# VEGETATION AND TERRESTRIAL FAUNA ASSESSMENT: DORSTFONTEIN WEST MINE EXPANSION

*Prepared for:*

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**March 2019**

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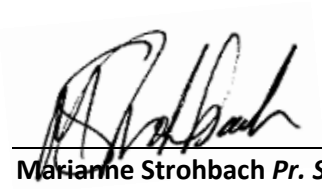
**DECLARATION**

I, **Marianne Strohbach**, declare that -

- I act as the independent specialist;
- I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant;
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting the specialist report relevant to this application, including knowledge of the National Environmental Management Act, 1998 (Act No. 107 of 1998), regulations and any guidelines that have relevance to the proposed activity;
- I will comply with the Act, regulations and all other applicable legislation;
- I will take into account, to the extent possible, the matters listed in Regulation 8;
- I have no, and will not engage in, conflicting interests in the undertaking of the activity;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the application by the competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- All the particulars furnished by me in this form are true and correct; and
- I realise that a false declaration is an offence in terms of Regulation 71 and is punishable in terms of section 24F of the Act.



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28 March 2019

Date

## EXECUTIVE SUMMARY

Dorstfontein Coal Mines (Pty) Ltd (DCM) appointed Nsovo Environmental to co-ordinate the specialist studies for the proposed expansion of operations at its Dorstfontein West Mine (DCMW). The proposed operational expansions will include the following:

1. Underground pillar extraction of coal on the farms Dorstfontein 71 IS, Portions 2 to 8, Vlakfontein 72 IS and the south-eastern extent of Rietkuil 558 IS.
2. Expanding the discard dump capacity:
    - Expansion of the existing Discard Dump. Access to this already exists.
    - Creation of a new Discard Dump, with three alternative sites delineated. Access routes to these discard dumps have not yet been determined, and will most likely be designed according to the outcomes of specialist studies
3. Construction of an overland conveyor belt and associated service road to link the coal wash plant of DCMW to loading facilities of the Dorstfontein East Mine (DCME).
    - Two routes for the conveyor were proposed by the client.

The activities related to the proposed expansion of discard dump facilities and movement of coal for loading will impact an area currently covered by natural (primary) and semi-natural (secondary) vegetation, in addition to already moderately to heavily modified areas. **This document reports on the investigation of the vegetation and terrestrial fauna** and related issues present on all these areas, referred to as the study area. Most of the focus of the study was on areas that will be directly affected above-ground. Potential impacts of the proposed activities were evaluated based on the description of expansion operations provided at the time of writing, and where necessary, recommendations for the most appropriate mitigation measures have been noted.

Historically, the entire study area and its surroundings were covered with Eastern Highveld Grassland. This is currently listed as a **Vulnerable Ecosystem**, with remaining primary vegetation regarded as sensitive and in need of conservation. On a provincial level, portions of remaining natural and near-natural vegetation were delineated as **CBA: Irreplaceable**, whilst some areas were considered Other Natural Areas or Moderately Modified – Old Lands.

The survey conducted 6 to 8 February 2019 yielded following results:

A total of 269 plant species were recorded, of which only **227** were **indigenous plant species**. **Six** of the observed indigenous plant species were **of conservation concern**, with a possibility of a further 18 such species emerging under more favourable conditions. These species are listed in Section 4.2. Of the exotic species, 23 species are listed according to NEMBA as in need of control. Likewise, high densities of one indigenous Encroacher species should be controlled according to CARA. Alien and invasive plant species are listed in Section 4.3. A full species list, sorted according to growth form and indicating the habitat in which such were observed, is provided in Appendix A.

Habitat types and their ecological sensitivity:

| FAUNAL HABITAT | VEGETATION HABITAT | SENSITIVITY | EXPECTED PS6 CLASSIFICATION |
|---|---|---|---|
| Dry Grasslands | *Eragrostis* species dominated Primary Grasslands | **High** | Natural habitat |
| | *Eragrostis lehmanniana* dominated Secondary Grasslands | **Medium** | Modified habitat |
| | *Cheilanthes viridis – Diospyros* species Rocky Ledges | **No-Go** | Natural habitat, could qualify for critical habitat |
| Moist Grasslands | *Eragrostis plana* Floodplain Grasslands | **High** | Natural habitat |
| | *Imperata cylindrica* Seepage Slope Grasslands | **Medium** | Modified to Natural habitat |
| Wetlands | Riparian Vegetation | **High** | Natural habitat, could qualify for critical habitat |
| Modified but Vegetated | Alien-Dominated Areas | **Low** | Modified habitat |
| Modified | Cultivated and Heavily Modified Areas | **Low** | Modified habitat |

From a terrestrial fauna perspective, the use of the habitats by at least 11 mammal species could be confirmed, including the Near Threatened Cape Clawless Otter (*Aonyx capensis*). Regarding herpetofauna, 6 amphibian species were observed, with a strong possibility of the Giant Bullfrog (*Pyxicephalus adspersus*) also utilising some of the area. Lastly, the presence of one species of Lepidoptera, the Marsh Sylph (*Metisella meninx*), was confirmed. Details of faunal observations are given in Section 4.5.

The highest risks of the proposed developments to the local biodiversity and its habitats related to:

- Loss of species and sensitive habitats:
    - Within the remaining natural and near-natural vegetation, a high diversity of indigenous plants was observed, as well as several faunal species. This also included provincially protected plants and fauna.
- Loss of ecological function of habitats:
    - Ecological function and –state was also found to be dependent on the prevailing soil surface and sub-surface hydrology – an interruption or drastic alteration of such natural hydrological patterns will have a significant detrimental effect on all lower-lying wet- and moist habitats, and all the species in or depending on such habitats.
- Pollution risk from potential acid mine drainage and coal dust.

Mitigation and monitoring requirements for the various risks and/or impacts overlap to a large degree, as do such mitigation action during the different phases of mining. They are thus all listed together under sections 5.6 and 5.7, focusing on avoidance, minimisation, reduction and rehabilitation.

The risks and impact significances determined are summarised below:

| ACTIVITY | ISSUE | MITIGATION | SIGNIFICANCE | OPTION RATING |
|---|---|---|---|---|
| **Underground Pillar Extraction** | Degradation from post-mining subsidence | No | 72 High | No alternatives |
| | | Yes | 46 Medium | |
| **Expansion of Discard Dump Facilities** | Loss of Indigenous Vegetation | No | 75 High | Existing Dump Exp.: ± 12 ha<br>Dump Site 1: ± 4 ha<br>**Dump Site 2: ± 2.7 ha**<br>Dump Site 3: ± 2 ha |
| | | Yes | 55 Medium | |
| | Loss of Exotic Vegetation | No | 65 Medium | No preference from ecological perspective |
| | | Yes | 35 Medium | |
| | Loss of or Displacement of Fauna | No | 60 Medium | No preference from ecological perspective |
| | | Yes | 27 Low | |
| | Loss of ecological function | No | 90 High | *Old Dump Expansion* |
| | | Yes | 44 Medium | |
| | | No | 80 High | *New dump site 1* |
| | | Yes | 39 Medium | |
| | | **No** | **72 High** | ***Preferred Option:***<br>***New dump site 2*** |
| | | **Yes** | **33 Medium** | |
| | | No | 90 High | *Worst Option:*<br>*New dump site 3* |
| | | Yes | 60 Medium | |
| | Increase in Alien Invasive Vegetation | No | 70 High | No preference from ecological perspective |
| | | Yes | 27 Low | |
| **DCMW to DCME conveyor and maintenance road** | Loss of Indigenous Vegetation | No | 80 High | *ROUTE A* |
| | | Yes | 60 Medium | |
| | | No | 80 High | *Worst Option:*<br>*ROUTE B* |
| | | Yes | 75 High | |
| | Loss of Exotic Vegetation | No | 65 Medium | No preference from ecological perspective |
| | | Yes | 35 Medium | |
| | Loss of or Displacement of Fauna | No | 75 High | ***Preferred Option:***<br>***ROUTE A*** |
| | | Yes | 27 Low | |
| | Loss of ecological function | No | 80 High | ***Preferred Option:***<br>***ROUTE A*** |
| | | Yes | 36 Medium | |

From a terrestrial ecology perspective, the expansion of the discard dump facilities could be accepted if all mitigation measures as described in Section 5.6 are duly implemented. Whilst there is no alternative to the expansion of the current discard dump, of the new discard dump proposals, Site 2 was preferred. For the conveyor route options presented, both Routes A and B were problematic from an ecological perspective, with Route B the worst choice. It must be noted though that much of the study area and surrounding areas do contain wetlands, hence the importance of wetlands will need to be considered along with this report in the final decision of approving the proposed development.

# TABLE OF CONTENTS

Executive Summary ..... ii
Table of Contents ..... v
List of Figures ..... viii
List of Tables ..... viii
**ABBREVIATIONS AND ACRONYMS** ..... ix
1 Introduction ..... 1
1.1 Project Description ..... 1
1.2 Terms of Reference ..... 2
1.3 Limitations ..... 2
1.4 Conditions of this Report ..... 2
1.5 Legislation and Policies ..... 3
1.5.1 Provincial ..... 3
1.5.2 National ..... 3
2 Study Area ..... 3
2.1 Climate and Surface Hydrology ..... 3
2.2 Land Use ..... 5
2.3 Historic Vegetation Overview ..... 5
2.4 Conservation Planning ..... 6
2.4.1 National ..... 6
2.4.2 Provincial ..... 7
3 Methods ..... 8
3.1 Vegetation Survey ..... 8
3.1.1 Vegetation Mapping ..... 10
3.1.2 Vegetation Sensitivity Analysis and Criteria ..... 10
3.2 Faunal Survey ..... 11
3.2.1 Desktop Assessment ..... 11
3.2.2 Field Techniques ..... 12
3.2.3 Faunal Sensitivity Analysis and Criteria ..... 13
4 Results ..... 15
4.1 Vegetation Survey ..... 15
4.1.1 Vegetation Habitat Overview ..... 15

4.1.2 Dry Grasslands ..... 18
4.1.3 Moist Grasslands ..... 22
4.1.4 Riparian Vegetation ..... 25
4.1.5 Alien-Dominated Areas ..... 26
4.2 Plant Species of Conservation Concern ..... 27
4.3 Invasive Plant Species ..... 29
4.4 Faunal Habitats ..... 32
4.4.1 Dry Grassland Habitats ..... 32
4.4.2 Wetland and Moist Grassland Habitats ..... 32
4.4.3 Cultivated and Alien-Dominated Areas (Modified Vegetated Habitats) ..... 33
4.4.4 Mining and other Anthropogenic Habitat ..... 33
4.5 Faunal Observations ..... 34
4.5.1 Mammals ..... 34
4.5.2 Herpetofauna ..... 35
4.5.3 Lepidoptera ..... 37
4.6 Habitat Sensitivity ..... 38
4.6.1 Sensitivity Evaluation of *Eragrostis* species dominated Primary Grasslands ..... 40
4.6.2 Sensitivity Evaluation of *Eragrostis lehmanniana* dominated Secondary Grasslands ..... 41
4.6.3 Sensitivity Evaluation of *Cheilanthes viridis – Diospyros* species Rocky Ledges ..... 41
4.6.4 Sensitivity Evaluation of *Eragrostis plana* Floodplain Grasslands ..... 42
4.6.5 Sensitivity Evaluation of *Imperata cylindrica* Seepage Slope Grasslands ..... 43
4.6.6 Sensitivity Evaluation of Riparian Vegetation ..... 44
4.6.7 Sensitivity Evaluation of Alien-Dominated Areas ..... 45
4.6.8 Sensitivity Evaluation of Modified Areas ..... 46
5 Impact/Risk assessment ..... 47
5.1 Anticipated Impacts ..... 47
5.2 Impact Assessment Criteria ..... 48
5.3 Assessment of Impacts Related to Underground Pillar Extraction of Coal ..... 51
5.4 Assessment of Impacts Related to the Expansion of Discard Dump Facilities ..... 54
5.4.1 Loss of Indigenous Vegetation for the Expansion or Creation of Discard Dump Facilities 54
5.4.2 Removal of Exotic Vegetation Cover for the Expansion or Creation of Discard Dump Facilities 55

5.4.3 Loss of or Displacement of Fauna ..... 57
5.4.4 Loss of Ecological Structure and –Function of Habitats ..... 58
5.4.5 Increase in Alien Invasive Vegetation ..... 61
5.5 Assessment of Impacts Related to the DCMW to DCME conveyor ..... 62
5.5.1 Loss of Indigenous Vegetation along the Conveyor Route ..... 64
5.5.2 Removal of Exotic Vegetation Cover for the Conveyor ..... 65
5.5.3 Loss of or Displacement of Fauna by the Conveyor ..... 66
5.5.4 Loss of Ecological Structure and –Function of Habitats ..... 67
5.6 Mitigation and Monitoring ..... 69
5.6.1 Avoid and Minimise ..... 69
5.6.2 Reduce ..... 71
5.6.3 Rehabilitate ..... 72
5.6.4 Official Commitments ..... 73
5.7 Monitoring Requirements ..... 74
5.8 Limitations of Impact Assessment ..... 75
6 Conclusion ..... 76
7 References ..... 77
8 Appendix A: Plant Phytosociological Table ..... 81
9 Appendix B: Listed Alien and Invasive Plant categories ..... 95

## LIST OF FIGURES

Figure 1: Locality Map of the study area ..... 4
Figure 2: Conservation Planning on and around the Study Area. ..... 9
Figure 3: Examples of modified areas exluded from the vegetation assessment. ..... 16
Figure 4: Vegetation Habitats identified. ..... 17
Figure 5: Typical view of areas with Primary Grasslands. ..... 19
Figure 6: Typical view of areas with Secondary Grasslands. ..... 20
Figure 7: Typical view of vegetation between Rocky Ledges. ..... 22
Figure 8: Typical view of areas with Floodplain Grasslands. ..... 23
Figure 9: Typical view of Seepage Slope Grasslands. ..... 24
Figure 10: Typical view of Riparian Vegetation. ..... 25
Figure 11: Typical view of Alien-Dominated areas ..... 26
Figure 12: Plant species of conservation concern observed during the survey. ..... 29
Figure 13: Some of the alien invasive species observed during the survey. ..... 31
Figure 14: Tracks of The Cape Clawless Otter (left) and Water Mongoose (right). ..... 35
Figure 15: *Metisella meninx* (Marsh Sylph) observed in the area investigated. ..... 37
Figure 16: Ecological Sensitivity Map of the area investigated. ..... 39
Figure 17: Diagram of landscape subsidence after pillar extraction (from Munnik et al. 2018). ..... 52
Figure 18: Map of the three conveyor route options assessed. ..... 63

## LIST OF TABLES

Table 1: The most typical indigenous species recorded in Primary Grasslands. ..... 18
Table 2: The most typical indigenous species recorded in Secondary Grasslands. ..... 20
Table 3: The most typical indigenous species recorded on and between Rocky Ledges. ..... 21
Table 4: The most typical indigenous species recorded in Floodplain Grasslands. ..... 23
Table 5: The most typical indigenous species recorded in Seepage Slope Grasslands ..... 24
Table 6: The most typical indigenous species recorded in Riparian Vegetation. ..... 25
Table 7: The most typical indigenous species persisting in Alien-Dominated Areas. ..... 26
Table 8: Floristic Species of Conservation Concern ..... 27
Table 9: Alien and invasive plant species observed in the study area and immediate surroundings. 30
Table 10: Mammals identified during the 2016 (STS) and 2019 field surveys ..... 34
Table 11: Red Listed mammal species likely to occur in the study area ..... 35
Table 12: Amphibians identified during the field survey. ..... 36
Table 13: Red Listed Amphibian species likely to occur in the study area ..... 36
Table 14: Endemic reptile species likely to occur within the larger study area ..... 37
Table 15: Summary of Sensitivity Ratings ..... 38
Table 16: Anticipated main impacts arising form the mining expansion activities ..... 47
Table 17: Descriptors and scoring for the EXTENT of an impact ..... 49
Table 18: Descriptors and scoring for the DURATION of an impact ..... 49

Table 19: Descriptors and scoring for the MAGNITUDE of an impact ..... 50
Table 20: Descriptors and scoring for the PROBABILITY OF OCCURRENCE of an impact ..... 50
Table 21: Descriptors for the SIGNIFICANCE score of an impact ..... 51
Table 22: Species and their percentage canopy cover as observed in each vegetation habitat. ..... 81

## ABBREVIATIONS AND ACRONYMS

| | |
|---|---|
| AIP | Alien Invasive Plant |
| BAP | Biodiversity Action Plan |
| BGIS | Biodiversity Geographic Information System (from SANBI) |
| BODATSA | Botanical Database of Southern Africa |
| CARA | Conservation of Agricultural Resources Act (Act No. 43 of 1983) |
| CBA | Critical Biodiversity Area |
| DEA | Department of Environmental Affairs |
| DCMW | Dorstfontein Complex Mine West |
| DCME | Dorstfontein Complex Mine East |
| ECO | Environmental Control Officer |
| EIA | Environmental Impact Assessment |
| EMPr | Environmental Management Programme |
| EN | Endangered |
| GPS | Global Positioning System |
| IFC | International Finance Corporation |
| IUCN | International Union for Conservation of Nature |
| LC | Least Concern |
| MBSP | Mpumalanga Biodiversity Sector Plan |
| MNCA | Mpumalanga Nature Conservation Act (Act No. 10 of 1998) |
| NEMA | National Environmental Management Act (Act 107 of 1998) |
| NEMBA | National Environmental Management: Biodiversity Act (No. 10 of 2004) |
| NT | Near Threatened |
| NWA | National Water Act (Act 36 of 1998) |
| P | Protected |
| PS6 | IFC Performance Standard 6 |
| SANBI | South African National Biodiversity Institute |
| VU | Vulnerable |

# 1 INTRODUCTION

## 1.1 Project Description

Dorstfontein Coal Mines (Pty) Ltd (DCM) appointed Nsovo Environmental to co-ordinate the specialist studies for the proposed expansion of operations at its Dorstfontein West Mine (DCMW). Dorstfontein West plans to mine the 4 seam with underground pillar extraction methods. At this stage, no open pits are planned within the DCMW mining expansion. The plant will wash coal product for the export market, and the plan is to transport the coal to the Dorstfontein East mine, which has a rapid load out facility. More specifically, the proposed operational expansions will include the following:

1. Underground pillar extraction of coal on the farms Dorstfontein 71 IS, Portions 2 to 8, Vlakfontein 72 IS and the south-eastern extent of Rietkuil 558 IS.
2. Expanding the discard dump capacity:
    - Expansion of the existing Discard Dump east of the R547, affecting Dorstfontein 71 IS Portion 8 and the eastern extent of Rietkuil 558 IS. Access to this already exists.
    - Creation of a new Discard Dump, with three alternative sites delineated. Access routes to these discard dumps have not yet been determined, and will most likely be designed according to the outcomes of specialist studies
3. Construction of an overland conveyor belt and associated service road to link the coal wash plant of DCMW to loading facilities of the Dorstfontein East Mine (DCME). Two alternative routes have been proposed, which will traverse and affect natural and semi-natural areas on Dorstfontein 71 IS Portions 2 and 8. The conveyor route will also traverse already heavily modified sections of Rietkuil 558 IS and Welstand 55 IS, portions 5, 11 and 13. These heavily modified areas have not been included in the vegetation assessment, as no natural vegetation was found to be remaining within these heavily modified areas.

The relevant specialist studies were undertaken in order to submit an application for the environmental authorisation in terms of NEMA, an application for a waste management licence in terms of NEMWA and an application for a water use licence in terms of NWA for the proposed activities associated with the DCMW expansion.

The activities related to the proposed expansion of discard dump facilities and movement of coal for loading will impact an area currently covered by natural (primary) and semi-natural (secondary) vegetation, in addition to already moderately to heavily modified areas. **This document reports on the investigation of the vegetation and terrestrial fauna** and related issues present on all these areas, referred to as the study area. Most of the focus of the study was on areas that will be directly affected above-ground. Potential impacts of the proposed activities were evaluated based on the description of expansion operations provided at the time of writing, and where necessary, recommendations for the most appropriate mitigation measures have been listed.

## 1.2 Terms of Reference

The vegetation and terrestrial fauna assessment was required to:

- Provide a description of the vegetation associations and their species composition present within the study area
- Identify key faunal habitats and verify the current use of such habitats by mammals, reptiles, amphibians and threatened insects
- Distinguish clearly between areas containing predominantly exotic, secondary and/or predominantly natural (primary) vegetation
- Indicate dominant, threatened and/or protected floristic and terrestrial fauna species occurring in the area as well as those expected to occur
- Evaluate impacts on the above arising from the proposed operational expansions and suggest relevant mitigation measures to avoid or mitigate anticipated negative impacts

## 1.3 Limitations

In order to obtain a comprehensive understanding of the dynamics and diversity of the biota on a site, including species of conservation concern, studies should include investigations through the different seasons of the year, over a number of years, and extensive sampling of the area. Due to project time constraints, such long term research was not feasible and information contained within this report is based on a single field survey, as well as findings of similar studies available for the area.

Plant species resprouting from storage tubers (geophytes) will take advantage of their stored reserves and low competition from grass cover after the dry season to grow and flower during spring and early summer before dying back during late autumn. Herbs, forbs, and grasses first need adequate rainfall before being able to fully develop and flower, usually between December and April. Most of the geophytes, forbs, succulents, and grasses can only be fully identified if they are actively growing *and* have either flowers or fruit. Although several geophytes and herbs were in flower at the time of the survey, it can be assumed that more species could emerge under favourable conditions, hence the full diversity of geophytes and forbs associated with the area is likely to be higher than currently recorded. The same would apply to fauna, which will use and area if there are sufficient resources available.

## 1.4 Conditions of this Report

Findings, recommendations and conclusions provided in this report are based on the author's best scientific and professional knowledge as well as information available at the time of compilation. The author, however, accepts no liability for any actions, claims, demands, losses, liabilities, costs, damages and expenses arising from or in connection with services rendered, and by the use of the information contained in this document. No form of this report may be amended or extended without the prior written consent of the author.

Any recommendations, statements or conclusions drawn from or based on this report must clearly cite or make reference to this report. Whenever such recommendations, statements or conclusions

form part of a main report relating to the current investigation, this report must be included in its entirety.

### 1.5 Legislation and Policies

The study was carried out in line with requirements and listings of the following legislation and policies published and promulgated up to the date of this study:

#### 1.5.1 Provincial

- The Mpumalanga Nature Conservation Act / MNCA (Act No. 10 of 1998)
- Mpumalanga Tourism and Parks Agency Act (Act No. 5 of 2005)
- Mpumalanga Biodiversity Sector Plan (MBSP, 2014)

#### 1.5.2 National

- The National Environmental Management Act (Act 107 of 1998) (NEMA) and all subsequent amendments
- The National Environmental Management Biodiversity Act (Act 10 of 2004) (NEMBA), and all subsequent amendments including:
    - Alien and Invasive Species Lists, 2014 (GN R599 in GG 37886 of 1 August 2014, updated 2016)
- Mining and Biodiversity Guidelines (2013)
- Conservation of Agricultural Resources Act / CARA (Act No. 43 of 1983)
- National Water Act (Act 36 of 1998) and all subsequent amendments

## 2 STUDY AREA

The farms Dorstfontein 71 IS, Vlakfontein 72 IS, Welstand 55 IS and Rietkuil 558 IS are situated within the Emalahleni Local Municipality and Nkangala District Municipality, Mpumalanga Province. The proposed project is located east the township of Thubelihle, north of Kriel and approximately 30 km northwest of Bethal and 25 km northeast of Secunda (Figure 1). The study area focused on area affected directly by the proposed overland conveyor system and associated haul road, discard dump expansion as well as areas where underground coal extraction will be expanded. The extent of the study area is shown in Figure 1, also indicating the area in which the conveyor system will be routed.

### 2.1 Climate and Surface Hydrology

The local rainfall regime consists of a strongly seasonal summer rainfall with very dry winters. MAP 650–900 mm (overall average: 726 mm). Rainfall ranges between 620 – 750 mm with the long term average around 650 mm with most rain falling between November and March, peaking between December and February. Summer day temperatures fluctuate daily on average between 12°C and 22°C in January, but higher temperatures are experienced. The daily winter temperatures in July fluctuate on average between 0°C and 18°C, and incidence of frost is frequent, ranging from 13 – 42 days (en.climate-data.org; worldweatheronline.com, Mucina and Rutherford 2006).

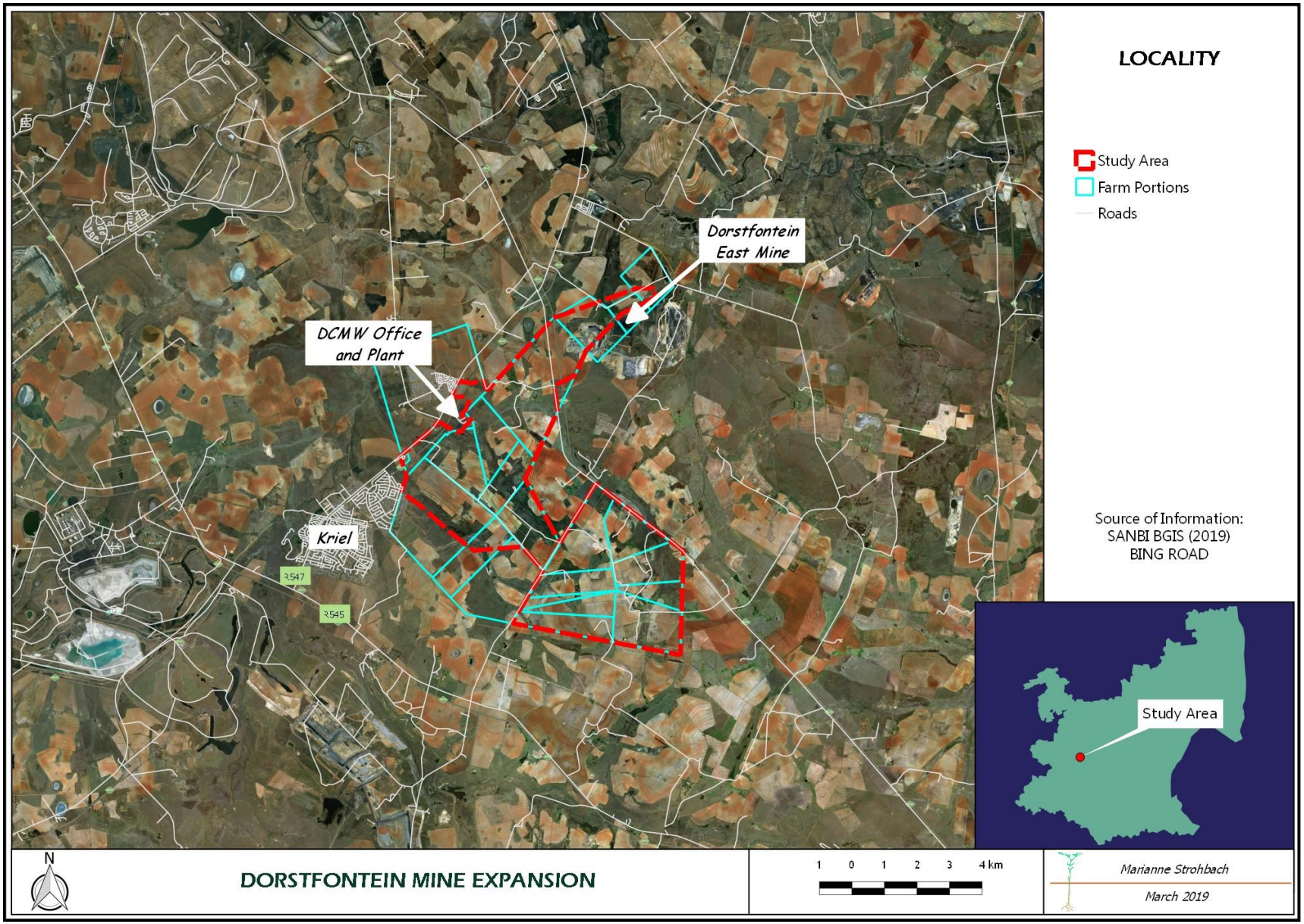


Figure 1: Locality Map of the study area

Dorstfontein West Mine (DCMW) is situated in Quaternary catchments B11B and B11D in the Upper Olifants Water Management Area (WMA). The Olifants River originates north-east of the mine and flows in a northerly direction. The Steenkoolspruit is located west of the mine. These two rivers converge north of the mine, from which point the river is called the Olifants River.

The ore processing area of DCMW is bordered by a small stream in the south, flowing in a westerly direction into the Steenkoolspruit, away from the DCMW. This stream is joined by a small south-flowing tributary flowing east of the DCMW office complex, and joining the stream north of the current box cut. The study area includes other channelled valley-bottom wetlands, the biggest situated just north of Kriel extending east to Vlakfontein, with a large seepage area along the northern periphery of Vlakfontein. The wetlands are described in more detail in the independent wetlands report (Lubbe 2019), but are distinguished as an important biodiversity habitat (see Section 4).

