DE CASTRO & BRITS
ECOLOGICAL CONSULTANTS

To: Ms Chiara Kotze
SLR Consulting
Block 7, Fourways Manor Office Park
Cnr Roos and Macbeth Streets
Fourways, Johannesburg, 2060

Date: 31/03/2016

Dear Ms Kotze

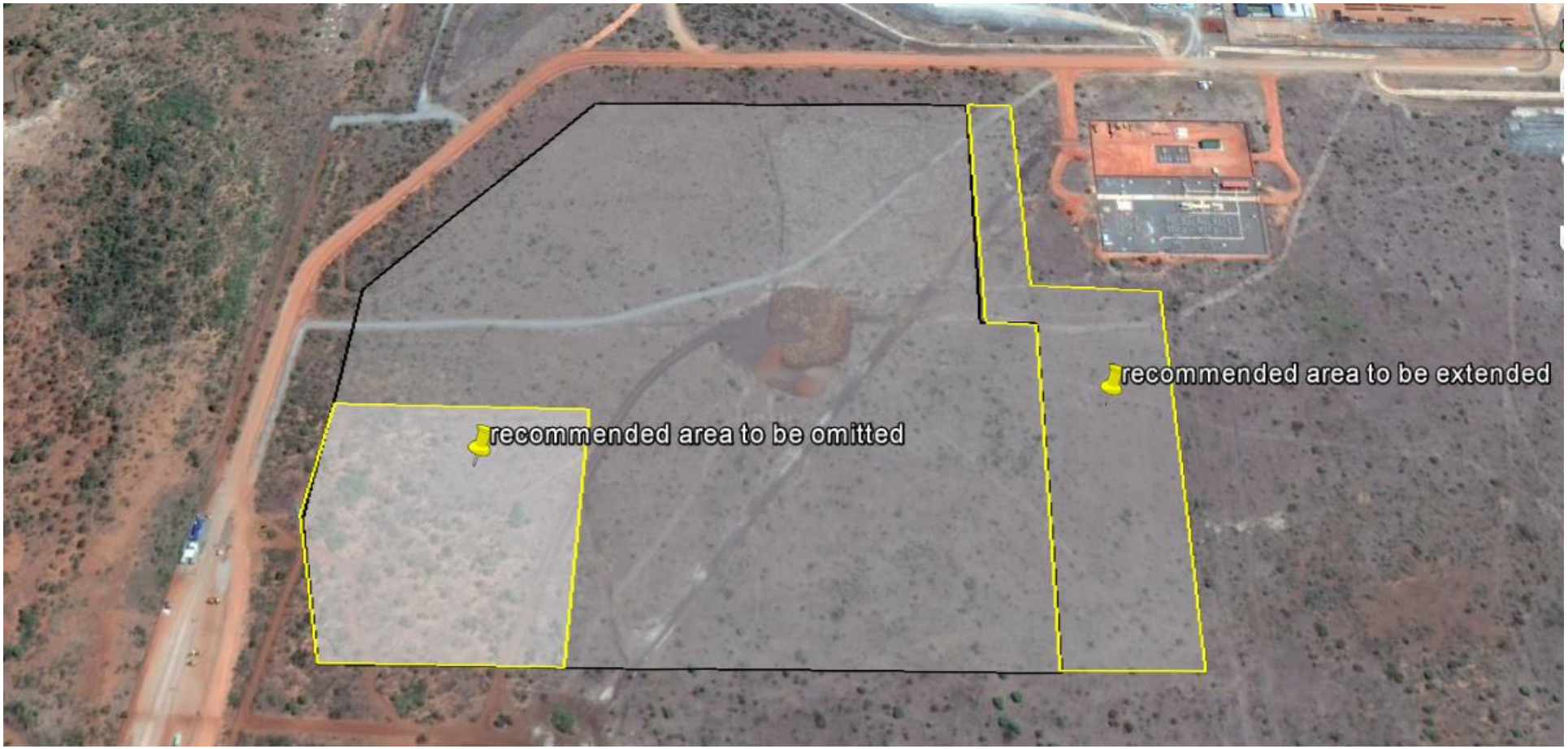
RE: Comment on the ecology of the footprint of the proposed Solar Plant at the Wesizwe Bakubung Platinum mine (Farm Frischgewaagd).

The footprint of the proposed Solar Plant is approximately 21.5ha in extent, of which 7.7ha (or 35.8%) comprises Mixed Woodland & Thicket (Unit 1.1), 1.8ha (or 8.4ha) comprises *Acacia mellifera* Bushland & Thicket (Unit 1.2) and 12.0ha (or 55.8%) comprises Secondary vegetation (Unit 6). Units 1.1 and 1.2 have High biodiversity conservation value and sensitivity and together comprise 54.2% of the footprint. Unit 6 has Moderate biodiversity conservation value and sensitivity and comprises 55.8% of the footprint. No plant 'species of conservation concern' or Protected plant species were recorded within the proposed footprint during the current or previous surveys. However, a thorough search of the proposed footprint for plant 'species of conservation concern' and Protected plant species was not conducted as part of the current survey as the proposed footprint was only selected after completion of the field work for this survey.

Recommendations:

- A thorough survey for plant 'species of conservation concern' and Protected plant species within the proposed Solar Plant footprint should be conducted prior to any development of the footprint. This survey should focus on searching for *Drimia sanguinea, Stentonstelma umbelluliferum, Boophone disticha* and *Hypoxis hemerocallidea* within the final development footprints prior to construction, and should be conducted in late October to early November and in January.
- The proposed Solar plant footprint should be modified so as reduce the extent of vegetation units with High biodiversity conservation value and sensitivity (Units 1.1 and 1.2) contained within the footprint. The attached mapping indicates the recommended realignment of the proposed footprint, which would result in the new footprint alignment including only 6.8ha of Unit 1.1, no area of Unit 1.2 and 14.7ha of Unit 6. Transformed habitats would therefore comprise 68.4% of the recommended footprint and the percentage of transformed habitat included within the final footprint could be further increased by shifting the eastern boundary of the footprint further to the east.

Tony de Castro
P.O. Box 2145, Cresta 2118
Tel.: 084 803 7205


recommended area to be omitted
recommended area to be extended

BOTANICAL BIODIVERSITY ASSEMENT REPORT FOR THE FOOTPRINTS OF CHANGES TO INFRASTRUCTURE AT THE BAKUBUNG PLANTINUM MINE
(Ledig, North-West Province)

Prepared by: De Castro & Brits c.c.

Author: Tony de Castro (Pr. Nat. Sci)

DATE: Feb 2016
STATUS: Draft Report

Specialist reports and reports on specialist processes - Checklist		
	NEMA Regs (2014) - Appendix 6	**Reference to section of specialist report or justification for not meeting requirement**
1	A specialist report or a report on a specialised process prepared in terms of these Regulations must contain -	
(a) i	the person who prepared the report; and	Title page
(a) ii	the expertise of that person to carry out the specialist study or specialised process;	Appendix 13
(b)	a declaration that the person is independent in a form as may be specified by the competent authority;	Appendix 14
(c)	an indication of the scope of, and the purpose for which, the report was prepared;	Chapter 2, Page 1
(d)	the date and season of the site investigation and the relevance of the season to the outcome of the assessment;	Chapter 5, Page 10
(e)	a description of the methodology adopted in preparing the report or carrying out the specialised process;	Chapters 3 & 4, Pages 3 - 10
(f)	the specific identified sensitivity of the site related to the activity and its associated structures and infrastructure	Chapters 7, 8, 10, 13 & 13, Pages 13 - 57
(g)	an identification of any areas to be avoided, including buffers;	Chapter 14, Pages 61 – 63 Appendix 12
(h)	a map superimposing the activity including the associated structures and infrastructure on the environmental sensitivities of the site including areas to be avoided, including buffers;	Figures 2 and 3 Appendixes 4, 8 and 12
(i)	a description of any assumptions made and any uncertainties or gaps in knowledge;	Chapter 5, Page 10
(j)	a description of the findings and potential implications of such findings on the impact of the proposed activity, including identified alternatives, on the environment;	Chapter 13, Pages 56 - 57 and Appendix 10
(k)	any mitigation measures for inclusion in the EMPr	Chapter 14, Pages 61 - 63 and Appendix 10
(l)	any conditions for inclusion in the environmental authorisation	-
(m)	any monitoring requirements for inclusion in the EMPr or environmental authorisation	Chapter 14, Pages 61 - 63 and Appendix 10
(n)	a reasoned opinion -	
.i	as to whether the proposed activity or portions thereof should be authorised and	Chapter 14, Pages 57 - 63

.ii	if the opinion is that the proposed activity or portions thereof should be authorised, any avoidance, management and mitigation measures that should be included in the EMPr, and where applicable, the closure plan;	Chatper 14, Pages 61 - 63
(o)	a description of any consultation process that was undertaken during the course of carrying out the study;	Chapter 4, Pages 3 – 8 No specific stakeholder consultation was undertaken or deemed necessary as part of this study. Comments received by SLR as part of the EIA were considered in the undertaking of this study
(p)	a summary and copies if any comments that were received during any consultation process, and -	Appendix 15 No specific stakeholder consultation was undertaken or deemed necessary as part of this study. Comments received by SLR as part of the EIA were considered in the undertaking of this study
(q)	any other information requested by the competent authority.	None

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

1.0 INTRODUCTION

In October 2015, SLR Consulting approached De Castro & Brits Ecological Consultants to conduct a botanical biodiversity survey and impact assessment for the footprints of additional support infrastructure at Wesizwe Platinum Limited (Wesizwe) Bakubung Platinum Mine, which will require additional Environmental Authorisations. The proposed infrastructure footprints are situated on two sections of the Wesizwe surface rights area, namely the farms Frischgewaagd 96 JQ (465.5ha) and the farm Mimosa 81 JQ (618.1ha), near Ledig in the Bojanala Platinum District Municipality of the North-West Province (see Figure 1). This report presents the findings of the requested study.

2.0 TERMS OF REFERENCE

In accordance with the accepted proposal for this study, the botanical specialist study presented in the current report was to assess the footprints of the following infrastructure components proposed within the Bakubung Platinum Mine study area (Mimosa and Frischgewaagd sections and the tailings pipeline corridor linking the two sections):

1. Concentrator Plant – 25.2ha (next to existing Shaft Complex on the farm Frischgewaagd),
2. Product Stockpiles and Ore Crusher – 6.3 (surrounding the Concentrator Plant on the farm Frischgewaagd),
3. Pollution Control Dam's for the Concentrator Plant – 5.1 ha (farm Frischgewaagd),
4. Tailings Storage Facility – 235.3ha (Farm Mimosa),
5. Return Water Dam – 14.9ha (farm Mimosa),
6. Storm Water Dam – 1.2ha (farm Mimosa),
7. Tailings Pipeline linking Concentrator Plant to Tailings Storage Facility – 30m wide construction servitude of a 3.83km long pipeline (alignment on the farms Frischgewaagd and Mimosa and the intervening area to the north of the Elands River between these farms),
8. Housing Development Phase 1a – 25.2 ha (farm Frischgewaagd).

The proposal for this study also included an assessment of the full extent of the network of the ephemeral drainage lines situated within the Frischgewaagd section of the study area to the north of Shaft Complex and to west of proposed Housing Phase 1 development footprint.

Though not included in the Terms of Reference provided in the accepted proposal, the following additional project infrastructure components are included in the current study as requested by the client (SLR) prior to the commencement of fieldwork:

1. Housing Development Phase 1 – 19.8ha (farm Frischgewaagd).
2. Eskom Ledig Substation – 5.1ha (farm Frischgewaagd).
3. Waste Rock Dump – 5.8ha (farm Frischgewaagd).
4. A 118m long road (including a bridge crossing of a deeply eroded ephemeral watercourse) linking Housing Phase 1 and Housing Phase 1a.

In accordance with the accepted proposal for this botanical study, the following aspects were to be included in this specialist report:

- '*Determination of the Vegetation Type/Types in accordance with existing national vegetation maps (Low & Rebelo, 1998; Mucina & Rutherford, 2006). A description of the regional biodiversity context using all existing published scientific information and*

relevant legislation will be provided. Most of this information will be sourced from the recently completed Biodiversity Management Plan for the mine.

- *Broad-scale structural classification of the vegetation into homogenous units following the approach of Edwards (1983). A brief description of the dominant and characteristic species and ecological status (i.e. untransformed or secondary) identified within the broad-scale plant communities comprising each of these units, will also be provided. These descriptions will be based on visual estimates of cover/abundance and density. The number of sampling sites will be limited by the relatively short duration of the available time for fieldwork, and this component will largely be extracted from the existing descriptions contained in the recently completed Biodiversity Management Plan for the mine, with refinement on the basis of data gathered during the proposed survey where necessary.*
- *Vegetation / habitat types will be mapped on the basis of available information (aerial photography, soil types, geology and existing vegetation and biodiversity mapping provided in the recently completed Biodiversity Management Plan) and will consist of structurally distinct vegetation units (wetland, grasslands, woodland) as well as transformed areas (cultivated land, areas of alien vegetation, urban areas etc.).*
- *Each identified vegetation or land-cover type unit will be briefly described in terms of its sensitivity, biodiversity value and conservation importance.*
- *Plant species list (to provide an accurate indication of the floristic diversity) according to latest taxonomic treatments used by the National Herbarium (Germishuizen et al., 2006). Alien invasive species, according to the Conservation of Agricultural Resources Act (Act No.43 of 1983) as listed in Henderson (2001), will be highlighted.*
- *Plant species that are Declared alien invasive species in terms the Regulations on Alien and Invasive Plant Species (AIS Regulations) as defined in Notice 3 of the National Environmental Management: Biodiversity Act (Act no. 10 of 2014), will be highlighted and their distribution and relative abundance of alien invasive plant species within the proposed infrastructure footprints will be broadly described.*
- *Determination of the occurrence, or possible occurrence, of plant 'species of conservation concern' (Raimondo et al., 2009 and http://redlist.sanbi.org) and sensitive plant communities, on the basis of field surveys, historical distribution records obtained from the PRECIS database of SANBI, the North West Province species database, and available literature.*
- *Further botanical assessments regarded as necessary will also be identified and 'Terms of Reference' for these assessments will be recommended. Such further assessments may include additional searches for potentially occurring threatened plant species that were not in flower at the time of the field surveys.*
- *An assessment of envisaged impacts to vegetation and flora associated with the proposed development will also be provided, as will appropriate preliminary mitigation measures for any identified 'species of conservation concern' and sensitive plant communities and habitats. The aforementioned information will be provided in a form that facilitates its incorporation into the impact assessment methodology used by SLR Consultanting. Impact assessment tables provided by the client will be completed by the specialists and provided in an Appendix to the report.*
- *The report will meet the requirements for specialist impact assessment reports provided in Appendix 6 to the 2014 EIA Regulations.*
- *A signed specialist declaration of independence will be provided to the client.'*

3.0 APPROACH

The botanical biodiversity characteristics, vegetation and land-cover types of the current study area, namely the Frischgewaagd and Mimosa sections of the Wesizwe surface rights area and the narrow pipeline alignment corridor linking the two sections, were described and mapped in some detail in the botanical biodiversity baseline report compiled by the current author in 2015 (De Castro & Brits, May 2015). The botanical biodiversity baseline report was based on field surveys conducted in November 2014 and March and April 2015. As per the accepted proposal for this study, the vegetation descriptions and mapping, and the descriptions of the flora and plant 'species of conservation concern' (*sensu* Raimondo *et al*., 2009) provided in the current report have been extracted from the botanical biodiversity baseline report (De Castro & Brits, May 2015) and, where necessary, updated on the basis of data gathered during the current study.

The brief field surveys for the current study focussed on the proposed infrastructure footprints and tailings pipeline alignment and were conducted over five days between the 18th and the 27th of November 2015. During the current study the footprints of all proposed infrastructure were briefly assessed in the field, and where necessary the available vegetation and biodiversity mapping and descriptions were refined and updated in order to provide an accurate baseline description of the ecology and botanical biodiversity value of the footprints and the potential impacts associated with the proposed infrastructure developments. Emphasis was also placed on searching the infrastructure footprints for potentially occurring plant 'species of conservation concern' (*sensu* Raimondo *et al*. 2009) using the 'timed meander search method' (Goff *et al*., 1982 and Huebner, 2007), and notes on species composition and vegetation physiognomy were compiled at representative sites during the meandering search. Though the focus of this study was on the proposed infrastructure footprints, Unit 1 (Ephemeral drainage lines – hygrophilous grassland and Thicket) within Frischgewaagd was also thoroughly surveyed and the mapping of this unit revised, as per the proposal for this study.

The entire length of the proposed ca. 3.8km pipeline alignment, as proposed by the client in November 2015, was subjected to a 'walkover' survey by the botanist. After the completion of the fieldwork, a final pipeline alignment was provided in December 2015 and an updated Tailings Storage Facility (TSF) layout was provided in February 2016. This final pipeline alignment closely follows the originally proposed alignment for most of its length, and was not subjected to a walkover survey, but was assessed at a desktop level and included in the mapping corridor for the tailings pipeline. As the November 2015 site visit entailed an assessment within a corridor surrounding the original design and the December 2015 pipeline layout falls mostly within this corridor, the findings of the November 2015 site visit are still deemed relevant. The changes in the TSF layout do not impact the findings of this report either and thus the mapping has been kept as per the previous TSF layout. Both the originally proposed alignment and the final alignment are shown on the map provided in Appendix 9.

The wetlands of the study are dealt with in more detail in the specialist wetland report compiled concurrently with this report by De Castro & Brits cc.

4.0 METHODOLOGY

Literature Review

Prior to the conduction of the field surveys, available literature and database information pertaining to the vegetation and threatened species of the north-eastern region of the North-West Province within which the study area is situated was obtained and reviewed. The reviewed literature includes the following specialist reports which address various aspects of the vegetation, ecology and soils of the Mimosa and Frischgewaagd sections of the study area and their surrounds:

- Botanical Biodiversity Baseline Report for the Frischgewaagd, Mimosa and Zwartkoppies surface rights areas of the Wesizwe Platinum Mine (De Castro & Brits, May 2015) [Study included vegetation descriptions and mapping, an assessment of plant species of conservation concern and biodiversity management recommendations].
- Flora and Fauna Baseline Survey for the Wesizwe Housing Project (De Castro & Brits cc., March 2014), [Study area included 130ha northern portion of Frischgewaagd section.]
- Wesizwe Platinum Biological Assessment, Veld Management Plan and Biodiversity Action Plan (Golder Associates, August 2007) [Study area included entire Frischgewaagd and Wesizwe sections as well as surrounding areas, but excluded Zwartkoppies section.],and
- Soil, Land Capability and Land Use Assessment for the Wesizwe Platinum Project (Rehab Green Monitoring Consultants, August 2007) [Study area included most of the Mimosa section and the entire Frischgewaagd section.].

The North West Biodiversity Sector Plan (NWBSP) 2015 has recently been completed but is not yet available on the SANBI or BGIS websites. A copy of the NWBSP 2015 and shapefiles for the Critical Biodiversity Areas (CBAs) for the North West Province contained in NWBSP was obtained from Mr Ray Schaller of the North West READ Department.

Stratification and Mapping

Prior to the initial field surveys, a preliminary broad-scale vegetation map was produced at a desktop level using the obtained literature, Google Earth imagery, available aerial photographs and 1:50 000 topocadastral maps. Historical aerial photographs from 1990 were obtained from National Geo-spatial Information (NGI), a component of the Department of Rural Development and Land Reform (DRDLR). The study area was broadly stratified into major classes on the basis of gradient, aspect, terrain units (e.g. crest, midslope, foot slope), rock cover, soils, land-use and vegetation physiognomy. Additional stratification units were demarcated along the rivers, streams, drainage lines and wetlands of the study area. This method has been successfully employed in various studies in the past (e.g. Coetzee *et al*. 1994, 1995) and has been shown to correlate well with observed vegetation patterns. The first approximation map was then used as a basis for selecting representative sampling sites within the study area.

The vegetation and land-cover type units presented here were derived on the basis of structural and functional criteria during the botanical biodiversity baseline survey (De Castro & Brits 2015). The term structure refers to various aspects of vegetation structure such as physiognomy, life-form composition, species composition, species dominance and stand

structure (Kent & Coker, 1992). Functional criteria include aspects such a characteristic ecosystem processes, habitat characteristics and ecological status (e.g. primary vegetation of untransformed habitats versus secondary vegetation of transformed or severely degraded habitats). The floristic data set gathered in 26 vegetation sampling plots was subjected to analysis to establish differences and similarities, and this analysis was used to only to guide the identification of the robust vegetation units described in this report, which are based on qualitative and semi-quantitative floristic, physiognomic and habitat data gathered at 87 sites including 26 sites where vegetation was sampled within $100m^2$ quadrats (see Appendix 2). Data gathered within the proposed infrastructure footprints during the current survey (November 2015) was used to verify and where necessary refine the vegetation and land cover-type mapping produced during the botanical biodiversity baseline assessment.

The criteria for the identification of wetlands as described in the Department of Water Affairs and Forestry (DWAF) document titled "A Practical field procedure for identification and delineation of wetlands and riparian areas (Final Draft)" (September, 2005), was used in this study. The DWAF document stipulates the use of the following indicators to identify wetlands: 'Terrain Unit Indicator' (terrain unit morphological classes), 'Soils Form Indicator' (presence of hydromorphic soils), 'Soil Wetness Indicator' and the 'Vegetation Indicator' (presence of hydrophytic and/or hygrophytic species).

In the current report the term 'untransformed' vegetation refers to vegetation that is in a 'climax' or 'steady state' (Kent & Coker, 1992) or has been somewhat degraded by impacts such as altered fire regimes and overgrazing, but which but is considered to still contain pre-disturbance species richness (α-diversity) and will quickly revert to a climax state under appropriate management. 'Secondary' vegetation refers to seral communities of pioneer species in habitats affected by catastrophic historical impacts such as ploughing.

Five, broad-scale botanical biodiversity 'sensitivity' categories are used in this report. These categories were developed for practical mapping purposes and are intended as a simple summary of the perceived botanical biodiversity value, of mapped broad-scale vegetation and land-cover type units, which is described in more detail in the description of each mapping unit. The five sensitivity categories are described in Table 1.

Table 1: Botanical biodiversity sensitivity categories.

Category	Synopsis of criteria
Very High	Mapping units comprising untransformed plant communities which are representative of vegetation types or broad-scale vegetation units (*sensu* Mucina & Rutherford, 2006) which are currently regarded as Critically Endangered or Endangered in the national vegetation map (Mucina & Rutherford, 2006) or provincial vegetation classifications (e.g. NWBCA, 2009), as well as units which are representative of Vulnerable vegetation types or broad-scale vegetation units which provided confirmed habitat for one or more threatened (Critically Endangered, Endangered, Vulnerable) plant species (*sensu* Raimondo *et al*., 2009 and http://redlist.sanbi.org).
High	Units comprising untransformed plant communities which are representative of vegetation types or broad-scale vegetation units (*sensu* Mucina & Rutherford, 2006) which are currently regarded as Vulnerable in the national vegetation map (Mucina & Rutherford, 2006) or provincial vegetation classifications (e.g. NWBCA, 2009), but which do not include confirmed habitat for any threatened plant species (*sensu* (Raimondo *et al*., 2009 and http://redlist.sanbi.org). Category can also include units comprising untransformed habitats and plant communities, which are representative of vegetation types / vegetation units which are currently regarded as Least Threatened, but provide confirmed habitat for threatened or Near Threatened plant species or have one or more of the following (or similar) attributes which

Category	Synopsis of criteria
	lend elevated conservation value: o highly spatially restricted in the region of the study area; o high species richness and/or unique floristic composition; o high functional value (e.g. wetland habitats).
Moderate	Units comprising untransformed plant communities which are representative of vegetation types or broad-scale vegetation units (*sensu* Mucina & Rutherford, 2006) which are currently regarded as Least Threatened in the national vegetation map (Mucina & Rutherford, 2006) or provincial vegetation classifications (e.g. NWBCA, 2009), and which do not include confirmed habitat for any threatened or Near Threatened plant species (*sensu* (Raimondo *et al*., 2009 and http://redlist.sanbi.org) and do not have any additional attributes that lend them elevated biodiversity conservation value. Category may also include secondary plant communities of historically transformed habitats which are in an advanced stage of secondary succession and are representative of a vegetation type or broad-scale vegetation unit (*sensu* Mucina & Rutherford, 2006) which is currently regarded as Critically Endangered, Endangered or Vulnerable in the national vegetation map (Mucina & Rutherford, 2006) or provincial vegetation classifications (e.g. NWBCA, 2009).
Low	Units comprising secondary plant communities of historically transformed habitats, other than those which meet the criteria for Moderate sensitivity. Also includes currently cultivated lands.
Negligible	Units comprising habitats completely and more or less permanently transformed by the construction of infrastructure (e.g. residential areas, industrial premises, offices and mine infrastructure such as tailings storage facilities and waste rock dumps).

Floristic Survey and Vegetation Sampling

At all 87 sites surveyed within the Frischgewaagd and Mimosa sections during the botanical baseline survey (De Castro & Brits, May 2015), and during the surveys of all infrastructure footprints and pipeline alignments conducted during the current study, use was made of the 'timed meander search' method and the vegetation was classified at representative sites using visual estimates of woody canopy cover according to the broad-scale structural classification of Edwards (1983). The 'timed meander search' method is a semi-quantitative survey procedure that focuses on the discovery of rare vascular plant species, which include most 'species of conservation concern' (Goff *et al*., 1982 and Huebner, 2007). The 'timed meander search' method has been shown to be highly effective and time efficient in detecting rare species and documenting α-diversity (Huebner, 2007).

The floristic data sets gathered in twenty-six 100 m^2 quadrats (plots) using standard vegetation survey procedures following the Braun-Blanquet approach (Mueller-Dombois & Ellenberger 1974 and Kent & Coker 1992), are provided in Appendix 3. The sample plot size was standardized at 10 x 10 metres (100 m^2) in order to facilitate comparisons between vegetation units, and for the purposes of possible comparison with studies done in other parts of the country. The following parameters were recorded in each plot:

- Floristic parameters;
  - all plant taxa, identifiable at the time of sampling, rooted in the sample site,
  - a growth form (tree, shrub, dwarf shrub, forb, grass) was assigned to each species;
  - projected canopy cover for each species recorded was visually estimated using the Braun-Blanquet cover-abundance scale;
  - in the case of woody communities, each site was classified according to the structural classification of Edwards (1983);
- Environmental parameters;
  - locality in degrees, minutes and seconds using a Global Positioning System (GPS) receiver (see Appendix 2);
  - slope, measured in degrees;

- aspect, measured in degrees;
- elevation, measured in metres using a barometric altimeter;
- terrain unit (midslope, foot slope, etc.);
- estimated percentage surface rock cover; and
- any visible disturbances (e.g. grazing, fire, old lands).

Specimens of plant taxa unknown at the time of field sampling were collected for later identification using the appropriate scientific keys, or sent to the National Herbarium in Pretoria for identification. Plant species names or nomenclature is that used by the National Herbarium, Pretoria as provided in the Plants of South Arica web-based database (http//:posa.sanbi.org). In the text of this report, alien species are always indicated by an asterisk.

Analysis of the Occurrence of 'Species of Conservation Concern' (*sensu* Raimondo *et al.*, 2009)

Prior to the conduction of the field surveys, available database information pertaining to the threatened plant species of the region of the North-West Province within which the study area is situated was obtained from the South African National Biodiversity Institutes' PRECIS database (http://posa.sanbi.org) and from Mr Ray Schaller of the North West Province Department of Rural, Environment and Agricultural Development (READ). All plant 'species of conservation concern' (*sensu* Raimondo *et al*., 2009 and http://redlist.sanbi.org, downloaded January 2016) historically recorded from the quarter degree grid square within which the study area is situated (2527AC), as well as four immediately adjacent grids (2526BD, 2526BC, 2526DB and 2527CA) which contain similar habitats, were extracted from these lists and are presented in Appendix 5. Emphasis was placed on searching the proposed infrastructure footprints for these plant species, and potentially suitable habitat for these species, during the field surveys. All 49 plant species regarded as 'priority species' for the North West Province (Hahn, June 2011) were also considered, and these 49 species are listed in Appendix 6.

Diversity Analysis

Species richness (α-diversity) was defined as the number of species per sampling plot and was presented as the mean species richness for each vegetation unit (Whittaker 1972). The total number of species recorded in all sampling plots within each vegetation unit is presented in Tables 5 and 7, and provides an indication of the species richness of each vegetation unit.

Impact Assessment

The impact assessment methodology as provided by the client (SLR) is set out in the Table 2. This assessment methodology enables the assessment of environmental issues including: cumulative impacts, the severity of impacts (including the nature of impacts and the degree to which impacts may cause irreplaceable loss of resources), the extent of the impacts, the duration and reversibility of impacts, the probability of the impact occurring, and the degree to which the impacts can be mitigated.

Table 2: Criteria for Assessing Impacts.

Note: Part A provides the definition for determining impact consequence (combining severity, spatial scale and duration)

and impact significance (the overall rating of the impact). Impact consequence and significance are determined from Part B and C. The interpretation of the impact significance is given in Part D.

PART A: DEFINITION AND CRITERIA*		
Definition of SIGNIFICANCE		**Significance = consequence x probability**
Definition of CONSEQUENCE		**Consequence is a function of severity, spatial extent and duration**
Criteria for ranking of the SEVERITY of environmental impacts	**H**	Substantial deterioration (death, illness or injury). Recommended level will often be violated. Vigorous community action.
	M	Moderate/ measurable deterioration (discomfort). Recommended level will occasionally be violated. Widespread complaints.
	L	Minor deterioration (nuisance or minor deterioration). Change not measurable/ will remain in the current range. Recommended level will never be violated. Sporadic complaints.
	L+	Minor improvement. Change not measurable/ will remain in the current range. Recommended level will never be violated. Sporadic complaints.
	M+	Moderate improvement. Will be within or better than the recommended level. No observed reaction.
	H+	Substantial improvement. Will be within or better than the recommended level. Favourable publicity.
Criteria for ranking the DURATION of impacts	**L**	Quickly reversible. Less than the project life. Short term
	M	Reversible over time. Life of the project. Medium term
	H	Permanent. Beyond closure. Long term.
Criteria for ranking the SPATIAL SCALE of impacts	**L**	Localised - Within the site boundary.
	M	Fairly widespread – Beyond the site boundary. Local
	H	Widespread – Far beyond site boundary. Regional/ national

PART B: DETERMINING CONSEQUENCE

SEVERITY = L

DURATION	Long term	**H**	**Medium**	**Medium**	**Medium**
	Medium term	**M**	**Low**	**Low**	**Medium**
	Short term	**L**	**Low**	**Low**	**Medium**

SEVERITY = M

DURATION	Long term	**H**	**Medium**	**High**	**High**
	Medium term	**M**	**Medium**	**Medium**	**High**
	Short term	**L**	**Low**	**Medium**	**Medium**

SEVERITY = H

DURATION	Long term	**H**	**High**	**High**	**High**
	Medium term	**M**	**Medium**	**Medium**	**High**
	Short term	**L**	**Medium**	**Medium**	**High**
			L	**M**	**H**
			Localised Within site boundary Site	Fairly widespread Beyond site boundary Local	Widespread Far beyond site boundary Regional/ national
			SPATIAL SCALE		

PART C: DETERMINING SIGNIFICANCE

PROBABILITY (of exposure to impacts)	Definite/ Continuous	**H**	**Medium**	**Medium**	**High**
	Possible/ frequent	**M**	**Medium**	**Medium**	**High**
	Unlikely/ seldom	**L**	**Low**	**Low**	**Medium**
			L	**M**	**H**
			CONSEQUENCE		

PART D: INTERPRETATION OF SIGNIFICANCE

Significance	Decision guideline
High	It would influence the decision regardless of any possible mitigation.
Medium	It should have an influence on the decision unless it is mitigated.
Low	It will not have an influence on the decision.

***H = high, M= medium and L= low and + denotes a positive impact.**

5.0 LIMITATIONS

The greater study area for this study comprises the Firshgewaagd section (465.5ha), the Mimosa section (618.1ha) and the tailings pipeline mapping corridor between these two sections (39.5ha). Within this greater study area the current study focussed on surveying the footprints of the proposed infrastructure totalling 343.9ha and the 3.83km long alignment of the proposed tailings pipeline.

The most significant limitations for the study presented here were as follows:

- A total of five days of field work and seven days of data analysis, mapping and reporting were available for the completion of this study which included the revision of the available vegetation maps for the Frischgewaagd and Mimosa sections of the study area, the compilation of a new vegetation map for the pipeline corridor and mapping of vegetation and searches for threatened plant species within the proposed infrastructure footprints.
- Vegetation mapping was based on the existing vegetation and land-cover type maps compiled by De Castro and Brits cc (May, 2015). The current survey focussed on verifying, and where necessary modifying, the vegetation mapping within the existing infrastructure footprints.
- The species list provided in this report (see Appendix 1) is based on field surveys conducted in November 2014 and March and April 2015 for the purposes of a baseline botanical biodiversity assessment (De Castro & Brits cc, May 2015) as well as five days of field work conducted for the current study in November 2015. All surveys where therefore conducted during the growing season and reasonable seasonal coverage has been incorporated. The timing of the field surveys used to compile this study is therefore not seen as a significant limitation, though additional brief surveys aimed at searching for potentially occurring 'species of conservation concern' are recommended in this report. Based on the authors experience the 414 plant species provided in Appendix 1 includes approximately 80% or more of the species actually present in the study area.
- The entire length of the proposed ca. 3.83km pipeline alignment, as proposed by the client in November 2015, was subjected to a 'walkover' survey by the botanist. In December 2015, after the completion of the fieldwork, a final pipeline alignment was designed by the client. After the completion of the fieldwork, a final pipeline alignment was provided in December 2015 and an updated Tailings Storage Facility (TSF) layout, which falls entirely within the larger original layout, was provided in February 2016. The final pipeline alignment closely follows the originally proposed alignment for most of its length, and was not subjected to a walkover survey, but was assessed at a desktop level and included in the mapping corridor for the tailings pipeline. As the November 2015 site visit entailed an assessment within a corridor surrounding the original design and much of the the December 2015 pipeline layout falls within this corridor or its immediate surrounds, the findings of the November 2015 site visit are still deemed relevant. The changes in the TSF layout do not impact the findings of this report either and thus the mapping has been kept as per the previous TSF layout. Both the originally proposed alignment and the final alignment are shown on the map provided in Appendix 9.
- Due to project scheduling constraints, the footprints of the proposed infrastructure were not subjected to seasonal surveys. Furthermore, the study area was experiencing a severe drought at the time of the field surveys (November) and the Mimosa section and pipeline mapping corridor were severely overgrazed. The species lists provided in

Appendix 1 can therefore not be regarded as comprehensive. Based on the authors experience the plant species lists provided in Appendix 1 probably include no more approximately 80% of the species present within the study area.

6.0 PROJECT DESCRIPTION

Wesizwe Platinum Limited (Wesizwe) is the owner of Bakubung Platinum Mine, currently shaft sinking on the farm Frischgewaagd 96JQ (see Figure 1). The mine is located near Ledig, just south of the Pilanesberg Game Reserve and Sun City in the North West Province. In 2008, Wesizwe conducted an Environmental Impact Assessment (EIA) process for the development of the Bakubung Platinum Mine. The Bakubung Platinum Mine received Environmental Authorisation in 2009, in terms of both the National Environmental Management Act (Act 107 of 1998) (NEMA) and Mineral and Petroleum Resources Development Act (Act 28 of 2002) (MPRDA). A Water Use Licence (WUL) was issued in terms of the National Water Act (Act 36 of 1998) (NWA) in 2010.

While construction at the Bakubung Platinum Mine has commenced, not all the proposed facilities have been constructed. Mining has not yet commenced. Wesizwe is now proposing to make several changes to the approved mine. The changes are required in order to cater for an increase in ore processing capacity, as well as additional support infrastructure which will require additional Environmental Authorisations, a Waste Management Licence (WML) and additional water uses requiring an amendment to their existing WUL.
The following changes are proposed to the Bakubung Platinum Mine (infrastructure components addressed in the current specialist botanical report, as per the approved proposal for this study and on the basis of subsequent communication with SLR, are shaded):

- The construction of a Tailings Storage Facility (TSF) of approximately 235.3ha on the farm Mimosa 81JQ. The height will be approximately 44m.
- An approximately 3.83km long Tailings Pipeline linking the Concentrator to TSF. The alignment will be situated on the Farms Frischgewaagd and Mimosa and the intervening area to the north of the Elands River between these farms. The pipeline will be 300mm in diameter and will be raised above ground level on plinths, and the construction servitude will be 30m wide.
- The construction of a Concentrator Plant on a footprint of approximately 6.3ha.
- The construction of a Product Stockpiles and Ore Crusher on a footprint of approximately 25.2ha adjacent to the Concentrator Plant.
- The construction of a Waste Rock Dump on a footprint of approximately 5.8ha.
- The construction of a Pollution Control Dam's for the Concentrator on a footprint of approximately 5.1 ha on the farm Frischgewaagd.
- The construction of a Return Water Dam with a footprint of approximately 1.2ha on the farm Mimosa.
- The construction of a Storm Water Dam with a footprint of approximately 14.9ha on the farm Mimosa.
- Relocation of the ore crusher circuit from underground to the surface.
- Inclusion of the minerals in the waste rock into the mining licence, as the waste rock may potentially be crushed and sold as aggregate.
- Construction of erosion control measures along watercourses within the mine.
- Storage and handling of dangerous goods such as diesel and reagents on site.
- Various pipeline and road crossings over watercourses.
- Construction of a 118m long road (including a bridge crossing of a deeply eroded ephemeral watercourse) linking Housing Phase 1 and Housing Phase 1a.
- New sewage and water pipelines.
- Settling and return water dams.
- New internal mine roads (some of which will cross watercourses).

- Ventilation shafts and raise boreholes.
- Generators or possibly a solar power plant on site, for back-up power.
- A salvage yard for temporary storage of general and hazardous waste.
- The construction of Phase 1 of the mine housing on a footprint of approximately 19.8ha on the farm Frischgewaagd
- The construction of Phase 1a of the mine housing on a footprint of approximately 25.2ha on the farm Frischgewaagd.
- The construction of the Eskom Ledig substation on a footprint of approximately 5.1ha adjacent to the Phase 1a mine housing.

The boundaries of the study area and the footprints of all infrastructure components assessed in the current report are shown on the map provided in Figure 1.

7.0 DESCRIPTION OF THE STUDY AREA

Locality and Land-Use

The study area is situated in the North-West Province approximately 30km northwest of Rustenburg in an area situated between the Pilanesberg Game Reserve to the north, the Elands River to the south and the western extremity of the Magaliesburg to the west. The approximately 1 123.8ha study area comprises two separate 'sections', namely the farms Frischgewaagd 96 JQ (465.5ha) and Mimosa 81 JQ (618.1ha), and a narrow tailings pipeline mapping corridor (39.5ha) linking Frischgewaagd and Mimosa. The existing Bakubung Mine shaft complex, as well as most of the proposed infrastructure components assessed in this study, are situated on the Frischgewaagd section of the study area, and only the proposed Tailings Storage Facility and adjacent Return Water Dam and Storm Water Dam are situated on the Mimosa section.

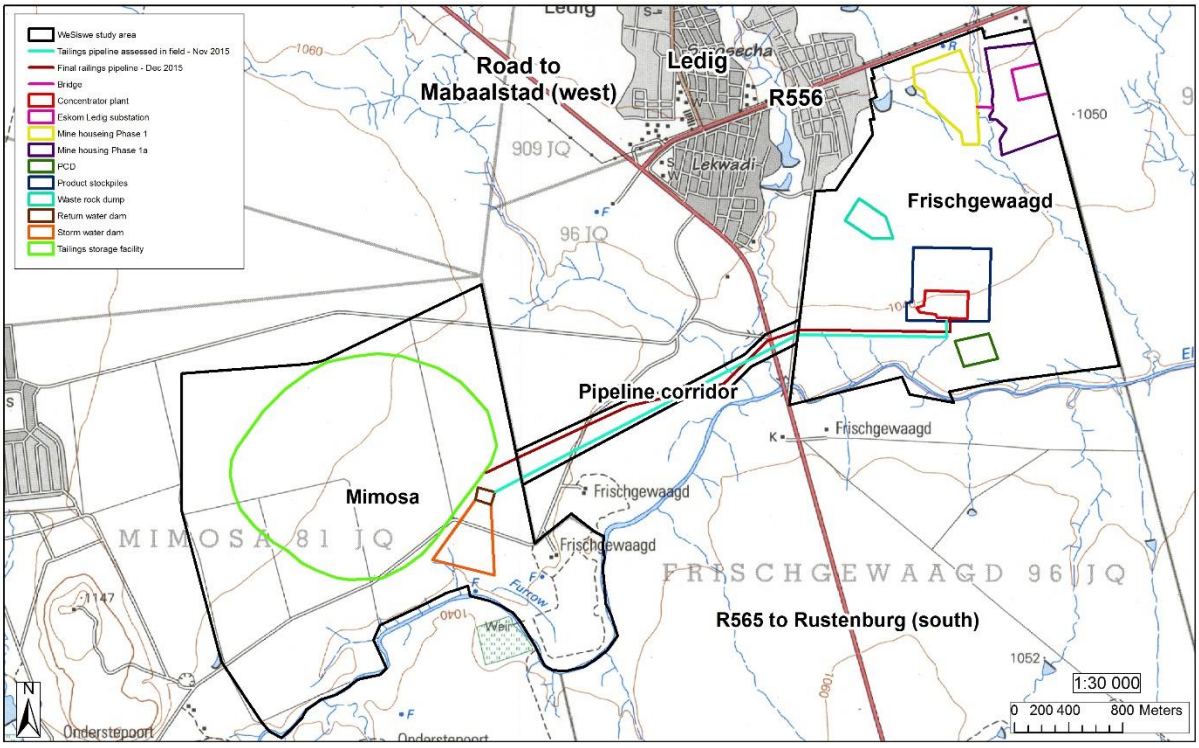
The Frischgewaagd section is situated immediately to the southeast of Ledig, the Mimosa section is situated some 2.1km to the west between Ledig and Phatsima. The Frischgewaagd and Mimosa sections fall within the quarter degree grid 2527AC. Both sections of the study area fall within the Bojanala Platinum District Municipality. A locality Map is provided in Figure 1.

