Specialist Report: Vegetation Assessment For The Proposed 2 x 500 kV Power lines From Nzhelele Sub Station (South Africa) To Zimbabwe

Commissioned by

Baagi Environmental Consultancy

Compiled by

EkoInfo CC & Associates

March 2016

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1995 - 2015

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Report Status	Version	File Route
Final	3	C:\Users\Baagi_Enock\Documents\Nzhelele\SPECIALIST REPORTS 18-04-16\EkoInfo CC Nzhelele_Zimbabwe Veg EIAv3_Fin.docx

1 EXECUTIVE SUMMARY

Baagi Environmental Consultancy appointed EkoInfo CC to facilitate the flora assessment concerning the Environmental Impact Assessment (EIA) for a proposed 500 power line, near Musina in the Limpopo Province. Willem de Frey, sole member and principal consultant of EkoInfo CC, completed the flora assessment. Willem de Frey is a registered scientific professional in the fields of ecological – and botanical science with more than 20 years' experience.

The fieldwork was done in May 2014, but due to changes in the corridor alternatives, the report was only finalised during April 2015.

Fifteen plots were surveyed using the Braun-Blanquet approach. Access was the main reason for only 15 of the 25 plots targeted being sampled, is due to the fact that most of the properties are fenced off with game fence and has locks on their gates.

The survey confirmed the presence of two continental and two regional vegetation units as indicated in the regional review. In addition to the presence of the small-scale vegetation units, the vegetation also reflected the change in terrain, which has an influence on the grazing behaviour of the livestock within the landscape.

Although the potential for threatened Red Data plants to occur is high, none was recorded during the survey, however one provincially and four nationally protected trees where recorded. They are: *Adansonia digitata* (Baobab), *Boscia albitrunca* (Shepard Tree), *Combretum imberbe* (Leadwood), *Sclerocarya birrea* (Marula). From the data collected during the survey, it was possible to determine that *Combretum imberbe* occurs localised, while *Boscia albitrunca* occurs widely. It was noted that very few young individuals (0 – 3 m in height) was present within the landscape.

Using terrain ruggedness, the number of water courses transected and Limpopo Provinces Conservation Plan, it was determined that alternative 2, 2B is the least sensitive and alternative 2, 2A the most sensitive from a flora perspective.

During an integration meeting in February 2016, it was determined that alternative 1 (grey corridor) is the preferred alternative, thereby avoiding the floristic most sensitive alignment (Alternative 2, 2B) and not following the floristic least sensitive alignment (Alternative 2,2A). Therefore the impacts of the proposed power line were evaluated in terms of the preferred corridor and a generic flora environmental management plan provided in the absence of detail information regarding the final alignment of the power line within the corridor.

The impact assessment indicated that if the final alignment is aligned to avoid sensitive floristic habitat (ridges and watercourses) and kept in close proximity to existing road infrastructure the impact of the powerline would be moderate in stead of high on the long term.

The generic flora environmental management focus on curtailing indirect impacts related to the construction and operation of the power line.

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2 INTRODUCTION

Baagi Environmental Consultancy (Baagi EC) appointed EkoInfo CC to assist with the vegetation study for the proposed construction of 400 kV power lines from the Nzhelele sub station to the south of Musina (Messina) in Limpopo Province to an unknown substation on the Zimbabwe/South Africa border, north of Musina (

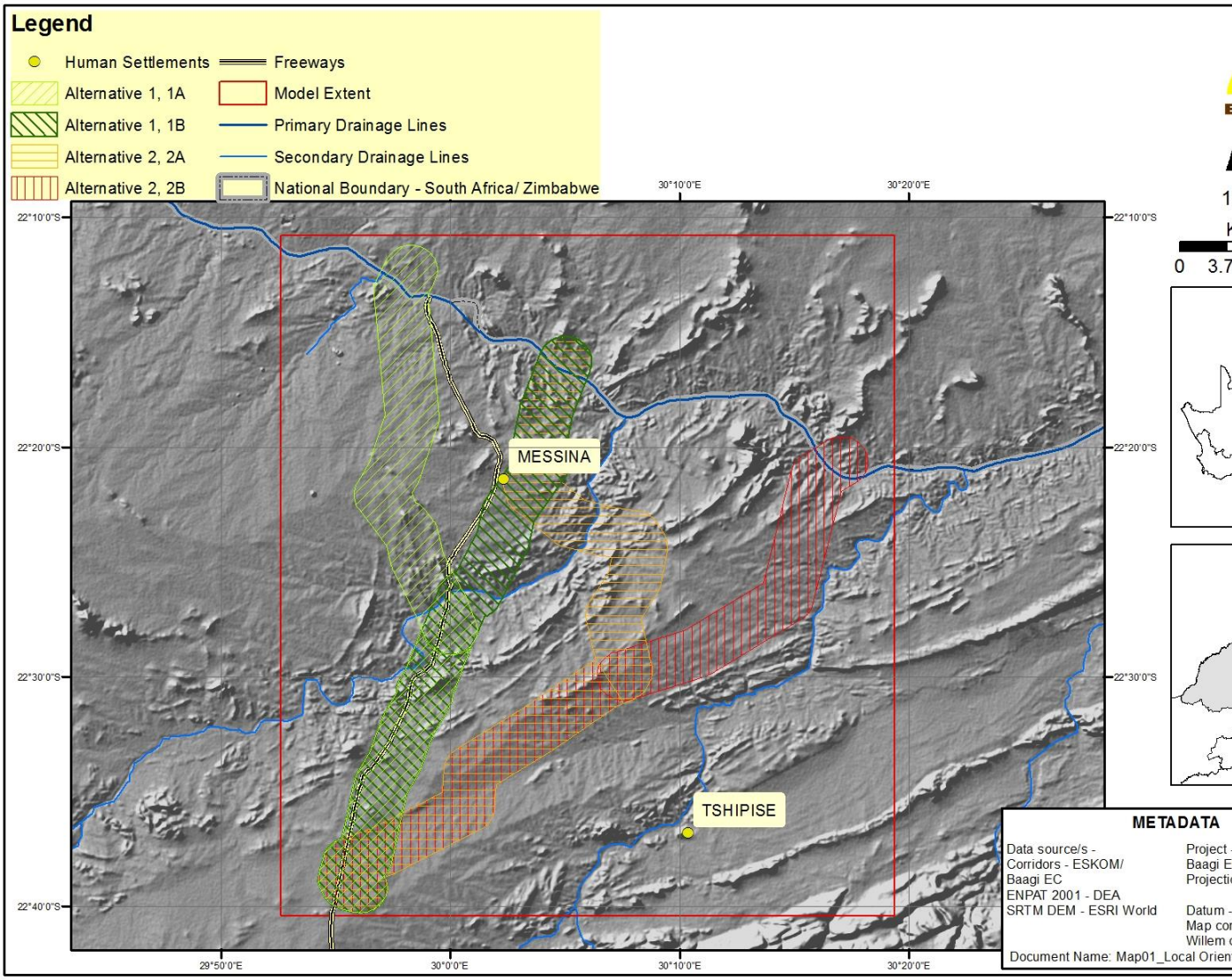

Figure 1).

2.1 Scope of work/ Terms of reference

Scope of work is based on emails received from Baagi EC and EkoInfo CC's experience of more than 20 years of facilitating vegetation studies with regards to Environmental Impact Assessment. In essence the study involves a regional overview of the vegetation communities and a local assessment of the species of concern. The aim of the regional overview is to flag the presence of threatened ecosystems, while the local assessment will flag and evaluate habitat for species of concern within the proposed corridors.

Based on the results of the regional and local assessment, the corridor that has the least impact on the vegetation will be indicated. Expected impacts on vegetation within the preferred corridor will be listed and contributions made to a generic Environmental Management Plan (EMP).

3 METHOD STATEMENT

3.1 Regional Context

The regional context is obtained through a literature – and desktop review process, which involves the following data sources:

1. Scientific – and popular publications
2. Internet searches of government -, academic and research institution websites
    a. Vegetation species information – provincial and topocadastral: http://posa.sanbi.org/searchspp.php
    b. Red Data plants: http://redlist.sanbi.org/?
3. Small scale spatial datasets
    a. Geology – 1: 1 000 000 scale, source – Council for Geoscience
    b. Climate – Weather Stations, source - SA Weather Bureau
    c. Topography - Shuttle Radar Topography Mission digital elevation model (100 x 100 m pixels), source – ESRI World Data/ Glovis[1]
    d. Soil – 1: 250 000 scale, source – Institute for Soil, Climate and Water
    e. Regional vegetation (Vegmap) – 1: 250 000 scale, source - South African National Biodiversity Institute
    f. Land cover – 1: 50 000 scale, source – Department of Environmental Affairs
    g. National biodiversity priority layer – 1: 250 000 scale, source - South African National Biodiversity Institute
    h. Limpopo Conservation Plan – 1: 50 000 scale, source - South African National Biodiversity Institute
    i. Landsat 8 Satellite Imagery – 1: 50 000 scale (25 x 25 m pixels), source – Glovis
    j. Topocadastral maps – 1: 50 000 scale (vector format), source – Surveyor - General

The above datasets were modelled and analysed using the following Geographic Information System software packages: Idrisi Selva, ESRI Arcview 10.1 and SAGA GIS. The main deliverables from the regional contexts are:

1. Flora sensitivity map
2. Least sensitive flora alignment
3. Least sensitive/ most suitable corridor from a floristic perspective