## 2.2 Land Use

The study area has been subjected to various disturbances in the past, as can be seen from historical Google-Earth imagery (dating from 2006). These included mostly cultivation of crops and continued grazing. Mining at Dorstfontein West had started during 1998, extracting coal with underground operations. Around 2012, open-pit operations as the Dorstfontein East Mine were initiated. Currently, only small areas, mostly on slope seepages and along channelled valley-floor wetland, appear to have indigenous (primary) vegetation remaining, unaltered by physical disturbance. However, the type and severity of surrounding disturbances, as well as continued grazing and frequent fires, would have had negative impacts on the small areas of natural vegetation.

## 2.3 Historic Vegetation Overview

Mpumalanga is known for its extensive grasslands and numerous wetlands, in which natural dominance of high shrubs and/or trees is largely prevented by frequent frost occurrences (and other factors) during winter, which tufted perennial grasses are better adapted to survive. Mpumalanga is host to approximately 21% of South Africa's flora. Of these plant species, 64% are forbs and geophytes that are restricted to the grassland biome. The majority of forbs and geophytes remain dormant during winter or very dry seasons, and re-sprout during early summer if rains are sufficient.

The grassland biome is made up of a mosaic of many different vegetation types, which vary according to the prevailing abiotic conditions. According to the delineation of these vegetation types as described and mapped for South Africa (Mucina & Rutherford, 2006; updated 2012 on BGIS), the entire study area and its surroundings were historically covered with Eastern Highveld Grassland (Gm 12, Mucina & Rutherford, 2006).

***Eastern Highveld Grassland (Gm 12):***

This grassland type historically covered the slightly to moderately undulating plains between Belfast in the east and the eastern side of Johannesburg in the west and extending southwards to Bethal, Ermelo and west of Piet Retief (Mucina and Rutherford, 2006). The vegetation of this grassland type

consists of short dense grassland dominated by the usual Highveld grass composition (*Aristida, Digitaria, Eragrostis, Themeda,* and *Tristachya*). Small, scattered rocky outcrops may have a variable cover of wiry, sour grasses and some woody species (*Senegalia caffra, Celtis africana, Diospyros lycioides* subsp*. lycioides, Parinari capensis, Protea caffra, P. welwitschii* and *Rhus magalismontanum*) (Mucina and Rutherford, 2006).

Dominant and/or prominent taxa in primary, undisturbed grasslands (Mucina and Rutherford, 2006) would have included following species:

Graminoids: *Aristida aequiglumis, A. congesta, A. junciformis* subsp*. galpinii, Brachiaria serrata, Cynodon dactylon, Digitaria monodactyla, D. tricholaenoides, Elionurus muticus, Eragrostis chloromelas, E. curvula, E. plana, E. racemosa, E. sclerantha, Heteropogon contortus, Loudetia simplex, Microchloa caffra, Monocymbium ceresiiforme, Setaria sphacelata, Sporobolus africanus, S. pectinatus, Themeda triandra, Trachypogon spicatus, Tristachya leucothrix, T. rehmannii, Alloteropsis semialata* subsp*. eckloniana*

Herbs: *Berkheya setifera, Haplocarpha scaposa, Justicia anagalloides, Pelargonium luridum, Acalypha angustata, Chamaecrista mimosoides, Dicoma anomala, Euryops gilfillanii, E. transvaalensis subsp. setilobus, Helichrysum aureonitens, H. caespititium, H. callicomum, H. oreophilum, H. rugulosum, Ipomoea crassipes, Pentanisia prunelloides* subsp*. latifolia, Selago densiflora, Senecio coronatus, Hilliardiella elaeagnoides, Wahlenbergia undulata*

Geophytes: *Gladiolus crassifolius, Haemanthus humilis* subsp*. hirsutus, Hypoxis rigidula* var*. pilosissima, Ledebouria ovatifolia*

Succulents: *Aloe ecklonis*

Low Shrubs: *Anthospermum rigidum* subsp*. pumilum, Stoebe plumosa*

## 2.4 Conservation Planning

### 2.4.1 National

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

**According to the Schedule of Threatened Terrestrial Ecosystems, remaining primary grassland areas of Eastern Highveld Grassland are considered as Vulnerable Ecosystems**. Only 55% of the natural area of Eastern Highveld Grassland remains and less than 1% of the original area of the ecosystem is currently protected. Remaining primary grassland vegetation and wetland areas are also classified as having moderate to highest biodiversity importance according to the Mining and Biodiversity Guidelines, indicating that extensive land modification should be avoided in these areas.

As the NEMBA Schedule points out (GN 1002 Section 5.2), "it is important to ground-truth the presence of indigenous vegetation of the ecosystem in question… Spatial data on the location of ecosystems and on land cover is always subject to errors of scale, and land cover data is never 100% up to date". It is further stated that:

> "if any development that requires environmental authorisation impacts on a Threatened Ecosystem, that impact should be avoided, minimised, mitigated and/or offset as appropriate…".

### 2.4.2 Provincial

The Mpumalanga Biodiversity Sector Plan (MBSP) is a comprehensive environmental inventory and spatial plan that is intended to guide conservation and land use decisions in support of sustainable development (Lötter & Ferrar, 2006; Lötter 2014; MTPA, 2014). The MBSP maps the distribution of the Province's known biodiversity into several categories. These are ranked according to ecological and biodiversity importance and their contribution to meeting the quantitative targets set for each biodiversity feature. Of relevance to the study area are the following mapping categories (Figure 2):

The categories used in the CBA maps are as follows:

- **Protected areas (PAs):** Areas that are already proclaimed under national or provincial legislation, including gazetted biodiversity stewardship sites.

- **Critical Biodiversity Areas (CBAs):** Areas that are required to meet biodiversity targets for species, ecosystems or ecological processes. These need to be kept in a natural or near-natural state, with no further loss of habitat or species. This category is split into:

    - **CBA: Irreplaceable –** Areas required to meet targets and with irreplaceability values of more than 80% (i.e. there are little of these features remaining in a natural state). They are also critical linkages in the landscape that must remain natural, and/or Critically Endangered ecosystems below their biodiversity target.

    - **CBA: Optimal –** (Previously called "Important and Necessary") planning units optimally located to meet biodiversity targets and other criteria defined in the analysis. Although these areas are not 'irreplaceable' they are the most efficient land configuration to meet all biodiversity conservation targets and design criteria.

- **Ecological Support Areas (ESAs):** Areas that are not essential for meeting biodiversity targets, but that play an important role in supporting the functioning of PAs or CBAs and for delivering ecosystem services such as water provision, flood mitigation, or carbon sequestration. In the terrestrial assessment they support landscape connectivity and strengthen resilience to climate change. ESAs need to be maintained in at least a functional and often natural state, supporting the purpose for which they were identified. They include features such as riparian habitat surrounding rivers or wetlands, corridors etc. Freshwater ESAs may include:

  - **Wetland Clusters:** these are smaller wetlands such as pans embedded within a landscape to allow for the migration of fauna and flora between wetlands.
  - **Wetlands:** wetlands that are important for supporting the hydrological functioning of rivers, water tables and freshwater biodiversity, as well as providing ecosystem services through the ecological infrastructure that they provide.

- **Other Natural Areas (ONAs):** Areas that have not been identified as a priority in the current systematic biodiversity plan but retain most of their natural character and perform a range of biodiversity and ecological infrastructural functions. Although they have not been prioritised for biodiversity now, they are still an important part of the natural ecosystem.

- **Moderately or Heavily Modified Areas:** (Sometimes called 'transformed') areas that have been modified by human activity so that they are no longer natural, and do not contribute to biodiversity targets. These areas may still provide limited biodiversity and ecological infrastructural functions, even if they are never prioritised for conservation action. Their biodiversity value has been significantly compromised.

According to the MBSP (2014), the study area contains portions of the following (Figure 2):

- CBA Irreplaceable Areas
- Other Natural Areas
- Moderately Modified – Old Lands (these are secondary grasslands)
- Heavily Modified Areas

# 3 METHODS

## 3.1 Vegetation Survey

The study area was visited for a field survey from 6 to 8 February 2019. According to one of the farmers at Vlakfontein (personal communication), the area had only received about 250 mm of rain up to date for the season, indicating relatively dry conditions. Established phytosociological survey and vegetation classification techniques generally used as the basis of vegetation surveys in South Africa (Brown *et al*., 2013) to describe vegetation and capturing species information, were implemented. This involved the recording of all species present within all relatively homogeneous units of vegetation – including indigenous and exotic invasive species. An estimate of the percentage canopy cover (or range thereof) of each species present was recorded as far as possible at the time. Both the species composition and their respective canopy cover can potentially vary significantly during different seasons and are affected by land-use practices. Typical species assemblages as recorded during the field survey were combined into species associations that are representative of a certain type of habitat.

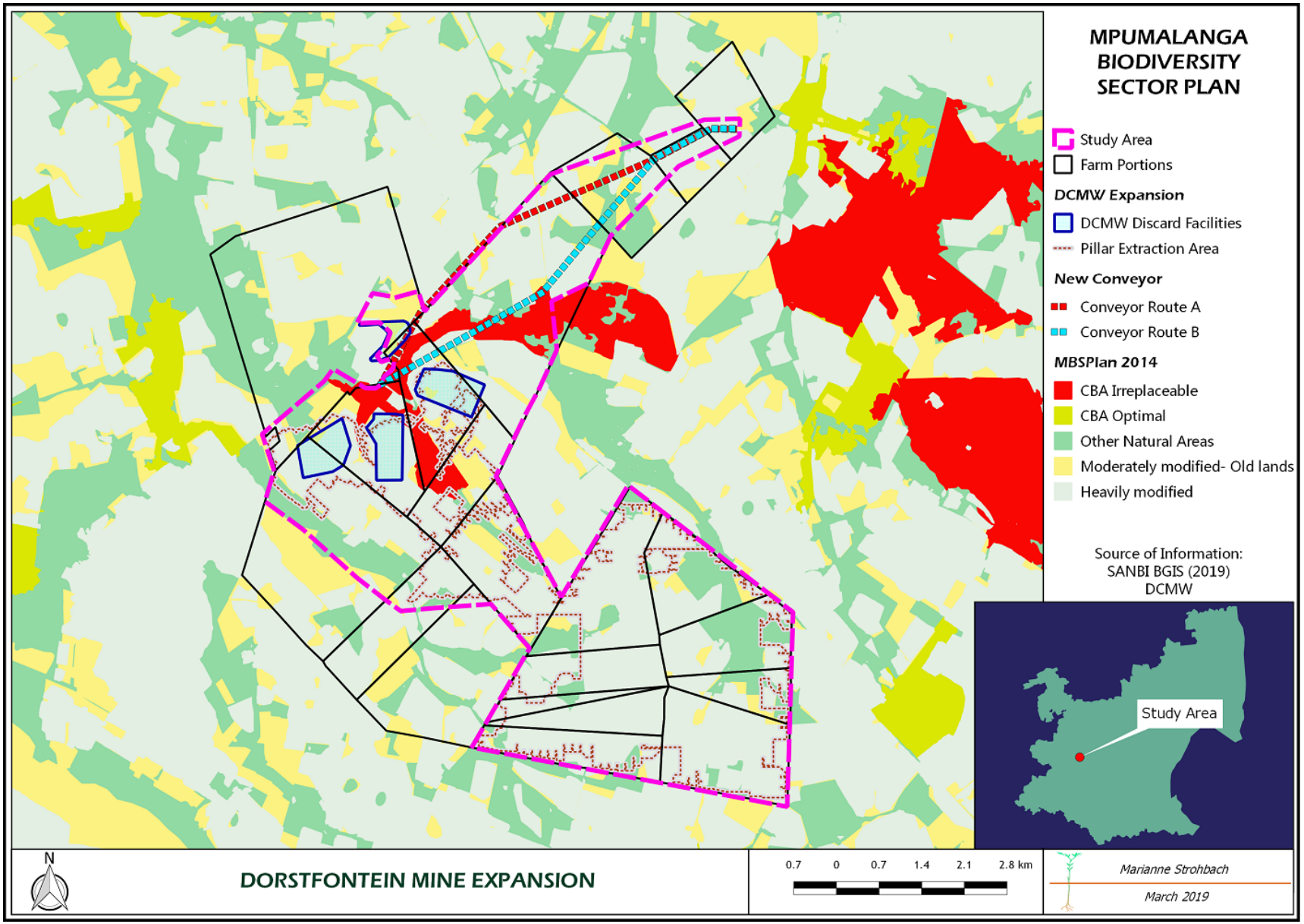


Figure 2: Conservation Planning on and around the Study Area.

A description of the habitats and plant associations is given in Section 4.1. A full list of plant species and their approximate abundance per habitat is supplied in Appendix A.

The SANBI species databases (BODATSA) were queried for any possible occurrence of species of conservation concern (listed and/or protected) previously recorded on or potentially occurring within the quarter degree square of the study area. These potential plant species of conservation concern, as determined above, are listed in Section 4.3.

Plant species nomenclature used was according to BODATSA (2019), the Red List of South African Plants (http://redlist.sanbi.org/, version 2017.1.), Henderson (2001), Bromilow (2010) and the online African Plant Database (CJB, 2019).

### 3.1.1 Vegetation Mapping

Mapping was done by comparing georeferenced ground survey information to the visual inspection of available historical and current Google-Earth Imagery (which is a generalised colour composite image without any actual reflectance data attached to it). In this way survey reference points were extrapolated to the entire study area. Delineations should be regarded as approximate, as vegetation associations in nature generally do not have abrupt borders but rather merge into one another in transition zones.

### 3.1.2 Vegetation Sensitivity Analysis and Criteria

The determination of specific ecosystem services and the sensitivity of ecosystem components, both biotic and abiotic, is rather complex and no single overarching criterion will apply to all habitats studied. The main aspects of an ecosystem that need to be incorporated in a sensitivity analysis, however, include the following:

- Describing the nature and number of species present, taking into consideration their conservation value as well as the probability of such species to survive or re-establish itself following disturbances and alterations to their specific habitats;
- Identifying the species or habitat features that are 'key ecosystem providers' and characterising their functional relationships (Kremen, 2005);
- Determining the aspects of community structure that influence function, especially aspects influencing stability or rapid decline of communities (Kremen, 2005); and
- Assessing key environmental factors that influence the provision of services (Kremen, 2005);

This implies that in the sensitivity analysis, not only should aspects that currently prevail on the area be taken into consideration, but also if there is a possibility of full restoration of the original environment and its biota, or at least the rehabilitation of ecosystem services resembling the original state after an area has been significantly disturbed. According to the above, as well as NEMBA Guidelines, sensitivity classes can be summarised as follows:

**High Sensitivity:** Areas that are relatively undisturbed or pristine (e.g. primary vegetation) and either one or more of the following:

- Very species-rich relative to immediate surroundings;
- With a very unique and restricted indigenous species composition;
- Constitute specific habitats or high niche diversity for faunal and/or floral species of conservation concern, and where the total extent of such habitats and associated species of conservation concern remaining in southern Africa is limited; and
- All primary vegetation of listed Threatened ecosystems, regardless of their state.

**Medium Sensitivity:** Areas where disturbances are relatively limited and with one or more of the following:

- Areas with a species diversity representative of its natural state, but not exceptionally high or unique compared to its surroundings;
- Areas whose biotic configuration does not constitute a very specific or restricted habitat or very high niche diversity;
- Areas that provide ecosystem services needed for the continued functioning of the ecosystem and the continued use thereof (e.g. grazing);
- Although species of conservation concern may occur on the area, these are not restricted to these habitats; and
- Areas that need to remain intact to ensure the functioning of adjacent ecosystems; ecological corridors or portions of land that prevent the excessive fragmentation of natural faunal and floral populations; areas that will be difficult or impossible to rehabilitate to a functional state after physical alteration.

**Low Sensitivity:** Areas that have been previously modified, heavily disturbed or:

- Areas that provide limited ecosystem services, or have a low ecological value;
- Species diversity may be low or all species present have a much wider distribution beyond this habitat or locality; and
- Landscapes where the abiotic nature is such that it can be rehabilitated relatively easy to allow the re-establishment of the original species composition, and where the proposed development will not lead to any unjustified degradation of landscapes or ecosystem services if adequately mitigated.

## 3.2 Faunal Survey

The faunal verification assessment was based on the integration of desktop findings and a field survey.

### 3.2.1 Desktop Assessment

The study made use of the following data sources to determine the possible geographical ranges of faunal species:

- The evaluation of the modelled conservation importance in terms of the MBSP
- The IUCN Red List of Threatened Species, version 2018.2

- Observed and associated likelihood of occurrence within different sections of the study area and surroundings as previously assessed by Scientific Terrestrial Services (STS, 2016)
- Mammals:
    - Field Guide to the Tracks and Signs of Southern, Central and East African Wildlife (Stuart & Stuart, 2013)
    - Stuart's Field Guide to Mammals of Southern Africa (Stuart & Stuart, 2015)
    - Smither's Mammals of Southern Africa. A field guide. (Apps 2000)
- Herpetofauna:
    - FrogMAP (SAFAP)
    - ReptileMAP (SARCA)
- Lepidoptera:
    - Atlas of African Lepidoptera, Animal Demography Unit Virtual Museum

The geographic distribution of faunal species was obtained from the IUCN online data and field guides. Species of conservation concern include nationally and provincially protected species, species categorized as 'Threatened' by the IUCN Red List, as well as Threatened or Protected species contained in the National Environmental Management: Biodiversity Act (NEMBA). These species are often associated with a limited geographic range, small population size, specialist habitat requirements and poor dispersal abilities (SANBI, 2010). Species of conservation concern that could potentially occur within the site were noted and associated habitat requirements were noted for cross-reference with those of the site.

### 3.2.2 Field Techniques

The desktop findings were ground-truthed during the same survey as the vegetation assessment. The primary aim of this survey was to determine the condition of available faunal micro-habitats (which were similar to identified vegetation habitats) and the identification of faunal activity associated with these areas. It must be noted that no trapping or use of camera traps were utilised as the terms of reference did not require such detail. Faunal surveys should ideally be conducted over varying seasons in order to obtain a comprehensive species list. This is due to seasonal activity variations of faunal species.

- **Mammals:** The study area was traversed and all direct and indirect mammalian signs such as tracks, scats, den sites, burrows and foraging markings such as diggings were noted. These signs were confirmed by utilising available literature.
- **Herpetofauna and Insects of Conservation Concern:** Opportunistic observations were recorded while traversing the study area. Specific habitat types were selected where active sampling was focused, often surrounding refuge sites. These included rocky areas, moribund termite mounds, fallen logs, holes in trees and watercourses. Positive identification of amphibian species was determined by visual sightings coupled with acoustic signals (males call to attract females).

The majority of faunal species are secretive, nocturnal and in the case of some amphibians and reptiles seasonal (due to their ectothermic physiological strategies), hence the availability and suitability of foraging and breeding habitats identified, direct sightings as well as signs of presence (e.g. scat and tracks) observed during the field investigation was used in conjunction with available data to determine the likelihood of occurrence of *species of conservation concern* within the larger study area. This method is considered effective when there are time restraints imposed on a project as it can be done irrespective of season. The likelihood of occurrence was based on the following parameters:

- **High:** Species whose distributional range coincides with the study area, as well as the presence of optimal foraging and breeding habitat within the study area. In addition, the ecological condition of the micro-habitats (based on the vegetation assessment) within the study area can sustain a viable breeding population (providing ecological corridors for migration between habitats), with a high population density possible and/or observed.
- **Moderate:** Species whose distributional range overlaps with the study area, but the available habitat within the site is considered to be sub-optimal. In addition, population densities do not reach high levels within the study area but cannot be classified as rare.
- **Low:** Species whose distributional range is peripheral to the study area, with the habitat considered as degraded and unable to consistently support population densities. These species are often classified as rarely frequenting such areas.

### 3.2.3 Faunal Sensitivity Analysis and Criteria

The faunal sensitivity analysis was compiled by assessing the current ecological condition of the identified micro-habitat and the ability to support biodiversity. This included the interaction between the sites sensitivity to the proposed development and the ecological structure of these habitats.

- **High:** These are sensitive systems with high ecological integrity and their preservation is vital to achieving conservation targets within Southern Africa. These habitats have experienced limited levels of disturbance and contain specific habitats and/or high niche diversity. Faunal species composition contains range-restricted species that require these unique habitats for foraging and breeding.

- **Medium**: These are sensitive systems with moderate ecological integrity. These habitats have been impacted by anthropogenic disturbances but this is relatively limited. These areas are characterised by a limited niche diversity. These habitats still provide important ecosystem goods and services required for the continued function of the ecosystem. These comprise of areas that need to remain intact to ensure the functioning of adjacent ecosystems, or ecological corridors or portions of land that prevent the excessive fragmentation of natural faunal and floral populations, or areas that will be difficult or impossible to rehabilitate to a functional state after physical alteration. Depending on the state of the faunal micro-habitats, it could be assigned medium-high (closer to arguments of high sensitivity) or medium-low (closer to arguments of low sensitivity) status.

- **Low:** These are habitats that have been degraded and disturbed with limited ecological integrity. Faunal diversity is predicted to be low, dominated by species with generalist and adaptable habitat requirements. Disturbances occurring within the site are high and faunal and floral species composition has been impacted. Limited suitable faunal habitats are present within the site and it is unlikely to contribute to achieving conservation targets. Landscapes where the proposed development will not lead to any unjustified degradation of landscapes or ecosystem services if adequately mitigated.

# 4 RESULTS

## 4.1 Vegetation Survey

At the time of the survey it, vegetation was fully developed, but overall not in an optimal state due to limited rainfalls received during this and the previous season, as well as the effects of an altered burning regime and high grazing levels. Most geophytes had already finished flowering whilst early-sprouting forbs may already have been dormant. A total of 269 plant species were recorded, of which only 227 were indigenous species. Overall, a somewhat higher (indigenous) species diversity can be expected to appear during more favourable conditions, especially in the areas with remaining primary vegetation.

### 4.1.1 Vegetation Habitat Overview

Overall, four broad habitat types could be identified, some of which were subdivided further according to their species assemblages. The latter are referred to as 'vegetation associations or -habitats', and the full list of species observed in each habitat, with approximate percentage cover, is provided in Appendix A. These can be summarised as follows:

1) Dry Grasslands:

   These were remains of primary as well as secondary vegetation. They were subdivided into:

   - *Eragrostis* species dominated Primary Grasslands, classified on the MBSP as 'Other Natural Areas' as well as CBA areas. They were found mostly on gently undulating landscapes, with signs of slope seepage common throughout.
   - *Eragrostis lehmanniana* dominated Secondary Grasslands, classified on the MBSP as 'Moderately Modified – Old Lands'. From historical satellite imagery it was apparent that these grasslands, mostly on gently sloping areas, had been cultivated or ploughed many years ago. The species composition also suggested that grazing was sown onto these lands after cultivation stopped.
   - *Cheilanthes viridis – Diospyros* species Rocky Ledges. These were designated by the MBSP as CBA area, and had a very unique species composition due to the many niches created by the rocky boulders. Within the study area, they were located either side of the stream south of the current DCMW ore washing plant.

2) Moist Grasslands:

   These grasslands were dominated by species typical for seasonally wet soils, and could be subdivided into:

   - *Eragrostis plana* Floodplain Grasslands, found mainly on the relatively flat floodplains adjacent to riparian areas or in channelled valley floor wetlands. Although degraded, these were designated by the MBSP as CBA area and have an important ecosystem functionality.
   - *Imperata cylindrica* Seepage Slope Grasslands, found on slightly to moderately sloped seasonal seepage areas, often associated with either a stream or artificial inundated areas, as well as around small pans between cultivated fields. Most of these areas

were rather degraded and heavily invaded by alien species, yet they retain an important ecosystem function.

3) Riparian Vegetation:

   These narrow bands along streams and drainage lines were dominated by Cyperoid and other species typical for areas with inundated soils, such as edges of streams, pans and artificial impoundments. This association merged into the moist grassland types, without a clear margin.

4) Alien-Dominated Areas:

   These areas were modified but vegetated areas, mostly areas that had been heavily impacted/degraded from continuous grazing or edge effects along and between cultivated fields. Many of the smaller pans in-between cultivated lands were originally Moist Grasslands, but had been modified completely to be weed-dominated.

5) Cultivated and Heavily Modified Areas:

   These included areas with Infrastructure, Mining Areas, Homesteads, etc. Although landscaped gardens and small areas of ruderal vegetation did exist in-between, they were not regarded as natural or near-natural, and were not studied further. Examples of such areas are shown in Figure 3 below.

The distribution of the vegetation associations is shown in Figure 4.

Figure 3: Examples of modified areas exluded from the vegetation assessment.

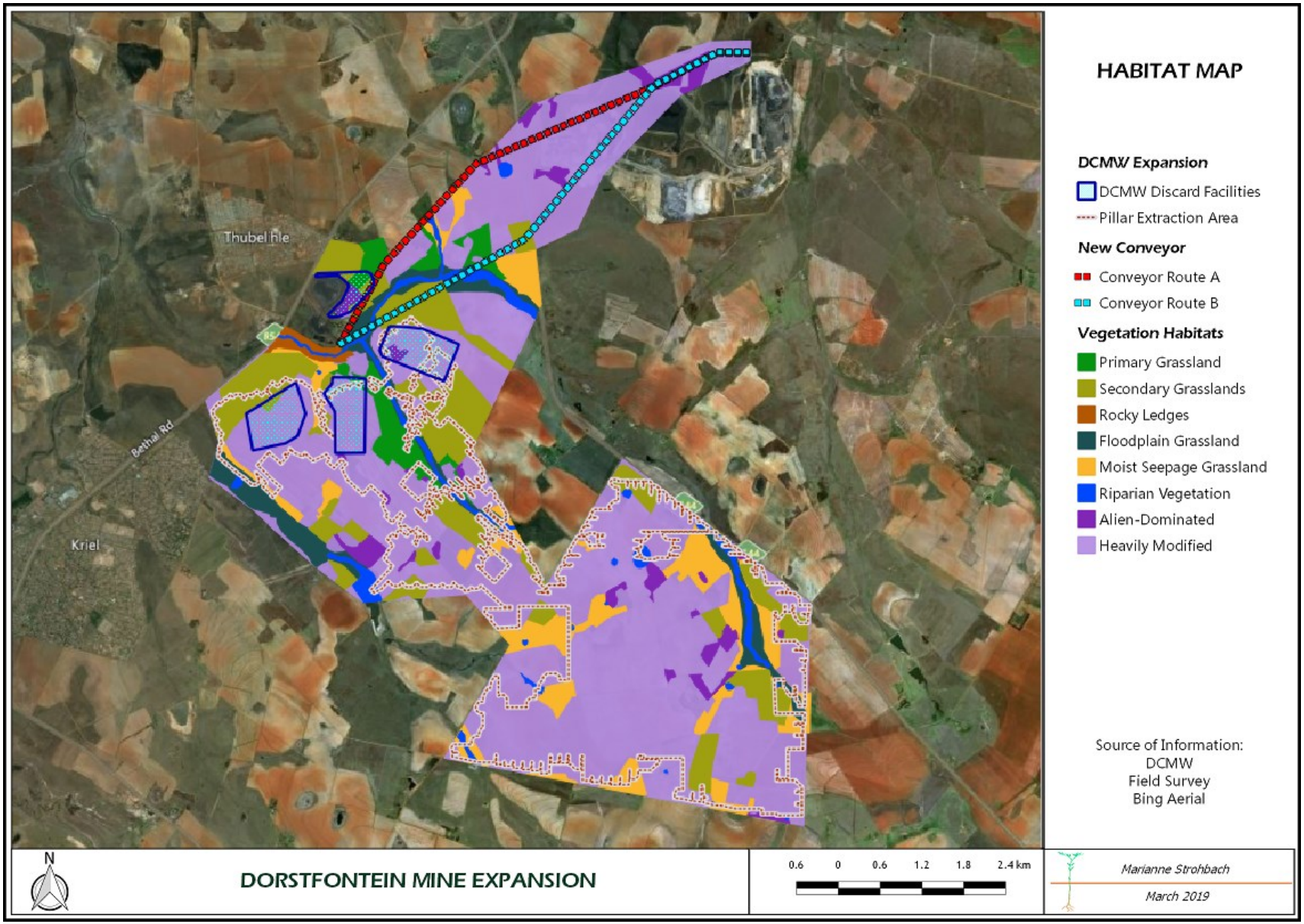


Figure 4: Vegetation Habitats identified.

### 4.1.2 Dry Grasslands

These included remains of primary vegetation, classified on the MBSP as 'Other Natural Areas' as well as CBA Irreplaceable areas – due to a combination of remaining areas of Threatened Ecosystems, as well as habitat for species with a restricted distribution. Included were also secondary grasslands, which had established after cultivation was ceased. These grasslands still exhibited a moderately high species diversity, were habitat to several species of conservation concern, but had been degraded to some extent by continuous negative impacts from past and current land-uses, as well as the edge effects and fragmentation. Rehabilitation, however, should be fully possible.