Until approximately 2010 the Frischgewaagd section was entirely undeveloped and used as communal grazing land, though much of the section had been historically cultivated, particularly those parts situated with soils of the Arcadia and Oakley forms. In approximately 2013 the majority of the section was fenced with security fencing and currently the only land-use within the fenced section is mining. Mining infrastructure covers approximately 14% of the surface area of the Frischgewaagd section. The narrow (up to ca. 260m broad) portion of the Frischgewaagd section situated between the security fence and the Elands River, which forms the southern boundary of this section, is used as communal grazing land.

The Mimosa section currently remains entirely undeveloped, though approximately 55% of the section has been historically ploughed (mostly prior to 1990). These historically ploughed areas comprise the vast majority of the central and northern parts of this section as well as smaller areas along the Elands River. Most of the historically ploughed soils are of the Arcadia and Shortlands soil forms and almost all Arcadia soils have been historically ploughed. In 2014 the majority of the section was fenced with security fencing but grazing by

cattle and goats belonging to the Phatsima community is still allowed within both the fenced area and the narrow (up to ca. 400m broad) portion of the Mimosa section situated between the security fence and the Elands River, which forms the southern boundary of this section. The entire Mimosa section is therefore currently used as communal grazing land.

The narrow tailings pipeline mapping corridor located between Frischgewaagd and Mimosa is situated on communal land that is used as grazing land for cattle and goats. The area is heavily grazed by livestock belonging to residents of the nearby Ledig and Phatsima residential areas, and the vegetation has also been degraded by extensive and ongoing cutting of trees for fuelwood and construction material and overly frequent and unseasonal burning. Approximately 8.1% of the mapping corridor comprises the completely transformed habitats of infrastructure footprints adjacent to the western boundary of the Frischgewaagd section. Approximately 15.4% of the mapping corridor comprises secondary vegetation of historically ploughed soils of the Shortlands and to a lesser extent Valsrivier soil forms.



Locality map for WeSiwe study area with proposed infrastructure
(1:50 000 Topographical map 2527AC Sun City)

January 2016
Created by:

Figure 1: Locality map showing the Mimosa and Frischgewaagd sections of the study area and the tailings pipeline 'mapping corridor'.

Physiography

Frischgewaagd

The topography of the Frischgewaagd section is generally flat with moderate slopes leading down to the Elands River in the southern parts. The entire Frischgewaagd section falls within the south-western parts of the Elands River catchment, and this river forms the south-western boundary of the section. Various ephemeral drainage lines occur within the section, the largest of which has a naturally eroded and deeply incised (ca. 5m) macro-channel running

from north to south through the north-eastern parts of the study area before exiting the eastern boundary and flowing into the Elands River. Two ephemeral and indistinct ephemeral tributaries of the aforementioned deeply eroded drainage line flow through the north-western parts of the study area and two small earth-walled farm dams have been built on these tributaries. Two short (less than 350m in length) ephemeral drainage lines with well incised channels are found in the south eastern parts of the study in naturally eroded areas on Shortlands and Arcadia soil forms with scattered to dense pebbles and calcrete nodules on the surface.

The elevation of the Frischgewaagd section varies from 1031m.a.s.l. in the south-eastern corner near the Elands River to 1067 m.a.s.l. along the northern boundary. The geology of the area comprises basic igneous rock of the Bushveld Complex, but very little surface rock is present. The soils of the vast majority of the Frischgewaagd section are heavy clay soils or sandy clay loam soils with alluvial soils along the southern boundary adjacent to the Elands River. According to the soil survey previously completed for the Frischgewaagd section (Rehab Green, 2007), the dominant soil types are black clay soils of the Arcadia form and red sandy clay loam soils of the Shortlands form. Other soil forms present include (listed from greatest to least surface area covered): Oakleaf, Valsrivier, Bonheim and Mispah (only 2.35ha). Rainfall in the study area is approximately 550-600 mm per annum and occurs almost exclusively in the summer, with winters being very dry (Mucina & Rutherford, 2006). Fairly frequent frosts occur in winter.

Mimosa

The topography of the Mimosa section is generally flat with moderate slopes leading down to the Elands River in the southern parts. The entire Mimosa section falls within the south-western parts of the Elands River catchment, and this river forms the southern boundary of the section. Only three small, first order ephemeral drainage lines were recorded within the section. All of these drainage lines are short (less than 350m) and situated on moderate slopes above the Elands River, and the most easterly of these flows into a small lake within a meander scar on the Elands River floodplain.

The elevation of the Mimosa section varies from 1036m.a.s.l. in the south-eastern corner along the Elands River to 1073 m.a.s.l. in the north-western corner. The geology of the area comprises almost entirely of basic igneous rocks of the Bushveld Complex, but very little surface rock is present. A small, low outcrop of quartzitic rock is situated near the central part of the western boundary of the study area. The soils of the vast majority of the Mimosa section are heavy clay soils or sandy clay loam soils with alluvial sandy loam soils along the southern boundary adjacent to the Elands River. According to the soil survey previously completed for parts of the Mimosa section and its surrounds (Rehab Green, 2007), the dominant soil types are black clay soils of the Arcadia form and red sandy clay loam soils of the Shortlands form, and these two soil forms cover the vast majority of the current Mimosa section. Other soil forms present include (listed from greatest to least surface area): Oakleaf, Valsrivier Mispah (confined to 3.8ha on quartzitic outcrop). Rainfall in the study area is approximately 550-600 mm per annum and occurs almost exclusively in the summer, with winters being very dry (Mucina & Rutherford, 2006). Fairly frequent frosts occur in winter.

Tailings pipeline mapping corridor

The pipeline mapping corridor is situated mostly on a gentle (ca. 2º to 4º) south-west facing slope. The 'final' pipeline alignment is situated to the north of the Elands River at a distance of approximately 130m to 750m. The Pipeline final alignment crosses the Sandspruit at a point situated some 330m west-south west of the point where it crosses the R565 tar road. No other watercourses of drainage lines are crossed by the pipeline within the mapping corridor.

The elevation within the mapping corridor varies from 1034 m.a.s.l at the crossing of the Sandspruit to 1050 m.a.s.l on the eastern boundary of the Mimosa section. The geology of the area comprises almost entirely of basic igneous rocks of the Bushveld Complex, but very little surface rock is present other than on a patch of rocky soils approximately 0.15ha directly to the west of the Sandspruit. This rocky patch is not crossed by the final pipeline alignment. The soils of the vast majority of the pipeline mapping corridor section are heavy clay soils or structured sandy clay loam soils. According to the recently completed specialist soil report for the mapping corridor (De Castro & Brits, Feb 2015), the vast majority of the mapping corridor is situated on soils of the Shortlands soils form with smaller areas of Valsrivier soils and a narrow band of Arcadia near the Mimosa boundary. A very narrow band of soils of the Oakleaf and Mispah forms occurs along the Sandspruit.

Broad-scale Vegetation and Habitat Patterns

The recently completed North West Biodiversity Sector Plan (2015) provides revised mapping of the national vegetation types (Mucina and Rutherford, 2006) within the North West Province. According to this revised mapping (see Appendix 7), six vegetation types occur within 3km of the study area and four vegetation types occur within the study area, indicating that the study area is situated within a zone of transition. The vast majority of the study area itself is mapped a Zeerust Thornveld, with a significant area of Western Sandy Bushveld indicated in the western parts of the Mimosa section and very small areas of Moot Plains Bushveld and Marikana Thornveld indicated along the southern boundaries of the Mimosa and Frischgewaagd sections respectively. However, the NWBSP vegetation map was compiled at a provincial scale and relied strongly on land type mapping (Land Type Survey Staff, 1972 – 2006) which is inaccurate for much of the study area (De Castro & Brits, Feb 2016). Furthermore, there are in reality seldom distinct boundaries between vegetation types and vegetation types grade into each over large areas referred to as transition zones.

Though the vegetation of the study area shows some physiognomic, and to a lesser extent floristic, elements of Zeerust Thornveld, it does not show any significant similarities to Western Sandy Bushveld, and conforms far more closely to the description of Marikana Thornveld provided by Mucina & Rutherford (2006), particularly in terms of species composition and dominance (see Table 3). The vegetation of the vast majority of the study area is therefore here regarded as Marikana Thornveld. The only other Mucina & Rutherford (2006) vegetation type identified within the study area is Gold Reef Mountain Bushveld, which is represented by a very small (ca. 2.5ha) area at site M37 on a low quartzitic outcrop near the western boundary of the Mimosa section.

The Marikana Thornveld vegetation type is included in the Central Bushveld Bioregion of the Savanna Biome (Mucina and Rutherford, 2006). Marikana Thornveld occurs entirely within North-West Province and the northern parts of Gauteng to the north of the Magaliesburg from Pretoria westwards. According to Mucina and Rutherford (2006) Marikana Thornveld has a national conservation status of Endangered, but the more recent NWBSP 2015 categorises Marikana Thornveld as **Vulnerable**. Marikana Thornveld originally covered approximately

165 663ha within the North West Province, of which 68 105ha (or 41.1%) remain untransformed (NWBSP 2015). Transformation is largely attributable to cultivation and to a lesser extent residential and industrial (e.g. mining) development. Less than 1% of this vegetation type is statutorily conserved and the Biodiversity conservation target is 19% (Mucina and Rutherford 2006). Erosion levels are very low to moderate and alien plant infestation occur localised and in high densities along drainage lines.

The Gold Reef Mountain Bushveld vegetation type is also included in the Central Bushveld Bioregion of the Savanna Biome (Mucina and Rutherford, 2006). Gold Reef Mountain Bushveld is largely confined to rocky quartzitic ridges of the Magaliesburg and the parallel ridge to the south, and occurs in the North-West, Gauteng, Free State and Mpumalanga Provinces. Gold Reef Mountain Bushveld has a national conservation status of **Least Threatened** (Mucina & Rutherford, 2006 and NWBSP 2015), and some 22% of this vegetation type is statutorily conserved mainly in the Magaliesburg Nature area and in smaller proportions in the Rustenburg, Wonderboom and Suikerbosrand Nature Reserves. Gold Reef Mountain Bushveld originally covered approximately 254 230ha within the North West Province, of which 213 914ha (or 84.1%) remain untransformed (NWBSP 2015). Transformation is largely attributable to cultivation and urbanisation. Alien plant infestation is still relatively low but dense stands of *Melia azedarach** are associated with alluvia along drainage lines embedded in this unit, and erosion is currently assessed as very low to low (Mucina & Rutherford, 2006).

Dominant and common plant species listed for Marikana Thornveld, Gold Reef Mountain Bushveld, Zeerust Thornveld and Western Sandy Bushveld by Mucina and Rutherford (2006) are presented in Table 3.

Table 3: Dominant and common plant taxa of Marikana Thornveld, Zeerust Thornveld, Gold Reef Mountain Bushveld and Western Sandy Bushveld (extracted from Mucina & Rutherford, 2006).

SVcb 6 – Marikana Thornveld	
Growth Form	**Species***
Tall trees	*Acacia burkei*
Small Trees	*Acacia caffra (d), Acacia gerrardii (d), Acacia karroo (d), Combretum molle (d), Searsia lancea (d), Ziziphus mucronata (d), Acacia nilotica, Accia tortilis* subsp. *heteracantha, Celtis africana, Dombeya rotundifolia, Pappea capensis, Peltophorum africanum, Terminalia sericea.*
Tall Shrubs	*Euclea crispa* subsp. *crispa (d), Olea europaea* subsp. *africana (d), Searsia pyroides* subsp. *pyroides (d), Diospyros lyciodes* subsp. *guerki, Eheretia rigida* subsp. *rigida, Euclea undulata, Grewia flava, Pavetta gardeniifolia*
Low Shrubs	*Asparagus cooperi (d), Rhynchosia nitens (d), Indigofera zeyheri, Justicia flava*
Woody Climber	*Clematis brachiata, Helinus integrifolius*
Herbaceous Climbers	*Pentarrhinum insipidum (d) Cyphostemma cirrhosum*
Graminoids	*Elionurus muticus (d), Eragrostis lehmanniana (d), Setaria sphacelata (d), Themeda triandra (d), Aristida scabrivalvis, Fingerhuthia Africana, Heteropogon contortus, Hyperthelia dissoluta, Melinis nerviglumis, Pogonarthria squarrosa.*
Herbs	*Hermannia depressa (d), Ipomoea obscura (d), Barleria macrostegia, Dianthus moiiensis* subsp. *mooiensis, Ipomoea oblongata, Vernonia oligocephala*.
Geophytic Herbs	*Ledebouria revoluta, Ornithogalum tenuifolium, Sanseviera aethiopica.*
Gold Reef Mountain Bushveld	

Growth Form	Species
Small Trees	*Acacia caffra (d), Combretum molle (d), Protea caffra (d),Celtis Africana, Dombeya rotundifolia, Englerophytum magalismontanum, Ochna pretoriensis, Rhus leptodictya, Vangueria infausta, V. Parvifolia, Ziziphus mucronata.*
Tall Shrubs	*Canthium gilfillanii, Ehretia rigida* subsp. *rigida, Grewia occidentalis, Gymnosporia buxifolia, Mystroxylon aethiopicum* subsp. *burkeanum.*
Low Shrubs	*Athrixia elata, Pearsonia cajanifolia, Rhus magalismontanum* subsp. *magalismontanum. R. rigida* var. *rigida.*
Woody Climber	*Ancylobotrys capensis*
Graminoids	*Loudetia simplex (d), Panicum natalense (d), Schizachyrium sanguineum (d), Trachypogon spicatus (d), Alloteropsis semialata* subsp. *eckloniana, Bewsia biflora, Digitaria tricholaenoides, Diheteropogon amplectens, Sporobolus pectinatus, Tristachya biseriata, T. leucothrix.*
Herbs	*Helichrysum nudifolium, H. rugulosum, Pentanisia angustifolia, Senecio venosus, Xerophyta retinervis.*
Geophytic Herbs	*Cheilanthes hirta, Hypoxis hemerocallidea, Pellaea calomelanos*
SVcb 3 - Zeerust Thornveld	
Growth Form	**Species**
Tall trees	*Acacia burkei (d), Acacia erioloba (d)*
Small trees	*Acacia burkei (d), A. erioloba (d), A. mellifera* subsp. *detinens (d), A. nilotica (d), A. tortilis* subsp. *heteracantha (d), Searsia lancea (d), A. fleckii, Peltophorum africanum, Terminalia sericea.*
Tall Shrubs	*Diospyros lycioides* subsp. *lycioides, Grewia flava, Mystroxylon aethiopicum* subsp. *burkeanum.*
Low Shrubs	*Agathisanthemum bojeri, Chaetacanthus costatus, Clerodendrum ternatum, Indigofera filipes, Searsia grandidens, Sida chrysantha, Stylossanthes fruticosa.*
Dominant Grasses	*Eragrostis lehmanniana (d), Panicum maximum (d), Aristida congesta, Cymbopogon pospischilii.*
Herbs	*Blepharis integrifolia, Chamaecrista absus, C. mimosoides, Cleome maculata, Dicoma anomala, Kyphocarpa angustifolia, Limeum viscosum, Lophiocarpus tenuissimus.*
SVcb 16 – Western Sandy Bushveld	
Growth Form	**Species**
Tall tree	*Acacia erioloba, Acacia nigrescens, Sclerocarya birrea.*
Small Trees	*Acacia eribescens (d), Acacia mellidera* subsp. *detinens (d), Acacia nilotica, Acacia tortilis* subsp. *heteracantha (d), Combretum apiculatum (d), Combretum imberbe (d), Terminalia sericea (d), Combretum zeyheri, Lannea discolor, Ochna pulchra, Peltophorum africanum.*
Tall Shrubs	*Combretum hereoense (d), Euclea undulata (d), Coptosperma supra-axillare, Dichrostachys cinerea, Grewia bicolor, Grewia flava, Grewia monticola.*
Low shrubs	*Clerodendrum ternatum, Indigofera filipes, Justicia flava.*
Graminoids	*Anthephora pubescens (d), Digitaria eriantha* subsp. *eriantha (d), Eragrostis pallens (d), Eragrostis rigidior (d), Schmidtia pappophoroides (d), Aristida congesta, A. diffusa, A. stipitat* subsp. *graciliflora, Eragrostis superba, Panicum maximum, Perotis patens.*
Herbs	*Blepharis integrifolia, Chamaecrista absus, Evolvulus alsinoides, Geigeria burkei, Kyphovapa angustifolia, Limeum fenestratum, L. viscosum, Lophiocarpus tenuissimus, Monsonia angustifolia.*

* Dominant species indicated with (d).

The study area is not situated within any of the South African centres of endemism recognised by Van Wyk and Smith (2001).

The North West Province Biodiversity Sector Plan (NWBSP) (North West Department of Rural, Environment and Agricultural Development, 2015), provides a map of Critical

Biodiversity Areas (CBAs) and Ecological Support Areas (ESAs) for the entire province, which is referred to as the CBA Map in the NWBSP. Categories used in the CBA Map are as follows:

- Protected Areas – declared and formally protected under the Protected Areas Act, such as National Parks, legally declared Nature reserves, World Heritage Sites and Protected Environments that are secured by appropriate legal mechanisms.
- Critical Biodiversity Areas (CBAs) – terrestrial and aquatic areas of the landscape that need to be maintained in a natural or near natural state in order to ensure the continued existence and functioning of species and ecosystems and the delivery of ecosystem services. In other words, if these areas are not maintained in a natural or near-natural state, then biodiversity targets cannot be met. Maintaining an area in a natural state can include a variety of biodiversity compatible land uses and resource uses.
- Ecological Support Areas (ESAs) – terrestrial and aquatic areas that are not essential for meeting biodiversity representation targets (thresholds), but which nevertheless play an important role in supporting the ecological functioning of critical biodiversity areas and/or in delivering ecosystem services that support socio-economic development, such as water provision, flood mitigation or carbon sequestration. The degree or extent of restriction on land use and resource use in these areas may be lower than that recommended for CBA's.
- Other Natural Areas - remaining natural areas not included in the above CBA or ESA categories. Degraded areas falling with the CBA and ESA categories. Areas that still contain natural habitat but that are not required to meet biodiversity targets.
- No Natural Habitat Remaining – areas that have been irreversibly modified (i.e. transformed) and do not contribute to maintaining biodiversity pattern or ecological processes. These include urban and rural settlements, crop lands, mining areas and forest plantations.

The principal 'Land Management Objectives' for CBA 2 areas provided in the NWBSP 2015 are reproduced in the 'text box' provided below.

TEXT BOX
(extracted from Table 12 of the NWBSP 2015)

CBA Map category	Land Management Objective
CBA 2	**Maintain in a natural or near natural state that maximises the retention of biodiversity pattern and ecological process**: • Ecosystems and species fully or largely intact and undisturbed. • Areas with intermediate irreplaceability or some flexibility in terms of meeting biodiversity targets. There are options for loss of some components of biodiversity in these landscapes without compromising the ability to achieve biodiversity targets, although the loss of these sites would require alternative sites to be added to the portfolio of CBAs. • These are biodiversity features that are approaching, but have not surpassed their limits of acceptable change.
ESA 1	**Maintain in at least a semi- natural state as ecologically functional landscapes that maintain basic natural attributes:** • Ecosystem still in a natural, near-natural or semi-natural state, and has not been previously developed (e.g. ploughed). • Ecosystems moderately to significantly disturbed but still able to maintain basic functionality. • Individual species or other biodiversity indicators may be severely disturbed or reduced. • These are areas with low irreplaceability with respect to biodiversity targets only.
ESA 2	**Maintain as much ecological functionality as possible (generally these areas have been**

TEXT BOX (extracted from Table 12 of the NWBSP 2015)	
CBA Map category	Land Management Objective
	substantially modified): • Maintain current land-use or restore area to a natural state. • Ecosystem NOT in a natural or near-natural state, and has been previously developed (e.g. ploughed). • Ecosystems significantly disturbed but still able to maintain some ecological functionality. • Individual species or other biodiversity indicators are severely disturbed or reduced and these are areas that have low irreplaceability with respect to biodiversity pattern targets only. • These are areas with low irreplaceability with respect to biodiversity targets only. These are areas required to maintain ecological processes especially landscape connectivity.

In terms of managing the loss of natural habitat in CBAs, the NWBSP 2015 states, amongst others, that '**further loss of natural habitat should be avoided in CBA 1, whereas loss should be minimised in CBA 2 i.e. land in these two categories should be maintained as natural vegetation cover as far as possible**'. Maps of showing the extent of CBA 2, ESA 1 and ESA 2 areas within the study area and its immediate surrounds, are provided in Appendix 8. The CBA Map categories of each section of the study area are briefly discussed below.

Distribution of CBA 2 and ESAs within the study area

The vast majority of the study area is mapped as **CBA Category 2** in the NWBSP 2015 (see map in Appendix 8). Small areas of ESA 1 and ESA 2 are mapped in the southern parts of Mimosa, and small areas of No Natural Habitat Remaining (20.4ha or 1.8% of the study area) are mapped in Frischgewaagd around the Bakubung mine shaft complex and along the boundary with Ledig. According to the available GIS information for the NWBSP, the principal criteria which lend CBA 2 status to the habitats of study area are that it is regarded as 'Natural Corridor Linkage' and 'Natural Protected Area Buffer' (within 5km of the Pilanesberg National Park). The small area of ESA 1 in Mimosa is based on the 'Natural Corridor Linkage' criteria and the small area of ESA 2 in Mimosa is based on the 'Natural Corridor Linkage' criteria and the small area of ESA 2 in Mimosa is based on the 'Non-natural Corridor Linkage criteria'.

Approximately 1 066.1ha (or 94.9%) of the 1 123.1 study area is mapped as CBA 2 in the NWBSP 2015, and all the proposed infrastructure footprints and alignments fall within the area mapped as CBA Category 2. However, the NWBSP 2015 mapping for the study area is not accurate, as CBA 2 includes large areas that have been transformed through cultivation and mining, and currently comprises secondary vegetation of historically cultivated areas or permanently transformed areas (i.e. mine shaft complex and associated infrastructure). Approximately 457.0ha (or 42.9%) of the 1 066.1ha area mapped as CBA 2 within the study area comprises transformed habitats with secondary vegetation or no vegetation.

The habitats and vegetation of approximately 527.5ha (or 47.0%) of the study area has been historically transformed and comprises secondary vegetation of historically cultivated areas or areas permanently transformed by mining infrastructure. The proposed infrastructure footprints (excluding the pipeline alignment) have a combined surface area of approximately 344.3ha, approximately 193.4ha (or 56.2%) of which has been transformed and comprises secondary vegetation of historically cultivated areas or areas permanently transformed by mining infrastructure. Approximately 1.13km's (or 29.4%) of the proposed 3.83km long

tailings pipeline alignment is situated within transformed habitats which comprise secondary vegetation of historically cultivated areas or areas permanently transformed by mining and road infrastructure.

Approximately 2.8% (or 31.4ha) of the study area is mapped as ESA 1 and approximately 0.5 % (or 5.2ha) of the study area is mapped as ESA 2. Both these ESA areas are located in the southern parts of Mimosa. Approximately half of the area mapped as ESA 1, and almost the entire area mapped as ESA 2, comprise secondary vegetation of historically cultivated areas.

8.0 DESCRIPTION OF VEGETATION AND LAND-COVER TYPE UNITS OF THE STUDY AREA

Frischgewaagd

Although the original vegetation cover of the Frischgewaagd section would have been short thorny woodland representative of Marikana Thornveld (Mucina & Rutherford, 2006), approximately 37.5% of this vegetation in the study area has been transformed through historical cultivation and mining, and currently comprises secondary vegetation of historically cultivated areas or permanently transformed areas (i.e. mine shaft complex and associated infrastructure). Historical cultivation is the greatest contributor to transformation within the study area. The remaining areas of untransformed vegetation, comprising mostly Thicket, Woodland and Bushland (*sensu* Edwards, 1983) have been degraded by anthropogenic impacts such as historical heavy grazing and browsing by cattle and goats, current (in the last four years) exclusion of grazers and browsers, altered fire regimes (burning to frequent in the past and fire currently excluded by mine), selective cutting of large trees, alterations to hydrological patterns and water quality, and invasion by alien plants along the Elands River.

The broad-scale vegetation units and land-cover type units described below have been derived on the basis of structural and functional criteria. The term structure refers to various aspects of vegetation structure such as physiognomy, life-form composition, species composition, species dominance and stand structure (Kent & Coker, 1992). Functional criteria include aspects such a characteristic ecosystem processes, habitat characteristics, habitat suitability for certain threatened species and ecological status (e.g. primary vegetation of untransformed habitats versus secondary vegetation of transformed or severely degraded habitats). The floristic data set gathered at fourteen sites within Frischgewaagd where vegetation was sampled within 100m^2 quadrats, is provided in Appendix 3.

Despite the high levels of transformation within the Frischgewaagd section, many of the remaining areas of untransformed habitat and vegetation remain diverse (in the context of the Savanna Biome) and species rich (α-diversity), as is reflected by the fact that 338 plant species and infra-specific taxa have thus far been recorded on the basis of relatively brief surveys (see Appendix 1). The Beta diversity (β-diversity), which is the 'rate of change in species composition across habitats or among communities' is also relatively high. The broad-scale vegetation units described below are therefore simply practical units that combine various plant communities which share structural and functional characteristics and have common management requirements.

A total of five units comprising untransformed vegetation and three units comprising transformed habitats with secondary vegetation or no vegetation (i.e. infrastructure) were identified. These eight units are listed and briefly described in Table 4, and each unit is described in more detail below. Photographs of the vegetation units are provided in Appendix 11. The approximate delineation of the vegetation and land-cover units listed in Table 4 is shown in Figure 2.

Table 4: Broad-scale vegetation and land-cover type units identified within the Frischgewaagd section.

Veg/land-cover unit no.	Name	Description
1	Marikana Thornveld	Untransformed woody communities representative of the Marikana Thornveld vegetation type (Mucina & Rutherford, 2006).
1.1	Mixed Woodland & Thicket - on red clay loam soils	Thicket, Short/Low Woodland and Bushland communities of red-brown clay loam soils. Dominated by *Searsia lancea, Zizphus mucronata* and *Acacia* spp
1.2	*Acacia mellifera* Bushland and Thicket	Dense *Acacia mellifera* Thicket and Bushland and *Acacia mellifera, Acacia tortilis* and *Tarchonanthus parvicapitulatus* communities on red-brown clay to grey brown soils in southern parts of study area.
2	Stony Grassland	Grassland and Low Open Shrubland on red-brown, soils of the Shortlands form with alluvial pebbles scattered on the surface. South-eastern parts of the study area.
3	Eroded ephemeral drainage lines - Grassland and Open Shrubland	Grassland and Shrubland along incised ephemeral drainage lines, with occasional, scattered trees. Includes small ephemeral drainage lines with shallowly incised channels surrounded by, stable eroded areas with exposed calcrete and rounded (probably alluvial) stones vegetated by Grassland and Shrubland in the southern parts of the study area, as well as a deeply incised larger ephemeral drainage line running from N to S through the north-eastern parts of the study area. No hygrophilous vegetation is present along the small southern drainage lines, but hygrophilous grassland is present along the active channel of the larger drainage line in the north.
4	Ephemeral drainage lines - hygrophilous Grassland and Thicket	Hygrophilous Grassland, Open Shrubland and Thicket of an indistinct ephemeral drainage line system in the north-western parts of the study area. The upper reaches of this drainage line comprise a series of small discontinuous swales, and the lower reaches a more distinctly incised channel. Periodically (e.g. March 2014) the upper reaches of this drainage line flood broad floodplains which may be over 50m wide. Most of the widely flooded areas are on black vertic clays.
5	Elands River vegetation	Vegetation of the macro-channel bank and periodic floodplain of the Elands River. Includes marginal vegetation of the macro-channel bed vegetation, riparian Closed Woodland and Forest, and Low Bushland to Short Thicket of upper parts of macro-channel bank.
6	Secondary vegetation	Secondary vegetation of historically cultivated areas, borrow pits and scoured soils. Includes mostly secondary Bushland and Shrubland with smaller areas of secondary Thicket and patches of secondary Grassland on recently disturbed sites. Includes almost all areas on black turf soils classified as Arcadia (Ar1) soils by Steenekamp (August, 2007) as well as areas of red-brown soils of the Oakleef and Vlasrivier forms. Vegetation structure varies greatly in accordance with soil type, time elapsed since disturbance and the nature and duration of disturbance.

7	Dams	Secondary wetland vegetation of farm dams.
8	Infrastructure	Mine plant, process water dams, waste rock dumps, topsoil stockpiles and associated infrastructure.

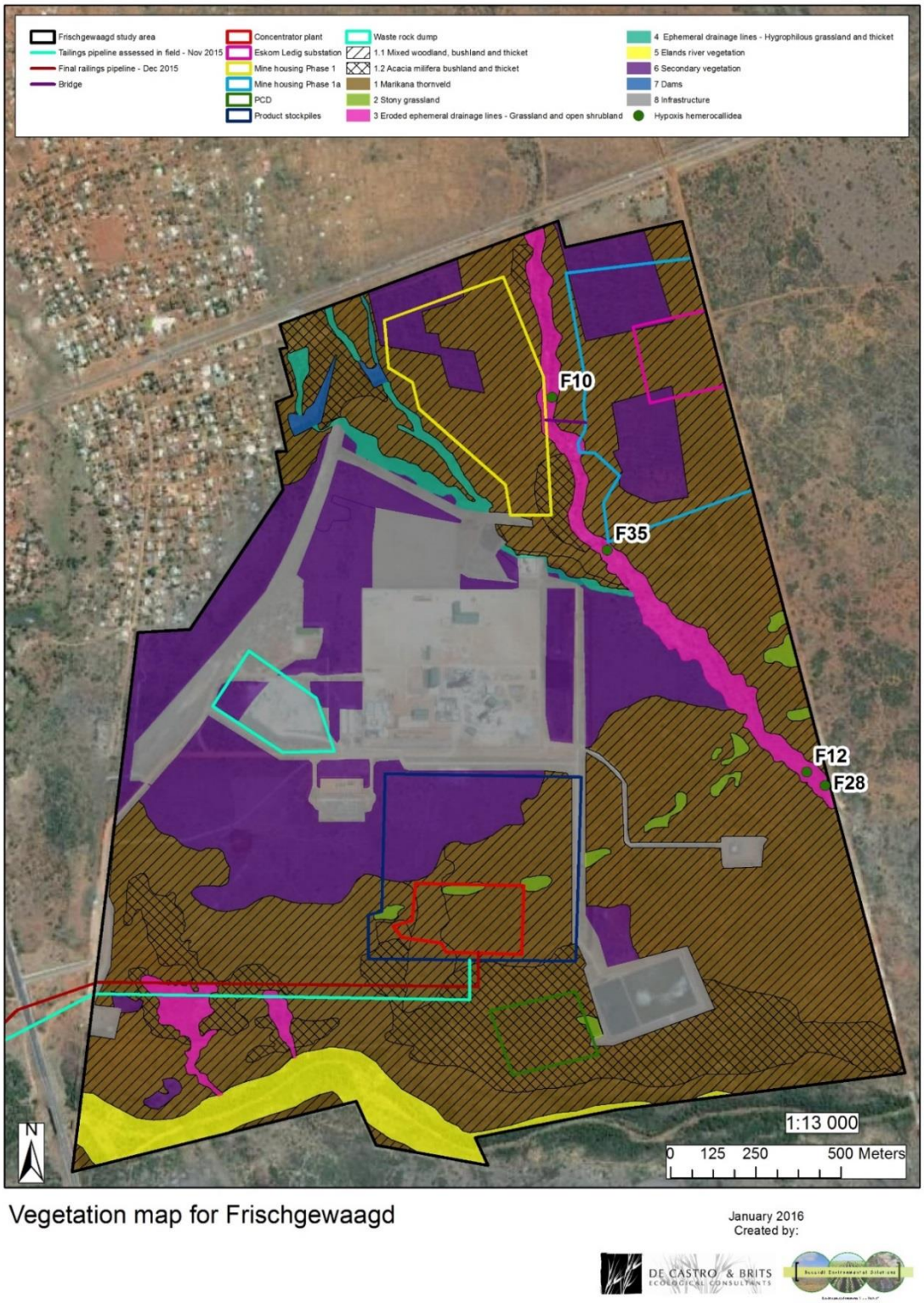


Figure 2: Vegetation and land-cover units identified within Frishgewaagd, showing footprints of proposed infrastructure components.

The percentage of the Frischgewaagd section occupied by each of the identified vegetation and land-cover units, number of surveyed quadrats in each unit, mean species richness per $100m^2$, and perceived biodiversity conservation value / sensitivity of each unit is provided in Table 5. A brief description of the vegetation structure, ecological status, habitat characteristics and biodiversity conservation value / sensitivity of each unit is provided below. The terminology used in describing the vegetation physiognomy of the woody and herbaceous plant communities, is that developed by Edwards (1983). In the vegetation descriptions provided below, an asterisk indicates an alien species.

Unit 1: Marikana Thornveld

The extent of this unit within Frischgewaagd is 249.0ha (or 53.5% of the section). This vegetation unit occurs mostly on deep red-brown to brown clay loam to sandy clay loam soils smaller areas on situated on black clay soils that have not been historically ploughed. The dominant soil form of this unit is Shortlands, but the following soil forms, in approximate descending order of importance, are present (Rehab Green, 2007): Arcadia, Oakley, Valsrivier, Bonheim and Mispah. Historically this unit covered the vast majority of the Frischgewaagd section but much of its original extent has been transformed by ploughing and historical cultivation. Historically, prior to commencement of mining, this unit was heavily grazed and browsed by domestic livestock and frequently burnt, and these impacts have almost certainly led to an increase in shrub density and cover and reduced tree density and cover. Currently much of the area of this unit is fenced within the Wesizwe security fence and is not grazed or browsed and vegetation of the fenced area is moribund.

In terms of physiognomy, the vegetation can be described as Short/Low Closed Woodland, Short/Low Thicket and Short Bushland. Two major plant communities occur within this unit, namely Mixed Thicket, Short/Low Woodland and Bushland on a variety of soil forms listed above (Unit 1.1) and a less extensive community of *Acacia mellifera* Thicket and Bushland on soils of the Valsrivier form (Unit 1.2).

In unit 1.1, common trees include *Acacia caffra, Acacia robusta, Acacia karoo, Acacia tortilis, Searsia lancea* and *Ziziphus mucronata*. Dominant shrubs include *Acacia caffra* and *Acacia karoo*. Common shrubs include *Acacia erubescens, Carissa bispinosa, Diospyros lycioides, Grewia flava, Acacia tortilis, Searsia lancea* and *Searsia pyroides*. The dominant grasses are *Themeda triandra* and *Cymbopogon pospischilii*. Common grasses include *Aristida canescens, Aristida congesta* subsp. *barbicollis, Enneapogon scoparius, Eragrostis rigidior, Eragrostis trichophora, Eragrostis superba, Melinis repens, Panicum coloratum* and *Panicum maximum.* Common forbs and geoxylic suffrutices include *Aptosimum procumbens, Barleria macrostegia, Commelina africana, Crabaea angustifolia, Geigeria burkei, Felicia muricata, Hermannia depressa, Hibiscus pusillus, Vernonia oligicephala* and *Ziziphus zeyheriana.* The low shrub *Asparagus suaveolens* and the succulent *Aloe davyana* are also common.

Unit 1.2 occurs predominantly on soils of the Valsrivier form and is not considered to be a secondary vegetation type though some encroachment of *Acacia tortilis* may have occurred as part of historical mismanagement (grazing and fire). This sub-unit has relatively high species richness and is regarded as an important contributor to habitat variation in the study area. In Unit 1.2 few trees occur. Common trees include *Acacia mellifera, Acacia karoo* and *Acacia tortilis*. The dominant shrub is *Acacia mellifera*, which usually constitutes the vast majority of woody cover. Common shrubs include *Diospyros lyciodes, Grewia flava,*

Gymnosporia buxifolia, Carissa bispinosa, Lycium cinereum and *Tarchonathus parvicapitulatus.* Dominant grasses include *Panicum coloratum, Eragrostis chloromelas, Eragrostis curvula* and *Heteropogon contortus*. Common grasses include *Sporobolus fimbriatus, Aristida congesta* subsp. *barbicollis, Aristida congesta* subsp. *congesta, Digitaria eriantha, Eragrostis trichophora* and *Melinis repens*. Common forbs include *Blepharis integrifolia, Commelina africana, Corchorus aspleniifolius, Evolvulus alsinoides, Justicia betonica, Merremia plamata, Ruelliopsis setosa* and *Seddera capensis*. The low shrub *Asparagus suaveolens* and the succulent *Aloe davyana* are also common.

Average species richness measured in sampling plots placed within vegetation unit as a whole (i.e. units 1.1 and 1.2) was 34 species per $100m^2$, which is high for Central Bushveld vegetation, and varied from 25 to 39 species per $100m^2$. This unit contains habitat that is considered suitable for one of the 'plant species of conservation concern' recorded or potentially occurring in the vicinity of the study area (see Appendix 5), namely *Drimia sanguinea* (Near Threatened). The only Protected tree species recorded at Frischgewaagd, namely *Boscia albitrunca*, was recorded within this unit. This unit is considered representative of somewhat degraded but untransformed Marikana Thornveld, a Vulnerable vegetation type (Mucina & Rutherford, 2006). Though somewhat degraded, the vegetation of this unit is still likely to contain its pre-disturbance species richness and should revert to a climax state under correct management. Much of the extent of Marikana in the vicinity of the study area has been transformed by urbanisation, cultivation and mining. This unit is therefore considered to have a **High** botanical biodiversity conservation value and sensitivity.

Unit 2: Stony Grassland

The extent of this unit within Frischgewaagd is 3.6ha (or 0.8% of the section). This unit is entirely restricted to a few small and distinct patches along the central parts of the eastern boundary of the Frischgewaagd section. These patches seem to overlie a discontinuous dolerite dyke, and all comprise areas of red, sandy clay loams which are a variation of the Shortlands form (Rehab Green 2007) and are characterised by scattered to dense rounded pebbles (3cm to 20cm diameter), on the surface. For approximately three years the area has not been grazed or burnt and the vegetation is moderately moribund.

In terms of physiognomy, the vegetation of this unit can be described as Short Closed Grassland which grades to Low Open Shrubland in smaller areas. Some patches of this Grassland community have been invaded by *Acacia tortilis, Acacia karoo* and *Acacia mellifera* shrubs, and fire plays an important role in preventing shrub encroachment for maintaining this plant community.

This plant community comprising this unit has high species richness (α-diversity). Grasses are dominant but there and there is high diversity of forbs and low (<50cm) shrubs. The dominant grasses are *Trachypogon spicatus, Elionurus muticus* and *Schizachyrium sanguineum*. Common grasses include *Anthephora pubescens, Aristida canescens, Bewsia biflora, Brachiaria nigropedata, Diheteropogon amplectans, Enneapogon scoparius, Heteropogon contortus, Loudetia flavida* and *Urelytrum agropyroides*. Common forbs and low shrubs include *Aptosimum procumbens, Bulbostylis hispidula, Cyanotis speciosa, Dicoma anomala, Gnidia caffra, Ipomoea bathycolpos, Rhynchosia minima, Rotheca* cf. *hirsuta, Sida chrysantha, Silene* sp., *Triumfetta sonderi, Vernonia oligocephala* and *Ruellia patula*.

Species richness measured in the only vegetation sampling plot placed within this unit was 41 species per $100m^2$, which is the highest species richness measured in any of the 14 sampling plots surveyed at Frischgewaagd, and is regarded a very high for the Central Bushveld Bioregion. This unit contains habitat that is considered suitable for one of the 'plant species of conservation' concern recorded or potentially occurring in the vicinity of the study area (see Appendix 5), namely *Boophone disticha* (Declining). Various species recorded in this unit were recorded only in this unit (e.g. *Bewsia biflora, Elionurus muticus, Loudetia flavida, Urelytrum agropyroids, Bulbine capitata* and *Rotheca* cf. *hirsuta*) or were recorded only in this unit and in Unit 3 (e.g. *Euphorbia davyi*). Given the unique and highly spatially restricted (both within the study area and its surrounds) habitat comprising this unit, as well as the fact that the area has been poorly explored botanically, this unit is considered to have high potential as habitat for 'species of conservation concern'. This unit forms a localised plant community within Marikana Thornveld. This unit is therefore considered to have a **High** botanical biodiversity conservation value and sensitivity.

Unit 3: Eroded ephemeral drainage lines – Grassland and Open Shrubland

The extent of this unit within Frischgewaagd is 15.6ha (or 3.3% of the section). This unit includes small ephemeral drainage lines with shallowly incised channels surrounded by stable, shallowly eroded areas with exposed calcrete and rounded (probably alluvial) stones vegetated by Grassland and Shrubland in the southern parts of the study area, as well as a deeply incised larger ephemeral drainage line running from north to south through the north-eastern parts of the study area. No hygrophilous vegetation is present along the two small southern drainage line systems, but hygrophilous grassland is present along the margins of the active channel of the larger drainage line in the north. The larger, northern drainage line runs through soils of the Oakley form (in its upper reach), Valsrivier form (along a short length of its middle reaches) and Arcadia form (along the lower half of its course) (Rehab Green, 2007). The eastern most of the two smaller southern drainage lines is situated on soils of the Arcadia form and the western one is situated on soils of the Shortlands form (Rehab Green, 2007). The larger, northern drainage line is deeply eroded to a depth of up to 6m in its upper reaches on Oakleaf soils, but in its lower reaches (on Arcadia soils) the macro-channel is broader and less incised and the macro-channel habitats and vegetation are similar to those of the smaller southern drainage lines.

