregeana</i>			1				
<i>Hyparrhenia cf. filipendula</i>			1				
<i>Loudetia simplex</i>				1	1		
<i>Melinis nerviglumis</i>					1		
<i>Melinis repens</i>	1	1	1	1	1	1	1
<i>Microchloa caffra</i>				1	1		
<i>Panicum coloratum</i> var. <i>coloratum</i>					1		
<i>Panicum maximum</i>	1						
<i>Panicum schinzii</i>	1	1	1	1	1		
* <i>Paspalum dilatatum</i>	1	1	1				
* <i>Pennisetum clandestinum</i>	1	1	1			1	
* <i>Pennisetum setaceum</i>	1	1	1		1		
<i>Phragmites australis</i>		1	1				
<i>Pogonarthria squarrosa</i>	1		1	1	1		
<i>Schizachyrium sanguineum</i>	1			1	1		
<i>Setaria sphacelata</i>		1		1	1		
* <i>Setaria pallide-fusca</i>		1					
<i>Setaria verticillata</i>	1	1		1			
* <i>Sorghum cf. bicolor</i>						1	
<i>Sporobolus africanus</i>				1	1		
<i>Sporobolus discosporus</i>				1			
<i>Sporobolus pyramidalis</i>		1		1	1		
<i>Stipagrostis uniplumis</i> var. <i>neesii</i>				1	1		
<i>Themeda triandra</i>				1	1		
<i>Trachypogon spicatus</i>				1	1		
<i>Tragus berteronianus</i>				1	1		
<i>Trichoneura grandiglumis</i>		1		1	1		
<i>Triraphis andropogonoides</i>		1		1	1		
<i>Urelytrum agropyroides</i>				1			
<i>Urochloa mossambicensis</i>	1	1	1	1	1	1	

FAMILY & Species	#1	#2	#3	#4	#5	#6	#7
<i>Urochloa panicoides</i>		1	1				
TYPHACEAE							
<i>Typha capensis</i>	1						
Dicotyledons							
ACANTHACEAE							
<i>Barleria macrostegia</i>				1	1		
<i>Blepharis integrifolia</i>				1	1		
<i>Blepharis squarrosa</i>				1	1		
<i>Crabbea acaulis</i>				1	1		
<i>Crabbea angustifolia</i>				1	1		
<i>Crabbea hirsuta</i>				1	1		
AMARANTHACEAE							
* <i>Alternanthera pungens</i>	1	1	1	1	1	1	1
* <i>Amaranthus hybridus</i>		1	1	1			
* <i>Gomphrena celosoides</i>	1	1	1	1	1	1	1
* <i>Guilleminea densa</i>	1	1	1	1	1	1	1
ANACARDIACEAE							
* <i>Schinus molle</i>	1			1	1		1
<i>Searsia lancea</i>	1	1	1	1	1	1	1
<i>Searsia pyroides</i>	1	1	1	1	1	1	
** <i>Searsia pendulina</i>		1		1	1		1
APOCYNACEAE							
<i>Gomphocarpus fruticosus</i>	1	1	1	1	1		
* <i>Nerium oleander</i>				1			1
<i>Pentarrhinum inspidum</i>		1		1			
<i>Raphionacme hirsuta</i>		1			1		
<i>Raphionacme cf. velutina</i>				1			
ASTERACEAE							
* <i>Bidens bipinnata</i>	1	1	1	1	1	1	1
* <i>Bidens pilosa</i>	1	1	1	1	1	1	1
* <i>Conyza albida</i>		1	1	1	1		
* <i>Conyza bonariensis</i>					1		
* <i>Conyza canadensis</i>		1		1	1		
<i>Conyza podocephala</i>				1			
* <i>Coreopsis lanceolata</i>				1			
<i>Dicoma anomala</i>				1			
<i>Dicoma macrocephala</i>				1			
<i>Felicia muricata</i>		1		1	1		
* <i>Flaveria bidentis</i>	1	1	1		1	1	1

