

ECOLOGICAL FAUNA AND FLORA HABITAT SURVEY AND  
BIODIVERSITY ASSESSMENT

**Proposed township establishment, Ixopo, KwaZulu-Natal  
Province**



Flowers and foliage of alien invasive *Solanum mauritianum* (bugweed) at the site.  
Photo: Reinier F. Terblanche.

**AUGUST 2022**

**COMPILED BY:**

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(M.Sc Ecology, *Cum Laude*; Pr.Sci.Nat, Reg. No. 400244/05)

ANTHENE ECOLOGICAL CC

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## I) SPECIALIST EXPERTISE

### SYNOPTIC CV: REINIER. F. TERBLANCHE

Reinier is an ecologist and in particular a habitat specialist with an exceptional combination of botanical and zoological expertise which he keeps fostering, updating and improving. He is busy with a PhD for which he registered at the Department of Conservation Ecology at the University of Stellenbosch. The PhD research focuses on the landscape ecology of selected terrestrial and wetland butterflies in South Africa. Reinier's experience includes being a lecturer in ecology and zoology at the North West University, Potchefstroom Campus (1998-2008). Reinier collaborates with a number of institutes, organizations and universities on animal, plant and habitat research.

#### Qualifications:

Qualification	Main subject matter	University
<b>M.Sc Cum Laude, 1998:</b> Botany: Ecology	Quantitative study of invertebrate assemblages and plant assemblages of rangelands in grasslands.	North-West University, Potchefstroom
<b>B.Sc Honns Cum Laude, 1992</b> Botany: Taxonomy	Distinctions in all subjects: Plant Anatomy, Taxonomy, Modern Systematics, System Modelling, Plant Ecology, Taxonomy Project, Statistics Attendance Course.	North-West University, Potchefstroom
<b>B.Sc</b> Botany, Zoology	Main subjects: Botany, Zoology.	North-West University, Potchefstroom
<b>Higher Education Diploma, 1990</b>	Numerous subjects aimed at holistic training of teachers.	North-West University, Potchefstroom

In research Reinier specializes in conservation biology, threatened butterfly species, vegetation dynamics and ant assemblages at terrestrial and wetland butterfly habitats as well as enhancing quantitative studies on butterflies of Africa. He has published extensively in the fields of taxonomy, biogeography and ecology in popular journals, peer-reviewed scientific journals and as co-author and co-editor of books (see 10 examples beneath).

Reinier practices as an ecological consultant and has been registered as a Professional Natural Scientist by SACNASP since 2005: Reg. No. 400244/05. His experience in consultation includes: Flora and fauna habitat surveys, Threatened species assessments, Riparian vegetation index surveys, Compilation of Ecological Management Plans, Biodiversity Action Plans and Status quo of biodiversity for Environmental Management Frameworks, Wetland Assessments, Management of Rare Wetland Species.

*Recent activities/ awards:* Best Poster Award at Oppenheimer De Beers Group Research Conference 2015, Johannesburg. One of the co-authors of Guidelines for Standardised Global Butterfly Monitoring, 2015, Group on Earth Observations Biodiversity Observation Network, Leipzig, Germany (UNEP-WCMC), GEO BON Technical Series 1. Awarded the prestigious Torben Larsen Memorial Tankard in October 2017; one is awarded annually to the person responsible for the most outstanding written account on Afrotropical Lepidoptera. Lectured as Conservationist-in-Residence in the Wildlife Conservation Programme of the African Leadership University, Kigali, Rwanda, 9-23 February 2019. Reinier won a photographic competition which resulted his photograph of the Critically Endangered *Erikssonia edgei* (Waterberg Copper) being on the front cover of the Synthesis Report of the National Biodiversity Assessment (2018) prepared by SANBI.

## EXPERIENCE

Lecturer: Zoology 1998-2008	Main subject matter and level	Organization
Lectured subjects	- <u>3<sup>rd</sup> year level</u> Ecology, Plantparasitology - <u>2<sup>nd</sup> year level</u> Ethology - <u>Master's degree</u> Evolutionary Ethology, Systematics in Practice, Morphology and Taxonomy of Insect Pests, Wetlands.	North-West University, Potchefstroom and University of South Africa
Co-promoter	PhD: Edge, D.A. 2005. Ecological factors that influence the survival of the Brenton Blue butterfly	North-West University, Potchefstroom
Study leader/ assistant study leader	Six MSc students, One BSc Honn student: Various quantitative biodiversity studies (terrestrial and aquatic).	North-West University, Potchefstroom
Teacher 1994-1998	Biology and Science, Secondary School	Afrikaans Hoër Seunskool, Pretoria
Owned Anthene Ecological CC 2008 – present	- Flora and Fauna habitat surveys - Highly specialized ecological surveys - Riparian vegetation index surveys - Ecological Management Plans - Biodiversity Action Plans - Biodiversity section of Environmental Management Frameworks - Wetland assessments	Private Closed Corporation that has been subcontracted by many companies
Herbarium assistant 1988-1991	- Part-time assistant at the A.P. Goossens herbarium, Botany Department, North-West University, 1988, 1989, 1990 and 1991 (as a student).	North-West University, Potchefstroom

## 10 EXAMPLES OF PUBLICATIONS OF WHICH R.F. TERBLANCHE IS AUTHOR/ CO-AUTHOR

(Three books, two chapters in books and five articles are listed here as examples)

- HENNING, G.A., **TERBLANCHE, R.F.** & BALL, J.B. (eds) **2009**. *South African Red Data Book: butterflies*. SANBI Biodiversity Series 13. South African National Biodiversity Institute, Pretoria. 158p. ISBN 978-1-919976-51-8
- MECENERO, S., BALL, J.B., EDGE, D.A., HAMER, M.L., HENNING, G.A., KRÜGER, M., PRINGLE, E.L., **TERBLANCHE, R.F.** & WILLIAMS, M.C. (eds). 2013. *Conservation Assessment of Butterflies of South Africa, Lesotho and Swaziland: Red List and atlas*. Saffronics (Pty) Ltd., Johannesburg & Animal Demography Unit, Cape Town.
- VAN SWAAY, C., REGAN, E., LING, M., BOZHINOVSKA, E., FERNANDEZ, M., MARINI-FILHO, O.J., HUERTAS, B., PHON, C.-K., KÓRÓSI, A., MEERMAN, J., PE'ER, G., UEHARA-PRADO, M., SÁFIÁN, S., SAM, L., SHUEY, J., TARON, D., **TERBLANCHE, R.F.** & UNDERHILL, L. 2015. Guidelines for Standardised Global Butterfly Monitoring. Group on Earth Observations Biodiversity Observation Network, Leipzig, Germany. GEO BON Technical Series 1.
- TERBLANCHE, R.F.** & HENNING, G.A. **2009**. *A framework for conservation management of South African butterflies in practice*. In: Henning, G.A., Terblanche, R.F. & Ball, J.B. (eds). *South African Red Data Book: Butterflies*. SANBI Biodiversity Series 13. South African National Biodiversity Institute, Pretoria. p. 68 – 71.
- EDGE, D.A., **TERBLANCHE, R.F.**, HENNING, G.A., MECENERO, S. & NAVARRO, R.A. 2013. Butterfly conservation in southern Africa: Analysis of the Red List and threats. In: Mecenero, S., Ball, J.B., Edge, D.A., Hamer, M.L., Henning, G.A., Krüger, M., Pringle, E.L., Terblanche, R.F. & Williams, M.C. (eds). *Conservation Assessment of Butterflies of South Africa, Lesotho and Swaziland: Red List and Atlas*. pp. 13-33. Saffronics (Pty) Ltd., Johannesburg & Animal Demography Unit, Cape Town.
- TERBLANCHE, R.F.**, SMITH, G.F. & THEUNISSEN, J.D. **1993**. Did Scott typify names in *Haworthia* (Asphodelaceae: Alooideae)? *Taxon* **42**(1): 91–95. (International Journal of Plant Taxonomy).
- TERBLANCHE, R.F.**, MORGENTHAL, T.L. & CILLIERS, S.S. **2003**. The vegetation of three localities of the threatened butterfly species *Chrysothrix aureus* (Lepidoptera: Lycaenidae). *Koedoe* **46**(1): 73-90.
- EDGE, D.A., CILLIERS, S.S. & **TERBLANCHE, R.F.** **2008**. Vegetation associated with the occurrence of the Brenton blue butterfly. *South African Journal of Science* **104**: 505 - 510.
- GARDINER, A.J. & **TERBLANCHE, R.F.** **2010**. Taxonomy, biology, biogeography, evolution and conservation of the genus *Eriksonia* Trimen (Lepidoptera: Lycaenidae) *African Entomology* **18**(1): 171-191.
- TERBLANCHE, R.F.** 2016. *Acraea trimeni* Aurivillius, [1899], *Acraea stenobeia* Wallengren, 1860 and *Acraea neobule* Doubleday, [1847] on host-plant *Adenia repanda* (Burch.) Engl. at Tswalu Kalahari Reserve, South Africa. *Metamorphosis* **27**: 92-102.

\* A detailed CV with more complete publication list is available.

## II) SPECIALIST DECLARATION

I, Reinier F. Terblanche, as the appointed independent specialist, in terms of the 2014 EIA Regulations (as amended), hereby declare that I:

- I act as the independent specialist in this application;
- I 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;
- regard the information contained in this report as it relates to my specialist input/study to be true and correct, and do not have and will not have any financial interest in the undertaking of the activity, other than remuneration for work performed in terms of the NEMA, the Environmental Impact Assessment Regulations, 2014 (as amended) and any specific environmental management Act;
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting the specialist report relevant to this application, including knowledge of the Act, Regulations and any guidelines that have relevance to the proposed activity;
- I will comply with the Act, Regulations and all other applicable legislation;
- I have no, and will not engage in, conflicting interests in the undertaking of the activity;
- I have no vested interest in the proposed activity proceeding;
- 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;
- I have ensured that information containing all relevant facts in respect of the specialist input/study was distributed or made available to interested and affected parties and the public and that participation by interested and affected parties was facilitated in such a manner that all interested and affected parties were provided with a reasonable opportunity to participate and to provide comments on the specialist input/study;
- I have ensured that the comments of all interested and affected parties on the specialist input/study were considered, recorded and submitted to the competent authority in respect of the application;
- all the particulars furnished by me in this specialist input/study are true and correct; and
- I realise that a false declaration is an offence in terms of regulation 48 and is punishable in terms of section 24F of the Act.

Name of Specialist: Reinier F. Terblanche



Signature of the specialist

Date: 26 August 2022

## **1 INTRODUCTION**

An ecological habitat survey was required for a proposed township establishment located on the Remaining Extent of Erf 175 and a Portion of Erf 174, Stewartstown, Ixopo, Ubuhlebezwe Local Municipality, KwaZulu-Natal Province (elsewhere referred to as the site). The survey focused on the possibility that threatened fauna or flora known to occur in KwaZulu-Natal Province are likely to occur within the proposed development or not as well as to provide a biodiversity assessment. Species of known high conservation priority that do not qualify for threatened status also received attention in the survey.