Although these grasslands were considered 'Dry', within them numerous patches could be found where moisture levels may be seasonally elevated relative to the general surroundings, evidenced by occasional dense stands of plant species more typical for seasonally inundated soils. Such examples included *Gnaphalium filagopsis* and *Agrostis eriantha,* as well as the patchy presence of Cyperoids (Sedges). Overall the distribution of plant species was very patchy, with only some of the dominant *Eragrostis* species and some forbs of the Asteraceae forming a relatively homogeneous layer. The more typical plant associations that could be distinguished within the Dry Grasslands are described below.

#### 4.1.2.1 *Eragrostis* species dominated Primary Grasslands

These grasslands were found on undulating slopes with relatively shallow to very soils and occasional patches of surface rockiness, as well as some areas appearing like sinkholes (Figure 5). They had a relatively high grass species diversity, but a lower than expected diversity in perennial forbs and low shrubs, which would have been more typical. The presence of underground trees such as *Pygmaeothamnus zeyheri,* geophytes that do not re-establish very quickly on disturbed soils, such as the *Disa* species observed, as well as a more homogeneous species distribution, indicated that these were primary grasslands.

These grasslands had been negatively affected by fragmentation, continued heavy grazing and edge effects from adjacent anthropogenic activities – resulting in a high load of alien invasive plants on the edges of these grasslands, and a decrease of climax grasses.

It was considered highly likely that more species of conservation concern – mostly geophytic species – may emerge later through the growing season. Especially *Gladiolus* species, of which one threatened species (see Section 4.2) had been collected in the vicinity, could start emerging late in the growing season. A thorough search-and rescue operation will have to be implemented prior to any physical disturbance on this habitat.

Table 1: The most typical indigenous species recorded in Primary Grasslands.

| Growth Form | Species |
|---|---|
| **Dwarf shrubs** | *Anthospermum rigidum, Erica drakensbergensis, Melolobium wilmsii, Pygmaeothamnus zeyheri, Nesaea schinzii, Solanum panduriforme, Stoebe plumosa* |
| **Grasses** | *Alloteropsis semialata, Aristida canescens, Cynodon dactylon, Elionurus muticus, Eragrostis chloromelas, Eragrostis curvula, Eragrostis gummiflua, Eragrostis* |

| Growth Form | Species |
|---|---|
| | *lehmanniana, Eragrostis obtusa, Eragrostis planiculmis, Eragrostis racemosa, Harpochloa falx, Heteropogon contortus, Setaria sphacelata v. torta, Sporobolus africanus, Sporobolus pyramidalis, Themeda triandra* |
| **Cyperoids** | *Kyllinga erecta, Scirpoides burkei* |
| **Forbs** | *Ajuga ophrydis, Berkheya setifera, Blepharis innocua, Chaetacanthus setiger, Chamaecrista mimosoides, Commelina africana, Crabbea acaulis, Haplocarpha lyrata, Helichrysum coriaceum, Helichrysum nudifolium var. nudifolium, Helichrysum nudifolium var. oxyphyllum, Hermannia depressa, Hermannia transvaalensis, Selago densiflora, Thesium costatum* |
| **Succulents** | *Euphorbia clavarioides* (rare occurrence) |
| **Geophytes** | *Disa* species, *Ledebouria ovatifolia, Xysmalobium undulatum* |
| **Observed species diversity** | 130 of which:<br>• 111 Indigenous species, including:<br>  ○ 2 protected species<br>  ○ 1 Encroacher species (according to CARA)<br>• 14 Exotic and/or naturalised species<br>• 5 Listed lien invasive species (according to NEMBA) |

Figure 5: Typical view of areas with Primary Grasslands.

#### 4.1.2.2 *Eragrostis lehmanniana* dominated Secondary Grasslands

These grasslands could be found on undulating slopes with relatively shallow to slightly deeper soils, on which cultivated lands had been in the past. It was assumed that some grass species, most notable *Eragrostis curvula*, may have been sown onto these areas after cultivation was ceased. Other than this grass, the presence of more valuable grazing species and perennial forbs with underground storage organs was rather low compared to the above primary grasslands (Figure 6). Since cessation of cultivation, several of the more common forbs of the grasslands, most notably of the Asteraceae,

had become re-established. Overall the species distribution was extremely patchy, with dense stands of some species occurring in smaller localities – usually with uneven soils. Signs of occasional areas with seasonally higher levels of moisture were also evident from small patches with grasses such as *Agrostis lachnantha, Agrostis eriantha,* and *Imperata cylindrica* locally dominant.

These grasslands were negatively affected by continued heavy grazing and frequent burning, and several patches with a high presence of a few species of alien invasive plants. In several areas, continued heavy grazing had led to a marked increase of the Encroacher species, *Stoebe plumosa* (Bankrupt Bush). Some protected plant species had also become re-established, although specimens were quite rare. A thorough search-and rescue operation will have to be implemented prior to any physical disturbance on this habitat.

Table 2: The most typical indigenous species recorded in Secondary Grasslands.

| Growth Form | Species |
|---|---|
| **Dwarf shrubs** | *Anthospermum rigidum, Gomphocarpus fruticosus, Stoebe plumosa, Ziziphus zeyheriana* |
| **Grasses** | *Aristida canescens, Cynodon dactylon, Elionurus muticus, Eragrostis chloromelas, Eragrostis curvula, Eragrostis gummiflua, Eragrostis lehmanniana, Eragrostis obtusa, Hyparrhenia hirta, Imperata cylindrica* |
| **Cyperoids** | *Cyperus esculentus, Kyllinga erecta, Scirpoides burkei* |
| **Forbs** | *Berkheya setifera, Chaetacanthus setiger, Commelina africana, Haplocarpha lyrata, Helichrysum nudifolium var. nudifolium, Helichrysum nudifolium var. pilosellum, Helichrysum rugulosum, Nidorella anomala, Senecio inornatus* |
| **Geophytes** | *Ledebouria ovatifolia, Xysmalobium undulatum* |
| **Observed species diversity** | 124 of which:<br>• 112 Indigenous species, including:<br>  ○ 3 protected species<br>  ○ 1 Encroacher species (according to CARA)<br>• 9 Exotic and/or naturalised species<br>• 3 Listed lien invasive species (according to NEMBA) |

Figure 6: Typical view of areas with Secondary Grasslands.

#### 4.1.2.3 *Cheilanthes viridis – Diospyros* species Rocky Ledges

Grasslands and low shrubs on and around low exposed rocky ledges, within the area investigated, were only found both sides of the Steenkoolspruit Tributary south of the current DCMW ore wash plant (Figure 7).

These primary grasslands were mapped as CBA-Irreplaceable Area, and with good reason: the low rocky ledges and their position near the base of seepage areas created a variety of heterogeneous niches, with equally variable soil moisture reserves and more variable soil depth than the more open grasslands. This facilitated the establishment and persistence of a number of plant species that are not able to survive in other more common grassland habitats. This habitat had the highest diversity of geophytes and ferns, and more unique species could emerge during more favourable rainfall years.

These grasslands, especially on the northern side of the Steenkoolspruit Tributary, were found to be already negatively impacted by leachate from the higher-lying coal washing plant. Edge effects from nearby anthropogenic activities, including heavy grazing and frequent fires, were found to lead to localised abundant invasions of alien plants, which will become worse if not managed.

Table 3: The most typical indigenous species recorded on and between Rocky Ledges.

| Growth Form | Species |
|---|---|
| **Woody shrubs and trees** | *Diospyros austro-africana, Diospyros lycioides, Searsia dentata, Searsia rigida* var. *margaretae* |
| **Dwarf shrubs** | *Melolobium wilmsii, Parinari capensis, Stoebe plumosa, Ziziphus zeyheriana* |
| **Grasses** | *Alloteropsis semialata, Aristida diffusa, Aristida junciformis, Brachiaria serrata, Eragrostis curvula, Eragrostis planiculmis, Oropetium capense, Themeda triandra* |
| **Cyperoids** | *Scirpoides burkei, Schoenoplectus leucanthus* |
| **Forbs** | *Acalypha angustata, Centella asiatica, Chaetacanthus costatus, Chaetacanthus setiger, Cheilanthes hirta, Cheilanthes viridis, Dianthus transvaalensis, Gerbera ambigua, Nolletia rarifolia, Selaginella dregei, Syncolostemon pretoriae* |
| **Succulents** | *Crassula lanceolata* |
| **Geophytes** | *Cyanotis speciosa, Ledebouria revoluta, Nerine rehmannii* |
| **Observed species diversity** | 120 of which:<br>• 109 Indigenous species, including:<br>  ○ 2 protected species<br>  ○ 1 Encroacher species (according to CARA)<br>• 8 Exotic and/or naturalised species<br>• 3 Listed lien invasive species (according to NEMBA) |

Figure 7: Typical view of vegetation between Rocky Ledges.

### 4.1.3 Moist Grasslands

Mpumalanga is known for its vast wetlands, which are often associated with coal deposits that were formed due to the presence of pre-historic peatlands and very wet conditions. Similarly, the area is favoured for crop production, but poor results are obtained from crops grown in soils that are seasonally wet and may cause anoxic (oxygen-deprived) conditions in soils. It was thus not surprising that most moist wetlands had been avoided by cultivation processes, but were rather used for livestock production. Within the study area, moist grasslands could be distinguished not only according to their species associations, but also where they were situated in the landscape overall. These two differing moist grasslands, always merging without a very clear border with riparian vegetation, are described below.

#### 4.1.3.1 *Eragrostis plana* Floodplain Grasslands

The Steenkoolspruit Tributaries and other larger wetland areas (as mapped in the Mpumalanga Highveld Wetlands Map, BGIS) were usually broad valley-bottom wetlands, with or without a clear channel, covered with dense grass vegetation and a host of other low forbs (Figure 8). These primary grasslands were mapped as CBA-Irreplaceable Area, as they had an important ecological function, but were also host to a variety of species specially adapted to the seasonally high soil moisture levels, and

thus had a restricted range of occurrence. Several of these plant species are not able to survive in other more common grassland habitats. This habitat had the highest density of geophytes, and more unique species could emerge during more favourable rainfall years. Although not part of this study, several sightings of the Marsh owl (*Asio capensis*) were made.

These grasslands, especially closer to Kriel, were found to be already negatively impacted by physical soil disturbance, heavy grazing and too frequent burning. In addition, the presence of alien invasive species was at levels that could still be controlled, but which will increase significantly if not managed. Of these alien invasives were occasional stands of *Gleditsia triacanthos* (Honey Locust), which has an aggressive suckering habit and can invade vast areas if not eradicated.

Table 4: The most typical indigenous species recorded in Floodplain Grasslands.

| Growth Form | Species |
|---|---|
| **Dwarf shrubs** | *Anthospermum rigidum, Solanum panduriforme, Stoebe plumosa* |
| **Grasses** | *Agrostis eriantha, Agrostis lachnantha, Cynodon dactylon, Eragrostis obtusa, Eragrostis plana, Eragrostis racemosa, Hemarthria altissima, Imperata cylindrica, Setaria sphacelata v. sericea, Sporobolus fimbriatus, Themeda triandra* |
| **Cyperoids** | *Cyperus denudatus, Cyperus esculentus, Cyperus obtusiflorus v. flavissimus, Juncus lomatophyllus, Kyllinga erecta, Schoenoplectus leucanthus, Scirpoides burkei* |
| **Forbs** | *Berkheya pinnatifida, Berkheya radula, Centella asiatica, Conyza podocephala, Falkia oblonga, Haplocarpha scaposa, Helichrysum nudifolium var. nudifolium, Helichrysum rugulosum, Nidorella anomala, Salvia repens, Senecio inornatus, Trifolium africanum, Wahlenbergia undulata* |
| **Geophytes** | *Crinum bulbispermum* (high numbers)*, Xysmalobium undulatum* |
| **Observed species diversity** | 156 of which:<br>• 130 Indigenous species, including:<br>  ○ 1 protected species<br>  ○ 1 Encroacher species (according to CARA)<br>• 19 Exotic and/or naturalised species<br>• 7 Listed lien invasive species (according to NEMBA) |

Figure 8: Typical view of areas with Floodplain Grasslands.

#### 4.1.3.2 *Imperata cylindrica* Seepage Slope Grasslands

On many of the lower slopes or gradual incisions in the undulating landscapes of the study area, water intermittently seeped out from higher-lying areas, especially after periods of high rainfall. Such areas could be found just upslope from floodplain grasslands, but also between cultivated fields. Because of their sloped landscape, water did not accumulate here as much as on floodplain grasslands, but these areas were still too moist during growing seasons for cultivation. Unfortunately, due to the high and constant impacts of activities on surrounding areas and an often high load of alien invasives on fields prior to planting, these areas had, over time, become variably infested with alien invasive species (Figure 9). Some of these primary but degraded grasslands were mapped as CBA-Irreplaceable Area, as they provide corridors and other ecological functions, but were also habitat to a number of unique species, including fauna.

Table 5: The most typical indigenous species recorded in Seepage Slope Grasslands.

| Growth Form | Species |
|---|---|
| **Grasses** | *Agrostis eriantha, Agrostis lachnantha, Cynodon dactylon, Eragrostis curvula, Eragrostis plana, Hyparrhenia hirta, Imperata cylindrica, Leersia hexandra, Panicum schinzii, Setaria sphacelata v. sericea, Sporobolus fimbriatus* |
| **Cyperoids** | *Eleocharis dregeana, Kyllinga erecta, Schoenoplectus corymbosus, Schoenoplectus decipiens, Scirpoides burkei* |
| **Forbs** | *Berkheya radula, Chironia purpurascens, Gnaphalium filagopsis, Helichrysum rugulosum, Lobelia flaccida, Nidorella anomala, Trifolium africanum, Vigna vexillata v. angustifolia* |
| **Geophytes** | *Asclepias gibba* |
| **Observed species diversity** | 66 of which:<br>• 49 Indigenous species, including:<br>• 12 Exotic and/or naturalised species<br>• 5 Listed lien invasive species (according to NEMBA) |

Figure 9: Typical view of Seepage Slope Grasslands.

### 4.1.4 Riparian Vegetation

Several larger tributaries of Steenkoolspruit flowed through the area investigated. The actual stream-channels were variously incised, and at times discontinuous. Further, there were numerous smaller pans and artificial impoundments, in and around which vegetation typical for at least seasonally inundated soils could be found (Figure 10). The larger portion of riparian vegetation closer to the current DCMW infrastructure was mapped as CBA-Irreplaceable Area. It had uniquely adapted plant species, but also was suitable habitat for several faunal species, mostly mammals and amphibians. This habitat had a high density of geophytes on its banks, and more unique species could emerge during more favourable rainfall years. Occasionally, small stands of the exotic *Salix babylonica* (Willow tree) were found in or near riparian vegetation. However, these trees are not regarded as aggressive invasive species, and their roots are known to stabilise banks of streams, and can thus remain.

Riparian vegetation around streambanks was found to still have a low presence of alien invasive species. Riparian vegetation around impoundments and seasonal pans, however, were often densely overgrown with alien species, most notably dense stands of *Verbena bonariensis* (Wild Verbena).

Table 6: The most typical indigenous species recorded in Riparian Vegetation.

| Growth Form | Species |
|---|---|
| **Dwarf shrubs** | *Gomphocarpus fruticosus* |
| **Grasses** | *Agrostis lachnantha, Cynodon dactylon, Eragrostis plana, Helictotrichon turgidulum, Imperata cylindrica, Sporobolus fimbriatus, Typha capensis* |
| **Cyperoids** | *Cyperus denudatus, Cyperus longus, Juncus effusus, Juncus lomatophyllus, Schoenoplectus decipiens* |
| **Forbs** | *Berkheya pinnatifida, Berula erecta, Chironia purpurascens, Falkia oblonga, Salvia repens, Scabiosa columbaria, Schistostephium crataegifolium* |
| **Geophytes** | *Crinum bulbispermum* (high numbers), *Ledebouria revoluta* |
| **Observed species diversity** | 60 of which:<br>• 51 Indigenous species, including:<br>  ○ 1 protected species<br>• 7 Exotic and/or naturalised species<br>• 2 Listed lien invasive species (according to NEMBA) |

Figure 10: Typical view of Riparian Vegetation.

### 4.1.5 Alien-Dominated Areas

In-between cultivated fields and places adjacent to roads were smaller pockets with a mixture of indigenous and alien plant species (Figure 11). In some cases such pockets may have been small pans or seepage areas that were once ploughed and that were repeatedly impacted by large machinery moving through them. Other areas were apparent old homesteads or gardens, whilst there were also small areas where exotic *Eucalyptus* and Wattle trees had been planted as windbreak. Essentially, these areas were not maintained in a particular manner, and had become dominated by alien and invasive species, with only a low and mostly pioneer indigenous herb layer. Whilst from a plant-ecological perspective these areas had low value, they may provide temporary shelter to fauna, especially larger mammals.

Table 7: The most typical indigenous species persisting in Alien-Dominated Areas.

| Growth Form | Species |
|---|---|
| **Dwarf shrubs** | *Anthospermum rigidum, Gomphocarpus fruticosus, Stoebe plumosa, Ziziphus zeyheriana* |
| **Grasses** | *Hyparrhenia hirta, Imperata cylindrica, Panicum schinzii, Urochloa panicoides* |
| **Cyperoids** | *Cyperus esculentus* |
| **Forbs** | *Conyza podocephala, Gnaphalium filagopsis, Helichrysum nudifolium var. nudifolium, Helichrysum rugulosum* |
| **Observed species diversity** | 54 of which:<br>• 40 Indigenous species, including:<br>  ○ 1 Encroacher species (according to CARA)<br>• 8 Exotic and/or naturalised species<br>• 6 Listed lien invasive species (according to NEMBA) |

Figure 11: Typical view of Alien-Dominated areas.

## 4.2 Plant Species of Conservation Concern

BODATSA records showed that several species were found in similar habitats within the half-degree 2629A, thus indicating a small likelihood that such species may occur within the study area as well. These are indicated below in Table 8. As species of conservation concern, all species that are either listed as threatened, protected (on national or provincial level) or are known as narrow endemics (occurring only in e.g. Mpumalanga), were included.

Table 8: Floristic Species of Conservation Concern

| Species as listed in BODATSA | Conservation Status<br>Protected in RSA by (see 1.5) | Possibility of occurring<br>*Habitat* |
|---|---|---|
| **Highest Conservation Concern:**<br>**Following species occurrences should be avoided and monitored where they may be impacted in any way. If unavoidable then necessary permits must be acquired and all individuals relocated.** | | |
| *Disa* species<br>Possibly *D. versicolor* or *D. woodii* | IUCN Status: Uncertain as exact identity could not be determined<br>Protected by MNCA | **Observed**<br>Primary Grasslands |
| *Gladiolus paludosus* | IUCN Status: Vulnerable<br>Protected by MNCA<br>Endemic | **Small possibility**<br>Wetlands or marshes in high altitude grassland that remain wet throughout the year or dry out for only a short period |
| *Gladiolus robertsoniae* | IUCN Status: Near Threatened<br>Protected by MNCA<br>Endemic | **Small possibility between rocky ledges**<br>*Moist Highveld grasslands, found in wet, rocky sites, mostly dolerite outcrops, wedged in rock crevices* |
| *Kniphofia typhoides* | IUCN Status: Near Threatened<br>Protected by MNCA<br>Endemic | **Small possibility**<br>Low lying wetlands and seasonally wet areas in climax Themeda triandra grasslands on heavy black clay soils, tends to disappear from degraded grasslands. |
| *Nerine gracilis* | IUCN Status: Vulnerable<br>Protected by MNCA | **Small possibility**<br>Undulating grasslands in damp areas |
| *Nerine* species<br>Possibly *Nerine krigei* | IUCN Status: Least Concern<br>Protected by MNCA | **Observed**<br>Moist Grasslands |
| *Nerine rehmannii* | IUCN Status: Least Concern<br>Protected by MNCA | **Observed**<br>Rocky Ledges |
| **Medium Conservation Concern:**<br>**Species should be avoided, but if unavoidable then necessary permits will have to be acquired and all individuals relocated.** | | |
| *Boophone disticha* | IUCN Status: Least Concern<br>Protected by MNCA<br>Medicinal Plant | **Observed**<br>Grassland |
| *Crinum bulbispermum* | IUCN Status: Least Concern<br>Protected by MNCA | **Observed**<br>Moist Grasslands |
| *Cyrtanthus tuckii* | IUCN Status: Least Concern<br>Protected by MNCA | **Small possibility**<br>Grassland |
| *Eucomis autumnalis* | IUCN Status: Least Concern<br>Protected by MNCA | **Possible**<br>Moist Grasslands |

| Species as listed in BODATSA | Conservation Status Protected in RSA by (see 1.5) | Possibility of occurring *Habitat* |
|---|---|---|
| *Eulophia ovalis* | IUCN Status: Least Concern<br>Protected by MNCA | **Small possibility**<br>Grassland |
| *Gladiolus crassifolius* | IUCN Status: Least Concern<br>Protected by MNCA | **Observed**<br>Grassland |
| *Gladiolus elliotii* | IUCN Status: Least Concern<br>Protected by MNCA | **Small possibility**<br>Grassland |
| *Gladiolus longicollis* subsp. *platypetalus* | IUCN Status: Least Concern<br>Protected by MNCA | **Small possibility**<br>Rocky grassland |
| *Gladiolus papilio* | IUCN Status: Least Concern<br>Protected by MNCA | **Small possibility**<br>Grassland |
| *Gladiolus sericeovillosus* | IUCN Status: Least Concern<br>Protected by MNCA | **Small possibility**<br>Grassland |
| *Habenaria epipactidea* | IUCN Status: Least Concern<br>Protected by MNCA | **Small possibility**<br>Grassland |
| *Habenaria filicornis* | IUCN Status: Least Concern<br>Protected by MNCA | **Small possibility**<br>Grassland |
| *Nerine angustifolia* | IUCN Status: Least Concern<br>Protected by MNCA | **Small possibility**<br>Grassland |
| *Orthochilus foliosus* | IUCN Status: Least Concern<br>Protected by MNCA | **Small possibility**<br>Grassland |
| *Schizocarphus nervosus* | IUCN Status: Least Concern<br>Protected by MNCA<br>Medicinal Plant | **Small possibility**<br>Grassland |
| **Low Conservation Concern:**<br>**Following species are either short-lived or very common, and will regenerate from seed. Permits will be necessary if these species are destroyed. Preferably some of them should be relocated if affected, especially if they are not common in the study area.** | | |
| *Aloe ecklonis* | IUCN Status: Least Concern<br>Protected by MNCA | **Small possibility**<br>Grassland |
| *Aloe greatheadii* var. *davyana* | IUCN Status: Least Concern<br>Protected by MNCA | **Small possibility**<br>Grassland |
| *Hypoxis hemerocallidea* | IUCN Status: Least Concern<br>Currently not Protected,<br>Medicinal Plant | **Observed**<br>Grassland |
| *Xysmalobium undulatum* | IUCN Status: Least Concern<br>Currently not Protected,<br>Medicinal Plant | **Observed**<br>Grassland |

Figure 12: Plant species of conservation concern observed during the survey.
Left: *Crinum bulbipsermum*
Right: *Disa* species

## 4.3 Invasive Plant Species

The introduction of alien invasive species often happens accidentally/unintentionally through machinery and staff movement onto and across sites, and large-scale disturbance of vegetation presents an ideal opportunity for the establishment of these unwanted plants.

Table 2 provides a list of alien and invasive plant species observed during the course of the present study. Given the scope of the present study, no detailed survey of the alien and invasive species within the area was conducted, and only anecdotal evidence was collected as part of the field survey. A full survey of alien invasive plants will be beneficial to streamline the implementation of control measures. In the table, the Impact Status of each alien invasive species is also indicated, which gives an idea of 'how bad' and alien invasive species is. An explanation of Alien Invasive categories and Impact Status is given in Appendix B. Based on the impact status and the observed occurrence/distribution of such species, a priority has been set for the control and eradication of such species.

Overall, the key to a long-term sustainable alien control plan for the study area will not only entail the control and eradication of alien invasives species, but also continued management that aims to (Van Wilgen *et al.* 2000):

- → **Restore** Veld Condition, e.g. by re-introducing or increasing a stronger, more palatable grass cover in line with the original descriptions for the relevant vegetation type
    - Areas treated to remove invasive plant infestations will show faster recover and less recurrent establishment of invasive species if the grass-layer is strengthened.

It is recommended that over-sowing of desirable grass species – as listed in past descriptions of the natural vegetation – is done where ever possible during the early growing season.

→ **Maintain** the ecosystem functionality and biodiversity of the landscapes within the study area that will be retained as natural and semi-natural landscapes

→ **Enhance** the overall biodiversity value of the natural and semi-natural landscapes for the continued conservation of its biodiversity as well as its important water resources

Table 9: Alien and invasive plant species observed in the study area and immediate surroundings.

| SCIENTIFIC NAME | COMMON NAME | CATEGORY | IMPACT STATUS | CONTROL PRIORITY |
|---|---|---|---|---|
| *Acacia mearnsii* | Black Wattle | 2 | MV | Moderate |
| *Ailanthus altissima* | Tree-of-Heaven | 1b | MV | High |
| *Argemone ochroleuca* | Mexican Poppy | 1b | MO | High |
| *Campuloclinium macrocephalum* | Pompom Weed | 1b | MR | Urgent |
| *Cereus jamacaru* | Queen of the Night | 1b | MO | High |
| *Cirsium vulgare* | Scotch/Spear Thistle | 1b | MO | High |
| *Cuscuta campestris* | Common Dodder | 1b | MO | Moderate |
| *Datura ferox* | Large Thorn Apple | 1b | MO | High |
| *Datura stramonium* | Common Thorn Apple | 1b | MO | High |
| *Eucalyptus sp.* | Red River Gum and Saligna Gum | 1b in riparian areas | MV | High in Riparian Areas, Low otherwise |
| *Flaveria bidentis* | Smelterbossie Smelter's-bush | 1b | MO | Moderate |
| *Gleditsia triacanthos* | Honey locust | 1b | MN | Moderate |
| *Ipomoea purpurea* | Morning Glory | 1b | MR | High |
| *Melia azedarach* | Seringa | 1b in riparian areas | MO | High |
| *Mirabilis jalapa* | Four-o'clock, Marvel-of-Peru | 1b | MN | Moderate |
| *Morus alba* | Common Mulberry | 3 | MN | Moderate |
| *Opuntia ficus-indica* | Prickly-Pear | 1b | MO | Low |
| *Pinus patula* | Patula Pine | 2 | MR | Low |
| *Populus x canescens* | Grey Poplar, Matchwood Poplar | 2 | MO | High |
| *Solanum sisymbriifolium* | Wild tomato, Dense-Thorned Bitter Apple | 1b | MO | Moderate |
| *Stoebe plumosa* | Bankrupt Bush | *Encroacher** | MR | Moderate |

| SCIENTIFIC NAME | COMMON NAME | CATEGORY | IMPACT STATUS | CONTROL PRIORITY |
|---|---|---|---|---|
| *Verbena bonariensis* | Wild Verbena, Purple Top | 1b | MR | High |
| *Verbena brasiliensis* | Brazilian Verbena | 1b | MR | Moderate |
| *Xanthium species* | Cocklebur | 1b | MR | Urgent |

* Conservation of Agricultural Resources Act (Act 43 of 1983)

For explanation of Category and Impact Status, refer to Appendix B.

Control Priority Explanation:

**Urgent**: Eradicate as soon as possible and ensure follow-up is maintained to prevent any re-establishment

**High**: Eradicate during the season and keep under control

**Moderate**: Continual reduction until stands are minimal and/or have disappeared

**Low**: Monitor spread if any and control as necessary

Figure 13: Some of the alien invasive species observed during the survey.
Left: Solanum sisymbriifolium
Right: Verbena bonariensis

## 4.4 Faunal Habitats

Faunal species are adapted to a particular niche which is often comprises a unique set of environmental conditions, creating optimal habitat. The reliance of fauna on species-specific plant resources indicates the interconnected nature between faunal and botanical diversity (Burnett et al., 1998). These "micro-habitats" do not always correspond strictly to vegetation associations, but rather to a combination of vegetation structure and species composition, topography, land use, available food sources and other factors. Landscapes composed of spatially heterogeneous abiotic conditions create a greater diversity of potential niches for faunal species, providing both diverse forage as well as refuge areas. Habitat availability is often used to determine the potential presence of faunal species coupled with distributional data collated from available databases due to the often cryptic, nocturnal and highly mobile nature displayed by many faunal species.

An investigation of the study area revealed the following important micro-habitats, most of which were verified from previous faunal assessments conducted in the area (STS 2016). In each case, some of the species likely to make use of the various micro-habitats have been described.

### 4.4.1 Dry Grassland Habitats

Faunal species, particularly generalists, do not discriminate between the species composition of grassland habitats but rather are influenced by availability of cover and associated predation risk, food resources and ecological connectivity, hence no in-depth distinction is made between the grassland units. A more detailed investigation of the grassland units is outlined in the vegetation description of this report. This would include all Dry Grassland Habitats, merging into some of the Wet Grassland Habitats. The latter are included in the wetland habitats from a faunal perspective. It was noted that basal cover was moderate to high in most areas, providing suitable cover for faunal species.