The central channel of the larger northern stream has distinct, narrow band of marginal vegetation. The vegetation can be described as marginal hygrophilous grassland with scattered riparian large shrubs and small trees, the most common of which is *Searsia lancea*. Other riparian shrubs and small trees include *Acacia karoo, Searsia pyroides* and *Ziziphus mucronata*. The dominant grasses include *Imperata cylindrica* and *Botriochloa insculpta*. Common to sub-dominant grasses include *Botriochloa bladhii, Eragrostis capensis, Hyparrhenia dregeana, Hyparrhenia filipendula, Hyparrhenia hirtaand* and *Themeda triandra*. Common forbs include *Berkheya radula, Cephalaria zeyheriana, Haplocarhpa lyrata, Lobelia thermalis, Nidorella resediifolia, Salvia runcinata* and *Vigna vexillata*.

Small trees which occur scattered on the naturally eroded areas associated with these drainage lines include *Acacia karoo, Acacia mellifera, Maerua angolensis, Olea europaea* subsp. *africana* and *Searsia lancea*. Common shrubs include *Acacia mellifera, Dodonaea viscosa* var. *angustifolia, Euclea undulata, Grewia flava, Searsia lancea* and *Tarconanthus parvicapitulatus*.

The vegetation of the naturally eroded areas associated with the two smaller southern drainage lines and the lower reaches of the larger northern drainage line is Short Closed Grassland. The dominant grass is *Aristida canescens* and *Trachypogon spicatus* is sub-dominant. Common grasses include *Cymbopogon pospischilii, Diheteropogon spicatus, Enneapogon scoparius, Fingerhuthia africana, Melinis repens, Schmidtia pappophoroides* and *Schizachyrium sanguineum*. Common forbs include *Ruelliopsis setosa, Bulbostylis hispidula, Chascanum* cf. *hederaceum, Dicoma anomala, Euphorbia davyi, Geigeria burkei, Indigofera heterotricha, Kohautia virgata, Oldenlandia* cf. *herbacea, Polygala krumaniana,* and *Ptycholobium plicatum*.

Average species richness measured in the three vegetation sampling plots placed within the Grassland and Open Shrubland communities of this unit was 23.7 species per 100m^2, and varied from 21 to 29 species per 100m^2. The only plant 'species of conservation concern' recorded within the study area, namely *Hypoxis hemerocallidea* (Declining), was recorded only within this unit from the margins of hygrophilous grassland along the channel of the larger northern ephemeral drainage line. This unit contains habitat that is considered suitable for two of the 'plant species of conservation concern' potentially occurring in the vicinity of the study area (see Appendix 5), namely *Drimia sanguinea* (Near Threatened) and *Boophone disticha* (Declining). Various species recorded in this unit were recorded only in this unit (e.g. *Dicoma macrocephala, Trichodesma angustifolia* and *Maerua angolensis*) or were recorded only in this unit and in unit 2 (e.g. *Euphorbia davyi* and *Gladiolus pretoriensis*). The only Protected tree species recorded at Frischgewaagd, namely *Boscia albitrunca*, was recorded within this unit. Given the unique and fairly restricted (both within the study area and its surrounds) habitat comprising this unit, as well as the fact that the area has been poorly explored botanically, this unit is considered to have significant potential as habitat for 'species of conservation concern'. All the drainage lines comprising this unit confluence with the Elands River which forms the southern boundary of the Frischgewaagd section, and most of the ephemeral drainage lines in the immediate surrounds of the study area have been severely degraded by urbanisation and other anthropogenic impacts. This unit is therefore considered to have a **High** botanical biodiversity conservation value and sensitivity.

Unit 4: Ephemeral drainage lines – hygrophilous Open Shrubland and Thicket

The extent of this unit within Frischgewaagd is 5.7ha (or 1.2% of the section). This unit includes two ephemeral drainage lines with no distinct channels, except for below their confluence situated some 500m from the large eroded drainage line in the north-eastern parts of the study area (Unit 3). Both drainage lines enter the Frishgewaagd section in the north-western corner and each drainage line has a dam built in its upper reaches within the study area. The northern of the two drainage lines comprises a series of narrow anastomosing swales, flowing over soils of the Valsrivier form (Rehab Green, 2007),which seldom hold surface flow but flood broad areas (50m or more) during wet periods such as in February of 2013. The southern drainage line flows over dark brown to black clay soils of the Bonheim and Arcadia forms with shrink and expand properties, has very indistinct swales but seemingly inundates or at least saturates wide areas (over 50m) of clay soils during wet periods. The wetland and soils studies conducted concurrently with the study presented here indicated that the southern drainage line qualifies as a wetland in accordance with the DWAF (2005) criteria for wetland classification, whereas the northern tributary comprises a drainage line. The community centre and the steel water reservoirs on the north eastern boundary of the shaft complex have already been built within this unit, and the recently (November 2015) constructed 'noise berm' has encroached on the southern parts of this unit. This system has,

until this section was recently fenced, been used as communal grazing land and has been frequently burnt and subjected to the historical cultivation of much of its catchment.

The northern tributary of this drainage system comprises narrow (ca. 2m) swales. The floors of these swales are vegetated by dense grass communities with very few forbs present. The vegetation is completely dominated by grasses (most of which are facultative hygrophytes). Dominant grasses include *Botriochloa insculpta* and *Aristida bipartita*. Common to locally dominant grasses include *Dicanthium annulatum, Ischaemum afrum, Botricochloa bladhii* and *Cynodon dactylon*. The margins of these swales and the periodically inundated soils adjacent to these swales are vegetated by Short Thicket. Dominant trees are *Searsia lancea* and *Acacia karoo*. Common trees include *Acacia tortilis* and *Ziziphus mucronata*. Dominant shrubs are *Acacia tortilis* and *Acacia karoo*. Common shrubs include *Acacia karoo, Aspargus laricinus, Searsia pyroides* and *Dichrostachys cinerea*. Common grasses include *Panicum maximum, Botriochloa insculpta* and *Sporobolus nitens*.

Along the southern tributary of the drainage system, the vegetation comprises Low Open Shrubland. The vegetation is dominated by grasses and the woody species are kept stunted by the 'root pruning' effect of shrinking and swelling clay soils. Common shrubs include *Acacia tortilis, Acacia karoo* and *Asparagus laricinus*. The dominant grasses are *Aristida bipartita* and *Dicanthium annulatum*. Common grasses include *Ischaemum afrum, Botriochloa insculpta, Brachiaria eruciformis* and *Eragrostis* cf. *micrantha*. The facultative hydrophytic geophyte *Crinum lugardiae* is abundant along the southern tributary (wetland) of this unit. This species is not currently categorised as a 'species of conservation concern', but is rare and highly localised within the North West Province.

No $100m^2$ quadrats were surveyed within this unit, but average species richness is moderate, as is typical of such drainage lines and wetlands in this region. None of the species recorded within this unit are entirely restricted to this unit. This unit contains habitat that is considered suitable for two of the 'plant species of conservation concern' recorded or potentially occurring in the vicinity of the study area (see Appendix 5), namely *Drimia sanguinea* (Near Threatened) and *Stentonstelma umbelluliferum* (Near Threatened). Given the unique and restricted (both within the study area and its surrounds) habitat comprising this unit, and the fact that such periodically (at long cycles) flooded drainage line systems are poorly described botanically and many plant species are only likely to be detectable during and shortly after flooding, this unit must currently be considered as potentially important in terms of botanical biodiversity conservation. All the drainage lines comprising this unit confluence with a tributary (Unit 3) of the Elands River. The Elands River forms the southern boundary of this Frischgewaagd section, and most of the ephemeral drainage lines in the immediate surrounds of the study area have been severely degraded by urbanisation and other anthropogenic impacts. The rare and localised geophyte *Crinum lugardiae* is largely restricted to this unit within the study area and its surrounds. This BMU is therefore considered to have a **High** botanical biodiversity conservation value and sensitivity.

Unit 5: Elands River vegetation

The extent of this unit within Frischgewaagd is 17.1ha (or 3.7% of the section). This unit comprises the vegetation of the Elands River macro-channel, including the active-channel banks, macro-channel bed and macro-channel banks. No significant floodplain habitats are present within Frischgewaagd due to the relatively steep slopes above the macro-channel banks. The soils of this unit comprise deep, sandy loam to loam, alluvial soils of the Oakleaf

form (Rehab Green, 2007). As is typical of such rivers, there is strong lateral zonation of vegetation as a result of variations in key habitat parameters such as flooding frequency and duration of flooding, speed of floodwaters and substrate characteristics. Though the vegetation of these riverine habitats is still dominated by indigenous species, many aliens (including habitat transformers) are present, and this is a reflection of the fact that the upstream reaches of this river channel and catchment are significantly degraded. The vegetation of this unit falls outside the security fence recently erected by the mine, is used as communal grazing land, and is overgrazed.

Three major plant communities have been recognised within this unit. The major plant communities include marginal vegetation of the channel floor vegetation, riparian Closed Woodland and Forest on the lower macro-channel banks, and Short Thicket to Low Bushland on the upper parts of macro-channel bank. These major plant communities are briefly described below.

The macro-channel bed comprises alluvial sands and gravel with scattered to dense alluvial rock cover on the surface. The vegetation comprises dense reed beds of the megagraminoid *Phragmites mauritianus*, interspersed with herbaceous plant communities dominated by hygrophytic grasses and sedges, which include many alien weeds. Frequent flooding by fast flowing waters largely precludes the establishment of mature trees other than rheophytes (e.g. *Salix mucronata*), but small trees and shrubs occur scattered on the macro-channel bed. Common small trees and shrubs include *Gomphostigma virgatum, Nicotiana glauca*, Salix mucronata, Searsia lancea, Eucalyptus camaldulensis** and *Sesbania punicea**. Common to dominant grasses, sedges and rushes include *Agrostis lachnantha, Cynodon dactylon, Echinochloa colona, Eragrostis rotifer, Hemarthria altissima, Imperata cylindrica, Paspalum dilatatum*, Paspalum distichum, Bulbostylis* sp., *Sporobolus fimbriatus, Cyperus fastigiatus, Cyperus marginatus, Cyperus eragrostis*, Cyperus sexangularis* and *Typha capensis*. Common forbs include *Aster squamatus*, Juncus excertus, Ludwigia adscendens* subsp. *diffusa, Persicaria lapatifolia*, Persicaria senegalensis, Pulicaria scabra, Schkhuria pinnata*, Verbena bonariensis** and *Xanthium strumarium**.

On the lower macro-channel banks are Riparian Closed Woodland and Forest communities. The dominant trees are *Acacia karoo, Combretum erythrophyllum* and *Searsia lancea*. Common trees include *Celtis africana, Melia azedarach*, Morus alba*, Searsia pyroides* and *Ziziphus mucronata*. The alien invasive trees *Eucalyptus camaldulensis** and *Populus* x *canescens** are localised but together with *Melia azedarach** and *Morus alba** pose a significant threat of habitat transformation in this riparian woodland. Common shrubs include *Diospyros lyciodes, Gymnosporia buxifolia, Searsia pyroides* and *Ziziphus mucronata*. Dominants in the herbacsous layer include the grasses *Panicum maximum* and *Setaria megaphylla* and the forb *Hypoestes forskaolii*. Common grasses include *Cynodon dactylon, Ehrharta erecta* and *Urochloa mossambicensis*. Common forbs include *Ambrosia crataegifolia, Asparagus virgatus, Malvastrum coromandelianum** and *Pavonia burchellii*. The climber *Clematis brachiata* is common.

On the upper parts of macro-channel bank in areas that are only periodically activated at intervals of many years, the vegetation comprises mostly Low Bushland and Low/Short Thicket. Common trees include *Acacia karoo, Melia azedarach*, Searsia lancea* and *Ziziphus mucronata*. Dominant shrubs include *Asparagus laricinus, Grewia flava, Diospyros lyciodes, Ziziphus mucronata*. Common shrubs include *Acacia tortilis, Gymnosporia*

buxifolia, *Lycium cinereum* and *Tarchonanthus parvicapitulatus*. The dominant grasses include *Digitaria eriantha*, *Cynodon dactylon* and *Eragrostis rigidior*.

No 100m^2 were surveyed within this unit, but average species richness is Moderate, as is typical of such rivers in this region. The plant communities of the macro-channel bed and to a lesser extent the riparian woodland communities are floristically distinct from the vegetation of all other units within Frischgewaagd. This unit does not contain habitat that is considered suitable for any of the 'plant species of conservation concern' recorded or potentially occurring in the vicinity of the study area (see Appendix 5). Though significant invasion by alien trees that are habitat transformers in riparian habitats in this part of the North-West Province is present, the vegetation of this unit is still dominated by indigenous species and habitat transformation by aliens is highly localised. According to the NWBCP (2009) the Elands River is regarded as a 'Critically Endangered Ecosystem' as it has already been significantly degraded by various anthropogenic impacts. Furthermore, the riverine vegetation comprising this unit is considered to be of elevated conservation importance for the following reasons:

- Much of the riparian vegetation along the Elands River in the North West Province has already been transformed by a variety of anthropogenic impacts such altered hydrological patterns (particularly water abstraction), reduced water quality, cultivation, and invasion by alien plant species, and any remaining area of untransformed riverine vegetation must therefore be regarded as of elevated conservation importance.
- A river is a 'longitudinal ecosystem', and its condition at any point is a reflection not only of all upstream activities within the river/drainage line, but also of all activities in the adjacent and upstream parts of the catchment (O'Keefe, 1986). This sensitivity is reflected by the fact that watercourses are protected by South African legislation, including the National Water Act and the National Environmental Management Act, according to which the vast majority of activities within 32m of a watercourse (including its floodplain) or in some cases even within 100m of a watercourse, will trigger an environmental authorisation process.
- Within the study area and its immediate surroundings, the riverine vegetation of the Elands River provides a unique and restricted habitat for a wide diversity of plants and animals that are largely or entirely restricted to such habitats.

This unit is therefore considered to have a **High** botanical biodiversity conservation value and sensitivity.

Unit 6: Secondary vegetation

The extent of this unit within Frischgewaagd is 96.2ha (or 20.7% of the section), which is the second largest surface area covered by any of the eight identified unit. This unit comprises vegetation of historically cultivated soils, most of which have not been ploughed for more than 10 years. Most of the secondary vegetation comprising this unit is therefore in a relatively advanced state of secondary succession. Almost all areas of heavy black clay soils (Arcadia form) within this section have been cultivated in the past. The dominant soils in this unit are black clays of the Arcadia form, but significant areas of Oakleaf soils and smaller areas of Valsrivier soils are also present (Rehab Green, 2007). Historically, prior to commencement of mining, this unit was heavily grazed and browsed by domestic livestock and frequently burnt, and these impacts have almost certainly led to increased shrub density and cover and reduced tree density and cover and a concomitant slowing down of the process

of secondary succession. Currently this secondary vegetation is fenced and not grazed or browsed and vegetation of the fenced area is moribund.

In terms of physiognomy, the vegetation can be described as secondary Low Bushland and Tall to High Shrubland with smaller areas of secondary Thicket and patches of secondary Grassland on recently disturbed sites. Vegetation structure and species composition varies greatly in accordance with soil type, time elapsed since disturbance and the nature and duration of the disturbance. The expected progress of succession is from secondary Grassland to Shrubland to Bushland to Thicket. Potentially the area may eventually revert to Short Closed Woodland after many decades. Species richness increases with time elapsed since disturbance, though parts of this section last ploughed more than 15 years ago are still vegetated by plant communities with markedly lower species richness than surrounding untransformed vegetation.

On recently disturbed black clay soils (e.g. site F44) the vegetation comprises Short Open Grassland with very low species richness, particularly in terms of indigenous forbs. The dominant grass is *Aristida bipartita*, and *Sorghum versicolor, Brachiaria eruciformis* and *Setaria sphacelata* are sub-dominant. Common forbs are *Zinnia peruviana*, Bidens bipinnata** and *Schkhuria pinnata**. A low density of *Acacia mellifera* and *Acacia tortilis* saplings is present.

In areas where succession has progressed further, the vegetation comprises mostly secondary Low Shrubland and Low Bushland with smaller areas of Thicket and species richness is higher than in the secondary grassland communities. In secondary communities on heavy black clay soils the only common small tree is *Acacia tortilis*. The dominant shrub is also *Acacia tortilis* and common shrubs include *Acacia karoo, Asparagus laricinus, Diospyros lyciodes* and *Ziziphus mucronata*. The dominant grasses are *Aristida bipartita* and *Ischaemum afrum*, and common grasses include *Cymbopogon pospischilii, Eragrostis chloromelas* and *Brachiaria eruciformis*. On red-brown sandy clay loams (Oakleaf form) the dominant shrubs are *Acacia tortilis* and *Dichrostachys cinerea*, and *Grewia flava* is common. The dominant grass is *Hyparrhenia filipendula* and common grasses include *Heteropogon contortus, Eragrostis superba, Eragrostis rigidior* and *Melinis repens*.

This unit comprises secondary vegetation of transformed habitats and has low species richness in terms of indigenous species. Average species richness measured in sampling plots placed within this unit was 21.3 species per $100m^2$, and varied from 17 to 27 species per $100m^2$. This unit does not contain suitable habitat for any 'plant species of conservation concern'. However, the vegetation of this unit is dominated by indigenous species, contains few alien plants and is mostly typical of the fairly advanced stages of secondary succession as it occurs in this region of the Central Bushveld Bioregion. The species richness of the vegetation comprising this unit is likely to increase significantly over time given correct management practices. This vegetation also provides significant habitat for animals. The vegetation of this unit is therefore considered to have **Moderate** botanical biodiversity conservation value and sensitivity.

Unit 7: Dams

The extent of this unit within the study area is 1.2ha (or 0.3% of the section).
This unit comprises two old earth-walled farm dams built on ephemeral drainage lines (Unit 4) and these dams therefore represent secondary drainage line habitat. Both are only

shallowly and partly inundated for brief periods during high rainfall periods. Depending on the state of inundation, the floor of the full supply level either comprises bare, dry clays or is vegetated by stands of indigenous hygrophytic grasses and indigenous and alien forbs which often occur in disturbed areas.

Dominant grasses are *Echinochloa colona* and *Cynodon dactylon*. Common grasses include *Botriochloa inscultpta, Dicanthium annulatum, Setaria sphacelata* and *Urochloa mossambicensis.* Common weedy forbs include *Ambrosia artemisiifolia*, Aster squamatus*, Denekia capensis, Indigastrum parviflorum, Nidorella resedifolia, Persicaria senegalensis* and *Xanthium strumarium*.* The alien biannual shrub **Sesbania bispinosa* var. *bispinosa* is common.

The dams comprising this unit represent transformed ephemeral drainage line and wetland habitat. Species richness is relatively low, and though many species typical of the drainage lines of the study area are present, the species richness incorporates a high percentage of alien species. This unit does not contain suitable habitat for any 'plant species of conservation concern'. The vegetation of this unit is therefore considered to have **Low** botanical biodiversity conservation value and sensitivity. Dam habitats do however provide productive habitat for a variety of animal species.

Unit 8: Infrastructure

This extent of this unit within Frischgewaagd is 77.1ha (or 16.5% of the section). The infrastructure comprising this unit was constructed mostly on soils of the Arcadia form. This unit comprises the mine shaft complex, discard dumps, steel water reservoirs, lined pollution control dams and linear infrastructure such as roads, canals and berms. The habitats of these areas have been completely transformed and the natural vegetation cleared.

The little vegetation occurring within this unit is all secondary in nature and has very low species richness in terms of indigenous species. This unit does not contain suitable habitat for any plant species of conservation concern. Untransformed vegetation in close proximity to these areas is also often degraded as a result of various 'edge effects' emanating from these transformed habitats. This unit therefore has N**egligible** botanical biodiversity conservation value and sensitivity.

Table 5: Percentage of the study area occupied by each of the vegetation or land-cover type units identified within **Frischgewaagd**, number of surveyed sites in each unit which are included in floristic table in Appendix 3, average species richness per 100m^2, and perceived sensitivity / biodiversity conservation value of each unit.

Vegetation or Land-cover type unit	**Percentage of the Frischgewaagd study area#**	***Number of 100m^2 plots surveyed within unit**	**Average Species richness per 100m^2 (α-diversity)**	**Total number of species recorded in 100m^2 sample plots**	**Biodiversity Conservation Value**
1. Marikana Thornveld	53.5% 249.0ha	6	34.0 (25-39)	98	High
1.1 Mixed Woodland and Thicket	42.9% 199.8ha	4	36.0 (32-39)	77	High
1.2. *Acacia mellifera*	10.6%	2	30.0	48	High

Vegetation or Land-cover type unit	Percentage of the Frischgewaagd study area[#]	*Number of 100m^2 plots surveyed within unit	Average Species richness per 100m^2 (α-diversity)	Total number of species recorded in 100m^2 sample plots	Biodiversity Conservation Value
Bushland and Thicket	49.2ha		(25-35)		
2. Stony Grassland	0.8% 3.6ha	1	41 (41)	41	High
3. Eroded ephemeral drainage lines	3.3% 15.6ha	3	23.7 (21-29)	46	High
4. Ephemeral drainage lines	1.2% 5.7ha	0	Moderate	-	High
5. Elands River vegetation	3.7% 17.1ha	0	Moderate to High	-	High
6. Secondary vegetation	20.7% 96.2ha	4	21.3 (17-27)	56	Moderate
7. Dams	0.3% 1.2ha	0	Low	-	Low
8. Infrastructure	16.5% 77.1ha	0	Very Low	-	Negligible
TOTAL[#]	465.5ha				

*Number of sites where quantitative sampling was undertaken within 100m^2 sampling plots/quadrats, and which are included in the floristic analysis provided in Appendix 3.
**Range is provided in brackets.
[#]**S**ub-units shaded grey are not included in Total area as they form part of Unit 1.

Mimosa

The original vegetation cover of almost the entire the Mimosa section would have been short thorny woodland representative of Marikana Thornveld (Mucina & Rutherford, 2006), with a very small (ca. 2.5ha), isolated patch of Gold Reef Mountain Bushveld on a low quartzitic outcrop at site M37. However, approximately 54.6% of the vegetation of the Mimosa section has been transformed by historical cultivation and currently comprises secondary vegetation. An additional 0.1% of the Mimosa section has been permanently transformed by infrastructure (an old farm homestead and a guard house). The remaining areas of untransformed vegetation, comprising mostly Thicket and Bushland with smaller areas of Closed Woodland (*sensu* Edwards, 1983), have been degraded by anthropogenic impacts such as historical heavy grazing and browsing by cattle and goats, altered fire regimes, selective cutting of large trees, medicinal plant harvesting and invasion by alien plants along the Elands River.

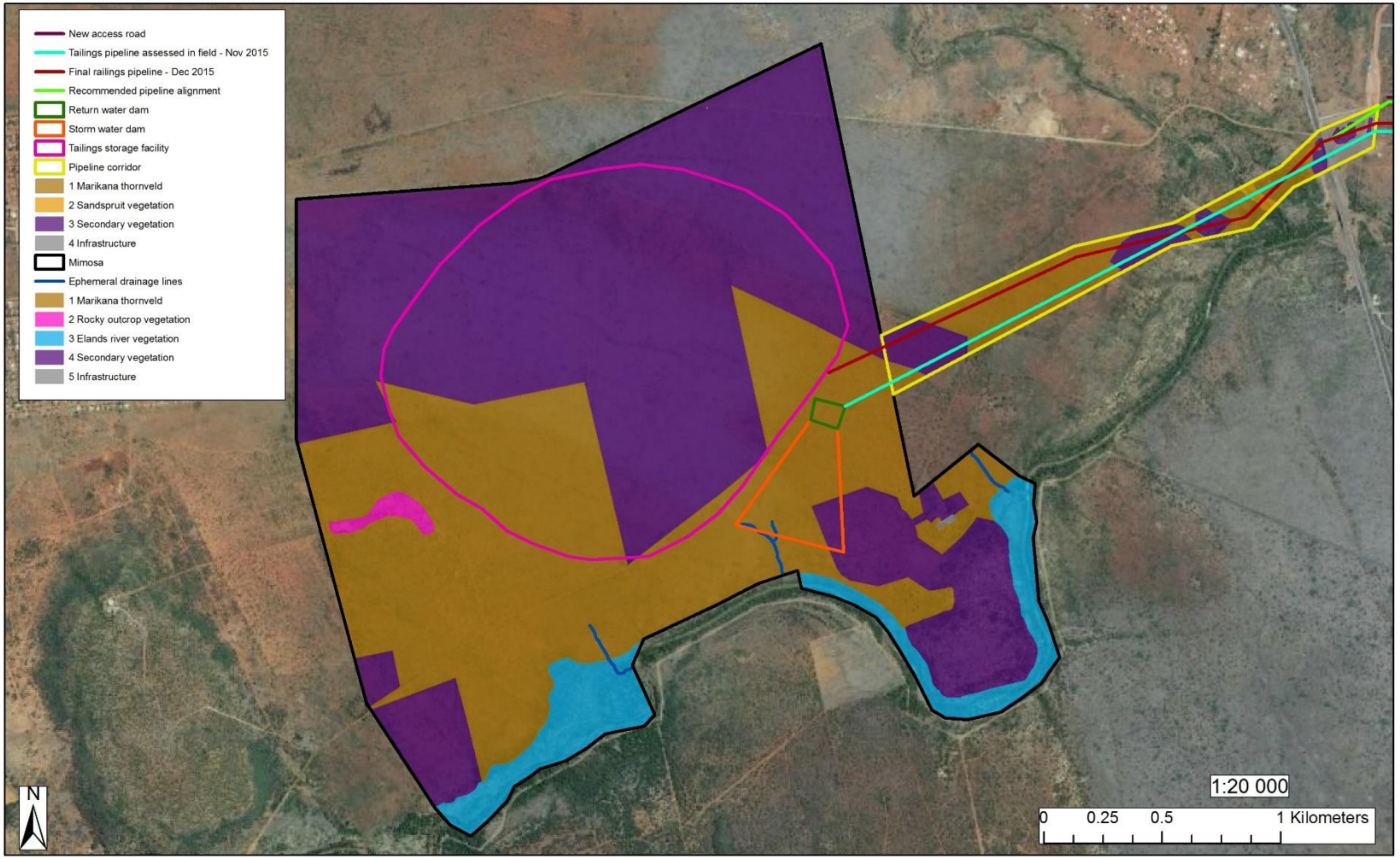
The broad-scale vegetation units and land-cover type units described below have been derived on the basis of structural and functional criteria. The term structure refers to various aspects of vegetation structure such as physiognomy, life-form composition, species composition, species dominance and stand structure (Kent & Coker, 1992). Functional criteria include aspects such a characteristic ecosystem processes, habitat characteristics, habitat suitability for certain threatened species and ecological status (e.g. primary vegetation of untransformed habitats versus secondary vegetation of transformed or severely degraded habitats). The floristic data set gathered at twelve selected sampling sites within Mimosa is provided in Appendix 3.

Despite the high levels of transformation within the Mimosa section, many of the remaining areas of untransformed habitat and vegetation remain relatively diverse (in the context of the Savanna Biome) and species rich (α-diversity), as is reflected by the fact that 294 plant species and infra-specific taxa have thus far been recorded on the basis of relatively brief surveys (see Appendix 1). The Beta diversity (β-diversity), which is the 'rate of change in species composition across habitats or among communities' is moderate to high. The broad-scale vegetation units or BMU's described below are therefore simply practical units that combine various plant communities which share structural and functional characteristics and have common management requirements.

A total of three units comprising untransformed vegetation and two units comprising transformed habitats with secondary vegetation or no vegetation (i.e. infrastructure) were identified. These five units are listed and briefly described in Table 6, and each unit is described in more detail below. Photographs of the vegetation units are provided in Appendix 11. The approximate delineation of the vegetation and land-cover units listed in Table 6 is shown in Figure 3.

Table 6: Broad-scale vegetation and land-cover type units identified within the Mimosa section.

BMU	Name	Description
1	Marikana Thornveld - Mixed Thicket Bushland and Woodland on red clay loam soils	Untransformed Thicket, Bushland and Woodland communities representative of Clay Thorn Bushveld (Mucina & Rutherford, 2006). Mostly Short/Low Thicket and Bushland communities, with smaller areas of Closed Woodland, on red-brown clay loam soils. Dominated by *Searsia lancea, Zizphus mucronata* and *Acacia* spp. Unit also includes three small (longest 300m), indistinct 1st order ephemeral drainage lines near the Elands River.
2	Rocky outcrop vegetation	*Acacia caffra* dominated Open Shrubland and Short Bushland of isolated, low, rocky (quartzitic) ridge near western boundary of the study area.
3	Elands River vegetation	Vegetation of the macro-channel bank and periodic floodplain of the Elands River. Includes instream and marginal vegetation, Riparian Closed Woodland and Forest, and Shrubland and Bushland of upper parts of macro-channel bank and broad floodplain around Sites M10 and M12.
4	Secondary vegetation	Secondary vegetation of historically cultivated areas and scoured soils. Includes mostly secondary Bushland and Shrubland with a few small patches of secondary Thicket in areas where succession is more advanced. Covers the majority of the northern half of the study area as well as several patches in the south-eastern and south-western parts of the study area along the Elands River. Includes almost all areas on black turf soils classified as Arcadia (Ar1) soils by Steenekamp (August, 2007) as well as areas of red-brown soils of various soil forms. Vegetation structure and species composition varies greatly in accordance with soil type, time elapsed since disturbance and the nature and duration of the disturbance.
5	Infrastructure	Farm homesteads and guard huts.



Vegetation map with proposed infrastructure for Mimosa and the Pipeline corridor

January 2016
Created by:

DE CASTRO & BRITS
ECOLOGICAL CONSULTANTS

Figure 3: Vegetation and land-cover type units identified within Mimosa, showing footprints of proposed infrastructure components.

The percentage of the Mimosa section occupied by each of the identified vegetation and land-cover units, number of surveyed quadrats in each unit, mean species richness per $100m^2$, and perceived biodiversity conservation value / sensitivity of each unit is provided in Table 7. A brief description of the vegetation structure, ecological status, habitat characteristics and biodiversity conservation value of each unit is provided below. The terminology used in describing the vegetation physiognomy of the woody and herbaceous plant communities, is that developed by Edwards (1983). In the vegetation descriptions provided below, an asterisk indicates an alien species.

Unit 1: Marikana Thornveld

The extent of this unit within Mimosa is 236.8ha (or 38.3% of the section), which is the second largest surface area covered by any of the five units identified within this section. This unit, which is the equivalent of Unit 1 in the Frischgewaagd section and Unit 1 of the pipeline mapping corridor, occurs mostly on deep red-brown to brown clay loam to sandy clay loam soils and on smaller areas situated on the remnant patches of black clay soils that have not been historically ploughed. The dominant soil form in this unit is Shortlands, but small areas of soils of the Arcadia form (heavy black clays) and soils that are transitional between these two forms, are also present. Historically this unit covered the vast majority of the Mimosa section but much of its original extent situated on Arcadia soils has been transformed by historical cultivation, particularly in the central, northern and south-eastern parts of this section. Historically, prior to fencing by the mine in 2014, this unit was heavily grazed and browsed by domestic livestock and frequently burnt, and these impacts have almost certainly led to an increase in shrub density and cover and reduced tree density and cover. Though recently fenced, the mine stills allows grazing and browsing by domestic livestock belonging to the local community, but it is not known whether there is any form of management of this utilisation by community livestock. The portions of this unit that fall outside of the security fence recently erected by the mine used as communal grazing land, and are overgrazed.

In terms of physiognomy, the vegetation can be described as mostly Short/Low Thicket grading to Short Bushland and Short/Low Closed Woodland. The species composition of these various physiognomic types is similar. Under correct management much of the area is likely to revert to Short Closed Woodland. Included in this unit are three small (longest 300m), indistinct 1^{st} order ephemeral drainage lines in the southern parts of the section near the Elands River. The vegetation of these ephemeral drainage lines is very similar to the surrounding terrestrial vegetation but does display some differences.

Common trees include *Acacia caffra, Acacia karoo, Acacia tortilis, Searsia lancea* and *Ziziphus mucronata*. Dominant shrubs include *Acacia caffra* and *Acacia karoo*. Common shrubs include *Acacia erubescens, Grewia flava, Acacia tortilis, Searsia lancea* and *Searsia pyroides*. The dominant grasses are *Cymbopogon pospischilii, Heteropogon contortus* and *Themeda triandra*. Common grasses include *Aristida congesta* subsp. *barbicollis, Eragrostis chloromelas, Eragrostis superba, Eragrostis rigidior, Eragrostis trichophora, Eragrostis superba, Melinis repens, Panicum coloratum, Panicum maximum, Panicum coloratum, Setaria sphacelata* and *Tragus racemosa.* Common forbs include *Aptosimum procumbens, Barleria macrostegia, Commelina africana, Corchorus aspleniifolius, Crabaea angustifolia, Hermannia depressa, Hibiscus pusillus, Indigofera circinnata, Nidorella resediifolia, Ptycholobium plicatum* and *Ziziphus zeyheriana*. The low shrub *Asparagus suaveolens* and the succulents *Aloe davyana* and *Aloe transvaalensis* are also common.

The vegetation of the three small ephemeral drainage lines near the Elands River is very similar to the surrounding terrestrial vegetation but does display some differences. The vegetation of the indistinct channel banks comprises Short/Low Thicket or Low Bushland. Common trees are *Acacia karoo, Olea europaea* subsp. *africana* and *Ziziphus mucronata*. The dominant shrub is *Acacia karoo*. Common shrubs include *Asparagus laricinus, Acacia erubescens, Combretum hereroense, Diospyros lycioides, Grewia flava, Gymnosporia buxifolia, Searsia pyroides, Tarchonanthus parvicapitulatus* and *Ziziphus mucronata*. Dominant grasses in the indistinct central channels include *Botriochloa insculpta and Setaria sphacelata.* Common grasses include *Cymbopogon pospischilii, Hyperthelia dissoluta, Ischaemum afrum* and *Themeda triandra*.

The most easterly of the three small ephemeral drainage lines situated within this unit discharges into a permanent floodplain lake in a meander scar of the Elands River floodplain, and is likely to play a significant role in the hydrology of this lake during long periods between full inundation caused by large floods in the Elands River.

Average species richness measured in sampling plots placed within this unit as a whole was 38.3 species per 100m^2, which is high for Central Bushveld vegetation, and varied from 36 to 43 species per 100m^2. Forty-three species per 100m^2 is the highest figure recorded in any of the twelve plots surveyed at Mimosa, and represents very high species richness for the Central Bushveld Bioregion. This unit contains habitat that is considered suitable for two of the 'plant species of conservation' concern recorded or potentially occurring in the vicinity of the study area (see Appendix 5), namely *Drimia sanguinea* (Near Threatened) and *Hypoxis hemerocallidea* (Declining). One of two Protected tree species recorded at Mimosa, namely *Sclerocarya birrea*, was recorded within this unit. This unit is considered representative of somewhat degraded but untransformed Marikana Thornveld, a Vulnerable vegetation type (Mucina & Rutherford, 2006). Though somewhat degraded the vegetation of this unit is still likely to contain its pre-disturbance species richness and should revert to a climax state under correct management. Much of the extent of Marikana in the vicinity of the study area has been transformed by urbanisation, cultivation and mining. This BMU is therefore considered to have a **High** botanical biodiversity conservation value and sensitivity.

Unit 2: Rocky outcrop vegetation

The extent of this unit within Mimosa is 3.5ha (or 0.6% of the section). This unit is entirely restricted to single low, linear rock (quartzite) outcrop situated near the western boundary of the section. The soils are shallow, reddish brown sandy clay loam soils of the Mispah soil form (Rehab Green, 2007). Surface cover of rock is high and varies from 10% to 70%. The vegetation is very heavily grazed and some stumps indicate the historical cutting of larger trees. There are also signs of overly frequent burning. Numerous excavations indicative of recent medicinal plant harvesting (including *Indigofera melanadenia* subsp. *melanadenia* roots) were recorded.

In terms of physiognomy, the vegetation of this unit can be described as Open Shrubland which grades to Short Bushland and smaller patches of Short Thicket.

This plant community comprising this unit has high species richness (α-diversity). Grasses are dominant but there and there is high diversity of forbs, shrubs and trees, many of which are restricted to this unit at Mimosa and within the entire study area (i.e. high floristic fidelity). Common trees include *Acacia caffra, Acacia tortilis, Boscia albitrunca, Dombeya*

rotundifolia, Sclerocarya birrea, Searsia lancea, Strychnos pungens and *Ziziphus mucronata*. The tree aloe, *Aloe marlothii*, is also common. The dominant shrub is *Acacia caffra*. Common shrubs include *Ehretia rigida, Elephantorrhiza burkei, Indigofera melanadenia* subsp. *melanadenia, Lannea discolor, Pavetta zeyheri, Searsia lancea, Searsia leptodictya, Vangueria infausta* and *Ximenia caffra.* Dominant grasses are *Schizachyrium jeffreysii, Loudetia flavida* and *Diheteropogon amplectans*. Common grasses include *Andropogon schirensis, Aristida congesta* subsp. *barbicollis Melinis repens, Trachypogon spicatus, Bewsia biflora, Elionurus muticus, Melinis repens, Themeda triandra, Trachypogon spicatus* and *Tricholaena monachne.* Common forbs include *Acalypha petiolaris, Bulbostylis hispidula, Chaetacanthus costatus, Chascanum cf. hederaceum, Dicoma anomala, Gnidia caffra, Ipomoea bathycolpos* and *Jamesbrittenia burkeana*. The succulent *Aloe davyana* and the woody climber/scrambler *Ancylobotrys capensis* are also common. The invasive large succulents *Cereus jamacuru** and *Agave Americana** are well established and pose a risk of significant habitat transformation within this unit.

Species richness measured in the only vegetation sampling plot placed within this unit was 43 species per 100m^2, which is the highest species richness recorded in any of the twelve sampling plots surveyed at Mimosa, and is regarded a very high for the Central Bushveld Bioregion. This unit contains habitat that is considered suitable for one of the 'plant species of conservation' concern recorded or potentially occurring in the vicinity of the study area (see Appendix 5), namely *Boophone disticha* (Declining). Various species recorded in this unit were recorded only in this unit at Mimosa (e.g. *Ancylobotrys capensis, Bewsia biflora, Burkea africana, Euphorbia* cf. *davyi, Jamesbrittenia burkeana, Pavetta zeyheri, Strychnos pungens,* and *Xerophyta* cf. *equisetoides* var. *equisetoides*). Both Protected tree species recorded at Mimosa, namely *Boscia albitrunca* and *Sclerocarya birrea*, were recorded within this unit. This unit is considered to comprise a small and isolated patch of the Gold Reef Mountain Bushveld vegetation type which is dominant to the west of the Mimosa section on the ridges representing the western extremity of the Magaliesburg. Though somewhat degraded the vegetation of this unit is still likely to contain its pre-disturbance species richness and should fairly rapidly revert to a climax state under correct management. Given the unique (within the Mimosa section and the study area as a whole) and highly restricted habitat comprising this unit, this small unit contributes significantly to the habitat diversity and species richness of the study area. This unit is therefore considered to have a **High** botanical biodiversity conservation value and sensitivity.

Unit 3: Elands River vegetation

The extent of this unit within Mimosa is 39.9ha (or 6.4% of the section). This unit comprises the vegetation of the Elands River macro-channel, including the active-channel banks, macro-channel bed and macro-channel banks, as well as a large floodplain of some 15ha directly downstream of the western boundary and a smaller floodplain with a floodplain lake on the eastern boundary. This unit is the equivalent of Unit 5 (Elands River vegetation of the Frischgewaagd section). The soils of the vast majority of this unit comprise deep, sandy loam to loam, alluvial soils of the Oakleaf form, but small areas of sandy clay loam soils of the Valsrivier form occur on the upper edge of the floodplain (Rehab Green, 2007). As is typical of such rivers, there is strong lateral zonation of vegetation as a result of variations in key habitat parameters such as flooding frequency and duration of flooding, speed of floodwaters and substrate characteristics. Though the vegetation of these riverine habitats is still dominated by indigenous species, many aliens (including habitat transformers) are present, and this is reflection of the fact that the upstream reaches of this river channel and catchment

are significantly degraded. The vegetation of this unit falls outside the security fence recently erected by the mine, is used as communal grazing land, and is overgrazed.

Four major plant communities have been recognised within this unit. The major plant communities include marginal vegetation of the channel bed, riparian Closed Woodland and Forest on the lower macro-channel banks, Short Thicket to Low Bushland on the upper parts of macro-channel bank and Tall Closed Shrubland and Low Bushland of the floodplain. These major plant communities are briefly described below (descriptions for all but the floodplain communities, are as for Frischgewaagd with minor modifications).