### **1.1 OBJECTIVES OF THE HABITAT STUDY**

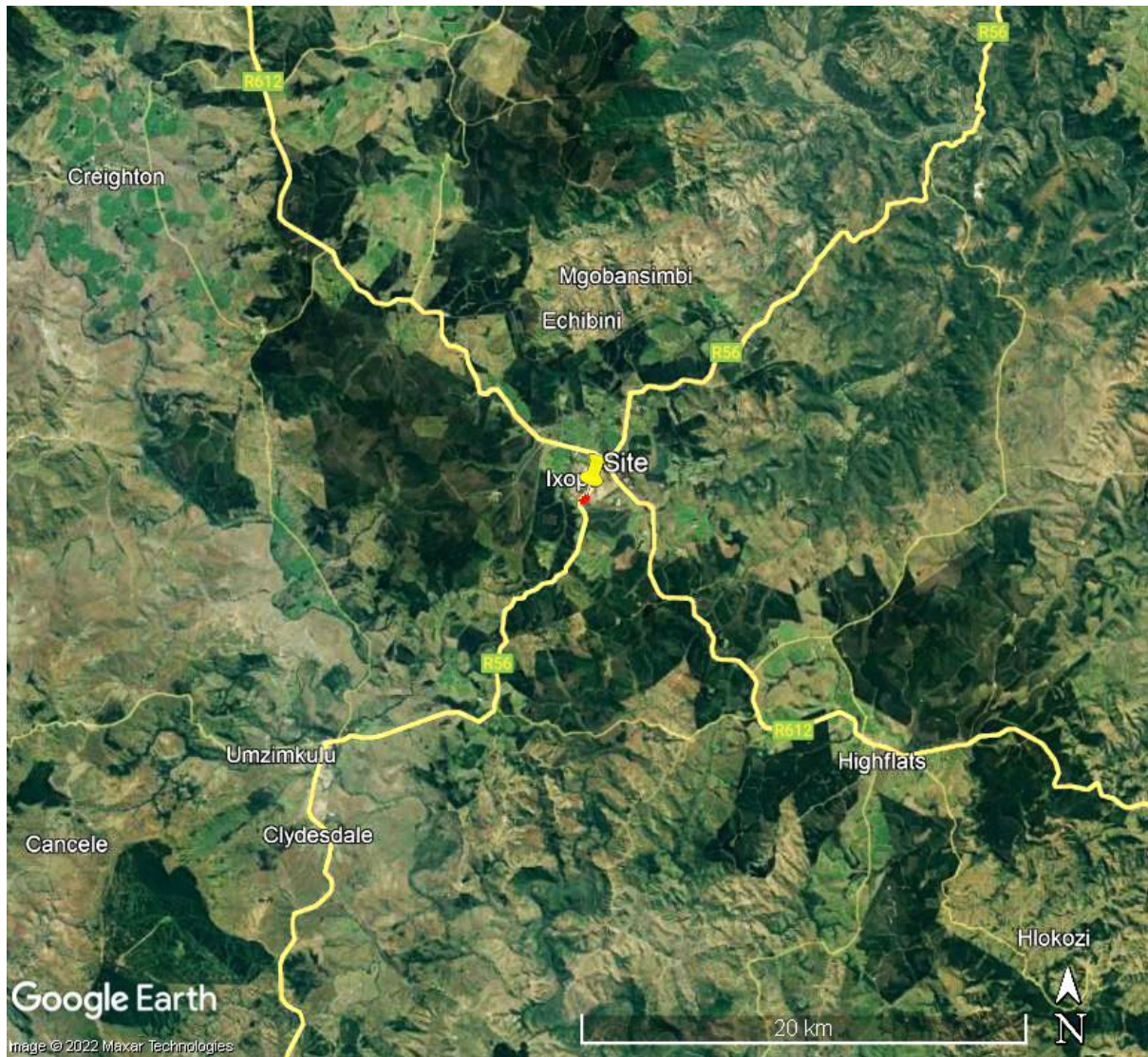
The objectives of the habitat study are to provide:

- A detailed fauna and flora habitat survey;
- A detailed habitat survey of possible threatened or localised plant species, vertebrates and invertebrates;
- Recording of possible host plants or foodplants of fauna such as butterflies.
- Evaluate the conservation importance and significance of the site with special emphasis on the current status of threatened species;
- Literature investigation of possible species that may occur on site;
- Identification of potential ecological impacts on fauna and flora that could occur as a result of the development; and
- Make recommendations to reduce or minimise impacts, should the development be approved.

### **1.2 SCOPE OF STUDY**

- Surveys to investigate key elements of habitats on the site, relevant to the conservation of fauna and flora.
- Recording of any sightings and/or evidence of existing fauna and flora.
- The selective and careful collecting of voucher specimens of invertebrates where deemed necessary.
- An evaluation of the conservation importance and significance of the site with special emphasis on the current status of threatened species.
- Recording of possible host plants or foodplants of fauna such as butterflies.
- Literature investigation of possible species that might occur on site.
- Integration of the literature investigation and field observations to identify potential ecological impacts that could occur as a result of the development.
- Integration of literature investigation and field observations to make recommendations to reduce or minimise impacts, should the development be approved.

## 2 STUDY AREA



**Figure 1** Map of larger area with indication of the location of the site.

Map information were analysed and depicted on Google images with the aid of Google Earth Pro (US Dept. of State Geographer, MapLink/ Tele Atlas, Google, 2022).

The study area is at Ixopo in the KwaZulu-Natal province. The study area is situated at the Grassland Biome (Mucina & Rutherford 2006). The Grassland Biome at the site is represented by Midlands Mistbelt Grassland (Gs 9) (Mucina & Rutherford 2006).

### **Gs 9 Midlands Mistbelt Grassland**

Distribution: In South Africa the Midlands Mistbelt Grassland is found in the KwaZulu-Natal and Eastern Cape Provinces. In the KwaZulu-Natal Midlands the vegetation type is scattered in a broad belt in the form of several major patches including the Melmoth-Babanango area, Kranskop and Greytown, Howick Lions River, Karkloof, Balgowan, Cedara, Edendale, Hilton, Richmond, Ixopo-Highflats area, Mount Malowe in the Umzimkulu enclave of the Eastern Cape Province and the Harding-Weza area. The southwesternmost section in the Eastern Cape Province falls in the Bulemnu, Gxwaleni, Longweni and Flagstaff areas. Altitude ranges from 760 m – 1400 m (Mucina & Rutherford, 2006).

Vegetation and landscape features. Hilly and rolling landscape mainly associated with a discontinuous east-facing scarp formed by dolerite intrusions (south of the Thukela River). Dominated by forb-rich, tall, sour *Themeda triandra* grasslands transformed by the invasion of native 'Ngongoni grass (*Aristida junciformis*). Only a few patches of the original species-rich grasslands remain (Mucina & Rutherford, 2006).

Geology and soils. Apedal and plinthic soil forms derived mostly from Ecca Group (Karoo Supergroup) shale and minor sandstone and less importantly from Jurassic dolerite dykes and sills. Dominant land type Ac, followed by Fa (Mucina & Rutherford, 2006).

Climate: Summer rainfall, with MAP of 915 mm, range 730-1280 mm. Heavy and frequent occurrence of mist provides significant amounts of additional moisture (Cedara near Pietermaritzburg has 46 misty days per year). Some of the rain is in the form of cold frontal activity, mainly in winter, spring and early summer. Thunderstorms are common in summer and autumn (Cedara: 60 days of thunderstorms per year). Frosts are generally moderate, but occasional severe frost may also occur (Mucina & Rutherford, 2006).

Important plant taxa: Graminoids: *Andropogon appendiculatus*, *Aristida junciformis* subsp. *galpinii*, *Diheteropogon filifolius*, *Eragrostis plana*, *Hyparrhenia hirta*, *Sporobolus africanus*, *Themeda triandra*, *Tristachya leucothrix*, *Alloteropsis semialata* subsp. *eckloniana*, *Andropogon schirensis*, *Brachiaria serrata*, *Cymbopogon ceasius*, *Cymbopogon nardus*, *Digitaria diagonalis*, *Digitaria tricholaenoides*, *Diheteropogon amplexans*, *Elionurus muticus*, *Eragrostis capensis*, *Eragrostis curvula*, *Eragrostis racemosa*, *Eulalia villosa*, *Harporchloa falx*, *Heteropogon contortus*, *Loudetia simplex*, *Microchloa caffra*, *Monocymbium cerasiiforme*, *Panicum aequinerve*, *Panicum ecklonii*, *Panicum natalense*, *Paspalum dilatatum*, *Paspalum scrobiculatum*, *Paspalum urvillei*, *Setaria nigrirostris*, *Setaria sphacelata*, *Sporobolus centrifugus*, *Trachypogon spicatus*. Herbs: *Acalypha glandulifolia*, *Acanthospermum australe*, *Berkheya rhapontica* subsp. *aristosa*, *Berkheya setifera*, *Commelina africana*, *Conyza*



*pinnata*, *Eriosema salignum*, *Helichrysum cephaloideum*, *Helichrysum simillimum*, *Indigastrum fastigiatum*, *Kohautia amatymbica*, *Nidorella auriculata*, *Pentanisia prunelloides* subsp. *latifolia*, *Sebaea sedoides* var. *schoenlandii*, *Spermacoce natalensis*, *Thunbergia atriplicifolia*, *Vernonia dregeana*, *Vernonia natalensis*, *Wahlenbergia undulata*. Herbaceous climber: *Vigna nervosa*. Geophytic herbs: *Pteridium aquilinum*, *Corycium nigrescens*, *Drimia macrocentra*, *Eriospermum ornithogaloides*, *Gladiolus ecklonii*, *Habenaria dives*, *Habenaria dregeana*, *Hypoxis multiceps*, *Hypoxis rigidula* var. *pilosissima*, *Rhodohypoxis baurii* var. *baurii*, *Rhodohypoxis baurii* var. *platypetala*, *Satyrium longicauda*. Low shrubs: *Helichrysum sutherlandii*, *Leonotis ocymifolia*, *Otholobium cafferum*.

Note: The above is an outline of the vegetation type that serves as a larger ecological context within which the site occurs. Not all the plant species listed above for the vegetation type necessarily occur at the site.

### **3 METHODS**

A desktop study comprised not only an initial phase, but also it was used throughout the study to accommodate and integrate all the data that become available during the field observations.

A survey consisted of visits by R.F. Terblanche during May 2022 to note key elements of habitats on the site, relevant to the conservation of fauna and flora. The main purpose of the site visit was ultimately to serve as a habitat survey that concentrated on the possible presence or not of threatened species and other species of high conservation priority.

The following sections highlight the materials and methods applicable to different aspects that were observed.

#### **3.1 HABITAT CHARACTERISTICS AND VEGETATION**

The habitat was investigated by noting habitat structure (rockiness, slope, plant structure/ physiognomy) as well as floristic composition. Voucher specimens of plant species were only taken where the taxonomy was in doubt and where the plant specimens were of significant relevance for invertebrate conservation. In this case no plant specimens were needed to be collected as voucher specimens or to be send to a herbarium for identification. A wealth of guides and detailed works of plant identifications, ecology and conservation is fortunately available and very useful. Field guides, biogeographic works, species lists, diagnostic outlines, conservation statuses and detail on specific plant groups were sourced from Boon (2010), Court (2010), Fish, Mashau, Moeaha & Nembudani (2015), Germishuizen (2003), Germishuizen, Meyer & Steenkamp (2006), Goldblatt (1986), Goldblatt & Manning (1998), Jacobsen (1983), Manning (2003), Manning (2009), McMurtry, Grobler, Grobler & Burns (2008), Pooley (1998), Retief & Herman (1997), Smit (2008), Van Ginkel, Glen, Gordon-Gray, Cilliers, Muasya & Van Deventer (2011), Van Jaarsveld (2006), Van Oudtshoorn (1999), Van Wyk (2000), Van Wyk & Smith (2001), Van Wyk & Smith (2003), Van Wyk & Malan (1998) and Van Wyk & Van Wyk (1997). Lists of species, species names and the conservation status of species were mainly sourced from Raimondo, von Staden, Victor, Helme, Turner, Kamundi & Manyama (2009) and updated versions of red lists and species from the Threatened Species Programme of SANBI and the Red List of South African Plants ([sanbi.org.za](http://sanbi.org.za)).

### **3.2 MAMMALS**

Mammals were noted as sight records by day. For the identification of species and observation of diagnostic characteristics Smithers (1986), Skinner & Chimimba (2005), Cillié, Oberprieler and Joubert (2004) and Apps (2000) are consulted. Sites have been walked, covering as many habitats as possible. Signs of the presence of mammal species, such as calls of animals, animal tracks (spoor), burrows, runways, nests and faeces were recorded. Walker (1996), Stuart & Stuart (2000) and Liebenberg (1990) were consulted for additional information and for the identification of spoor and signs. Trapping was not done since it proved not necessary in the case of this study.

Habitat characteristics were also surveyed to note potential occurrences of mammals. Many mammals can be identified from field sightings but, with a few exceptions, bats, rodents and shrews can only be reliably identified in the hand, and then some species needs examination of skulls, or even chromosomes (Apps, 2000).

### **3.3 BIRDS**

Birds were noted as sight records, mainly with the aid of binoculars (10x30). Nearby bird calls of which the observer was sure of the identity were also recorded. For practical skills of noting diagnostic characteristics, the identification of species and observation techniques Ryan (2001) is followed. For information on identification, biogeography and ecology Barnes (2000), Hockey, Dean & Ryan, P.G. (2005), Cillié, Oberprieler & Joubert (2004), Tarboton & Erasmus (1998) and Chittenden (2007) were consulted. Ringing of birds fell beyond the scope of this survey and was not deemed necessary. Sites have been walked, covering as many habitats as possible. Signs of the presence of bird species such as spoor and nests have additionally been recorded. Habitat characteristics were surveyed to note potential occurrences of birds.

### **3.4 REPTILES**

Reptiles were noted as sight records in the field. Binoculars (10x30) can also be used for identifying reptiles of which some are wary. For practical skills of noting diagnostic characteristics, the identification of species and observation techniques, Branch (1998), Marais (2004), Alexander & Marais (2007) and Cillié, Oberprieler and Joubert (2004) were followed. Sites were walked, covering as many habitats as possible. Smaller reptiles are sometimes collected for identification, but this practice was not necessary in the case of this study. Habitat characteristics are surveyed to note potential occurrences of reptiles.