[1] http://glovis.usgs.gov/

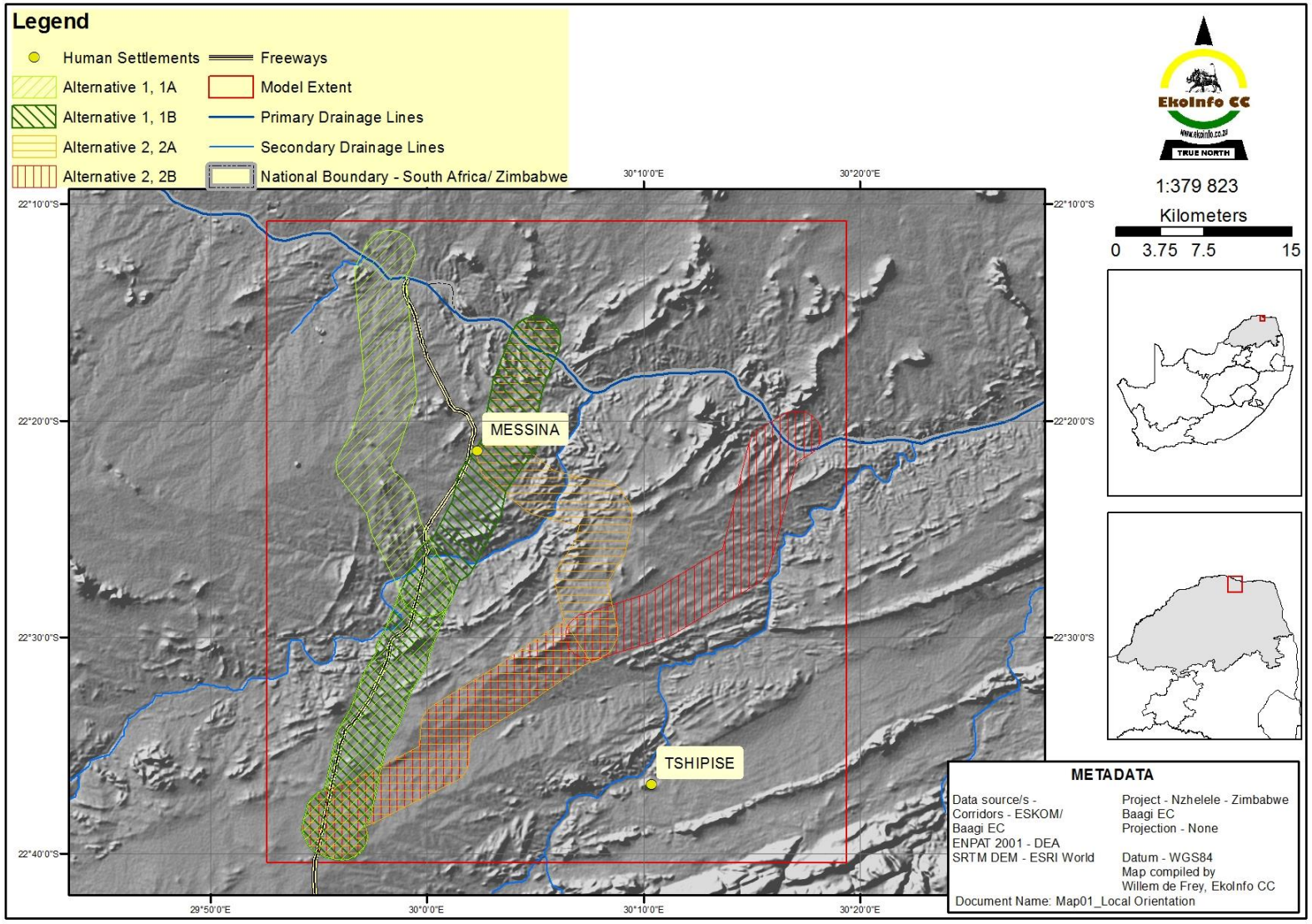

Figure 1: Regional orientation of the proposed power line corridors from Nzhelele substation to the Zimbabwe border, Limpopo South Africa

3.2 Local Context

The aim of the local context survey was to verify and refine the results from the regional context assessment. Fifteen (15) Braun-Blanquet surveys formed the basis of the assessment. These 15 plots were surveyed over a four-day period in May 2014 (Figure 2). In addition seven (7) protected tree plots were surveyed to determine the presence and extent of nationally and provincially protected species.

At the 15 Braun-Blanquet plots the following information was collected:

1. GENERAL INFORMATION
    a. Relevé number
    b. GPS coordinates (Decimal degrees, Datum WGS84)
    c. Date (yy/mm/dd)
    d. Surveyor
    e. Photo no
    f. Photo direction (Bearing)
    g. Notes
2. ENVIRONMENTAL DATA
    a. Altitude (m)
    b. Aspect (Bearing)
    c. Slope (%)
    d. Terrain unit
    e. Local topography
    f. Stratigraphy
    g. Petrology
    h. Lithology
    i. Soil form
    j. Termitaria present
    k. Cover Gravel
    l. Cover Small stones
    m. Cover Medium stones
    n. Cover Large stones
    o. Rock
    p. Soil depth (mm)
    q. Erosion categories
    r. Surface crusting
    s. Estimate % Clay (A - horizon)
    t. Cover open water (%)
    u. Cover bare rock (%)
3. VEGETATION CHARACTERISTICS
    a. Cover total (%)
    b. Cover tree layer (%)
    c. Cover shrub layer (%)
    d. Cover herb layer (%)
    e. Cover grass layer (%)
    f. Cover forbs layer (%)
    g. Height (highest) trees (m)
    h. Height lowest trees (m)
    i. Height (highest) shrubs (m)
    j. Height lowest shrubs (m)
    k. Aver height (high) herbs (cm)
    l. Aver height lowest herbs (cm)
    m. Maximum height herbs (cm)

A list of all species within an approximate 200m^2 area was recorded in the following growth form categories: grasses, forbs and woody species (shrubs and trees). Cover abundance values was estimated for each species within the sample plot. Unknown species or potential red data species was identified using field guides (Van Oudtshoorn 1991, Van Wyk & Malan 1988, Van Rooyen 2001, Van der Walt 2009), the University of Pretoria's herbarium and specialists from the National Botanical Institute.

A single team consisting of a professionally registered scientist in the fields of ecological – and botanical science and a field assistant facilitated the fieldwork.

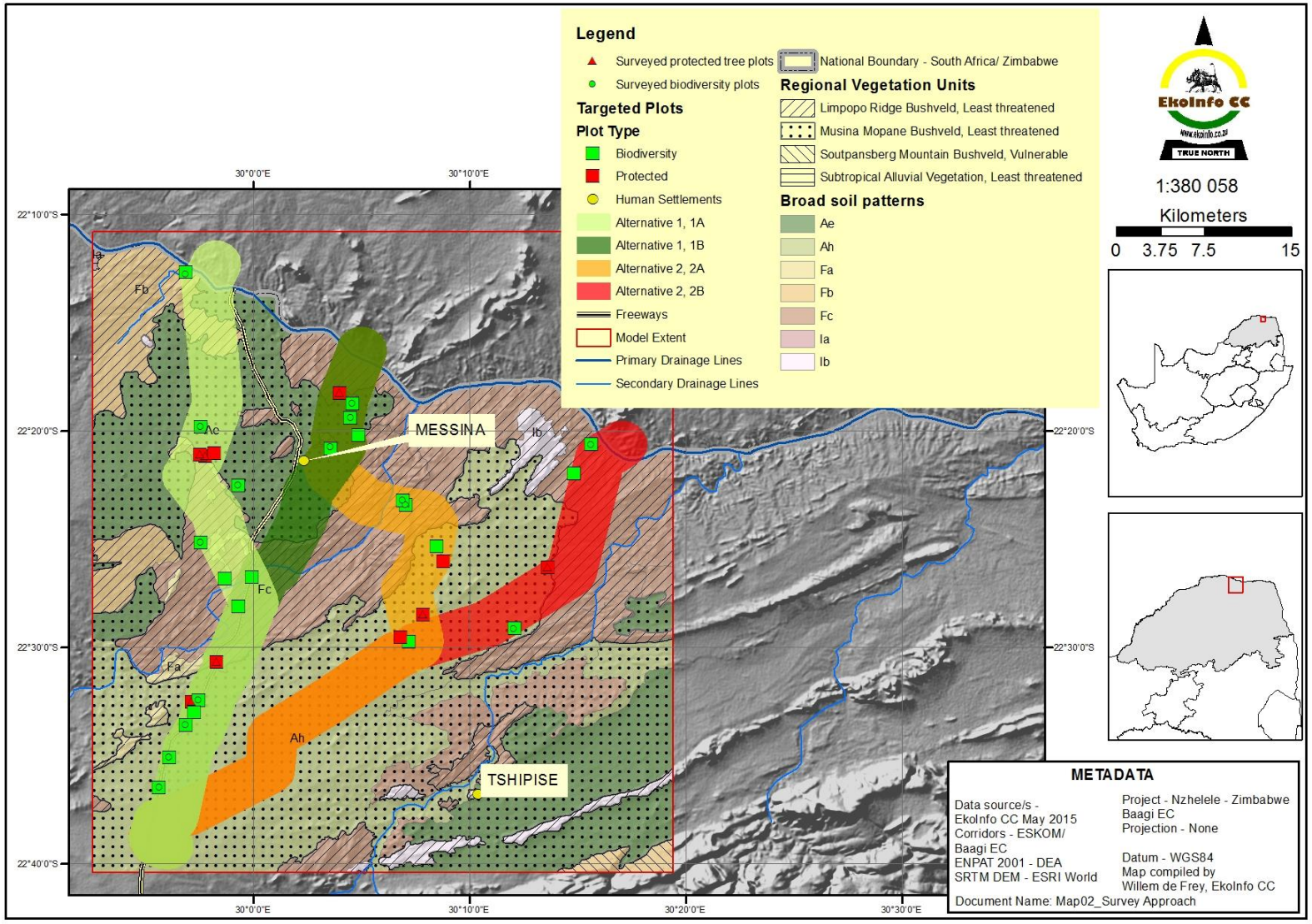

Figure 2: Overview of the distribution of the targeted and surveyed biodiversity and protected vegetation plots across the proposed corridor alternatives

The survey results were entered into a relational database for record purposes and analysis of the abiotic and vegetation characteristics. The species data was entered into TURBOVEG (Hennekens 1996) and analysed with Juice[2]. A vegetation map was compiled and refined, based on the results of the phytosociological table and boundaries of the homogenous units.

This approach follows the guidelines recommended for phytosociological studies on a national level with regards to the classification and description of vegetation in southern Africa (Brown *et al.* 2013).

The protected species plots focused on the protected trees and made use of variable plot sizes at the same location, all nationally and provincially protected trees present within a 25 x 25 m and 50 x 50 m area was recorded. The individuals present were recorded within the following height classes:

1. 0 – 3 m
2. 3 – 6 m
3. 6 m >

If none or less than five individuals of a protected species is recorded within the 25 x 25 m area (625 m^2), then the survey is expanded into the next area (50 x 50 m = 2500 m^2) up to a maximum of 10 individuals per protected species. The collected data was extrapolated to number of individuals per height class per hectare and number of individuals overall per species per hectare (10 000 m^2).

The above information was used to refine the flora sensitivity model and guide the least environmental corridor assessment.

3.3 Limitations And Assumptions

1. It is assumed that all the information from third parties (government -, academic – and research institutions) is accurate.
2. Due to the presence of game fences and locked gates access was limited resulting in less plots sampled that originally targeted.
3. Due to the width of the corridor alternatives at 4 km each, the assessment is approached from a strategic perspective, as it was not practically possible to assess the whole area in detail within the available time and budget.
4. The main aim of the actual surveys was to assess the presence of ecological trends related to species of concern.

4 STUDY AREA

4.1 Alternative Corridors

The corridors concern actually two alternatives with two deviations each (Figure 1), namely:

1. Corridor 1 with deviations:
    a. 1A
    b. 1B
2. Corridor 2 with deviations:
    a. 2A
    b. 2B

Table 1 provides an overview of the two alternatives and their associated deviations in terms of surface area and distance, from this information it is evident that alternative 1, 1B is the shortest at 50 km, and alternative 2, 2A is the longest at 64 km. As would be expected the longest corridor at a width of 4 km covers the largest extent 25 510 ha (Table 1).

It should however be realised that each section of an alternative cannot be assessed in isolation, and therefore each alternative with its associated deviation will be assessed as single entity, which implies that there is effectively four corridor alternatives to be assessed.

[2] http://www.sci.muni.cz/botany/juice/

Table 1: Overview of the surface area and distance associated with each alternative and associated deviation

Alternative	Surface Area (Ha)	Units (m)			Length (km)
		Area	Length	Width	
1, 1A	22 855	228 545 036	57 136	4 000	57
1, 1B	20 133	201 325 538	50 331	4 000	50
2, 2A	25 510	255 098 516	63 775	4 000	64
2, 2B	23 442	234 423 075	58 606	4 000	59

4.2 Environmental Overview

The scoping document concerning the ecology of the project (Niemand 2014), highlighted the importance of the geology on influencing the distribution of vegetation, and evaluated the various corridors in terms of the regional vegetation units which these corridors transects. The scoping document also provides information on the land cover (human influences) associated with these corridors, as well as the distribution of protected areas (conservation priority areas) and therefore will not be repeated in this document. Table 2 however does provide an overview of the ecological drivers that influence the distribution of vegetation on a regional and a local scale within the model extent area (Figure 1), as well as the areas of conservation priority in the area.