FAMILY & Species	#1	#2	#3	#4	#5	#6	#7
<i>Gazania krebsiana</i>				1	1		
<i>Helichrysum caespititium</i>				1	1		
<i>Helichrysum dregeanum</i>				1			
<i>Helichrysum nudifolium</i> [<i>H. coriaceum</i>]	1			1	1	1	
<i>Helichrysum rugulosum</i>				1	1		
<i>Lactuca inermis</i>			1				
<i>Nidorella resedifolia</i>			1	1	1		
<i>Nidorella hottentotica</i>				1	1		
<i>Osteospermum muricatum</i>				1			
<i>Osteospermum scariosum</i> var. <i>scariosum</i>				1			
<i>Pseudognaphalium luteo-album</i>			1				
* <i>Schkuhria pinnata</i>	1	1	1	1	1	1	1
<i>Senecio affinis</i>		1					
<i>Senecio erubescens</i>				1			
<i>Senecio coronatus</i>							1
<i>Seriphium plumosum</i>				1	1		1
<i>Sonchus dregeanus</i>	1	1					
* <i>Tagetes minuta</i>	1	1	1	1	1	1	1
<i>Ursinia nana</i>				1	1		
<i>Vernonia oligocephala</i>				1	1		
<i>Vernonia</i> cf. <i>staehelinoidea</i>	1						
* <i>Xanthium strumarium</i>	1						
BIGNONIACEAE							
* <i>Jacaranda mimosifolia</i>	1						
* <i>Macfadyena unguis-cati</i>				1			1
* <i>Tecoma stans</i>				1		1	
BORAGINACEAE							
<i>Ehretia rigida</i>				1			
<i>Heliotropium</i> sp.			1	1			
BRASSICACEAE							
<i>Lepidium africanum</i>		1					
* <i>Lepidium bonariense</i>		1		1			
<i>Rorippa nudiuscula</i>				1			
CACTACEAE							
* <i>Cereus jamacaru</i>				1			
* <i>Opuntia ficus-indica</i>		1					
CAMPANULACEAE							
<i>Wahlenbergia</i> cf. <i>virgata</i>			1				

FAMILY & Species	#1	#2	#3	#4	#5	#6	#7
CAPPARACEAE							
<i>Cleome maculata</i>					1		
<i>Cleome monophylla</i>					1		
<i>Cleome rubella</i>					1		
CARYOPHYLLACEAE							
<i>Dianthus mooiensis</i>				1			
<i>Pollichia campestris</i>				1	1		
CASUARINACEAE							
* <i>Casuarina cunninghamiana</i>							1
CELTIDACEAE							
* <i>Celtis australis</i>	1	1	1	1	1	1	1
<i>Celtis africana</i>	1	1			1		
CELASTRACEAE							
<i>Gymnosporia buxifolia</i>		1					
CHENOPODIACEAE							
* <i>Chenopodium album</i>		1					1
* <i>Chenopodium carinatum</i>	1	1	1	1	1	1	1
* <i>Salsola kali</i>	1		1				
COMBRETACEAE							
** <i>Combretum erythrophyllum</i>		1		1	1		1
CONVOLVULACEAE							
<i>Convolvulus sagittatus</i> subsp. <i>sagittatus</i> var. <i>phyllosepalus</i>					1		
<i>Ipomoea bathycolpos</i>				1	1		
<i>Ipomoea crassipes</i>				1	1		
<i>Ipomoea obscura</i>					1		
* <i>Ipomoea purpurea</i>	1			1		1	1
<i>Ipomoea transvaalensis</i>				1	1		
<i>Xenostegia tridentata</i> [<i>Merremia tridentata</i>]					1		
CRASSULACEAE							
<i>Crassula lanceolata</i> subsp. <i>transvaalensis</i>				1			
CUCURBITACEAE							
<i>Coccinia sessilifolia</i>	1						
<i>Cucumis zeyheri</i>				1	1		
<i>Trochomeria macrocarpa</i> subsp. <i>macrocarpa</i>					1		
EBENACEAE							
<i>Diospyros lycioides</i>			1				
EUPHORBIACEAE							
<i>Acalypha angustata</i> var. <i>glabra</i>				1	1		

FAMILY & Species	#1	#2	#3	#4	#5	#6	#7
<i>Chamaesyce inaequilatera</i>	1	1	1	1	1		
<i>Chamaesyce hirta</i>			1				1
<i>Phyllanthus cf. incurvus</i>				1	1		
FABACEAE							
** <i>Acacia galpinii</i>							1
<i>Acacia hereroensis</i>				1	1		
<i>Acacia karroo</i>	1			1	1	1	1
<i>Acacia tortilis</i>					1		
* <i>Acacia melanoxylon</i>							1
<i>Chamaecrista comosa</i>	1			1	1		
<i>Crotalaria cf. sphaerocarpa</i>		1		1	1		
<i>Elephantorrhiza elephantina</i>				1	1		
* <i>Gleditsia triacanthos</i>		1	1	1	1		1
<i>Indigofera daleoides</i> var. <i>daleoides</i>		1					
<i>Indigofera heterotricha</i>		1	1	1	1		
<i>Indigofera melanadenia</i>				1	1		
<i>Neorautanenia ficifolius</i>		1		1	1		
<i>Rhynchosia adenodes</i>			1	1	1		
<i>Senna italica</i> subsp. <i>arachoides</i>				1			1
<i>Tephrosia</i> sp.				1	1		
* <i>Tipuana tipu</i>	1	1	1	1	1		
<i>Vigna vexillata</i> var. <i>vexillata</i>				1	1		
<i>Zornia linearis</i>				1			
FAGACEAE							
* <i>Quercus</i> spp.							1
GERANIACEAE							
<i>Monsonia angustifolia</i>					1		
<i>Monsonia burkeana</i>					1		
LAMIACEAE							
<i>Salvia radula</i>				1			
MALVACEAE							
<i>Hibiscus pusillus</i>				1	1		
* <i>Malvastrum coromandelianum</i>	1	1	1		1	1	1
<i>Sida</i> cf. <i>chrysantha</i>		1	1	1	1		
<i>Sida dregei</i>	1				1	1	
<i>Sida rhombifolia</i>	1	1		1	1	1	1
MELIACEAE							
* <i>Melia azedarach</i>	1	1	1	1		1	1
MOLLUGINACEAE							