### **3.5 AMPHIBIANS**

Frogs and toads are noted as sight records in the field or by their calls. For practical skills of noting diagnostic characteristics, the identification of species and observation techniques Carruthers (2001), Du Preez (1996), Conradie, Du Preez, Smith & Weldon (2006) and the recent complete guide by Du Preez & Carruthers (2009) are consulted. CD's with frog calls by Carruthers (2001) and Du Preez & Carruthers (2009) are used to identify species by their calls when applicable. Sites are walked, covering as many habitats as possible. Smaller frogs are often collected by pitfall traps put out for epigeal invertebrates (on the soil), but this practice falls beyond the scope of this survey. Habitat characteristics are also surveyed to note potential occurrences of amphibians.

### **3.6 BUTTERFLIES**

Butterflies were noted as sight records or voucher specimens. Voucher specimens are mostly taken of those species of which the taxa warrant collecting due to taxonomic difficulties or in the cases where species can look similar in the veldt. Many butterflies use only one species or a limited number of plant species as host plants for their larvae. Myrmecophilous (ant-loving) butterflies such as the *Aloeides*, *Chrysoritis*, *Eriksonia*, *Lepidochrysops* and *Orachrysops* species (Lepidoptera: Lycaenidae), which live in association with a specific ant species, require a unique ecosystem for their survival (Deutschländer & Bredenkamp, 1999; Terblanche, Morgenthal & Cilliers, 2003; Edge, Cilliers & Terblanche, 2008; Gardiner & Terblanche, 2010, Armstrong, 2020). Known food plants of butterflies were therefore also recorded. After the visits to the site and the identification of the butterflies found there, a list was also compiled of butterflies that will most probably be found in the area in all the other seasons because of suitable habitat. The emphasis is on a habitat survey.

### **3.7 FRUIT CHAFER BEETLES**

Different habitat types in the areas were explored for any sensitive or special fruit chafer species. Selection of methods to find fruit chafers depends on the different types of habitat present and the species that may be present. Fruit bait traps would probably not be successful for capturing *Ichneustoma* species in a grassland patch (Holm & Marais 1992). Possible chafer beetles of high conservation priority were noted as sight records accompanied by the collecting of voucher specimens with grass nets or containers where deemed necessary.

### **3.8 ROCK SCORPIONS**

Relatively homogenous habitat / vegetation areas were identified and explored to identify any sensitive or special species. Selected stones that were lifted to search for Arachnids were put back very carefully resulting in the least disturbance possible. All the above actions were accompanied by the least disturbance possible.

### **3.9 LIMITATIONS**

For each site visited, it should be emphasized that surveys can by no means result in an exhaustive list of the plants and animals present on the site, because of the time constraint. Site surveys were conducted during early May 2022 which includes a sub-optimal time of the year to find animals such as invertebrates as well as habitat sensitive plant and vertebrate animal species high conservation priority. Weather conditions during the survey were favourable for recording fauna and flora. The focus of the survey remains a habitat survey that concentrates on the possibility that species of particular conservation priority occur on the site or not. It is unlikely that any more visits would reveal information that would change the outcome of this assessment both in terms of ecosystems of special conservation concern or suitable habitats of species of particular conservation concern. Visits that were conducted therefore appear to be sufficient to address the objectives of this study.

## 4 RESULTS

### 4.1 HABITAT AND VEGETATION CHARACTERISTICS

**Table 4.1** Outline of main landscape and habitat characteristics of the site.

HABITAT FEATURE	DESCRIPTION
Topography	The site that includes the proposed footprints developments is on gentle to moderate slopes in an undulating area.
Rockiness	Rocky outcrops at the site appear to be absent.
Presence of wetlands	Wetlands appear to be absent at the site.
Vegetation	Extensive covers of alien invasive plant species are conspicuous at the site. Vegetation is transformed at parts of the site, owing to residences, and at other parts, modified or degraded. Indigenous grass species at the site include <i>Aristida junciformis</i> , <i>Eragrostis curvula</i> , <i>Sporobolus africanus</i> , <i>Urochloa panicoides</i> and <i>Setaria sphacelata</i> . Indigenous herb species include such as <i>Senecio madagascariensis</i> and <i>Nidorella auriculata</i> . Alien invasive tree species such as <i>Solanum mauritianum</i> , <i>Acacia decurrens</i> , <i>Acacia mearnsii</i> , and <i>Melia azedarach</i> are present. The alien invasive tree <i>Solanum mauritianum</i> is in particular visibly abundant at the site. The shrubs <i>Lantana camara</i> , <i>Ricinus communis</i> and <i>Rubus cuneifolius</i> are noticeable at many parts of the site. Alien invasive grass species include <i>Paspalum dilatatum</i> and <i>Pennisetum clandestinum</i> . Numerous alien invasive herbaceous plant species occur at the site which include <i>Bidens pilosa</i> , <i>Amaranthus hybridus</i> , <i>Oenothera biennis</i> , <i>Plantago lanceolata</i> , <i>Galinsoga parviflora</i> , <i>Chenopodium album</i> , <i>Tagetes minuta</i> , <i>Oxalis corniculata</i> , <i>Canna indica</i> and <i>Hypochaeris radicata</i> .
Signs of disturbances	Ecological disturbances at the site include residential settlements where vegetation has been transformed. Extensive informal dumping and roads with ditches where stormwater is channelled, are found at the site. Extensive and visibly dense covers of alien invasive plant species are conspicuous at the site.
Ecological connectivity at site and surrounding areas.	There is little scope for the site to be part of a conservation corridor of particular importance.



**Photo 1** View at the part of the site (the tower in the background is outside the site).  
Photo: R.F. Terblanche



**Photo 2** Part of the site where informal settlements are present. Informal dumping is widespread at the site.  
Photo: R.F. Terblanche.



**Photo 3** View of part of the site and adjacent residential area.  
Photo: R.F. Terblanche.



**Photo 4** View of part of the site where infestation by alien invasive plant species is in particular conspicuous.  
Photo: R.F. Terblanche.





**Photo 5** View of part of the site and adjacent developments.  
Photo: R.F. Terblanche.



**Photo 6** Part of the site.  
Photo: R.F. Terblanche.



**Photo 7** View of dense cover of alien invasive plant species at the site.  
Photo: R.F. Terblanche.



**Photo 8** Flowers and foliage of the alien invasive *Solanum mauritianum* (bugweed) at the site.  
Photo: R.F. Terblanche.



**Photo 9** Alien invasive *Canna indica* among other plants at the site.  
Photo: R.F. Terblanche.



**Photo 10** Alien invasive herb *Oenothera biennis* at the site.  
Photo: R.F. Terblanche.

## 4.2 ASSESSMENT OF PLANT SPECIES OF CONSERVATION CONCERN

**Table 4.2** Threatened plant species of the KwaZulu-Natal Province that are listed in the **Critically Endangered** category. The list here follows the most recent updated red list of South African plant species (Raimondo *et al.* 2009). No = Plant species is not a resident on the site; Yes = Plant species is a resident at a site.

Species	Status: Global status or national status indicated	Resident at the site
<i>Aloe saundersiae</i>	Critically Endangered	No
<i>Brachystelma natalense</i>	Critically Endangered	No
<i>Encephalartos aemulans</i>	Critically Endangered	No

**Table 4.3** Threatened plant species of the KwaZulu-Natal Province that are listed in the **Endangered** category. The list here follows the most recent updated red list of South African plant species (Raimondo *et al.* 2009, SANBI updates). No = Plant species is not a resident on the site; Yes = Plant species is a resident at a site.

Species	Status: Global status or national status indicated	Resident at the site
<i>Begonia dregei</i>	Endangered	No
<i>Eriosema populifolium</i> subsp. <i>populifolium</i>	Endangered	No
<i>Eriosema umtamvunense</i>	Endangered	No
<i>Gerbera aurantiaca</i>	Endangered	No
<i>Helichrysum pannosum</i>	Endangered	No
<i>Ocotea bullata</i>	Endangered	No
<i>Tephrosia inandensis</i>	Endangered	No

**Table 4.4** Threatened plant species of the KwaZulu-Natal Province that are listed in the **Vulnerable** category. The list here follows the most recent updated red list of South African plant species (Raimondo *et al.* 2009, SANBI updates). No = Plant species is not a resident on the site; Yes = Plant species is a resident at a site.

Species	Status: Global status or national status indicated	Resident at the site
<i>Alepidea amatymbica</i>	Vulnerable	No
<i>Asclepias woodii</i>	Vulnerable	No
<i>Asclepias concinna</i>	Vulnerable	No
<i>Aloe gersternerii</i>	Vulnerable	No
<i>Aloe neilcrouchii</i>	Vulnerable	No
<i>Argyrolobium longifalcum</i>	Vulnerable	No
<i>Asclepias concinna</i>	Vulnerable	No
<i>Brachystelma petraeum</i>	Vulnerable	No

<i>Crinum moorei</i>	Vulnerable	No
<i>Clivia gardenii</i>	Vulnerable	No
<i>Diaphanthe millarii</i>	Vulnerable	No
<i>Dierama luteo-albidum</i>	Vulnerable	No
<i>Dierama pallidum</i>	Vulnerable	No
<i>Dioscorea sylvatica</i>	Vulnerable	No
<i>Dracosciadium italaе</i>	Vulnerable	No
<i>Encephalartos ghellinckii</i>	Vulnerable	No
<i>Eriosemopsis subanisophylla</i>	Vulnerable	No
<i>Gerrardanthus tomentosa</i>	Vulnerable	No
<i>Hermannia sandersonii</i>	Vulnerable	No
<i>Impatiens flanaganiae</i>	Vulnerable	No
<i>Phyllica natalensis</i>	Vulnerable	No
<i>Senecio dregeanus</i>	Vulnerable	No
<i>Sisyranthus fanniniae</i>	Vulnerable	No
<i>Stachys comosa</i>	Vulnerable	No
<i>Stangeria eriopus</i>	Vulnerable	No
<i>Woodia verruculosa</i>	Vulnerable	No

**Table 4.5** Near Threatened plant species of the KwaZulu-Natal Province. The list here follows the most recent updated red list of South African plant species (Raimondo *et al.* 2009). No = Plant species is not a resident on the site; Yes = Plant species is a resident at the site.

Species	Status: Global status or national status indicated	Resident at the site
<i>Aloe dominella</i>	Near Threatened	No
<i>Aloe linearifolia</i>	Near Threatened	No
<i>Brachystelma pulchellum</i>	Near Threatened	No
<i>Encephalartos natalensis</i>	Near Threatened	No
<i>Haemanthus deformis</i>	Near Threatened	No
<i>Merwillia plumbea</i>	Near Threatened	No
<i>Moraea hiemalis</i>	Near Threatened	
<i>Moraea graminicola</i> subsp. <i>graminicola</i>	Near Threatened	

**Table 4.6** Least Concern (= not threatened) plant species of the KwaZulu-Natal Province that are however of particular conservation concern and listed in the **Rare** category. The list here follows the most recent red list of South African plant species (Raimondo *et al.* 2009). No = Plant species is not a resident on the site; Yes = Plant species is a resident at the site.

Species	Status: Global status or national status indicated	Resident at the site
<i>Brunsvigia undulata</i>	Rare	No

**Table 4.7** Not threatened plant species of the KwaZulu-Natal Province which are however of conservation concern and listed in the **Declining** category. The list here follows the most recent red list of South African plant species (Raimondo *et al.* 2009). No = Plant species is not a resident on the site; Yes = Plant species is a resident at the site.

<b>Species</b>	<b>Status:</b> Global status or national status indicated	<b>Resident at the site</b>
<i>Acridocarpus natalitius</i>	Declining	No
<i>Adenia gummifera</i>	Declining	No
<i>Aloe cooperi</i>	Declining	No
<i>Anselia africana</i>	Declining	No
<i>Boophone disticha</i>	Declining	No
<i>Cassipourea malosana</i>	Declining	No
<i>Cryptocarya latifolia</i>	Declining	No
<i>Eucomis autumnalis</i>	Declining	No
<i>Gunnera perpensa</i>	Declining	No
<i>Rapanea melanophloeos</i>	Declining	No
<i>Sandersonia aurantiaca</i>	Declining	No

**Table 4.8** Some of the tree species of the KwaZulu-Natal Province which are not threatened but listed as **Protected Species** under the National Forests Act No. 84 of 1998, Section 15(1) (Schedule A, Notice 536 of 2018). No = Plant species is not a resident on the site; Yes = Plant species is a resident at the site.