Table 2: Overview of the ecological drivers and conservation priority areas that influence vegetation distribution on a regional and local scale

Ecological Drivers & Conservation Significance	Model Extent – 251 512 ha
Geology – 1: 1 000 000 scale	Gneiss, Quartzite, Pelite (26%)
Climate Zone – 1: 1 000 000 and smaller	Northern Transvaal; Hot Steppe with Summer rainfall; (BShw mainly) (100%)
Rainfall – Quaternary catchments	Range: 288 – 621 mm, mode: 305 mm & 333 mm (90%)
Altitude range	387 – 909 metre above mean sea level, mean – 548 m.a.m.s.l
Soil pattern – 1: 250 000 scale (Figure 2)	Ah (33%) – red and yellow, well drained soils with high base status
Regional vegetation – 1: 250 000 scale (Figure 2)	Musina Mopane Bushveld, Least threatened – 62%
Land Cover 2000 Cover (Human influences)	Thicket, Bushland, Bush Clumps, High Fynbos – 47%
National Biodiversity Priority Areas (Figure 3)	High – Legally protected areas > 40%, mode: high biodiversity – 27%
Limpopo Province Conservation Priority Areas – Version 2, 2013 (Figure 4)	Conservation Priority Areas Cover – 65%, mode: Critical Biodiversity Area 2 – 26%

From the overview in Table 2, it is evident that the landscape associated with the alternative corridors are diverse, with low human influence (Table 3) and large areas of conservation priority on both national (Table 4) and provincial level (Table 5).

Therefore it would be difficult for the proposed corridor alternatives to avoid areas of conservation concern.

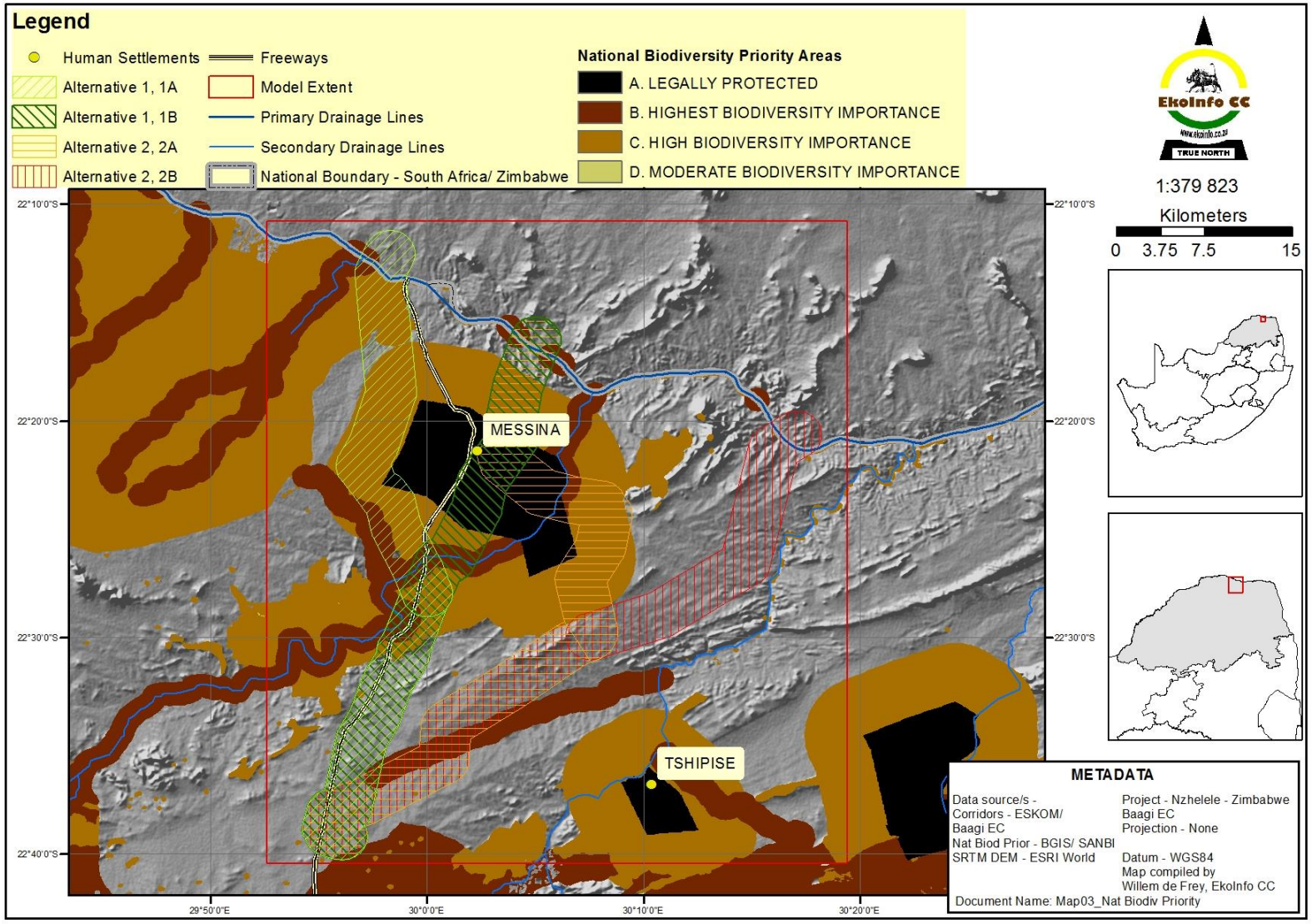

Figure 3: Overview of the distribution and extent of national biodiversity priority areas within the landscape associated with the alternative corridors

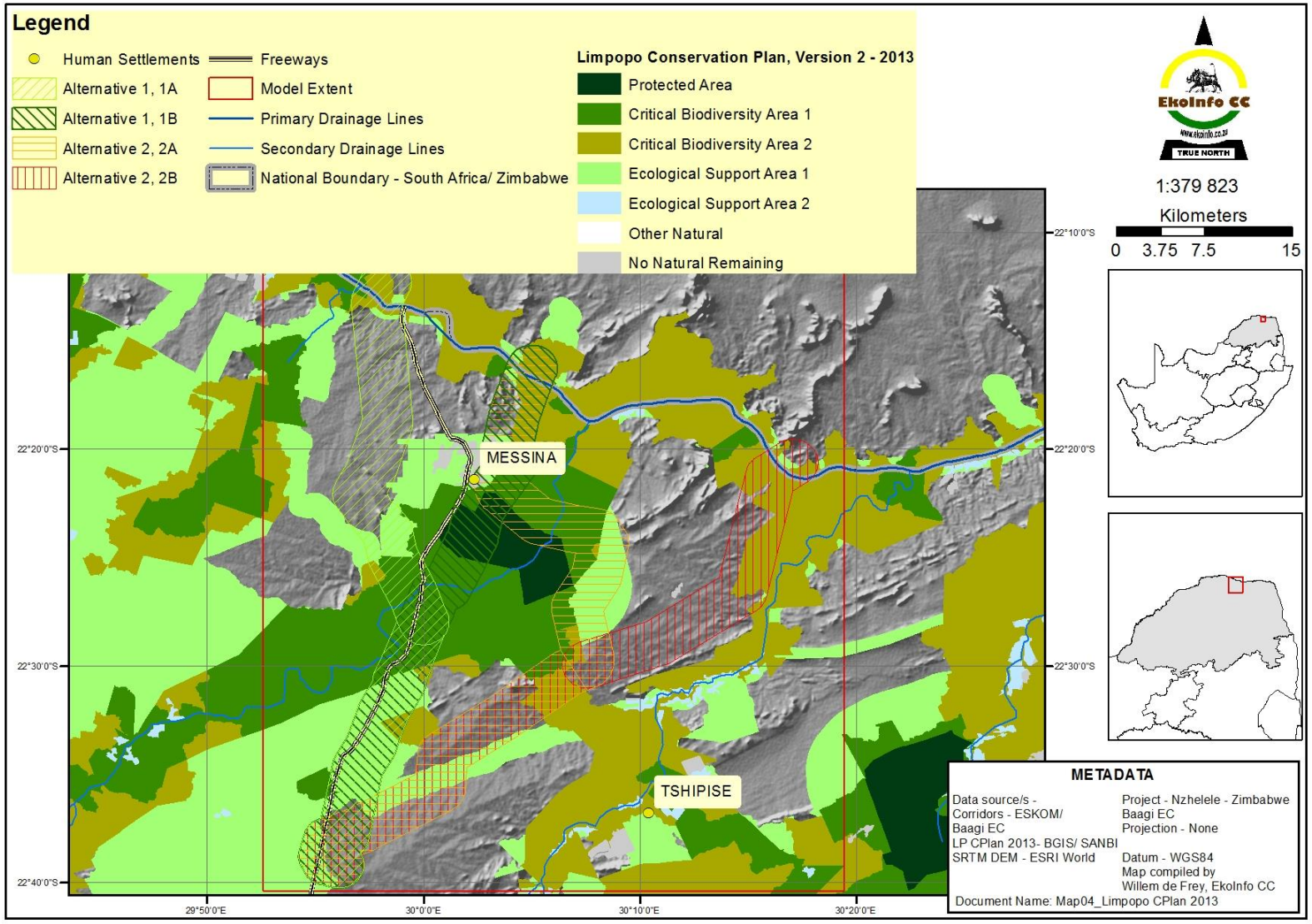

Figure 4: Overview of the distribution and extent of the provincial conservation priority areas within the landscape associated with the alternative corridors

Table 3: Overview of the land cover 2000 categories present within the landscape (model extent) associated with the alternative corridors

Land Cover 2000 categories	Surface Area (ha)	% Cover	Ecological Status	
			Natural	Transformed
Bare Rock and Soil (natural)	1 651	1%	1 651	
Cultivated, permanent, commercial, irrigated	2 086	1%		2 086
Cultivated, temporary, commercial, dryland	536	0%		536
Cultivated, temporary, commercial, irrigated	530	0%		530
Cultivated, temporary, subsistence, dryland	10 807	4%		10 807
Degraded Forest & Woodland	1 486	1%	1 486	
Degraded Thicket, Bushland, etc	1 961	1%	1 961	
Forest (indigenous)	1	0%	1	
Mines & Quarries (surface-based mining)	150	0%	150	
Thicket, Bushland, Bush Clumps, High Fynbos	113 878	47%	113 878	
Urban / Built-up (residential)	123	0%		123
Urban / Built-up (residential, formal suburbs)	424	0%		424
Urban / Built-up (residential, formal township)	1 156	0%		1 156
Urban / Built-up (residential, informal township)	17	0%		17
Urban / Built-up (rural cluster)	5	0%		5
Urban / Built-up, (commercial, mercantile)	47	0%		47
Urban / Built-up, (industrial / transport : light)	40	0%		40
Waterbodies	1 018	0%	1 018	
Wetlands	15	0%	15	
Woodland (previously termed Forest and Woodland)	108 835	44%	108 835	
TOTALS	**244 768**	**100%**	**228 996**	**15 772**
			94%	6%

Table 4: Overview of the national biodiversity priority categories present within the landscape (model extent) associated with the alternative corridors

National Biodiversity Priority Category	Surface area (ha)	% cover of model extent (251 512 ha)
A. Legally Protected	14 573	6%
B. Highest Biodiversity Importance	28 766	11%
C. High Biodiversity Importance	67 348	27%
D. Moderate Biodiversity Importance	1	0%
		44%

Table 5: Overview of the provincial conservation categories present within the landscape (model extent) associated with the alternative corridors

Limpopo Conservation Plan Categories	Hectares	% Cover	Conservation Priority	No/ limited Conservation Priority
Critical Biodiversity Area 1	38 918	18%	38 918	
Critical Biodiversity Area 2	56 620	26%	56 620	
Ecological Support Area 1	40 386	18%	40 386	
Ecological Support Area 2	1 768	1%	1 768	
No Natural Remaining	1 800	1%		1 800
Other Natural Area	76 687	35%		76 687
Protected Area	4 980	2%	4 980	
TOTALS	**221 159**	**100%**	**142 672**	**78 487**
			65%	35%

5 RESULTS

The results aim to evaluate the two aspects indicated in the National Environmental Management Biodiversity Act (No 10 of 2004), namely: ecosystem and species on both a regional (model extent) level and local level (within the alternative corridors) (Figure 1).