FAMILY & Species	#1	#2	#3	#4	#5	#6	#7
* <i>Limeum viscosum</i>							1
MORACEAE							
* <i>Morus alba</i>		1	1	1	1	1	1
MYRTACEAE							
* <i>Acca (=Feijoa) sellowiana</i>				1			
* <i>Callistemon viminalis</i>							1
* <i>Eucalyptus</i> sp.							1
* <i>Eucalyptus</i> cf. <i>camaldulensis</i>	1	1	1			1	1
NYCTAGINACEAE							
* <i>Boerhavia</i> cf. <i>erecta</i>	1	1	1	1	1	1	1
OLEACEAE							
* <i>Ligustrum</i> cf. <i>japonicum</i>	1					1	1
** <i>Olea europaea</i> subsp. <i>africana</i>		1					
* <i>Fraxinus</i> cf. <i>americana</i>	1	1	1	1	1	1	1
ONAGRACEAE							
* <i>Oenothera tetraptera</i>				1			
OROBANCHACEAE							
<i>Striga bilabiata</i>				1			
<i>Striga elegans</i>			1		1		
OXALIDACEAE							
* <i>Oxalis corniculata</i>		1	1				
PAPAVERACEAE							
* <i>Argemone ochroleuca</i>	1					1	
PINACEAE							
* <i>Pinus</i> spp.		1					1
PEDALIACEAE							
<i>Dicerocaryum eriocarpum</i>				1			
PLANTAGINACEAE							
<i>Plantago lanceolata</i>	1					1	
PLUMBAGINACEAE							
** <i>Plumbago</i> cf. <i>auriculata</i>	1						
POLYGALACEAE							
<i>Polygala hottentota</i>				1			
POLYGONACEAE							
<i>Oxygonum dregeanum</i>		1		1	1		
* <i>Persicaria lapathifolia</i>			1				
* <i>Rumex</i> cf. <i>usambarensis</i>						1	
PORTULACACEAE							
<i>Portulaca kermesina</i>				1	1		

FAMILY & Species	#1	#2	#3	#4	#5	#6	#7
<i>Portulaca cf. quadrifida</i>				1	1		
PROTEACEAE							
* <i>Grevilea robusta</i>		1			1		
RANUNCULACEAE							
<i>Clematis brachiata</i>		1	1	1	1		
RHAMNACEAE							
<i>Ziziphus mucronata</i>		1	1	1	1		1
<i>Ziziphus zeyheriana</i>					1		
ROSACEAE							
* <i>Pyracantha angustifolia</i>	1	1					
RUBIACEAE							
<i>Anthospermum rigidum</i>				1	1		
<i>Kohautia amatymbica</i>					1		
<i>Pygmaeothamnus zeyheri</i>					1		
<i>Vangueria infausta</i> subsp. <i>infausta</i>		1					
SALICACEAE							
* <i>Populus deltoides</i>	1		1				1
SANTALACEAE							
<i>Thesium</i> sp.				1	1		
SCROPHULARIACEAE							
<i>Jamesbrittenia aurantiaca</i>					1		
<i>Selago densiflora</i>				1	1		
SOLANACEAE							
* <i>Datura ferox</i>		1					
* <i>Nicotiana glauca</i>		1	1				
* <i>Physalis angulata</i>					1		
<i>Solanum incanum</i>					1		
* <i>Solanum mauritianum</i>	1						
<i>Solanum panduriforme</i>					1		
<i>Solanum supinum</i>				1	1		
STERCULIACEAE							
<i>Hermannia depressa</i>				1	1		
<i>Hermannia tomentosa</i>				1			
<i>Hermannia transvaalensis</i>				1			
<i>Waltheria indica</i>					1		
TAMARICACEAE							
* <i>Tamarix</i> sp.	1	1	1				
THYMELAEACEAE							
<i>Gnidia capitata</i>				1	1		

FAMILY & Species	#1	#2	#3	#4	#5	#6	#7
TILIACEAE							
<i>Corchorus asplenifolius</i>	1		1	1	1		
<i>Grewia flava</i>		1		1	1		
<i>Triumfetta sonderi</i>					1		
ULMACEAE							
* <i>Ulmus parvifolia</i>		1		1			
VERBENACEAE							
<i>Chascanum hederaceum</i>				1			
<i>Lantana rugosa</i>					1		
<i>Lippia scaberrima</i>				1	1		1
* <i>Verbena bonariensis</i>		1	1		1		
* <i>Verbena officinalis</i>	1	1	1	1	1	1	1
ZYGOPHYLLACEAE							
<i>Tribulus terrestris</i>		1		1	1	1	