The macro-channel bed comprises alluvial sands and gravel with scattered to dense alluvial rock cover on the surface. The vegetation comprises dense reed beds of the megagraminoid *Phragmites mauritianus*, interspersed with herbaceous plant communities dominated by hygrophytic grasses and sedges, which include many alien weeds. Frequent flooding by fact flowing waters largely precludes the establishment of mature trees other than rheophytes (e.g. *Salix mucronata*), but small trees and shrubs occur scattered on the macro-channel bed. Common small trees and shrubs include *Gomphostigma virgatum, Nicotiana glauca*, Salix mucronata, Searsia lancea, Eucalyptus camaldulensis** and *Sesbania punicea**. Common to dominant grasses, sedges and rushes include *Agrostis lachnantha, Cynodon dactylon, Echinochloa colona, Eragrostis rotifer, Hemarthria altissima, Imperata cylindrica, Paspalum dilatatum*, Paspalum distichum, Bulbostylis* sp., *Sporobolus fimbriatus, Cyperus fastigiatus, Cyperus marginatus, Cyperus eragrostis*, Cyperus sexangularis* and *Typha capensis.* Common forbs include *Aster squamatus*, Juncus excertus, Ludwigia adscendens* subsp. *diffusa, Persicaria lapatifolia*, Persicaria senegalensis, Pulicaria scabra, Schkhuria pinnata*, Verbena bonariensis** and *Xanthium strumarium*.*

On the lower macro-channel banks the vegetation is riparian Closed Woodland and Short to Tall Forest. The dominant trees are *Acacia karoo, Combretum erythrophyllum* and *Searsia lancea*. Common trees include *Celtis africana, Melia azedarach*, Morus alba*, Searsia pyroides* and *Ziziphus mucronata*. Common shrubs include *Diospyros lyciodes, Gymnosporia buxifolia, Searsia pyroides* and *Ziziphus mucronata*. Dominants in the herbaceous layer include the grasses *Panicum maximum* and *Setaria megaphylla* and the forb *Hypoestes forskaolii*. Common grasses include *Cynodon dactylon, Ehrharta erecta* and *Urochloa mossambicensis*. Common forbs include *Ambrosia crataegifolia, Asparagus virgatus, Malvastrum coromandelianum** and *Pavonia burchellii.* The climber *Clematis brachiata* is common. Patches of Tall Forest on the seldom activated upper parts of the macro-channel banks the western boundary (site M9) have practically identical woody species compostion to that mentioned above with the addition of *Olea europaea* subsp. *africana* as a common tree, *Acalypha glabrata* var. *pilosior* as a common shrub, and a higher species richness in the herbaceous layer. The alien invasive trees *Eucalyptus camaldulensis** and *Populus* x *canescens** are localised but together with widespread *Melia azedarach** and *Morus alba** pose a significant threat of habitat transformation in this riparian woodland. The alien invasive woody climber *Dolichandra unguis-cati** is already a severe invader and habitat transformer in riparian Tall Forest on the western boundary of the study area (site M9) and poses a significant threat to all riparian forest along this reach of Elands River.

On the upper parts of macro-channel bank in areas that are only periodically activated at intervals of many years, the vegetation comprises mostly Low Bushland and Low/Short Thicket. Common trees include *Acacia karoo, Melia azedarach*, Searsia lancea* and *Ziziphus mucronata*. Dominant shrubs include *Asparagus laricinus, Grewia flava, Diospyros*

lyciodes, Ziziphus mucronata. Common shrubs include *Acacia tortilis, Gymnosporia buxifolia, Lycium cinereum* and *Tarchonanthus parvicapitulatus.* The dominant grasses include *Digitaria eriantha, Cynodon dactylon* and *Eragrostis rigidior*.

On the broad floodplain directly adjacent to the western boundary of the Mimosa section, and on a smaller floodplain on the eastern boundary, the vegetation comprises Tall Closed Shrubland to Low Bushland. The only common tree is *Acacia karoo*. The dominant shrub is *Grewia flava*. Common shrubs include *Acacia karoo, Asparagus laricinus, Dichrostachys cinerea, Diospyros lycioides, Grewia bicolor, Gymnosporia buxifolia, Tarconanthus parvicapitulatus* and *Ziziphus mucronata*. Dominant grasses include *Botriochloa insculpta, Digitaria eriantha, Tragus racemosa* and *Urochloa mossambicenis*. *Cenchrus ciliaris* is a localised dominant. Common grasses include *Aristida* cf. *adscensionis, Aristida bipartita, Botriochloa radicans, Panicum coloratum, Panicum maximum* and *Heteropogon contortus*. Forb diversity is low. Common forbs include *Corchorus aspleniifolius, Talinum caffrum, Indigastrum parviflorum, Ledebouria* sp., *Nidorella resediifolia* and *Cullen tomentosum*. The low shrub *Asparagus suaveolens* is common as are the climbers *Asapagus* cf. *setaceus* and *Cyphostemma sulcatum*.

Average species richness measured in the two vegetation sampling plots placed within the Tall Closed Shrubland and Short Bushland communities of this unit was 21.5 species per $100m^2$, and varied from 16 to 27 species per $100m^2$. This unit has high habitat diversity and comprises four major habitat and major plant communities, each with moderate species richness as is typical of such rivers in this region. The plant communities of the macro-channel bed and to a lesser extent the riparian woodland and forest communities are floristically distinct from the vegetation of all other units within Mimosa. This unit does not contain habitat that is considered suitable for the any of the 'plant species of conservation concern' recorded or potentially occurring in the vicinity of the study area (see Appendix 5). Though significant invasion by alien trees that are habitat transformers in riparian habitats in this part of the North West Province is present, the vegetation of this unit is still dominated by indigenous species and habitat transformation by aliens is highly localised. According to the NWBCP (2009) the Elands River is regarded as a 'Critically Endangered Ecosystem' as it has already been significantly degraded by various anthropogenic impacts. Furthermore, the riverine vegetation comprising this unit is considered to be of elevated conservation importance for the following reasons:

- Much of the riparian vegetation along the Elands River in the North West Province has already been transformed by a variety of anthropogenic impacts such as altered hydrological patterns (particularly water abstraction), reduced water quality, cultivation, and invasion by alien plant species, and any remaining area of untransformed riverine vegetation must therefore be regarded as of elevated conservation importance.
- A river is a 'longitudinal ecosystem', and its condition at any point is a reflection not only of all upstream activities within the river/drainage line, but also of all activities in the adjacent and upstream parts of the catchment (O'Keefe, 1986). This sensitivity is reflected by the fact that watercourses are protected by South African legislation, including the National Water Act and the National Environmental Management Act, according to which the vast majority of activities within 32m of a watercourse (including its floodplain) or in some cases even within 100m of a watercourse, will trigger an environmental authorisation process.
- Within the study area and its immediate surroundings, the riverine vegetation of the Elands River provides a unique and restricted habitat for a wide diversity of plants and animals that are largely or entirely restricted to such habitats.

- The most easterly of the three small ephemeral drainage lines that originate in Unit 1 and flow to the Elands River, discharges into a more or less permanent floodplain lake (though water levels are likely to fluctuate greatly), of approximately 0.5ha in extent, situated in a meander scar of the Elands River floodplain on the eastern boundary of Mimosa. This floodplain lake (not visited during the current study) is the only such lake situated along the reach of the Elands River situated between Zwartkoppies to the west and Frischgewaagd to the east, and represents a highly restricted and unique habitat type which is likely to contain unique and spatially restricted plant communities and scarce and localised species.

This unit is therefore considered to have a **High** botanical biodiversity conservation value and sensitivity.

Unit 4: Secondary vegetation

The extent of this unit within Mimosa is 337.6ha (or 54.6% of the section), which is the largest surface area covered by any of the five units identified within this section. This unit comprises vegetation of historically cultivated soils. Most of the red-brown sandy clay loam soils have not been ploughed for at least the past five years, but the time elapsed since cultivation of the heavy black clay soils is seemingly more than 15 years in almost all cases. Most of the secondary vegetation comprising this unit is therefore in a relatively advanced state of secondary succession, but some areas where succession has only been in progress for the last five years are also present. Almost all areas of heavy black clay soils (Arcadia form) within the Mimosa section have seemingly been cultivated in the past. The dominant soils in this unit are black clays of the Arcadia form, but significant areas of red to red-brown sandy clay loams of the Shortlands form are also present (Rehab Green, 2007).

Historically, prior to fencing by the mine in 2014, this unit was heavily grazed and browsed by domestic livestock and frequently burnt, and these impacts have almost certainly led to a disruption of the process of secondary succession and the prevention of pioneer species such as *Acacia tortilis* and *Acacia karoo* from reaching a tree growth form. Therefore few trees occur and relative shrub density and cover is higher than would be expected at this stage of the secondary succession process. The felling of trees prior to fencing has also reduced expected tree cover. Though recently fenced, the mine stills allows grazing and browsing by domestic livestock belonging to the local community, but it is not known whether there is any form of management of this utilisation by community livestock. The portions of this unit that fall outside of the security fence recently erected by the mine, are used as communal grazing land, and are overgrazed.

In terms of physiognomy, the vegetation can be described as secondary Tall Closed Shrubland to Low Closed Bushland on red-brown soils and Tall Open Shrubland on black clay soils. Vegetation structure and species composition vary greatly in accordance with soil type, time elapsed since disturbance and the nature and duration of the disturbance. The expected progress of succession is from secondary Grassland to Shrubland to Bushland to Thicket. Potentially the area may eventually revert to Short Closed Woodland after many decades. Species richness increases with time elapsed since disturbance, though parts of this section last ploughed more than 15 years ago are still vegetated by plant communities with significantly lower species richness than surrounding untransformed vegetation. The secondary vegetation of the Mimosa section is very similar in terms of species composition to that of Frischgewaagd.

In secondary Tall Closed Shrubland to Low Closed Bushland on red-brown sandy clay loams and clay loam soils (mostly Shortlands form), common trees include *Acacia karoo, Acacia tortilis* and *Ziziphus mucronata*. The dominant shrub is Acacia tortilis. Common shrubs include *Acacia karoo, Acacia mellifera* and *Ziziphus mucronata*. The dominant grasses are *Aristida congesta* subsp. *barbicollis, Eragrostis rigidior* and *Urochloa mossambicensis*. Common grasses include *Cynodon dactylon, Eragrostis curvula, Eragrostis trichophora, Heteropogon contortus, Panicum maximum* and *Tragus racemosa*. Common forbs include *Berkheya carilinopsis* subsp. *magalismontanum, Boerhavia diffusa*, Corchorus aspleniifolius, Gomphrena celosiodes*, Indigofera circinnata. Indigofera melanadenia subsp. malacostachys, Kyphocarpha angustifolia, Nidorella resediifolia, Osteospermum muricatum, Pentarrhinum insipidum* and *Solanum eleagnifolium**.

In secondary In Tall Open Shrubland communities on heavy black clay soils, the vegetation is dominated by grasses. The only common small tree is *Acacia tortilis,* though small *Acacia karoo* trees are present in places. Common shrubs include *Acacia tortilis, Asparagus laricinus, Dichrostachys cinerea* and *Ziziphus mucronata.* and *Diospyros lycioides* and common shrubs include *Acacia karoo, Asparagus laricinus, Diospyros lyciodes* and *Ziziphus mucronata*. The dominant grasses are *Aristida bipartita, Eragrostis chloromelas* and *Ischaemum afrum,* and common grasses include *Brachiaria eruciformis, Cymbopogon pospischilii, Setaria incrassate* and *Themeda triandra.* Common forbs include *Acalypha indica, Convolvulus sagittatus, Corchorus aspleniifolius, Elephantorrhiza elephantina* (geoxylic suffrutex), *Jamesbrittenia aurantiaca, Kouhautia virgate, Nidorella resediifolia, Rhynchosia minima* and *Schkhuuria pinnata*.*

This unit comprises secondary vegetation of transformed habitats and has low species richness in terms of indigenous species. Average species richness measured in sampling plots placed within this unit was 23.0 species per $100m^2$, and varied from 18 to 29 species per $100m^2$. This unit does not contain suitable habitat for any 'plant species of conservation concern'. However, the vegetation of this unit is dominated by indigenous species, contains few alien plants and is mostly typical of the fairly advanced stages of secondary succession as it occurs in this region of the Central Bushveld Bioregion. The species richness of the vegetation comprising this unit is likely to increase significantly over time given correct management practices. This vegetation also provides significant habitat for animals. The vegetation of this unit is therefore considered to have **Moderate** botanical biodiversity conservation value and sensitivity.

Unit 5: Infrastructure

The extent of this unit within Mimosa is 0.3ha (or 0.1% of the section). The infrastructure comprising this unit includes a farm homestead near the south-eastern corner of the section, and a small guardhouse on the northern boundary. The habitats of these areas have been completely transformed and the natural vegetation cleared.

The little vegetation occurring within this unit is all secondary or comprises planted aliens, and has very low species richness in terms of indigenous species. This unit does not contain suitable habitat for any plant species of conservation concern. Untransformed vegetation in close proximity to these areas is also often degraded as a result of various 'edge effects' emanating from these transformed habitats. This unit therefore has **Negligible** botanical biodiversity conservation value and sensitivity.

Table 7: Percentage of the study area occupied by each of the vegetation or land-cover type units identified within **Mimosa**, number of surveyed sites in each unit which are included in floristic table in Appendix 3, average species richness per 100m^2, and perceived sensitivity / biodiversity conservation value of each unit.

Vegetation or Land-cover type unit	Percentage of the Mimosa study area	*Number of 100m^2 surveyed within unit	Average Species richness per 100m^2 (α-diversity)	Total number of species recorded in 100m^2 sample plots	Biodiversity Conservation Value
1. Marikana Thornveld	38.3% 236.8ha	3	38.3 (36-43)	69	High
2. Rocky outcrop vegetation	0.6% 3.5ha	1	43.0 (43)	43	High
3. Elands River vegetation	6.4% 39.9ha	2	21.5 (16-27)	32	High
4. Secondary vegetation	54.6% 337.6ha	6	23 (18-29)	81	Moderate
5. Infrastructure	0.1% 0.3ha	0	Very Low	-	Negligible
TOTAL	618.1ha				

*Number of sites where quantitative sampling was undertaken within 100m^2 sampling plots/quadrats, and which are included in the floristic analysis provided in Appendix 3.
**Range is provided in brackets.

Tailings Pipeline Mapping Corridor

The original vegetation cover of almost the entire the 39.5ha tailings pipeline mapping corridor would have been short thorny woodland representative of Marikana Thornveld (Mucina & Rutherford, 2006), with a narrow band of riparian vegetation ('Sandspruit vegetation' unit) along the Sandspruit. However, approximately 38.2% of the vegetation of the pipeline mapping corridor has been transformed through historical cultivation (last ploughed at least 15 years ago), road construction and mining associated infrastructure, and currently comprises secondary vegetation (mostly Shrubland and Bushland) of historically cultivated areas or permanently transformed areas (i.e. R565 tar road, dog kennels for the mine and access roads). Historical cultivation is the greatest contributor to transformation within the pipeline mapping corridor. The remaining areas of untransformed vegetation, comprising mostly Thicket and Bushland with smaller areas of Short Closed Woodland (*sensu* Edwards, 1983) along the Sandspruit, have been degraded by anthropogenic impacts such as historical and ongoing heavy grazing and browsing by cattle and goats, altered fire regimes, selective cutting of large trees, medicinal plant harvesting and invasion by alien plants along the Sandspruit. The entire pipeline mapping corridor is situated within what is seemingly a communal grazing area with access to residents of nearby settlements (Ledig and Phatsima).

A total of two units comprising untransformed vegetation (units 1 and 2) and two units comprising transformed habitats (units 3 and 4) with secondary vegetation or no vegetation (i.e. infrastructure) were identified. These four units are listed in Table 8. The percentage of the Mimosa section occupied by each of the identified vegetation and land-cover units and perceived botanical biodiversity conservation value / sensitivity of each unit is also provided

in Table 8. Photographs of the vegetation units are provided in Appendix 11. The approximate delineation of the four vegetation and land-cover type units is shown Figure 3 and Appendix 9.

Table 8: Percentage of the study area occupied by each of the vegetation or land-cover type units identified within the tailings pipeline 'mapping corridor' and perceived sensitivity / biodiversity conservation value of each unit.

Vegetation or Land-cover type unit	Percentage of the pipeline mapping corridor	Biodiversity Conservation Value
1. Marikana Thornveld	59.8% 23.6ha	High
2. Sandspruit vegetation	2.0% 0.8ha	High
3. Secondary vegetation	30.1% 11.9ha	Moderate
4. Infrastructure	8.1% 3.2ha	Negligible
TOTAL	39.5ha	

The broad-scale vegetation units and land-cover type units described listed in Table 8 have been derived on the basis of structural and functional criteria using the same approach applied to vegetation mapping in the Mimosa and Frischgewaagd sections. With the exception of the 'Sandspruit vegetation' unit, the units identified for the pipeline mapping corridor are equivalent to units with the same names identified for the Mimosa and Frischgewaagd sections in terms of structural and functional criteria as well as botanical biodiversity conservation value and sensitivity, and are not separately described here. No plant species regarded as 'species of conservation concern' (*sensu* Raimondo *et al*., 2009) or Protected plant species were recorded within the 39.5ha pipeline mapping corridor.

Vegetation Unit 2 (Sandspruit vegetation) of the pipeline mapping corridor does not occur within the Mimosa and Frischgewaagd sections, and is therefore briefly described below in terms of vegetation structure, ecological status, habitat characteristics and biodiversity conservation value. The terminology used in describing the vegetation physiognomy of the woody and herbaceous plant communities, is that developed by Edwards (1983). In the vegetation descriptions provided below, an asterisk indicates an alien species.

Unit 2: Sandspruit vegetation

This extent of this unit within the pipeline mapping corridor is 0.8ha (or 2.0% of the mapping corridor). This unit comprises the vegetation of the Sandspruit River macro-channel, including the macro-channel bed, active-channel banks (marginal zone) and the macro-channel banks. The Sandspruit is a weakly perennial stream. No significant floodplain habitats are present within the short (ca. 150m) reach of the Sandspruit situated within the mapping corridor, due to the deeply incised (ca. 8m) macro-channel and the relatively steep slopes above the macro-channel banks. The Sandspruit confluences with the Elands River approximately 110 m downstream of the pipeline mapping corridor. The soils of this unit comprise a mixture of sandy clay loam soils of the Oakleaf, Valsrivier and Mispah forms (De Castro & Brits soils report, 2016). As is typical of such rivers, there is strong lateral zonation

of vegetation as a result of variations in key habitat parameters such as flooding frequency and duration of flooding, speed of floodwaters and substrate characteristics. Though the vegetation of these riverine habitats is still dominated by indigenous species, many aliens (including habitat transformers) are present, and this is a reflection of the fact that the upstream reaches of this river channel and catchment, which flow past Ledig, are significantly degraded. The vegetation of this unit falls within a communal grazing area situated between Mimosa and Frischgewaagd, and is overgrazed and subjected to extensive cutting of trees for fuel and construction material.

Three major plant communities have been recognised within this unit. The major plant communities include herbaceous vegetation of the channel floor, Open Shrubland on the lower macro-channel banks and riparian Short Closed Woodland on the upper macro-channel banks. These major plant communities are briefly described below.

The exposed macro-channel bed (between pools) comprises alluvial sands and gravel with scattered to dense alluvial rock cover on the surface. The vegetation comprises herbaceous plant communities dominated by hygrophytic grasses and sedges, which include many alien weeds. Frequent flooding by fast flowing waters largely precludes the establishment of mature trees, but rheophytic shrubs occur scattered on the macro-channel bed. Common shrubs include the rheophytes *Gomphostigma virgatum, Salix mucronata,* and *Sesbania punicea**. Dominant grasses and rushes include *Cynodon dactylon* and *Juncus excertus.* Common grasses and sedges include *Agrostis lachnantha, Hemarthria altissima, Paspalum distichum, Cyperus eragrostis** and *Cyperus sexangularis.* Common forbs include *Aster squamatus*, Lobelia thermalis, Pulicaria scabra* and *Xanthium strumarium*.*

On the lower macro-channel banks the vegetation comprises Open Shrubland with a relatively sparse and heavily grazed herbaceous layer. Frequent flooding by fast flowing waters largely precludes the establishment of mature trees other than rheophytes. Common small trees are *Salix mucronata* and *Morus alba**. The dominant shrub is *Searsia lancea*. Common shrubs include *Conyza scabrida, Gymnosporia buxifolia, Salix mucronata* and *Sesbania punicea*.* The dominant species in the herbaceous layer are the sedge *Cyperus sexangularis* and the grass *Cynodon dactylon*. Common grasses include *Paspalum dilatatum*, Hemarthria altissima, Botriochloa insculpta* and *Sporobolus fimbriatus.* Common forbs include *Juncus excertus, Pulicaria scabra* and *Ranunculus multifidus, Verbena officinalis.*

On the upper macro-channel banks, the vegetation is riparian Short Closed Woodland. The dominant trees are *Searsia lancea* and *Acacia karoo.* Common trees include *Morus alba*, Olea europaea* subsp. *africana, Ziziphus mucronata*. The dominant shrubs are *Acacia karoo* and *Gymnosporia buxifolia*. Common shrubs include *Asparagus laricinus, Grewia flava, Searsia pyroides, Searsia lancea* and *Tarchonanthus parvipunctulatus*. The dominant species in the herbaceous layer is the grass *Panicum maximum*. Common forbs include *Hypoestes forskaolii* and *Pavonia burchellii.* Young plants of the alien invasive succulent *Agave americana** are locally abundant along the macro-channel banks.

No 100m^2 were surveyed within this unit, but average species richness is Moderate, as is typical of such rivers in this region. The plant communities of the macro-channel bed and to a lesser extent the riparian woodland communities are floristically distinct from the vegetation of all other units within the study area other than the 'Elands River vegetation' unit of Frischgewaagd and Mimosa. This unit does not contain habitat that is considered suitable for

any of the 'plant species of conservation concern' recorded or potentially occurring in the vicinity of the study area (see Appendix 5). Though significant invasion by alien trees that are habitat transformers in riparian habitats in this part of the North-West Province is present, the vegetation of this unit is still dominated by indigenous species and riparian habitat transformed by aliens was not recorded in the assessed reach of the Sandspruit. Furthermore, the riverine vegetation comprising this unit is considered to be of elevated sensitivity for the following reasons:

- Much of the riparian vegetation along the tributaries of the Elands River in the North West Province has already been transformed by a variety of anthropogenic impacts such as altered hydrological patterns (particularly water abstraction), reduced water quality, cultivation, and invasion by alien plant species, and any remaining area of untransformed riverine vegetation must therefore be regarded as of elevated conservation importance.
- A river is a 'longitudinal ecosystem', and its condition at any point is a reflection not only of all upstream activities within the river/drainage line, but also of all activities in the adjacent and upstream parts of the catchment (O'Keefe, 1986). This sensitivity is reflected by the fact that watercourses are protected by South African legislation, including the National Water Act and the National Environmental Management Act, according to which the vast majority of activities within 32m of a watercourse (including its floodplain) or in some cases even within 100m of a watercourse, will trigger an environmental authorisation process.
- Within the study area and its immediate surroundings, the riverine vegetation of the Sandspruit provides a unique and restricted habitat for various plants and animals that are largely or entirely restricted to such habitats.

This unit is therefore considered to have a **High** botanical biodiversity conservation value and sensitivity.

9.0 SPECIES RICHNESS AND ALIEN PLANT SPECIES OF THE STUDY AREA

According to the National Herbarium PRECIS database records (http://posa.sanbi.org), the quarter degree grid within which the study area is situated (2527AC) has been very poorly explored botanically. The PRECIS database contains 253 herbarium records for the grid within which Mimosa and Frischgewaagd are situated (2527AC), and only 29 herbarium records for the grid immediately to the west (2526BD). During a previous biological assessment of an approximately 1650ha area which includes the Frischgewaagd and Mimosa sections of the current study area (Golder Associates, August 2007), 146 plant species were recorded for the entire 1650ha study area. The current report provides a list of 414 plant species and infraspecific taxa have thus far been recorded by the author within the 1 123.1ha study area (comprising Frischgewaagd, Mimosa and the 39.5ha tailings pipeline mapping corridor), 356 of which are indigenous taxa, and 58 (14.0%) of which are naturalised aliens. Of the 58 alien species listed in Appendix 1, 22 are declared alien invasive plant species in terms of the Alien Invasive Species (AIS) regulations. Alien species are indicated by an asterisk.

In the discussions of the plant species lists and alien species provided for each study area section below, reference is made to declared alien invasive plant species in terms of the Regulations on Alien and Invasive Plant Species (AIS Regulations). The AIS regulations are defined in the National Environmental Management: Biodiversity Act (Act no. 10 of 2004), published in the Government Gazette No. 37886, Notice 599 of 1 August 2014. In terms of the AIS regulation, declared alien invasive plant species (as listed in Notice 3 of the Act)

must be eradicated or controlled by the landowner. The AIS regulations furthermore place each declared alien invasive plant species into one of four categories, and stipulate measures for the eradication and stipulate of plants in each of the four categories (Table 9).

Table 9: Legal requirements for the control or eradication of the four categories of alien invasive species listed in the 'Regulations on Alien and Invasive Species' (AIS) in terms of the National Environmental Management: Biodiversity Act (Act No 10 of 2004), published in the Government Gazette No. 37885, Notice 598 of 1 August 2014 (as amended).

Categories of Listed Invasive Species	
Category	**Definition and legal requirements**
1a	1. Category 1a Listed Invasive Species are those species listed as such by notice in terms of section 70(1)(a) of the Act as species which must be combatted or eradicated. 2. A person in control of a Category 1a Listed Invasive Species must: a. comply with the provisions of section 73(2) of the Act; b. immediately take steps to combat or eradicate listed invasive species in compliance with sections 75(1), (2) and (3) of the Act; and c. allow an authorised official from the Department to enter onto land to monitor, assist with or implement the combatting or eradication of the listed invasive species. 3. If an Invasive Species Management Programme has been developed in terms of section 75(4) of the Act, a person must combat or eradicate the listed invasive species in accordance with such programme.
1b	1. Category 1b Listed Invasive Species are those species listed as such by notice in terms of section 70(1)(a) of the Act as species which must be controlled. 2. A person in control of a Category 1b Listed Invasive Species must control the listed invasive species in compliance with sections 75(1), (2) and (3) of the Act. 3. If an Invasive Species Management Programme has been developed in terms of section 75(4) of the Act, a person must control the listed invasive species in accordance with such programme. 4. A person contemplated in sub-regulation (2) must allow an authorised official from the Department to enter onto land to monitor, assist with or implement the control of the listed invasive species, or compliance with the Invasive Species Management Programme contemplated in section 75(4) of the Act.
2	1. Category 2 Listed Invasive Species are those species listed as such by notice in terms of section 70(1)(a) of the Act as species which require a permit to carry out a restricted activity within an area specified in the Notice or an area specified in the permit, as the case may be. 2. Unless otherwise indicated in the notice, no person may carry out a restricted activity in respect of a Category 2 Listed Invasive Species without a permit. 3. A landowner on whose land a Category 2 Listed Invasive Species occurs or person in possession of a permit, must ensure that the specimens of the species do not spread outside of the land or the area specified in the Notice or permit. 4. If an Invasive Species Management Programme has been developed in terms of section 75(4) of the Act, a person must control the listed invasive species in accordance with such programme. 5. Unless otherwise specified in the Notice, any species listed as a category 2 Listed Invasive species that occurs outside of the specified area contemplated in sub-regulation (1), must, for purposes of these regulations, be considered to be a Category 1b Listed Invasive Species and must be managed according to Regulation 3. 6. Notwithstanding the specific exemptions relating to existing plantations in respect of Listed Invasive Plant Species published in the Government Gazette No. 37886, Notice 599 of 1 August 2014 (as amended), any person or organ of state must ensure that the specimens of such Listed Invasive Plant Species do not spread outside of the land over which they have control.
3	1. Category 3 Listed Invasive Species are species that are listed by notice in terms of section 70(1)(a) of the Act, as species which are subject to exemptions in terms of section 71(3) and prohibitions in terms of section 71A of the Act, as specified in the Notice. 2. Any plant species identified as a Category 3 Listed Invasive Species that occurs in riparian areas, must, for the purposes of these regulations, be considered to be a Category 1b Listed Invasive Species and must be managed according to Regulation 3. 3. If an Invasive Species Management Programme has been developed in terms of section 75(4) of the Act, a person must control the listed invasive species in accordance with such programme.

The landowner should develop an integrated alien plant control program (as per the AIS Regulations), which considers all appropriate chemical, mechanical, biological and cultural control methods for the alien species listed in Appendix 1. Emphasis should be placed on controlling the 22 declared alien invasive species listed in Appendix 1, and in particular the nine species discussed below and listed in Table 9 which are regarded as the most important (in terms of habitat transformation) alien invasive plant species recorded within the study area.

Frischgewaagd

A total of 338 plant species and infra-specific taxa were recorded within Frischgewaagd during the current survey, of which 286 are indigenous taxa and 52 (15.4%) are naturalized aliens. The majority of the recorded alien species are found in the large areas of secondary vegetation of historically cultivated soils (Unit 6), existing mining infrastructure (Unit 8), and a disturbed reach of the Elands River (Unit 5), are the primary reasons for this relatively high percentage of alien species. Of the 52 alien species listed in Appendix 1, nineteen are declared alien invasive plant species in terms of the Alien Invasive Species (AIS) regulations. Based on the author's experience the list of 339 plant species probably includes approximately 80% of the species actually present.

Based on the available literature, the author's experience in the region and observations made during the current survey, the following six recorded alien species pose a significant threat to the indigenous vegetation of the study area and its immediate surrounds, namely *Eucalyptus camaldulensis*, Melia zedarach*, Morus alba*, Nicotiana glauca*, Populus* x *canescens* and *Sesbania punicea*.* These species are highly invasive transformers of riverine habitats in the eastern parts of the North-West province, have already become well established along the reach of the Elands River bordering the study area, and should be controlled as a matter of urgency.

Mimosa and tailings pipeline mapping corridor

A total of 294 plant species and infra-specific taxa were recorded within Mimosa and the tailings pipeline mapping corridor during the current survey, of which 257 are indigenous taxa and 37 (12.6%) are naturalized aliens. The majority of the recorded alien species are found in the transformed northern parts of the study area, which comprises entirely of areas of secondary vegetation of historically cultivated soils (Unit 4) and, particularly along the Elands River (Unit 3) and Sandspruit. Of the 37 alien species listed in Appendix 1, thirteen are declared alien invasive plant species in terms of the AIS regulations. Based on the author's experience the list of 294 plant species probably includes approximately 80% of the species actually present.

Based on the available literature, the author's experience in the region and observations made during the current survey, the following five recorded alien species pose a significant threat to the indigenous vegetation of the study area and its immediate surrounds: *Agave sisalana*, Cereus jamacuru*, Dolichandra anguis-cati*, Eucalyptus camaldulensis*, Melia zedarach*, Morus alba*, Nicotiana glauca* and *Sesbania punicea*.* With the exception of *Cereus jamacuru** which invades only rocky outcrop vegetation (Mimosa Unit 2), the aforementioned species are all highly invasive transformers of riverine habitats in the eastern parts of the North-West province, have already become well established along the reach of the Elands River bordering the study area and the reach of the Sandspruit crossed by the tailings pipeline, and should be controlled as a matter of urgency. Of particular interest is the fact that *Agave americana*,* a species not known as an invader of riparian habitat, is well established in riparian woodland at the tailings pipeline crossing of the Sandspruit and is seemingly spreading rapidly.

Table 10: Most important (in terms of habitat transformation) alien invasive plant species recorded within the two sections of the study area and the pipeline mapping corridor.

Species	Category in terms of the AIS Regulations	Vegetation or land-cover type unit	
		Frischgewaagd	Mimosa
Agave americana	-	-	2
Cereus jamacuru	Category 1b	-	2
Dolichandra anguis-cati	Category 1b	-	3
Eucalyptus camaldulensis	Category 1b or 3 depending on location	5	3
Melia zedarach	Category 1b Category 3 in urban areas	5	3
Morus alba	Category 3	5	3
Nicotiana glauca	Category 1b	5	3
Opuntia ficus-indica	Category 1b	1	
Populus x *canescens*	Category 2	5	
Sesbania punicea	Category 1b	5	3

10.0 PROTECTED PLANT SPECIES OF THE STUDY AREA

Two pieces of current legislation grant protected status to selected indigenous plant species within the North-West Province, namely:

- National Forests Act (Act 84 of 1998, as amended on the 23rd of September 2010), and
- National Environmental Management: Biodiversity Act (Act 10 of 2004, as amended on the 16th of April 2013).

Schedule A of the National Forests Act (Act 84 of 1998) lists 47 tree species that are Protected in South Africa and may not be removed or damaged without the granting of a licence by the National Department of Agriculture, Forestry and Fisheries. Though protected, most of these species have large distribution ranges, are common to abundant throughout much of their distribution ranges and are not threatened with extinction. **Two of the 47 tree species listed in Schedule A of the National Forests Act were recorded within the study area during the current survey.** These two tree species are listed in Table 11, together with the sections (i.e. Frischgewaagd or Mimosa) and vegetation units within which they were recorded.

The Biodiversity Act (Act 10 of 2004, as amended in April 2013), is intended to protect plant and animal species that are directly threatened by utilisation. This Act assigns species threatened by utilisation to one of four categories, namely Critically Endangered, Endangered, Vulnerable and Protected, but it must be emphasised that these categories are not the same as the rigorously defined IUCN Ver. 3.1 categories for threatened plant species (IUCN, 2001). The destruction, collection or trading of any species listed in the Act requires a permit which must be obtained from the North West Department of Rural, Environmental and Agricultural Development. No species listed in the Biodiversity Act were recorded within the study area.

The damaging or destruction of Protected plant species during development should be avoided wherever possible, and a permit for the destruction of any such protected plant

must be obtained from the provincial authorities prior to development. If any Protected herbaceous plant species are recorded within the study area in future, it is recommended that such species are rescued and placed in a nursery or donated to a research institute (e.g. SANBI or botanical garden) prior to mining, rather than simply being destroyed upon receipt of a permit. Where feasible, viable populations of such species can also be translocated to transformed (including rehabilitation areas) or untransformed areas within the study area which provide potentially suitable habitats, but such translocations will require a permit and will have to be carried out in a manner that ensures that no ecological degradation of the host habitat occurs, and will have to be evaluated by a botanist for each species and each potential translocation area. Interested research and conservation institutions (e.g. SANBI and universities) should be provided within an opportunity to search the development footprints prior to development in order to obtain material for research or propagation (e.g. medicinal and horticultural species).

Table 11: List of trees recorded within the study area that are protected species in terms of the National Forests Act (Act 84 of 1998, as amended on the 23rd of September 2010).

Species	Family	Vegetation unit	
		Frischgewaagd	Mimosa
Boscia albitrunca	Capparaceae	1 3	2
Sclerocarya birrea subsp. *africana*	Celastraceae	Not recorded but a few plants likely to occur.	1 2

11.0 PLANT 'SPECIES OF CONSERVATION CONCERN' (*sensu* Raimondo *et al*., 2009)

Prior to the conduction of the field surveys, available database information pertaining to the threatened plant species of the region of the North-West Province within which the study area is situated was obtained from the National Herbarium PRECIS database (http://posa.sanbi.org). All 'threatened species', namely Critically Endangered, Endangered and Vulnerable species, and other 'species of conservation concern', namely Near Threatened, Declining, Critically Rare and Rare species (*sensu* Raimondo *et al*., 2009 and http://redlist.sanbi.org, downloaded May 2015) historically recorded from the quarter degree grid square within which the study area is situated (2527AC), as well as four immediately adjacent grids (2526BC, 2526BD, 2526DB and 2527CA) which contain similar habitats, were extracted from these lists and are presented in Appendix 5. Emphasis was placed on searching for these plant species, and potentially suitable habitat for these species, during the field surveys.

The Red List of South African Plants (Raimondo *et al*., 2009) provided an assessment of all South African Plant taxa. The Red List therefore contains species that are currently regarded as being threatened with extinction (Critically Endangered, Endangered and Vulnerable) or are close to being threatened with extinction (Near Threatened), as well as species that are currently not regarded as being threatened with extinction (Least Concern), in accordance with IUCN Version 3.1 criteria (IUCN, 2001). In addition to the IUCN categories, the South African Red List also includes unique categories for species which currently do not qualify as Threatened or Near Threatened in accordance with IUCN criteria, and are thus categorised as

Least Concern by the IUCN, but which are of some conservation concern (Raimondo *et al*., 2009). These South Africa categories are Critically Rare, Rare and Declining, and were developed specifically to highlight species that though not threatened with extinction possibly require some conservation effort and monitoring. In terms of the recommended methodology provided by Raimondo *et al*. (2009), the term 'species of conservation concern' includes the IUCN threatened and Near Threatened categories as well as the South African Red List categories (i.e. Critically Rare, Rare and Declining), and this approach is followed here.

The obtained lists of historically recorded 'species of conservation concern' included nine plant 'species of conservation concern', namely *Aloe peglerae* (Endangered), *Prunus africana* (Vulnerable), *Adromischus umbraticola* subsp. *umbraticola* (Near Threatened), *Drimia sanguinea* (Near Threatened), *Boophone disticha* (Declining), *Gunnera perpensa* (Declining), *Ilex mitis* (Declining), *Rapanea melanophloeos* (Declining) and *Frithia pulchra* (Rare). These nine species are included in Appendix 5 together with relevant information on their known habitat requirements, flowering periods, known distribution and 'probability of occurrence' within the study area. Also included in Appendix 5 are two additional species, namely *Stenostelma umbelluliferum* (Near Threatened) and *Hypoxis hemerocallidea* (Declining). Though not currently included in the PRECIS database records for the five grids considered here, *Stenostelma umbelluliferum*, does occur in the eastern parts of the North-West province in habitats similar to those found in the study area, and is therefore included as a potentially occurring species. *Hypoxis hemerocallidea*, was also not listed for the five quarter degree grids, but was recorded at Frischgewaagd by the author during the baseline bidoversity survey for Frischgewaagd (De Castro & Brits, May 2015) and the current survey. Emphasis was placed on searching for these 11 plant species, and potentially suitable habitat for these species. Recorded and potentially occurring 'species of conservation concern' are briefly discussed below.

Only one of the eleven species listed in Appendix 5 has thus far been recorded within the study area, namely *Hypoxis hemerocallidea* (Declining). This species was recorded at four sites within Frischgewaagd, namely F10, F12, F28 and F35 (see Figure 2). All four sites are situated within Grassland and Open Shrubland on stony soils of the eroded macro-channel of the large ephemeral stream in the north-eastern parts of Frischgewwagd within Unit 3 ('Eroded ephemeral drainage lines'), and suitable habitat for this species is considered unlikely to occur in significant numbers elsewhere in the study area. At all four localities only a small number of plants (<10) was present. *Hypoxis hemerocallidea* is not a threatened species as defined by the IUCN criteria, but is categorised as Declining in the latest Red List of South African Plants (Raimondo *et al*., 2009 and http://redlist.sanbi.org). Declining is a South African Red List category reserved for species which are not threatened or Near Threatened, but which are declining as a result of over-utilisation, and therefore merit some conservation effort. *Hypoxis hemerocallidea* has a large distribution range ('Extent of Occurrence') that extends over much of the eastern half of southern Africa, and is common to abundant over much of its range. This species is not under any immediate threat of extinction, and has been categorised as Declining as a result of the fact that it is a popular and fairly heavily utilised medicinal plant which is long-lived and slow growing, and there are concerns that long-term over-utilisation of wild plants will lead to a decline in many of the sub-populations of this species. **It is therefore recommended that prior to any development that may lead to the destruction of *Hypoxis hemerocallidea* or any other Declining plant species, permission for their removal should be obtained from the provincial Directorate of Biodiversity Management, and if necessary appropriate *in situ* and / or *ex situ* conservation measures should be developed and implemented in conjunction with**

the Directorate. Where feasible, viable populations of such species should be translocated to degraded or untransformed areas within the study area which provide potentially suitable habitats, but such translocations will have to be carried out in a way that ensures no ecological degradation of the host habitat occurs, and will have to be evaluated by a botanist for each species and each potential translocation area. Alternatively plants should be offered to research and conservation institutions such as SANBI botanical gardens or universities. Illegal medicinal plant harvesting should be monitored and discouraged through control of access to untransformed habitats and vegetation within the study area.

The ten plant species which are listed in Appendix 5, and which have thus far **not been recorded** in the study area, include three species which have a Moderate probability of occurrence within the study area (see Appendix 5).These three species are the Near Threatened species *Drimia sanguinea* and *Stentonstelma umbelluliferum*, and the Declining medicinal plant species *Boophone disticha*. Vegetation and land-cover type units most likely to contain potentially suitable habitat for each of these three species are listed in Table 12.

Table 12: Vegetation and land-cover type units containing potentially suitable habitat for plant 'species of conservation' concern which have a moderate probability of occurring within the study area.

Species	**Conservation status** (http://redlist.sanbi.org)	**Vegetation and land-cover type units containing potentially suitable habitat**		
		Frischgewaagd	Mimosa	Pipeline mapping corridor
Boophone disticha	Declinning	2 and 3	2	none
Drimia sanguinea	Near Threatened	1 and 4	1	1
Stenostelma umbelluliferum	Near Threatened	4	none	none

Drimia sanguinea and *Stentonstelma umbelluliferum* are very difficult to detect and identify when not in flower, whereas *Boophone disticha* and *Hypoxis hemerocallidea* are conspicuous species, even when not in flower. Additional surveys for 'plant species of conservation concern' should therefore be carried out during the flowering seasons for *Drimia sanguinea* and *Stentonstelma umbelluliferum.* **It is therefore recommended that additional, brief floristic surveys, focussed on searching for *Drimia sanguinea, Stentonstelma umbelluliferum, Boophone disticha* and *Hypoxis hemerocallidea* within the proposed development footprints, should be conducted in late October to early November and in January. The brief floristic surveys should focus on searching those parts of the proposed infrastructure footprints containing potentially suitable habitat for *Drimia sanguinea* (see Table 12). These surveys will also contribute towards confirming the presence or absence of other 'species of conservation concern' within the study area. In the event of any threatened or near threatened species being recorded during follow-up surveys, appropriate *in situ* and / or *ex situ* conservation measures should be developed and implemented in conjunction with the provincial Directorate of Biodiversity Management.**

12.0 DESCRIPTION OF THE PROPOSED INFRASTRUCTURE FOOTPRINTS

The percentage of the surface area of each of the eleven infrastructure footprints (excluding the tailings pipeline construction servitude) comprised of the various vegetation and land-cover type units identified within the study area, is provided in Table 13. The percentage of the surface area of the 30m wide construction servitude of the final tailings pipeline alignment (December 2015) comprised of the various vegetation and land-cover type units identified within the study area, is provided in Table 14. All proposed infrastructure footprints and the proposed final tailings pipeline alignment fall entirely within areas mapped as a CAB 2 in the recently completed NWBSP 2015.