Various portions of the grassland micro-habitat identified within the site were disturbed by the presence of alien invasive vegetation, historic and current agricultural practices and the compaction of soils through anthropogenic activities. The disturbance of grasslands had important implications to biodiversity as these habitats are complex, slow-evolving systems of diverse plant communities, of which a large part of the species diversity reproduces vegetatively (rootstocks etc.) rather than by seed production (Little et al., 2005). It is likely that more generalist small rodents, e.g. *Lepus saxatilis* (Scrub Hare), *Hystrix africaeaustralis* (Porcupine) and small antelope will utilise this habitat unit, whilst it may serve as a movement corridor for other faunal species such as *Canis mesomelas* (Black-backed Jackal). Although the grassland micro-habitat within the area has been negatively impacted as a result of disturbance and encroachment from mining activities, they provide corridors of natural vegetation and foraging opportunities for faunal species.

### 4.4.2 Wetland and Moist Grassland Habitats

Numerous wetland habitats were identified within the study area. Included in these habitats are the Wet Grasslands, as these also support distinct floristic and faunal species and create a transitional zone between terrestrial and aquatic habitats. Both Wet Grasslands and Riparian Areas provide moderate to dense cover, as well as foraging and breeding opportunities for faunal species. A series of low rocky ledges south of the current DCMW Office and Ore complex, increase the heterogeneity

of the existing habitat by providing a variation in biophysical characteristics, which again provide suitable habitat for rock-dependent faunal species. These rocky ledges and crevices often act as refugia for reptiles and mammals within homogenous landscapes.

Wetlands provide unique habitats on which some species depend for persistence: Some of the slightly sloped seepage wetlands were comprised of pockets of *Leersia hexandra*. *Metisella meninx* (Marsh Sylph) was confirmed to be present during the present study, and these wetlands are likely to act as a key movement corridor for the species to reach other sections of the wetland system, which may be dominated by their host plant (*Leersia hexandra)*. Alongside the stream north of the current box cut, numerous fresh tracks next to open water confirmed the presence of both *Aonyx capensis* (Cape Clawless Otter) as well as *Atilax paludinosus* (Water Mongoose).

Wetland habitats form important biological corridors for mammals, reptiles, amphibians and invertebrate species. These biological corridors are vital in transformed landscapes (such as the case of the study area) where natural vegetation has been degraded and often completely destroyed. The effective conservation of these habitats is vital for the preservation of biodiversity as well as the provision of ecosystem goods and services. After sufficient rains the standing water within these systems will attract avian, amphibian and water dependant reptile and mammal species and habitat surrounding these systems is often utilised by burrowing species. Although some wetlands have been dammed and others degraded due to anthropogenic activities, they still provide biodiversity support.

### 4.4.3 Cultivated and Alien-Dominated Areas (Modified Vegetated Habitats)

The largest part of the study area consists of cultivated lands, interspersed with sections of weed dominated-areas (around isolated pans, along roads and old homesteads) and include gravel tracks, and past windbreaks of exotic woody vegetation (*Eucalyptus spp.*, Figure 18). This has resulted in the colonisation by pioneer and alien invasive species on areas not actively cultivated. These historic and current anthropogenic activities exert negative pressure on ecosystems through altered land use (resulting in a decline in faunal diversity associated with grassland systems) and habitat fragmentation. However, cultivated land can provide foraging opportunities for certain faunal species (mainly Muridae) through the process of land preparation many insects, seeds, bulbs and other food sources become readily accessible. It is thus not surprising that small colonies of burrows, typical of *Tatera brantsii* (Highveld Gerbil), were observed in close proximity to cultivated fields, whilst *Mus minutoides* (Pygmy Mouse), *Mastomys coucha* (Multimammate Mouse), and *Aethomys chrysophilus* (Red Vlei Rat) have been observed during previous studies (STS, 2016).

### 4.4.4 Mining and other Anthropogenic Habitat

This habitat comprises of above-ground mining infrastructure, homesteads and larger roads, and has been completely modified. The habitat presented within this unit is not desirable to faunal species except some common generalists able to persist in anthropogenic landscapes, and as such contained a low diversity and abundance of faunal species.

## 4.5 Faunal Observations

In determining the likelihood of a faunal species frequenting and/or present within the study area, the assessment of the available micro-habitats, actual past and current observations and review of available distribution data and was carried out. Apart from actual observations, the focus of the present study was on species of conservation concern that may be impacted on by the proposed mining expansion operations.

It is important to note that, although the predicted impacts are mostly concerned with Red Data species, non-Red Data species will also benefit from the proposed mitigation measures as they share the same habitat and face similar potential impacts. In order to effectively develop strategies to protect endangered species it is important the communities, ecosystems and landscapes must be the focus on conservation efforts (Burnett et al., 1998).

Threat status has been indicated in the sections below as:

LC: Least Concern
NT: Near Threatened
VU: Vulnerable
EN: Endangered

### 4.5.1 Mammals

According to available data, approximately 90 mammal species have historically been recorded within the geographic area of the proposed development area (ADU, 2019). During the February 2019 survey, eight mammals were identified within the study area (Table 5). These were dominated by small to medium sized species.

Table 10: Mammals identified during the 2016 (STS) and 2019 field surveys

| Family | Scientific Name | Common Name | Conservation Status | | Survey Date |
|---|---|---|---|---|---|
| | | | MTP | IUCN | |
| Bovidae | *Sylvicapra grimmia* | Common Duiker | LC | LC | 2019* |
| Canidae | *Canis mesomelas* | Black-backed Jackal | LC | LC | 2016<br>2019● |
| Herpestidae | *Atilax paludinosus* | Water Mongoose | LC | LC | 2016<br>2019● |
| Herpestidae | *Galerella sanguinea* | Slender Mongoose | LC | LC | 2016<br>2019* |
| Hystricidae | *Hystrix africaeaustralis* | Cape Porcupine | LC | LC | 2016<br>2019● |
| Leporidae | *Lepus saxatilis* | Scrub Hare | LC | LC | 2016<br>2019* |
| Muridae | *Aethomys chrysophilus* | Red Vlei Rat | LC | LC | 2016 |
| Muridae | *Mastomys coucha* | Multimammate Mouse | LC | LC | 2016 |
| Muridae | *Mus minutoides* | Pygmy Mouse | LC | LC | 2016 |

| | | | | | |
|---|---|---|---|---|---|
| Muridae | *Tatera brantsii* | Highveld Gerbil | LC | LC | 2016<br>2019● |
| Mustelidae | *Aonyx capensis* | Cape Clawless Otter | NT | NT | 2019● |

*Sighting, ●Tracks, scat or other

Figure 14: Tracks of The Cape Clawless Otter (left) and Water Mongoose (right).

Table 11: Red Listed mammal species likely to occur in the study area

| Scientific Name | Common Name | Conservation status | Likelihood of Occurrence |
|---|---|---|---|
| *Leptailurus serval* | Serval | NT | High |
| *Dasymys incomtus* | African Marsh Rat | NT | High |
| *Mystromys albicaudatus* | White-tailed Mouse | VU | Moderate |
| *Hyaena brunnea* | Brown Hyena | NT | Low |

### 4.5.2 Herpetofauna

Herpetofauna are secretive, and accurate lists require intensive field surveys over numerous seasons, which was beyond the scope of the current study.

#### 4.5.2.1 Amphibians

Suitable environmental conditions and hence very specific habitats, particularly breeding sites, are critical for the presence and persistence of amphibians. According to available data, Mpumalanga contains 51 species (ADU 2019). The study area falls within the distribution range of twenty amphibian species, with three species confirmed within the study area, and the possible presence of more species. The majority of these amphibian species are common with a wide distribution. Some of the wetland areas appeared suitable as foraging and breeding habitat for *Pyxicephalus adspersus* (Giant Bullfrog; currently listed as Protected in terms of NEMBA).

Due to their biphasic life cycle coupled with their moist, semi-permeable skin (sensitive to chemical pollutants) amphibian species are effective ecosystem indicators. Most amphibian species are also

dependant on aquatic habitats for reproduction. Both adult and larval anurans are sensitive to water pollution through chemicals, herbicides, pesticides and acid mine drainage.

Table 12: Amphibians identified during the field survey.

| Family | Scientific Name | Common Name | Conservation Status | | Record |
|---|---|---|---|---|---|
| | | | MTP | IUCN | |
| Bufonidae | *Amietophrynus (Sclerophrys ) gutturalis* | Guttural Toad | LC | LC | ● |
| Hyperoliidae | *Kassina senegalensis* | Bubbling Kassina | LC | LC | ● |
| Hyperoliidae | *Semnodactylus wealii* | Rattling Frog | LC | LC | ● |
| Pipidae | *Xenopus laevis* | Common Platanna | LC | LC | * |
| Pyxicephalidae | *Cacosternum boettgeri* | Common Caco | LC | LC | ● |
| Pyxicephalidae | *Strongylopus grayii* | Clicking Stream Frog | LC | LC | ● * |

*Sighting, ●sound

Table 13: Red Listed Amphibian species likely to occur in the study area

| Scientific Name | Common Name | Conservation status | Likelihood of Occurrence |
|---|---|---|---|
| *Amietia delalandii* | Delalande's River Frog | Endemic | High |
| *Pyxicephalus adspersus* | Giant Bullfrog | NT in RSA<br>LC IUCN | High |

#### 4.5.2.2 Reptiles

Reptiles have adapted to a wide variety of habitats with the occurrence largely related to broad scale micro-habitats including terrestrial, aquatic and associated wetland habitats.

The study area falls within the distribution range of 29 reptile species and the Southern African Reptile Conservation Assessment (SARCA, ADU 2019) indicated that 18 species have been recorded within the study area's grid, 2629A Half-degree Square. Of these, six endemic species, comprised of one gecko and five snakes, have a high to moderate expected occurrence within the study area (Table 12). The Transvaal Gecko (*Pachydactylus affinis*) was the only endemic species recorded by SARCA within the 2629A Half-degree Square. The Striped Harlequin Snake (*Homoroselaps dorsalis*) is listed as Near Threatened and is endemic to South Africa. *H. dorsalis* is secretive and often utilises moribund termitaria (Bates et al., 2014). Due to the presence of termitaria (although of limited size and availability) within the grassland area, there is a moderate likelihood of occurrence within the study area. However, the existing levels of disturbance and historic agricultural activities would have had a negative impact on existing populations.

Table 14: Endemic reptile species likely to occur within the larger study area

| Scientific Name | Common Name | Likelihood of Occurrence | Habitat |
|---|---|---|---|
| *Lycodonomorphus rufulus* | Common Water Snake | Moderate | Streams, moist savannah, seasonal pans and vleis |
| *Hemachatus haemachatus* | Rinkhals | High | Grasslands |
| *Pachydactylus affinis* | Transvaal Gecko | High | Rocky areas and moribund termite mounds |
| *Typhlops bibronii* | Bibron's Blind Snake | High | Highveld and coastal grasslands |
| *Lamprophis aurora* | Aurora House Snake | Moderate | Grasslands, coastal bush and fynbos |
| *Homoroselaps dorsalis* | Striped Harlequin Snake | Moderate | Highveld grassland and moist savanna; moribund termite mounds |

### 4.5.3 Lepidoptera

According to LepiMAP (ADU 2019), 101 butterfly species are known to occur within the 2629A Half-degree Square. 11 Threatened Lepidopterans have been recorded within Mpumalanga (Henning et al., 2009). Of these, *Metisella meninx* (Figure 15) is the only species of conservation concern (Vulnerable locally, Least Concern according to IUCN) occurring within the study area. The host plant of the larva, *Leersia hexandra*, was noted within the some of the moist grassland and wetland areas. Major threats to *M. meninx* include loss of wetland habitats due to urban, residential, agricultural and mining infrastructure, anthropogenic pollution, and general degradation of suitable habitats, most significantly by the increased establishment of alien invasive species (Henning et al., 2009). This has resulted in a rapid population decline.

Figure 15: *Metisella meninx* (Marsh Sylph) observed in the area investigated.

## 4.6 Habitat Sensitivity

Faunal habitats and vegetation associations and their habitats overlap to a large degree, although fauna may not discriminate as much between primary or secondary grasslands, for example, as long as these are in an acceptable ecological state and have a sufficient resource base. Nevertheless, the sensitivity rating has been based on vegetation associations, but also taking into account faunal observations during the field investigation, previous studies and evaluation of habitat availability for faunal species of conservation concern. The sensitivity ratings are summarised in Table 15. The expected IFC PS 6 Classification of each Vegetation Habitat is also indicated.

Table 15: Summary of Sensitivity Ratings

| Faunal Habitat | Vegetation Habitat | Sensitivity | Expected PS6 Classification |
|---|---|---|---|
| Dry Grasslands | *Eragrostis* species dominated Primary Grasslands | **High** | Natural habitat |
| | *Eragrostis lehmanniana* dominated Secondary Grasslands | **Medium** | Modified habitat |
| | *Cheilanthes viridis – Diospyros* species Rocky Ledges | **No-Go** | Natural habitat, could qualify for critical habitat |
| Moist Grasslands | *Eragrostis plana* Floodplain Grasslands | **High** | Natural habitat |
| | *Imperata cylindrica* Seepage Slope Grasslands | **Medium** | Modified to Natural habitat |
| Wetlands | Riparian Vegetation | **High** | Natural habitat, could qualify for critical habitat |
| Modified but Vegetated | Alien-Dominated Areas | **Low** | Modified habitat |
| Modified | Cultivated and Heavily Modified Areas | **Low** | Modified habitat |

The above is mapped in Figure 16, together with an overlay of species of conservation concern that were mapped (more information in Section 4.2 and 4.5). The derivation of the sensitivity ratings is explained in more detail in the subsections below.

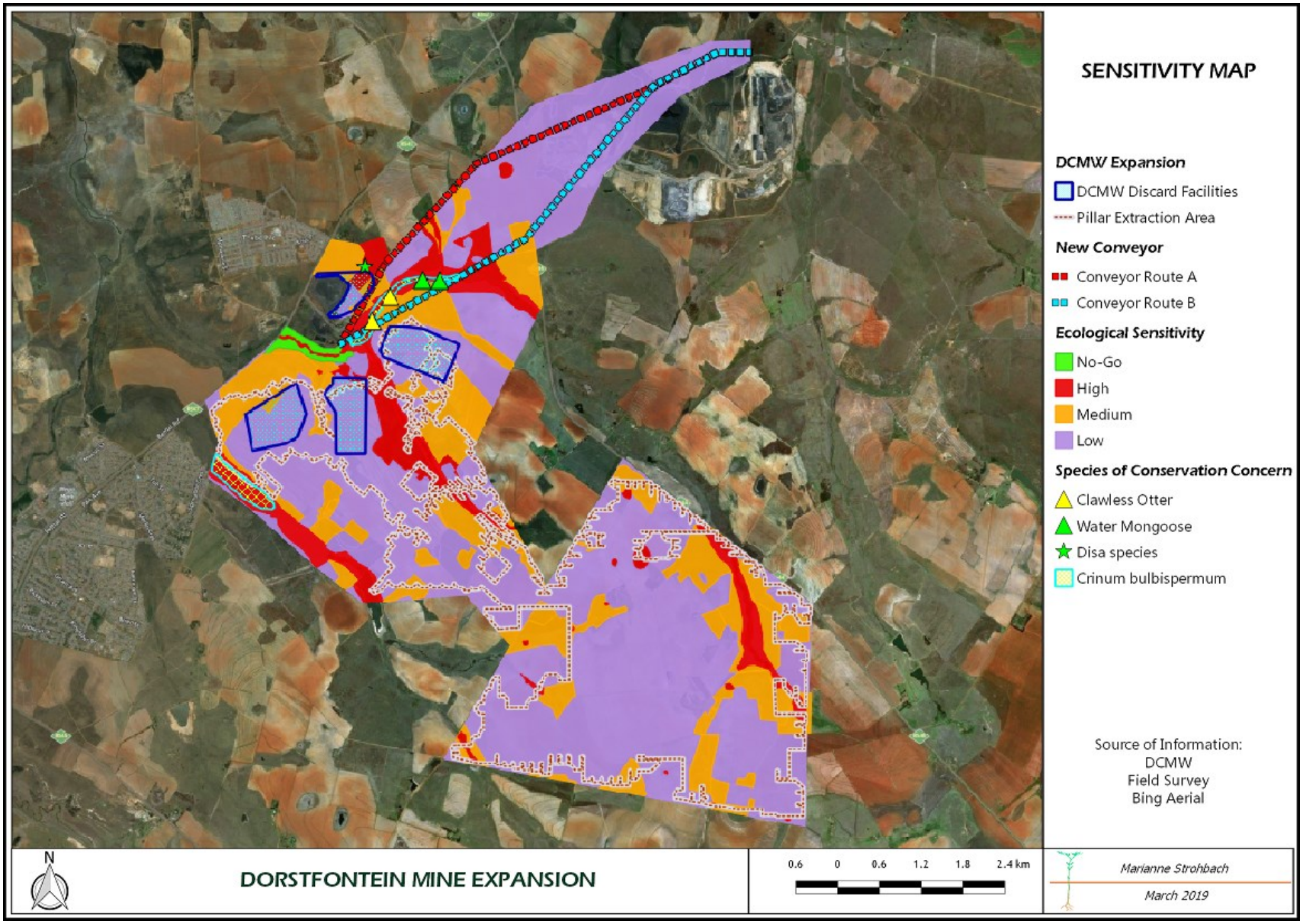


Figure 16: Ecological Sensitivity Map of the area investigated.

### 4.6.1 Sensitivity Evaluation of *Eragrostis* species dominated Primary Grasslands

| | |
|---|---|
| **Conservation value** | • Medium in terms of species of conservation concern<br>  ○ Although only two protected species were observed, more are expected to be present, and the *Disa* species may be threatened<br>• High in terms of threat-status to the specific ecosystem (Vulnerable Threatened Ecosystem)<br>• Currently mapped as a CBA 1 Irreplaceable Area as well as Other Natural Areas |
| **Habitat value and Current Ecological State** | • Medium-High:<br>  ○ Ecological state is moderate, albeit somewhat degraded – most likely due to high continuous grazing pressure and too frequent fires<br>  ○ Grass- and forb density, as well as emergence of geophytes will fluctuate during seasons and from year to year<br>  ○ Dense grass- and perennial forb layer is important to reduce sheet-erosion of soils, attenuate runoff after heavy rainfalls and reduce further degradation of downslope habitats (floodplains and riparian areas)<br>  ○ These Grasslands provide high habitat value due to the availability of cover, foraging and breeding opportunities for faunal species as well as acting as biological corridors for mammals, reptiles, amphibians and insects<br>  ○ Grasslands also create important faunal micro-habitats within the largely modified surrounding landscape. |
| **Current drivers of potential degradation** | • High pressure from exotic and alien invasive seeds on edges<br>• High continuous grazing<br>• Frequent burning<br>• Fragmentation<br>• Collection of medicinal plants |
| **Stability** | • High where the vegetation layer is moderate to dense, lower where soils become bare<br>• Grass, forb and emergence of geophytes will fluctuate significantly during seasons and from year to year<br>• Low if soil surface if extensively disturbed or compacted |
| **Reversibility of impacts** | • Re-establishment of full diversity after physical modification will be limited – it is anticipated that after physical disturbance, a different composition of vegetation will establish as the abiotic configuration has been changed and/or soil-seedbanks lost<br>• Disturbance will most likely lead to a rapid invasion by alien invasive plants, and control measures will be required. |
| ***Sensitivity Rating*** | ***High*** |

### 4.6.2 Sensitivity Evaluation of *Eragrostis lehmanniana* dominated Secondary Grasslands

| | |
|---|---|
| **Conservation value** | • Medium-low in terms of species of conservation concern<br>  ○ Three protected species were observed, but these are not currently threatened<br>• Currently mapped as a Moderately Modified – Old Lands |
| **Habitat value and Current Ecological State** | • Medium:<br>  ○ Ecological state is moderate to low, albeit somewhat degraded – most likely due to high continuous grazing pressure and too frequent fires<br>  ○ Widespread soil sheet erosion and soil surface capping was observed<br>  ○ Many areas with a high density of Encroacher bush and/or ruderal species<br>  ○ Dense grass- and perennial forb layer helps reduce sheet-erosion of soils, attenuate runoff after heavy rainfalls and reduce further degradation of downslope habitats (floodplains and riparian areas)<br>  ○ These Grasslands provide moderate habitat value, but there is still an availability of cover, foraging and breeding opportunities for faunal species as well as acting as biological corridors for mammals, reptiles, amphibians and insects<br>  ○ Grasslands also create important faunal micro-habitats within the largely modified surrounding landscape. |
| **Current drivers of potential degradation** | • High pressure from exotic and alien invasive seeds on edges<br>• High continuous grazing<br>• Frequent burning |
| **Stability** | • High where the vegetation layer is moderate to dense, lower where soils become bare<br>• Low if soil surface if extensively disturbed, becomes bare or is compacted |
| **Reversibility of impacts** | • Re-establishment of current diversity after physical modification will be possible – it is anticipated that after physical disturbance, a different composition of vegetation will establish as existing soil-seedbanks may be lost<br>• Disturbance will most likely lead to an increased invasion and dominance by alien invasive plants, and control measures will be required. |
| ***Sensitivity Rating*** | ***Medium*** |

### 4.6.3 Sensitivity Evaluation of *Cheilanthes viridis – Diospyros* species Rocky Ledges

| | |
|---|---|
| **Conservation value** | • Medium-High in terms of species of conservation concern<br>  ○ Although only two protected species were observed, more are expected to be present, and species such as *Nerine rehmannii* were restricted to these habitats<br>• High in terms of threat-status to the specific ecosystem (Vulnerable Threatened Ecosystem)<br>• Currently mapped as a CBA 1 Irreplaceable Area<br>• High number of species unique to/dependent on this habitat |

| | |
|---|---|
| **Habitat value and Current Ecological State** | • High:<br>○ Ecological state is moderate to high<br>○ Grass- and forb density, as well as emergence of geophytes will fluctuate during seasons and from year to year<br>○ Dense grass- and perennial forb layer is important to attenuate runoff from higher slopes after heavy rainfalls and reduce further degradation of riparian areas<br>○ Important refuge for more palatable grasses, which are not reachable between rocks<br>○ These Grasslands provide high habitat value due to the availability of cover, foraging and breeding opportunities for faunal species as well as acting as biological corridors for mammals, reptiles, amphibians and insects<br>○ Rocky ledges and -crevices create important and unique faunal micro-habitats within the largely modified surrounding landscape.<br>○ Shelter is available for smaller fauna and habitat and reduced competition for unique plant species |
| **Current drivers of potential degradation** | • High pressure from exotic and alien invasive seeds<br>• High grazing levels<br>• Frequent burning<br>• Leaching of pollutants from ore wash area<br>• Collection of medicinal plants |
| **Stability** | • High where the vegetation layer is moderate to dense and the habitat configuration (rocky ledges) are intact<br>• Grass, forb and emergence of geophytes will fluctuate significantly during seasons and from year to year<br>• Low if soil surface if extensively disturbed or compacted |
| **Reversibility of impacts** | • Re-establishment of full diversity after physical modification will be extremely limited to impossible – the specific habitat configuration cannot be recreated after physical disturbance<br>• Disturbance will most likely lead to a loss of unique species, significant change in species composition and rapid invasion by alien invasive plants, and control measures will be required. |
| ***Sensitivity Rating*** | ***High (NO-GO)*** |

### 4.6.4 Sensitivity Evaluation of *Eragrostis plana* Floodplain Grasslands

| | |
|---|---|
| **Conservation value** | • High in terms of species of conservation concern<br>○ Highest density of *Crinum bulbispermum* was observed in the Floodplain Grasslands<br>○ It is expected that under more favourable rainfall conditions, some Orchidaceae may also be present<br>• High in terms of threat-status to the specific ecosystem (Vulnerable Threatened Ecosystem) |

| | |
|---|---|
| | • Currently parts of these Floodplain Grasslands are mapped as a CBA 1 Irreplaceable Area<br>• High number of species unique to/dependent on this habitat<br>• Numerous but isolated small burrows detected, possibly of amphibians |
| **Habitat value and Current Ecological State** | • High:<br>o Ecological state is moderate due to high grazing and dry conditions, but this can improve<br>o Dense grass- and perennial forb layer is important to attenuate stormwater from higher slopes after heavy rainfalls, and reduce further degradation of riparian areas by removing sediment and possible pollutants<br>o Forms buffer zones around wetlands<br>o These Grasslands provide high micro-habitat value due to the availability of cover, foraging and breeding opportunities for faunal species<br>o Important corridor for movement of all terrestrial fauna, enabling movement between different types of faunal micro-habitats<br>o Provides faunal habitat that enables foraging and breeding for aquatic and semi-aquatic species, and terrestrial species |
| **Current drivers of potential degradation** | • High pressure from exotic and alien invasive seeds in adjacent areas<br>• High grazing levels, especially near DCMW plant<br>• Frequent burning |
| **Stability** | • High where the vegetation layer is moderate to dense and the habitat configuration is intact<br>• Grass, forb and emergence of geophytes will fluctuate significantly during seasons and from year to year<br>• Low if soil surface is physically disturbed or compacted |
| **Reversibility of impacts** | • Re-establishment of full diversity after physical modification may be limited and will take time<br>• Disturbance will most likely lead to a loss of unique species, significant change in species composition, rapid invasion by alien invasive plants, and accelerated erosion<br>• Accelerated erosion and channel incision will lead to a quicker loss of moisture from the ecosystem, and will also impact adjacent and downstream riparian areas negatively |
| ***Sensitivity Rating*** | ***High*** |

### 4.6.5 Sensitivity Evaluation of *Imperata cylindrica* Seepage Slope Grasslands

| | |
|---|---|
| **Conservation value** | • Medium in terms of species of conservation concern<br>o Occurrence of the Marsh Sylph (*Metisella meninx*) confirmed in these habitats<br>o Numerous animal burrows observed – these were most likely of amphibians<br>• High in terms of threat-status to the specific ecosystem (Vulnerable Threatened Ecosystem)<br>• Currently mapped as a CBA 1 Irreplaceable Area<br>• High number of species unique to/dependent on this habitat |

| | |
|---|---|
| **Habitat value and Current Ecological State** | • Medium:<br>○ Ecological state is moderate to low<br>○ Grass- and forb density, as well as emergence of geophytes will fluctuate during seasons and from year to year<br>○ Dense grass- and perennial forb layer is important to attenuate runoff from surrounding and/or higher slopes after heavy rainfalls and reduce further degradation of riparian areas<br>○ These Grasslands provide high micro-habitat value due to the availability of cover, foraging and breeding opportunities for faunal species<br>○ Important corridor for movement of all terrestrial fauna, enabling movement between different types of faunal micro-habitats<br>○ Provides faunal habitat that enables foraging and breeding for aquatic and semi-aquatic species, and terrestrial species |
| **Current drivers of potential degradation** | • High pressure from exotic and alien invasive seeds<br>• High grazing levels<br>• Impacts from continued surrounding agricultural practices |
| **Stability** | • High where the vegetation layer is moderate to dense and the habitat is intact<br>• Grass, forb and emergence of geophytes will fluctuate significantly during seasons and from year to year<br>• Low if soil surface is physically disturbed or compacted |
| **Reversibility of impacts** | • Re-establishment of full diversity after physical modification should be possible to some degree<br>• Disturbance will most likely lead to a significant change in species composition and rapid invasion by alien invasive plants, and control measures will be required. |
| ***Sensitivity Rating*** | ***Medium*** |

### 4.6.6 Sensitivity Evaluation of Riparian Vegetation

| | |
|---|---|
| **Conservation value** | • Medium-High in terms of species of conservation concern<br>○ *Crinum bulbispermum* had a high occurrence all along the banks of the Steenkoolspruit tributary, and other species may emerge during more favourable rainfall seasons.<br>○ Tracks of both the Cape Clawless Otter as well as the Marsh Mongoose were observed along the stream east and north of the DCMW offices.<br>• High in terms of threat-status to the specific ecosystem (Vulnerable Threatened Ecosystem)<br>• Large portions of this riparian vegetation falls within the currently mapped CBA 1 Irreplaceable Area<br>• High number of species unique to/dependent on this habitat, most faunal species observed and likely to be present can only persist in this kind of micro-habitat |
| **Habitat value and Current Ecological State** | • High:<br>○ Ecological state is moderate to high<br>○ Grass- and forb density, as well as emergence of geophytes may fluctuate during seasons and from year to year |

| | |
|---|---|
| | ○ Dense grass- and perennial forb layer is important to attenuate floods and reduce further degradation of riparian areas, especially gully- and head-cut erosion<br>○ Important refuge and corridor for fauna dependent on these habitats<br>○ Habitat for unique plant species<br>○ Potential breeding habitat for Giant Bullfrog and other species<br>○ Provides faunal habitat (foraging and breeding) for aquatic and semi-aquatic species, whilst an important resource to other terrestrial fauna |
| **Current drivers of potential degradation** | • High pressure from exotic and alien invasive species in surroundings<br>• High grazing levels and associated localised trampling leading to accelerated erosion of steeper banks<br>• Frequent burning<br>• Leaching of pollutants from ore wash area |
| **Stability** | • High where the vegetation layer is moderate to dense<br>• Low if surface if physically disturbed |
| **Reversibility of impacts** | • Re-establishment of full diversity after physical modification will be limited to possible, but only if the specific habitat configuration will be recreated after physical disturbance<br>• This also implies that floodwater may not be unduly impounded nor concentrated, e.g. under bridges.<br>• Disturbance will most likely lead to a loss of unique species, significant change in species composition and rapid invasion by alien invasive plants, and control measures will be required. |
| ***Sensitivity Rating*** | ***High*** |

### 4.6.7 Sensitivity Evaluation of Alien-Dominated Areas

| | |
|---|---|
| **Conservation value** | • Low in terms of species of conservation concern<br>○ No plant species of conservation concern, nor suitable habitat for such<br>○ May provide temporary shelter to small antelopes or other small mammals and herpetofauna, but very limited foraging habitat. |
| **Habitat value and Current Ecological State** | • Low:<br>○ Ecological state is low<br>○ Grass- and forb density will fluctuate significantly between seasons, possibly leaving soils bare during dry seasons and then susceptible to erosion at the onset of rainy seasons<br>○ Stands of taller trees may provide shelter for smaller mammals<br>○ Eucalyptus species may provide resources for pollinators (e.g. bees) when in flower<br>○ Litter of *Eucalyptus* and Australian *Acacia* species may change the chemical composition of the topsoils they cover, effectively preventing the germination and establishment of indigenous perennial plant species |

| | |
|---|---|
| | ○ High density of presence of alien invasive species in this area created source-areas of regenerative material that may spread to other natural and near-natural areas if not controlled<br>○ May provide temporary shelter to small antelopes or other small mammals and herpetofauna, but very limited foraging or breeding habitat. |
| **Current drivers of potential degradation** | • High pressure from exotic and alien invasive plants<br>• Ecological barrier to the establishment of indigenous species due to litter with a high amount of oils from alien tree species |
| **Stability** | • In its current state, the bare soils during winter and/or under groves of alien trees may lead to accelerated erosion<br>• Areas with a high amount of herbaceous alien invasive species should be cleared of such and oversown with indigenous grass species |
| **Reversibility of impacts** | • Re-establishment of and indigenous species diversity after physical modification and/or control of alien invasives will be possible and is desirable |
| ***Sensitivity Rating*** | ***Low*** |

### 4.6.8 Sensitivity Evaluation of Modified Areas

As stated in section 4.1, these consist of areas that are used for cultivation, have infrastructure on and generally are subject to high and constant anthropogenic disturbance levels. They do not provide suitable habitat for species of conservation concern, which are usually habitat specialists (i.e. in need of specific habitat requirements to be able to persist), not do they retain any meaningful ecosystem function. The ecological sensitivity of these areas is thus low.