<b>Species</b>	<b>Conservation status</b>	<b>Resident at the site</b>
<i>Afzelia quanzensis</i>	Protected	No
<i>Balanites maughamii</i>	Protected	No
<i>Barringtonia racemosa</i>	Protected	No
<i>Boscia albitrunca</i>	Protected	No
<i>Breonadia salicina</i>	Protected	No
<i>Bruguiera gymnorrhiza</i>	Protected	No
<i>Catha edulis</i>	Protected	No
<i>Ceriops tagal</i>	Protected	No
<i>Cleistanthus schlechteri schlechteri</i>	Protected	No
<i>Combretum imberbe</i>	Protected	No
<i>Curtisia dentata</i>	Protected	No
<i>Elaeodendron transvaalensis</i>	Protected	No
<i>Ficus trichopoda</i>	Protected	No
<i>Lumnitzera racemosa</i> var. <i>racemosa</i>	Protected	No
<i>Mimusops caffra</i>	Protected	No

<b><i>Newtonia hildebrandtii</i> var. <i>hildebrandtii</i></b>	Protected	No
<b><i>Ocotea bullata</i></b>	Protected	No
<b><i>Pittosporum viridiflorum</i></b>	Protected	No
<b><i>Podocarpus falcatus</i></b>	Protected	No
<b><i>Podocarpus henkelii</i></b>	Protected	No
<b><i>Podocarpus latifolius</i></b>	Protected	No
<b><i>Prunus africana</i></b>	Protected	No
<b><i>Pterocarpus angolensis</i></b>	Protected	No
<b><i>Rhizophora mucronata</i></b>	Protected	No
<b><i>Sclerocarya birrea</i> subsp. <i>caffra</i></b>	Protected	No
<b><i>Sideroxylon inerme</i> subsp. <i>inerme</i></b>	Protected	No
<b><i>Warburgia salutaris</i></b>	Protected	No

### 4.3 ASSESSMENT OF VERTEBRATE SPECIES OF CONSERVATION CONCERN

#### 4.3.1 Mammals of particular high conservation priority

**Table 4.9 Threatened** mammal species of the KwaZulu-Natal Province. Literature sources: Friedman & Daly, (2004), Skinner & Chimimba (2005), Child *et. al.* (2017).

Species	Red Listed Status	Recorded at site during survey	Likely to be found based on habitat assessment
<b><i>Cercopithecus albogularis labiatus</i></b> Samango Monkey (EC and parts of KZN)	Vulnerable	No	No
<b><i>Chrysospalax villosus</i></b> Rough-haired golden mole	Vulnerable	No	No
<b><i>Cloeotis percivali</i></b> Short-eared Trident Bat	Endangered (RSA)	No	No
<b><i>Dendrohyrax arboreus</i></b> Tree Hyrax	Endangered	No	No
<b><i>Diceros bicornis</i></b> Black Rhinoceros	Critically Endangered	No	No
<b><i>Loxodonta africana</i></b> African elephant	Vulnerable	No	No
<b><i>Mystromys albicaudatus</i></b> White-tailed mouse	Endangered	No	No
<b><i>Neoromicia rendalli</i></b> Rendall's Serotine	Critically Endangered (RSA)	No	No
<b><i>Ourebia orebi orebi</i></b> Oribi	Endangered	No	No
<b><i>Panthera leo</i></b> Lion	Vulnerable	No	No
<b><i>Panthera pardus</i></b> Leopard	Vulnerable	No	No
<b><i>Smutsia temminckii</i></b> Ground Pangolin	Vulnerable	No	No



**Table 4.10 Near Threatened** mammal species known to occur in the KwaZulu-Natal Province. Literature sources: Skinner & Chimimba (2005), Child *et. al.* (2017).

Species	Red Listed Status	Recorded at site during survey	Likely to be found based on habitat assessment
<b><i>Ceratotherium simum</i></b> White Rhinoceros	Near Threatened	No	No
<b><i>Cercopithecus albogularis erythrarchus</i></b> Samango Monkey (northern KZN and further north)	Near Threatened	No	No
<b><i>Otomops martiensseni</i></b> Large-eared free tailed bat	Near Threatened (Global)	No	No

#### 4.3.2 Birds of particular high conservation priority

**Table 4.11 Threatened** bird species of the KwaZulu-Natal. Literature sources Barnes (2000), Hockey, Dean & Ryan, P.G. (2005) and Chittenden (2007).

Species	Common name	Red Listed Status	Recorded at site during survey	Likelihood of residential status at the site: Confirmed, Highly likely, Likely, Medium possibility, Unlikely, Highly unlikely
<i>Aegypius tracheliotos</i>	<b>Lappet-faced Vulture</b>	Endangered	No	Unlikely
<i>Anthropoides paradiseus</i>	<b>Blue Crane</b>	Vulnerable	No	Highly unlikely
<i>Gypaetus barbatus</i>	<b>Bearded Vulture</b>	Critically Endangered (RSA)	No	Highly unlikely
<i>Anthus chloris</i>	<b>Yellow-breasted Pipit</b>	Vulnerable	No	Unlikely
<i>Balearica regulorum</i>	<b>Grey Crowned Crane</b>	Endangered	No	Unlikely
<i>Bucorvis leadbeateri</i>	<b>Southern Ground Hornbill</b>	Vulnerable	No	Unlikely
<i>Bugeranus carunculatus</i>	<b>Wattled Crane</b>	Critically Endangered (RSA)	No	Highly unlikely

Species	Common name	Red Listed Status	Recorded at site during survey	Likelihood of residential status at the site: Confirmed, Highly likely, Likely, Medium possibility, Unlikely, Highly unlikely
<i>Circus maurus</i>	<b>Black Harrier</b>	Vulnerable (Global) Endangered	No	Unlikely
<i>Falco biarmicus</i>	<b>Lanner Falcon</b>	Vulnerable	No	Unlikely
<i>Geronticus calvus</i>	<b>Southern Bald Ibis</b>	Vulnerable	No	Unlikely
<i>Gyps coprotheres</i>	<b>Cape Vulture</b>	Endangered	No	Unlikely
<i>Hirundo atrocaerulea</i>	<b>Blue Swallow</b>	Critically Endangered (RSA)	No	Unlikely
<i>Neotis denhami</i>	<b>Denham's Bustard</b>	Vulnerable	No	Highly unlikely
<i>Poicephalus robustus</i>	<b>Cape Parrot</b>	Vulnerable	No	Unlikely
<i>Polemaetus bellicosus</i>	<b>Martial Eagle</b>	Vulnerable	No	Unlikely
<i>Sagittarius serpentarius</i>	<b>Secretarybird</b>	Vulnerable	No	Unlikely
<i>Sarothrura affinis</i>	<b>Striped Flufftail</b>	Vulnerable	No	Unlikely
<i>Sarothrura ayresi</i>	<b>White-winged Flufftail</b>	Critically Endangered	No	Highly unlikely
<i>Stephanoaetus coronatus</i>	<b>African Crowned Eagle</b>	Vulnerable	No	Unlikely
<i>Therathopius ecaudatus</i>	<b>Bateleur</b>	Endangered (RSA)	No	Unlikely
<i>Turnix nanus</i>	<b>Black-rumped Buttonquail</b>	Vulnerable	No	Unlikely
<i>Tyto capensis</i>	<b>African Grass-Owl</b>	Vulnerable	No	Unlikely

**Table 4.12 Near Threatened** bird species of the KwaZulu-Natal Province. Literature sources Barnes (2000), Hockey, Dean & Ryan, P.G. (2005) and Chittenden (2007).

Species	Common name	Red Listed Status	Recorded at site during survey	Likelihood of residential status at the site: Confirmed, Highly likely, Likely, Medium possibility, Unlikely, Highly unlikely
<i>Ciconia nigra</i>	<b>Black Stork</b>	Near Threatened	No	Unlikely
<i>Lioptilus nigricapillus</i>	<b>Bush Blackcap</b>	Near Threatened	No	Unlikely
<i>Vanellus melanopterus</i>	<b>Black-winged Lapwing</b>	Near Threatened	No	Unlikely

Species	Common name	Red Listed Status	Recorded at site during survey	Likelihood of residential status at the site: Confirmed, Highly likely, Likely, Medium possibility, Unlikely, Highly unlikely
<i>Zoothera gurneyi</i>	Orange ground-thrush	Near Threatened	No	Unlikely

### 4.3.3 Reptiles of particular high conservation priority

The following table lists possible presence or absence of reptile species of particular conservation concern at the site. This list to assess the possible presence or not of reptile species of conservation concern was compiled by using mainly the source Bates, Branch, Bauer, Burger, Marais, Alexander & De Villiers (2014), that is the Atlas and Red List of South Africa, Lesotho and Swaziland.

**Table 4.13 Threatened** reptile species in KwaZulu-Natal Province. Main source: Bates, Branch, Bauer, Burger, Marais, Alexander & De Villiers (2014). No = Reptile species is not a resident on the site; Yes = Reptile species is found to be resident on the site.

Species	Red Listed Status	Resident at site	Recorded at site during survey	Likely to be found based on habitat assessment
<b><i>Bradypodion thamnobates</i></b> Natal Midlands Dwarf Chameleon	Endangered	No	No	No
<b><i>Scelotes bourquinii</i></b> Bourquin's Dwarf Burrowing Skink	Vulnerable	No	No	No

**Table 4.24 Near Threatened** reptile species in KwaZulu-Natal Province. Main source: Bates, Branch, Bauer, Burger, Marais, Alexander & De Villiers (2014). No = Reptile species is not a resident on the site; Yes = Reptile species is found to be resident on the site.

Species	Red Listed Status	Resident at site	Recorded at site during survey	Likely to be found based on habitat assessment
<b><i>Bradypodion melanocephalum</i></b> Black-headed Dwarf Chameleon	Near Threatened	No	No	No

#### 4.3.4 Amphibian species of particular high conservation priority

**Table 4.15 Threatened** frog species of the KwaZulu-Natal Province. No = Amphibian species is not a resident on the site; Yes = Amphibian species is found to be resident on the site.

<b>Species</b>	<b>Threatened Status</b>	<b>Resident at site</b>	<b>Recorded at site during survey</b>	<b>Likely to be found based on habitat assessment</b>
<i>Anhydrophryne ngongoniensis</i> Mistbelt Moss Frog	Endangered	No	No	No
<i>Leptopelis xenodactylus</i> Long-toed Tree Frog	Endangered	No	No	No

## 4.4 ASSESSMENT OF INVERTEBRATE SPECIES OF PARTICULAR CONSERVATION PRIORITY

### 4.4.1 Butterflies of particular conservation priority

**Table 4.16 Threatened** butterfly species in the KwaZulu-Natal Province (Mecenero *et. al.* 2020). Sources of information: Henning, Terblanche & Ball (2009), Mecenero *et al.* (2013), Mecenero *et.al.* (2020). Invertebrates such as threatened butterfly species are often very habitat specific and residential status imply a unique ecosystem that is at stake.

Species	Threatened Status	Recorded at site during survey	Residential status at the site: Yes confirmed, Highly likely, Likely, Medium possibility, Unlikely, Highly unlikely
<b><i>Capys penningtoni</i></b> iNkomasi Protea Butterfly	Critically Endangered	No	Highly unlikely
<b><i>Chrysothrix lyncurium</i></b> Tsomo Golden Opal	Vulnerable	No	Highly unlikely
<b><i>Chrysothrix phosphor borealis</i></b> Phosphor Butterfly	Endangered	No	Highly unlikely
<b><i>Dingana dingana</i></b> Midlands Widow	Endangered	No	Highly unlikely
<b><i>Durbania amakosa albescens</i></b> Whitish Amakosa Rocksitter	Vulnerable	No	Highly unlikely
<b><i>Durbania amakosa flavida</i></b> Yellowish Amakosa Rocksitter	Endangered	No	Highly unlikely
<b><i>Hypolycaena lochmophila</i></b> Coastal Hairstreak	Vulnerable	No	Highly unlikely
<b><i>Iolais lulua</i></b> White-spotted Sapphire	Vulnerable	No	Highly unlikely
<b><i>Lepidochrysops ketsi leucomacula</i></b> White-spotted Ketsi Giant Cupid	Endangered	No	Highly unlikely
<b><i>Lepidochrysops pephredo</i></b> Estcourt Giant Cupid	Vulnerable	No	Highly unlikely
<b><i>Orachrysops ariadne</i></b> Karkloof Cupid	Endangered	No	Highly unlikely
<b><i>Teriomima zuluana</i></b> Zulu Yellow Buff	Vulnerable	No	Highly unlikely

**Table 4.17** Butterfly species of the KwaZulu-Natal Province that are (Mecenero *et al.*, 2020). No = Butterfly species is unlikely to be a resident at the study area; Yes = Butterfly species is a resident at the study area. Sources of information Henning, Terblanche & Ball (2009), Mecenero *et. al.* (2013), Mecenero *et. al.* (2020).