5.1 Regional Context

The regional context is defined by the model extent, which represents the landscape associated with the proposed alternative corridors. It covers an area of 251 512 ha (Table 2), which represents 25 times the minimum extent (10 000 ha) for an area to be evaluated on a landscape level (Turner *et al.* 2001, Wiens *et al.* 2006).

5.1.1 Ecosystem Diversity

Due the nature of the project, which involves power distribution across international boundaries, the ecosystem diversity is presented from both a global/ continental and national perspective.

5.1.1.1 Global/ Continental Perspective

From Figure 5, it can be observed that two global ecoregions (are associated with the area which the alternative corridors transect namely:

1. Southern Africa bushveld
2. Zambezian and Mopane woodlands
3. Drakensberg montane grasslands, woodlands and forests

The Southern Africa bushveld covers the largest portion, mainly to the south, while the Zambezian and Mopane woodlands covers the northern section and stretches in to Zimbabwe.

The Southern Africa bushveld[3] is described and summarised as follows:

> "The Southern African Bushveld is part of the vast savannas that cover much of southern Africa. There is little in the way of endemic flora or fauna, but the charismatic large mammals and rich bird life typical of African savannas are present. The rugged Waterberg Mountains contain the highest levels of species richness and endemism in the region, and are noted for their reptile endemism. Cattle ranching and urban expansion from the nearby Pretoria-Witwatersrand-Vereeniging complex are the major threats to the conservation of this ecoregion. However, ecotourism has become a major land-use activity in the bushveld and has led to the establishment of many small nature reserves and private game parks in the area, which enhance the conservation status of this ecoregion."
>
> This ecoregion is classified as Vulnerable.
>
> "Types and Severity of Threats
>
> The major land-use activities in the northern Province of South Africa are game and cattle farming. Game farming preserves the natural habitat whereas cattle farming can lead to its degradation. Cattle directly degrade the habitat by grazing and trampling plants and by exposing and compacting the soil, leading to soil erosion. Cattle can also lead to bush encroachment by reducing grass cover and subsequent fire frequency. These processes lead to reduced biodiversity within the area. The predatory and scavenging fauna of the bushveld are perceived as pests by farmers and routinely exterminated. Blackbacked jackals (*Canis mesomelas*), caracals (*Felis caracal*), and vulnerable Cape vultures (*Gyps coprotheres*) (Hilton-Taylor 2000) are common target species. Poisoned carcasses are a popular method of killing these species. Non-target species such as bat-eared foxes (*Otocyon megalotis*), aardwolves (*Proteles cristarus*), and aardvarks (*Orycteropus afer*) are often also killed….

[3] https://www.worldwildlife.org/ecoregions/at0717

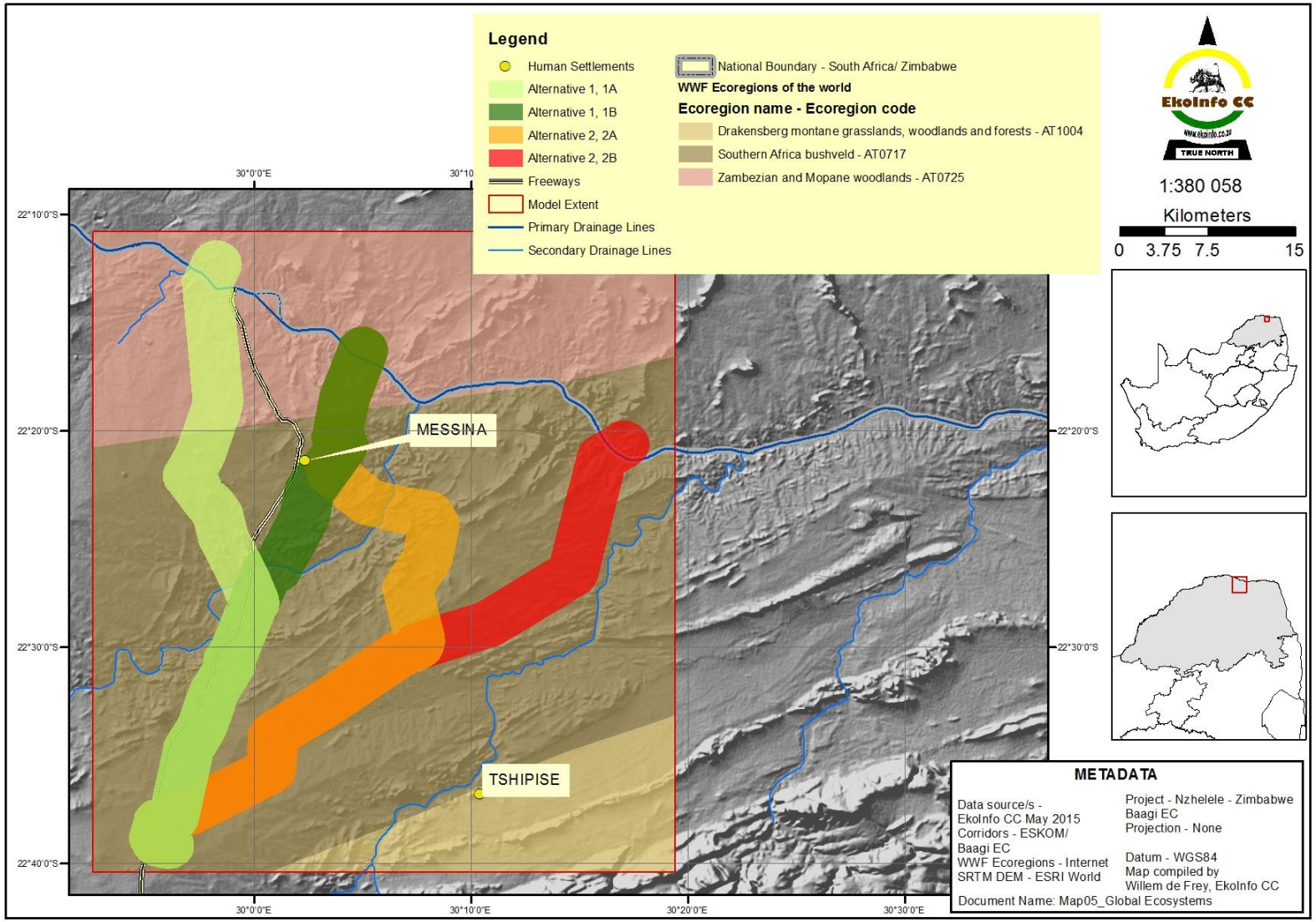

Figure 5: Overview of the global WWF ecoregion units present within the landscape associated with the alternative corridors

Table 6: Overview of the global WWF ecoregions associated with landscape in which the alternative corridors occur

WWF Ecoregions	Surface Area (ha)	% Cover
Drakensberg montane grasslands, woodlands and forests	22 034	9%
Southern Africa bushveld	160 893	64%
Zambezian and Mopane woodlands	68 552	27%
Grand Total	**251 479**	**100%**

There are fewer threats to the north of the ecoregion in Botswana and Zimbabwe, where low-intensity goat and cattle farming create the major impact. The removal of dead wood for firewood may also negatively impact obligate tree-hole nesting birds and small mammals (du Plessis 1995). In large areas of Botswana and Zimbabwe, wildlife contributes significantly to the local economy. Wildlife utilization was originally mostly licensed trophy hunting, but is now increasingly oriented toward non-consumptive recreation and tourism. This trend should improve the conservation status in the north of the ecoregion…"

The Zambezian and Mopane woodlands[4] is described and summarised as follows:

"Zambezian and Mopane Woodlands are dispersed throughout southern Africa, bounded by the Luangwa River in the north and the Pongola River in the south. Mopane tree (*Colophospermum mopane*) woodlands mix with Zambezian woodlands in lower-elevation areas, often along major river valleys. Although the ecoregion, particularly the mopane communities, is considered to be poor in endemics, it supports some of the largest and most significant wildlife populations in Africa, particularly those of the endangered elephant (*Loxodonta africana*) and critically endangered black rhino (*Diceros bicornis*). Important populations of predators are also found in the Zambezian and Mopane Woodlands. The abundance of wildlife can be largely attributed to the high level of protection in the ecoregion, in which more than 45 percent of the habitat is devoted to various forms of state and private conservation. Two cross-border conservation efforts are set to further increase the extent of protected lands in the near future."

This ecoregion is classified as Relatively Stable/Intact.

"Types and Severity of Threats

The most widespread threat to the ecoregion is poaching and exploitation of wildlife (Stuart et al. 1990). Black rhino and wild dog are species of special concern. Black rhinos are still threatened by demands for rhino horn products and wild dogs are often destroyed by livestock farmers, who perceive them as pests (Stuart et al. 1990). In many areas of the ecoregion, poaching is rife due to poor levels of protection provided by understaffed local authorities, particularly in Zambia and Mozambique (IUCN 1992). However, great efforts have been made in the past few years to rejuvenate and expand many of Mozambique's protected areas (The Peace Parks Foundation 2000a), so an improvement in the quality of wildlife protection is likely.

Land transformation and degradation through agriculture, settlement and livestock grazing poses some threat to the ecoregion, particularly in South Africa and Swaziland, where population densities are as high as 174 persons per km^2 (Els 1996) and large-scale agricultural plans have been introduced (Stalmans and Peel, 1999). In the near future, steadily growing populations (particularly those bordering Kruger National Park) could force the South African government to cede portions of the park and other protected areas to communities demanding space and resources (Els and Bothma 2000). The Zambezi Valley portion of the ecoregion in Mozambique may also be at risk from the steady influx of people and development as stability returns following the civil war. The cattle industry in Botswana threatens wildlife populations, as ranching activities supplant indigenous ungulates, destroy predators, and cattle and veterinary fences impede the movements of migratory mammals (Stuart et al. 1990). Illegal livestock grazing, settlement in protected areas, and uncontrolled bush fires are all threats to the ecoregion in Zambia (IUCN 1992), as well as the overuse of natural resources exacerbated by a declining economy (NESDA 2000). Another concern is the potential habitat destruction caused by uncontrolled elephant populations in some parts of the ecoregion, particularly in Botswana and Zambia (Stuart et al. 1990, IUCN 1992). Culling and translocations are used to regulate elephant populations within protected areas and research into immunocontraception has also been undertaken.

Invasive alien plants are posing an increasing threat to the ecoregion. Current data from the southeastern portion of the ecoregion show that alien plants cover 0.1 to 5 percent of the entire ecoregion in South Africa and Swaziland, with alien cover exceeding more than 20 percent in places (CSIR, undated). Among the more prolific invaders are the shrub and tree species *Lantana camara* and *Melia azederach*, cactii of the genus *Opuntia*, and the water weeds *Salvinia molesta* and *Eichornia crassipes*. Invasive plants are supplanting indigenous vegetation and

[4] https://www.worldwildlife.org/ecoregions/at0725

destroying faunal habitats, as well as altering hydrological and nutrient cycles (CSIR, undated; IUCN 1997/1998).