The project components (not including the tailings pipeline alignment) have a total combined footprint of 344.3ha, of which 203.1ha (or 59.0%) comprises transformed habitats with secondary vegetation (historically ploughed areas) or no vegetation (existing infrastructure). The footprint of the ca. 3.83km final tailings pipeline alignment (December 2015) is 11.5ha, of which 3.0ha (or 26.1%) comprises transformed habitats with secondary vegetation (historically ploughed areas) or no vegetation (existing infrastructure). In the case of both the eleven infrastructure footprints and the pipeline construction servitude, the vast majority of the transformed areas comprise secondary vegetation of historically ploughed soils.

The vast majority of the area of untransformed habitats and vegetation included in the footprints of the eleven infrastructure components (not including the tailings pipeline alignment) comprises Marikana Thornveld vegetation unit, which though untransformed has been degraded through the study area by historical and ongoing impacts such as altered fire regimes (mostly in the form of overly frequent and unseasonal burning), overgrazing, and cutting of trees. Approximately 139.7ha (or 40.6%) of the 344.3ha total combined footprint of the eleven infrastructure components comprises Marikana Thornveld. Approximately 7.9ha (or 68.7%) of the 11.5ha footprint of the final tailings pipeline alignment comprises Marikana Thornveld. The proposed infrastructure footprints (including the pipeline alignment construction servitude) therefore include a total area of 139.7ha of areas mapped as the Marikana Thornveld vegetation unit. Marikana Thornveld is regarded as a Vulnerable vegetation type in the recently published NWBSP 2015.

As previously stated, the eleven infrastructure components (not including the tailings pipeline alignment) have a total combined footprint of 344.3ha, of which 203.1ha (or 59.0%) comprises transformed habitats with secondary vegetation or no vegetation, and 139.7ha (or 40.6%) comprises Marikana Thornveld. The remaining 1.5ha (or 0.4%) of the total combined footprint comprises of the following spatially restricted untransformed habitats and vegetation:

- A total of 1.0ha of 'Stony grassland' (Unit 2 of Frischgewaagd section) comprising 0.3ha within the Concentrator Plant footprint, 0.6ha within the Product Stockpile footprint and 0.1ha within the Pollution Control Dam footprint.
- A total of 0.5ha of 'Eroded ephemeral drainage lines' (Unit 3 of Frischgewaagd section) comprising 0.3ha within the Housing Phase 1 footprint, 0.1ha within the Housing Phase 1a footprint and 0.1ha within the Bridge footprint.

Though not mapped or described as a separate vegetation or land-cover type unit in this report, a small and indistinct drainage line embedded within the Marikana Thornveld vegetation unit of the Mimosa section, is partly situated within the proposed footprint of the Storm Water Dam. A 150m section of the uppermost reach of this indistinct drainage line is situated within the stormwater dam footprint. This ephemeral drainage line has no distinct vegetation and is described in more detail in the specialist wetland and water course report

completed for the Bakubung Platinum mine expansion project (De Castro & Brits, February 2015).

As previously stated, the footprint of the ca. 3.83km final tailings pipeline alignment construction servitude is 11.5ha in extent, of which 3.0ha (or 26.1%) comprises transformed habitats with secondary vegetation or no vegetation, and 7.9ha (or 68.7%) comprises Marikana Thornveld. The remaining 0.6ha (or 5.2%) of the pipeline construction servitude comprises of the following spatially restricted untransformed habitats and vegetation:

- A total of 0.4ha of 'Eroded ephemeral drainage lines' (Unit 3 of Frischgewaagd). A total of 137m of pipeline alignment is situated within areas mapped as 'Eroded ephemeral drainage lines'.
- A total of 0.2ha within the 'Sandspruit vegetation' vegetation unit (Unit 2 of the pipeline mapping corridor). A 51m section of the pipeline alignment crosses the riparian habitats of Sandspruit.

No habitats that qualify as 'wetland' according the DWAF (2005) criteria were recorded within any of the eleven proposed infrastructure footprints or the final tailings pipeline alignment construction servitude. Wetlands, rivers and drainage lines of the study area are described in more detail in the specialist wetland report compiled for this project (De Castro & Brits, February 2016).

No 'plant species of conservation concern' (*sensu* Raimondo *et al*., 2009 and http://redlist.sanbi.org, downloaded May 2015) were recorded within the proposed infrastructure footprints or the construction servitude of the proposed final tailings pipeline alignment (December 2015). No plant species that are Protected in terms of the National Forests Act or the Biodiversity Act were recorded within the proposed infrastructure footprints or the construction servitude of the final tailings pipeline alignment.

Table 13: Extent of vegetation and land-cover type units within proposed infrastructure footprints (excluding the tailings pipeline alignment).

Vegetation or land-cover type unit*	**Infrastructure - Frischgewaagd**								**Infrastructure - Mimosa**			**TOTAL no. of hectares**
	Concentrator plant	**Product stockpiles & ore crusher**	**Pollution control dam**	**Waste rock dump**	**Housing Phase 1**	**Housing Phase 1a**	**Eskom Ledig substation**	**Bridge & road to bridge****	**Tailings storage facility**	**Return water dam**	**Storm water dam**	
Frischgewaagd									-	-	-	
1. Marikana Thornveld	95.2% 6.0ha	55.2% 13.9ha	96.0% 4.9ha	-	83.8% 16.6ha	58.7% 14.8ha	92.2% 4.7ha	75.0% 0.3ha	-	-	-	**61.2ha**
1.1 Mixed Woodland and Thicket	95.2% 6.0ha	52.0% 13.1ha	-	-	80.8% 16.0ha	58.7% 14.8ha	92.2% 4.7ha	75.0% 0.3ha	-	-	-	**54.9ha**
1.2. *Acacia mellifera* Bushland and Thicket	-	3.2% 0.8ha	96.0% 4.9ha	-	3.0% 0.6ha	-	-	-	-	-	-	**6.3ha**
2. Stony Grassland	4.8% 0.3ha	2.4% 0.6ha	2.0% 0.1ha	-	-	-	-	-	-	-	-	**1.0ha**
3. Eroded ephemeral drainage lines	-	-	-	-	1.5% 0.3ha	0.4% 0.1ha	-	25.0% 0.1ha	-	-	-	**0.5ha**
4. Ephemeral drainage lines	-	-	-	-	-	-	-	-	-	-	-	**0.0ha**
5. Elands River vegetation	-		-	-	-	-	-	-	-	-	-	**0.0ha**
6. Secondary vegetation	-	38.5% 9.7ha	-	19.0% 1.1ha	14.7% 2.9ha	40.9% 10.3ha	7.8% 0.4ha	-	-	-	-	**24.4ha**
7. Dams	-	-	-	-	-	-	-	-	-	-	-	**0.0ha**
8. Infrastructure	-	3.9% 1.0ha	2.0% 0.1ha	81.0% 4.7ha	-	-	-	-	-	-	-	**5.8ha**
Mimosa												
1. Marikana Thornveld	-	-	-	-	-	-	-	-	27.4% 64.5ha	100% 1.2ha	85.9% 12.8ha	**78.5ha**
2. Rocky outcrop vegetation	-	-	-	-	-	-	-	-	-	-	-	**0.0ha**
3. Elands River vegetation	-	-	-	-	-	-	-	-	-	-	-	**0.0ha**
4. Secondary vegetation	-	-	-	-	-	-	-	-	72.6% 170.8ha	-	14.1% 2.1ha	**172.9ha**
5. Infrastructure	-	-	-	-	-	-	-	-	-	-	-	**0.0ha**
TOTAL	**6.3ha**	**25.2ha**	**5.1ha**	**5.8ha**	**19.8ha**	**25.2ha**	**5.1ha**	**0.4ha**	**235.3ha**	**1.2ha**	**14.9ha**	**344.3ha**

[#]**S**ub-units shaded grey are not included in Total area as they form part of Unit 1. ****** Surface area calculated on the basis of a 118m long and 30m construction servitude.

Table 14: The percentage of the surface area of the 30m wide construction servitude of the final tailings pipeline alignment (December 2015).

Final tailings pipeline alignment (December 2015)	
Vegetation or land-cover type	**Length of pipeline and surface area of 30m wide construction servitude**
Marikana Thornveld (Combines Frischgewaagd Unit 1, Mimosa Unit 1 and the Pipeline mapping corridor Unit 1)	2625m 7.9ha
Eroded ephemeral drainage lines (Frishgewaagd Unit 3)	137m 0.4ha
Sandspruit vegetation (Pipeline mapping corridor Unit 2)	51m 0.2ha
Secondary vegetation (Combines Frischgewaagd Unit 6, Mimosa Unit 4, and Pipeline mapping corridor Unit 3)	873m 2.6ha
Infrastructure (Combines Frischgewaagd Unit 8, and Pipeline mapping corridor Unit 4)	147m 0.4ha
TOTAL	**3833m** **11.5ha**

13.0 POTENTIAL IMPACTS OF THE PROJECT

The potential impacts of the project on the botanical biodiversity of the study area are assessed under four broad impacts, namely:

- loss of vegetation types (*sensu* Mucina & Rutherford, 2006 and the NWBSP 2015);
- loss of spatially restricted vegetation units / plant communities;
- loss of flora (species richness);
- loss of plant 'species of conservation concern' (*sensu* Raimondo *et al.*, 2009).

A formal Impact Assessment which describes the impacts in more detail, determines the significance of each impact (impact rating) and provides mitigation and monitoring measures for each impact, is provided in Appendix 10. The nature of each of the four impacts is briefly described below.

Loss of Vegetation Types

This impact refers to the loss of vegetation types (or broad-scale vegetation units) described and mapped in the national vegetation map (Mucina & Rutherford, 2006) and the North West Biodiversity Sector Plan (NWBSP) 2015. The NWBSP 2015 equates these vegetation types with ecosystems. The vegetation of the study area is regarded as representative of Marikana Thornveld, which is currently categorised as a Vulnerable vegetation type in the NWBSP 2015. Loss of untransformed Marikana Thornveld vegetation will result from the clearing of vegetation within the construction footprints of ten of the eleven proposed infrastructure components and the construction servitude of the tailings pipeline. A loss of Marikana Thornveld may also result should there be soil pollution caused by contaminated seepage and spillage from the Tailings Storage Facility and the Tailings Pipeline.

Loss of Spatially Restricted Plant Communities / Habitats

This impact refers to the loss of spatially restricted plant communities and habitats, embedded within Marikana Thornveld, which have been included in the following vegetation units:

- Stony grassland (Frischgewaagd Unit 2),
- Eroded ephemeral drainage lines (Frischgewaagd Unit 3),
- Ephemeral drainage lines (Frischgewaagd Unit 4),
- Elands River vegetation (Frischgewaagd Unit 5 and Mimosa Unit 3)
- Rocky outcrop vegetation (Mimosa Unit 2),
- Sandspruit vegetation (pipeline mapping corridor Unit 2).

The construction of the 11 proposed infrastructure components will lead to the loss of small areas of the 'Eroded ephemeral drainage lines' and 'Stony grassland' units and the construction of the tailings pipeline will affect small areas of 'Eroded ephemeral drainage lines' and 'Sandspruit vegetation' units. A loss of 'Eroded ephemeral drainage lines' and 'Sandspruit vegetation' may also result from soil pollution caused by accidental spillage from Tailings pipeline during the operational phase.

Loss of Plant 'Species of Conservation Concern'

This impact refers to the loss of 'species of conservation concern' (*sensu* Raimondo *et al*., 2009). Plant 'species of conservation concern' are species that are currently categorised as threatened (Critically Endangered, Endangered and Vulnerable), Near Threatened, Declining, Rare or Critically Rare in accordance with SANBI's continually updated online Red List (http://redlist.sanbi.org). The only plant 'species of conservation concern' thus far recorded within the 1588.6ha study area is the Declining medicinal plant *Hypoxis hemerocallidea*, which was not recorded within any of the proposed infrastructure footprints.

Loss of Flora

This impact refers to the loss of species richness (α-diversity) and of plant species that are Protected in terms of the National Forests Act (Act 84 of 1998, as amended on the 23rd of September 2010) and the Biodiversity Act (Act 10 of 2004, as amended on the 16th of April 2013). A total of 356 indigenous plant species have thus far been recorded within the study area, two of which are protected in terms of the National Forests Act, namely *Sclerocarya birrea* and *Boscia albitrunca.*

14.0 SUMMARY AND CONCLUSIONS

Description of the Study Area

This report presents the findings of botanical biodiversity survey and impact assessment for the footprints of additional support infrastructure components and a tailings pipeline alignment at the Bakubung Platinum Mine belonging to Wesizwe Platinum Limited (Wesizwe). The entire study area is situated on the farms Frischgewaagd 96 JQ and Mimosa 81 JQ and comprises the Frischgewaagd section (465.5ha) and the Mimosa section (618.1ha) of the Wesizwe surface rights area as well as a 'tailings pipeline mapping corridor' (39.5ha) situated on communal grazing land between the Frischgewaagd and Mimosa sections (see Figure 1).

According to the revised mapping of the national vegetation types (Mucina and Rutherford, 2006) provided in the North West Biodiversity Sector Plan 2015 (NWBSP 2015), six vegetation types occur within 3km of the study area, indicating that the study area is situated

within a zone of transition. The vast majority of the study area itself is mapped as Zeerust Thornveld. Though the vegetation of the study area shows some physiognomic, and to a lesser extent floristic, elements of Zeerust Thornveld, it conforms far more closely to the description of Marikana Thornveld provided by Mucina & Rutherford (2006), particularly in terms of species composition and dominance (see Table 3), and is therefore here regarded as Marikana Thornveld. The only other Mucina & Rutherford (2006) vegetation type identified within the study area is Gold Reef Mountain Bushveld, which is represented by a very small (ca. 2.5ha) area at site M37 on a low quartzitic outcrop near the western boundary of the Mimosa section. The NWBSP 2015 categorises the conservation status of Marikana Thornveld as Vulnerable and that of Gold Reef Mountain Bushveld as **Least Threatened**. However, the habitats and vegetation of approximately 527.5ha (or 47.0%) of the study area has been historically transformed and comprises secondary vegetation of historically cultivated areas or unvegetated areas permanently transformed by mining infrastructure. The remaining areas of untransformed vegetation, comprising mostly Thicket, Woodland and Bushland (*sensu* Edwards, 1983) have been degraded by anthropogenic impacts such as historical heavy grazing and browsing by cattle and goats, current (in the last four years) exclusion of grazers and browsers from the Frischgewaagd section, altered fire regimes, selective cutting of large trees, alterations to hydrological patterns and water quality (Frischgewaagd section) and invasion by alien plants along the Elands River and Sandspruit.

Approximately 1 066.1ha (or 94.9%) of the 1 123.1 study area is mapped as CBA 2 in the NWBSP 2015, and all the proposed infrastructure footprints and alignments fall within the area mapped as CBA Category 2. The 57.0ha (or 5.1%) of the study area not mapped as CBA 2 is mapped as ESA 1, ESA 2 and 'No Natural Habitat Remaining'. According to the available GIS information for the NWBSP 2015, the principal criteria which lend CBA 2 status to the habitats of study area are that it is regarded as 'Natural Corridor Linkage' and 'Natural Protected Area Buffer' (within 5km of the Pilanesberg National Park). In terms of managing the loss of natural habitat in CBAs, the NWBSP 2015 states, amongst others, that '**further loss of natural habitat should be avoided in CBA 1, whereas loss should be minimised in CBA 2 i.e. land in these two categories should be maintained as natural vegetation cover as far as possible**'. However approximately 457.0ha (or 42.9%) of the 1 066.1ha area mapped as CBA 2 within the study area comprises transformed habitats with secondary vegetation or no vegetation. All proposed infrastructure footprints and the proposed final tailings pipeline alignment fall entirely within areas mapped as a CAB 2 in the recently completed NWBSP 2015. The briefly ground-truthed vegetation and land-cover type map provided in the current report (Appendix 4) provides a far more accurate indication of the distribution untransformed habitats and vegetation which are of most importance in terms of botanical biodiversity conservation.

Ten broad-scale vegetation units and land-cover units have been identified and mapped for the study area as a whole (i.e. including the Frischgewaagd and Mimosa sections of the Wesizwe surface rights area and the tailings pipeline mapping corridor). The ten vegetation and land-cover type units identified for the study area been derived on the basis of structural and functional criteria. The term 'structure' refers to various aspects of vegetation structure such as physiognomy, life-form composition, species composition, species dominance and stand structure (Kent & Coker, 1992). Of the units described, seven comprise untransformed (though not necessarily pristine) vegetation and three comprise transformed habitats with secondary vegetation or no vegetation (i.e. infrastructure). The seven untransformed vegetation and land-cover type units comprise approximately 595.6ha (or 53.0%) of the study area and the three transformed units comprise approximately 527.5ha (or 47.0%) of the study

area. The seven units are 'Marikana Thornveld', and the following far smaller, spatially restricted units embedded within Marikana Thornveld: 'Stony grassland', 'Rocky outcrop vegetation', 'Eroded ephemeral drainage lines', 'Ephemeral drainage lines', 'Elands River vegetation' and 'Sandspruit vegetation'. All of these untransformed units have been assigned High sensitivity. The three transformed units are 'Secondary vegetation', 'Infrastructure' and 'Dams' all of which have been assigned Moderate to Negligible sensitivity and biodiversity conservation value.

A total of 414 plant species and infraspecific taxa have thus far been recorded by the author within the 1 123.1ha study area, 356 of which are indigenous taxa, and 58 (14.0%) of which are naturalised aliens. It should also be emphasised that the species list provided in Appendix 1 is based on relatively limited fieldwork and cannot be regarded as complete, and based on the author's experience probably includes approximately 80% of the species actually present. Of the 58 alien species listed in Appendix 1, twenty-two are declared alien invasive plant species in terms of the Alien Invasive Species (AIS) regulations (National Environmental Management: Biodiversity Act, Act no. 10 of 2014). The nine most important alien invasive species provisionally identified for the study area are *Agave sisalana*, Cereus jamacuru*, Dolichandra anguis-cati*, Eucalyptus camaldulensis*, Melia zedarach*, Morus alba*, Nicotiana glauca, Populus* x *canescens* and *Sesbania punicea*.*

Despite the high levels of transformation within the study area, many of the remaining areas of untransformed habitat and vegetation remain diverse (in the context of the Central Bushveld Bioregion) and species rich (α-diversity), as is reflected by the fact that 356 indigenous plant species and infra-specific taxa were recorded during the current, brief survey. The Beta diversity (β-diversity), which is the 'rate of change in species composition across habitats or among communities' is also relatively high.

No threatened (Critically Endangered, Endangered or Vulnerable) or Near Threatened plant species were recorded within the study area. One plant 'species of conservation concern' (*sensu* Raimondo *et al*., 2009) was recorded within the study area during the current survey, namely the medicinal plant *Hypoxis hemereocallidea* (Declining) which was recorded only at four sites within the 'Eroded ephemeral drainage lines' of the Frischgewaagd section. A further three plant 'species of conservation concern' are considered to have a Moderate probability of occurrence within the study area (see Appendix 5). These three species are the Near Threatened species *Drimia sanguinea* and *Stentonstelma umbelluliferum*, and the Declining medicinal plant species *Boophone disticha*. Two tree species which are Protected species in terms of Schedule A of the National Forests Act were recorded within the study area during the current survey, namely *Boscia albitrunca* and *Sclerocarya birrea*, both of which are uncommon and localised within the study area.

Description of the Project Infrastructure Footprints

The percentage of the surface area of each of the eleven infrastructure footprints and the final tailings pipeline alignment construction servitude comprised of the various vegetation and land-cover type units identified within the study area, is provided in Tables 13 and 14.
The eleven infrastructure components (not including the tailings pipeline alignment) have a total combined footprint of 344.3ha, of which 203.1ha (or 59.0%) comprises transformed habitats with secondary vegetation or no vegetation, and 139.7ha (or 40.6%) comprises Marikana Thornveld. The remaining 1.5ha (or 0.4%) of the total combined footprint comprises of the following spatially restricted untransformed habitats and vegetation:

- A total of 1.0ha of 'Stony grassland' (Unit 2 of Frischgewaagd section) comprising 0.3ha within the Concentrator Plant footprint, 0.6ha within the Product Stockpile footprint and 0.1ha within the Pollution Control Dam footprint.
- A total of 0.5ha of 'Eroded ephemeral drainage lines' (Unit 3 of Frischgewaagd section) comprising 0.3ha within the Housing Phase 1 footprint, 0.1ha within the Housing Phase 1a footprint and 0.1ha within the Bridge footprint.

The footprint of the ca. 3.83km final tailings pipeline alignment construction servitude is 11.5ha in extent, of which 3.0ha (or 26.1%) comprises transformed habitats with secondary vegetation or no vegetation, and 7.9ha (or 68.7%) comprises Marikana Thornveld. The remaining 0.6ha (or 5.2%) of the pipeline construction servitude comprises of the following spatially restricted untransformed habitats and vegetation:

- A total of 0.4ha of 'Eroded ephemeral drainage lines' (Unit 3 of Frischgewaagd). A total of 137m of pipeline alignment is situated within areas mapped as 'Eroded ephemeral drainage lines'.
- A total of 0.2ha within the 'Sandspruit vegetation' vegetation unit (Unit 2 of the pipeline mapping corridor). A 51m section of the pipeline alignment crosses the riparian habitats of Sandspruit.

No plant 'species of conservation concern' (*sensu* Raimondo *et al*., 2009 and http://redlist.sanbi.org) or species that are Protected in terms of the National Forests Act or the Biodiversity Act were recorded within the proposed infrastructure footprints or the construction servitude of the final tailings pipeline alignment.

Potential Impacts of the Project

The potential impacts of the project on the botanical biodiversity of the study area were assessed under four broad impacts, namely:

- loss of vegetation types (*sensu* Mucina & Rutherford, 2006 and the NWBSP 2015);
- loss of spatially restricted vegetation units / habitats;
- loss of flora (species richness);
- loss of plant 'species of conservation concern' (*sensu* Raimondo *et al.*, 2009).

Table 15 summarises the impact rating assigned to each of the identified impacts both with mitigation and in the absence of mitigation. A formal Impact Assessment which describes the nature of the impacts, determines the significance of each impact (impact rating) and provides mitigation and monitoring measures for each impact, is provided in Appendix 10.

Table 15: Impact rating with and without mitigation.

Impact	Severity	Duration	Spatial scale	Consequence	Probability	Significance
Unmitigated						
Loss of vegetation types	H	H	M	H	H	H
Loss of spatially restricted vegetation units	H	H	M	H	H	H
Loss of plant 'species of conservation concern'	M	H	L	M	L	L

Impact	Severity	Duration	Spatial scale	Consequence	Probability	Significance
Unmitigated						
Loss of flora	M	H	L	M	L	L
Mitigated						
Loss of vegetation types	H	H	L	H	H	H
Loss of spatially restricted vegetation units	H	M	L	M	M	M
Loss of plant 'species of conservation concern'	L	H	L	M	L	L
Loss of flora	L	H	L	M	L	L

Provided mitigation recommendations suggested in this report are implemented, the project is not considered to contain any fatal flaws in terms of botanical biodiversity. There is therefore no objection to the project from a botanical biodiversity perspective.

General Mitigation Measures

The following measures are recommended in order to minimise envisaged negative impacts of the proposed mine infrastructure on botanical biodiversity within the study area:

- The area of untransformed habitat and vegetation of High sensitivity included in the proposed infrastructure footprints should be minimised, and the footprint should be placed within the 'Secondary vegetation' and 'Infrastructure' units of Moderate or Low sensitivity mapped for the study area. Particular emphasis should be placed on avoiding vegetation units comprising highly spatially restricted (within the study area and its surrounds) habitats and plants communities, e.g. Unit 2 (Stony Grassland) of Frischgewaagd and Unit 2 (Rocky outcrop vegetation) of Mimosa.
- The footprints of the proposed infrastructure components should not encroach on any area of ephemeral drainage lines or wetlands. Such areas include the 'Eroded ephemeral drainage lines' (Unit 3) and 'Ephemeral drainage lines' (Unit 4) units within Frischgewaagd and the indistinct ephemeral drainage lines mapped within the Marikana Thornveld unit (Unit 1) within Mimosa. The drainage lines and wetlands of the study area are mapped (with recommended zones) and assessed in more detail in the wetlands and watercourse specialist study compiled for this project (De Castro & Brits, February 2016).
- The section of the final tailings pipeline alignment within the Frischgewaagd section should be realigned so that it is situated along the newly constructed access road. This measure will ensure that the pipeline does not cross any highly sensitive 'Eroded ephemeral drainage lines' (Unit 3 of Frischgewaagd section). Placing the pipeline alignment along the newly constructed access road will place the Frischgewaagd section of the pipeline entirely within an existing 'corridor of disturbance', reduce habitat fragmentation and reduce the risk of erosion and accidental tailings spills in 'Eroded ephemeral drainage lines' and the nearby Elands River.
- The 'final' tailings pipeline alignment (December 2015) was not available prior to the conduction of the fieldwork for this study. It was therefore assessed largely at a desktop level and the construction servitude was not searched for plant 'species of conservation concern'. Furthermore, this study recommends additional changes to the alignment of the 'final' tailings pipeline alignment. Once the alignment of the tailings pipeline alignment

has been completely finalised, the construction servitude of the alignment should be searched for 'species of conservation concern'.

- In order to reduce habitat fragmentation and ensure the maintenance of functional biological corridors within the study area, a buffer zone extending 300m from the Elands River should be implemented in both the Mimosa and Frischgewaagd sections. None of the eleven infrastructure components proposed within the Mimosa and Frischgewaagd sections should be located within 300m of the Elands River unless they are situated to the north of existing mine infrastructure. This buffer zone should form part of the network of recommended biological corridors mapped for the study area in Appendix 12. This network of biological corridors contains representative and ecologically viable areas of all untransformed habitats and vegetation units recorded within the study area, as well as the vast majority (if not all) of the plant species richness (α-diversity) recorded within the study area. The recommended biological corridors shown in Appendix 12 should be refined and included in the final Biodiversity Management Plan and EMPr for the mine.
- The existing Biodiversity Management Plan (BMP) completed for the study area in 2015 (Clean Stream 2015a and 2015b) should be refined on the basis of the final approved project layout, and all parts of the study area not destroyed by the approved project infrastructure should be managed in accordance with the BMP, with particular emphasis on managing the biodiversity of the biological corridors recommended in the current report (see Appendix 12). This measure should be incorporated in the EMPr for the mine. As 94.9% of the study area is mapped as a CBA 2, this recommendation is in accordance with the guidelines of the NWBSP 2015 which stipulate that a Biodiversity Management Plan must be developed and implemented for areas categorised as CBA 2.
- Additional, brief floristic surveys, focussed on searching for *Drimia sanguinea, Stentonstelma umbelluliferum, Boophone disticha* and *Hypoxis hemerocallidea* within the final development footprints are recommended prior to construction, and should be conducted in late October to early November and in January. The brief floristic surveys should focus on searching those parts of the proposed infrastructure footprints containing potentially suitable habitat for *Drimia sanguinea* (see Table 12). These surveys will also contribute towards confirming the absence of other 'species of conservation concern' within the study area.
- In the event of any threatened (i.e. Critically Endangered, Endangered and Vulnerable) or Near Threatened plant species being recorded within the study area or proposed development footprints in future, appropriate *in situ* and/or *ex situ* conservation measures should be developed in consultation with the North-West Province Directorate of Biodiversity Management.
- In the event of any Declining (*sensu* Raimondo *et al*., 2009) plant species being recorded within approved development footprints in future, permission for their removal or destruction should be obtained from the provincial Directorate of Biodiversity Management. Where feasible, viable populations of such species should be translocated to degraded or untransformed areas within the study area which provide potentially suitable habitats, but such translocations will have to be carried out in a way that ensures no ecological degradation of the host habitat occurs, and will have to be evaluated by a botanist for each species and each potential translocation area. Illegal medicinal plant harvesting should be monitored and discouraged through control of access to untransformed habitats and vegetation within the study area.
- The damaging or destruction of any plant species Protected in terms of the National Forest Act or the Biodiversity Act should be avoided wherever possible, and a permit for the destruction of any such protected plant must be obtained from the provincial Directorate of Biodiversity Management prior to development. If herbaceous Protected

plant species that are readily transplantable are found (e.g. many geophytes), viable populations of such species can also be translocated to transformed (including rehabilitation areas) or untransformed areas within the study area which provide potentially suitable habitats, but such translocations will have to be carried out in a manner that ensures that no ecological degradation of the host habitat occurs, and will have to be evaluated by a botanist for each species and each potential translocation area. Alternatively such species should be rescued and placed in a nursery or donated to a research institute (e.g. SANBI and universities), rather than simply being destroyed upon receipt of a permit.

- Botanical research and conservation institutions (e.g. SANBI and universities), should be afforded an opportunity to search the footprint for species that are of research or horticultural interest, prior to commencement of development.
- A 'veld management plan' should be developed and implemented for all parts of the study area that are not utilised for mining activities. The veld management plan should be based on a 'veld condition assessment' which determines the carrying capacity of the study area and recommends appropriate stocking rates. A crucial component of the 'veld management plan' would be the recommendation of an appropriate 'burning plan'. Appropriate burning intervals for areas that are managed for high biodiversity, are those that mimic the 'natural' fire regimes of the area. In the Savanna Biome of Africa, fire is a natural environmental phenomenon that does not normally produce serious residual effects. Fire is in fact a natural and beneficial disturbance of the vegetation structure (including species composition), prevents vegetation from becoming moribund, is essential in nutrient recycling and distribution and, at correct intervals, assists in maintaining high levels of biodiversity (Goldammer & de Ronde, 2004).
- In terms of the Alien and Invasive Plant Species (AIS) regulations National Environmental Management: Biodiversity Act (Act no. 10 of 2014), alien invasive plant species (as listed in Notice 3 of the Act) must be eradicated or controlled by the landowner. The mine must therefore develop an integrated alien plant control program, which considers all appropriate chemical, mechanical, biological and cultural control methods for the alien plant species listed in Appendix 1. Emphasis should be placed on controlling the 22 declared alien invasive species listed in Appendix 1, and in particular the nine priority invasive species identified for the study area, where they occur within and adjacent to the footprints of the proposed project infrastructure. The nine priority invasive species provisionally identified for the study area are *Agave sisalana*, Cereus jamacuru*, Dolichandra anguis-cati*, Eucalyptus camaldulensis*, Melia zedarach*, Morus alba*, Nicotiana glauca, Populus* x *canescens* and *Sesbania punicea*.*
- The implementation of a simple monitoring programme that focuses on the following aspects is strongly recommended:
    - use of repeatable fixed point photography to monitor sensitive habitats and vegetation within the untransformed vegetation units mapped for the study area,
    - simple quantitative methods to monitor the population size and health of any threatened or Near Threatened species that are recorded within the study area in future, as well as the recorded Declining species (*Hypoxis hemerocallidea*),
    - evaluation of the nature of secondary succession in rehabilitated areas (e.g. tailings pipeline construction servitude) should be evaluated in order to determine whether a favourable successional pathway towards indigenous vegetation cover is occurring and whether the establishment of alien invasive plants is occurring.

- Where planting of trees and shrubs in or around mining infrastructure footprints is deemed necessary, only trees and shrubs indigenous to the study area and its immediate surrounds should be planted, and these should wherever possible be grown from seeds collected within the study area or its immediate surrounds.

15.0 REFERENCES

ACOCKS, J.P.H. 1988. Veld types of South Africa. *Memoirs of the Botanical Survey of South Africa* **Vol 57.**

CLEAN STREAM BIOLOGICAL SERVICES. 2015a. First-phase biodiversity management plan for Wesizwe Platinum Mine: Frischgewaagd section. Report no. WPM/BMP/F/2015 to Wesizwe Platinum Mine.

CLEAN STREAM BIOLOGICAL SERVICES. 2015b. First-phase biodiversity management plan for Wesizwe Platinum Mine: Mimosa section. Report no. WPM/BMP/F/2015 to Wesizwe Platinum Mine.

DE CASTRO & BRITS CC. March 2014. Flora and Fauna Baseline Survey for the Wesizwe Housing Project. Specialist report prepared for Cathy Theron Environmental cc.: Johannesburg.

DE CASTRO & BRITS CC. May 2015. Botanical Biodiversity Baseline Report for the Frischgewaagd, Mimosa and Zwartkoppies surface rights areas of the Wesizwe Platinum Mine (Rustenburg, North-West Province). Specialist report prepared for Cathy Theron Environmental cc.: Johannesburg.

DE CASTRO & BRITS CC. February 2015. Soil, Agricultural Potential, Land Capability and Land Use study: Impact of a proposed tailings pipeline on the Farms Frischgewaagd and Mimosa, near the Town of Ledig, North West Province. Specialist report prepared by De Castro & Brits (author: P.S. Rossouw) for SLR Consulting: Johannesburg.

DENT, M.C., LYNCH, S.D. AND SCHULZE, R.E. 1989. Mapping mean annual and other rainfall statistics in southern Africa. Department of Agricultural Engineering, University of Natal. ACRU Report No. 27.

DRIVER, A., MAZE, K., LOMBARD A.T., NEL, J., ROUGET, M., TURPIE, J.K., COWLING, R.M., DESMET, P., GOODMAN, P., HARRIS, J., JONAS, Z., REYERS, B., SINK, K. & STRAUSS, T. 2004. *South African National Spatial Biodiversity Assessment 2004: Summary Report.* South African National Biodiversity Institute, Pretoria.

EDWARDS, D. 1983. A broad-scale classification of vegetation for practical purposes. *Bothalia* 14 (3): 705–712.

GERMISHUIZEN, G., STEENKAMP, Y. & KEITH, M. (eds) 2006. A Checklist of South African Plants. *Southern African Botanical Diversity Network Report* No. 41. SABONET, Pretoria. .

GOLDAMMER, J.G. & DE RONDE, C. (eds) 2004. *Wildland Fire Management Handbook for Sub-Sahara Africa*. Global Fire Monitoring Centre.

GOFF, F.G., DAWSON, G.A. & ROCHOW, J.J. 1982. Site examination for threatened and endangered plant species. *Environmental Management*: 6 (4): 307-316.

GOLDBLAT, P. 1989. *The genus Watsonia*. National Botanical Gardens: Pretoria.

GOLDER ASSOCIATES AFRICA (Pty) Ltd. August 2007. Wesizwe Platinum Biological Assessment, Veld Management Plan and Biodiversity Action Plan. Specialist Report prepared for TWP Environmental Services: Johannesburg.

GOLDING, J. (ed.) 2002. Southern African plant Red Data lists. *Southern African Botanical Diversity Network Report* No. 14.

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

HILTON-TAYLOR, C. 1996. Red Data List of Southern African Plants. *Strelitzia* 4.

HOARE, D.B. in preparation. Patterns and determinants of species richness in mesic, temperate grasslands of South Africa. PhD thesis, University of Port Elizabeth, Port Elizabeth.

HUEBNER, C.D. 2007. Detection and Monitoring of Invasive Exotic Plants: a comparison of four sampling methods. *North-eastern Naturalist:* 14 (2): 183-206.

IUCN. 2001. *IUCN Red Data List categories and criteria: Version 3.1*. IUCN Species Survival Commission: Gland, Switzerland.

KENT, M & COKER, P. 1996. Vegetation Description and Analysis. John Wiley & Sons, New York.

LOW, A.B. & REBELO, A.G. 1998 Vegetation of South Africa, Lesotho and Swaziland. *Strelitzia* 19.

MUCINA, L. & RUTHERFORD, M.C. (eds) 2006. The Vegetation of South Africa, Lesotho and Swaziland. *Strelitzia* 19. South African National Biodiversity Institute: Pretoria.

MUCINA, L., RUTHERFORD, M.C. & POWRIE, L.W. (eds) 2005. *Vegetation Map of South Africa, Lesotho and Swaziland, 1:1 000 000 scale sheet maps.* South African National Biodiversity Institute: Pretoria.

MUELLER-DOMBOIS, D. & ELLENBERG, H. 1974. *Aims and methods of vegetation ecology.* Wiley, New York.

NORTH WEST DEPARTMENT OF RURAL, ENVIRONMENT AND AGRICULTURAL DEVELOPMENT (READ). December 2015. North West Biodiversity Sector Plan 2015. North West Provincial Government, Mahikeng.

PFAB, M.F. 2001. Red Data Plant Policy for Environmental Impacts Evaluations. Department of Agriculture, Conservation, Environment and Affairs, Pretoria.

PFAB, M.F. 2001b (As amended in June 2006). Background to the EIA Administrative Guidelines on Red List Plant Species. Gauteng Department of Agriculture, Conservation and Environment, Johannesburg.

POOLEY, E. 1998. *A field guide to the wild flowers of the KwaZulu-Natal and*

Eastern Cape region. Natal Flora Publications Trust: Durban.

RAIMONDO, D., VAN STADEN, L., FODEN, W., VICTOR, J.E., HELME, N.A., TURNER, R.C., KANUNDI, D. & MANYANA, P.A. (Eds.) 2009. Red Data Book of South African Plants. *Strelitzia* No. 25.

REHAB GREEN MONITORING CONSULTANTS CC. August 2007. Soil, Land Capability and Land Use Assessment for the Wesizwe Platinum Project. Specialist Report prepared for TWP Environmental Services: Johannesburg.

RETIEF, E, & HERMAN, P.P.J. 1997. Plants of the northern provinces of South Africa: keys and diagnostic characters. *Strelitzia* No. 6.

ROSSOUW P.S. & GROBLER L.E.R. 2014. Identification and Classification Of Watercourses, Such As Potential Wetlands and Stream Flow Channels, for the Western Section Of Portion 11 Of the Farm Frischgewaagd 96 JQ, Located Close to Ledig, North West Province. Rossouw & Associates Specialist Report for Cathy Theron Environmental CC. Johannesburg.

RUTHERFORD, M.C. & WESTFALL, R.H. 1994. *Biomes of southern Africa: an objective categorization*. National Botanical Institute: Pretoria.

VAN WYK, A.E. & SMITH, G.F. 2001. *Regions of Floristic Endemism in Southern Africa.* Umdaus Press: Hatfield.

VAN WYKB.-E., VAN OUDTSHOORN, B. & GERICKE, N. 1997. *Medicinal Plants of South Africa.* Briza Publications, Pretoria.

WATT, J.M. & BREYER-BRANDWIJK, M.G. 1962. *The Medicinal and Poisonous Plants of Southern and Eastern Africa.* 2nd edition. Livingstone, London.

WHITTAKER, R.H. 1972. Evolution and measurement of species diversity. *Taxon* **21:** 213–251.

APPENDIX 1: Checklist of plant species recorded within the current study area during the baseline botanical biodiversity survey of the study area (2014 and 2015) and during the current survey. The list is therefore comprised of species recorded during surveys conducted in November 2014, February, March, April and May 2015 and November 2015. Species marked with an asterisk are naturalized aliens. Species taxonomy is according to the National Herbarium PRECIS database (http://posa.sanbi.org). A total of 414 plant species and infraspecific taxa have thus far been recorded within the 1 123.8ha study area (comprising Frischgewaagd, Mimosa and the 39.5ha tailings pipeline mapping corridor), 356 of which are indigenous taxa, and 58 (14.0%) of which are naturalised aliens. Of the 58 alien species listed, 22 are declared alien invasive plant species in terms of the Alien Invasive Species (AIS) regulations. Alien species are indicated by an asterisk. Species highlighted in red are taxa categorised as 'species of conservation concern' (Raimondo *et al.*, 2009 and http://redlist.sanbi.org, downloaded May 2015). All voucher numbers are A. de Castro numbers and all specimens were lodged at the National Herbarium in Pretoria. Site localities given are only examples of sites where a species was recorded and are not all-inclusive.