# 5 IMPACT/RISK ASSESSMENT

Any anthropogenic activity, whether historic, current, or proposed, carried out within a natural or semi-natural ecosystem will have an impact on the immediate and surrounding environment, usually in a negative way. As required for any sustainable development and according to legislation (see Section 1.5), it was necessary to determine and assess the significance of any potential impacts of the proposed discard dump facility expansion and new conveyor belt area and related activities, and to provide a description of available mitigation measures required to limit or reduce the perceived negative impacts on the natural environment.

Mining and its related activities can have the following types of impacts:

- *Direct impacts* are those impacts directly linked to the project (e.g. clearing of land, extraction of water, contamination of water bodies, blasting, sedimentation, and change in water table levels). These can be temporary or remain as residual impacts.
- *Indirect impacts* are those impacts resulting from the project that may occur beyond or downstream of the boundaries of the project site and/or after the project activity has ceased (e.g. migration of pollutants from waste sites, reduced flow in downstream rivers).
- *Induced impacts* are impacts that are not directly attributable to the project, but are anticipated to occur because of the presence of the project (e.g. impacts of associated industries, establishment of residential settlements with increased pressure on biodiversity).
- *Cumulative impacts* are those impacts from the project combined with the impacts from past, existing and reasonably foreseeable future projects that would affect the same biodiversity or natural resources (e.g. a number of mines in the same catchment or ecosystem type collectively affected water quality or flow, or impacting the same local endemic species).

Ecosystems consist of a mosaic of many different patches. At the periphery of patches, influences of neighbouring patches become apparent, known as the 'edge effect'. Patch edges may be subjected to increased levels of heat, dust, desiccation, disturbance, invasion of exotic species and other factors. Edges seldom contain species that are rare, habitat specialists or species that require larger tracts of undisturbed core habitat. An extension of edge habitat causes a shift in species composition, which in turn reduces the functionality of ecosystems (Perlman & Milder, 2005).

## 5.1 Anticipated Impacts

Impacts on the receiving environment will be relevant during more than one phase of the proposed mining expansion, and are thus only described once. These are summarised in Table16, together with the phases during which such impact will most likely occur:

Table 16: Anticipated main impacts arising form the mining expansion activities

| IMPACT | SENSITIVE RECEPTORS | DEVELOPMENT PHASE |
|---|---|---|
| Subsidence of landscape tracts due to pillar extraction mining | All natural and semi-natural habitats<br>Species of conservation concern<br>Rehabilitation potential of landscapes | Possible during operation<br>Closure or post-closure |

| IMPACT | SENSITIVE RECEPTORS | DEVELOPMENT PHASE |
|---|---|---|
| Loss of Indigenous Vegetation | Remaining primary vegetation of a threatened ecosystem<br>Plant species of conservation concern<br>Unique sensitive habitats, including CBA areas and wetlands<br>Unique or suitable habitat for species of conservation concern to establish or persist | Construction<br>Possibly during operation |
| Removal of exotic and cultivated vegetation cover | Vegetated topsoil | Construction<br>Possibly during operation |
| Loss of or displacement of fauna | Range-restricted fauna<br>Fauna of conservation concern<br>Biological corridors used by fauna | Construction<br>Operation<br>Closure |
| Loss of ecological structure and – function of habitats | All wetland habitats<br>Topsoil resources<br>Surface and sub-surface hydrological patterns essential for maintaining lower-lying habitats | Construction<br>Operation<br>Possible post closure |
| Increase in Alien Invasive Plants | All habitats | Construction<br>Operation<br>Closure and post-closure |

The above anticipated or possible impacts on the biodiversity by the proposed expansion will overlap for several of the activities, but may vary in severity depending on the actual extent, position and nature of the activity. They were thus grouped and evaluated according to alternatives where applicable into:

1. Impacts related to the underground pillar extraction of coal
2. Expansion of the discard dump capacity, including:
    - Expansion of the existing Discard Dump.
    - Creation of a new Discard Dump, with three alternative sites delineated.
    - *Possible impact(s) of related access routes were not evaluated as such access routes are currently not known*
3. Construction of an overland conveyor system, with two alternatives, and associated haul road

Likewise, indirect-, induced- and cumulative impacts, as well as mitigation measures overlap to a large degree for every anticipated or possible impact. These are therefore not listed per impact evaluated, but rather collectively for each of the above activities.

## 5.2 Impact Assessment Criteria

Potential impacts of the proposed activity on the environment were assessed according to pre-determined criteria (listed below) to derive their most likely severity without the implementation of corrective measures. The most practical and necessary mitigation or corrective measures were then

listed, the impact severities re-evaluated, assuming that the proposed corrective measures can be fully implemented. The criteria used are described as follows:

The **SOURCE** of an impact refers to a description of the activity, inherent features, characteristics and/or qualities of the impact. Thus, each impact is comprehensively detailed and contextualised prior to being assessed.

The **NATURE** of an impact indicates either of the following:

- ***Negative*** effect – presenting a `cost' to the environment
- ***Positive*** effect – presenting a `benefit' to the environment
- ***Neutral*** – no particular effect on the environment

The **EXTENT** refers to the impact footprint. This would imply that if for example a narrow-endemic species were to be lost entirely, then the extent would be global because that species would be lost to the world.

Table 17: Descriptors and scoring for the EXTENT of an impact

| Descriptors | Definitions | Score |
|---|---|---|
| Site only | The impact remains within the footprint of the site. | 1 |
| Local | The impact extends beyond the footprint of the site, to include the immediately adjacent and surrounding areas. | 2 |
| Regional | The impact includes the greater surrounding area within which the site is located. | 3 |
| National | The scale/extent of the impact is applicable to the Republic of South Africa. | 4 |
| Global | The scale /extent of the impact is global (i.e. world-wide). | 5 |

The **DURATION** is the period of time for which the impact would be manifest. Importantly, the concept of reversibility is taken into consideration: the longer the impact endures, the less likely is the reversibility of the impact.

Table 18: Descriptors and scoring for the DURATION of an impact

| Descriptors | Definitions | Score |
|---|---|---|
| Immediate | The impact endures for only a short period of time (0-1 years). | 1 |
| Short term | The impact continues to manifest for a period of between 1-5 years. | 2 |
| Medium term | The impact continues to manifest for a period of 5-15 years. | 3 |
| Long term | The impact will cease after the operational life of the activity. | 4 |
| Permanent | The impact will continue indefinitely. | 5 |

The **MAGNITUDE** is the measure of the potential severity of the impact on the associated environment. As with duration, the concept of reversibility should is taken into account when considering the magnitude of the potential impact.

Table 19: Descriptors and scoring for the MAGNITUDE of an impact

| Descriptors | Definitions | Score |
|---|---|---|
| None | The ecosystem pattern, process and functioning are not affected | 0 |
| Minor | Minor impact - a minor impact on the environment and processes will occur. | 2 |
| Low | Low impact - slight impact on ecosystem pattern, process and functioning. | 4 |
| Moderate | Valued, important, sensitive or vulnerable systems or communities are negatively affected, but ecosystem pattern, process and functions can continue albeit in a slightly modified way. | 6 |
| High | The environment is affected to the extent that the ecosystem pattern, process and functions are altered and may even temporarily cease. Valued, important, sensitive or vulnerable systems or communities are substantially affected. | 8 |
| Very High | The environment is affected to the extent that the ecosystem pattern, process and functions are completely destroyed and may permanently cease. | 10 |

The **PROBABILITY of OCCURRENCE** is the likelihood of the impact manifesting. Although the term probability may be regarded as having a very specific mathematical and/ or statistical connotation, in the context of this assessment it does not imply an accurate empirically or mathematically defined expression of risk.

Table 20: Descriptors and scoring for the PROBABILITY OF OCCURRENCE of an impact

| Descriptors | Definitions | Score |
|---|---|---|
| None | The impact will not occur | 0 |
| Very improbable / Rare | Where it is highly unlikely that the impact will occur, either because of design or because of historic experience | 1 |
| Low probability | Improbable – where the impact is unlikely to occur (some possibility), either because of design or historic experience. | 2 |
| Medium probability | There is a distinct probability that the impact will occur (≤ 50% chance of occurring) | 3 |
| Highly Probable | Most likely that the impact will occur (51 – 90% chance of occurring) | 4 |
| Definite | The impact will occur regardless of any prevention or mitigating measures (>90% chance of occurring). | 5 |

The **SIGNIFICANCE** of an impact is derived through combining ratings of all criteria as follows:

**(Extent + Duration + Magnitude) x Probability = Significance**

Table 21: Descriptors for the SIGNIFICANCE score of an impact

| Descriptors | Definitions | Score |
|---|---|---|
| Low | The perceived impact will not have a noticeable negative influence on the environment and is unlikely to require management intervention that would incur significant cost, or<br>The perceived impact is considered acceptable and would not have a direct influence on the decision to develop, whilst the implementation of recommended mitigation measures recommended. | 0 – 29 |
| Medium | The perceived impact is likely to have a negative effect on the receiving ecosystem, and is likely to influence the decision to approve the activity. Implementation of mitigation measures is required, as is routine monitoring to ensure effectiveness of recommended mitigation measures. | 30-60 |
| High | The perceived impact will have a significant impact on the receiving ecosystem, and will likely to have an influence on the decision-making process. Strict implementation of mitigation measures as provided is required, and strict monitoring and high levels of compliance and enforcement in respect of the impact in question are required. | 61 – 90 |
| Possible Fatal Flaw | The impact on the receiving ecosystem is considered of high significance and likely to be irreversible, and therefore highly likely to result in a fatal flaw for the project. Alternatives to the proposed activity are to be investigated as impact will have an influence on the decision-making process. | 91 - 100 |

## 5.3 Assessment of Impacts Related to Underground Pillar Extraction of Coal

At DCMW, up to date coal was extracted with the conventional bord-and-pillar method. This entails extracting columns of coal with a continuous miner to leave a void (the bord), with coal remaining in supporting pillars between the bord, to prevent the roof from collapsing. At this stage, direct impacts on above-ground biodiversity and natural habitats is minimal and restricted to rescue bays and adits, which already exist throughout the project area and are therefore not further evaluated.

### 5.3.1 Degradation of habitats due to post-mining subsidence

***Source of impact:***

To extend the life of the mine, pillar extraction of the 4-seam will be undertaken, which also means that the pillars themselves will eventually be mined by replacing the current remaining coal-pillars with mobile roof supports. Depending on the thickness and composition of the roof, which determines its long-term strength and stability (which is regarded as uncertain at the stage of writing), over time this roof may collapse and cause subsidence. Even without extensive pillar extraction, unless the mine workings have been backfilled to support the roof, any surface area lying above an area where coal has been mined by underground methods may subside at any time in the future. Sinkholes from bord-and-pillar mining may develop unpredictably 20 to 50 years after mining takes place, and with the current project it has been shown that subsidence will be definite without adequate support.

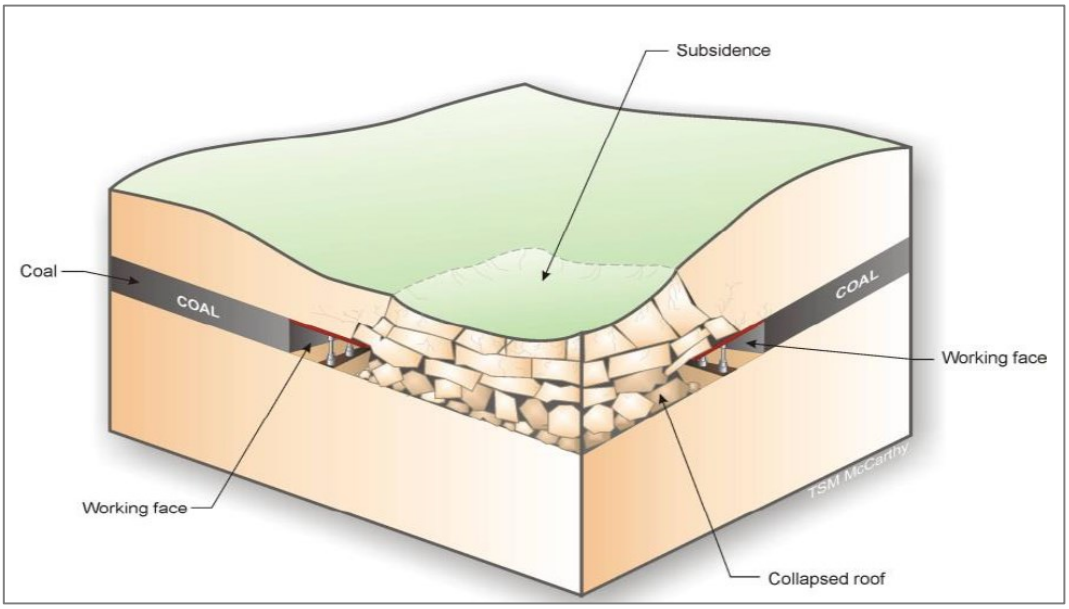


Figure 17: Diagram of landscape subsidence after pillar extraction (from Munnik et al. 2018).

Subsidence creates depressions and hollows in the surface that will over time fill with water. This recharge into the collapsed material implies that water after rain will percolate down to the original mine floor with a subsequent filling of the void until it decants at the lowest point. If there is an elevated pyrite content associated with rock layers (that have now been broken up due to the roof collapse) these voids start generating sulphates and acid (as a natural reaction between pyrites, water and oxygen). The mine drainage water exiting the mine area at such decant point(s) then leads to the establishment of acid and/or sulphate rich seeps, which leach into lower-lying wetland areas and associated habitats (van der Waals, 2016).

| ISSUE | CORRECTIVE MEASURES | IMPACT RATING CRITERIA | | | | | SIGNIFICANCE |
|---|---|---|---|---|---|---|---|
| | | Nature | Extent | Duration | Magnitude | Probability | |
| **Degradation of habitats due to post-mining subsidence** | No | Negative | 3 | 5 | 10 | 4 | 72 High |
| | Yes | Negative | 3 | 5 | 8 | 3 | 46 Medium |
| **Confidence** | • Moderate to High, as this is based on anecdotal data (see references above) as well as the Rock Engineering Report from Exxaro | | | | | | |
| **Direct Impacts** | • Change of soil surface and sub-surface hydrology, depleting or reducing replenishment of moisture of lower-lying habitats depending on hillslope seeps<br>• Change in soil chemistry of all lower-lying habitats affected by acid leachate, causing die-off of indigenous plants and loss of resources to fauna<br>• Degradation of soil moisture reserves as well as water resources in more sensitive habitats, such as riparian areas | | | | | | |
| **Indirect Impacts** | • Significant reduction in replenishment of moisture from hillslope seeps may cause the transformation of moist and wet grasslands and riparian areas to dry grasslands, with an associated loss of species dependent on such habitats | | | | | | |

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| | • Loss of above grasslands leads to a displacement of fauna due to a reduction of suitable habitat<br>• Wetland reserves polluted with acid drainage may lead to the direct loss of fauna and flora, including species of conservation concern |
| **Induced Impacts** | • Loss of above grasslands leads to a displacement of fauna due to a reduction of suitable habitat and resources<br>• Loss of associated habitats and/or their functionality leads to a significant reduction in ecosystem services, such as flood attenuation or harvestable species. This may extend throughout the upper reaches of the Olifants-River catchment |
| **Most Likely Cumulative Impacts** | • Increased loss or fragmentation of unique and vulnerable habitats and plant species of conservation concern, increasing the impact of existing surrounding anthropogenic activities.<br>• Possible spread and establishment of alien invasive species.<br>• Potential for tracts of sensitive habitats adjacent to the mining operations to deteriorate further indefinitely due the effect of long-term dust deposition<br>• Possible change in plant vigour in downstream environments due to changes in surface and sub-surface runoff patterns – most noticeable in riparian and wetland vegetation |

***Mitigation Measures:***

Mitigation measures, if the impact does occur, would have to be devised by a suitably qualified specialist to mitigate the cause of acid mine drainage, not just the effect. Such mitigation measures need to look at:

- Backfilling mined-out areas with discard materials, focusing on areas that may be subject to uncontrolled roof-collapse
- Preventing acid-forming rock fragments from coming into contact with oxygen to limit the formation of acid
- If possible, isolate areas from which acid drainage has been recorded
- Treatment of areas where such acid leakage is formed or found, which may include:
    - Reclamation of contaminated land by adding suitable alkaline materials to neutralize the acidity, adding uncontaminated top soil, planting tolerant vegetation, and modifying slopes to stabilize the soil and reduce infiltration of surface water into underlying contaminated material.
    - Direct treatment of the contaminated water
    - Diverting runoff from the subsidence area

***Monitoring requirements:***

- Due to the high uncertainty regarding this impact, the stability of the roof underground must be determined and monitored on an ongoing basis (details of which are beyond the scope of the biodiversity report)
- Constantly monitor boreholes as well as stream water to determine any unnatural rise in acidity levels, even after mine closure

## 5.4 Assessment of Impacts Related to the Expansion of Discard Dump Facilities

Coal mined in South Africa has to meet several quality criteria to be sold to consumers. This entails that marketable coal must be separated from poor quality coal, as well as shale and other waste rock that had to be removed as part of gaining access to or extracting the coal ore. Discarded materials resulting from the mining and subsequent coal-washing operations are then stockpiled on dedicated discard dump facilities. The creation and operation of such facilities poses several risks to the receiving and surrounding environment, which will be evaluated and discussed below. Mitigation measures will overlap for all anticipated impacts and will be compiled at the end of the section.

***The assessments are all based on the assumption that upon closure of mine, the discard dumps will be obliterated and the area rehabilitated entirely.***

### 5.4.1 Loss of Indigenous Vegetation for the Expansion or Creation of Discard Dump Facilities

The significance of this impact will be the same for every option of the discard dumps, hence will be evaluated once – although the total area of indigenous vegetation differs. For the expansion of the existing Discard Dump there is no alternative, however, for the new Discard Dump three alternative sites have been delineated (see section 5.5 below for the map) relative to the ecological sensitivity of the area.

The relative areas of indigenous vegetation affected are as follows:

- Existing Dump Expansion: ± 12 ha
- Dump Site 1: ± 4 ha
- Dump Site 2: ± 2.7 ha
- Dump Site 3: ± 2 ha

The total area may be larger, as topsoils will have to be stripped and stockpiled somewhere as well prior to the area being used as discard dump. Possible localities for topsoil stockpiles have not been indicated. The negative impact of indigenous vegetation clearing may be exacerbated by poor placement of access roads to the new discard facilities, which were not delineated at the time of reporting. At the time of writing no routes for haul roads to the new Discard Dumps had been proposed, so these could not be assessed. However, under mitigation measures best practices and considerations for the alignment of such haul roads are presented.

***Source of impact:***

- Direct destruction and complete obliteration of natural habitats and all species therein by clearing the target area, landscaping and subsequent use of the proposed discard dump area
- Direct destruction of plant species of conservation concern and direct reduction of viable populations of such species, including species with very limited range of occurrence
- Destruction of the abiotic configuration and related resources of natural habitats needed by flora
- Interim storage of topsoil (position and layout to be determined)

| ISSUE | CORRECTIVE MEASURES | IMPACT RATING CRITERIA | | | | | SIGNIFICANCE |
|---|---|---|---|---|---|---|---|
| | | Nature | Extent | Duration | Magnitude | Probability | |
| **Loss of Indigenous Vegetation** | No | Negative | 2 | 5 | 8 | 5 | 75 High |
| | Yes | Negative | 1 | 4 | 6 | 5 | 55 Medium |
| **Confidence** | • High | | | | | | |
| **Direct Impacts** | • Loss of portions of remaining primary vegetation of a Vulnerable Ecosystem<br>• Potential loss of plant species of conservation concern<br>  o Re-establishment rates of relocated plant species that are restricted to specific habitats may be low if such plants are not relocated at the end of the growing season or relocated to areas not suitable for their persistence.<br>• Compaction and possible pollution of topsoils by unforeseen hydrocarbon spills and unauthorised/uncontrolled off-road driving, especially with heavy machinery | | | | | | |
| **Indirect Impacts** | • Erosion increases dramatically when the protective plant cover is removed and the remaining soil is not stabilized<br>• Decline in foraging, breeding and roosting opportunities for faunal species as well ecosystem goods and services<br>• Possible degradation of adjacent natural habitats due to a reduction of moisture input by cutting off/preventing natural flow of water, resulting in a decline of habitat quality and/or increased invasion by alien plant species<br>• Possible continued decline/degradation of natural vegetation and plant species of conservation concern within adjacent or downstream habitats, due to excessive dust deposition, possible leaching or deposition of pollutants. | | | | | | |
| **Induced Impacts** | • Continued loss of plant species of conservation concern due to a reduction of individuals of affected species, leading to loss of genetic diversity and gradual decline of sub-populations remaining.<br>  o The above will be exacerbated if relocation of selected species leads to further isolation of sub-populations and/or poor re-establishment and loss of such sub-populations<br>• Continued loss of indigenous vegetation generally affects nutrient cycles, removes the organic litter layer, and may result in habitat fragmentation and destruction of wildlife corridors. | | | | | | |
| **Most Likely Cumulative Impacts** | • Increased loss or fragmentation of unique and vulnerable habitats and plant species of conservation concern, increasing the impact of existing surrounding anthropogenic activities.<br>• Possible spread and establishment of alien invasive species.<br>• Potential for tracts of sensitive habitats adjacent to the mining operations to deteriorate further indefinitely due the effect of long-term dust deposition<br>• Possible change in plant vigour in downstream environments due to changes in surface and sub-surface runoff patterns – most noticeable in riparian and wetland vegetation | | | | | | |

### 5.4.2 Removal of Exotic Vegetation Cover for the Expansion or Creation of Discard Dump Facilities

The significance of this impact will be the same for every option of the discard dumps, hence will be evaluated once – although the total area of vegetation cover differs. The negative impact may be

exacerbated by poor placement of access roads to the new discard facilities, which were not delineated at the time of reporting.

The size of exotic and cultivated vegetation affected are as follows:

- Existing Dump Expansion: ± 10 ha
- Dump Site 1: ± 52 ha
- Dump Site 2: ± 48 ha
- Dump Site 3: ± 51 ha

The total area may be larger, as topsoils will have to be stripped and stockpiled somewhere as well prior to the area being used as discard dump. Possible localities for topsoil stockpiles have not been indicated.

***Source of impact:***

- Direct destruction and complete obliteration of moderately and completely modified habitats and all species therein by clearing the target area, landscaping and subsequent use of the proposed discard dump area
- Interim storage of topsoil

| ISSUE | CORRECTIVE MEASURES | IMPACT RATING CRITERIA | | | | | SIGNIFICANCE |
|---|---|---|---|---|---|---|---|
| | | Nature | Extent | Duration | Magnitude | Probability | |
| **Loss of Exotic Vegetation** | No | Negative | 2 | 5 | 6 | 5 | 65 Medium |
| | Yes | Neutral | 1 | 4 | 2 | 5 | 35 Medium |
| **Confidence** | • High | | | | | | |
| **Direct Impacts** | • Direct destruction of low sensitivity habitats and their soil resources, where such are in good condition and available.<br>• Small-scale loss of alien invasive vegetation (Positive)<br>• Potential direct destruction of temporary faunal habitat.<br>• Compaction and possible pollution of topsoils by unforeseen hydrocarbon spills and unauthorised/uncontrolled off-road driving, especially with heavy machinery | | | | | | |
| **Indirect Impacts** | • Erosion increases dramatically when the protective plant cover is removed and the remaining soil is not stabilized<br>• Possible degradation of adjacent natural habitats due to a reduction of moisture input by cutting off/preventing natural flow of water, resulting in a decline of habitat quality and/or increased invasion by alien plant species.<br>• Possible continued decline/degradation of natural vegetation and plant species of conservation concern within adjacent or downstream habitats, due to excessive dust deposition, possible leaching or deposition of pollutants, or distribution of reproductive material of invasive species. | | | | | | |
| **Induced Impacts** | • Possible accelerated erosion of bare areas<br>• Continued loss of species of conservation concern in adjacent more sensitive habitats due to the indirect degradation of available habitat | | | | | | |

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| **Most Likely Cumulative Impacts** | • Increased loss of or fragmentation of suitable habitats for especially faunal species, increasing the impact of existing surrounding anthropogenic activities.<br>• Possible spread and establishment of alien invasive species.<br>• Potential for tracts of sensitive habitats adjacent to the mining operations to deteriorate further indefinitely due to effects of long-term dust deposition or significantly changed hydrological patterns.<br>• Possible change in plant vigour and hence resources for fauna in downstream environments due to changes in surface runoff patterns – most noticeable in riparian and wet grassland vegetation. |

### 5.4.3 Loss of or Displacement of Fauna

The significance of this impact will differ slightly between the existing and new discard dumps, predominantly due their relative position to the surrounding environment. The total area may be larger, as topsoils will have to be stripped and stockpiled somewhere as well prior to the area being used as discard dump. Possible localities for topsoil stockpiles have not been indicated. Further, the impact may be exacerbated by poor placement of access roads to the new discard facilities.

***Source of impact:***

- Direct destruction and complete obliteration of natural or modified habitats and all species therein by clearing the target area, landscaping and subsequent use of the discard dump area
- Interim storage of topsoil
- Influx of people to natural areas, increasing the chance of negative faunal interactions.
- Disturbance created by noise-pollution, vibrations, excessive dust, and artificial lighting associated with workers and mining activities.

| ISSUE | CORRECTIVE MEASURES | IMPACT RATING CRITERIA | | | | | SIGNIFICANCE |
|---|---|---|---|---|---|---|---|
| | | Nature | Extent | Duration | Magnitude | Probability | |
| **Loss of or Displacement of Fauna** | No | Negative | 2 | 5 | 8 | 4 | 60 Medium |
| | Yes | Negative | 1 | 4 | 4 | 3 | 27 Low |
| **Confidence** | • High | | | | | | |
| **Direct Impacts** | • Loss of available faunal habitats and associated resources<br>• Negative faunal interactions including poaching, trapping and collisions with vehicles. | | | | | | |
| **Indirect Impacts** | • Possible degradation of adjacent natural habitats due to a reduction of moisture input by cutting off/preventing natural flow of water, resulting in a decline of habitat quality for fauna dependent on at least seasonal available water<br>o This will also create a loss or reduction of biological corridors for fauna<br>• Artificial light has important consequences for nocturnal species because it alters predator-prey interactions, foraging, reproduction, communication and competition between individuals.<br>o For species drawn to light, it may increase the risk of collisions | | | | | | |

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| **Induced Impacts** | • Elevated levels of disturbance will affect local wildlife utilising adjacent habitats. These disturbances may result in faunal species moving away from the area and a subsequent localised decline in biodiversity. |
| **Most Likely Cumulative Impacts** | • Increased loss of or fragmentation of suitable habitats for faunal species, increasing the impact of existing surrounding anthropogenic activities.<br>• Increased reduction in faunal diversity from the region |

### 5.4.4 Loss of Ecological Structure and –Function of Habitats

The significance of this impact will vary for every option of the discard dumps, hence will be evaluated as such. For the expansion of the existing Discard Dump there is no alternative, however, for the new Discard Dump three alternative sites have been delineated (see section 4.6 for a map) relative to the ecological sensitivity of the area. What is important in the evaluation of this impact, is also the positioning of the discard dump in the landscape, most importantly their proximity to surrounding slopes and hillslope seeps (also see Wetland Report, Lubbe 2019). This can be problematic due to the nature of the discard, which consists mainly of poor quality coal, carbonaceous shale and waste rock. Iron pyrite occurs in all of the above in higher concentrations than in the coal product (Van Rooyen, 1992).