The most immediate threat to the ecoregion is the present land invasion crisis in Zimbabwe, in which a large percentage of private farms have been occupied since the beginning of 2000. Zimbabwe's private conservation industry has been particularly affected, notably the large Save Valley and Chiredzi Conservancies in southeastern Zimbabwe near Gonarezhou National Park (Sharman 2000). The land invasions have coincided with a sharp increase in poaching, which have already caused huge losses to wildlife, as well as the application of slash-and-burn farming methods to areas unsuitable for agriculture, particularly in the mopane woodlands and scrub woodlands (Sharman 2000). Community conservation initiatives, such as the CAMPFIRE program, are also reported to have collapsed in the areas where land invasions have occurred (Sharman 2000)."

The Drakensberg montane grassland, woodlands and forest ecoregion is excluded from the discussion as it is located toward the southeast and unlikely to be influenced by the proposed activity.

On a continental scale, a standardised terrestrial ecosystems[5] map of Africa was compiled (Figure 6), of which eight units occur within the landscape associated with the alternative corridors, namely:

1. Zambesian Cryptosepalum Dry Forest
2. Southern African Scarp Forest
3. Limpopo Mopane
4. Zambezi Mopane
5. Wet Miombo
6. Dry Miombo
7. Sub-Escarpment Grassland
8. Lowveld-Limpopo Salt Pan

Of the eight units, the most dominant/ prominent units are the Limpopo Mopane and Zambezi Mopane (Table 7), which cover 82% and 14% respectively of the area.

The Limpopo Mopane unit is described as follows:

"This macrogroup is formed by the savanna communities occurring in the Limpopo province of South Africa and neighboring Zimbabwe, between 300 and 800 m elevation, on undulating to hilly plains with a variety of soils from deep clayey to deep sandy to shallow skeletal types of soils. The mean annual rainfall ranges from 300-550 mm and is strongly seasonal (summer). The vegetation varies from woodland to shrubland to more open savanna. Commonly the dominant species is *Colophospermum mopane*, but other dominants are *Combretum apiculatum*, *Terminalia prunioides*, *Terminalia sericea*, *Grewia flava*, *Acacia tortilis* ssp. *heteracantha*, *Acacia senegal* ssp. *leiorhachis*, *Acacia nigrescens*, *Adansonia digitata*, and *Sclerocarya birrea* ssp. *caffra*."

The Zambezi Mopane unit is described as follows:

"This type groups mopane-dominated and other open dry types of savanna occurring in the lowlands of southern Eastern Africa, south of the Central African Plateau. The altitudinal range is from 200 to 800 m and the mean annual precipitation is from 400-800 mm with few drier or wetter exceptions; the predominant rainfall regime is that of summer rainfall. The vegetation structure of the communities varies according to the soil types and the moisture availability, with dense and tall woodland types on alluvial soils to stunted shrublands on alkaline soils, and all the grades in between. Dominant species besides the mopane are *Albizia* spp., *Combretum* spp., *Adansonia digitata*, *Diospyros mespiliformis*, *Ficus sycomorus*, *Kigelia africana*, *Lonchocarpus capassa*, *Trichilia emetica*, *Xanthocercis zambesiaca*, and *Xeroderris stuhlmannii* in the north, and further south are *Acacia gerrardii*, *Acacia nigrescens*, *Acacia nilotica*, *Combretum apiculatum*, *Combretum collinum*, *Dichrostachys cinerea*, *Kirkia acuminata*, *Peltophorum africanum*, *Piliostigma thonningii*, *Sclerocarya birrea*, and *Terminalia sericea*."

[5] http://www.aag.org/cs/africaecosystems

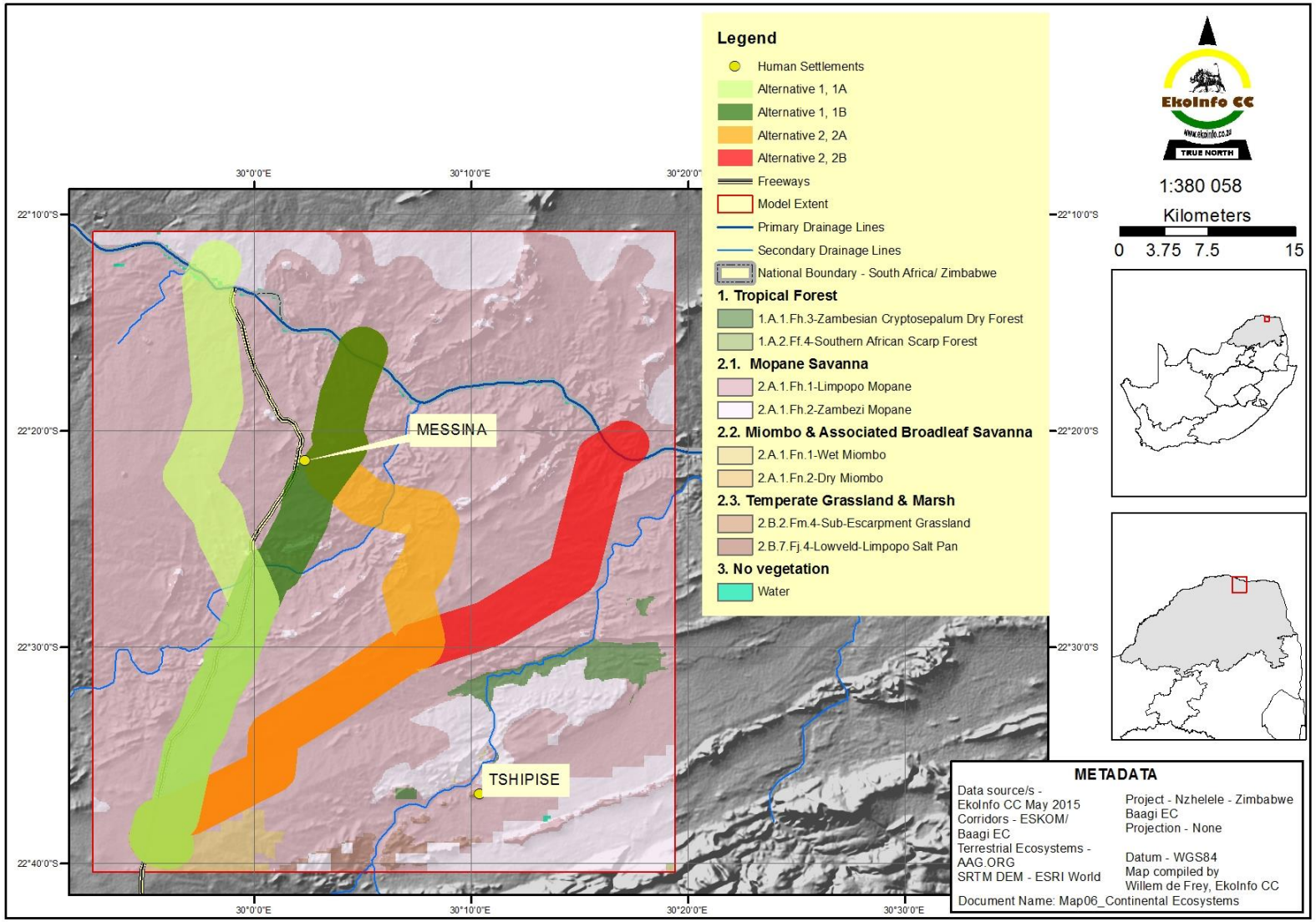

Figure 6: Overview of the standardized continental terrestrial ecosystems present within the landscape associated with the alternative corridors

Table 7: Overview of the hierarchical classification of the standardized continental terrestrial ecosystems present within the landscape associated with the alternative corridors and their extent (percentage cover)

Row Labels	Surface Area (ha)	% of total area
1 Forest to Open Woodland	**3 743**	**1.5%**
1.A Tropical Forest	3 743	1.5%
1.A.1 Tropical Seasonally Dry Forest	3 709	1.5%
1.A.1.Fh Southern African Dry Tropical Forest	3 709	1.5%
Zambesian Cryptosepalum Dry Forest	3 709	1.5%
1.A.2 Tropical Lowland Humid Forest	34	0.0%
1.A.2.Ff Eastern & Southern African Lowland Evergreen & Semi-Evergreen Forest	34	0.0%
Southern African Scarp Forest	34	0.0%
2 Shrubland & Grassland	**245 633**	**98.5%**
2.A Tropical Grassland, Savanna & Shrubland	243 740	97.7%
2.A.1 Tropical Lowland Grassland, Savanna & Shrubland	243 740	97.7%
2.A.1.Fh Mopane Savanna	240 239	96.3%
Limpopo Mopane	205 543	82.4%
Zambezi Mopane	34 696	13.9%
2.A.1.Fn Miombo & Associated Broadleaf Savanna	3 501	1.4%
Dry Miombo	3 471	1.4%
Wet Miombo	31	0.0%
2.B Temperate & Boreal Grassland & Shrubland	**1 893**	**0.8%**
2.B.2 Temperate Grassland, Meadow & Shrubland	10	0.0%
2.B.2.Fm Southern African Montane Grassland	10	0.0%
Sub-Escarpment Grassland	10	0.0%
2.B.7 Salt Marsh	1 882	0.8%
2.B.7.Fj Southern African Salt Pan	1 882	0.8%
Lowveld-Limpopo Salt Pan	1 882	0.8%
Grand Total	**249 376**	

5.1.1.2 National Perspective

On a national scale, four regional units are present within the landscape associated with the alternative corridors (Figure 2), they are:

1. Limpopo Ridge Bushveld
2. Musina Mopane Bushveld
3. Soutpansberg Mountain Bushveld
4. Subtropical Alluvial Vegetation

These four regional vegetation units belong to two biomes, of which the most prominent is the Savanna Biome, which covers 99% (Table 8), of the three Savanna regional vegetation units, the Musina Mopane Bushveld covers 62% and the Limpopo Ridge Bushveld covers 37%. Both these two regional vegetation units' conservation status is least threatened. The only threatened regional vegetation unit is the Soutpansberg Mountain Bushveld, which is classified as Vulnerable and occurs in the southeastern corner, and therefore will not be influenced by the proposed corridor alternatives.

The Musina Mopane Bushveld is described as follows (Mucina & Rutherford 2006):

"Vegetation and landscape features

Undulating to very irregular plains, with some hills. In the western section, open woodland to moderately closed shrubveld dominated by *Colophosperumum mopane* on clayey bottomlands and *Combretum apiculatum* on hills. In the eastern section on basalt, moderately closed to open shrubveld is dominated by *Colophospermum mopane* and *Terminalia prunoides*. On areas with deep sandy soils, moderately open savannah dominated by *Colophospermum mopane*, *T. sericea*, *Grewia flava* and *Combretum apiculatum*. Field layer well developed (especially on the basalt), open during the dry season, the herbaceous layer is poorly developed in areas with dense cover of *Colophospermum mopane* shrubs, for example, north of Alldays bordering the Limpopo floodplain."