Species	Threatened Status	Recorded at site during survey	Residential status at the site: Yes confirmed, Very likely, Likely, Medium possibility, Unlikely, Highly unlikely
<b><i>Abantis bicolor</i></b> Bicoloured Paradise Skipper	Near Threatened	No	Highly unlikely
<b><i>Dingana alaedeus</i></b> Wakkerstroom Widow	Near Threatened	No	Highly unlikely
<b><i>Metisella meninx</i></b> Marsh Sylph	Near Threatened	No	Highly unlikely
<b><i>Ornipholidotos peucetia penningtoni</i></b> Southern Large Glasswing	Near Threatened	No	Highly unlikely

## **5 DISCUSSION**

### **5.1 HABITAT AND VEGETATION CHARACTERISTICS**

An outline of the habitat and vegetation characteristics is given in Table 4.1.

### **5.2 PLANT SPECIES**

Threatened, Near Threatened and other plant species of high conservation priority in the KwaZulu-Natal Province are listed in Tables 4.2 – 4.8. The presence or not of all the species listed in the tables were investigated during the survey. Presence of Threatened and Near Threatened species of plants at the site is unlikely. Presence of any other plant species of particular conservation concern at the site is unlikely.

### **5.3 VERTEBRATES**

#### **5.3.1 Mammals**

Table 4.9 and Table 4.10 list the possible presence or absence of threatened mammal species and near threatened mammal species at the site. Literature sources that were used are Friedman & Daly (2004), Skinner & Chimimba (2005) and Child *et. al.* (2017). Because the site falls outside reserves, threatened species such as the black rhinoceros (*Diceros bicornis*) are obviously not present. No smaller mammals of particular high conservation significance are likely to be found on the site as well.

#### **5.3.2 Birds**

Table 4.11 and Table 4.12 list the possible presence or absence of threatened bird species and near threatened bird species at the site. Literature sources that were mainly consulted are Barnes (2000), Hockey, Dean & Ryan, P.G. (2005) and Chittenden (2007). The site does not appear to form part of any habitat of particular importance for any threatened bird species or any bird species of particular conservation importance.

### **5.3.3 Reptiles**

Tables 4.13 – 4.14 list the possible presence or absence of threatened or near threatened reptile species on the site. The Atlas and Red List of Reptiles of South Africa, Lesotho and Swaziland were used to compile the list for the assessment (Bates, Branch, Bauer, Burger, Marais, Alexander & De Villiers, 2014). There appears to be no threat to any reptile species of particular high conservation importance if the site is developed.

### **5.3.4 Amphibians**

Table 4.15 lists the frog species of particular conservation concern that could occur are likely to occur at the site or not. No suitable habitat for any of these amphibian species of particular conservation concern are found at the site and it is unlikely that any of these amphibian species would occur at the site.

## **5.4 Invertebrates**

### **5.4.1 Butterflies**

Tables 4.16 - 4.17 list butterfly species that are threatened or near threatened in the KwaZulu-Natal Province. Studies about the vegetation and habitat of threatened butterfly species in South Africa showed that ecosystems with a unique combination of features are selected by these localised threatened butterfly species (Deutschländer and Bredenkamp 1999; Edge 2002, 2005; Terblanche, Morgenthal & Cilliers 2003; Lubke, Hoare, Victor & Ketelaar 2003; Edge, Cilliers & Terblanche, 2008, Armstrong, 2020). Threatened butterfly species in South Africa can then be regarded as bio-indicators of rare ecosystems. No suitable habitat of any of the butterfly species of particular conservation concern in KwaZulu-Natal appears to occur at the site. It is unlikely that the development if approved will pose any threat to butterfly species of particular conservation concern.

### **5.4.2 Other invertebrates**

None of the invertebrate species that are of known particular conservation concern, are likely to be present at the site.

## 5.5 SCREENING TOOL (DEFFE) AND GROUNDTRUTHING

Possible ecological sensitivities at the site were indicated by a report generated from the screening tool of DEFFE. These ecological sensitivities that could possibly/ are present at the site, follow.

### *Animal species theme sensitivity*

Relative animal species theme sensitivity is listed as high. No suitable habitat for *Hirundo atrocaerulea* (Blue Swallow) is present at the site and the occurrence of this species at the site is highly unlikely. No suitable habitat for the butterfly species *Chrysoritis phosphor borealis* is present at the site (needs specific indigenous forest habitat). No signs or observations of *Chrysospalax villosus*, *Dendrohyrax arboreus* or *Ourebia ourebi ourebi* were noted at the site and based on habitat conditions it is highly unlikely that any of these mammals occur at the site. Such as listed in Tables 4.9 – 4.17 no animals of particular conservation concern are likely to be present at the site. The overall animal theme sensitivity, following the ground truthing at the site, appears to be low.

### *Aquatic biodiversity theme sensitivity*

Relative aquatic biodiversity theme sensitivity at the site is listed as very high owing to the presence of an aquatic CBA and strategic water source area. The site is not part of a FEPA Freshwater Ecosystem Priority Area (Nel *et al.*, 2011). There are important wetlands and watercourses in the larger area. The present rain water run off systems at the site, in particular given the presence of extensive informal dumping and informal residences, are of concern. There are no wetlands at the site and locally at the site the aquatic biodiversity theme sensitivity is low. However, because of the importance of the strategic water source area the stormwater system, if the development is approved, should be carefully planned,

### *Plant species theme sensitivity*

Relative plant species theme sensitivity is listed as medium. Extensive covers of alien invasive plant species are conspicuous at the site. Vegetation is transformed at parts of the site, owing to residences, and at other parts, modified or degraded. It is highly unlikely that plant species such as *Stachys comosa*, *Woodia verruculosa*, *Helichrysum pannosum*, *Sisyranchthes fanninae* and *Senecio dregeanus* would be present at the site. No signs of these species were observed. It is also highly unlikely that other sensitive species, such as Declining species prone to harvesting (see Table 4.7 and Table 4.8) would occur at the site. The overall plant theme sensitivity, following the ground truthing, appears to be low.

### *Terrestrial biodiversity theme sensitivity*

Relative terrestrial biodiversity at the site is listed as very high. This high sensitivity that is ascribed to the site area, is because of the presence of Critical Biodiversity Area 1, an Ecological Support Area, a Protected Areas Expansion



Strategy, Strategic Water Source Areas and a mapped Vulnerable Ecosystem, the Midlands Mistbelt Grassland. During surveys at the site, it was found that the original vegetation type is partly transformed, modified, visibly degraded and that the relatively small site is largely isolated. There is little scope to restore the grassland at the site and conserve it as a natural unit of Midlands Mistbelt Grassland. The terrestrial biodiversity theme at the proposed footprints appears to be low at the site.

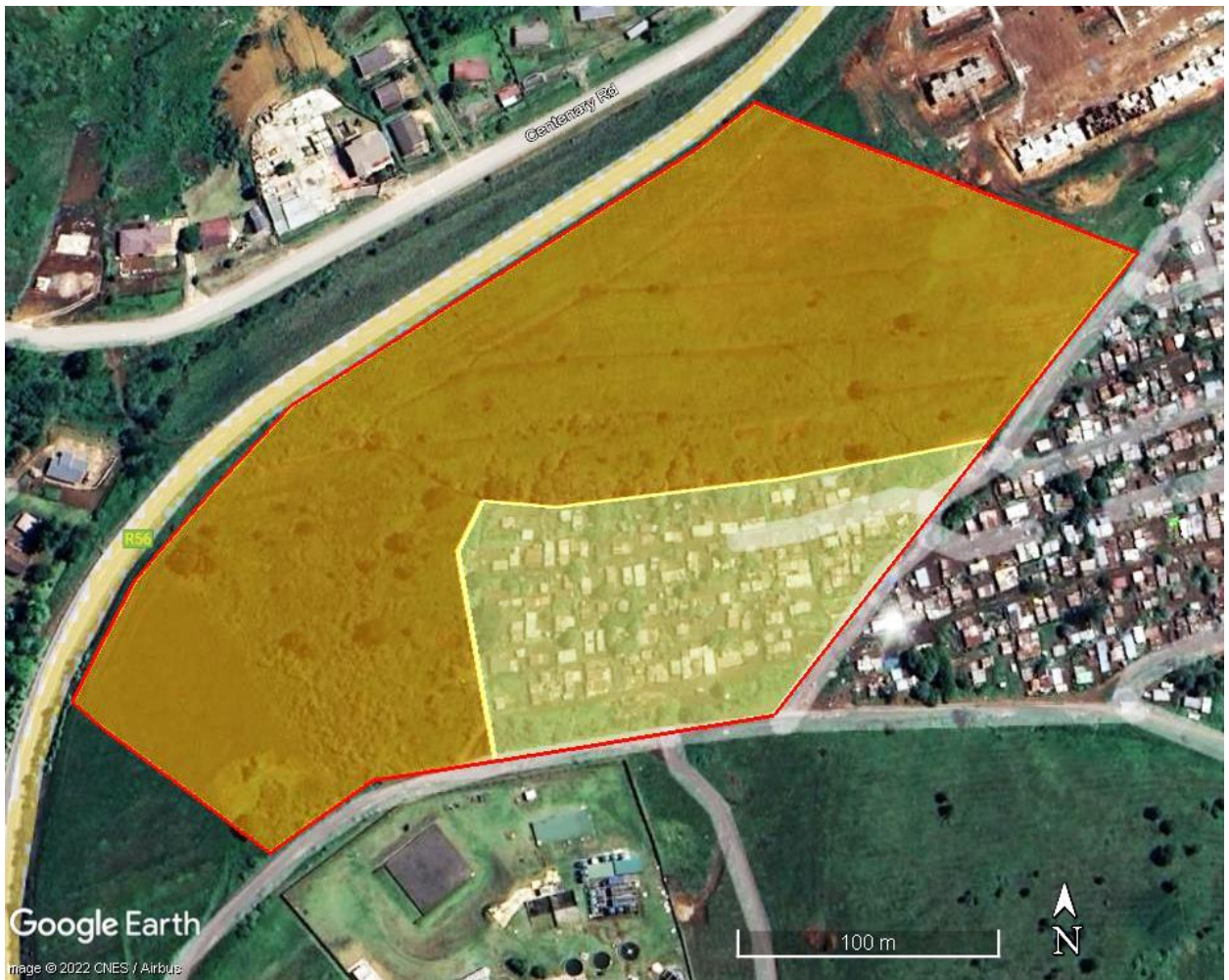
## **5.6 ECOLOGICAL SENSITIVITY AT THE SITE**

Ecological sensitivity at the parts of the site where residential settlements occur, and vegetation has been transformed, is very-low (Figure 3). Ecological sensitivity at the remainder of the site where vegetation is modified and where extensive and visibly dense covers of alien invasive plant species are present, is low (Figure 3). The scope for restoring and conserving the vegetation at the site in a natural state, is small.






Figure 2 Indication of ditch that serves as stormwater canal at present.

— Red outline                      Study area



**Figure 3** Indications of ecological sensitivity at the site.

- |   |                                  |                        |
|---|----------------------------------|------------------------|
|  | Red outline                      | Boundaries of the site |
|  | Light yellow outline and shading | Very-low Sensitivity   |
|  | Orange outline and shading       | Low Sensitivity        |

## 6 RISKS, IMPACTS AND MITIGATION

### Background:

Habitats of threatened plants are in danger most often due to urban developments such as is the case for the Gauteng Province (Pfab & Victor, 2002) and in the KwaZulu-Natal Province. Habitat conservation is the key to the conservation of invertebrates such as threatened butterflies (Deutschländer and Bredenkamp 1999; Edge 2002, 2005; Terblanche, Morgenthal & Cilliers 2003; Lubke, Hoare, Victor & Ketelaar 2003; Edge, Cilliers & Terblanche, 2008, Armstrong, 2020). Furthermore, corridors and linkages may play a significant role in insect conservation (Pryke & Samways, 2003, Samways, 2005).

Urbanisation is a major additional influence on the loss of natural areas (Rutherford & Westfall 1994). In the South Africa the pressure to develop areas are high since its infrastructure allows for improvement of human well-being. Urban nature conservation issues in South Africa are overshadowed by the goal to improve human well-being, which focuses on aspects such as poverty, equity, redistribution of wealth and wealth creation (Cilliers, Müller & Drewes 2004). Nevertheless, the conservation of habitats is the key to invertebrate conservation, especially for those threatened species that are very habitat specific. This is also true for any detailed planning of corridors and buffer zones for invertebrates. Though proper management plans for habitats are not in place, setting aside special ecosystems is in line with the recent Biodiversity Act (2004) of the Republic of South Africa.