Carbonaceous materials (e.g. shale) and pyrites will generate heat when oxidizing. If this oxidation is not arrested at an early stage on a discard dump and the temperature of the dump increases above 80°C, spontaneous combustion frequently occurs. Smouldering discard dumps emit large amounts of atmospheric pollution, which may lead to localized acid rain (Van Rooyen, 1992, Onifade & Genc, 2018), and may cause veld-fires if not adequately controlled.

Iron pyrites, when exposed to water and oxygen, produce sulphuric acid. This, and the oxidation of other trace elements, is accelerated under the high temperature conditions generated by spontaneous combustion. Hence, water is polluted when it runs off discard dumps in both abandoned and working mines before it enters seepages, streams, wetlands, and other water resources, with detrimental effects on the species in those habitats (van der Waals, 2016).

***Source of impact:***

- Erosion increases dramatically when the protective plant cover is removed and the remaining soil is not stabilized
- Iron Pyrite present in discarded rock and coal that oxidises to acid and leaches off the dump during rainfall events
- Creation of heat that may lead to spontaneous combustion of discard dump and surrounding grasslands
- Coal dust originating and blown off onto surrounding areas
- The above will also be exacerbated by a poor placement of access roads or other means of depositing discard on those dumps. Whilst the access road of the existing (old) discard dump will not change, the route of access to the new discard dumps has not yet been determined.

Poor placement may see such cut through highly sensitive habitats, or increase runoff potential off discard dumps into such habitats.

Mitigation thus will have to focus on retaining whatever processes may occur on and within a discard dump (oxidation, heat generation, combustion, dust) strictly to the dump site only.

| ISSUE *OLD DUMP EXPANSION* | CORRECTIVE MEASURES | IMPACT RATING CRITERIA | | | | | SIGNIFICANCE |
|---|---|---|---|---|---|---|---|
| | | Nature | Extent | Duration | Magnitude | Probability | |
| **Loss of ecological function** | No | Negative | 3 | 5 | 10 | 5 | 90 High |
| | Yes | Negative | 2 | 4 | 8 | 3 | 44 Medium |
| **Confidence** | • Moderate-High, as this is based on anecdotal data (see references above), but the expansion will cut into a hillslope seepage area directly above a valley-bottom wetland and associated habitats, whilst it will also extend into a section of highly sensitive primary vegetation with a known population of a *Disa* species (of which the exact identification still needs to be confirmed). | | | | | | |

| ISSUE *NEW DUMP SITE 1* | CORRECTIVE MEASURES | IMPACT RATING CRITERIA | | | | | SIGNIFICANCE |
|---|---|---|---|---|---|---|---|
| | | Nature | Extent | Duration | Magnitude | Probability | |
| **Loss of ecological function** | No | Negative | 3 | 5 | 8 | 5 | 80 High |
| | Yes | Negative | 2 | 4 | 7 | 3 | 39 Medium |
| **Confidence** | • Moderate, as this is based on anecdotal data (see references above)<br>o Access to the site, if not via existing national roads, will potentially cut across No-Go habitats to the north.<br>o The area is on the edge of a hillslope seep, from which acid drainage may enter more sensitive and unique habitats to the north of the dump. A hydro-geomorphic study will clarify risks of leakage of acid drainage, and opportunities to curtail such. | | | | | | |

| ISSUE *NEW DUMP SITE 2* | CORRECTIVE MEASURES | IMPACT RATING CRITERIA | | | | | SIGNIFICANCE |
|---|---|---|---|---|---|---|---|
| | | Nature | Extent | Duration | Magnitude | Probability | |
| **Loss of ecological function** | No | Negative | 3 | 5 | 8 | 4 | 72 High |
| | Yes | Negative | 1 | 4 | 6 | 3 | 33 Medium |
| **Confidence** | • Moderate, as this is based on anecdotal data (see references above)<br>o Access route to the existing mine entrance and associated access routes is shortest, with the implication that the same access routes should be used for moving materials to this site<br>o The area is on the edge of hillslope seeps, from which acid drainage may enter more sensitive and unique habitats to the west of the dump. A hydro-geomorphic study will clarify risks of leakage of acid drainage, and opportunities to curtail such. | | | | | | |

| ISSUE *NEW DUMP SITE 3* | CORRECTIVE MEASURES | IMPACT RATING CRITERIA | | | | | SIGNIFICANCE |
|---|---|---|---|---|---|---|---|
| | | Nature | Extent | Duration | Magnitude | Probability | |
| **Loss of ecological function** | No | Negative | 3 | 5 | 10 | 5 | 90 High |
| | Yes | Negative | 3 | 4 | 8 | 4 | 60 Medium |
| **Confidence** | • Moderate, as this is based on anecdotal data (see references above)<br>• Access route to this site will have to cross sensitive wetland habitats, whilst also necessitating the movement of materials up a steeper slope.<br>• The elevated position relative to the landscape implies that unforeseen leakage of acid drainage and dust will be deposited on larger areas of sensitive habitats downslope to the west and north of the dump, where it will also directly affect species of conservation concern<br>• The area is on the edge of hillslope seeps, from which acid drainage may enter more sensitive and unique habitats. A hydro-geomorphic study will clarify risks of leakage of acid drainage, and opportunities to curtail such. | | | | | | |

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| **Direct Impacts** | • Change of soil surface and sub-surface hydrology, depleting or reducing replenishment of moisture of lower-lying habitats depending on hillslope seeps<br>• Change in soil chemistry of all lower-lying habitats affected by acid leachate, causing die-off of indigenous plants and loss of resources to fauna as well as aquatic fauna<br>• Degradation of soil moisture reserves as well as water resources in more sensitive habitats, such as riparian areas |
| **Indirect Impacts** | • Significant reduction in replenishment of moisture from hillslope seeps may cause the transformation of moist and wet grasslands and riparian areas to dry grasslands, with an associated loss of species dependent on such habitats<br>• Loss of above grasslands leads to a displacement of fauna due to a reduction of suitable habitat<br>• Reduction in air quality due to unforeseen combustion may lead to a decline of surrounding indigenous flora, as well as render surrounding habitats unfavourable for fauna<br>• Wetlands polluted with acid drainage (or acid rain) may lead to the direct loss of fauna and flora, including species of conservation concern<br>• Excessive heat may lead to an increase in veld fires<br>• Loss of rehabilitation capacity of topsoils |
| **Induced Impacts** | • Loss of above grasslands leads to a displacement of fauna due to a reduction of suitable habitat and resources<br>• A diminished vegetation cover on hillslope seeps and the valley-bottom wetlands leads to accelerated erosion, increased sedimentation of streams (and downstream dams), loss of water-filtering function and loss of runoff-attenuation functionality<br>• Loss of above functionality leads to a significant reduction in ecosystem services, such as flood attenuation. This may extend throughout the upper reaches of the Olifants-River catchment |

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| **Most Likely Cumulative Impacts** | • Increased loss or fragmentation of unique and vulnerable habitats and plant species of conservation concern, increasing the impact of existing surrounding anthropogenic activities.<br>• Possible spread and establishment of alien invasive species.<br>• Potential for tracts of sensitive habitats adjacent to the mining operations to deteriorate further indefinitely due the effect of long-term dust deposition<br>• Possible change in plant vigour in downstream environments due to changes in surface and sub-surface runoff patterns – most noticeable in riparian and wetland vegetation |

### 5.4.5 Increase in Alien Invasive Vegetation

Any physical disturbance to vegetation and soils creates a window of opportunity for the establishment of (more) alien invasive species, especially if ample regenerative material is already being produced in the vicinity on an annual basis, as is the case within the study area. This is also exacerbated were regenerative material is transported inadvertently by movement of machinery or vehicles, e.g. if seed-laden mud sticks to tyres. Introduction of alien invasive species is almost always accidental, and it will require an ongoing program to control such plants to prevent a build-up of large seedbanks and populations that become large enough to start negatively affecting rehabilitation efforts as well as remaining natural habitats.

***Sources of Impact***

- Existing stands of alien invasive species on and around the study area that act as source of reproductive material
- Existing soil seed banks of alien invasive species due to continued persistence
- Extensive disturbance of indigenous vegetation and topsoil, which creates a window of opportunity for the establishment of alien invasive species
- Transport of reproductive materials of alien invasive species by movement of personnel, machinery or other agents from infested areas to areas with primary or secondary indigenous vegetation
- Soil of areas with high presence of alien invasive species being used for rehabilitation or being transported to areas with primary or secondary indigenous vegetation

| ISSUE | CORRECTIVE MEASURES | IMPACT RATING CRITERIA | | | | | SIGNIFICANCE |
|---|---|---|---|---|---|---|---|
| | | Nature | Extent | Duration | Magnitude | Probability | |
| **Increase in Alien Invasive Vegetation** | No | Negative | 3 | 5 | 6 | 5 | 70 High |
| | Yes | Negative | 2 | 3 | 4 | 3 | 27 Low |
| **Confidence** | • High | | | | | | |
| **Direct Impacts** | • Possible continued distribution and increased establishment of alien invasive species, also in surrounding areas<br>• Possible increased displacement of indigenous vegetation by alien invasive species | | | | | | |

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| | • Possible reduction of suitable habitat for plant species of conservation concern due to degradation of such habitats caused by the negative impacts of alien invasive species on abiotic resources as well as indigenous species themselves. |
| **Indirect Impacts** | • Possible continued distribution and increased establishment of alien invasive species, also in surrounding areas<br>• Possible continued degradation of ecosystem functionality |
| **Induced Impacts** | • Possible increased cost and time required to achieve annual and post-closure rehabilitation goals<br>• Possible further reduction of agricultural potential of rehabilitated and surrounding areas |
| **Most Likely Cumulative Impacts** | If mitigation measures are not strictly implemented:<br>• Possible increased modification and degradation of natural and unique habitats and continued loss of species unique to the area and affected ecosystems, increasing the impact of existing surrounding mining activities in the greater grassland area<br>• Possible continued and unabated spread and establishment of alien invasive species, far beyond the boundary of the proposed activity |

## 5.5 Assessment of Impacts Related to the DCMW to DCME conveyor

This involves the construction of an overland conveyor belt to link the link the coal wash plant of DCMW to loading facilities at DCME. Two alternative routes have been proposed, being Option A and Option B. (Figure 18). *Parallel and adjacent to the conveyor will be a construction and maintenance road*, *which is assessed as part of the conveyor route as it is within the same servitude*. From an ecological perspective, the alternative routes can be described as follows:

| Route | Sensitive Receptor | Approximate Extent affected |
|---|---|---|
| **A** | Secondary Grassland on a hillslope seep | 800 m |
| | Primary Grassland, but disturbed | 40 m |
| | Seepage Slope Grasslands | Two sections, 290 m |
| | Riparian Vegetation | 155 m wetland area |
| **B Not Feasible** | Floodplain Grassland with species of conservation concern observed | Four sections, 830 m |
| | Riparian Vegetation along channelled valley bottom wetland with species of conservation concern observed | Two sections, 270 m |
| | Secondary Grassland on a hillslope seep | Two sections, 1,412 m |
| | Primary Grassland | 275 m |

***The assessments were made with the assumption that the conveyor will be covered, and the service road will remain a gravel road, but not tarred or cemented.***

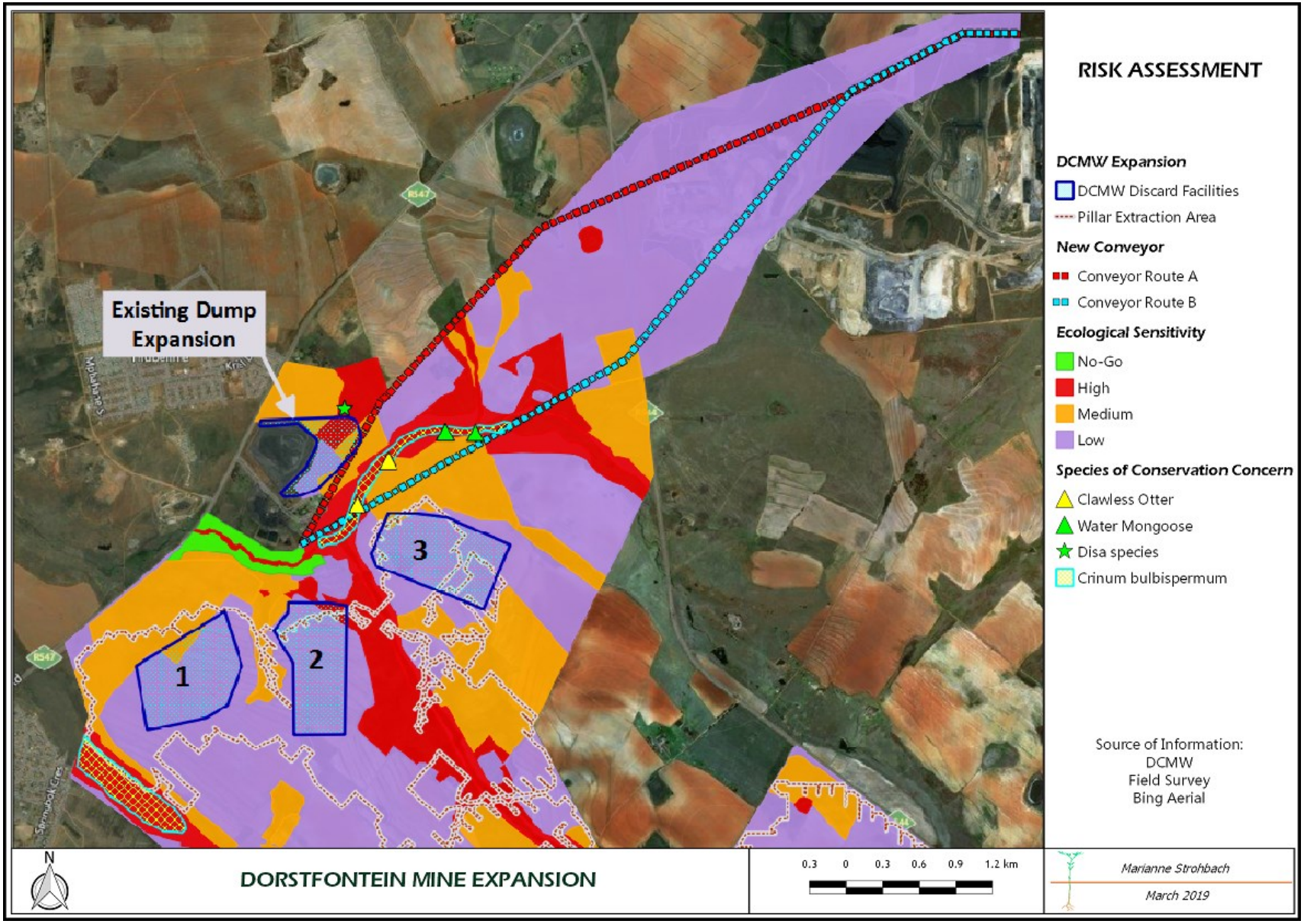


Figure 18: Map of the conveyor route options assessed.

### 5.5.1 Loss of Indigenous Vegetation along the Conveyor Route

The significance of this impact will differ between the different conveyor route options, hence will be evaluated as such.

***Source of impact:***

- Direct destruction and fragmentation of natural habitats and all species therein by clearing the target area, landscaping and subsequent construction and use of the proposed conveyor and adjacent maintenance road
- Direct destruction of plant species of conservation concern and direct reduction of viable populations of such species, including species with very limited range of occurrence
- Destruction of the abiotic configuration of natural habitats
- Possible blockage of natural corridors

| ISSUE *ROUTE A* | CORRECTIVE MEASURES | IMPACT RATING CRITERIA | | | | | SIGNIFICANCE |
|---|---|---|---|---|---|---|---|
| | | Nature | Extent | Duration | Magnitude | Probability | |
| **Loss of Indigenous Vegetation** | No | Negative | 3 | 5 | 8 | 5 | 80 High |
| | Yes | Negative | 2 | 4 | 6 | 5 | 60 Medium |
| **Confidence** | • High, sensitive areas affected:<br>o Secondary Grassland on a hillslope seep **800 m**<br>o Primary Grassland, but disturbed **40 m**<br>o Seepage Slope Grasslands **Two sections, 290 m**<br>o Riparian Vegetation **155 m wetland area** | | | | | | |

| ISSUE *ROUTE B* | CORRECTIVE MEASURES | IMPACT RATING CRITERIA | | | | | SIGNIFICANCE |
|---|---|---|---|---|---|---|---|
| | | Nature | Extent | Duration | Magnitude | Probability | |
| **Loss of Indigenous Vegetation** | No | Negative | 3 | 5 | 8 | 5 | 80 High |
| | Yes | Negative | 3 | 4 | 8 | 5 | 75 High |
| **Confidence** | • High, sensitive areas affected:<br>o Floodplain Grassland, species of conservation concern **4 sections, 830 m**<br>o Riparian Vegetation along channelled valley bottom wetland, species of conservation concern **2 sections, 270 m**<br>o Secondary Grassland on a hillslope seep **2 sections, 1412 m**<br>o Primary Grassland **275 m** | | | | | | |

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|---|---|
| **Direct Impacts** | • Loss of portions of remaining primary vegetation of a Vulnerable Ecosystem<br>• Increased fragmentation of habitats<br>• Potential loss of plant species of conservation concern<br>o Re-establishment rates of relocated plant species that are restricted to specific habitats may be low if such plants are not relocated at the end of the growing season or relocated to areas not suitable for their persistence. |

| | |
|---|---|
| | • Compaction and possible pollution of topsoils by unforeseen hydrocarbon spills and unauthorised/uncontrolled off-road driving, especially with heavy machinery<br>• Pollution of adjacent and lower-lying areas by coal dust coming off conveyor belt |
| **Indirect Impacts** | • Erosion increases dramatically when the protective plant cover is removed and soils on and around the maintenance track are not stabilised and fitted with adequate storm-water protection<br>• Decline in access to foraging, breeding and roosting opportunities for faunal species<br>• Possible degradation of adjacent natural habitats due to a reduction of moisture input by cutting off/preventing natural flow of water, resulting in a decline of habitat quality and/or increased invasion by alien plant species<br>• Possible continued decline/degradation of natural vegetation and plant species of conservation concern within adjacent or downstream habitats, due to excessive coal dust deposition and its further transport by runoff. |
| **Induced Impacts** | • Continued loss of plant species of conservation concern due to a reduction of individuals of affected species, leading to loss of genetic diversity and gradual decline of sub-populations remaining.<br>o The above will be exacerbated if relocation of selected species leads to further isolation of sub-populations and/or poor re-establishment and loss of such sub-populations.<br>• Habitat fragmentation causes the destruction of wildlife corridors. |
| **Most Likely Cumulative Impacts** | • Increased loss or fragmentation of unique and vulnerable habitats and plant species of conservation concern, increasing the impact of existing surrounding anthropogenic activities.<br>• Possible spread and establishment of alien invasive species.<br>• Potential for tracts of sensitive habitats adjacent to the conveyor operations to deteriorate further indefinitely due the effect of long-term dust deposition<br>• Possible change in plant vigour in seepage and downstream environments due to changes in surface and sub-surface runoff patterns – most noticeable in riparian and wetland vegetation |

### 5.5.2 Removal of Exotic Vegetation Cover for the Conveyor

The significance of this impact will be the same for every option of the conveyor, hence will be evaluated once – although the total area of vegetation cover differs (and will fluctuate during the seasons).

***Source of impact:***

- Direct destruction of a linear portion of modified habitats and all species therein by clearing the target area, landscaping, construction and subsequent use of the conveyor belt and its maintenance track
- Soil seed banks of alien vegetation

| ISSUE | CORRECTIVE MEASURES | IMPACT RATING CRITERIA | | | | | SIGNIFICANCE |
|---|---|---|---|---|---|---|---|
| | | Nature | Extent | Duration | Magnitude | Probability | |
| **Loss of Exotic Vegetation** | No | Negative | 2 | 4 | 4 | 5 | 65 Medium |
| | Yes | Neutral | 1 | 4 | 2 | 5 | 35 Medium |
| **Confidence** | • High | | | | | | |
| **Direct Impacts** | • Direct destruction of low sensitivity habitats and their soil resources, where such are in good condition and available.<br>• Small-scale loss of alien invasive vegetation (Positive)<br>• Potential direct destruction of temporary faunal habitat.<br>• Compaction and possible pollution of topsoils by unforeseen hydrocarbon spills and unauthorised/uncontrolled off-road driving, especially with heavy machinery<br>• Pollution of adjacent and lower-lying areas by coal dust coming off conveyor belt | | | | | | |
| **Indirect Impacts** | • Erosion increases dramatically when the protective plant cover is removed and soils on and around the maintenance track are not stabilised and fitted with adequate storm-water protection<br>• Decline in access to foraging, breeding and roosting opportunities for faunal species<br>• Possible degradation of adjacent natural habitats due to a reduction of moisture input by cutting off/preventing natural flow of water, resulting in a decline of habitat quality and/or increased invasion by alien plant species<br>• Possible continued decline/degradation of natural vegetation and plant species of conservation concern within adjacent or downstream habitats, due to excessive coal dust deposition and its further transport by runoff. | | | | | | |
| **Induced Impacts** | • Possible accelerated erosion of bare areas<br>• Continued loss of species of conservation concern in adjacent more sensitive habitats due to the indirect degradation of available habitat | | | | | | |
| **Most Likely Cumulative Impacts** | • Increased fragmentation of suitable corridors for faunal species, increasing the impact of existing surrounding anthropogenic activities.<br>• Possible spread and establishment of alien invasive species.<br>• Potential for tracts of sensitive habitats adjacent to the mining operations to deteriorate further indefinitely due to effects of long-term dust deposition or modified hydrological patterns. | | | | | | |

### 5.5.3 Loss of or Displacement of Fauna by the Conveyor and Service Road

The conveyor may create a barrier to fauna, especially if it is positioned through extensive wetland and floodplain habitats, as in Route B. The choice of route in this case will be considered part of the mitigation, as will be listed in Section 5.6.

***Source of impact:***

- Direct destruction of sections of natural or modified habitats
- Fragmentation and disruption of biological corridors
- Influx of people to natural areas, increasing the chance of negative faunal interactions.
- Possible collisions with fauna by moving machinery

- Possible blockage of natural corridors
- Disturbance created by noise-pollution, vibrations, excessive coal dust, and artificial lighting associated with conveyor operation.

| ISSUE | CORRECTIVE MEASURES | IMPACT RATING CRITERIA | | | | | SIGNIFICANCE |
|---|---|---|---|---|---|---|---|
| | | Nature | Extent | Duration | Magnitude | Probability | |
| **Loss of or Displacement of Fauna** | No | Negative | 3 | 4 | 8 | 5 | 75 High |
| | Yes | Negative | 1 | 4 | 4 | 3 | 27 Low |
| **Confidence** | • High | | | | | | |
| **Direct Impacts** | • Loss of available faunal habitats and associated resources<br>• Negative faunal interactions including poaching, trapping and collisions with vehicles.<br>• Restriction of movement corridors for fauna, and hence also restricted access of fauna to different natural resources within the wider area<br>• Possibility of injury or death of fauna due to negative interaction with moving parts of the conveyor system | | | | | | |
| **Indirect Impacts** | • Possible degradation of adjacent natural habitats due to a reduction of moisture input by cutting off/preventing natural flow of water, resulting in a decline of habitat quality for fauna dependent on at least seasonal available water<br>• Restricted access for fauna to wetland breeding habitats may cause a decline in populations<br>• Artificial light has important consequences for nocturnal species because it alters predator-prey interactions, foraging, reproduction, communication and competition between individuals.<br>o For species drawn to light, it may increase the risk of collisions | | | | | | |
| **Induced Impacts** | • Elevated levels of disturbance will affect local wildlife utilising adjacent habitats. These disturbances may result in faunal species moving away from the area and a subsequent localised decline in biodiversity. | | | | | | |
| **Most Likely Cumulative Impacts** | • Increased loss of or fragmentation of suitable habitats for faunal species, increasing the impact of existing surrounding anthropogenic activities.<br>• Increased reduction in faunal diversity and abundance from the region | | | | | | |

### 5.5.4 Loss of Ecological Structure and –Function of Habitats

The significance of this impact will vary for every option of the conveyor route, but the choice of the most viable option (Route A), will be regarded as a mitigation measure in itself. The most severe impact will be a possible significant change in surface and possible subsurface hydrological patterns, which may lead to blockage of ecological corridors, accelerated erosion of fluvial systems, possible desiccation of wetlands, and gradual conversion of the latter to degraded terrestrial systems. A further risk of the operation of the conveyor and its service road will be long-term deposition of coal dust around the conveyor, which will be transported into lower-lying habitats by runoff.

***Source of impact:***

- Erosion increases dramatically when the protective plant cover is removed and the remaining soil is not stabilized
- Coal dust originating from movement of coal is further distributed onto surrounding areas
- Compacted surfaces of the road through wetlands and channels may lead to change of natural flows, leading again to possible accelerated erosion and/or degradation of downstream habitats
- Modification and potential blockage of natural runoff and flow patterns and subsequent reduced moisture input into wetland habitats

| ISSUE | CORRECTIVE MEASURES | IMPACT RATING CRITERIA | | | | | SIGNIFICANCE |
|---|---|---|---|---|---|---|---|
| | | Nature | Extent | Duration | Magnitude | Probability | |
| **Loss of ecological function** | No | Negative | 3 | 5 | 8 | 5 | 80 High |
| | Yes | Negative | 2 | 4 | 6 | 3 | 36 Medium |
| **Confidence** | • Moderate-High, as this is based on anecdotal data | | | | | | |
| **Direct Impacts** | • Change of soil surface and sub-surface hydrology, depleting or reducing replenishment of moisture of wetland habitats<br>• Change in soil chemistry of adjacent and potentially lower-lying habitats affected by coal dust, causing die-off of indigenous plants and loss of resources to fauna as well as aquatic fauna<br>• Degradation of soil moisture reserves as well as water resources in more sensitive habitats, such as riparian areas | | | | | | |
| **Indirect Impacts** | • Significant reduction in replenishment of moisture from higher-lying areas may cause the transformation of moist and wet grasslands and riparian areas to dry grasslands, with an associated loss of species dependent on such habitats<br>• Loss of rehabilitation capacity of topsoils | | | | | | |
| **Induced Impacts** | • Loss of wetland grasslands leads to a displacement of fauna due to a reduction of suitable habitat and resources<br>• A diminished vegetation cover on hillslope seeps and the valley-bottom wetlands leads to accelerated erosion, increased sedimentation of streams (and downstream dams), loss of water-filtering function and loss of runoff-attenuation functionality<br>• Loss of above functionality leads to a significant reduction in ecosystem services, such as flood attenuation. This may extend throughout the upper reaches of the Olifants-River catchment | | | | | | |
| **Most Likely Cumulative Impacts** | • Increased loss or fragmentation of unique and vulnerable habitats and plant species of conservation concern, increasing the impact of existing surrounding anthropogenic activities.<br>• Possible spread and establishment of alien invasive species.<br>• Potential for tracts of sensitive habitats adjacent to the mining operations to deteriorate further indefinitely due the effect of long-term dust deposition<br>• Possible change in plant vigour in downstream environments due to changes in surface and sub-surface runoff patterns – most noticeable in riparian and wetland vegetation | | | | | | |

## 5.6 Mitigation and Monitoring

Mitigation and monitoring measures need to also incorporate measures contained within the wetland and other relevant specialist reports.