The following species were recorded as important taxa within this unit:
Acacia nigrescens, Acacia senegal var. leiorhachis, Acacia tortilis subsp. heteracantha, Acalypha indica var. indica, Acrotome inflata, Adansonia digitata, Aptosimum lineare var. lineare, Aristida adscensionis, Aristida congesta subsp. congesta, Barleria senensis, Becium filamentosum, Boscia albitrunca, Boscia foetida subsp. rehmanniana, Bothriochloa insculpta, Brachiaria deflexa, Cenchrus ciliaris, Colophospermum mopane, Combretum apiculatum subsp. apiculatum, Commiphora glandulosa, Commiphora pyracanthoides, Commiphora tenuipetiolata, Commiphora viminea, Dicoma tomentosa, Digitaria eriantha, Enneapogon cenchroides, Eragrostis lehmanniana var. lehmanniana, Eragrostis pallens, Felicia clavipilosa subsp. transvaalensis, Fingerhuthia africana, Gardenia volkensii subsp. volkensii var. volkensii, Gossypium herbaceum subsp. africanum, Grewia bicolor var. bicolor, Grewia flava, Harpagophytum procumbens subsp. transvaalense, Heliotropium steudneri, Hermannia glanduligera, Hermbstaedtia odorata var. odorata, Heteropogon contortus, Hoodia currorii subsp. lugardii, Maerua parvifolia, Momordica balsamina, Neuracanthus africanus var. africanus, Oxygonum delagoense, Pechuel-Loeschea leubnitziae, Ptycholobium contortum, Rhigozum zambesiacum, Schmidtia pappophoroides, Sclerocarya birrea subsp. caffra, Seddera suffruticosa, Sesamothamnus lugardii, Sporobolus nitens, Stapelia gettliffei, Stapelia kwebensis, Sterculia rogersii, Stipagrostis hirtigluma subsp. patula, Stipagrostis uniplumis var. uniplumis, Tephrosia polystachya var. polystachya, Terminalia prunioides, Terminalia sericea, Tetrapogon tenellus, Urochloa mosambicensis, Ximenia americana var. microphylla

"Conservation

Least Threatened. Target 19%. Only 2% staturorily conserved mainly in Mapungubwe National Park as well as in Nwanedi and Honnet Nature Reserves. Additionally, about 1% conserved in the Baobab Tree Reserve. Roughly 3% transformed, mainly by cultivation. Erosion is high to moderate."

Table 8: Overview of the biomes and regional vegetation units present within the landscape associated with the alternative corridors

BIOMES And Regional vegetation units	Conservation Status		Grand Total	% of total area
	Least threatened	Vulnerable		
AZONAL VEGETATION	**117**		**117**	**0.1%**
Subtropical Alluvial Vegetation	117		117	0.1%
SAVANNA BIOME	**203 195**	**1 336**	**204 531**	**99.9%**
Limpopo Ridge Bushveld	75 449		75 449	36.9%
Musina Mopane Bushveld	127 746		127 746	62.4%
Soutpansberg Mountain Bushveld		1 336	1 336	0.7%
Grand Total	**203 312**	**1 336**	**204 648**	
	99.3%	0.7%		

The Limpopo Ridge Bushveld is described as follows (Mucina & Rutherford 2006):

"Vegetation and landscape features

Extremely irregular plains with ridges and hills. Moderately open savannah with poorly developed ground layer. Umbrella-shape canopied *Kirkia acuminate* is prominent on some ridge skylines with the often enormous *Adansonia digitata* on shallow calcareous gravel; the shrub *Catophractes alexandri* is dominant on calc-silicate soils. These are particularly striking landscapes with rock walls and passages within areas of sandstone of the Clarens Formation (e.g. within the Mapungubwe National Park)"

The following species were recorded as important taxa within this unit:
Acacia nigrescens, Acacia senegal var. leiorhachis, Acacia tortilis subsp. heteracantha, Adansonia digitata, Aristida adscensionis, Aristida stipitata subsp. stipitata, Barleria affinis, Blepharis diversispina, Boscia albitrunca, Catophractes alexandri, Cissus cornifolia, Colophospermum mopane, Combretum apiculatum subsp. apiculatum, Combretum imberbe, Commiphora gracilifrondosa, Commiphora mollis, Commiphora pyracanthoides, Commiphora tenuipetiolata, Digitaria eriantha, Enneapogon cenchroides, Ficus abutilifolia, Ficus tettensis, Gardenia resiniflua subsp. resiniflua, Grewia bicolor var. bicolor, Hibiscus calyphyllus, Hibiscus micranthus var. micranthus, Kirkia acuminata, Neuracanthus africanus var. africanus, Panicum maximum, Plinthus rehmannii, Ptycholobium contortum, Schmidtia pappophoroides, Sclerocarya birrea subsp. caffra, Sterculia rogersii, Stipagrostis uniplumis var. uniplumis, Tavaresia barklyi, Terminalia prunioides, Ximenia americana var. microphylla. The following two species are endemic taxa: *Cleome oxyphylla var. oxyphylla, Pavonia dentata*.

"Conservation

Least threatened. Target 19%. Some 18% statutorily conserved, mainly in the Kruger and Mapungubwe National Parks. An additional 2% conserved in the Baobab Tree Reserve (thus together attaining the target). Only about 1% is transformed, mainly for cultivation and mining"

Therefore it is expected that any vegetation surveys within the study area would reflect the presence of these two regional vegetation units, of which neither is threatened.

5.1.2 Species Diversity

SANBI's POSA[6] database lists 4 799 flora species for the province, of which 71 species are classified as threatened (Vulnerable, Endangered, Critical Endangered) (Table 9). Appendix B contains the list of threatened Red Data flora for Limpopo Province as obtained from the POSA website on the 28th of April 2015. These 71 species represents 33 plant families and 52 genera.

Nine topocadastral maps are associated with the corridor alternatives (Figure 7), these nine topocadastral grids contain 742 species or 15% of all the species recorded within Limpopo Province. **No threatened Red Data plants had been recorded within these nine grids.**

In terms of provincially protected flora the following 26 species had been recorded in terms of the Limpopo Environmental Management Act (Act 7 of 2003) within the nine grids associated with the study area: *Adansonia digitata, Adenium multiflorum, Aloe globuligemma, Aloe littoralis, Aloe lutescens, Ansellia africana, Ceropegia ampliata, Combretum vendae, Cyrtorchis praetermissa, Eulophia angolensis, Eulophia hereroensis, Hermbstaedtia capitata, Hibiscus sabiensis, Huernia whitesloaneana, Huernia zebrina, Ochna glauca, Orbea lugardii, Orbea rogersii, Orbea valida, Orbea woodii, Peristrophe cliffordii, Phyllanthus pinnatus, Stapelia gettliffei, Stapelia kwebensis, Tavaresia barklyi, Tridactyle tricuspis, Xylopia parviflora* (Table 10). **It should be noted in certain cases all the species in the genus or family is protected.**

Three nationally protected flora in terms of the National Environmental Management Biodiversity Act (No 10 of 2004), they are: *Dioscorea sylvatica, Harpagophytum procumbens, Orbea woodii* (Table 11).

[6] Plants of Southern Africa - http://posa.sanbi.org/searchspp.php

Table 9: Overview of the number of threatened Red Data flora species within Limpopo Province

Threatened Red Data flora category	No of species	% of total
Vulnerable (VU)	40	56%
Endangered (EN)	17	24%
Critical Endangered (CR)	14	20%
Grand Total	71	44%

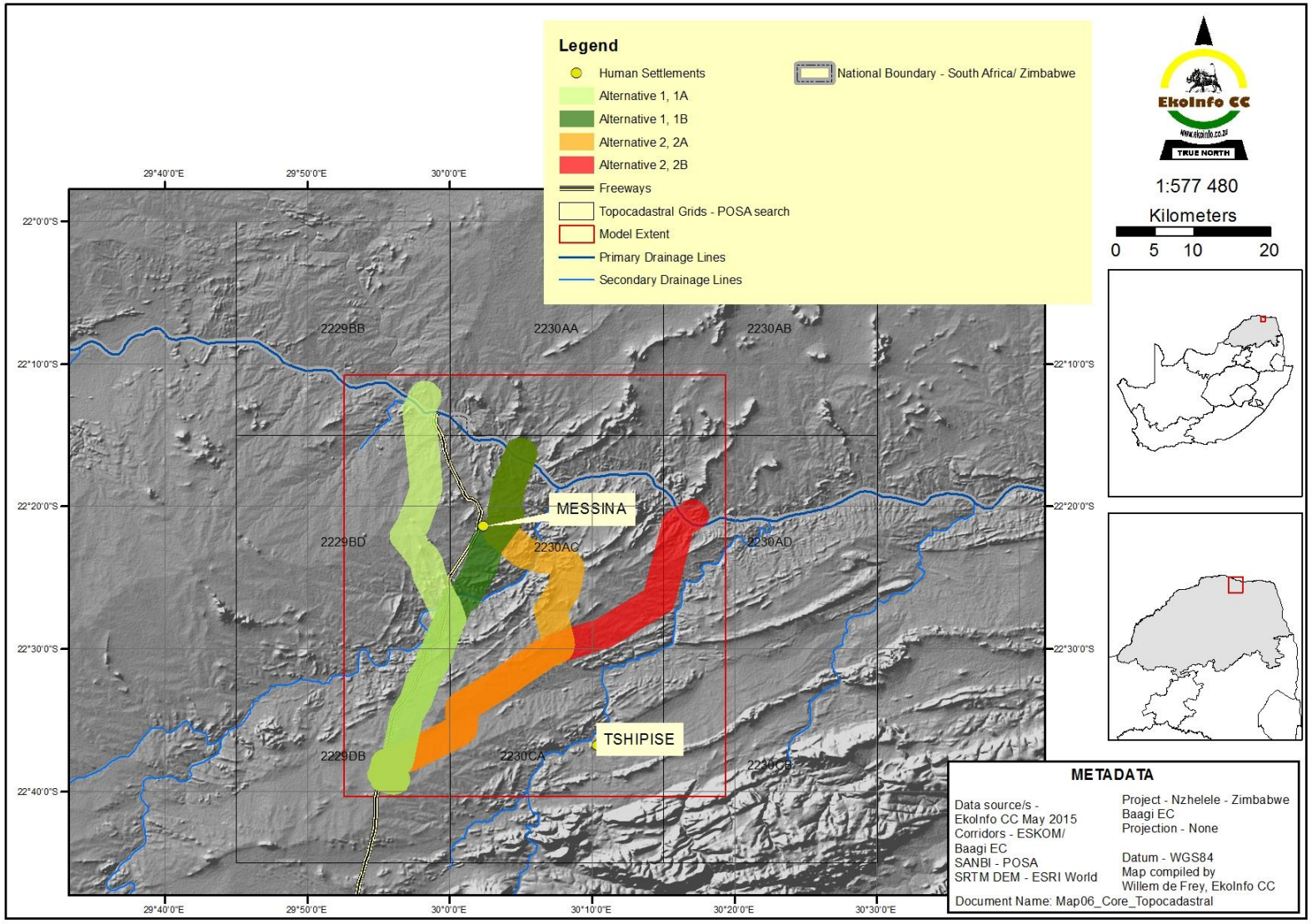

Figure 7: Overview of the nine topocadastral used in the POSA search

Table 10: Overview of the 26 provincially protected species present within the nine topocadastral grids associated with the corridor alternatives

Botanical Name	Taxon	Protection level
Adansonia digitata		Specific species only
Adenium multiflorum		
Combretum vendae		
Hermbstaedtia capitata		
Hibiscus sabiensis		
Ochna glauca		
Peristrophe cliffordii		
Phyllanthus pinnatus		
Xylopia parviflora		
Aloe globuligemma	Aloe	All species in genus
Aloe littoralis		
Aloe lutescens		
Ceropegia ampliata	Ceropegia	
Huernia whitesloaneana	Huernia	
Huernia zebrina		
Orbea lugardii	Orbea	
Orbea rogersii		
Orbea valida		
Orbea woodii		
Stapelia gettliffei	Stapelia	
Stapelia kwebensis		
Tavaresia barklyi	Tavaresia	
Ansellia africana	Orchidaceae	All species in family
Cyrtorchis praetermissa		
Eulophia angolensis		
Eulophia hereroensis		
Tridactyle tricuspis		

Table 11: Overview of the three nationally protected species in terms of the National Environmental Management Biodiversity Act

Botanical Name	Conservation Status - National
Dioscorea sylvatica	Vulnerable
Harpagophytum procumbens	Protected
Orbea woodii	Vulnerable

Within the nine topocadastral grids associated with the corridor alternatives, the following four trees which are protected in terms of the National Forest Act (No 84 of 1998), were recorded: *Adansonia digitata, Boscia albitrunca, Combretum imberbe* and *Philenoptera violacea*.