Corridors are important to link ecosystems of high conservation priority. Such corridors or linkages are there to improve the chances of survival of otherwise isolated populations (Samways, 2005). How wide should corridors be? The answer to this question depends on the conservation goal and the focal species (Samways, 2005). For an African butterfly assemblage this is about 250m when the corridor is for movement as well as being a habitat source (Pryke and Samways 2003). Hill (1995) found a figure of 200m for dung beetles in tropical Australian forest. In the agricultural context, and at least for some common insects, even small corridors can play a valuable role (Samways, 2005). Much more research remains to be done to find refined answers to the width of grassland corridors in South Africa. The width of corridors will also depend on the type of development, for instance the effects of the shade of multiple story buildings will be quite different from that of small houses. To summarise: In practice, as far as developments are concerned, the key would be to prioritise and plan according to sensitive species and special ecosystems.

### In the case of this study:

Extensive covers of alien invasive plant species are conspicuous at the site. Vegetation is transformed at parts of the site, owing to residences, and at other parts, modified or degraded.

No wetlands or rocky ridges appear to be present at the site.

Grassland at the site is represented by the Midlands Mistbelt Grassland (Gs 9) vegetation type which is listed as a Threatened Ecosystem, Vulnerable, according to the National List of Threatened Ecosystems (2011). The vegetation at the site is partly transformed, modified, visibly disturbed and largely isolated. The scope for the restoration and conservation of natural grassland unit at the site is small.

No Threatened or Near Threatened plant- or animal species appear to be resident at the site. No other plant or animal species of particular conservation concern are likely to be found at the site.

There is little scope for the partly transformed, modified and visibly disturbed and isolated relatively small patch of grassland to be part of a conservation corridor of particular importance.

Ecological sensitivity at the parts of the site where residential settlements occur, and vegetation has been transformed, is very-low (Figure 3). Ecological sensitivity at the remainder of the site where vegetation is modified and where extensive and visibly dense covers of alien invasive plant species are present, is low (Figure 3).

The following potential risks, impacts and mitigation measures apply to the proposed development:

## **6.1 Identification of potential impacts and risks**

The potential impacts identified are:

### **6.1.1 Summary of Issues identified during the Project Notification Phase**

The potential botanical issues identified include:

- Loss of habitat owing to the removal of vegetation at the proposed footprint.
- Loss of sensitive species (Threatened, Near Threatened, Rare, Declining or Protected species).
- Loss of connectivity and conservation corridor networks in the landscape.
- An increased infestation of exotic or alien invasive plant species owing to disturbance.
- Contamination of soil during construction.

### **6.1.2 Identification of Potential Impacts/Risks**

The potential impacts identified are:

#### **Construction Phase**

- Potential impact 1 Loss of habitat owing to the removal of vegetation at the proposed footprint.

- Potential impact 2 Loss of sensitive species (Threatened, Near Threatened, Rare, Declining or Protected species) during the construction phase.
- Potential impact 3 Loss of connectivity and conservation corridor networks in the landscape.
- Potential impact 4 Contamination of soil during construction in particular by hydrocarbon spills.
- Potential impact 5 Killing of vertebrate fauna during the construction phase.

### Operational Phase

- Potential impact 6 An increased infestation of exotic or alien invasive plant species owing to disturbance.

## 6.2 Potential Impacts during the Construction Phase

Aspect/Activity	Removal of vegetation at the proposed footprint.
Type of Impact (i.e. Impact Status)	Direct
Potential Impact	Clearing of vegetation at habitat of low or very-low sensitivity at the proposed footprint.
Status	Negative
Mitigation Required	Cultivation of indigenous plant species at the site is imperative. Control of alien invasive plant species should be applied.
Impact Significance (Pre-Mitigation)	Moderate
Impact Significance (Post-Mitigation)	Moderate

Aspect/Activity	Removal of sensitive species
Type of Impact	Direct
Potential Impact	Sensitive species: Presence of Threatened or Near Threatened Mammals, Reptiles, Amphibians and Invertebrates at the site appear to be unlikely.
Status	Neutral
Mitigation Required	No mitigation measure for species of particular conservation concern, specific to the site, apply.
Impact Significance (Pre-Mitigation)	Low
Impact Significance (Post-Mitigation)	Low

Aspect/Activity	Fragmentation of corridors of particular conservation concern
Type of Impact	Direct
Potential Impact	The scope for the site to be a corridor of particular conservation concern is small.
Status	Negative
Mitigation Required	Cultivation of indigenous plant species at the site is imperative.
Impact Significance (Pre-Mitigation)	Moderate
Impact Significance (Post-Mitigation)	Low

Aspect/Activity	Contamination of soil by leaving rubble/ waste or spilling petroleum fuels or any pollutants on soil which could infiltrate the soil
Type of Impact (i.e. Impact Status)	Direct
Potential Impact	Rubble or waste could lead to infiltration of unwanted pollutants into the soil. Spilling of petroleum fuels and unwanted chemicals onto the soils that infiltrate these soils could lead to pollution of soils.
Status	Negative
Mitigation Required	Rubble or waste that could accompany the construction effort, if the development is approved, should be removed during and after construction. Measures should be taken to avoid any spills and infiltration of petroleum fuels or any chemical pollutants into the soil during construction phase.
Impact Significance (Pre-Mitigation)	Moderate
Impact Significance (Post-Mitigation)	Low

<b>Aspect/Activity</b>	<b>Possible disturbance, trapping, hunting and killing of vertebrates during construction phase</b>
<b>Type of Impact (i.e. Impact Status)</b>	Direct
<b>Potential Impact</b>	During the construction phase animal species could be disturbed, trapped, hunted or killed.
<b>Status</b>	Negative
<b>Mitigation Required</b>	If the development is approved, contractors must ensure that no animal species are disturbed, trapped, hunted or killed during the construction phase.
<b>Impact Significance (Pre-Mitigation)</b>	Moderate
<b>Impact Significance (Post-Mitigation)</b>	Low

### 6.3 Potential Impacts during the Operational Phase

<b>Aspect/Activity</b>	An increased infestation of exotic or alien invasive plant species owing to clearance or disturbance where the footprint took place.
<b>Type of Impact</b>	Direct
<b>Potential Impact</b>	Infestation by alien invasive species could replace indigenous vegetation or potential areas where indigenous vegetation could recover. It is in particular declared alien invasive species such as <i>Solanum mauritianum</i> (bugweed), <i>Melia azedarach</i> (Syringa berrytree) and Australian <i>Acacia</i> species that should not be allowed to establish because once established these combating these alien invasive plant species may become very expensive in the long term.
<b>Status</b>	Negative
<b>Mitigation Required</b>	Continued monitoring and eradication of alien invasive plant species are imperative. It is in particular declared alien invasive species such as alien invasive Australian <i>Acacia</i> species, <i>Melia azedarach</i> (Syringa berrytree) and <i>Solanum mauritianum</i> (bugweed) that should not be allowed to establish.
<b>Impact Significance (Pre-Mitigation)</b>	Moderate
<b>Impact Significance (Post-Mitigation)</b>	Low

Table 6.4.1: Impact Assessment Summary Table for the Construction Phase

Construction Phase													
Direct Impacts <sup>7</sup> .													
Aspect/ Impact Pathway	Nature of Potential Impact/ Risk	Status	Spatial Extent	Duration	Consequence	Probability	Reversibility of Impact	Irreplaceability	Potential Mitigation Measures	Significance of Impact and Risk		Ranking of Residual Impact/ Risk	Confidence Level
										Without Mitigation/ Management	With Mitigation/ Management (Residual Impact/ Risk)		
Clearing of vegetation	Habitat loss, loss of indigenous species	Negative	Site	Long-Term	Substantial	Very likely	Moderate	Moderate	Cultivation of indigenous plant species at the site is imperative. Control of alien invasive plant species should be applied.	Moderate	Moderate	3	High
Loss of sensitive species	Loss of sensitive species (Note no Threatened species or Near Threatened species)	Neutral	Site	Long-Term	Moderate	Very likely	Moderate	Moderate	No mitigation measure for species of particular conservation concern, specific to the site, apply.	Low	Low	4	High
Loss of corridors of particular conservation concern	Fragmentation of landscape and loss of connectivity	Negative	Site	Long-Term	Moderate	Very unlikely	Moderate	Moderate	Cultivation of indigenous plant species at the site is imperative.	Moderate	Low	5	High



Contamination of soil by spilling pollutants on soil which could infiltrate the soil	Soil contamination	Negative	Site	Long-Term	Moderate	Unlikely	Moderate	Moderate	Rubble and waste removal. Measures that avoid hydrocarbon (petroleum) spills to get into contact with the soil.	Moderate	Low	High	
Disturbance or killing of vertebrates	Disturbance or killing of species	Negative	Site	Long-Term	Moderate	Unlikely	Moderate	Moderate	If the development is approved, contractors must ensure that no animal species are disturbed, trapped, hunted or killed during the construction phase.	Moderate	Low	High	

**Table 6.4.2: Impact Assessment Summary Table for the Operational Phase**

Operational Phase													
Direct Impacts													
Aspect/ Impact Pathway	Nature of Potential Impact/ Risk	Status	Spatial Extent	Duration	Consequence	Probability	Reversibility of Impact	Irreplaceability	Potential Mitigation Measures	Significance of Impact and Risk		Ranking of Residual Impact/ Risk	Confidence Level
										Without Mitigation/ Management	With Mitigation/ Management (Residual Impact/ Risk)		
Increased infestation of exotic or alien invasive plant species	Loss of habitat quality	Negative	Site	Long-Term	Substantial	Likely	Moderate	Moderate	Monitoring and eradication of alien invasive plant species	Moderate	Low	3	High

## 6.5 Summary of risks and impacts

Ecological sensitivity at the parts of the site where residential settlements occur, and vegetation has been transformed, is very-low (Figure 3). Ecological sensitivity at the remainder of the site where vegetation is modified and where extensive and visibly dense covers of alien invasive plant species are present, is low (Figure 3).

No Threatened or Near Threatened plant or animal species appear to be resident at the site. No other plant or animal species of particular conservation importance appear to be present at the site.

Following the mitigations which will be upheld and planned footprint for development all the impact risks listed above are moderate or low.

## 7 CONCLUSION

- Extensive covers of alien invasive plant species are conspicuous at the site. Vegetation is transformed at parts of the site, owing to residences, and at other parts, modified or degraded.
- Indigenous grass species at the site include *Aristida junciformis*, *Eragrostis curvula*, *Sporobolus africanus*, *Urochloa panicoides* and *Setaria sphacelata*. Indigenous herb species include such as *Senecio madagascariensis* and *Nidorella auriculata*. Alien invasive tree species such as *Solanum mauritianum*, *Acacia decurrens*, *Acacia mearnsii*, and *Melia azedarach* are present. The alien invasive tree *Solanum mauritianum* (bugweed) as well as *Rubus cuneifolius* (American bramble) are in particular visibly dense at parts of the the site. The shrubs *Lantana camara*, *Ricinus communis* and *Rubus cuneifolius* are noticeable at many parts of the site. Alien invasive grass species include *Paspalum dilatatum* and *Pennisetum clandestinum*. Numerous alien invasive herbaceous plant species occur at the site which include *Bidens pilosa*, *Amaranthus hybridus*, *Oenothera biennis*, *Plantago lanceolata*, *Galinsoga parviflora*, *Chenopodium album*, *Tagetes minuta*, *Oxalis corniculata*, *Canna indica* and *Hypochaeris radicata*.
- No wetlands or rocky ridges appear to be present at the site.
- Grassland at the site is represented by the Midlands Mistbelt Grassland (Gs 9) vegetation type which is listed as a Threatened Ecosystem, Vulnerable, according to the National List of Threatened Ecosystems (2011). The vegetation at the site is partly transformed, modified, visibly disturbed and largely isolated. The scope for the restoration and conservation of natural grassland unit at the site is small.
- No Threatened or Near Threatened plant- or animal species appear to be resident at the site. No other plant or animal species of particular conservation concern are likely to be found at the site.
- There is little scope for the partly transformed, modified and visibly disturbed and isolated relatively small patch of grassland to be part of a conservation corridor of particular importance.
- Possible ecological sensitivities at the site were indicated by a report generated from the screening tool of DEFFE. These ecological sensitivities that could possibly/ are present at the site, follow.
- *Animal species theme sensitivity*  
Relative animal species theme sensitivity is listed as high. No suitable habitat for *Hirundo atrocaerulea* (Blue Swallow) is present at the site and the occurrence of this species at the site is highly unlikely. No suitable habitat for the butterfly species *Chrysoritis phosphor borealis* is present at the site (needs specific indigenous forest habitat). No signs or observations of *Chrysospalax villosus*, *Dendrohyrax arboreus* or *Ourebia ourebi*

*ourebi* were noted at the site and based on habitat conditions it is highly unlikely that any of these mammals occur at the site. Such as listed in Tables 4.9 – 4.17 no animals of particular conservation concern are likely to be present at the site. The overall animal theme sensitivity, following the ground truthing at the site, appears to be low.