### 5.6.1 Avoid and Minimise

- Avoid or minimise loss of sensitive habitats:
    - Avoid any disturbance to the No-Go habitats, i.e. the rocky ledges south of the current mining plant
    - Minimise the physical destruction of any remaining *primary* vegetation, especially in or near wetland areas. In general, minimise clearing and operations in habitats with a High sensitivity rating and clearly delineate and maintain a no-go buffer of at least 100 m around such habitats.
    - Use existing gravel roads and already disturbed areas to access mining operations as far as possible to avoid the creation of new roads or access routes across natural areas.
    - Avoid any direct impacts of mining operations on any surrounding or adjacent areas with sensitive habitats or any adjacent or nearby riparian habitats (except the clearing of alien invasive species).
    - Avoid blocking and/or destruction of any seasonal streams, channelled or un-channelled valley bottom wetlands or hillslope seepage areas.
        - Minimise channel crossings for any kind of road, if this is unavoidable, ensure channels are crossed by elevating the road surface and allowing free flow of water by the installation of culverts
        - Above culverts must span the entire width of the channel, and may under no circumstance concentrate water, i.e. round pipe-culverts are not permissible
        - The channel area immediately downstream of the culverts must be protected from accelerated erosion by the installation of appropriate Reno-mattresses
- After the final layouts of new mining operation components has been approved and **PRIOR TO ANY NEW GROUNDWORKS**, conduct a thorough footprint investigation (during summer) to record all Protected or Threatened plant species (population location and its size).
    - Map (by GPS) all populations of Threatened and Protected species that must be avoided or relocated.
    - Compile a photographic and relocation guide for the affected species.
    - Follow up by implementing the necessary Search and Rescue actions prior to any groundworks taking place, in line with future mining plans to ensure no destruction of indigenous species of conservation concern
- Planning and construction of the conveyor route and its service road should be done in such a way that connectivity between sensitive, and at least all wetland and moist grassland habitat types is strictly retained, even if they need to be bridged. This is important to enable movement of fauna between different types of natural resources, as well as retaining natural hydrological patterns.
    - Eco passages for small fauna at regular intervals by way of tunnels or other along the conveyor route should be implemented

  - Access of fauna to moving parts of the conveyor route should be prevented by specialised fencing or cover

- Avoid the loss of indigenous fauna and fauna of conservation concern by implementing following rules:
  - No wild animals may under any circumstance be handled, removed or be interfered with by construction workers and mine personnel.
  - The implementation of an environmental awareness programme for all mining personnel. This must focus on biodiversity issues such as damage to sensitive habitats, collection of fauna and vigilant driving techniques. This includes the implementation and enforcement of speed limits within the site.
  - No hunting or collection of fauna.
  - Prohibit mining personnel and contractors from bringing domestic dogs and cats into the study area.
  - Any snares or traps found on or adjacent to the site must be removed and disposed of.
  - No Giant Bullfrogs, if observed, may be collected. During this and the 2016 (STS) survey, no Bullfrogs were observed, but suitable habitat was identified, thus there may be a small possibility of such species appearing within the project area during construction or operation.
    - The relocation and removal of *Pyxicephalus adspersus* (Giant Bullfrog), if such are present, will require a Bullfrog monitoring and management plan, as well as a permit obtained from the provincial MEC in terms of NEMBA.
  - Any faunal species observed on the site during the construction phase, which cannot relocate themselves (e.g. burrowing animals), must be moved to a more suitable location. This should be undertaken by a suitably qualified ecologist/faunal specialist.
  - Should any Threatened faunal species be exposed during excavation, mining activities within the vicinity of the sighting must be halted. The relevant conservation authorities must be informed, and the species relocated by a suitably qualified ecologist/faunal specialist.
  - The formation of ecological corridors linking sensitive faunal habitats to the larger area must be maintained during the construction and operational phases to ensure faunal movement patterns are not completely restricted.

- Prevent and minimise pollution from mining operations by:
  - Diverting clean runoff water away from the Discard Dump and conveyor belt and other areas prone to potential hydrocarbon or other spills
  - Ensuring no acid seepage from the discard dumps percolates beyond the boundaries of the discard dump by implementing and monitoring the effectiveness of adequate cut-off trenches and, if necessary, other sealant measures
  - Cleaning up any unforeseen hydrocarbon spills as soon as they occurred
  - Preventing, monitoring and mitigating emissions from unforeseen spontaneous combustion of materials on discard dumps
  - Prevent any pollutants from reaching any wetland or seepage area

- No open fires may be lit for cooking or any other purposes, unless in specifically designated and secured areas.
- Delineate all permissible areas so that all movement of vehicles and heavy machinery can be restricted to permissible areas, these being designated access roads, maintenance roads, turning points and parking areas. No off-road driving beyond designated areas may be allowed.
- An ecologically-sound stormwater management plan must be implemented for surface water runoff and ground water seepage. Appropriate water diversion systems must be put in place.
    - Design and create berms to stop runoff from the discard dumps during/after a periodic extreme rainfall event to enter directly into existing washes.
    - If seepage of acid water from discard dumps to lower-lying areas will be problematic, ensure the surface below the discard dump is adequately sealed (after topsoil has been removed) to prevent such seepage.
    - Steps must be undertaken to ensure no acid mine water or fine sediments such as coal dust can enter wetlands.
- Erosion must not be allowed to develop on a large scale before effecting repairs.
    - Leave areas vegetated for as long as possible if not in use, or re-vegetate disturbed areas as soon as possible, including topsoil stockpiles, using desirable indigenous species only

### 5.6.2 Reduce

- Keep the clearing of natural vegetation to a minimum.
    - Areas of high conservation significance in close proximity but outside the physical mining footprint need to be clearly demarcated with appropriate barriers and signage to ensure no further encroachment or disturbance. Any infringements will be reported and appropriate penalties are to be enforced on transgressing staff or contractors.
- Reduce fragmentation of natural habitat by keeping long-term or permanently impacted areas as close as possible together (but avoiding the blockage of or increased impact on sensitive habitats).
- Reduce impacts on wetland areas by minimising crossing of wetlands and seepages
    - The crossings should only constructed at the shortest possible route, perpendicular to the natural drainage system, so as to ensure the least ecological damage as possible, i.e. the least riparian and in-stream disturbance.
    - Where possible, bridge crossings should span the entire stretch of the flood line or highly sensitive area.
    - Install adequate drainage structures to ensure that water flows are never concentrated or blocked in any way.
- The following activities will be prohibited for staff and contractors or any other person that may be present within or have access to the Dorstfontein Complex Mining area:
    - Purchase or transport of any wildlife/indigenous plant products from local communities or passing traders who cannot prove that they have valid permits for having such plants in their possession.

  - Collection of any indigenous plants, fauna or products thereof for trade, consumption, medicinal use or cultivation.

- Reduce light disturbance on fauna by designing outside lighting to minimize impacts on fauna.
  - All outside lighting should be directed away from sensitive areas.
  - Fluorescent and mercury vapour lighting should be avoided and sodium vapour (yellow) lights should be used wherever possible.

- Ensure topsoils, where available, are first removed and kept for rehabilitation purposes.
  - All topsoil stockpiles must be cleared on an ongoing basis of all alien invasive vegetation before such vegetation starts flowering or reproducing any other regenerative material
  - Aim to keep topsoil stockpiles vegetated with desirable indigenous vegetation
  - Aim to not store topsoil higher than 1 m, definitely not higher than 1.5 m.

- Dust from all activities must be controlled and minimised at all times using potable water or other environmentally compatible method.
  - Measures to trap coal-dust along the conveyor route must be implemented to avoid such dust to be distributed into surrounding areas, regardless of habitat type
  - Contaminated soils must be treated
  - Strict speed limits must be set and adhered to in order to reduce dust fall out.

- Any unauthorised driving to areas not directly affected by the mine, but which may contain species of conservation concern and/or natural habitat within the Dorstfontein Mine Complex will not be allowed.
- Parking and operational areas should be regularly inspected for oil spills and covered with an impermeable or absorbent layer (with the necessary storm water control) if oil and fuel spillages are highly likely to occur. Reinforce portions of existing access routes that are prone to erosion or seasonal inundation, create structures or low banks to drain the access road rapidly during rainfall events, yet preventing erosion of the track and surrounding areas.

- If filling material is to be used, this should be sourced from areas free of invasive species, and alien plant control measures are to be applied to all areas used for sourcing fill materials.

- Efforts will be taken to minimise the footprint of short-duration activities and/or linear infrastructure during construction, operation and decommissioning phases of the mine. Efforts to minimise such footprints will include grouping all infrastructure to the same servitude and/or as close as possible to existing and planned long-term physical disturbances. This will also reduce fragmentation due to mining operations.

### 5.6.3 Rehabilitate

- Backfill mined-out underground areas as soon as possible, prioritising areas where post-mining subsidence may pose a risk.
- As far as possible, obliterate discard dumps and rehabilitate any remaining dumps, if applicable, using latest biotechnological insights (Sekhohola and Cowan, (2017)
- Landscaping along the edges of retained sensitive habitat types, if applicable, should provide for high structural diversity (mosaic of plant species and grasses). Edges should be curvilinear,

complex and soft, and should refrain from straight, simple or hard edges. This will ensure increased movement of fauna across edges and not along edges.

- Rehabilitate and revegetate all areas that have been disturbed as soon as practically possible and progressively during all phases of the mine, i.e. construction, operation and decommissioning. This will be according to a Rehabilitation Plan that needs to be compiled by a suitably qualified specialist and complement a Biodiversity Action Plan (BAP). It will include the following:
    - Erosion control structures
    - Re-vegetation measures of disturbed/modified areas using indigenous shrubs and grasses only. The selection of species used for rehabilitation may not include any species that are not suitable to the receiving environment (i.e. must occur there naturally), and also **no** species that are indicative of habitat degradation, such as species declared as Encroaching (by CARA) or Increaser II or –III grasses.
    - Special attention will be paid to ensuring that critical topography and natural surface and sub-surface hydrology is reconstructed as far as practical.
- After decommissioning, if access roads or portions thereof will not be of further use to the landowner(s), remove all foreign material and rip area to a depth of at least 30 cm to facilitate the establishment of vegetation, followed by a suitable revegetation program.

### 5.6.4 Official Commitments

Following specific requirements will have to be part of the EMPr and revised on a regular basis:

- A detailed surface runoff and stormwater management plan with the following minimum requirements:
    - Prevention of any potentially polluted runoff (acid drainage from discard dumps or coal-dust) to reach wet and moist grassland and riparian areas (all wetlands and seeps).
    - Measures are implemented to ensure that the energy of storm-water that may reach any wetland or seep is dissipated.
- An Open Space Management Plan, incorporating:
    - No off-road driving
    - Management and monitoring of wetland and stream health
    - Veld-fire management and prevention of too frequent fires on natural grasslands (i.e. fires permissible only every 4-5 years, not more frequently)
- An Alien Invasive Plant Management and Control Plan
    - This must be according to the DEA minimum requirements
- Biodiversity Action Plan looking at:
    - Monitoring and managing natural and semi-natural habitats
    - Monitoring and managing species of conservation concern
    - Aims for improving ecosystem services and habitats

## 5.7 Monitoring Requirements

- Thorough pre-construction surveys need to be conducted by a suitably qualified botanist for all mine-related footprint areas, including areas potentially affected by dust-fallout from the proposed mining operations. This will be done to identify all individual plants needing to be relocated or monitored, based on their levels of conservation concern (Section 4.2), leading to the compilation of a detailed Plant Search- and Rescue, and Monitoring Plan
    - Such investigation must be carried out at a time when the maximum amount of species are actively growing and thus visible
    - It must include the identification of sites/areas suitable for the continued persistence of relocated plants, and should ideally be as close as possible to the original habitat
    - It must be followed by implementing the necessary Search and Rescue actions prior to any groundworks taking place. Geophytes need to be relocated during the end of the growing season, after seed-set.
    - It must include monitoring of all plants relocated as well as plants retained in-situ (if any) but potentially affected by dust or other impacts as identified above
- A detailed biodiversity action plan (BAP) is required to ensure that the proposed avoidance and mitigation measures associated with mine construction and operation are effectively implemented. The plan should include:
    - Outcomes of the pre-construction survey (as outlined above) of species of conservation concern, and a description of all Search and Rescue operations undertaken. Part of the Search and Rescue Plan will include the identification of suitable relocation sites for species rescued prior to groundworks, as well as monitoring of their re-establishment.
    - The involvement of a competent plant ecologist in the development, audit and review (every 5 years is recommended) and evaluation of the implementation of this plan.
    - A map and monitoring plan of habitats and threatened and narrow endemic plants within the area that can be affected by regular dust-fallout (see also mitigation measures in Section 5.4.5).
    - Activities that align it to the final decommissioning and rehabilitation plan.
    - The BAP must be part of or aligned to the BAP for the wider mine concession area, which will show where suitable conservation areas will be established and how overall ecosystem functionality can be retained.
        - Ideally, studies on the nature and extent of dust particles and their effect on soil surface characteristics and small succulents should be undertaken by an academic institution.
- Regular inspections must be carried out to detect any snares or traps for fauna, and if found on or adjacent to the site, these must be removed and disposed of
    - As soon as any Giant Bullfrog (*Pyxicephalus adspersus*) is sighted within the project area, a suitably qualified herpetologist will have to create a Bullfrog monitoring and management plan to ensure the mining activities do not impact on this population.
    - Should any termite mounds be destroyed during the construction of infrastructure, a suitably qualified herpetologist must excavate the larger termite mounds as well as

around the termite mounds and remove any faunal species within these systems to a safe location away from the construction area.

- Monitor dust emissions from all operation areas
    - Dust emission from the existing discard dump extension must be monitored, as it is close to plant species of conservation concern. Couple this with monitoring programmes of the plants affected (*Disa* species) to advise management if any immediate remedial action will be required such as plant relocation.
    - Coal-dust deposits adjacent to the conveyor route need to be strictly monitored and remedial action taken as soon as such dust is observed outside the conveyor route containment area
- Monitor possible leakage of acid
- Continually monitor the progress/success of rehabilitation efforts and adapt if rehabilitation targets are not met in acceptable timeframes.
- Monitor the establishment of (alien) invasive species and remove as soon as detected, whenever possible before flowers or other regenerative material can be produced.

## 5.8 Limitations of Impact Assessment

There is a key difference between the approach of the ecological consultant and that of the ecological researcher. In consultancy, judgements have to be made and advice provided that is based on the best available evidence, combined with collective experience and professional opinion. The available evidence may not be especially good, potentially leading to over-simplification of ecological systems and responses, and do contain a considerable deal of uncertainty. This is opposed to ecological research, where evidence needs to be compelling before conclusions are reached and research is published (Hill and Arnold, 2012). The best option available to the consulting industry is to push for more research to be conducted to address its questions. However, such research is often of a baseline nature and thus attracts little interest by larger institutions that need to do innovative research to be able to publish and attract the necessary funding. Clients in need of ecological assessments are used to funding such assessments, but are seldom willing to fund further research to monitor the effects of developments. Furthermore, a review to test the accuracy of the predictions of an ecologist following completion of the development is very rarely undertaken, which means the capacity to predict the future is not tested and therefore remains unknown (Hill and Arnold, 2012).

Predictions on future changes on ecosystems and populations once a development has happened are seldom straightforward, except in cases such as the total loss of a habitat to development. However, most development impacts are indirect, subtle, and cumulative or unfold over several years following construction or commencement of mining. Whilst a possible mechanism for an impact to occur can usually be identified, the actual likelihood of occurrence and its severity are much harder to describe (Hill and Arnold, 2012).

A closely related issue is that of the effectiveness of ecological mitigation which stems from ecological assessments, as well as in response to legal and planning policy requirements for development. Many recommendations may be incorporated into planning conditions or become conditions of protected species licences, but these recommendations are implemented to varying degrees, with most compliance being for the latter category (i.e. protected species) because there is a regulatory framework for implementation. What is often missing is the follow-up monitoring and assessment of the mitigation with sufficient scientific rigour or duration to determine whether the mitigation, compensation or enhancement measure has actually worked in the way intended (Hill and Arnold, 2012).

# 6 CONCLUSION

The areas earmarked for the expanded discard dump, the new discard dump as well as the conveyor belt route, were subjected to various types and intensity of disturbances and/or modifications in the past. Hence, only a limited section of the study area still had primary vegetation, but this was part of a Vulnerable Ecosystem, and some sections of it thus considered CBA Irreplaceable areas.

The highest risks of the proposed developments to the local biodiversity and its habitats related to:

*Loss of species and sensitive habitats:*

- Within the remaining natural and near-natural vegetation, a high diversity of indigenous plants was observed, as well as several faunal species. This also included provincially protected plants and fauna.

*Loss of ecological function of habitats:*

- Ecological function and –state was also found to be dependent on the prevailing soil surface and sub-surface hydrology – an interruption or drastic alteration of such natural hydrological patterns will have a significant detrimental effect on all lower-lying wet- and moist habitats, and all the species in or depending on such habitats.

*Pollution risk from potential acid mine drainage and coal dust.*

From a terrestrial ecology perspective, the expansion of the discard dump facilities could be accepted if all mitigation measures as described in Section 5.6 are duly implemented. Whilst there is no alternative to the expansion of the current discard dump, of the new discard dump proposals, Site 2 was preferred. For the conveyor route options presented, both Routes A and B were problematic from an ecological perspective, with Route B the worst choice. It must be noted though that much of the study area and surrounding areas do contain wetlands, hence the importance of wetlands will need to be considered along with this report in the final decision of approving the proposed development.

# 7 REFERENCES

Alexander, G. & Marais, J. (2007). *A Guide to the Reptiles of Southern Africa*. Struik Nature, Cape Town, South Africa

Apps, P. (Ed). (2000). *Smither's Mammals of Southern Africa. A field guide*. Random House Struik, Cape Town, RSA.

Bacher S., Blackburn T.M., Essl F., *et al.* (2017): Socio-economic impact classification of alien taxa (SEICAT). *Methods in Ecology and Evolution*. In Press: 1‑10. https://doi. org/10.1111/2041-210X.12844

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 Reptiles of South Africa, Lesotho and Swaziland*. Suricata 1. South African Biodiversity Institute, Pretoria.

Blaum, N., Rossmanith, E., Popp, A. & Jeltsch, F. (2007). Shrub encroachment affects mammalian carnivore abundance and species richness in semiarid rangelands. *Acta Oecologia,* 31**,** 86-92.

Bromilow C. (2010). *Problem plants and alien weeds of South Africa*. Briza Publications, Pretoria, RSA.

Brown, L.R., Du Preez, P.J., Bezuidenhout, H., Bredenkamp, G.J., Mostert, T.H.C. and Collins, N.B. (2013). Guidelines for phytosociological classifications and descriptions of vegetation in southern Africa, *Koedoe* 55(1), Art. #1103, 10 pages. http://dx.doi.org/10.4102/koedoe.v55i1.1103

Burnett, M.R., August, P.V., Brown, J.H. & Killingbeck, K.T. (1998). The influence of geomorphological heterogeneity on biodiversity. A patch-scale perspective. *Conservation Biology* 12: 363-370

Department of Environmental Affairs (2011). National Environmental Management: Biodiversity Act, 2004: National list of ecosystems that are threatened and in need of protection, *Government Gazette Number 34809*, Notice 1002, 9 December 2011, Pretoria: DEA.

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

Department of Environmental Affairs, Department of Mineral Resources, Chamber of Mines, South African Mining and Biodiversity Forum, and South African National Biodiversity Institute (2013). Mining and Biodiversity Guideline: Mainstreaming biodiversity into the mining sector. Pretoria. 100 pages

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

Germishuizen, G. and Meyer, N.L. (Eds). (2003). *Plants of southern Africa: an annotated checklist*. Strelitzia 14. South African National Biodiversity Institute, Pretoria

Henderson L. (2007): Invasive, naturalized and casual alien plants in southern Africa: a summary based on the Southern African Plant Invaders Atlas (SAPIA). *Bothalia* 37, 2: 215–248.

Henderson, L. (2001). *Alien weeds and invasive plants: A complete guide to declared weeds and invaders in South Africa*. Agricultural Research Council, Paarl Printer, Cape Town

Henning, G.A., Terblanche, R.F. & Ball, J.B. (2009): *South African Butterfly Conservation Assessment*, Sanbi Biodiversity Series 13, Pretoria.

Hill, D. and R. Arnold (2012). Building the evidence base for ecological impact assessment and mitigation, *Journal of Applied Ecology* 49(1): 6-9.

Kremen, C. (2005). Managing ecosystem services: what do we need to know about their ecology? *Ecology Letters* 8: 468-479

Little, I.T., Little, R.M., Jansen, R. & Crowe, T.M. (2005). Winter bird assemblages, species richness and relative abundance at a re-vegetated coal mine in the Middleburg district, Mpumalanga procvince, South Africa. *South African Journal of Wildlife Research* 35: 13-22

Lötter, M.C. (2014). *Technical Report for the Mpumalanga Biodiversity Sector Plan – MBSP*. Mpumalanga Tourism & Parks Agency, Nelspruit

Lötter, M.C. (2014). *Technical Report for the Mpumalanga Biodiversity Sector Plan – MBSP*. Mpumalanga Tourism & Parks Agency, Nelspruit

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

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

Lubbe, W. (2019). DORSTFONTEIN WEST COAL MINE EXPANSION: Wetland Impact Assessment. Report prepared for Nsosvo.

Macfarlane, D.M. & Bredin, I.P. (2016). *Buffer zone guidelines for rivers, wetlands and estuaries*. Part 1: Technical Manual. WRC Report No (tbc), Water Research Commission, Pretoria

Mpumalanga Tourism and Parks Agency (2014). *Mpumalanga Biodiversity Sector Plan Handbook*, Compiled by Lötter M.C., Cadman, M.J. and Lechmere-Oertel R.G. Mbombela (Nelspruit): Mpumalanga Tourism and Parks Agency.

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

Munnik, V., Humby, T.-L., Thomson, G., Holleman, H., Wolff, M and Palmer, C. (2018). How to Engage with Coal Mines Through a Catchment Management Forum. Handbook, Water Research Commission.

Onifade, M. & Genc, B. (2018). Spontaneous combustion of coals and coal-shales. Int J Min Sci Technol, 28 (6) pp. 933-940. https://doi.org/10.1016/j.ijmst.2018.05.013

Perlman, D.L. and Milder, J.C. (2005). *Practical ecology for planners, developers and citizens*. Island Press, Washington

Raimondo, D., Von Staden, L., Foden, W., Victor, J.E., Helme, N.A., Turner, R.C. Kamundi, D.A. and Manyama, P.A. (Eds.). (2009). *Red list of South African plants 2009*. Strelitzia 25: 1-668. Updated Online: http://redlist.sanbi.org/

SANBI (2010). Threatened Species: *A guide to Red Lists and their use in conservation*. Threatened Species Programme, Pretoria, South Africa. 28 pp

SANBI. (2013). *Grasslands Ecosystem Guidelines: landscape interpretation for planners and managers*. Compiled by Cadman, M., de Villiers, C., Lechmere-Oertel, R. and D. McCulloch. South African National Biodiversity Institute, Pretoria. 139 pages

Scientific Terrestrial Services (2016). *Faunal and floral ecological assessment as part of the environmental assessment and authorisation process for the proposed construction of a water pipeline from the Dorstfontein West to the Dorstfontein East Mine and the 80 ha expansion of an open pit within the Dorstfontein East Mine, near Kriel within the Mpumalanga Province.* Report prepared for SRK Consulting (South Africa) (Pty) Ltd.

Sekhohola, L.M. & Cowan, A.K. (2017). Biological conversion of low-grade coal discard to a humic substance-enriched soil-like material. Int J Coal Sci Technol. 4: 183. https://doi.org/10.1007/s40789-017-0167-0

Stuart, C. & Stuart, T. (2013). A *Field Guide to the Tracks & Signs of Southern and East African Wildlife* (4th eds), Cape Town: Struik

Stuart, C. & Stuart, T. (2015). *Stuart's Field Guide to Mammals of Southern Africa* (5th eds), Cape Town: Struik Nature

Van der Waals, J.H. (2016). *Wetland Assessment, Conservation, Management and Rehabilitation in Mining Environments on the Mpumalanga Highveld*. Internal Report, Water Research Commission.

Van Rooyen, K.C. (1992). *An Integrated Method of Coal Discard and Slurry Disposal to Reduce the Environmental Impact from Coal Residue*. M.SC. Thesis, Rand Afrikaanse Universiteit.

Van Wilgen B.W. and Wilson, J.R.U. (2017): *The status of biological invasions and their management in South Africa in 2017* (Unpublished Draft Copy).

Van Wilgen B.W., Richardson D.M. and Higgins, S. (2000): Integrated control of alien plants in terrestrial ecosystems. In: *Best Management Practices for Preventing and Controlling Invasive Alien Species.* (Eds G. Preston, G. Brown and E. van Wyk) pp. 118–128. Working for Water Programme, Cape Town. URL: https://www.researchgate.net/publication/46534222_Integrated_control_of_invasive_alien_plants_in_terrestrial_ecosystems

Van Wyk, B., Van Oudshoorn B. and Gericke N. (2005). *Medicinal Plants of South Africa*. Briza Publications, Pretoria.