Therefore it should be quite evident that there is a very high potential for either provincially or nationally protected flora to occur within the corridor alternatives.

5.2 Local Context

This section is based on the results of the actual vegetation surveys using the Braun-Blanquet approach during May 2014.

5.2.1 Ecosystem Diversity

A two-way species indicator analysis (TWINSPAN) of the collected species data (Appendix C) and correlation with the recorded environmental data (Table 12) indicates the presences of two major units. These two major units are representative of the continental and regional vegetation units described within the regional context section, namely cluster one and two (TWINSPAN level 1) is associated with the Limpopo Mopane continental unit or Musina Mopane Bushveld regional vegetation unit and cluster three and four being associated with the Zambezi Mopane continental unit or Limpopo Ridge Bushveld regional vegetation unit (Figure 8).

The vegetation also reflect a grazing gradient (level of utilisation) based on the ruggedness of the terrain (Figure 9), with cluster one and two which is associated with the flat landscape, being more accessible to livestock, whether domestic or game, compared to cluster three and four which are associated with a steeper, more rugged landscape, which is less accessible to livestock. The presence (high constancy and abundance) of the following species in cluster one and two, support this statement: *Dicoma tomentosa* (Appendix C – Species Group A), *Acacia tortilis* (Species Group A), *Aristida congesta* (Species Group B), *Aristida rhiniochloa* (Species Group B), *Tragus berteronianus* (Species Group B), *Acacia erubescens* (Species Group B), *Aristida adscensionis* (Species Group G) and *Dichrostachys cinerea* (Species Group H), all of these species are associated with over utilisation of natural veld (Van Wyk & Van Wyk 1997, Van Oudtshoorn 1991). The following species in Species Group F are in contrast associated with well-managed or responsibly utilised veld: *Digitaria eriantha*, *Tricholaena monachne* and *Panicum maximum* (Van Oudtshoorn 1991)

Based on this information, it is evident that the corridor alternatives transects through vegetation dominated by *Colophospermum mopane* (Appendix C, Species Group H), followed by *Terminalia prunioides*, which confirms the dominance of the Musina Mopane Bushveld in this area.

5.2.2 Species Diversity

5.2.2.1 Species Richness

During the survey, which involved 15 plots, 95 species (Appendix C) were recorded or 13% of the 742 species recorded within the nine topocadastral grids associated with the study area. On average 26 species were recorded per plot, while the minimum was 16 species and the maximum 37 species (Table 13).

Of the 95 species, 37 species or 39% are forbs, 22 species or 23% are grasses and 36 species or 38% are woody species (trees and shrubs) (Table 14).

5.2.2.2 Threatened Red Data and Protected Plants

None of the potential 71 threatened Red Data plants listed for Limpopo Province were recorded within the plots surveyed; however this does not imply that some of the species could not be present.

Table 12: Overview of the average quantitative environmental attributes associated with the TWINSPAN clusters based on the floristic composition of the data recorded

TWINSPAN	Source	Average values												
		GPS	SRTM DEM	Estimated	SRTM DEM	SRTM DEM	Estimated	Measured	Estimated % cover					SRTM DEM
Level 1	No of species	Altitude (m)	Altitude (m)	Slope (%)	Slope (°)	Wetness Index	% Clay (A-horizon):	Soil depth (mm)	Gravel	Small stones	Medium stones	Large stones	Rock	Ruggedness Index
100000	8	572	572	1	2	10	4	425	12	6	5	2	0	3
200000	7	512	515	4	3	9	6	457	4	6	5	6	1	5

TWINSPAN	Source	Average values												
		GPS	SRTM DEM	Estimated	SRTM DEM	SRTM DEM	Estimated	Measured	Estimated % cover					SRTM DEM
Level 2	No of species	Altitude (m)	Altitude (m)	Slope (%)	Slope (°)	Wetness Index	% Clay (A-horizon):	Soil depth (mm)	Gravel	Small stones	Medium stones	Large stones	Rock	Ruggedness Index
110000	1	683	680	1	1	10	4	600	10	0	0	0	0	2
120000	7	556	557	1	2	10	4	400	12	7	6	2	0	3
210000	4	530	533	5	4	9	7	450	6	6	5	4	1	5
220000	3	489	492	3	3	9	6	467	2	5	5	10	2	6

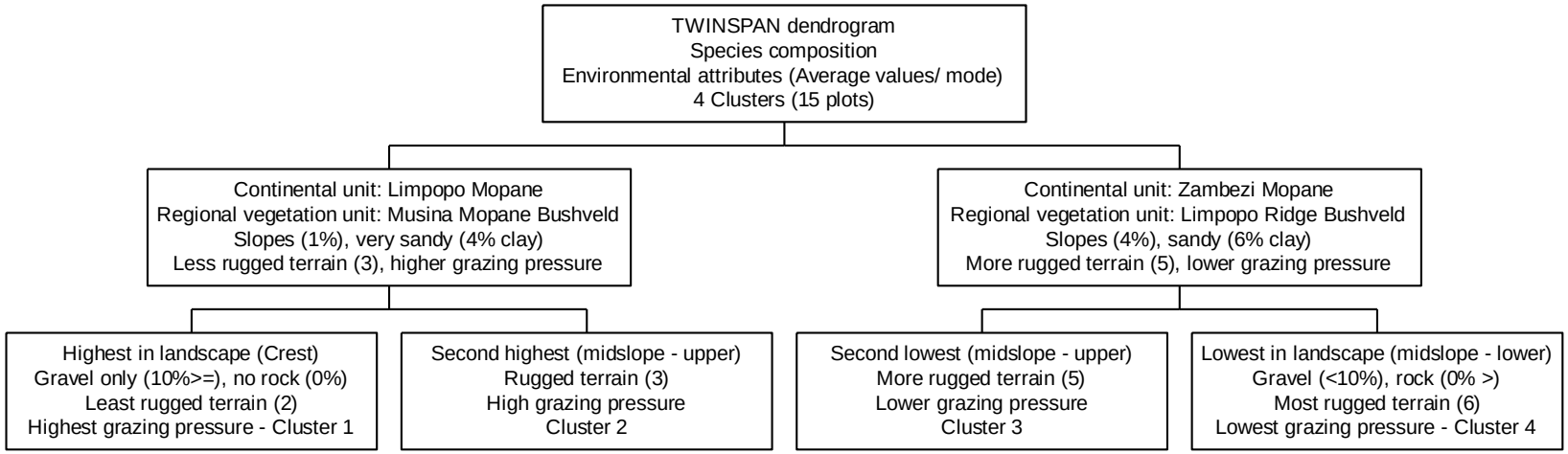

Figure 8: TWINSPAN dendrogram based on the floristic composition reflecting the quantitative environmental attribute influences

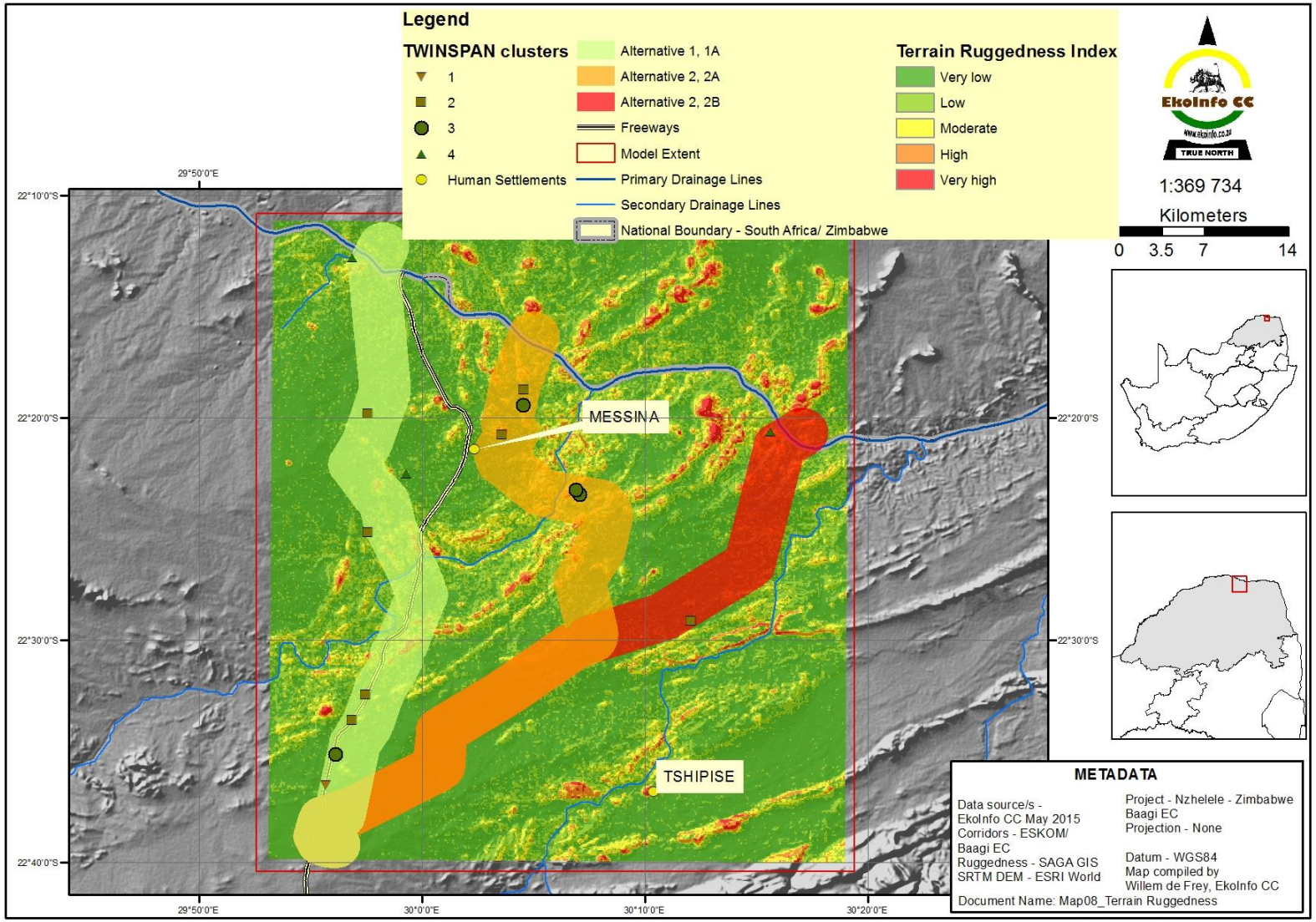

Figure 9: Overview of the level terrain ruggedness within the study areas, which influences grazing patterns of livestock

Table 13: Overview of the number of species recorded per sample plot

Plot no	No of species
1	35
2	27
3	26
6	25
10	16
18	20
19	18
20	17
21	28
26	37
27	20
29	27
30	33
31	35
33	21
Minimum	**16**
Average	**26**
Maximum	**37**

Please note the plot number is not the same as the table number.