- *Aquatic biodiversity theme sensitivity*

Relative aquatic biodiversity theme sensitivity at the site is listed as very high owing to the presence of an aquatic CBA and strategic water source area. The site is not part of a FEPA Freshwater Ecosystem Priority Area (Nel *et. al.*, 2011). There are important wetlands and watercourses in the larger area. The present rain water run off systems at the site, in particular given the presence of extensive informal dumping and informal residences, are of concern. There are no wetlands at the site and locally at the site the aquatic biodiversity theme sensitivity is low. However, because of the importance of the strategic water source area the stormwater system, if the development is approved, should be carefully planned,

- *Plant species theme sensitivity*

Relative plant species theme sensitivity is listed as medium. Extensive covers of alien invasive plant species are conspicuous at the site. Vegetation is transformed at parts of the site, owing to residences, and at other parts, modified or degraded. It is highly unlikely that plant species such as *Stachys comosa*, *Woodia verruculosa*, *Helichrysum pannosum*, *Sisyranchthes fanninae* and *Senecio dregeanus* would be present at the site. No signs of these species were observed. It is also highly unlikely that other sensitive species, such as Declining species prone to harvesting (see Table 4.7 and Table 4.8) would occur at the site. The overall plant theme sensitivity, following the ground truthing, appears to be low.

- *Terrestrial biodiversity theme sensitivity*

Relative terrestrial biodiversity at the site is listed as very high. This high sensitivity that is ascribed to the site area, is because of the presence of Critical Biodiversity Area 1, an Ecological Support Area, a Protected Areas Expansion Strategy, Strategic Water Source Areas and a mapped Vulnerable Ecosystem, the Midlands Mistbelt Grassland. During surveys at the site, it was found that the original vegetation type is partly transformed, modified, visibly degraded and that the relatively small site is largely isolated. There is little scope to restore the grassland at the site and conserve it as a natural unit of Midlands Mistbelt Grassland. The terrestrial biodiversity theme at the proposed footprints appears to be low at the site.

- Ecological sensitivity at the site is low or very-low. Ecological sensitivity at the parts of the site where residential settlements occur, and vegetation has been transformed, is very-low (Figure 3). Ecological sensitivity at the remainder of the site where vegetation is modified and where extensive and visibly dense covers of alien invasive plant species are present, is low (Figure 3).

- While the ecological sensitivity at the site is low and also following the ground truthing for the DEFFE listing, two key issues are to be taken into account:
  - 1) Alien invasive plant species should be controlled at the site so that a source area for the spread of alien invasive plant species should no longer be present at the site,
  - 2) Because the catchment of the larger area of which the site is part, is so important and also the larger area as a Strategic Water Source Area (DEFFE), the quality of water and the stormwater systems should be planned carefully at the site, if the development is approved.
- Following the mitigations which will be upheld and planned footprint for development all the impact risks listed above are moderate or low.

## 8 REFERENCES

- Alexander, G. & Marais, J. 2007. A guide to the reptiles of Southern Africa. Struik, Cape Town.
- Apps, P. 2012. Smithers' mammals of Southern Africa 4<sup>th</sup> ed: A field guide, revised and updated by Peter Apps. Struik Nature, Cape Town.
- Armstrong, A.J. 1991. On the biology of the marsh owl, and some comparisons with the grass owl. *Honeyguide* 37:148-159.
- Armstrong, A.J. 2020. The status and distribution of Pennington's Protea butterfly, *Capys penningtoni* (Lepidoptera: Lycaenidae: Theclinae. *Metamorphosis* 31(1): 139-147.
- Barnes, K.N. ed. 2000. The Eskom Red Data Book of birds of South Africa, Lesotho and Swaziland. BirdLife South Africa, Johannesburg.
- Bates, M.F., Branch, W.R., Bauer, A.M., Burger, M., Marais, J., Alexander, G.J. & De Villiers, M.S. (eds). 2014. Atlas and Red List of the Reptiles of South Africa, Lesotho and Swaziland. *Suricata* 1. South African National Biodiversity Institute, Pretoria.
- Boon, R. 2010. *Pooley's trees of eastern South Africa: a complete guide 2<sup>nd</sup> ed.* Flora and Fauna Publications Trust, Durban.
- Branch, B. 1998. Field guide to snakes and other reptiles of southern Africa. 3<sup>rd</sup> ed. Struik, Cape Town.
- Branch, B. 2008. Tortoises, Terrapins & Turtles of Africa. Struik Nature, Cape Town.
- Branch, W.R. & Patterson, R.W. 1975. Notes on the ecology of the Giant Girdled Lizard, *Cordylus giganteus*. *Journal of Herpetology* 9(4): 364-366.
- Bronner, G. 2011. *Mammals*. In: Picker, M. & Griffiths, C. 2011. *Alien & Invasive animals: a South African perspective*. Struik Nature, Cape Town, p 22-35.
- Bromilow, C. 2010. Problem plants and alien weeds of South Africa. Briza Publications, Pretoria.
- Carruthers, V. & Du Preez, 2011. Frogs and frogging in southern Africa 2<sup>nd</sup> ed. Struik, Cape Town.
- Child, M.F., Roxburgh, L., Do Linh San, E., Raimondo, D. & Davies-Mostert, H.T. (eds.). 2017. The 2016 Red List of Mammals of South Africa, Swaziland and Lesotho. South African National Biodiversity Institute and Endangered Wildlife Trust, South Africa.
- Child, M.F., Roxburgh, L., Do Linh San, E., Raimondo, D. & Davies-Mostert, H.T. (eds.). 2017. The 2016 Red List of Mammals of South Africa, Swaziland and Lesotho. South African National Biodiversity Institute and Endangered Wildlife Trust, South Africa.
- Chittenden, H., Davies, G. & Weiersbye, I. 2016. Roberts Bird Guide. 2<sup>nd</sup> ed. John Voelcker Book Fund, Cape Town.
- Cillié, B., Oberprieler, U. & Joubert, C. 2004. Animals of Pilanesberg: an identification guide. Game Parks Publishing, Pretoria.
- Cilliers, S.S., Müller, N. & Drewes, E. 2004. Overview on urban nature conservation: situation in the western-grassland biome of South Africa. *Urban forestry and urban greening* 3: 49-62.
- Coetzee, N. & Monadjem, A. 2008. *Mystromys albicaudatus*. In: IUCN 2012. IUCN Red List of Threatened Species. Version 2012.2. <[www.iucnredlist.org](http://www.iucnredlist.org)>.
- Conradie, W., Du Preez, L.H., Smith, K. & Weldon, C. 2006. Field guide to the frogs and toads of the Vredefort Dome World Heritage Site. School of Environmental Sciences and Development, Potchefstroom.
- Court, D. 2010. *Succulent Flora of Southern Africa*. Struik Nature, Cape Town.
- Crouch, N.R., Klopper, R.R., Burrows, J.E. & Burrows, S.M. 2011. Ferns of Southern Africa: a comprehensive guide. Struik Nature, Cape Town.
- Del Hoyo, J., Elliot, J. & Sargatal, J. 1992. Handbook of the birds of the world, Vol. 1. Lynx Editions, Barcelona.
- Deutshländer, M.S. & Bredenkamp, C.J. 1999. Importance of vegetation analysis in the conservation management of the endangered butterfly *Aloeides dentatis* subsp. *dentatis* (Swierstra) (Lepidoptera: Lycaenidae). *Koedoe* 42(2): 1-12.
- Dippenaar-Schoeman, A.S. 2002. Baboon and trapdoor spiders in southern Africa: an identification manual. Plant Protection Research Institute Handbook No. 13. Agricultural Research Council, Pretoria.
- Dippenaar-Schoeman, A.S. 2014. Field guide to the spiders of South Africa. LAPA, Pretoria.
- Dippenaar-Schoeman, A.S. & Jocqué, R. 1997. African spiders: an identification manual. Plant Protection Research Institute Handbook No. 9. Agricultural Research Council, Pretoria.
- Drinkwater, T.W., Bate, R. & Du Toit, H.A. 1998. A field guide for identification of maize pests in South Africa. Agricultural Research Council: Grain-crops Institute, Potchefstroom.

- Duncan, G. 2016. The Amaryllidaceae of southern Africa. Umdaus Press, Hatfield.
- Du Preez, L.H. 1996. Field guide and key to the frogs and toads of the Free State. Department of Zoology and Entomology, University of the Orange Free State, Bloemfontein.
- Du Preez, L.H. & Carruthers, V. 2009. A complete guide to the frogs of southern Africa. Struik Nature, Cape Town. CD with calls included.
- Edge, D.A., Cilliers, S.S. & Terblanche, R.F. 2008. Vegetation associated with the occurrence of the Brenton blue butterfly. *South African Journal of Science* 104: 505 - 510.
- Fish, L., Mashau, A.C., Moeaha, M.J. & Nembudani, M.T. 2015. Identification guide to southern African grasses. An identification manual with keys, descriptions and distributions. *Strelitzia* 36. South African National Biodiversity Institute, Pretoria.
- Filmer, M.R. 1991. Southern African spiders: an identification guide. Struik, Cape Town.
- Gardiner, A.J. & Terblanche, R.F. 2010. Taxonomy, biology, biogeography, evolution and conservation of the genus *Erikssonia* Trimen (Lepidoptera: Lycaenidae). *African Entomology* 18(1): 171 – 191.
- Germishuizen, G. 2003. Illustrated guide to the wildflowers of northern South Africa. Briza, Pretoria.
- Germishuizen, G., Meyer, N.L. & Steenkamp (eds) 2006. A checklist of South African plants. Southern African Botanical Diversity Network Report No. 41. SABONET, Pretoria.
- Goldblatt, P. 1986. The Moraeas of Southern Africa. *Annals of Kirstenbosch Botanic Gardens*, Volume 14. National Botanic Gardens, Cape Town.
- Goldblatt, P. 1989. The genus *Watsonia*. *Annals of Kirstenbosch Botanic Gardens*, Volume 19. National Botanic Gardens, Cape Town.
- Goldblatt, P. & Manning, J. 1998. *Gladiolus* in Southern Africa.
- Henderson, L. 2001. *Alien weeds and alien invasive plants: a complete guide to the declared weeds and invaders in South Africa*. Plant Protection Research Institute Handbook No. 12. ARC: Plant Protection Research Institute, Pretoria.
- Henderson, L. & Cilliers, C.J. 2002. *Invasive aquatic plants: a guide to the identification of the most important and potentially dangerous invasive aquatic and wetland plants in South Africa*. Plant Protection Research Handbook No. 16. Agricultural Research Council, Pretoria.
- Henning, S.F. & Henning, G.A. 1989. South African Red Data Book: butterflies. *South African National Scientific Programmes Report* No. 158. CSIR, Pretoria.
- Henning, G.A., Terblanche, R.F. & Ball, J.B. (eds) 2009. South African Red Data Book: butterflies. *SANBI Biodiversity Series No 13*. South African National Biodiversity Institute, Pretoria.
- Hill, C.J. 1995. Conservation corridors and rainforest insects. (In Watt, A.D., Stork, N.E. & Hunter, M.D. (eds.), *Forests and Insects*. Chapman & Hall, London. p. 381-393.)
- Hockey, P. 2011. *Birds*. In: Picker, M. & Griffiths, C. 2011. *Alien & Invasive animals: a South African perspective*. Struik Nature, Cape Town, p 36-44.
- Hockey, P.A.R., Dean, W.J.R. & Ryan, P.G. (eds.). 2005. *Roberts Birds of Southern Africa*. John Voelcker Bird Book Fund, Cape Town.
- Holm, E. & Marais, E. 1992. Fruit chafers of southern Africa. Ekogilde, Hartebeespoort.
- IUCN. 2001. *IUCN Red List Categories and Criteria: Version 3.1*. IUCN Species Survival Commission. IUCN, Gland, Switzerland and Cambridge, UK.
- IUCN. 2012. IUCN Red list of Threatened Species. Version 2012.1)
- Johnson, S & Bytebier, B. 2015. *Orchids of South Africa*. Struik Nature, Cape Town.
- Kemper, N.P. 2001. RVI: Riparian Vegetation Index, final report, WRC Report No. 850/3/1. Institute for Water Research, Pretoria.
- Kok, J.C. 1998. *Vrystaatse bome, struik en klimplante* Kontak-uitgewers, Pretoria.
- Liebenberg, L. 1990. *A field guide to the animal tracks of Southern Africa*. David Philip Publishers, Cape Town.
- Leeming, J. 2003. *Scorpions of southern Africa*. Struik, Cape Town.
- Leroy, A. & Leroy, J. 2003. *Spiders of southern Africa*. Struik, Cape Town.
- Low, A.B. & Rebelo, A.G. (Eds.) 1996. *Vegetation of South Africa, Lesotho and Swaziland*. Department of Environmental Affairs and Tourism, Pretoria.