FAMILY and species	**Voucher no.**	**Listed Alien and Invasive Species (AIS Regulations)# and 'species of conservation concern'(*sensu* Raimondo *et al*., 2009) ##**	**Portion of study area**	
			Frischgewaagd	**Mimosa** (incl. pipeline mapping corridor)
PTERIDOPHYTA				
SINOPTERIDACEAE				
Pellaea calomelanos var. *calomelanos*			X	X
MONOCOTYLEDONAE				
AGAVACEAE				
**Agave americana*		-		X Sandspruit
ALLIACEAE				
Tulbaghia leucantha				X
AMARYLLIDACEAE				
Ammocharis coranica				M32 Tailings Storage Facility
Crinum lugardiae			F16, F43	
Scadoxus puniceus			F42	M12
ASPARAGACEAE				
Asparagus africanus				X
Asparagus cf. *cooperi*			X	X
Asparagus flavicaulis subsp. *flavicaulis*			X	M37
Asparagus laricinus			X	M14
Asparagus cf. *setaceus*			X	X
Asparagus suaveolens			X	X
Asparagus virgatus				M9
ASPHODELACEAE				
Aloe davyana [= *Aloe greatheadii* var. *davyana*]			F14	X
Aloe transvaalensis [= *Aloe zebrina* in part]			X	X
Aloe marlothii subsp. *marlothii*				M37
Bulbine capitata			F31	
COMMELINACEAE				

Commelina africana			X	X
Commelina erecta				X
Cyanotis speciosa			F15	
CYPERACEAE				
Abildgaardia ovata			F47	
Bulbostylis hispidula			X	X
Cyperus congestus			X	X
**Cyperus esculentus*		-	X	X
Cyperus sexangularis			X	M11
Fimbristylis ferruginea	ADC 1622		F44	M26
Schoenoplectus cf. *decipiens*			X	
Schoenoplectus cf. *muriculatus*			F40	
DRACAENACEAE				
Sansevieria aethiopica			X	
ERIOSPERMACEAE				
Eriospermum cooperi			X	
HYACINTHACEAE				
Drimia indica				M14
Drimiopsis burkei			F39	
Ledebouria cf. *apertifolia*			X	
Ledebouria marginata			X	X
Ledebouria ovatifolia			X	
Ledebouria cf. *revoluta*			X	X
Ledebouria sp.				M12
Ornithogalum tenuifolium			F24	
HYPOXIDACEAE				
Hypoxis hemerocallidea			F10, F12, F28, F35	
IRIDACEAE				
Gladiolus pretoriensis			F16, F22, F47	
JUNCACEAE				
Juncus excertus			X	M11
Juncus punctorius			X	M11
POACEAE				
Agrostis lachnantha				M11
Andropogon schirensis			F17	X
Anthephora pubescens			F38	X
Aristida adscensionis			X	X
Aristida bipartita			X	X
Aristida canescens			X	X
Aristida congesta subsp. *barbicollis*			X	X
Aristida congesta subsp. *congesta*			X	X
Aristida stipitata ssp. *graciliflora*				M3
Bewsia biflora			F31	M37
Botriochloa bladhii			F28	M8
Bothriochloa insculpta			X	X
Bothriochloa radicans			X	M12
Brachiaria deflexa				X
Brachiaria eruciformis			X	M6
Brachiaria nigropedata			F39	X

Brachiaria serrata			F31	X
Cenchrus ciliaris				M10
Chloris virgata			X	X
Chrysopogon serrulatus				
Cymbopogon caesius [*C. excavatus*]			F39	X
Cymbopogon pospischilii [C. plurinodis]			F25	X
Cynodon dactylon			X	X
Dichanthium annulatum			X	M11
Digitaria argyrograpta			F26	
Digitaria eriantha			X	X
Diheteropogon amplectans			X	X
Echinochloa colona			F40	X
Echinochloa holubii			X	
Echinochloa pyramidalis			X	X
Ehrharta erecta				M9
**Eleusine coracana* ssp. *africana*		-	X	X
Elionurus muticus			X	X
Enneapogon cenchroides			X	X
Enneapogon scoparius			X	X
Eragrostis chloromelas			X	X
Eragrostis curvula			X	X
Eragrostis gummiflua			X	X
Eragrostis lehmanniana			X	X
Eragrostis cf. *micrantha*			F41	
Eragrostis pseudosclerantha				M19
Eragrostis rigidior			X	X
Eragrostis rotifer			F6	
Eragrostis superba			X	X
Eragrostis trichophora			X	X
Eustachys paspaloides			F23	
Fingerhuthia africana			F16	
Heteropogon contortus			X	X
Hyparrhenia filipendula			X	X
Hyparrhenia hirta			X	X
Hyparrhenia dregeana			F28	
Hyperthelia dissoluta				X
Imperata cylindrica			X	
Ischaemum afrum			X	M6
Ischaemum fasciculatum				X
Loudetia flavida			F30	
Melinis repens subsp. *repens*			X	X
Panicum coloratum			X	X
Panicum maximum			X	X
Panicum deustum				M11
Panicum coloratum	ADC1618 ADC1619		F25, F26	X
**Paspalum dilatatum*		-	X	X
**Pennisetum clandestinum*		Category 1b in Protected Areas and wetlands in which it does not already occur	X	
Pennisetum sphacelatum				M9

Phragmites mauritianus			X	M11
Pogonarthria squarrosa				X
Rottboelia chinensis			X	
Schizachyrium jeffreysii				X
Schizachyrium sanguineum			F31	
Schmidtia pappophoroides			X	X
Setaria incrassata			X	X
Setaria megaphylla			X	M9
Setaria nigrirostris			X	
Setaria pumila			X	X
Setaria sphacelata			X	X
Setaria lindenbergiana			X	X
Setaria verticillata			F2	
Sorghum bicolor			X	
**Sorghum halepense*		Category 2	X	
Sorghum versicolor			F44	M12
Sporobolus africanus			X	X
Sporobolus fimbriatus			F24	
Sporobolus iocladus	ADC 1620		F26	X
Sporobolus nitens			X	
Sporobolus stapfianus			X	
Themeda triandra			X	X
Trachypogon spicatus			X	X
Tragus racemosa			X	X
Tragus berteronianus			X	X
Tricholaena monachme				X
Trichoneura grandiglumis			X	X
Urochloa mossambicensis			X	X
Urelytrum agropyroides			F31	
VELLOZIACEAE				
Xerophyta cf. *equisetoides* var. *equisetoides*				M37
DICOTYLEDONAE				
ACANTHACEAE				
Barleria macrostegia			F38	X
Blepharis integrifolia			F26	M21
Blepharis serrulata	ADC 1616		F11	
Chaentacanthus costatus			X	
Crabbea angustifolia			X	X
Crabbea hirsuta			X	
Dicliptera eenii	ADC 1625			M11
Hypoestes forskaolii	ADC 1624		F44	M11
Justicia betonica			F30	X
Justicia flava			X	
Ruellia cordata			F38	
Ruellia patula	ADC 1406		F31	X
Ruelliopsis setosa	ADC 1614		F46	M19
Thunbergia neglecta			X	X
AMARANTHACEAE				
**Achyranthes aspera* var. *aspera*		-		X
Aerva leucura			X	
Alternathera sessilis			F45	

**Amaranthus hybridus*		-	X	
Cyathula cylindrica			X	X
**Gomphrena celosioides*		-	X	X
**Guilleminea densa*		-	X	
Kyphocarpa angustifolia			X	X
ANACARDIAEAE				
Lannea discolor				M37
Sclerocarya birrea				M37
Searsia lancea			X	X
Searsia leptodictya			F39	X
Searsia pyroides var. *pyroides*			F14	X
APOCYNACEAE				
Ancylobotrys capensis				M37
**Araujia sericifera*		Category 1b	F40	X
Carissa bispinosa			F39	X
Duvalia polita			F24	
Gomphocarpus fruticosus				X
Huernia zebrina subsp. *magniflora*			X	
Pentarrhinum insipidum			X	X
Raphionacme hirsuta			X	X
ASTERACEAE				
**Acanthospermum australe*		-	X	X
**Acanthospermum hispidum*		-	X	X
**Ambrosia artemisiifolia*		-	F40	M11
**Aster squamatus*		-	X	X
Berkheya cf. *carilinopsis* subsp. *magalismontana*	ADC 1631		F38	X
Berkheya radula			F35	
Berkheya zeyheri subsp. *zeyheri*			X	
**Bidens bipinnata*		-	X	X
**Bidens pilosa*		-	X	X
Chrysocoma cf. *ciliata*			F3	
**Conyza albida*		-	X	X
**Conyza bonariensis*		-	X	X
**Conyza canadensis*		-	X	
Dicoma anomala subsp. *anomala*			X	X
Dicoma macrocephala			F16	
Felicia muricata			F26	X
**Flaveria bidentis*		Category 1b	X	
Geigeria burkei			F16	X
Haplocarpha lyrata			F28	
Kleinia longiflora			X	
Nidorella anomala			X	
Nidorella hottentotica			F31	
Nidorella resedifolia			X	X
Nolletia rarifolia				M17
Osteospermum muricatum			X	X
Osteospermum scariosum			X	X
**Pseudognaphalium luteo-album*		-	X	X
Pseudognaphalium oligandrum			F41	

Pulicaria scabra				M11
**Schkuhria pinnata*		-	X	X
Schistostephium crataegifolium			F46	
Senecio cf. *consanguineus*			X	
Senecio oxyrifolius			F24	
Senecio sp.				M14
**Sonchus asper*			X	
**Sonchus oleraceus*		-	X	
**Tagetes minuta*		-	X	X
Tarchonanthus parvicapitulatus			F24	X
Vernonia oligocephala			F26	X
Vernonia poskeana			X	
**Xanthium strumarium*		Category 1b	X	M11
**Zinnia peruviana*		-	X	X
BIGNONIACEAE				
**Dolichandra unguis-cati*		Category 1b		M9
BORAGINACEAE				
Ehretia rigida			X	X
Heliotropium ciliatum			X	
Heliotropium strigosum			X	
Trichodesma angustifolia			F16	X
BURSERACEAE				
Commiphora africana				X
CACTACEAE				
**Cereus jamacaru*		Category 1b		M37
**Opuntia ficus-indica*		Category 1b	F3	
CAPPARACEAE				
Cleome monophylla			X	
Boscia albitrunca			F8, F10, F27	M37
Boscia foetida subsp. *rehmanniana*			X	
Cadaba aphylla			X Pipeline alignment	
Maerua angolensis			F8	
Silene sp.			F31	
CELASTRACEAE				
Gymnosporia buxifolia [=*Maytenus heterophylla*]			X	X
Gymnosporia polyacantha				X
CELTIDACEAE				
Celtis africana			F45	M9
CHENOPODIACEAE				
**Chenopodium album*		-	X	X
**Chenopodium ambrosioides*		-	X	
COMBRETACEAE				
Combretum apiculatum				X Storm Water Dam
Combretum erythrophyllum			X	M9
Combretum hereroense				X
CONVOLVULACEAE				
Convolvulus sagittatus			X	X

Cuscutta campestris				X
Evolvulus alsinoides var. *linifolius*	ADC 1621		X	X
Ipomoea bathycolpos			F27	M37
Ipomoea bolusiana				X
Ipomoea oblongata			F26	M37
Ipomoea obscura var. *obscura*			F16	
**Ipomoea purpurea*		Category 1b	X	
Ipomoea cf. *transvaalensis*			F, 19, F31	M33
Merremia palmata			F15	
Seddera capensis			F24	X
Xenostegia tridentata subsp. *angustifolia*			F31	X
CUCURBITACEAE				
Coccinia sessilifolia				M32
Cucumis cf. *hirsutus*			X	
Cucumis zeyheri			X	X
Momordica balsamina				M32
DIPSACACEAE				
Cephalaria zeyheriana			F28	
EBENACEAE				
Diospyros lycioides			X	X
Euclea crispa				X
Euclea undulata				X
EUPHORBIACEAE				
Acalypha indica			X	X
Acalypha glabrata var. *pilosior*				M9
Acalypha petiolaris				M37
Acalypha villicaulis			X	
Euphorbia davyi			F23, F29, F50	M37
**Euphorbia hirta*		-	X	
**Euphorbia heterophylla*		-	X	M9
Euphorbia inaequilatera			X	
Jatropha cf. *zeyheri*			F37	
Phyllanthus sp.			F31	M37
Phyllanthus parvulus			X	
**Ricinus communis*		Category 2	X	X
FABACEAE				
Acacia caffra			X	X
Acacia erubescens				X
Acacia karroo			X	X
Acacia luederitzii var. *luederitzii*			X	X
Acacia mellifera ssp. *detinens*			X	X
Acacia nilotica			X	X
Acacia robusta			F9	
Acacia tortilis			X	X
Burkea africana				M37
Chamaecrista comosa var. *comosa*			X	X
Chamaecrista mimosoides			X	X
Crotalaria lotoides				M8

Cullen tomentosum	ADC 1626			M8, M26
Dichrostachys cinerea			X	X
Elephantorrhiza burkei				M37
Elephantorrhiza elephantina			X	X
Indigastrum parviflorum				F40
Indigofera circinnata			F7	X
Indigofera cryptantha			F36	M33
Indigofera filipes			X	X
Indigofera heterotricha			X	M19
Indigofera melanadenia subsp. *malachostachys*			F39	Z3, Z11
Indigofera melanadenia subsp. *melanadenia*				M37
Indigofera cf. *torulosa*			F15	
Lotononis calycina				M37
Lotononis cf. *listii*				M18
Macrotylloma axillare			X	
Melolobium cf. *microphyllum*			F29	
Neorautanenia ficifolius			F14	
Ptycholobium plicatum			F16	M19
Rhynchosia densiflora ssp. *chrysadenia*				M9
Rhynchosia minima			F37	X
Rhynchosia nitens			F41	
Rhynchosia totta var. *totta*			F14	X
Senna italica ssp. *arachoides*				M2
**Sesbania bispinosa* var. *bispinosa*		-	F40	X
**Sesbania punicea*		Category 1b	F2, F45	M11
Sesbania transvaalensis			F40	M13
Stylosanthes fruticosa				X
Tephrosia capensis			X	X
Tephrosia longipes subsp. *longipes*			F31	X
Tephrosia multijuga			X	
Tephrosia purpurea			X	X
Tephrosia sp.			F14	
Vigna vexillata			F28	
Zornia milneana			X	
LAMIACEAE				
Clerodendrum ternatum			X	X
Leucas capensis	ADC 1623		X	X
Ocimum americanum				X
Rotheca cf. *hirsuta*			F31	
**Salvia reflexa*		-	X	
Salvia runcinata			X	X
**Scutellaria racemosa*		-	X	
Salvia runcinata			F31	X
Satchys sp.	ADC 1623			M4
Teucrium trifidum			1	
LOBELIACEAE				
Lobelia thermalis			F28	X
LORANTHACEAE				

Agelanthus natalitius subsp. *zeyheri*			F38	
MALPHIGIACEAE				
Sphedamnocarpus pruriens subsp. *pruriens*			F14	
MALVACEAE				
Abutilon angulatum				M25
Dombeya rotundifolia			X	X
Gossypium herbaceum ssp. *africanum*				X
Hermannia coccocarpa				X
Hermannia depressa			X	X
Hermannia boragniflora				X
Hermannia cf. *tomentosa*				X
Hibiscus aethiopicus			F23	
**Hibiscus cannabinus*		-	X	
Hibiscus microcarpus			X	X
Hibiscus pusillus			F38	M3
**Hibiscus trionum*		-	X	X
* *Malvastrum coromandelianum*		Category 1b		X
Pavonia burchellii				X
Sida chrysantha			F26	X
Sida rhombifolia			F45	X
Waltheria indica			X	X
MELIACEAE				
**Melia azedarach*		Category 1b Category 3 in urban areas	F45, F46	M11
MENISPERMACEAE				
Antizoma angustifolia			F24	X
MORACEAE				
**Morus alba*		Category 3	F45	X
MYRTACEAE				
**Eucalyptus camaldulensis*		In study area: Category 1b in riparian areas, Category 2 in plantations, wind-rows etc., Not listed within 50m of main farmhouse, Not listed in urban area if diameter at 1m greater than 40cm.	F45	X
NYCTAGINACEAE				
**Boerhavia diffusa*		-	X	X
Commicarpus pentandrus			X	X
OLACACEAE				
Ximenia caffra			X	M37
OLEACEAE				
Menodora africana			F15, F25	M3
Olea europea subsp. *africana*			X	M1
ONAGRACEAE				
Ludwigia adscendens subsp. *diffusa*			X	M11
OXALIDACEAE				
**Oxalis corniculata*		-	X	X
Oxalis depressa			X	
PAPAVERACEAE				

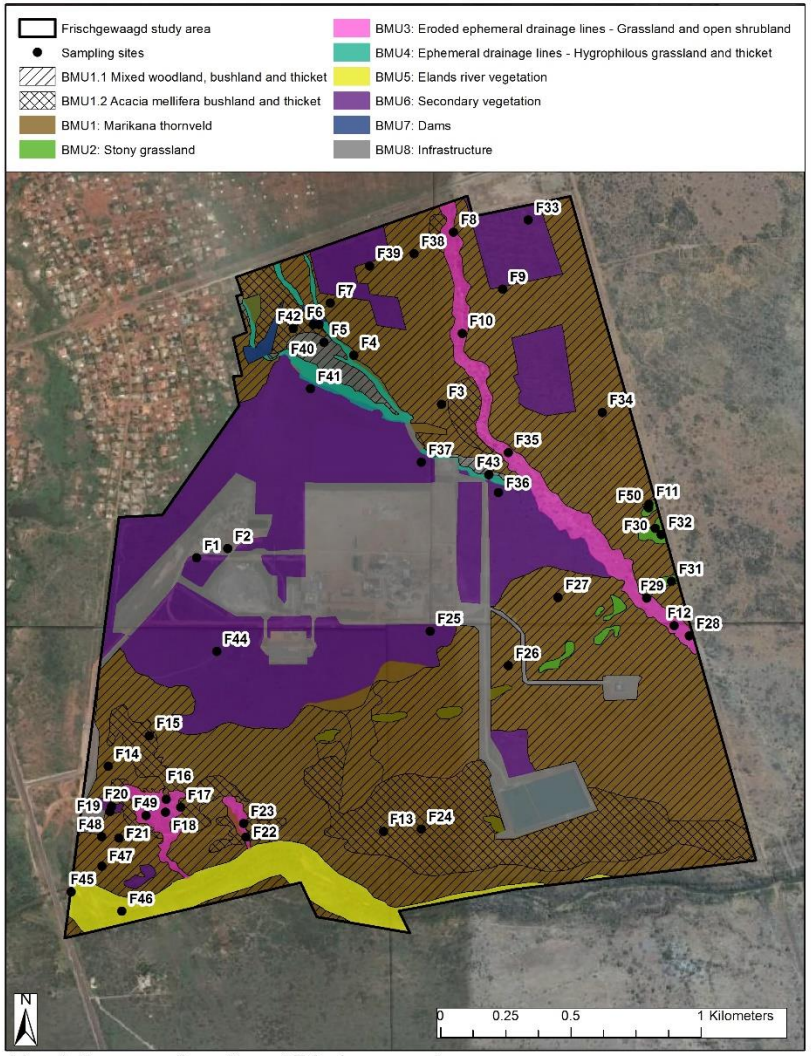
**Argemone ochroleuca*		Category 1b	F2	X
PEDALIACEAE				
Ceratotheca triloba			X	
Dicerocaryum seneciodes subsp. *seneciodes*			F33	
Pterodiscus ngamicus			X	
Sesamum triphyllum			X	
PLUMBAGINACEAE				
Plumbago zeylanica				X
POLYGALACEAE				
Polygala hottentotta				M17
Polygala krumaniana	ADC 1617		F19, F23	
POLYGONACEAE				
Oxygonum dregeanum			F23	
**Persicaria lapathifolia*		-	F45	M11
Persicaria senegalensis Forma *senegalensis*				M13
PORTULACACEAE				
Portulaca kermesina			X	X
**Portulaca oleracea*		-	X	
Talinum caffrum			F26	X
RANUNCULACEAE				
Clematis brachiata			X	M5
RHAMNACEAE				
Ziziphus mucronata			F14	X
Ziziphus zeyheriana			F14	M21
RUBIACEAE				
Anthospermum rigidum subsp. *pumilum*				M18
Kohautia amatymbica				X
Kohautia virgata			X	X
Kohautia caespitosa ssp. *brachyloba*			F26	
Oldelandia cf. *herbacea*			F23	
Pavetta zeyheri				X
Rubia horrida			X	
Vangueria infausta subsp. *infausta*				X
SALICACEAE				
**Populus* x *canescens*		Category 2	X	
Salix mucronata			F45	X Sandspruit
SANTALACEAE				
Osyris lanceolata			F10	
SAPINDACEAE				
Dodonaea viscosa var. *angustifolia*			F8	
SCROPHULARIACEAE				
Aptosimum cf. *lineare*			F34	
Aptosimum procumbens var. *elongatum*			X	X
Chaetacanthus cf. *costatus*				X

Jamesbrittenia aurantiaca			X	X
Jamesbrittenia burkeana				M37
Manulea parviflora			X	
Mimulus gracilis			X	X
SOLANACEAE				
**Datura ferox*		Category 1b	X	
**Datura stramonium*		Category 1b	X	
Lycium cinereum			X	X
**Nicotiana glauca*		Category 1b	F2	M11
Solanum delagoense			F14	
**Solanum elaeagnifolium*		Category 1b	F33	X
Solanum incanum			X	X
Solanum panduriforme			X	X
Withania somnifera			F9	
STERCULIACEAE				
Dombeya rotundifolia var. *rotundifolia*			X	X
Melhania prostrata				
Waltheria indica			X	X
THYMELEACEAE				
Gnidia capitata			F31	
Gnidia kraussiana				
Gnidia sericocephala			X	
TILIACEAE				
Corchorus asplenifolius			X	M10
Corchorus confusus				X
Grewia bicolor				X
Grewia flava			F24	X
Triumfetta sonderi			X	X
URTICACEAE				
Didymodoxa cf. *caffra*				X
VERBENACEAE				
Chascanum cf. *hederaceum*			X	X
Lippia javanica				X
Lantana rugosa			F26	X
**Verbena bonariensis*		Category 1b	X	
VIOLACEAE				
Hybanthus densifolius			X	
Hybanthus enneaspermus var. *serratus*			X	
VITACEAE				
Cyphostemma sp. 1 (trifoliate)				M7
Cyphostemma sulcatum (compound leaf)	ADC 1627		X	M8, M32
Rhoicissus tridentata			X	
ZYGOPHYLLACEAE				
Tribulus terrestris			X	X

As included in the List of Alien Invasive Plant Species under National Environmental Management: Biodiversity Act (10/2004): Alien and Invasive Species List, 2014 (Government Gazette, 37886, 1 August 2014). Referred to in table as 'AIS Regulations'.

Extracted from Raimondo *et al.* (2009) and the SANBI online Red List of South African plants (http://redlist.sanbi.org, accessed in January 2016).

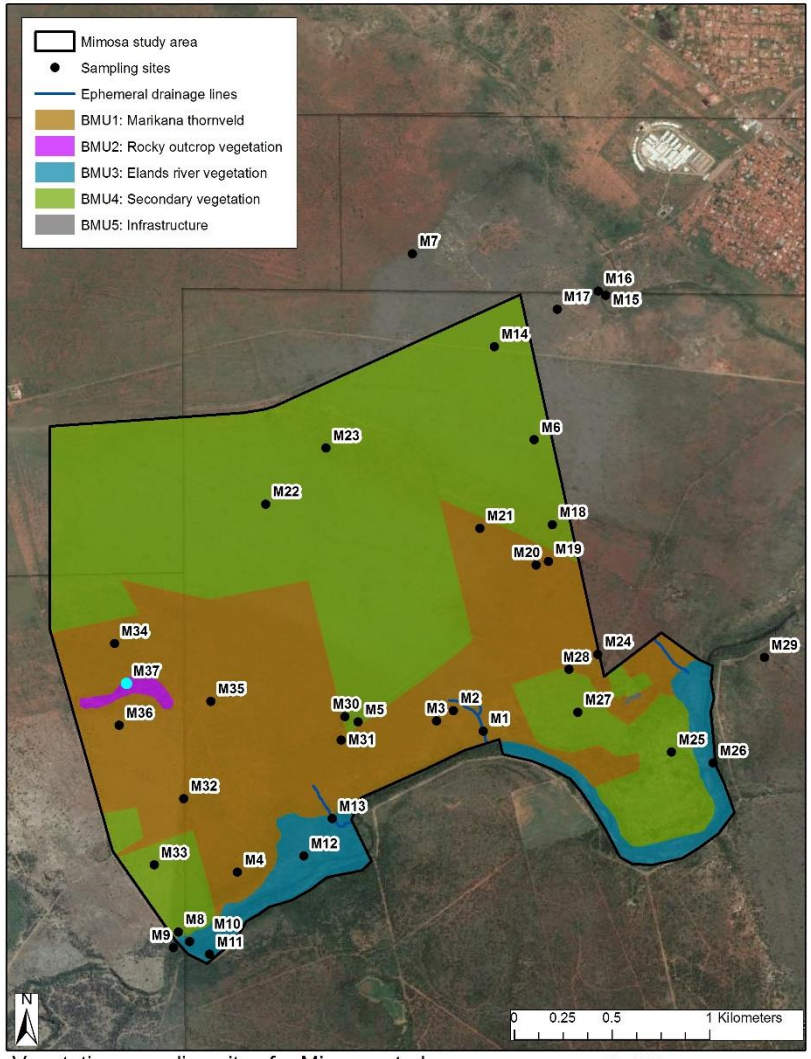
APPENDIX 2: Localities of vegetation sampling sites selected during the botanical biodiversity baseline survey (De Castro & Brits, May 2015).



Vegetation sampling sites at Frischgewaagd study area

May 2015
Created by:

DE CASTRO & BRITS ECOLOGICAL CONSULTANTS



Vegetation sampling sites for Mimosa study area

May 2015
Created by:

DE CASTRO & BRITS ECOLOGICAL CONSULTANTS

APPENDIX 3: Lists of taxa recorded from twenty-six 100m^2 (10m x 10m) vegetation sampling quadrats surveyed at Frischgewaagd (14 quadrats) and Mimosa (12 quadrats). Estimated cover-abundance values (using Braun-Blanquet method) for each of the species recorded at each site are provided. The list for Frischgewaagd comprises 158 species and infra-specific taxa and the list for Mimosa 149 species and infra-specific taxa.

Frischgewaagd (fourteen 100m^2 vegetation sampling quadrats)														
Species	**Site numbers** **(all site numbers are as shown and geo-referenced on aerial images in Appendix 2, and sites are grouped in BMU's and habitats)**													
	BMU 1 – Zeerust Thornveld						**BMU 2** – Stony Grassland	**BMU 3** – Eroded ephemeral drainage lines - Grassland and Open Shrubland			**BMU 6** – Secondary vegetation			
	1.1 Mixed Thicket & Woodland				1.2 *A.mellifera* Bushland & Thicket						Oakleef soils	Arcadia soils		
	F14	F26	F38	F39	F15	F24	F31	F16	F23	F29	F33	F25	F37	F41
Grasses														
Anthephora pubescens			1											
Aristida bipartita										1		1	4	3
Aristida canescens	1	1		+	1		1	2b	3	4				
Aristida congesta subsp. barbicollis	2a	1		+	1		+							
Aristida congesta subsp. congesta		1	1											
Bewsia biflora							1							
Brachiaria eruciformis												+	+	
Brachiaria nigropedata				1										
Brachiaria serrata							+							
Cymbopogon caesius				2a										
Cymbopogon pospischilii	1	2a	2b		2a		+		+	+		2a	+	
Cynodon dactylon	+			1										
Digitaria argyrograpta		2a												
Digitaria eriantha					1									
Diheteropogon amplectans						1	1	1	1	1				
Elionurus muticus							2b							
Enneapogon scoparius			1	1		2a	1	1		1				
Eragrostis chloromelas					1	2b						1	1	
Eragrostis curvula					2a	1								
Eragrostis cf. micrantha														1
Eragrostis rigidior		1	1	2a			R	1			+			
Eragrostis superba			1								1			
Eragrostis trichophora	+	1			1				2a					
Eustachys paspaloides									+					

Fingerhuthia africana								1	1	1				
Heteropogon contortus	1	1	2a	1	2a	1					1			
Hyparrhenia filipendula				2a							5			
Hyparrhenia hirta			+											
Ischaemum afrum												3	2a	2a
Loudetia flavida							1							
Melinis repens		1	1	1	2a		+	1	+	1	+			
Panicum coloratum		2a	1	1	3	2b						3		
Schmidtia pappophoroides										1				
Schizachyrium sanguineum							2a	1						
Setaria incrassata												+		
Setaria sphacelata	2b	1												
Sporobolus fimbriatus						2b								
Themeda triandra	3	2a	2a	2a							+	+		
Trachypogon spicatus							3	2a	+	2a				
Urochloa mossambicenis						1								
Urelytrum agropyroides							1							
Forbs & low shrubs														
Acalypha indica													1	1
Aloe davyana	1	+	1	+	+	+	R							
Antizoma angustifolia						R								
Aptosimum procumbens		1	2a	2a				1			1			
Asparagus cf. cooperi				+		1								
Asparagus suaveolens	+		+	+	+	1						1		
Barleria macrostegia		R	+	+							1			
Barleria sp. 3					+	1		+	+	1				
Berkheya cf. carilinopsis subsp. magalismontana			+	1										
Blepharis integrifolia		+			+	+		+						
Bulbine capitata							R							
Bulbostylis hisdpidula							1	1						
Chaetacathus costatus							+	+						
Chascanum cf. hederaceum							+	1						
Commelina africana	1	1	+	+	+									
Commicarpus pentandrus		R			R									
Convolvulus sagittatus												+	+	
Corchorus aspleniifolius	+				+							+		
Crabbaea angustifolia	+	1	+	+							+		+	R
Cyanotis speciosa					R		R							
Dicerocaryum seneciodes subsp. seneciodes											1			

Dicoma anomala							+	2a		1				
Dicoma macrocephala								+						
Drimiopsis burkei				+								+		
Duvalia polita						R								
Elephatorrhiza elephantina											1			
Euphorbia davyi							R	+	+	R				
Evolvulus alsinoides					1			+						
Felicia muricata		1	2a	1				R			+			
Geigeria burkei				1			+	+		+				
Gladiolus pretoriensis								R						
Gnidia caffra							1							
Hermannia depressa	1	1	+	1							2a			
Hibiscus aethiopicus									R					
Hibiscus pusillus	+	+	+	+	1		+	+				+		+
*Hibiscus trionum														+
Indigofera circinnata			1	1										
Indigofera heterotricha							+		1					
Indigofera melanadenia subsp. malachostachys		+		+							1			
Indigofera cf. torulosa					+									
Ipomoea bathycolpos		+								1				
Ipomoea oblongata		1	+											
Ipomoea obscura var. obscura								R						
Ipomoea cf. transvaalensis							+							
Jamesbrittenia aurantiaca												1		1
Jatropha sp.													+	
Justicia betonica	R	1			+	1	+							
Kohautia caespitosa ssp. brachyloba		+												
Kohautia virgata									+	R				
Kyphocarpha angustifolia					+				R					
Ledebouria cf. revoluta	+											+		R
Melolobium cf. microphyllum										+	1			
Menodora africana					+		+			R				
Merremia palmata				+	1						2a			
Neorautanenia ficifolius	+													
Nidorella hottentotica							R							
Nidorella resediifolia				1	R							1	+	3
Oldenlandia cf. herbacea								R	1					

Phyllanthus sp.		+					+	R						
Pavonia burchellii														R
Ornithogalum tenuifolium		R				R					R	+	R	
Oxygonum dregeanum									+					
Polygala krumaniana									+	+				
Pseudognaphalium oligandrum														+
Ptycholobium plicatum	R							+	R		+			
Raphionacme hirsuta		R		+			R							
Ruellia cordata			+											
Ruellia patula					+		1							
Rhynchosia minima												1	1	R
Rhynchosia totta	+													
Rotheca cf. hirsuta							1							
Rubia horrida	+													
Salvia runcinata														+
Sclerochiton sp. 2							+							
*Schkhuria pinnata												+		
Senecio oxyrifolius					+									
Sida chrysantha		R												
Silene sp.														
Solanum delagoense	R						+							
*Solanum eleagnifolium											+			
Seddera capensis						+						+		
Talinum caffrum		R												
Tephrosia capensis				+										
Tephrosia longipes							R							
Tephrosia sp.	R													
Trichodesma angustifolia								+						
Triumfetta sonderi							2b							
Vernonia oligocephala		2a	+								1			
Xenostegia tridentata subsp. angustifolia							+			R				
Ziziphus zeyheriana	2b	2b												
Trees & Shrubs														
Acacia caffra	1	2b												
Acacia karoo	2b		2b	2a	1		1					1	1	2a
Acacia mellifera					1	3			+	+		1		
Acacia robusta				2a										
Acacia tortilis		1	1	1	2a						1	2b	2a	2a
Asparagus laricinus	+											+		+

Carissa bispinosa			+	1		1								
Dichrostachys cinera			+								1			
Diospyros lyciodes			1		1	+						+		
Grewia flava	1	1	1		+	1					1			
Gymnosporia buxifolia	1					1								
Lantana rugosa		1												
Lycium cinereum						1								
Searsia lancea			+	1										
Searsia leptodictya				+										
Searsia pyroides	1		1	1										
Tarchonanthus parvicapitulatus					+	2a			1					
Ziziphus mucronata	+		1	+								+	+	+
Unidentified taxa														
Dicot sp. 1													R	
Dicot sp. 2	R													
Dicot sp. 3		+			+									
Dicot sp. 4								R	R	R				
Dicot sp. 5								R						
Malvaceae sp.													+	
Monocot sp. 1												R		
Monocot sp. 2							R							
TOTAL no. of taxa	32	39	34	39	35	25	41	29	21	21	23	27	17	18

*Estimated Cover Abundance Values:

R = negligible canopy cover (one or two small individuals)
+ = less than 1% canopy cover
1 = 1-5% canopy cover
2a = 6-15% canopy cover
2b = 16-25% canopy cover
3 = 26-50% canopy cover
4 = 51-75% canopy cover
5 = 76-100% canopy cover

Mimosa (twelve 100m^2 vegetation sampling quadrats)												
Species	**Site numbers** **(all site numbers are as shown and geo-referenced on aerial images in Appendix 2, and sites are grouped in BMU's and habitats)**											
	BMU 1 – Zeerust Thornveld			**BMU 2** – Rocky outcrop vegetation	**BMU 3** – Elands River vegetation		**BMU 4** – Secondary vegetation					
	Mixed Thicket & Woodland				Shrubland & Bushland of floodplain		Shortlands and other soils				Arcadia soils	
	M19	M21	M32	M37	M10	M12	M18	M25	M27	M33	M14	M22
Pteridophytes												
Pellaea calomelanos var. calomelanos				+								
Grasses												
Andropogon schirensis				1								
Aristida cf. adscensionis						1		1				
Aristida bipartita		+				1					2b	2a
Aristida canescens	+											
Aristida congesta subsp. barbicollis	1			+			2a	2a	2b	1		
Aristida congesta subsp. congesta			+				+					
Aristida canescens				+								
Aristida stipitata										+		
Bewsia biflora				1								
Botriochloa insculpta						2a	+					
Botriochloa radicans					1	1						
Brachiaria deflexa						1						
Brachiaria eruciformis		1									1	1
Brachiaria nigropedata			+									
Cymbopogon caesius									+			
Cymbopogon pospischilii	1	3	2b	+			1				3	
Cynodon dactylon							2b					
Digitaria eriantha			1		1	2b		1				
Diheteropogon amplectans				2a								
Elionurus muticus				+								
Eragrostis chloromelas		2a	1	+							1	3
Eragrostis curvula										1	+	
Eragrostis rigidior	1		1	1			2a	1	4	1		

Eragrostis superba	1		+				1					
Eragrostis pseudosclerantha	+											
Eragrostis trichophora	1	+						2a				
Heteropogon contortus	1	1	2b	+		1	1	1		1		
Hyparrhenia filipendula									1			
Ischaemum afrum											2a	2a
Loudetia flavida				2a								
Melinis repens	+	1		2a								
Panicum coloratum	1	1	2a			2a						
Panicum maximum	1		1		1			+	1	1		
Schizachyrium jeffreysii				2b								
Setaria incrassata											1	2a
Setaria sphacelata	+	1										
Themeda triandra	2a	2a	1	1	R						1	
Trachypogon spicatus				1								
Tragus racemosa	+	1	1		2b			2b		1		
Tragus berteronianus									+			
Tricholaena monachne				1								
Urochloa mossambicenis	+		1		1	2a	1	2a	2a	3		
Forbs s & low shrubs												
Abutilon cf. angulatum										+		
Acalypha indica												+
Acalypha petiolaris				1								
*Achyrathes aspera								+				
Aloe davyana	1		1	+								
Aloe transvaalensis		2a										
Ammocharis coracanica			+									
Ancylobotrys capensis				1								
Antizoma angustifolia	+	+										
Anthospermum rigidum subsp. pumilum							R					
Aptosimum procumbens	1						+					
Asparagus cf. cooperi	+											
Asparagus flavicaulis	+			+								
Asparagus cf. setaceus					2a	1		+		+		
Asparagus suaveolens	1		+		1	1						
Barleria macrostegia		+	+				R					
Berkheya cf. carilinopsis subsp. magalismontana							+		+			
*Bidens bipinnata						+						
Blepharis integrifolia		+										

*Boerhavia diffusa								2a				
Bulbostylis hisdpidula				1								
Chaetacathus costatus				+								
Chamaecrista mimosoides												+
Chascanum cf. hederaceum	+			+								
Clerodendrum ternatum	+											
Coccinia sessilifolia			R									
Commelina africana		+	+	+							+	
Convolvulus sagittatus												1
Corchorus aspleniifolius	+	+	R			+	+	+		+	R	+
Crabbaea angustifolia	R	+										
Crotalaria lotoides										1		
Cyperus sp.						+						
Cyphostemma sp. 1 (trifoliate)		1										
Cyphostemma sulcatum (compound leaves)			+		+	1						
Dicoma anomala				1								
Drimia indica											+	
Elephatorrhiza elephantina											1	R
Euphorbia cf. davyi				+								
*Gomphrena celosiodes								1				
Hermannia depressa	+	1					1					
Hibiscus pusillus	+	1					+					
*Hibiscus trionum												+
Indigastrum parvifolium	+						+					
Indigofera circinnata	+	+							+			
Indigofera cryptantha										R		
Indigofera heterotricha	+	R										
Indigofera melanadenia subsp. malachostachys		+					1		2a			
Ipomoea bathycolpos				R								
Ipomoea oblongata			2a						+			
Ipomoea cf. transvaalensis										R		
Jamesbrittenia aurantiaca											R	R
Jamesbrittenia burkeana				+								
Kohautia virgata											R	+
Kyphocarpha angustifolia								1	+	R		
Ledebouria cf. revoluta	R											
Ledebouria sp.					R	+						
Lotononis listii							1					

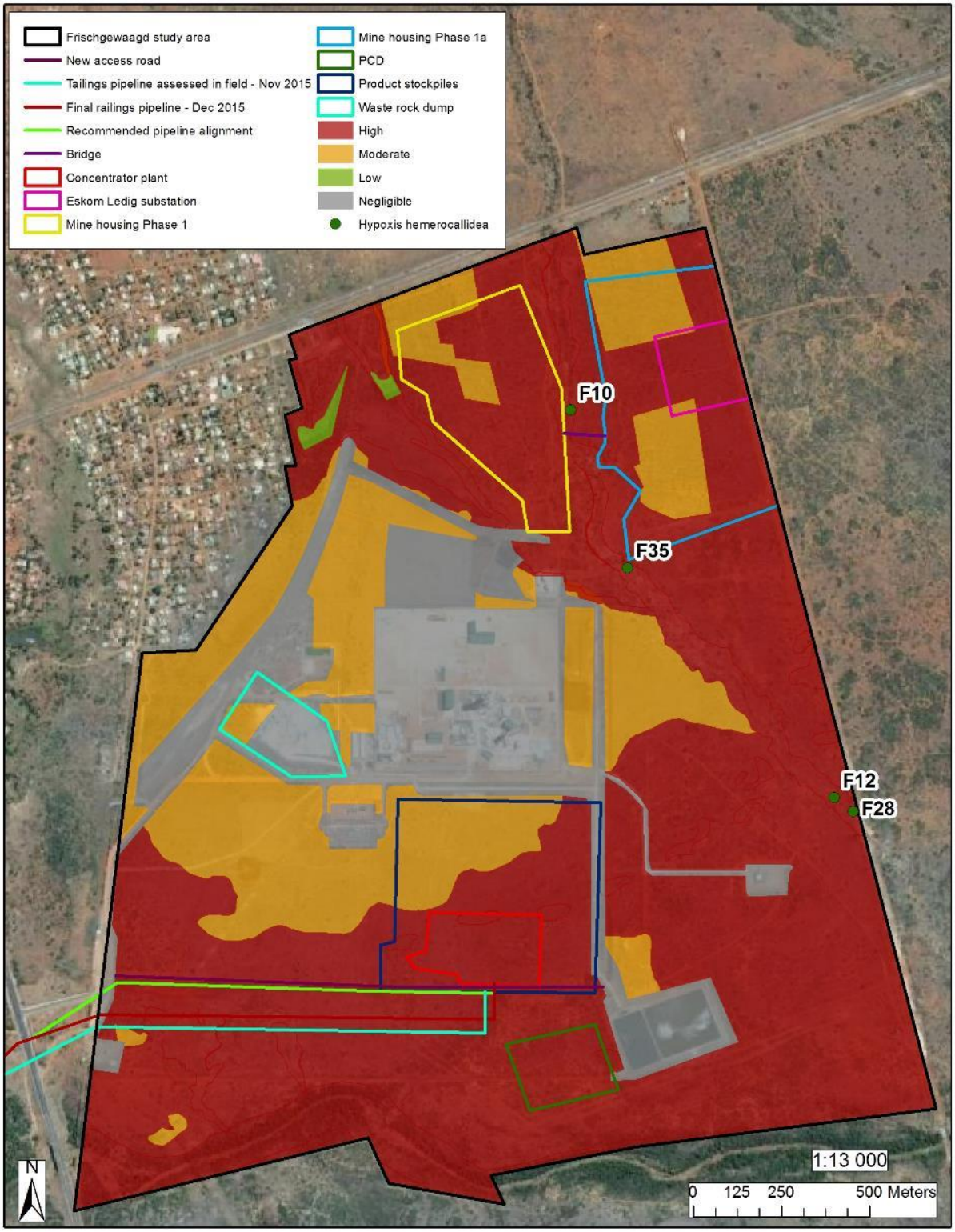
*Malvastrum coromandelianum								+				
Momordica balsamina			R									
Nidorella resediifolia	+	+	1			+	+	+		1	+	1
Osteospermum muricatum							+		+			
Pavonia burchellii			+	+					+			
Pentarrhinum insipidum			+					R	+			
Phyllanthus sp.				+		+		+		+		
Ptycholobium plicatum	+	+	R									
Raphionacme hirsuta		+										
Rhynchosia minima								+			+	1
Ruelliopsis setosa	+											
*Schkhuria pinnata								1				+
Seddera capensis			+									
Senecio sp.											+	
*Solanum eleagnifolium					+		+	+	+	+		
Solanum incanum				R								
Talinum caffrum		+	+		+	1	+					
Tephrosia cf. capensis		+						1			R	
Tephrosia longipes												+
Tephrosia purpurea										1		
Tribulus terrestris								1				
Triumfetta sonderi				+								
Vernonia oligocephala							+				+	
Xerophyta cf. equisetoides var. equisetoides				+								
Ziziphus zeyheriana		1										
Trees & Shrubs												
Acacia caffra	1		1	2a								
Acacia erubescens	+		+									
Acacia karoo	2a	2b	2b		1	1	1	1	1	2a		
Acacia mellifera								1				
Acacia tortilis	1	1	+				1	2b	1			1
Asparagus laricinus	+				+			+			1	
*Cereus jamacaru				+								
Dichrostachys cinera			1			1						+
Diospyros lycioides						1	+				1	+
Ehretia rigida						+						
Elephantorrhiza burkei				+								
Euclea undulata				+						1		
Grewia flava	+	1	2a		3	3						