**Digital References**

CJB (Conservatoire et Jardin botaniques de la Ville de Genève) (2019): AFRICAN PLANT DATABASE: http://www.ville-ge.ch/musinfo/bd/cjb/africa/recherche.php

IUCN (2018.2). http://www.iucnredlist.org/

*SANBI databases:*

Red List of South African Plants: http://redlist.sanbi.org/

BODATSA: http://newposa.sanbi.org/sanbi/Explore

BGIS: http://bgis.sanbi.org/SpatialDataset

*Climate:*

http://en.climate-data.org/

https://www.worldweatheronline.com

ADU Databases: http://vmus.adu.org.za

# 8 APPENDIX A: PLANT PHYTOSOCIOLOGICAL TABLE

Table 22: Species and their percentage canopy cover as observed in each vegetation habitat.

| *Species* | Conservation Status | 1. Primary Grasslands | *2.* Secondary Grassland | 3. Rocky Ledges | 4. Floodplain Grasslands | 5. Seepage Slope Grassland | 6. Riparian Vegetation | 3. Alien-Dominated Areas |
|---|---|---|---|---|---|---|---|---|
| **TREES AND HIGH SHRUBS** | | | | | | | | |
| *Eucalyptus* species | AIP | | | | | | | 0-30 |
| *Salix babylonica* | Exotic | | | | | 0-5 | 0-8 | |
| *Acacia mearnsii* | AIP | | | | | | | 0-80 |
| *Diospyros austro-africana* | | | | 1 | | | | |
| *Diospyros lycioides* | | | | 1 | | | | |
| *Gleditsia triacanthos* | AIP | 0-1 | | | 0-1 | | | |
| **DWARF SHRUBS** | | | | | | | | |
| *Anthospermum rigidum* | | 0.1-1 | 0.1 | 0.1 | 0.1-1 | | 0.1 | 0.2-3 |
| *Erica drakensbergensis* | | 0-0.1 | | | | | | |
| *Gomphocarpus fruticosus* | Med | | 0.1-1 | | 0-0.2 | | 0.2 | 0.2-2 |
| *Melolobium wilmsii* | | 0.1 | | 1 | | | | |
| *Mirabilis jalapa* | AIP | | | | | | | 0-2 |
| *Nesaea schinzii* | | 0.01-0.3 | | | | | | |
| *Parinari capensis* | | | | 1 | | | | |
| *Pygmaeothamnus zeyheri* | | 0.1-0.2 | | | 0-0.1 | | | |
| *Searsia dentata* | | | | 1 | | | | |
| *Searsia rigida v. margaretae* | | | | 1 | | | | |
| *Solanum panduriforme* | | 0.1-0.5 | 0.2-2 | | 0.1-3 | | | 0.5-1 |
| *Solanum sisymbriifolium* | AIP | | | 0.2 | | | | 0.1 |

| *Species* | Conservation Status | 1. Primary Grasslands | *2.* Secondary Grassland | 3. Rocky Ledges | 4. Floodplain Grasslands | 5. Seepage Slope Grassland | 6. Riparian Vegetation | 3. Alien-Dominated Areas |
|---|---|---|---|---|---|---|---|---|
| *Solanum supinum* | | | 0.1 | | | | | |
| *Stoebe plumosa* | Encroacher | 0-3 | 3-35 | 1 | 1-20 | | | 2-5 |
| *Ziziphus zeyheriana* | | 0.1 | 0.2 | 1 | | | | 0.1-5 |
| **GRASSES** | | | | | | | | |
| *Agrostis eriantha* | | 0.2-25 | 0.1-15 | 0.1 | 0.5-15 | 0.2-3 | | |
| *Agrostis lachnantha* | | | 0.1-2 | | 0.3-2 | 2-12 | 3 | |
| *Alloteropsis semialata* | | 0-1 | | 1 | 0-0.2 | | | |
| *Andropogon appendiculatus* | | | | | 0.1 | | | |
| *Andropogon eucomus* | | 0.1 | | 0.1 | | 0.1 | | |
| *Andropogon schirensis* | | | | | | | 0.3 | |
| *Aristida canescens* | | 0-1 | 0.2-8 | | | | | |
| *Aristida congesta* | | | 0.2 | | | | | |
| *Aristida diffusa* | | | 0.2 | 1-2 | 0.1 | | 0.1 | |
| *Aristida junciformis* | | 0.1 | | 1-3 | 0.1 | | | |
| *Brachiaria eruciformis* | | | | | 0.1-0.3 | | | |
| *Brachiaria serrata* | | 0.2-0.5 | | 1-3 | | | | |
| *Bromus catharticus* | Exo | | | | | 0-0.2 | | 0.1-2 |
| *Cymbopogon validus* | | | | 0.1 | | 0-0.2 | 0.1 | |
| *Cynodon dactylon* | | 15-50 | 5-40 | 1 | 20-50 | 20-30 | 15 | |
| *Digitaria diagonalis* | | | 0.1 | | | | | |
| *Digitaria eriantha* | | | | | 0-0.3 | | | |

| *Species* | Conservation Status | 1. Primary Grasslands | *2.* Secondary Grassland | 3. Rocky Ledges | 4. Floodplain Grasslands | 5. Seepage Slope Grassland | 6. Riparian Vegetation | 3. Alien-Dominated Areas |
|---|---|---|---|---|---|---|---|---|
| *Digitaria monodactyla* | | | | | | 0.01 | | |
| *Elionurus muticus* | | 1-8 | 1-5 | | 0.2-0.5 | | | |
| *Eragrostis capensis* | | 0.1 | 0.1 | 1 | 0.1 | | | |
| *Eragrostis chloromelas* | | 8-20 | 5-10 | | 0.1-10 | | | |
| *Eragrostis curvula* | | 5-8 | 3-30 | 5 | 0.5-10 | 0.2-10 | | |
| *Eragrostis gummiflua* | | 1-15 | 5-30 | 1 | 3 | | 0.1 | |
| *Eragrostis lehmanniana* | | 15-30 | 20-50 | | 8-15 | | | |
| *Eragrostis obtusa* | | 0.5-2 | 1-20 | | 0.2-2 | | | |
| *Eragrostis plana* | | 0-20 | | | **30-70** | 5-40 | 70 | |
| *Eragrostis planiculmis* | | 0-1 | | 10 | 2-8 | | | |
| *Eragrostis racemosa* | | 0.1-5 | 0.1-0.5 | | 3-40 | | 10 | |
| *Fingerhuthia sesleriiformis* | | | | | | | 0.1 | |
| *Harpochloa falx* | | 0-0.2 | 0.1 | 1 | 0.01 | | | |
| *Helictotrichon turgidulum* | | 0.1-0.5 | 0.2-0.5 | | 0.1 | 0.2 | 1 | |
| *Hemarthria altissima* | | | | | 0.2-10 | | | |
| *Heteropogon contortus* | | 1-2 | 0.1-0.2 | 0.2 | 0.1-0.5 | | | |
| *Hyparrhenia hirta* | | | 0.2-5 | | | 0.5-3 | 0.2 | 3-20 |
| *Imperata cylindrica* | | 0-5 | 10-50 | 0.5 | 15-40 | 30-80 | 30 | 3-15 |
| *Koeleria capensis* | | | | | 0-1 | | | |
| *Leersia hexandra* | | | | | 0.1 | 0.2-15 | | |
| *Melinis nerviglumis* | | | 0.01-0.2 | 0.01 | | | | |

| ***Species*** | **Conservation Status** | **1. Primary Grasslands** | ***2.* Secondary Grassland** | **3. Rocky Ledges** | **4. Floodplain Grasslands** | **5. Seepage Slope Grassland** | **6. Riparian Vegetation** | **3. Alien-Dominated Areas** |
|---|---|---|---|---|---|---|---|---|
| *Microchloa caffra* | | | 0.1 | 0.1 | 0.01 | | | |
| *Monocymbium ceresiiforme* | | 0.01 | | 0.1 | | | | |
| *Oropetium capense* | | | | 1 | | | | |
| *Panicum coloratum* | | 0-2 | | | 0.1-1 | | | |
| *Panicum natalense* | | | | | 0.1 | | | |
| *Panicum schinzii* | | | 0.1-0.3 | | 0.1-15 | 2-80 | | 20-50 |
| *Paspalum dilatatum* | Exo | 0.2 | | | 0.1-2 | 1-5 | 0.5 | 1-3 |
| *Paspalum urvillei* | Exo | 0.1-1 | 0.1-1 | 1 | 0.1-0.3 | 1-8 | | 1-3 |
| *Pennisetum clandestinum* | AIP | | | | 0-10 | 0.1-50 | | 2-80 |
| *Phragmites australis* | | | | | | | 0.2 | |
| *Pogonarthria squarrosa* | | 0.01 | | | | | | |
| *Schizachyrium sanguineum* | | | 0.1-0.5 | 1 | 0.01 | | 0.2 | |
| *Setaria nigrirostris* | | 0.1-1 | 0-0.2 | | 0.1-0.2 | | | |
| *Setaria pumila* | | | 0.1 | | 0.2 | | | |
| *Setaria sphacelata v. sericea* | | 0.1-1 | | | 0.5-1 | 1-5 | | |
| *Setaria sphacelata v. sphacelata* | | 0.1-0.5 | 0.1-0.3 | 1 | 0-0.2 | | | |
| *Setaria sphacelata v. torta* | | 0-0.3 | | | 0.01-0.5 | 0.2 | | |
| *Sporobolus africanus* | | 1-3 | 0-2 | 1 | 0.1 | | | |
| *Sporobolus fimbriatus* | | | | | 0.1-3 | 2-10 | 1 | |
| *Sporobolus pyramidalis* | | 0.1-5 | | | 0.1 | | | |
| *Themeda triandra* | | 0.2-10 | 0-0.3 | 3 | 1-30 | 0-1 | 0.2 | |

| *Species* | Conservation Status | 1. Primary Grasslands | *2.* Secondary Grassland | 3. Rocky Ledges | 4. Floodplain Grasslands | 5. Seepage Slope Grassland | 6. Riparian Vegetation | 3. Alien-Dominated Areas |
|---|---|---|---|---|---|---|---|---|
| *Tristachya leucothrix* | | | | 0.1 | | | | |
| *Tristachya rehmannii* | | | 0.1 | | | | | |
| *Typha capensis* | Med | | | | 0.01 | 2-15 | 15-60 | |
| *Urochloa panicoides* | | | | | 0.1-2 | | | 3-8 |
| *Urochloa trichopus* | | 0.2-5 | | | | | | |
| **CYPEROIDS/SEDGES** | | | | | | | | |
| *Bulbostylis species* | | 0.01 | 0.01 | | | | 0.1 | |
| *Cyperus denudatus* | | | | | 0.1-2 | | 0.2 | |
| *Cyperus esculentus* | | | 1-15 | | 0.1-10 | | | 0.2-15 |
| *Cyperus longus* | | | | | | | 0.5 | |
| *Cyperus obtusiflorus v. flavissimus* | | 0-0.1 | 0.1 | 0.01 | 0-0.1 | | | 0.1 |
| *Cyperus rigidifolius* | | 0-0.2 | | | | 0.1-1 | | |
| *Cyperus rupestris* | | 0.1 | 0.1 | 0.01 | | | | |
| *Eleocharis dregeana* | | | | | | 1-5 | | |
| *Juncus effusus* | | | | | 0.1 | | 0.1 | |
| *Juncus lomatophyllus* | | | | | 0-0.1 | | 0.2 | |
| *Kyllinga alata* | | 0.1-1 | | 0.1 | 0.01-0.2 | | | |
| *Kyllinga erecta* | | 0.5-2 | 0.5-2 | | 0.2-10 | 1-10 | | |
| *Pycreus nitidus* | | 0-0.1 | | 0.1 | 0.01-0.2 | | | |
| *Schoenoplectus brachyceras* | | | | | | | | |
| *Schoenoplectus corymbosus* | | | | | | 1-5 | | |

| *Species* | Conservation Status | 1. Primary Grasslands | *2.* Secondary Grassland | 3. Rocky Ledges | 4. Floodplain Grasslands | 5. Seepage Slope Grassland | 6. Riparian Vegetation | 3. Alien-Dominated Areas |
|---|---|---|---|---|---|---|---|---|
| *Schoenoplectus decipiens* | | | | | | 2-15 | 0.2 | |
| *Schoenoplectus leucanthus* | | 0-0.1 | | 0.1 | 0-0.2 | | | |
| *Scirpoides burkei* | | 0.1-5 | 0-15 | 1 | 0.2-15 | 1-10 | | 0.1 |
| **FORBS** | | | | | | | | |
| *Acalypha angustata* | | 0.1-0.3 | | 2 | | | | |
| *Afroaster serrulatus* | | | 0.01 | 0.1 | | | | |
| *Ajuga ophrydis* | | 0.01-0.3 | | 0.2 | 0.1-0.2 | | | |
| *Amaranthus thunbergii* | Exo | | | | 0-0.2 | | | |
| *Argemone ochroleuca* | AIP | 0-0.2 | | | | | | |
| *Argyrolobium tuberosum* | | | | 0.1 | | | | |
| *Berkheya pinnatifida* | | 0-0.5 | | | 0.2-8 | 0.3 | 0.5 | |
| *Berkheya radula* | | | | | 0.3-3 | 0.1-0.5 | | 0.1-0.5 |
| *Berkheya setifera* | | 1 | 0-2 | 0.1 | 0.2 | | 0.1 | |
| *Berula erecta* | Med | | | | | 0-0.2 | 0.2 | |
| *Bidens pilosa* | Exo | | | 0.1 | 0-1 | | | |
| *Blepharis innocua* | | 0.01-0.1 | | 0.2 | | | | |
| *Campuloclinium macrocephalum* | AIP | | | | 0-0.2 | 0-0.2 | | |
| *Capsella bursa-pastoris* | Exo | 0-0.1 | | | | | | |
| *Centella asiatica* | Med | 0-1 | | 1 | 0.01-2 | | | |
| *Chaetacanthus costatus* | | 0-0.2 | | 1 | | | | |
| *Chaetacanthus setiger* | | 0.1-1 | 1-3 | 5 | 0.2-10 | | | |

| *Species* | Conservation Status | 1. Primary Grasslands | *2.* Secondary Grassland | 3. Rocky Ledges | 4. Floodplain Grasslands | 5. Seepage Slope Grassland | 6. Riparian Vegetation | 3. Alien-Dominated Areas |
|---|---|---|---|---|---|---|---|---|
| *Chamaecrista mimosoides* | | 0.1-1 | 0.1 | 0.1 | 0.1 | 0.1 | | |
| *Chenopodium album* | Exo | | | | | 0-0.2 | | 0.2-5 |
| *Chenopodium carinatum* | Exo | 0-0.1 | | | | | | |
| *Chironia purpurascens* | | 0-0.1 | 0.1 | | 0.1-1 | 1-3 | 0.3 | 0-0.1 |
| *Cyclospermum leptophyllum* | Exo | | | | 0.2-2 | 0.1-3 | 2 | |
| *Cirsium vulgare* | AIP | 0-0.2 | 0-0.1 | | 0-0.2 | 0-0.1 | 0.1 | |
| *Cleome maculata* | | 0-0.1 | | | | | | |
| *Cleome monophylla* | | | 0-0.1 | 0.1 | | | | |
| *Commelina africana* | Med | 0.1-1 | 0.2-0.3 | 0.1 | 0.1-0.5 | | | 0.1 |
| *Commelina benghalensis* | | | 0-0.1 | 0.01 | | | | 0-0.1 |
| *Conyza podocephala* | | | 0.1-2 | | 0.5-15 | | | 0.2-2 |
| *Conyza sumatrensis* | Exo | 0.1-2 | 0-50 | | 0.2-3 | 0.5-15 | 0.5 | 2-20 |
| *Cosmos bipinnatus* | Exo | | 0.2 | 0.1 | 0-0.1 | | | |
| *Crabbea acaulis* | | 0.1-1 | 0.1 | 0.2 | 0.1 | | 0.1 | |
| *Cuscuta campestris* | AIP | | | 0.1 | | | | 0.1 |
| *Cycnium tubulosum* | | | 0-0.1 | 0.01 | 0.1 | 0.1 | 0.1 | 0-0.1 |
| *Datura stramonium* | AIP | | | | | | | 0.1-3 |
| *Denekia capensis* | | | | | 0.01 | | | |
| *Dianthus transvaalensis* | | | | 0.5 | | | | |
| *Eriosema salignum* | | | 0-0.1 | 0.01 | 0.01 | | | |
| *Euphorbia epicyparissias* | | 0.1-1 | 0.1-0.5 | 0.1 | 0.1-0.2 | | | 0.1 |

| *Species* | Conservation Status | 1. Primary Grasslands | *2.* Secondary Grassland | 3. Rocky Ledges | 4. Floodplain Grasslands | 5. Seepage Slope Grassland | 6. Riparian Vegetation | 3. Alien-Dominated Areas |
|---|---|---|---|---|---|---|---|---|
| *Euphorbia inaequilatera* | | | | | 0.1 | | | |
| *Falkia oblonga* | | | | | 0-5 | | 5 | |
| *Felicia mossamedensis* | | | | | 0-0.1 | | | |
| *Felicia muricata* | | | 0.1-0.3 | | | | | |
| *Gazania krebsiana s. serrulata* | | | | | 0.1 | | | |
| *Geigeria burkei* | | | | | | | 0.1 | |
| *Gerbera ambigua* | | | 0-0.1 | 0.2 | | | | |
| *Gerbera piloselloides* | | 0-1 | | 0.01 | | | | 0-0.1 |
| *Gerbera viridifolia* | | | | 0.01 | 0-0.2 | | | |
| *Gisekia africana* | | 0-0.1 | 0.1 | | | | | |
| *Gnaphalium filagopsis* | | 0-1 | 2-20 | | 0.1-0.3 | 0.2-3 | | 0.2-3 |
| *Gomphrena celosioides* | Exo | 0.1-0.2 | | 1 | 0-0.3 | | | |
| *Guilleminea densa* | Exo | 0-0.2 | | | | | | |
| *Haplocarpha lyrata* | | 0-3 | 2-5 | 0.5 | 0.01-0.2 | | | 0.1-0.3 |
| *Haplocarpha scaposa* | | 0-1 | 0-0.5 | 0.1 | 0.1-2 | 0.1-0.3 | 5 | |
| *Helichrysum aureonitens* | | | | | 0.1-0.2 | | | 0.2 |
| *Helichrysum coriaceum* | | 0-1 | 0.2-0.5 | | 0.1-0.3 | | | 0.1 |
| *Helichrysum difficile* | | | | | 0-0.2 | 0.1-0.3 | | |
| *Helichrysum nudifolium var. nudifolium* | Med | 0.5 | 0.3-2 | 2 | 0.1-3 | | | 0.2-1 |
| *Helichrysum nudifolium var. oxyphyllum* | Med | 0.1 | | 0.1 | | | | 0.1 |
| *Helichrysum nudifolium var. pilosellum* | Med | 0.1 | 0.1-3 | 0.1 | 0.1 | | | |

| *Species* | Conservation Status | 1. Primary Grasslands | *2.* Secondary Grassland | 3. Rocky Ledges | 4. Floodplain Grasslands | 5. Seepage Slope Grassland | 6. Riparian Vegetation | 3. Alien-Dominated Areas |
|---|---|---|---|---|---|---|---|---|
| *Helichrysum rugulosum* | | 0.1-1 | 1-15 | 1-3 | 0.5-2 | 1-2 | 0.2 | 0.2-5 |
| *Hermannia depressa* | Med | 0.3-1 | 0.1 | | 0.1-0.3 | | | |
| *Hermannia erodioides* | | | | 0.01 | 0.01 | | 0.2 | |
| *Hermannia transvaalensis* | | 0.2-1 | 0.1 | 1 | 0.1 | | | 0.1 |
| *Hibiscus microcarpus* | | | 0.1 | | | | | |
| *Hibiscus pusillus* | | 0.01 | | 0.1 | | | | |
| *Hibiscus trionum* | Exo | | | | 0-0.2 | | | |
| *Hilliardiella elaeagnoides* | Med | 0.2-0.5 | 0.2 | 1-3 | | | | |
| *Hypericum lalandii* | | | 0-0.1 | 0.01 | | | | |
| *Hypochaeris radicata* | Exo | | 0.2-1 | 0.1 | 0.1 | | | 0.2 |
| *Indigofera zeyheri* | | | 0.1 | 0.1 | | | | |
| *Ipomoea bathycolpos* | | | 0.2 | 1 | | 0.1-0.2 | | 0.1 |
| *Jamesbrittenia aurantiaca* | | | | 0.01 | | | 0.1 | |
| *Kohautia amatymbica* | | | 0.1-1 | | | | | |
| *Kohautia cynanchica* | | | 0.1 | | | | 0.1 | |
| *Kohautia virgata* | | 0.1 | 0.1 | | | | | |
| *Lactuca inermis* | | 0.1 | 0.1 | 0.1 | 0.1-1 | | | |
| *Lasiosiphon kraussianus* | Med | 0.1 | | | | | | |
| *Leobordea foliosa* | | 0.1 | | 0.2 | | | | |
| *Limosella maior* | | | | | 0-0.2 | | | |
| *Listia heterophylla* | | 0.1-1 | | 1 | | | | 0.1-0.5 |

| *Species* | Conservation Status | 1. Primary Grasslands | *2.* Secondary Grassland | 3. Rocky Ledges | 4. Floodplain Grasslands | 5. Seepage Slope Grassland | 6. Riparian Vegetation | 3. Alien-Dominated Areas |
|---|---|---|---|---|---|---|---|---|
| *Lobelia angolensis* | | | | | 0.1 | | 0.1 | 0.1 |
| *Lobelia flaccida* | | | 0.01 | 0.1 | 0-0.5 | 0-0.5 | | |
| *Lotononis calycina* | | 0.1 | 0.1 | | | | | |
| *Merremia verecunda* | | | 0.1 | | | | | |
| *Mimulus gracilis* | | | | | 0.01 | | | |
| *Monopsis decipiens* | | 0.1 | 0.1 | | 0.1-0.3 | | | 0.1 |
| *Monsonia angustifolia* | | | | 0.1 | | | | |
| *Nemesia fruticans* | | | 0.1 | 0.1 | 0.01 | | | |
| *Nidorella anomala* | | | 0.1-30 | 1 | 0-5 | 0-2 | | |
| *Nolletia rarifolia* | | | | 0.2 | | | | |
| *Oenothera rosea* | Exo | | | | | 0.1-0.2 | | |
| *Oenothera tetraptera* | Exo | 0-0.3 | 0.1-0.2 | | 0-0.3 | | 0.2 | |
| *Oldenlandia herbacea* | | | 0.1-0.2 | 0.1 | | | | |
| *Persicaria lapathifolia* | Exo | | | | 0-0.1 | 0-0.1 | | |
| *Persicaria species* | | | | | | | 0.1 | |
| *Physalis angulata* | AIP | | | | 0-0.1 | | | |
| *Plantago lanceolata* | | | | | 0.2-0.5 | | | |
| *Plantago major* | Exo | 0.2-1 | 0.2-0.5 | 1 | 0.2-0.5 | | | 0.3 |
| *Pollichia campestris* | | 0.1 | | 1-5 | | | | |
| *Polygala amatymbica* | | 0.01 | 0.01 | | 0.01 | | 0.2 | |
| *Polygala hottentotta* | | 0.01 | | 0.1 | 0.1 | | 0.1 | 0.01 |

| *Species* | Conservation Status | 1. Primary Grasslands | *2.* Secondary Grassland | 3. Rocky Ledges | 4. Floodplain Grasslands | 5. Seepage Slope Grassland | 6. Riparian Vegetation | 3. Alien-Dominated Areas |
|---|---|---|---|---|---|---|---|---|
| *Polygala krumanina* | | | 0.01 | | | | | |
| *Portulaca oleracea* | Exo | 0-0.2 | | | 0-0.1 | | | |
| *Pseudognaphalium luteo-album* | Exo | 0.1-3 | | | 0.1-15 | 0.2-1 | | 0.2-3 |
| *Ranunculus multifidus* | | | | | 0.1 | 0.1 | | |
| *Rhynchosia minima* | | 0.1 | 0.1 | 0.1 | 0.01-0.1 | | | 0.1 |
| *Rhynchosia totta* | | | | 0.1 | 0.01-0.1 | | | |
| *Richardia brasiliensis* | Exo | | 0.5-3 | | | | | |
| *Rorippa fluviatilis* | | 0-0.1 | | | | | | |
| *Rumex species* | | | | | 0-0.1 | 0-0.1 | | |
| *Salvia repens* | | | | | 0.1-2 | | 0.5 | |
| *Scabiosa columbaria* | Med | 0.1 | 0.1 | 0.1 | 0.1-0.2 | | 0.3 | |
| *Schistostephium crataegifolium* | | | | | 0.1-1 | 0-0.2 | 5 | |
| *Schkuhria pinnata* | Exo | 0-0.3 | 0.1-1 | 1 | 0.1-5 | 0.2-1 | 3 | |
| *Sebaea grandis* | | | | | 0.01 | | | |
| *Selago densiflora* | | 0.3-1 | 0.1-0.5 | | 0.1-1 | | | |
| *Senecio consanguineus* | | | 0.1 | | 0.1 | | | |
| *Senecio erubescens* | | 0.2-1 | 0.1-0.3 | | 0.1-0.3 | | 0.2 | |
| *Senecio inornatus* | | 0-1 | 0.2-0.5 | | 0.2-15 | 0.1-0.2 | | |
| *Sonchus species* | Exo | | | | 0.01 | | 0.1 | |
| *Striga bilabiata* | | | | | | 0.01 | | |
| *Syncolostemon pretoriae* | | | | 1 | | | | |

| *Species* | Conservation Status | 1. Primary Grasslands | *2.* Secondary Grassland | 3. Rocky Ledges | 4. Floodplain Grasslands | 5. Seepage Slope Grassland | 6. Riparian Vegetation | 3. Alien-Dominated Areas |
|---|---|---|---|---|---|---|---|---|
| *Tagetes minuta* | Exo | 0-15 | 0.2-8 | 1 | 0.1-2 | 2-30 | | 2-20 |
| *Tephrosia capensis* | | 0.1-0.5 | 0.1-0.5 | 0.5 | 0.01-0.5 | | | 0.2 |
| *Thesium costatum* | | 0.01-0.1 | 0.1 | 0.1 | | 0.01 | | |
| *Thesium scirpioides* | | | 0.1 | | | | | |
| *Tribulus terrestris* | Exo | 0-0.2 | | | | | | |
| *Trifolium africanum* | | | | | 0.01-3 | 0.2-2 | 10 | |
| *Verbena bonariensis* | AIP | 0.2-1 | 0.1-3 | 0.1 | 0.2-8 | 0.1-30 | 2 | |
| *Verbena brasiliensis* | AIP | 0-1 | 0.1-0.3 | | 0.1 | | | |
| *Vicia sativa* | AIP | | | | | 0.01 | | |
| *Vigna vexillata v. angustifolia* | | | 0.1 | | 0.1 | 0.1-2 | | |
| *Wahlenbergia banksiana* | | | | | 0.01 | | | 0-0.1 |
| *Wahlenbergia undulata* | | 0-1 | 0.1 | | 0.01-2 | 0.1 | 0.1 | |
| *Zornia capensis* | | 0.1-1 | 0.1 | 0.1 | | 0.1 | | |
| **PTERIDOPHYTES/FERNS** | | | | | | | | |
| *Cheilanthes hirta* | Med | | | 0.1 | | | | |
| *Cheilanthes viridis* | | | 0-0.1 | 2 | | | | |
| *Selaginella dregei* | | | | 1 | | | | |
| **GEOPHYTES** | | | | | | | | |
| *Anthericum fasciculatum* | | 0.1 | 0.01 | 0.1 | 0.1 | | | |
| *Asclepias gibba* | | 0.01 | | 0.1 | 0.01 | 0.1 | | |
| *Boophone disticha* | P, Med | | 0.01 | | | | | |

| ***Species*** | **Conservation Status** | **1. Primary Grasslands** | ***2.* Secondary Grassland** | **3. Rocky Ledges** | **4. Floodplain Grasslands** | **5. Seepage Slope Grassland** | **6. Riparian Vegetation** | **3. Alien-Dominated Areas** |
|---|---|---|---|---|---|---|---|---|
| *Crinum bulbispermum* | P, Med | | | | 0-10 | | 2 | |
| *Cyanotis speciosa* | | | | 0.1 | | | | 0.1 |
| *Dipcadi ciliare* | | | 0.01 | | 0.01 | | | |
| *Dipcadi viride* | | 0.01 | | | 0.01-0.2 | | | |
| *Disa* species | P | 0-0.3 | | | | | | |
| *Empodium elongatum* | | 0.1 | 0.01 | | 0.1 | | | |
| *Eriospermum species* | | 0.01 | 0.01 | | | | | |
| *Gladiolus crassifolius* | P | 0.01 | 0.01 | 0.01 | | | | |
| *Hypoxis hemerocallidea* | Med | | 0.1 | 1 | 0-0.1 | | | |
| *Hypoxis iridifolia* | | 0.1 | 0.1 | | | | | |
| *Hypoxis obtusa* | | | | | 0-0.1 | | | 0-0.1 |
| *Hypoxis rigidula* | Med | 0.1-0.5 | 0-1 | 0.1 | 0.1-0.5 | | | |
| *Ledebouria ovalifolia* | | | | 1 | | | | |
| *Ledebouria ovatifolia* | | 0.1-1 | 0.1-1 | | 0.1-0.5 | | | |
| *Ledebouria revoluta* | | | | 0.3 | | | 1 | |
| *Nerine rehmannii* | P | | | 0.1 | | | | |
| *Nerine species* | P | | 0.01 | | | | | |
| *Oxalis corniculata* | Exo | | | | 0.01 | | | |
| *Oxalis obliquifolia* | | 0.01 | 0.01 | 0.1 | 0.01 | | | 0.01 |
| *Pelargonium luridum* | Med | 0.1 | 0.1 | 0.1 | 0.01 | 0.1 | | |
| *Trachyandra saltii* | | | | 0.1 | | | | |

| *Species* | Conservation Status | 1. Primary Grasslands | *2.* Secondary Grassland | 3. Rocky Ledges | 4. Floodplain Grasslands | 5. Seepage Slope Grassland | 6. Riparian Vegetation | 3. Alien-Dominated Areas |
|---|---|---|---|---|---|---|---|---|
| *Tulbaghia acutiloba* | | | | 0.01 | | | | |
| *Xysmalobium undulatum* | Med | 0-1 | 0-0.3 | | 0-1 | | 0.1 | 0-0.2 |
| **SUCCULENTS** | | | | | | | | |
| *Crassula lanceolata* | | | | 0.2 | | | | |
| *Euphorbia clavarioides* | | 0.01 | | | | | | |
| *Opuntia ficus-indica* | AIP | | | | | | | 0.1 |

AIP: Alien Invasive Plant; Exo: Exotic; P: Protected; Med: Medicinal

# 9 APPENDIX B: LISTED ALIEN AND INVASIVE PLANT CATEGORIES

The following regulations of CARA, amplified in NEMBA (2014 and 2016) need to be adhered to before, during and after any development:

- Not allowed: Conveying, moving or otherwise translocating any specimen of a listed invasive species; and
- Not allowed: Spreading or allowing the spread of any specimen of a listed invasive species, which implicates that species must be destroyed so that seedbanks are not further amplified.

NEMBA (2014) categorises alien invasive species as follows:

**Category 1b:** Species that must be controlled, removed or destroyed, may not be allowed to multiply.

**Category 2:** Species that can only be retained with a permit, ensuring that they do not spread outside of the land specified in the permit.

**Category 3:** Species that may remain in prescribed areas, but plants in riparian-, protected- or threatened ecosystem areas may be reclassified Category 1b

CARA also identifies problematic indigenous species that may cause degradation as '**Indicators of Bush Encroachment**', referred to as **Encroacher** in this report. Generally, such species must also be controlled if they reach a density that will lead to degradation of the habitat, which can be seen as densities above 10% canopy cover (Blaum *et al.* 2007).

For each species, as far as could be gleaned from available literature, additional information can be used to aid in the prioritization of eradication (see also Henderson 2007). The current perceived Impact Status Classes (Bacher *et al*. 2017, van Wilgen and Wilson 2017) as used in the table are defined as follows:

**Impact Status**

**Massive (MV):** A species is leads to the replacement and local extinction of native species, and produces irreversible changes in the structure of communities and the abiotic or biotic composition of ecosystems.

**Major (MR):** The species causes the local or population extinction of at least one native species, and leads to reversible changes in the structure of communities and the abiotic or biotic composition of ecosystems, and has no impacts that cause it to be classified in the MA impact category.

**Moderate (MO):** The species causes declines in the population densities of native species, but no changes to the structure of communities or to the abiotic or biotic composition of ecosystems, and has no impacts that would cause it to be classified in a higher impact category.

**Minor (MN):** The species causes reductions in the fitness of individuals in the native biota, but no declines in native population densities, and has no impacts that would cause it to be classified in a higher impact category.

**Minimal (MC):** The species is unlikely to have caused deleterious impacts on the native biota or abiotic environment. Species that have been evaluated but for which impacts have not been assessed in any study should rather should be categorised as Data Deficient.

**Not Evaluated (NE):** A species is Not Evaluated when it has not yet been evaluated against the criteria.