- Manning, J. 2003. Photographic guide to the wild flowers of South Africa. Briza, Pretoria.
- Manning, J. 2009. Field guide to the wild flowers of South Africa. Struik, Cape Town.
- Marais, J. 2004. A complete guide to the snakes of southern Africa. Struik, Cape Town.
- McMurtry, D., Grobler, L., Grobler, J. & Burns, S. 2008. Field guide to the orchids of northern South Africa and Swaziland. Umदाus Press, Hatfield.
- Mecenero, S., Ball, J.B., Edge, D.A., Hamer, M.L., Henning, G.A., Krüger, M., Pringle, E.L., Terblanche, R.F. & Williams, M.C. 2013. *Conservation Assessment of Butterflies of South Africa, Lesotho and Swaziland: Red List and Atlas*. Safronics, Johannesburg & Animal Demography Unit, Cape Town.
- Minter, L.R., Burger, M., Harrison, J.A., Braack, H.H., Bishop, P.J. & Kloepfer, D. eds. 2004. Atlas and Red Data Book of the Frogs of South Africa, Lesotho and Swaziland. SI/MAB series 9, Smithsonian Institution, Washington DC.
- Mucina, L. & Rutherford, M.C. eds. 2006. The vegetation of South Africa, Lesotho and Swaziland. *Strelitzia* 19. Pretoria: South African National Biodiversity Institute.
- Mucina, L., Rutherford, M.C., and Powrie, L.W. eds. 2005. Vegetation map of South Africa, Lesotho and Swaziland, 1:1 000 000 scale sheet maps. Pretoria: South African National Biodiversity Institute.
- New, T.R. 1993. ed. Conservation biology of *Lycaenidae* (butterflies). *Occasional paper of the IUCN Species Survival Commission* No. 8.
- Peacock, F. 2006. Pipits of Southern Africa. Published by the author, Pretoria. www.pipits.co.za.
- Pfab, M.F. 2002. Priority ranking scheme for Red Data plants in Gauteng, South Africa. *South African Journal of Botany* (68): 299-303.
- Pfab, M.F. & Victor, J.E. 2002. Threatened plants of Gauteng, South Africa. *South African Journal of Botany* (68): 370-375.
- Picker, M. & Griffiths, C. 2011. Alien & Invasive animals: a South African perspective. Struik Nature, Cape Town.
- Picker, M., Griffiths, C. & Weaving, A. 2004. Field guide to insects of South Africa. 2<sup>nd</sup> ed. Cape Town: Struik.
- Pooley, E. 1998. A field guide to wild flowers of KwaZulu-Natal and the eastern region. Natal Flora Publications Trust, Durban.
- Pringle, E.L., Henning, G.A. & Ball, J.B. eds. 1994. Pennington's Butterflies of Southern Africa. Struik Winchester, Cape Town.
- Pryke, S.R. & Samways, M.J. 2001. Width of grassland linkages for the conservation of butterflies in South African afforested areas. *Biological Conservation* 101: 85-96.
- Pullin, A.S. ed. 1995. Ecology and conservation of butterflies. Chapman & Hall, London.
- Raimondo, D., von Staden, L., Foden, W., Victor, J.E., Helme, N.A., Turner, R.C., Kamundi, D.A. & Manyama, P.A. (eds.). 2009. Red list of South African plants 2009. *Strelitzia* 25. South African National Biodiversity Institute, Pretoria.
- Retief, E. & Herman, P.P.J. 1997. Plants of the northern provinces of South Africa: keys and diagnostic characteristics. *Strelitzia* 6. National Botanical Institute, Pretoria.
- Rutherford, M.C. & Westfall, R.H. 1994. Biomes of southern Africa: An objective categorisation, 2<sup>nd</sup> ed. *Memoirs of the Botanical Survey of South Africa*, Vol. 63, pp. 1-94. National Botanical Institute, Pretoria.
- Ryan, P. 2001. Practical Birding: A guide to birdwatching in southern Africa. Struik, Cape Town.
- SANBI. 2017. Technical guidelines for CBA Maps: Guidelines for developing a map of Critical Biodiversity Areas & Ecological Support Areas using systematic biodiversity planning. First Edition (Beta Version), June 2017. Compiled by Driver, A., Holness, S. & Daniels, F. South African National Biodiversity Institute, Pretoria.
- Samways, M.J. 2005. Insect diversity conservation. Cambridge University Press, Cambridge.
- Skelton, P. 2001. A complete guide to the freshwater fishes of Southern Africa. Struik, Cape Town.
- Skelton, P. & Weyl, O. 2011. *Fishes*. In: Picker, M. & Griffiths, C. 2011. *Alien & Invasive animals: a South African perspective*. Struik Nature, Cape Town, p 36-44.
- Skinner, J.D. & Chimimba, C.T. 2005. The mammals of the southern African subregion. Cambridge University Press, Cape Town.
- Sliwa, A. 2008. *Felis nigripes*. In: IUCN 2012. IUCN Red List of Threatened Species.
- Smit, N. 2008. Field guide to the *Acacias* of South Africa. Briza, Pretoria.
- Smith, G.F., Crouch, N.R. & Figueiredo, E. 2017. Field guide to succulents in southern Africa. Struik Nature, Cape Town.

- Smithers, R.H.N. 1986. South African Red Data Book: Terrestrial mammals. *South African National Scientific Programmes Report No. 125*. CSIR, Pretoria.
- South Africa. 2004. National Environmental Management: Biodiversity Act No. 10 of 2004. Government Printer, Pretoria.
- Stuart, C. & Stuart, T. 2006. Field guide to the larger mammals of Africa 3<sup>rd</sup> ed. Struik Nature, Cape Town.
- Stuart, C. & Stuart, T. 2013. A field guide to the tracks and signs of Southern, Central and East African wildlife 4<sup>th</sup> ed. Struik Nature, Cape Town.
- Tarboton, W. & Erasmus, R. 1998. Owls and owling in southern Africa. Struik, Cape Town.
- Taylor, J.C., Janse Van Vuuren, M.S. & Pieterse, A.J.H. 2007. The application and testing of diatom-based indices in the Vaal and Wilge Rivers, South Africa. *Water SA* 33(1): 51-59.
- Terblanche, R.F. & Edge, D.A. 2007. The first record of an *Orachrysops* in Gauteng. *Metamorphosis* 18(4): 131-141.
- Terblanche, R.F., Morgenthal, T.L. & Cilliers, S.S. 2003. The vegetation of three localities of the threatened butterfly species *Chrysoritis aureus* (Lepidoptera: Lycaenidae). *Koedoe* 46(1): 73-90.
- Terblanche, R.F. & Van Hamburg, H. 2003. The taxonomy, biogeography and conservation of the myrmecophilous *Chrysoritis* butterflies (Lepidoptera: Lycaenidae) in South Africa. *Koedoe* 46(2): 65-81.
- Terblanche, R.F. & Van Hamburg, H. 2004. The application of life history information to the conservation management of *Chrysoritis* butterflies (Lepidoptera: Lycaenidae) in South Africa. *Koedoe* 47(1): 55-65.
- Van den Berg, J. & Drinkwater, T.W. 1998. Field guide to identification of sorghum pests in South Africa. Agricultural Research Council: Grain-crops Institute, Potchefstroom.
- Van Ginkel, C.E., Glen, R.P., Gordon-Gray, K.D., Cilliers, C.J., Muasya, M. & van Deventer, P.P. 2011. Easy identification of some South African Wetland Plants. WRC Report No TT 479/10. Water Research Commission, Gezina.
- Van Jaarsveld, E.J. 2006. The Southern African *Plectranthus* and the art of turning shade to glade.
- Van Oudtshoorn, F. 2012. Guide to grasses of southern Africa, 3<sup>rd</sup> ed. Briza, Pretoria.
- Van Wyk, B. 2000. A photographic guide to wild flowers of South Africa. Struik, Cape Town.
- Van Wyk, B. & Malan, S. 1998. Field Guide to the Wild Flowers of the Highveld. Struik, Cape Town.
- Van Wyk, A.E. & Smith, G.F. 2001. Regions of floristic endemism in Southern Africa: a review with emphasis on succulents, Umdaus Press, Pretoria.
- Van Wyk, B.E. & Smith, G.F. 2014. Guide to the aloes of South Africa, 3<sup>rd</sup> ed. Briza, Pretoria.
- Van Wyk, B.E., van Oudtshoorn, B. & Gericke, N. 2009. Medical plants of South Africa. Briza, Pretoria.
- Van Wyk, B. & Van Wyk, P. 2013. Field guide to trees of southern Africa. 2<sup>nd</sup> ed. Struik Nature, Cape Town.
- Walker, C. 1996. Signs of the Wild. 5<sup>th</sup> ed. Struik, Cape Town.
- Watt, A.D., Stork, N.E. & Hunter, M.D. (eds.), *Forests and Insects*. London: Chapman & Hall. (p. 381-393.)

## ANNEXURE 1

### List of plant species recorded at the site

Sources: Bromilow (2010); Crouch, Klopper, Court (2010); Duncan (2016); Fish, Mashau, Moeaha & Nembudani (2015); Germishuizen (2003), Goldblatt (1986); Goldblatt & Manning (1998); Johnson & Bytebier (2015); Manning (2007), Manning (2009), McMurtry, Grobler, Grobler & Burns (2008); Smith, Crouch. & Figueiredo (2017); Van Ginkel *et al.* (2011); Van Jaarsveld (2006); Van Oudtshoorn (2012); Van Wyk (2000); Van Wyk & Gericke (2000); Van Wyk & Malan (1998); Van Wyk & Van Wyk (2013); Van Wyk & Smith (2014); Van Wyk, van Oudtshoorn & Gericke (2009);

Plant species are listed alphabetically under main taxonomic groups.

Species marked with an asterisk \* are exotic.

TAXON	COMMON NAMES	FAMILY
<b>ANGIOSPERMAE: MONOCOTYLEDONS</b>		
<i>Aristida junciformis</i>	Nogongoni grass	POACEAE
<i>Brachiaria eruciformis</i>		POACEAE
* <i>Canna indica</i>	Garden Canna	CANNACEAE
<i>Cynodon dactylon</i>	Couch Grass	POACEAE
<i>Eleusine coracana</i>	Goose Grass	POACEAE
<i>Eragrostis curvula</i>	Weeping Love Grass	POACEAE
<i>Hyparrhenia hirta</i>	Common Thatching Grass	POACEAE
<i>Melinis repens</i>	Natal Red-top	POACEAE
* <i>Paspalum dilatatum</i>		POACEAE
* <i>Pennisetum clandestinum</i>	Kikuyu Grass	POACEAE
<i>Setaria sphacelata</i> var. <i>sericea</i>	Golden Bristle Grass	POACEAE
<i>Sporobolus africanus</i>	Rat's-tail Dropseed	POACEAE
<i>Urochloa panicoides</i>		POACEAE

ANGIOSPERMS: DICOTYLEDONS		
* <i>Acacia decurrens</i>	Green Wattle	FABACEAE
* <i>Acacia mearnsii</i>	Black Wattle	FABACEAE
* <i>Acanthospermum australe</i>		ASTERACEAE
* <i>Amaranthus hybridus</i>	Pigweed	AMARANTHACEAE
* <i>Bidens pilosa</i>		ASTERACEAE
* <i>Chenopodium album</i>	White Goosefoot	CHENOPODIACEAE
* <i>Eucalyptus sp.</i>	Red Gum	MYRTACEAE
* <i>Galinsoga parviflora</i>	Small-flowered Quickweed	ASTERACEAE
* <i>Hypochaeris radicata</i>	Spotted cat's ear	ASTERACEAE
* <i>Lantana camara</i>	Common Lantana	VERBENACEAE
* <i>Malva parviflora</i>	Small Mallow	MALVACEAE
* <i>Melia azedarach</i>	Seringa	MELIACEAE
<i>Nidorella auriculata</i>		ASTERACEAE
* <i>Oenothera biennis</i>		ONAGRACEAE
* <i>Oxalis corniculata</i>	Creeping Sorrel	OXALIDACEAE
* <i>Ricinus communis</i>	Caster-oil Plant	EUPHORBIACEAE
* <i>Rubus cuneifolius</i>	American Bramble	ROSACEAE
* <i>Plantago lanceolata</i>	Buckhorn Plantain	PLANTAGINACEAE
<i>Senecio madagascariensis</i>		ASTERACEAE
* <i>Solanum mauritianum</i>	Bugweed	SOLANACEAE

* <i>Tagetes minuta</i>	Khaki Weed	ASTERACEAE
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