Gymnosporia buxifolia						1						
Indigofera melanadenia subsp. melanadenia				1								
Lannea discolor				1								
Pavetta zeyheri				1								
Sclerocarya birrea				1								
Searsia pyroides	1											
Tarchonanthus parvicapitulatus		+			1	1						
Ximenia caffra				+								
Ziziphus mucronata	2b	+	1			+		+				
Unidentified taxa												
Dicot sp. 1	+	+										
Dicot sp. 2												+
Lamiaceae sp.											+	
TOTAL no. of taxa	43	36	36	43	16	27	27	29	18	21	22	21

*Estimated Cover Abundance Values:

R = negligible canopy cover (one or two small individuals)
+ = less than 1% canopy cover
1 = 1-5% canopy cover
2a = 6-15% canopy cover
2b = 16-25% canopy cover
3 = 26-50% canopy cover
4 = 51-75% canopy cover
5 = 76-100% canopy cover

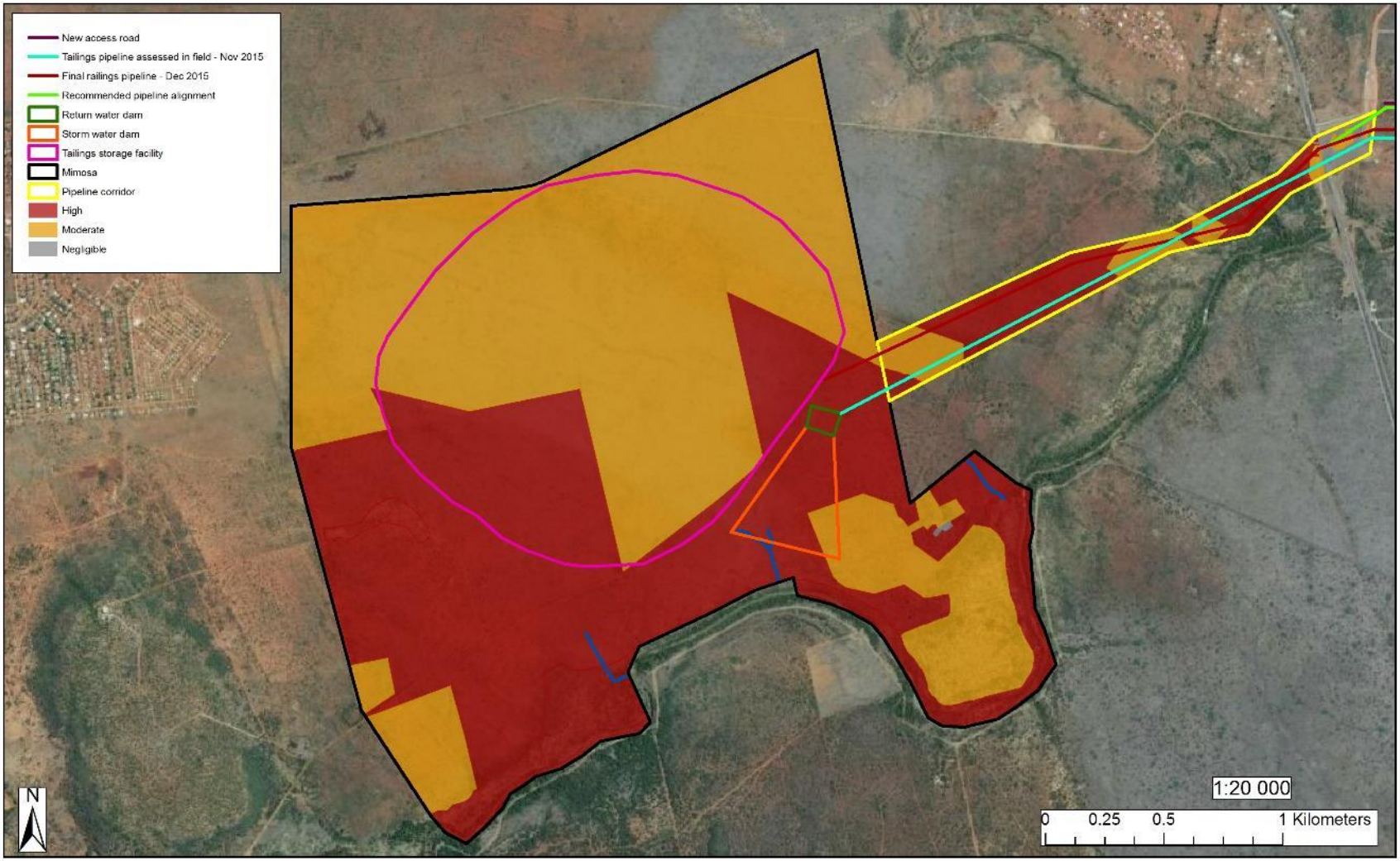
APPENDIX 4: Maps of sensitivity / botanical biodiversity conservation value of the various vegetation and land-cover type units identified within the study area.



Senisitivity map with proposed infrastructure for Frischgewaagd

January 2016
Created by:

DE CASTRO & BRITS
ECOLOGICAL CONSULTANTS



Sensitivity map with proposed infrastructure for Mimosa and the Pipeline corridor

January 2016
Created by:

DE CASTRO & BRITS
ECOLOGICAL CONSULTANTS

APPENDIX 5: List of all plant nine 'species of conservation concern' (*sensu* Raimondo *et al*., 2009 and http://redlist.sanbi.org, downloaded May 2015) historically recorded from the quarter degree grid square within which the study area is situated (2527AC), as well as in adjacent grids containing similar habitat (2526BC, 2526BD, 2526DB and 2527CA), as obtained from the National Herbarium PRECIS database (http://posa.sanbi.org). Also included in the list are *Stenostelma umbelliferum* and *Hypoxis hemerocallidea*. *Stenostelma umbelliferum*, though not historically recorded from any of the aforementioned grids, does occur in the eastern parts of the North-West province in habitats similar to those found in the study area. *Hypoxis hemerocallidea*, was also not listed for the five quarter degree grids, but was recorded at Frischgewaagd by the author. Emphasis was placed on searching for these 11 plant species, and potentially suitable habitat for these species, during the field surveys.

Taxon	**Conservation Status Category***	**Habitat**	**Flowering Time**	**Grids in which recorded**	**Probability of occurrence**	
					Frischgewaagd	**Mimosa**
AIZOACEAE						
Frithia pulchra	Rare	Coarse, shallow, quartzitic soils on sandstones.	November to March	2527CA	Low	Low
AMARYLLIDACEAE						
Boophone disticha	Declining	Dry grassland and woodland, particularly in rocky areas.	July to October	2527CA 2527AC	Low	Medium
APOCYNACEAE						
Stenostelma umbelluliferum	Near Threatened	Deep black turf in open woodland mainly in the vicinity of drainage lines.	September to February	None	Medium	Low
AQUIFOLIACEAE						
Ilex mitis var. *mitis*	Declining	Along rivers and streams in forests and thickets, sometimes in the open. Found from sea level to inland mountain slopes.	September to February	2526 DB, 2527 CA	Low	Low
ASPHODELACEAE						
Aloe peglerae	Endangered	Grassland, in shallow, gravely quartzitic soils on rocky, north-facing slopes or summits of ridges.	July to August	2527CA	Negligible	Negligible
CRASSULACEAE						
Adromischus umbraticola subsp. *umbraticola*	Near Threatened	South-facing rock crevices on ridges, restricted to Gold Reef Mountain Bushveld in the northern parts of its range, and Andesite Mountain	October to March	2527CA	Negligible	Negligible

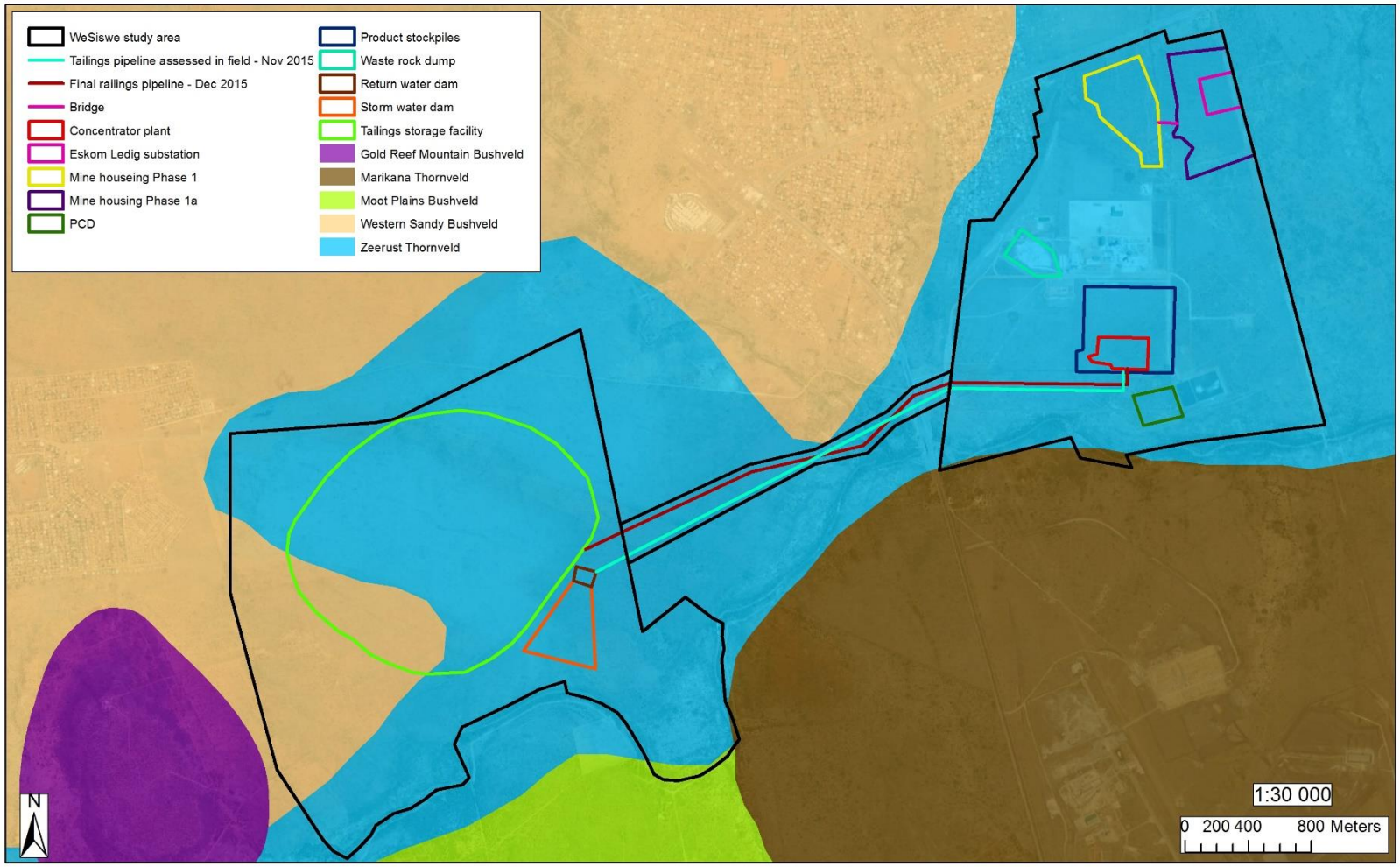
		Bushveld in the south				
GUNNERACEAE						
Gunnera perpensa	Declining	In marshy, cold or cool, continually moist localities, mainly along upland streambanks. From coast to 2400m.	September to February	2527CA	Negligible	Negligible
HYACINTHACEAE						
Drimia sanguinea	Near Threatened	Open veld and scrubby woodland in a variety of soil types.	September to November	2627CA	Medium	Medium
HYPOXIDACEAE						
Hypoxis hemerocallidea	Declining	Grassland and mixed woodland, including secondary grassland of historically cultivated soils. Usually in moist situations.	August to April	2527AC	RECORDED	High
MYRSINACEAE						
Rapanea melanophloeos	Declining	Coastal, swamp and mountain forest, on forest margins and in bushclumps, often in damp areas from coast to mountains.	April to October	2527CA	Negligible	Negligible
ROSACEAE						
Prunus africana	Vulnerable	Evergreen forests near the coast, inland mistbelt forests and afromontaone forests up to 2100m.	April to July	2527CA	Negligible	Negligible

* Status follows the latest Red Data Plant Book of South African Plants (Raimondo *et al*., 2009), and the continuously updated online Red List of SANBI (http://redlist.sanbi.org, downloaded May 2015).

APPENDIX 6:List of 49 plant species regarded as 'priority species' for the North West Province, as extracted from Hahn (June 2011). IUCN conservation status categories are those provided by Raimondo *et al.* (2009). Of the 49 listed species, only the 27 shaded in grey are regarded as 'species of conservation concern' (*sensu* Raimondo *et al*. 2009) in the latest Red List of South African plants (http://redlist.sanbi.org).

Aloe peglerae Schöland	Endangered
Aloe cryptopoda Bak. (Enselsberg Form)	Least Concern
Amphiglossa tecta (Brausse) Koekemoer	Least Concern
Anacampseros dicapitata sp. nov. in ms P. Burgoyne	DDD
Barleria randii S. Moore	Least Concern
Blepharis angustata (Nees) T. Anderson	Least Concern
Brachycorythis conica (Summerh.) subsp. *transvaalensis* Summerh.	Vulnerable
Brachystelma canum R.A. Dyer	Critically Endangered
Brachystelma dimorphum R.A. Dyer *subsp. gratum* R.A. Dyer	Rare
Brachystelma discoideum R.A. Dyer	Endangered
Brachystelma glenense R.A. Dyer	DDT
Brachystelma gracillimum R.A. Dyer	Critically Endangered
Brachystelma incanum R.A. Dyer	Vulnerable
Ceropegia deciduas E.A. Bruce subsp. *pretoriensis* R.A. Dyer	Vulnerable
Ceropegia insignis R.A. Dyer	Rare
Ceropegia stentiae E.A. Bruce	Vulnerable
Ceropegia turricula E.A. Bruce	Near Threatened
Cheilanthes botsawanae Schelpe & N.C. Anthony	Least Concern
Commelina bella Oberm.	DDT
Corchorus pinnatipartitus Wild	DDT
Cynodon polevansii Stent.	DDT
Delopserma macellum (N.E. Br.) N.E. Br.	Endangered
Dicliptera magaliesbergensis K. Balkwill	Threatened
Ebracteola wilmaniae (L. Bolus) Glen	Least Concern
Erythrophysa transvaalensis Verdoorn	Least Concern
Eulophia coddii A.V. Hall	Vulnerable
Euphorbia knobelii Letty	DDT
Euphorbia perangusta R.A. Dyer	Endangered
Euphorbia planiceps A.C. White, R.A. Dyer & E.B. Sloane	Least Concern
Frithia pulchra N.E. Br.	Rare
Gladiolus filiformis Goldblatt & J.C. Manning	Critically Rare
Gnaphalium nelsonii Burtt Davy	Rare
Habenaria culveri Schltr.	Rare
Indigofera commixta N.E. Br.	Least Concern
Jamesbrittenia burgei P. Lemmer	Vulnerable
Ledebouria atrobrunnea S. Venter	Vulnerable
Ledebouria confus S. Venter	Least Concern
Lessertia phillipsiana Burt Davy	Least Concern
Lobelia cuneifolia Link & Otto var, *ananda* E. Wimm.	Least Concern
Marsilea farinosa Launert subsp. *arrecta* J.E. Burrows	Vulnerable
Melolobium subspicatum Conrath	Vulnerable
Miraglossum laeve Kupicha	Least Concern
Nuxia glomerulata (C.A. Sm.) Verdoorn	Least Concern
Prunus africana (Hook f.) Kalkman	Vulnerable
Rennera stellata P.P.J. Herman	Vulnerable
Searsia maricoana (Moffet) Moffet	Vulnerable
Senecio holubii Hutch. & Burt Davy	DDT
Thesium celatum N.E. Br.	DDT
Thesium nationae A.W. Hill	DDT

APPENDIX 7: National vegetation types (Mucina & Rutherford, 2006) mapping boundaries in relation to the study area, as mapped in the NWBSP 2015.

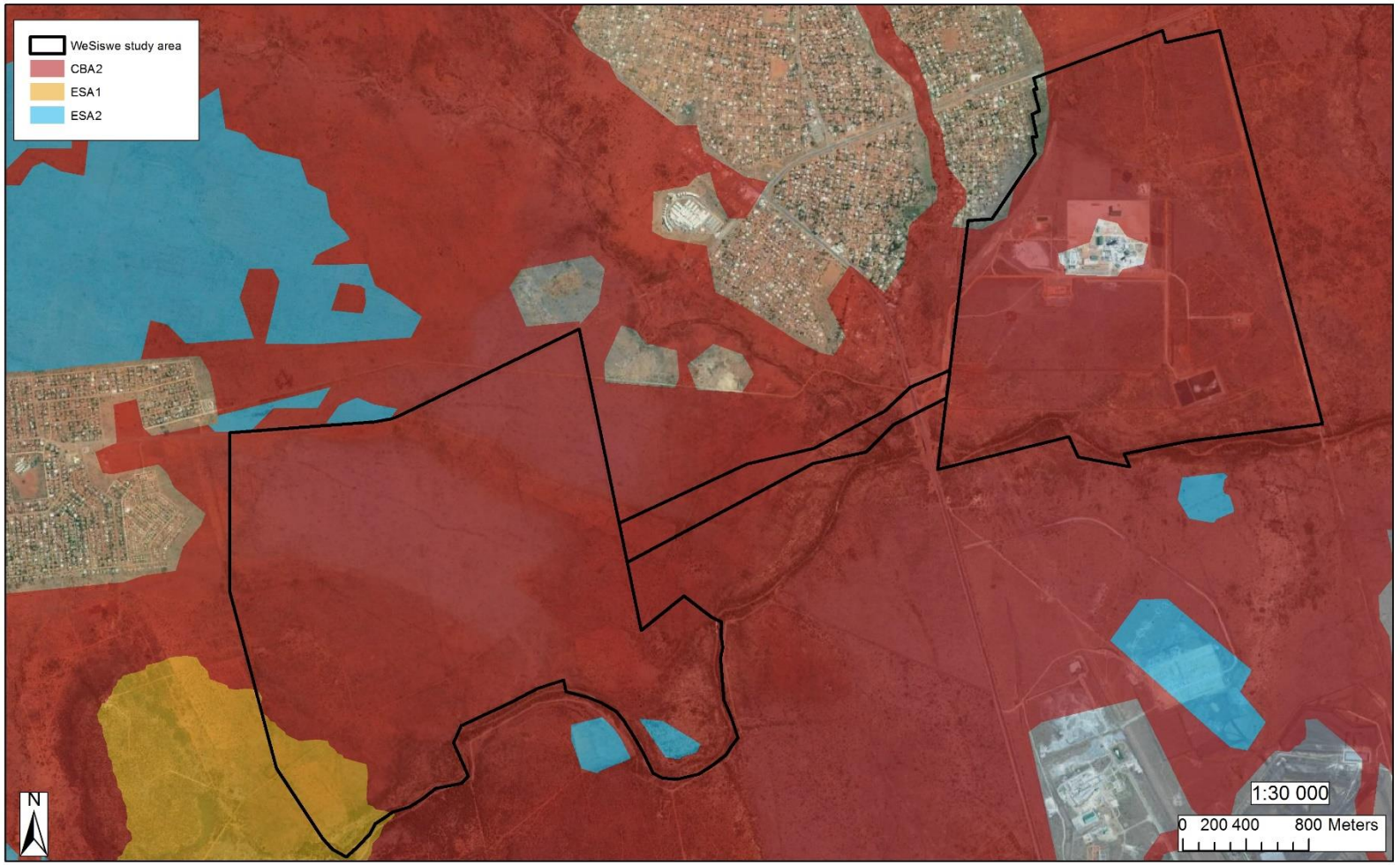


Mucina & Rutherford (2006) vegetation types as mapped in the NWBSP 2015

January 2016
Created by:

DE CASTRO & BRITS
ECOLOGICAL CONSULTANTS

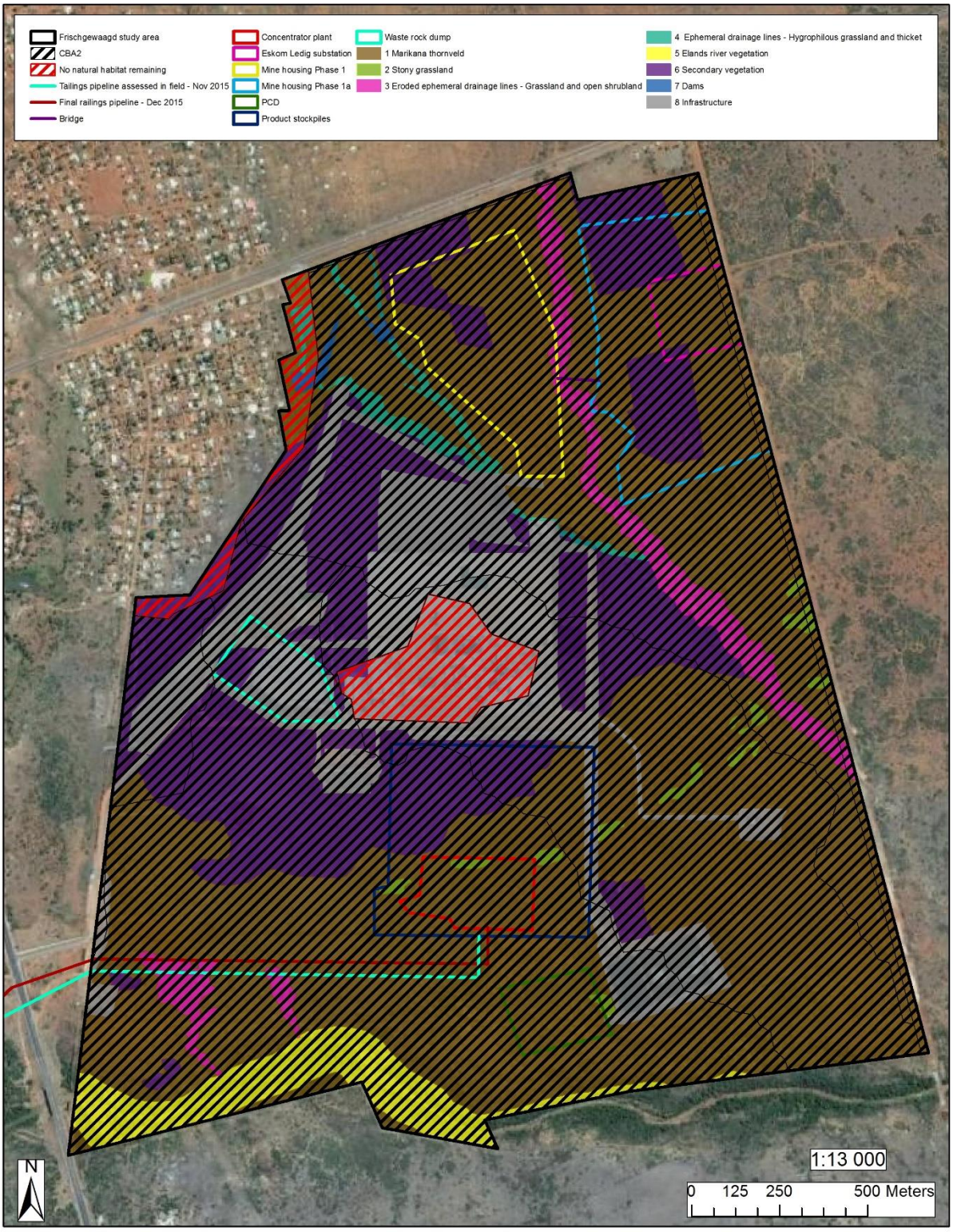
APPENDIX 8: North West Province Biodiversity Sector Plan (NWBSP) (North West Department of Rural, Environmental and Agricultural Development, 2015) maps for the Frischgewaagd section and the Mimosa section and 'pipeline mapping corridor'.



NWBSP 2015 Biodiversity classification for the Wesizwe study area

January 2016
Created by:

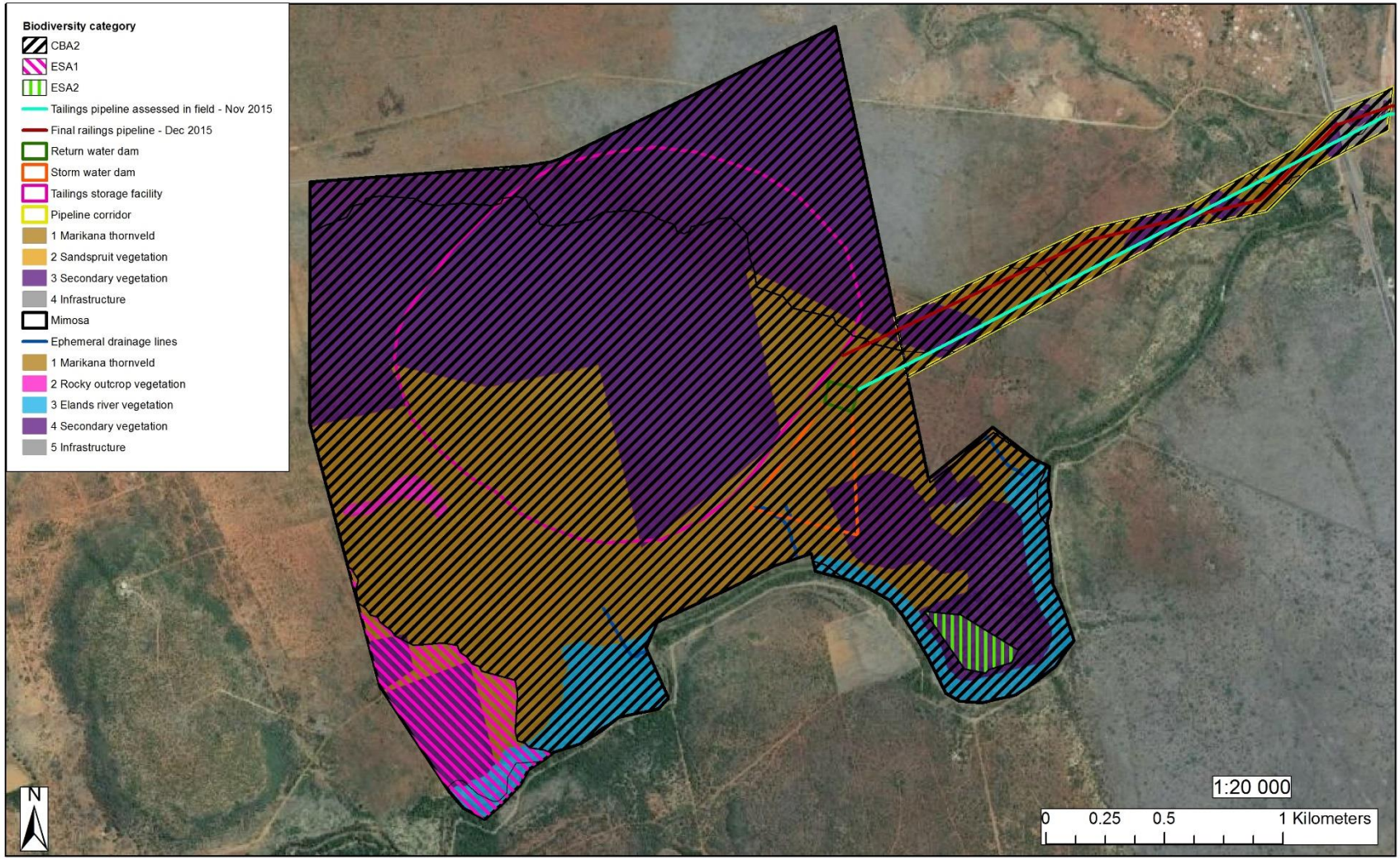
DE CASTRO & BRITS
ECOLOGICAL CONSULTANTS



Biodiversity classification with proposed infrastructure for Frischgewaagd

January 2016
Created by:

DE CASTRO & BRITS
ECOLOGICAL CONSULTANTS

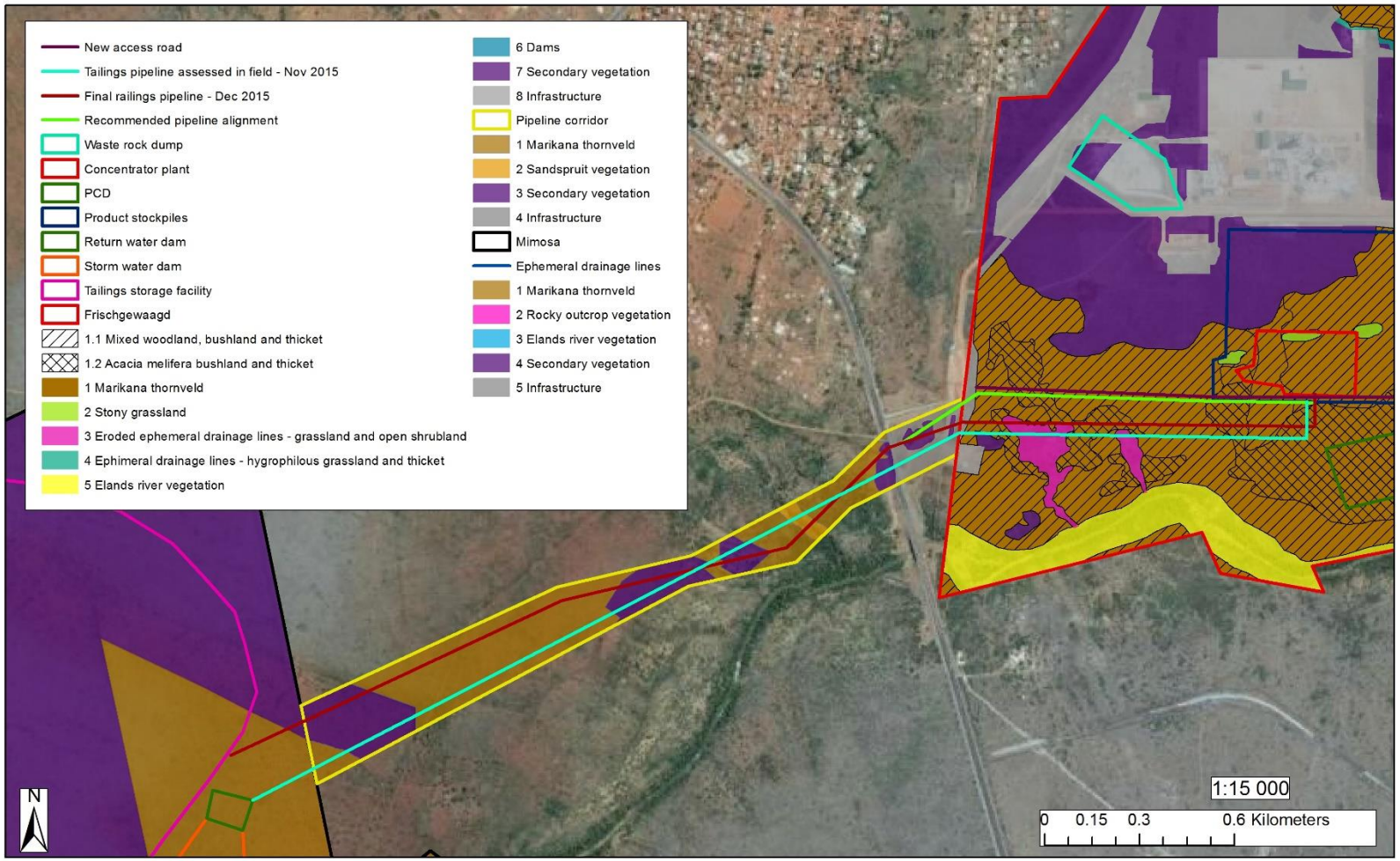


Biodiversity categories with proposed infrastructure for Mimosa and the Pipeline corridor (Northwest Biodiversity Sector Plan, 2015)

January 2016
Created by:

DE CASTRO & BRITS
ECOLOGICAL CONSULTANTS

APPENDIX 9: Map of the proposed realignment of the eastern proption on the 'Final tailings pipeline alignment' provided by the client (Dec 2015).



Proposed pipeline alignments of the tailings pipeline and recommended realignment of eastern section of the 'Final tailings pipeline' alignment

January 2016
Created by:

DE CASTRO & BRITS
ECOLOGICAL CONSULTANTS

APPENDIX 10: Impact Assessment

IMPACT TYPE: LOSS OF VEGETATION TYPES

Rating of Impact

Severity / Nature

This impact refers to the loss of vegetation types (or broad-scale vegetation units) described and mapped in the national vegetation map (Mucina & Rutherford, 2006) and the NWBSP 2015. The NWBSP 2015 equates these vegetation types with ecosystems. The vegetation of the study area is regarded as representative of Marikana Thornveld, which is currently categorised as a **Vulnerable** vegetation type in the NWBSP 2015. Loss of untransformed Marikana Thornveld vegetation will result from the clearing of vegetation and topsoils within the construction footprints of ten of the eleven proposed infrastructure components and the construction servitude of the tailings pipeline during the construction phase.

The eleven infrastructure components (not including the tailings pipeline alignment) have a total combined footprint of 344.3ha, of which 203.1ha (or 59.0%) comprises transformed habitats with secondary vegetation or no vegetation, and 139.7ha (or 40.6%) comprises Marikana Thornveld [The TSF footprint contains by far the greatest area of Marikana Thornveld (i.e. 64.5ha) of any of the footprints]. The remaining 1.5ha (or 0.4%) of the total combined footprint comprises of spatially restricted untransformed habitats and vegetation. The footprint of the ca. 3.83km final tailings pipeline alignment construction servitude is 11.5ha in extent, of which 3.0ha (or 26.1%) comprises transformed habitats with secondary vegetation or no vegetation, and 7.9ha (or 68.7%) comprises Marikana Thornveld. The remaining 0.6ha (or 5.2%) of the pipeline construction servitude comprises of spatially restricted untransformed habitats and vegetation. A total of 147.6ha of untransformed Marikana Thornveld will therefore be cleared during construction.

An additional loss of an unpredictable extent of Marikana Thornveld may also result from soil pollution caused by contaminated seepage and accidental spillage from the Tailings Storage Facility and the Tailings pipeline, and to a lesser extent other edge effects such as alien plant invasion and dust emissions. Polluted tailings effluent is likely to cause salinization of soils, contamination with heavy metals and changes in soil chemistry which will make the soils more dispersive and increase erosion risk. All these impacts will cause severe and largely irreversible changes to various aspects of vegetation structure (e.g. physiognomy, life-form composition, species richness, species composition, species dominance and stand structure).

The clearing of 147.6ha of Marikana Thornveld (a Vulnerable vegetation type) within an area mapped in the MBSP as a CBA 2, is rated as an impact of **High** severity for both the unmitigated and mitigated scenarios.

Duration

This impact will occur predominately during the construction phase (vegetation clearing) but will extend into the operational and decommissioning phases in the event of soil contamination (De Castro & Brits, February 2016) in areas surrounding the Tailings Pipeline and TSF during the life of the mine.

The 139.7ha of Marikana Thornveld cleared for construction of the eleven infrastructure footprints is considered a permanent or irreversible loss. The 7.9ha area of Marikana Thornveld cleared in the tailings pipeline construction servitude can be rehabilitated to enable the establishment of seral plant communities which will typically (in this part of the Central Bushveld Bioregion) remain representative of secondary vegetation for many decades if not permanently (i.e. stalled secondary succession). Duration is rated **High** for both the unmitigated and mitigated scenarios.

Spatial scale
The clearing of vegetation will be confined to the infrastructure footprints, but soil contamination may occur beyond the footprints as a result of the migration of the pollution plume through the soils and overland flow of tailings spills or other contaminated effluent.

Redesign of infrastructure footprints, and in particular the TSF footprint, so that they are placed largely within 'Secondary vegetation' will significantly reduce the area of Marikana Thornveld lost. Spatial scale is rated **Medium** for the unmitigated scenario and **Low** for the mitigated scenario.

Consequence
The consequence is **High** for both the unmitigated and mitigated scenarios.

Probability
Marikana Thornveld will be cleared during construction of infrastructure and the probability of a leak occurring along the pipeline or seepage and runoff occurring from the tailings facility during the life of mine is considered high. The probability is therefore rated **High** for both the unmitigated and mitigated scenarios.

Significance
The significance rating is **High** for both the unmitigated and mitigated scenarios. The implementation of the recommended mitigation measures will lead to a meaningful reduction in the area of Marikana Thornveld destroyed by construction of project infrastructure, but due to the robustness of the impact assessment methodology used in this study the significance rating remains High in the mitigated scenario. In the opinion of the author a rating to Moderate to High would be more appropriate for the mitigated scenario.

Overall mitigation objectives for each assessed impact or group of impacts:

- Minimise clearing of untransformed vegetation by placing infrastructure footprints within transformed habitats and vegetation (i.e. 'Secondary vegetation' and 'Infrastructure' units) wherever possible.
- Avoid transformation of vegetation surrounding footprints by preventing soil contamination and habitat fragmentation and ensuring the remaining areas of Marikana Thornveld are manged for optimal biodiversity (i.e. sound veld management).

Mitigation measures:

1. Modify infrastructure footprints so as to reduce the area of Marikana Thornveld and other untransformed vegetation units within the footprints wherever possible. Realigned footprints should be placed within Secondary vegetation as far as possible.
2. Avoid placement of any infrastructure footprints within the buffer zones for the biological corridors recommended in this report (see Appendix 12).
3. Modify TSF footprint so as to maximise the surface area comprising Secondary vegetation and minimise the extent of Marikana Thornveld within the footprint.
4. Modify the storm water dam footprint by shifting it to the north and west so that it is situated outside of the recommended buffer zone for the biological corridor along the Elands River (see Appendix 12).
5. Realign the Frischgewaagd section of the 'final tailings pipeline alignment' along the recently constructed access road (see Appendix 9) and reduce the width of the construction servitude in untransformed habitats.
6. Limit transformation only to development footprints.
7. Develop and implement an alien plant control programme for the study area, with emphasis on areas surrounding infrastructure footprints.
8. Develop and implement a veld management plan for the study area, which emphasises the use of sustainable grazing and controlled fires to ensure optimal vegetation condition and biodiversity levels in areas of Marikana Thornveld and spatially restricted untransformed vegetation units not destroyed by the project.

9. Implement pollution control measures recommended in the soil, geotechnical and hydrological specialist reports for the project.
10. Develop and implement a rehabilitation plant for the tailings pipeline construction servitude. The principal objectives of the plan should be the optimal reintroduction of stripped topsoil and the establishment of indigenous seral plant communities through the natural process of secondary succession.

Mitigation type:

Measures 1 to 5 are modify types, measures 6 to 9 are control types and measure 10 is a remedy.

The degree to which the impact can – be reversed: Not (can be partially reversed only in the case of the tailings pipeline spills).
Cause irreplaceable loss of resource: Definite
Be avoided, managed or mitigated: Partially avoided

Monitoring recommendations:

- Continuous monitoring by an Environmental Site Officer during the construction phase to ensure construction activities are restricted to infrastructure footprints and that impacts such as setting of fires, cutting of trees and collection of firewood are not occurring.
- Implementation of a simple annual vegetation monitoring programme that focuses on the use of repeatable fixed point photography and, when necessary, vegetation sampling to monitor remaining Marikana Thornveld and other untransformed vegetation within the study area. Emphasis should be placed on monitoring untransformed vegetation situated in close proximity to infrastructure (particularly areas around the TSF and Tailings Pipeline). A brief evaluation of the success of any future rehabilitation activities should also be included in monitoring. Baseline monitoring should be conducted prior to the construction phase and monitoring should be conducted annually thereafter.

Summary of assessment:

Management	Severity	Duration	Spatial scale	Consequence	Probability	Significance
All phases						
Unmitigated	H	H	M	H	H	H
Mitigated	H	H	L	H	H	H

IMPACT TYPE: LOSS OF SPATIALLY RESTRICTED VEGETATION UNITS / PLANT COMMUNITIES

Rating of Impact

Severity / Nature

This impact refers to the loss of spatially restricted plant communities and habitats, embedded within Marikana Thornveld, which have been included in the following vegetation units:

- Stony grassland (Frischgewaagd Unit 2),
- Eroded ephemeral drainage lines (Frischgewaagd Unit 3),
- Ephemeral drainage lines (Frischgewaagd Unit 4),
- Elands River vegetation (Frischgewaagd Unit 5 and Mimosa Unit 3)
- Rocky outcrop vegetation (Mimosa Unit 2),
- Sandspruit vegetation (pipeline mapping corridor Unit 2).

The construction of the 11 proposed infrastructure components will lead to the direct loss of 0.5ha of the 'Eroded ephemeral drainage lines' unit and 1.0ha of the 'Stony grassland' unit, and the construction of the tailings pipeline will directly affect 0.4ha of the 'Eroded ephemeral drainage lines' unit and 0.2ha of the 'Sandspruit vegetation' unit. A total of 2.1ha of spatially restricted vegetation units will therefore be lost due to clearing of infrastructure footprints. An additional loss of 'Eroded ephemeral drainage lines' and 'Sandspruit vegetation' may also result from soil pollution caused by accidental spillage from Tailings Pipeline during the operational phase. Three spatially restricted vegetation units will therefore be directly impacted, namely 'Stony grassland', 'Eroded ephemeral drainage lines' and 'Sandspruit vegetation'. Only a very small percentage of the total mapped area (within the study area) of the 'Eroded ephemeral drainage lines' and 'Sandspruit vegetation' units will be cleared during construction. The 1.0ha of Stony Grassland included in the infrastructure footprints represents 27.8% of the 3.6ha total extent of 'Stony grassland' patches mapped for the study area.

An additional loss of an unpredictable extent of 'Eroded ephemeral drainage lines' and 'Sandspruit vegetation' may also result from soil pollution caused by contaminated spillage from the Tailings Pipeline, and to a lesser extent other edge effects such as alien plant invasion and dust emissions. Polluted tailings effluent is likely to cause salinization of soils, contamination with heavy metals and changes in soil chemistry which will make the soils more dispersive and increase erosion risk. All these impacts will cause severe and largely irreversible changes to various aspects of vegetation structure (e.g. physiognomy, life-form composition, species richness, species composition, species dominance and stand structure).

The spatially restricted plant communities and habitats, embedded within Marikana Thornveld, are a Vulnerable vegetation type according to the NWBSP 2015. All areas of the spatially restricted vegetation units that will be cleared are furthermore mapped in the MBSP as a CBA 2.

The severity of the impact is rated as **High** for both the unmitigated mitigated scenarios.

Duration

This impact will occur predominately during the construction phase (vegetation clearing) but will extend into the operational and decommissioning phases in the likely event of soil and water contamination (De Castro & Brits, February 2016) in areas surrounding the Tailings Pipeline during the life of the mine.

The 2.1ha of spatially restricted vegetation units / plant communities cleared for construction of the eleven infrastructure footprints is considered a permanent or irreversible loss. Duration is rated **High** for the unmitigated scenario and **Moderate** for the mitigated scenario.

Spatial scale

The clearing of vegetation will be confined to the infrastructure footprints, but soil contamination may occur beyond the footprints as a result of overland flow of tailings spills or other contaminated effluent.

Minor redesign of the Pollution Control Dam footprint and minor realignment of the section of the Tailings Pipeline situated within Frischgewaagd, will avoid all direct impacts to eroded 'Ephemeral ephemeral drainage lines' and moderately reduce the area of 'Stony grassland' which will be cleared. Spatial scale is rated **Medium** for the unmitigated scenario and **Low** for the mitigated scenario.

Consequence

The consequence is **High** for the unmitigated scenario and **Medium** for the mitigated scenario.

Probability

Spatially restricted vegetation units / plant communities will be cleared during construction of infrastructure and the probability of a leak occurring along the pipeline during the life of mine is

considered high. However, in the mitigated scenario, complete avoidance of the 'Eroded ephemeral drainage line unit by the tailings pipeline alignment is possible, and avoidance of some of the area of 'Stony grassland is also possible'. The probability is therefore rated **High** for the unmitigated scenario and **Medium** for the mitigated scenario.

Significance
The significance rating is **High** for the unmitigated scenario and **Medium** for the mitigated scenario.

Overall mitigation objectives for each assessed impact or group of impacts:

- Minimise clearing of untransformed vegetation by placing infrastructure footprints within transformed habitats and vegetation (i.e. 'Secondary vegetation' and 'Infrastructure' units) wherever possible.
- Avoid transformation of spatially restricted vegetation units surrounding footprints by preventing soil contamination and habitat fragmentation and ensuring the remaining areas of spatially restricted vegetation units are managed for optimal biodiversity (i.e. sound veld management).

Mitigation measures:

1. Modify infrastructure footprints so as to reduce the area of spatially restricted units and other untransformed vegetation units within the footprints wherever possible. Realigned footprints should be placed within the 'Secondary vegetation' unit in as far as possible.
2. Avoid placement of any infrastructure footprints within the buffer zones for the biological corridors recommended in this report (see Appendix 12).
3. Modify PCD footprint by shifting it approximately 50m to the north-west so as avoid a small patch of 'Stony grassland' and situate it outside of the recommended buffer zone for the biological corridor along the Elands River (see Appendix 12).
4. Realign the Frischgewaagd section of the 'final tailings pipeline alignment' along the recently constructed access road (see Appendix 9).
5. Limit transformation only to development footprints.
6. Develop and implement an alien plant control programme for the study area, with emphasis on areas surrounding infrastructure footprints.
7. Develop and implement a veld management plan for the study area, which emphasises the use of sustainable grazing and controlled fires to ensure optimal vegetation condition and biodiversity levels in spatially restricted vegetation units and surrounding areas of Marikana Thornveld not destroyed by the project.
8. Implement pollution control measures recommended in the soil, geotechnical and hydrological specialist reports for the project.
9. Develop and implement a rehabilitation plant for the tailings pipeline construction servitude. The principal objectives of the plan should be the optimal reintroduction of stripped topsoil and the establishment of indigenous seral plant communities through the natural process of secondary succession.

Mitigation type:

Measures 1 to 4 are modify types, measures 5 to 8 are control types and measure 9 is a remedy.

The degree to which the impact can –
Be reversed: Not (can be partially reversed only in the case of the tailings pipeline spills).
Cause irreplaceable loss of resource: Definite
Be avoided, managed or mitigated: Partially avoided, managed and mitigated.

Monitoring recommendations:

- Continuous monitoring by an Environmental Site Officer during the construction phase to ensure construction activities are restricted to infrastructure footprints and that impacts such setting of fires, cutting of trees and collection of firewood are not occurring.
- Implementation of a simple annual vegetation monitoring programme that focuses on the use of repeatable fixed point photography and, when necessary, vegetation sampling to monitor remaining spatially restricted vegetation units and Marikana Thornveld vegetation within the study area. Emphasis should be placed on monitoring untransformed vegetation situated in close proximity to infrastructure (particularly areas around the TSF and Tailings Pipeline). A brief evaluation of the success of any future rehabilitation activities should also be included in monitoring. Baseline monitoring should be conducted prior to the construction phase and monitoring should be conducted annually thereafter.

Summary of assessment:

Management	Severity	Duration	Spatial scale	Consequence	Probability	Significance
All phases						
Unmitigated	H	H	M	H	H	H
Mitigated	H	M	L	M	M	M

IMPACT TYPE: LOSS OF PLANT 'SPECIES OF CONSERVATION CONCERN'

Rating of Impact

Severity / Nature
This impact refers to the loss 'species of conservation concern' (*sensu* Raimondo *et al*., 2009) during clearing of vegetation. Plant 'species of conservation concern' are species that are currently categorised as threatened (Critically Endangered, Endangered and Vulnerable), Near Threatened, Declining, Rare or Critically Rare in accordance with SANBI's continually updated online Red List (http://redlist.sanbi.org).

No 'plant species of conservation concern' were recorded within the proposed infrastructure footprints or the construction servitude of the proposed final tailings pipeline alignment (December 2015).

The only plant 'species of conservation concern' thus far recorded within the study area is the Declining medicinal plant *Hypoxis hemerocallidea.* Three additional plant 'species of conservation concern' have a Moderate probability of occurrence within the study area, namely the Near Threatened species *Drimia sanguinea* and *Stentonstelma umbelluliferum*, and the Declining medicinal plant species *Boophone disticha*. None of these species are considered likely to occur within the proposed infrastructure footprints, but the possibility of a few individuals of plant 'species of conservation concern' occurring within the footprints and pipeline alignment cannot be excluded until the final footprints for all infrastructure components are searched for these species.

The severity of the impact is rated as **Moderate** for the unmitigated scenario and **Low** for the mitigated scenario.

Duration
This impact will occur predominately during the construction phase (vegetation clearing).
The duration of the loss of a few individuals of a plant 'species of conservation concern' would be permanent in the eleven infrastructure, excluding the small Tailings Pipeline construction servitude where with certain pioneer species such as *Hypoxis hemerocallidea* it would be reversible within the life of the mine.

Duration is rated **High** for both the unmitigated and mitigated scenarios.

Spatial scale
The clearing of vegetation will be confined to the infrastructure footprints, but soil contamination may occur beyond the footprints as a result of seepage and runoff from the TSF and overland flow of tailings spills or other contaminated effluent.

Spatial scale is rated **Low** for both the unmitigated and mitigated scenarios.

Consequence
The consequence is **Medium** for both the unmitigated and mitigated scenarios.

Probability
Only one plant 'species of conservation concern' (a Declining medicinal plant species) and no threatened or Near Threatened species have been recorded within the footprints and alignments of proposed infrastructure or the study area as a whole, despite the conduction of fairly extensive field surveys conducted in 2014 and 2015. The probability of impacts to plant 'species of conservation concern' is therefore rated **Low** for both the mitigated and unmitigated scenarios.

Significance
The significance rating is **Low** for both the unmitigated and mitigated scenarios.

Overall mitigation objectives for each assessed impact or group of impacts:

- Avoid placing any of the infrastructure footprints or alignments on confirmed habitat for plant 'species of conservation concern', and in particular plant 'species of conservation concern' categorised as threatened or Near Threatened.
- Minimise clearing of untransformed vegetation by placing infrastructure footprints within transformed habitats and vegetation (i.e. 'Secondary vegetation' and 'Infrastructure' units) wherever possible.
- Avoid transformation of spatially restricted vegetation units surrounding footprints by preventing soil contamination and habitat fragmentation and ensuring the remaining areas of spatially restricted vegetation units are managed for optimal biodiversity (i.e. sound veld management).

Mitigation measures:

1. Modify infrastructure footprints so as to reduce the area of spatially restricted vegetation units and Marikana Thornveld within the footprints wherever possible. Realigned footprints should be placed within the 'Secondary vegetation' unit in as far as possible.
2. Conduct additional, brief floristic surveys, focussed on searching for *Drimia sanguinea, Stentonstelma umbelluliferum, Boophone disticha* and *Hypoxis hemerocallidea* within the final development footprints prior to construction. Surveys should be conducted in late October to early November and in January. The brief floristic surveys should focus on searching those parts of the proposed infrastructure footprints containing potentially suitable habitat for *Drimia sanguinea*. These surveys will also contribute towards confirming the absence of other 'species of conservation concern' within the study area.
3. The 'final' Tailings Pipeline alignment (December 2015) was not surveyed in the field during the current study and was assessed only at a desktop level. The final Tailings Pipeline alignment, and the final footprints of other infrastructure components for which realignments have been recommended in this report, should be searched for plant 'species of conservation concern' prior to the commencement of construction.
4. In the event of any threatened (i.e. Critically Endangered, Endangered and Vulnerable) or Near Threatened plant species being recorded within the study area or proposed development footprints in future, appropriate *in situ* and/or *ex situ* conservation measures should be

developed in consultation with the North-West Province Directorate of Biodiversity Management.

5. In the event of any Declining (*sensu* Raimondo *et al*., 2009) plant species being recorded within approved development footprints in future, permission for their removal or destruction should be obtained from the provincial Directorate of Biodiversity Management. Where feasible, viable populations of such species should be translocated to degraded or untransformed areas within the study area which provide potentially suitable habitats, but such translocations will have to be carried out in a way that ensures no ecological degradation of the host habitat occurs, and will have to be evaluated by a botanist for each species and each potential translocation area.
6. Illegal medicinal plant harvesting should be discouraged through control of access to untransformed habitats and vegetation within the study area.

Mitigation type:
Measure 1 is a modify type, measures 2, 3and 6 are control types, and measures 4 and 5 are remedy types.
The degree to which the impact can –
Be reversed: Not
Cause irreplaceable loss of resource: Unlikely
Be avoided, managed or mitigated: Fully avoided.

Monitoring recommendations:

- Implementation of a simple annual monitoring programme for the recorded medicinal plant *Hypoxis henorocallidea* and all subpopulations of plant 'species of conservation concern' recorded within the study area in future. Emphasis must be placed on monitoring any threatened or Near Threatened species that may be recorded in future. Monitoring should consist of simple techniques such as fixed-point photography of habitat and counts or estimates of the number of plants present and the age structure. This simple monitoring of plant 'species of conservation concern' should be incorporated into the recommended annual vegetation monitoring programme.
- Continuous monitoring by an Environmental Site Officer during the construction phase to ensure construction activities are restricted to infrastructure footprints that impacts such setting of fires, cutting of trees and collection of firewood and medicinal plants are not occurring.

Summary of assessment:

Management	**Severity**	**Duration**	**Spatial scale**	**Consequence**	**Probability**	**Significance**
All phases						
Unmitigated	M	H	L	M	L	L
Mitigated	L	H	L	M	L	L

IMPACT TYPE: LOSS OF FLORA

Rating of Impact

Severity / Nature

This impact refers to the loss of species richness (α-diversity) and of plant species that are Protected in terms of the National Forests Act (Act 84 of 1998, as amended on the 23rd of September 2010) and the Biodiversity Act (Act 10 of 2004, as amended on the 16th of April 2013). A total of 356 indigenous plant species have thus far been recorded within the study area, two of which are protected in terms of the National Forests Act, namely *Sclerocarya birrea* and *Boscia albitrunca.*

Neither *Sclerocarya birrea* nor *Boscia albitrunca* were recorded within the proposed infrastructure footprints or the construction servitude of the proposed final tailings pipeline alignment (December 2015).The untransformed vegetation unit that will suffer the greatest loss as a result of the clearing of the eleven infrastructure components and the pipeline construction servitude is the spatially restricted unit 'Stony grassland' 27.8% of the extent of which will be cleared. A far lesser percentage of the surface area of other untransformed units will be lost. Viable and representative areas of all identified untransformed vegetation units will remain after project construction, and none of the 356 indigenous plant species thus far recorded within the study area were recorded only within the infrastructure footprints. Few, if any, of the plant species occurring within the study area are therefore likely to be lost within the study area and it is considered highly unlikely that there will be any significant loss of species richness (α-diversity) within the study area. It is however possible that a few species will suffer a moderate reduction in numbers (i.e. population size) at the scale of the study area.

The severity of the impact is rated as **Medium** for the unmitigated scenario and **Low** for the mitigated scenario.

Duration
This impact will occur predominately during the construction phase (vegetation clearing). The duration of the possible loss of all individuals of a species restricted to the footprints of the eleven infrastructure components (at the scale of the study area) would quite likely be permanent. In the unlikely event that any indigenous pioneer species are restricted entirely to the pipeline construction servitude, such species may become re-established after rehabilitation.

Duration is rated **High** for both the unmitigated and mitigated scenarios.

Spatial scale
The clearing of vegetation will be confined to the infrastructure footprints, but soil contamination may occur beyond the footprints as a result of seepage and runoff from the TSF and overland flow of tailings spills or other contaminated effluent.

Spatial scale is rated **Low** for both the unmitigated and mitigated scenarios.

Consequence
The consequence is **Medium** for both the unmitigated and mitigated scenarios as a result of Duration being rated high.

Probability
None of the 356 indigenous plant species thus far recorded within the study area are confined to the footprints or alignments of proposed infrastructure, and neither of the two plant species recorded within the study area which are protected in terms of the National Forests Act, namely the conspicuous trees *Sclerocarya birrea* and *Boscia albitrunca,* have been recorded within the development footprints despite the conduction of fairly extensive field surveys in 2014 and 2015. The probability of impacts to plant flora and Protected plant species is therefore rated **Low** for both the mitigated and unmitigated scenarios.

Significance
The significance rating is **Low** for both the unmitigated and mitigated scenarios.

Overall mitigation objectives for each assessed impact or group of impacts:

- Minimise clearing of untransformed vegetation by placing infrastructure footprints within transformed habitats and vegetation (i.e. 'Secondary vegetation' and 'Infrastructure' units) wherever possible.

- Avoid transformation of spatially restricted vegetation units surrounding footprints by preventing soil contamination and habitat fragmentation and ensuring the remaining areas of spatially restricted vegetation units are managed for optimal biodiversity (i.e. sound veld management).

Mitigation measures:

1. Modify infrastructure footprints so as to reduce the area of spatially restricted vegetation units and Marikana Thornveld within the footprints wherever possible. Realigned footprints should be placed within the 'Secondary vegetation' unit in as far as possible.
2. The 'final' Tailings Pipeline alignment (December 2015) was not surveyed in the field during the current study and was assessed only at a desktop level. The final Tailings Pipeline alignment, and the final footprints of other infrastructure components for which realignments have been recommended in this report, should be searched for Protected plant species prior to the commencement of construction.
3. The damaging or destruction of any plant species Protected in terms of the National Forest Act or the Biodiversity Act should be avoided wherever possible, and a permit for the destruction of any such protected plant must be obtained from the provincial Directorate of Biodiversity Management prior to development.
4. Botanical research and conservation institutions (e.g. SANBI and universities), should also be afforded an opportunity to search the footprint for species that are of research or horticultural interest, prior to commencement of development.
5. If herbaceous Protected plant species that are readily transplantable are found (e.g. many geophytes), viable populations of such species can also be translocated to transformed (including rehabilitation areas) or untransformed areas within the study area which provide potentially suitable habitats, but such translocations will have to be carried out in a manner that ensures that no ecological degradation of the host habitat occurs, and will have to be evaluated by a botanist for each species and each potential translocation area. Alternatively such species should be rescued and placed in a nursery or donated to a research institute (e.g. SANBI and universities), rather than simply being destroyed upon receipt of a permit.

Mitigation type:
Measures 1 and 3 are modify types, measure 2 is a control type, and measures 4 and 5 are remedy types.

The degree to which the impact can –
Be reversed: Not
Cause irreplaceable loss of resource: Unlikely
Be avoided, managed or mitigated: Fully avoided, and partially mitigated.

Monitoring recommendations:

- Continuous monitoring by an Environmental Site Officer during the construction phase to ensure construction activities are restricted to infrastructure footprints and that impacts such setting of fires, cutting of trees and collection of firewood are not occurring.
- Implementation of a simple annual vegetation monitoring programme that focuses on the use of repeatable fixed point photography and, when necessary, vegetation sampling to monitor remaining spatially restricted vegetation units and Marikana Thornveld vegetation within the study area. Emphasis should be placed on monitoring untransformed vegetation situated in close proximity to infrastructure (particularly areas around the TSF and Tailings Pipeline). A brief evaluation of the success of any future rehabilitation activities should also be included in monitoring. Baseline monitoring should be conducted prior to the construction phase and monitoring should be conducted annually thereafter.

Summary of assessment:

Management	Severity	Duration	Spatial scale	Consequence	Probability	Significance
All phases						
Unmitigated	M	H	L	M	L	L
Mitigated	L	H	L	M	L	L

APPENDIX 11: Photographs of the untransformed BMU's identified for the study area.

FRISCHGEWAAGD

Unit 1.1: Site F38.

Unit 1.2: Site F24.

Unit 2: Site F31.

Unit 3: Site F10.

Unit 3: Site F18.

Unit 4: Site F6.

Unit 4: Site F43.

Unit 4: Site F41.

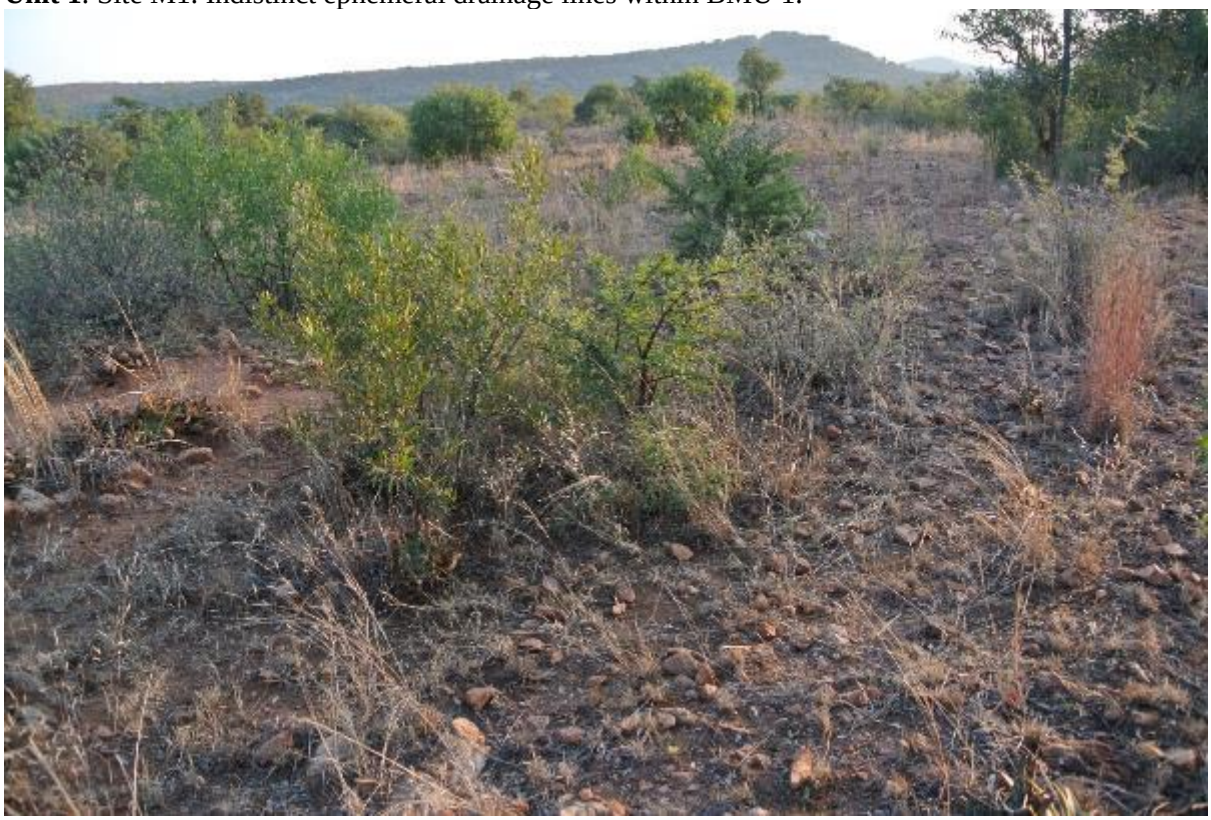
Unit 5: Site F45.

Unit 6: Site F37.

MIMOSA

Unit 1: Site M19.

Unit 1: Site M1. Indistinct ephemeral drainage lines within BMU 1.



Unit 2: Site M37.

Unit 3: Site M11. Elands River channel bed and macro-channel banks.

Unit 3: Site M12. Bushland on Elands River upper floodplain which is seldom activated.

Unit 4: Site M14. Secondary Open Shrubland on black turf soils (Arcadia soil form).

Unit 4: Site M25. Secondary Bushland on historically cultivated sandy clay loam soils.

TAILINGS PIPELINE MAPPING CORRIDOR

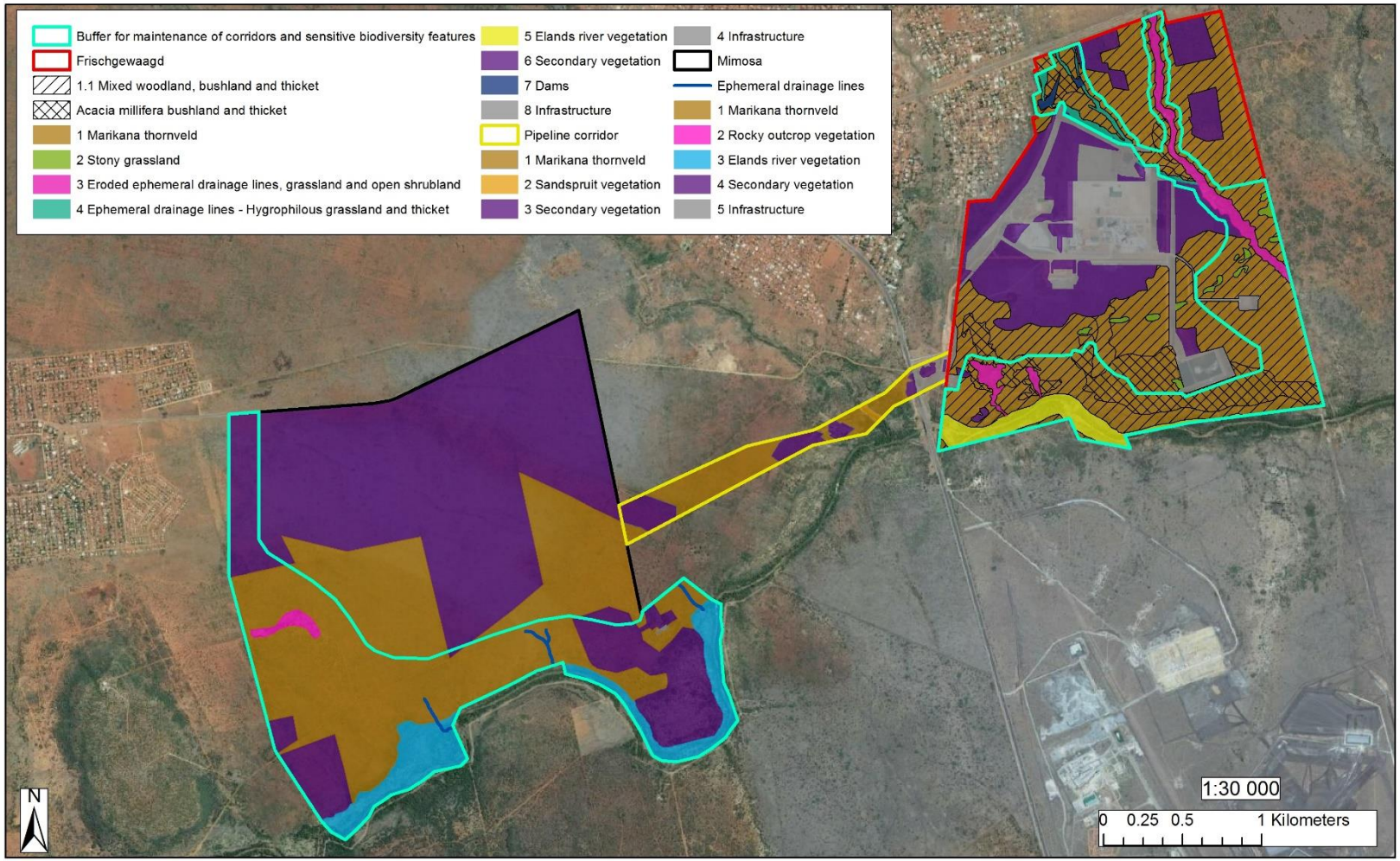
Unit 1: Untransformed Woodland and Thicket to east of Sandspruit along tailings pipeline alignment.

Unit 1: Untransformed but degraded (frequent burning, cutting of trees and overgrazing) Marikana Thornveld along the tailings pipeline alignment to the west of the Sandspruit.

Unit 2: Sandspruit, 40m upstream of the Final tailings pipeline alignment (December 2015).

Unit 3: Secondary *Acacia tortilis* Shrubland on soils last cultivated approximately 15 years ago. Herbaceous layer particularly sparse due to drought conditions and overgrazing.

APPENDIX 12: Map of proposed biological corridors in the Mimosa and Frischgewaagd sections of the study area.



Buffer for maintenance of corridors and sensitive biodiversity features

January 2016
Created by:

DE CASTRO & BRITS
ECOLOGICAL CONSULTANTS

APPENDIX 13: Brief Curriculum Vitae for Antonio De Castro.

1. **Name** **: Antonio (Tony) De Castro**
2. **Specialist field** **:** Botanist and Ecologist
3. **Company / Consortium** **:** De Castro & Brits Ecological Consultants
4. **Nationality** **:** South African
5. **Date of Birth** **:** 17/01/1970
6. **Education**

Name of Institution:	**Degree Obtained:**	**Dates:**
Rand Afrikaans University	BSc Botany and Zoology	1991
Rand Afrikaans University	BSc Hons in Botany	1994

7. **Membership of Professional Associations:**

Name of Association	**Membership Category:**	**Dates:**
SA Council of Natural Scientists	Professional Natural Scientist in Ecological Science and Botanical Science (Registration number: 400270/07)	2007 to present
SA Wetlands Society	Ordinary Member	2014 to present
International Mire Conservation Group	Ordinary Member	2014 to present

8. **Other Training:**

Name of Institution:	**Training Details:**	**Dates:**
University of Pretoria	Certificate in Seed Science	1996

9. **Countries of Work Experience:**

Country	**Dates: from – to**
South Africa	1992 - present
Lesotho	2003, 2005 – 2006, 2011
Swaziland	1999-2006
Mozambique	1996, 2000 - 2005, 2007, 2009, 2010, 2012, 2014, 2015
Botswana	2002
Madagascar	2012
Angola	2009

10. Employment Record

Dates: :	1992 - 1997
Employer:	Rand Afrikaans University (now University of Johannesburg)
Position held:	Part-time Technical Lecturer in the Department of Botany and Research Assistant to Prof. Ben-Erik Van Wyk
Location of Position	Johannesburg
Responsibilities:	Preparation of 3rd Practical Classes. Collection identification and curation of plant material for taxonomic and ethnobotanical research projects. Taxonomic studies in the genus *Alepidea*. Long-term floristic surveys and vegetation sampling in the Zuurberg National Park, Golden Gate National Park and Magaliesburg Protected Natural Environment.
Dates:	1997 - 1999
Employer:	ECOSUN c.c.
Position held:	Senior Botanical and Ecological Consultant.
Location of Position	Johannesburg
Responsibilities:	Responsible for botanical and ecological baseline assessments and Impact Assessments.
Dates:	1999 - present
Employer:	De Castro and Brits Ecological Consultants c.c.
Position held:	Managing Member and Senior Botanical and Ecological Consultant
Location of Position	Johannesburg
Responsibilities:	Botanical and Ecological specialist consultant on projects involving the description of terrestrial, wetland and aquatic ecosystems, the assessment of anthropogenic impacts on these systems and the sustainable utilisation of natural resources. Also coordinating Specialist/Team leader for biophysical aspects of Environmental Impact Assessments, Environmental Management Plans, Strategic Environmental Assessments, Resettlement Plans and Sustainable Utilisation Plans. Specialises in the botany and ecology of the Grassland, Savanna and Forest Biomes.

11. Examples of work undertaken.

Project 1
• Dates (from – to): 2014-2015 • Location: Mozambique. Inhambane Province. Inhassoro District. • Client: Golder Associates on behalf of SASOL Temane (Pty) Ltd. • Main project features: EIA and EMP for the proposed SASOL PSA and LPG development project, comprising the construction of approximately 120km of new hydrocarbon flow lines and 18 new gas and oil wells.

- Positions held: Principal Ecologist and Botanist.
- Activities performed: Ecologist and Botanist responsible for the description of the wetland and terrestrial habitats and botanical biodiversity of the 49 000ha study area, the identification of potential impacts to habitats and biodiversity and the development of suitable mitigation measures for these impacts. De Castro identified a Critical Habitat (*sensu* IFC) during this study.

Project 2

- Dates (from – to): 2010-2011
- Location: Zinave National Park, Inhambane Province, Mozambique.
- Client: EcoAcao Lda on behalf of the Mozambique Government.
- Main project features: Ecological Assessment of a 7000ha area within the Zinave National Park earmarked as a breeding area for threatened ungulates.
- Positions held: Ecologist
- Activities performed: Floristic surveys and, together with Professor Noel Van Rooyen, vegetation sampling and mapping, conduction of a grazing and browsing capacity assessment, recommendation of mammal species suitable for introduction, and development of a Management Plan.

Project 3

- Dates (from – to): 2010
- Location: Anglo Coal Landau Colliery, Mpumalanga, South Africa.
- Client: Anglo American: Technical Services
- Main project features: Baseline Ecological assessment and Biodiversity Management Plan, and ongoing Biodiversity Monitoring for the 11 500ha Landau Colliery.
- Positions held: Lead Consultant, Principal Ecologist.
- Activities performed: Vegetation sampling and mapping, compilation of species inventory, alien plant survey, medicinal plant assessment, co-ordination of biological specialists and compilation of a comprehensive Biodiversity Management Plan.
-

Project 4

- Dates (from – to): 2010
- Location: Lesotho and the North-West, Gauteng, Free State, Mpumalanga, KwaZulu-Natal and Eastern Cape provinces of South Africa.
- Client: South African National Biodiversity Institute.
- Main project features: National Resource Survey for the medicinal plant *Pelargonium sidoides*.
- Positions held: Lead Consultant and Principal Botanist.
- Activities performed: Field surveys aimed at establishing population size and harvesting pressure on *Pelargonium sidoides*. Co-ordination of a team of three botanists, and main author of the resulting 'National Resource Survey' report.

Project 5

- Dates (from – to): 2008 - 2009
- Location: Linear alignment between Durban and Heidelberg, South Africa
- Client: Mark Wood Consultants on behalf of Petronet
- Main project features: Baseline Vegetation and Faunal Assessment and EIA for the 500km Petronet Multi Products Pipeline alignment situated between Durban and Heidelberg.
- Positions held: Ecologist and Principal Threatened Species Biologist.
- Activities performed: Ecologist responsible for vegetation mapping, threatened species surveys and impact assessment and mitigation for the 220km section of the pipeline between Harrismith and Heidelberg. In the second phase of the project was the principal Threatened Species Biologist leading a team of three biologist responsible for follow-up

threatened species surveys and impact mitigation (i.e. route alignment deviations).

Project 6

- Dates (from – to): 2005-2006
- Location: Lesotho highlands. Roma-Semonkong-Sekake Road Construction Project.
- Client: Consult 4 on behalf of the Lesotho Government.
- Main project features: EIA and EMP for road construction project.
- Positions held: Senior Ecologist and EIA.
- Activities performed: Ecologist and Biophysical Specialist Co-ordinator for all biophysical work required for the completion of the EIA and EMP for this 150km long road alignment, including ecological survey (including vegetation and fauna) of the entire road alignment. Author of Biophysical EIA and EMP.

Project 7

- Dates (from – to): 2000 to 2004
- Location: Inhambane Province, Mozambique.
- Client: Mark Wood Consultants on behalf of Sasol (Pty) Ltd.
- Main project features: SASOL Natural Gas Project, comprising gas processing facilities, seismic exploration cutlines and the 520km pipeline route alignment extending from Vilanculos to Ressano Garcia.
- Positions held: Principal Botanist and Ecologist.
- Activities performed: Ecological surveys (including vegetation mapping, floristics and fauna) of 300 000ha Seismic Exploration Block, Temane Central Processing Facility and 520km pipeline route alignment. Specialist surveys conducted include a survey of available commercial timber resources and the sustainable management of these resources.

Project 8

- Dates (from – to): 1999 - 2006
- Location: Maguga Dam, Swaziland
- Client: Maguga Dam Development network
- Main project features: Task MDC-7. Scoping Report, EIA and CMP Reports and Recommendation of Monitoring Programme. Implementation of EMP's for the Reservoir area and the Resettlement area for displaced people.
- Positions held: Senior Botanist, Co-ordinator of all biological specialist, Biophysical EIA Co-ordinator and author.
- Activities performed: All Ecological aspects of the Review of Task MDC-6, all Botanical studies required for the completion of the environmental studies (including a Scoping Report, EIA & CMP Reports and Recommendation of Monitoring Programme). Supervision and Monitoring of implementation of EMP's for the Reservoir area and the Resettlement area for displaced people. Co-ordination of all biological specialists and writing of EMP, CMP and Monitoring Plans for Reservoir and Host Area. Botanical surveys included vegetation mapping, floristic surveys, threatened and medicinal plant surveys, and wood resources surveys, as well as monitoring of all these aspects.

12. Certification:

I, the undersigned certify that to the best of my knowledge and belief, this CV correctly describes myself, my qualifications, and my experience.

Signature: **Date:** February, 2016

APPENDIX 14: Specialist Declaration.

I, Antonio D. P. De Castro, declare that I –

- act as an independent specialist consultant in the fields of soil science;
- do not have and will not have any financial interest in the undertaking of the activity, other than remuneration for work performed in terms of the Environmental Impact Assessment Regulations, 2014;
- have and will not have any vested interest in the proposed activity proceeding;
- have no, and will not engage in, conflicting interests in the undertaking of the activity;
- undertake to disclose, to the competent authority, any material information that have or may have the potential to influence the decision of the competent authority or the objectivity of any report; and
- will provide the competent authority with access to all information at my disposal regarding the application, whether such information is favourable to the applicant or not.

Antonio D.P. De Castro

APPENDIX 15: Correspondence with Mr R. Schaller (NW Province READ Department)

EMAIL received from Ray Schaller of North West Province READ Department on the 4th February 2016

Hi Tony

The link to the GIS data is
https://www.dropbox.com/sh/gf7y1d0th9a4qne/AABqTjTUnOqKOtSodEahzqAra?dl=0

If it is too large let me know and I will post a DVD off to you. I unfortunately cannot access Dropbox at work. The technical report is still a draft. I am rerunning the Land cover change analysis and will incorporate into report in the next week or so.

Please do not distribute this copy of technical report. I will check the species info tomorrow am. and get back to you

Regards

Ray

Ray Schaller
Conservation Planner

NW READ
Department Rural, Environment and Agricultural Development
North West Provincial Government
Republic of South Africa

Tel: +27-18-389-5324
Cell: +27-82-375-9934
Email: rschaller@nwpg.gov.za

>>> "Tony de Castro" <mwdcandb@iafrica.com> 02/04/16 10:57 AM >>>
Hi Ray

As discussed earlier I would greatly appreciate it if you could send me the links for the 2015 NWBSP technical document and shapefiles as they not yet available on the SANBI or BGIS sites. If at all possible I would greatly appreciate it if you could send me the information by the end of the week so that I can incorporate it into my report. Many thanks for your assistance.

Kind regards

Tony De Castro

From: Tony de Castro
Sent: Monday, February 1, 2016 11:29 AM
To: Ray Schaller
Subject: Plant species of conservation concern for the grid 2527AC

Hi Ray

I would greatly appreciate it if you could send me your latest records for plant 'species of conservation concern' for the QDS **2527AC**. I have attached the kmz files for the boundaries of the two properties which are owned by the Wesizwe Platinum mine and comprise my study area for the EIA assessment I am currently completing. Point localities for the species situated within or in close proximity to these properties would also be greatly appreciated, if this is possible.

In the 2014 Biodiversity Baseline assessment I completed for the mine property I used the NWBCA 2009 information as your department was then busy finalising the revised NWBCA. Has the revised NWBCA been completed and if so where can I obtain it.

Thanks for your assistance

Kind regards

Tony De Castro

EMAIL received from Ray Schaller of North West Province READ Department on the 8th February 2016

Hi Tony.

This is the Biodiversity Data that we have at the moment.

Regards

Ray

>>> "Tony de Castro" <mwdcandb@iafrica.com> 2/4/2016 10:47 PM >>>
Hi Ray

Thanks so much for your rapid response, and for sending me the draft technical report. Much appreciated!

Cheers

Tony

From: Ray Schaller
Sent: Thursday, February 4, 2016 10:28 PM
To: mwdcandb@iafrica.com
Subject: Re: Fw: Plant specie sof conservation concern for the grid 2527AC

Hi Tony

The link to the GIS data is
https://www.dropbox.com/sh/gf7y1d0th9a4qne/AABqTjTUnOqKOtSodEahzqAra?dl=0

If it is too large let me know and I will post a DVD off to you. I unfortunately cannot access Dropbox at work. The technical report is still a draft. I am rerunning the Land cover change analysis and will incorporate into report in the next week or so.

Please do not distribute this copy of technical report. I will check the species info tomorrow am. and get back to you

Regards

Ray

Ray Schaller
Conservation Planner

NW READ
Department Rural, Environment and Agricultural Development
North West Provincial Government
Republic of South Africa

EMAIL received from Ray Schaller of North West Province READ Department on the 10th February 2016

Hi Tony

I see the lookup table wasn't included on the Data DVD, but it is in the Technical Document. I have attached an Excel Spreadsheet of this table.

With regards the cell values, 2,3,4,5 and 9 you can ignore these. These refer to CBA Map Classes, i.e.
CBA 1 = 2
CBA 2 = 3
ESA 1 = 4
ESA 2= 5
9 = null value (not CBA or ESA). Go to the right of the table and you will see the fields; Min_CBA and CBA_Disp. This reflects the CBA or ESA value for each Biodiversity Feature/ Planning unit

In the same table ignore CBA_T1a, CBA_T2a etc and just look at the fields CBA_T1 and CBA_T2

Thanks for pointing this out. I will update the draft technical report and make ensure SANBI's BGIS has the lookup table uploaded

Kind regards

Ray

Ray Schaller
Conservation Planner

NW READ
Department Rural, Environment and Agricultural Development
North West Provincial Government
Republic of South Africa

Tel: +27-18-389-5324
Cell: +27-82-375-9934
Email: rschaller@nwpg.gov.za