Table 14: Overview of the major growth forms recorded during the survey

Major Growth Form	No of species	% of total
Forbs	37	39%
Grasses	22	23%
Woodies	36	38%
Grand Total	**95**	**100%**

The only provincially protected plant in terms of the Limpopo Environmental Management Act recorded within the plots surveyed was *Adansonia digitata* (Baobab).

The following nationally protected trees were recorded within the 15 plots surveyed, namely: *Adansonia digitata* (Baobab), *Boscia albitrunca* (Shepard Tree), *Combretum imberbe* (Leadwood), *Sclerocarya birrea* (Marula). From the Braun-Blanquet table (Appendix C), it is evident that *Combretum imberbe* occurs localised, mainly in close proximity to watercourse, while the other three species are common throughout the area, *Adansonia digitata* being more prominent on or in the vicinity of outcrops/ ridges.

It should be noted that a permit is required for the destruction of these species in terms of the National Forest Act.

From the data in Table 15, it is possible to make the following observations with regards to these four nationally protected trees:

1. *Boscia albitrunca* is the most common protected tree in the area, and was present in all of the plots surveyed, it occurs at an average density of 18 individuals per hectare.
2. *Combretum imberbe* is the most localised protected species due to its association with watercourses.
3. *Sclerocarya birrea subsp. caffra* is the second most abundant, and occurred in more than 50% of the plots sampled; it is present at an average density of 11 individuals per hectare.
4. *Adansonia digitata* is more localised than *Sclerocarya birrea* subsp *caffra*, but less than *Combretum imberbe*, it occurs at an average density of four individuals per hectare.
5. Overall it would appear as if there is not enough young individuals (0 – 3 m) within the protected tree populations, with the majority of the individuals being present in the 3 – 6 m class, and only a limited number of very large individuals, the exceptions are *Adansonia digitata* were there is equal numbers of young, middle age and old individuals and *Sclerocarya birrea* subsp. *caffra* where the very large (mature) individuals outnumber the middle age size class. The absence of young individual could be attributed to the over utilisation of the landscape by livestock, especially cattle or the absence of the relevant propagation agents, especially in areas where ecological process had been disrupted.

5.2.2.3 Medicinal Plants

The following two species with medicinal properties were recorded within the 15 plots surveyed, namely: *Adansonia digitata* and *Sclerocarya birrea subsp. caffra* (Van Wyk, Van Oudtshoorn & Gericke 2000), both species occur widely throughout the study area.

5.2.2.4 Alien invasive species

A single declared alien invasive species were recorded within the 15 plots surveyed, namely *Opuntia ficus-indica*, it is a Category 1 species in terms of the Conservation of Agricultural Resources Act (No 43 of 1985) and needs to be eradicated and controlled. The majority of the species belonging to the Cactacea family is considered to be a serious threat to the biodiversity in South Africa and needs to be controlled. In terms of the National Environmental Management Biodiversity Act, this species is classified as Category 1b and must be controlled via an invasive species management programme.

Table 15: Overview of the number of individuals per hectare of nationally protected trees based on seven plots

Nationally protected trees	Plot number								Density per ha – all height classes			% constancy
	5	7	11	15	23	24	32	Grand Total	minimum	average	maximum	
Adansonia digitata		**4**				**4**	**4**	**12**	**4**	**4**	**4**	**43%**
0 - 3 m							4	4				
3 - 6 m		4						4				
6 m +						4		4				
Boscia albitrunca	**12**	**12**	**16**	**28**	**20**	**20**	**20**	**128**	**12**	**18**	**28**	**100%**
0 - 3 m					4	16		20				
3 - 6 m	12	4	16	28	16			76				
6 m +		8				4	20	32				
Combretum imberbe		**16**						**16**	**16**	**16**	**16**	**14%**
3 - 6 m		4						4				
6 m +		12						12				
Sclerocarya birrea subsp. caffra			**4**	**8**		**12**	**20**	**44**	**4**	**11**	**20**	**57%**
3 - 6 m						8	4	12				
6 m +			4	8		4	16	32				
Grand Total	**12**	**32**	**20**	**36**	**20**	**36**	**44**	**200**				

6 SENSITIVITY ANALYSIS

From the data collected and observations made during the survey in May 2014, as well as the information contained in the regional overview, it is evident that the corridor alternative transects a mainly intact landscape consisting of least threatened vegetation, but with provincial and national protected species throughout. However it was noted that certain protected trees tend to increase in number the more rugged the landscape become, which either correlates with the presence of ridges or the eroded landscape adjacent to water course. Therefore the terrain ruggedness index is considered to be a relevant surrogate for the evaluation of the sensitivity of the three corridor alternatives. It is expected that the more watercourses present in a corridor, the more likely it would be that it would impact on a protected tree such as *Combretum imberbe* (Leadwood), while it was noted that *Adansonia digitata* (Baobab) occurs at higher densities in more rugged terrain.

Based on this approach, corridor alternative 2, 2B is the least sensitive and corridor alternative 2, 2A the most sensitive (Table 16). If the number of water course transected by the corridor alternatives are considered then Alternative 2, 2B remains the least sensitive, but alternative 1, 1A becomes the most sensitive (Table 17). When the Limpopo Province conservation plan is used as a surrogate to assess the sensitivity of the corridors, then alternative 2, 2B is once again the least sensitive, with alternative 2, 2A being the most sensitive once again (Table 18).

If a weighted approach is applied using all three the surrogates, then alternative 2, 2B remains the least sensitive and alternative 2, 2A the most sensitive (Table 19).

Therefore from a floristic perspective, alternative 2, 2B should be considered for the construction of the power line, while alternative 2, 2A should be avoided.

Table 16: Overview of the sensitivity analysis per corridor alternative based on terrain ruggedness

Terrain ruggedness categories	Category number	Corridor Alternatives		
		Alt 1, 1A	Alt 2, 2A	Alt 2, 2B
		Hectares	Hectares	Hectares
Very low	1	15282	16222	17486
Low	2	5784	6594	4723
Moderate	3	1154	2059	760
High	4	414	408	80
Very high	5	45	54	21
TOTALS		**22680**	**25337**	**23070**
Very low	1	67%	64%	76%
Low	2	26%	26%	20%
Moderate	3	5%	8%	3%
High	4	2%	2%	0%
Very high	5	0%	0%	0%
TOTALS		**100%**	**100%**	**100%**
Sensitivity level			**Most**	**Least**
Sensitivity weighting		**2**	**3**	**1**

Table 17: Overview of the corridor alternative sensitivity based on number of water courses transected

	Corridor Alternatives		
	Alt 1, 1A	Alt 2, 2A	Alt 2, 2B
Number of water course transected	28	25	19
Sensitivity level	**Most**		**Least**
Sensitivity weighting	**3**	**2**	**1**

Table 18: Overview of the corridor alternative sensitivity based on the Limpopo Province Conservation Plan

Limpopo Conservation Plan Categories	C Plan Code	Corridor Alternatives		
		Alt 1, 1A	Alt 2, 2A	Alt 2, 2B
		Hectares	Hectares	Hectares
Critical Biodiversity Area 1	CBA1	4595	5013	438
Critical Biodiversity Area 2	CBA2	1433	3516	4836
Ecological Support Area 1	ESA1	6923	6205	3125
Ecological Support Area 2	ESA2	6		
No Natural Remaining	NNR	15	257	
Other Natural Area	ONA	9466	9414	14419
Protected Area	PA	4	1080	
TOTALS		**22442**	**25484**	**22819**
Critical Biodiversity Area 1	CBA1	20%	20%	2%
Critical Biodiversity Area 2	CBA2	6%	14%	21%
Ecological Support Area 1	ESA1	31%	24%	14%
Ecological Support Area 2	ESA2	0%	0%	0%
No Natural Remaining	NNR	0%	1%	0%
Other Natural Area	ONA	42%	37%	63%
Protected Area	PA	0%	4%	0%
TOTALS		**100%**	**100%**	**100%**
Sensitivity level			**Most**	**Least**
Sensitivity weighting		**2**	**3**	**1**

Table 19: Overview of the parameters used to determine the least sensitive corridor

Sensitivity Surrogates	Corridor Alternatives		
	Alt 1, 1A	Alt 2, 2A	Alt 2, 2B
Terrain ruggedness	2	3	1
Number of water courses transected	3	2	1
Limpopo Conservation Plan	2	3	1
TOTALS	**7**	**8**	**3**
Sensitivity level		**Most**	**Least**

7 ENVIRONMENTAL IMPACT ASSESSMENT

During an integration meeting held on the 9th of February 2016, it was concluded that the preferred alignment from an overall environmental perspective is Route Corridor Alternative 1 (green corridor - Figure 9, grey corridor - Figure 10). However this represents the second most sensitive alignment from a vegetation perspective (Table 19), mainly due to the higher occurrence of:

1. Water courses – rivers, streams, wetlands, where protected trees such as Leadwood (*Combretum imberbe*) could occur.
2. Ridges (areas with slopes of more than 5° or 8%), where protected trees such as Baobab (*Adansonia digitata*) could occur at higher densities.

Therefore, the impacts associated with route corridor alternative 1 (Figure 10), will be higher overall than if route corridor alternative 2, 2B, the floristic least sensitive alignment, had been constructed.

In the absence of detailed design (final alignment, roads, wetland crossings, construction camps) and construction (duration, human resources) information, it is not possible to do a detailed impact assessment on the preferred alignment one (grey corridor - Figure 10), and is therefore limited to those direct impacts generally associated with the construction of a power line, especially through a wooded landscape, namely:

1. Removal of vegetation in general (Photo plate 1)
2. Removal of species of concern (Red Data, protected – national and provincial)

Removal of both, vegetation in general and of species of concern, will occur during both the construction and operational phases, especially of woody species (trees and shrubs) within:

1. The power line servitude.
2. Pylon positions.
3. Access roads.
4. Construction camp or laydown areas.

To mitigate the above impacts associated with the removal of vegetation, the proposed power line servitude should preferably favour already transformed or disturbed areas within the preferred corridor (route alternative one (grey corridor)) (Figure 10). However, from recently available land cover data from 2014 (Figure 11), it is evident that this level of mitigation has limited potential to reduce the impacts, as only 1% of the land uses within the corridor contributes to transformation (Table 20).

Therefore the next level of mitigation should be to avoid expected areas of high density species of concern (water courses, ridges) and keep the alignment close to existing road infrastructure (Figure 12). If the final alignment is optimised to use as much as possible of existing road infrastructure, thereby reducing the need to create additional roads or watercourse crossings, the impact of the proposed alignment could be reduced from high to moderate.

IMPACT: Removal of vegetation at construction camps and burrow pits
In the long term and on a local scale, the removal of natural vegetation at the construction sites and burrow pits will have a moderate negative impact.
MITIGATION: Placing construction camps in all ready transformed areas such as cultivated fields or revamping derelict homesteads or other abandoned infrastructure can mitigate this impact. New burrow pits should be kept to the minimum; existing one should rather be used than new ones created. If successfully mitigated, the impact on the vegetation could be considered low on a local scale in the long term.

IMPACT: Harvesting of medicinal plants and wood
Harvesting of medicinal plants and wood for cooking have a moderate negative impact on the population dynamics and vegetation structure on a local scale and in the long term.
MITIGATION: The following mitigation is recommended:

1. Construction companies should make sure that the necessary medical facilities are available for their staff on site. The Health and Safety Act will most probably cover this aspect.
2. Gas and electrical cooking facilities should be provided. The same apply to heating during the winter months. Open fires should be discouraged and only used under controlled circumstance.

Photo plate 1: Photographs showing the impacts of a transmission power line on the vegetation in the Savanna Biome

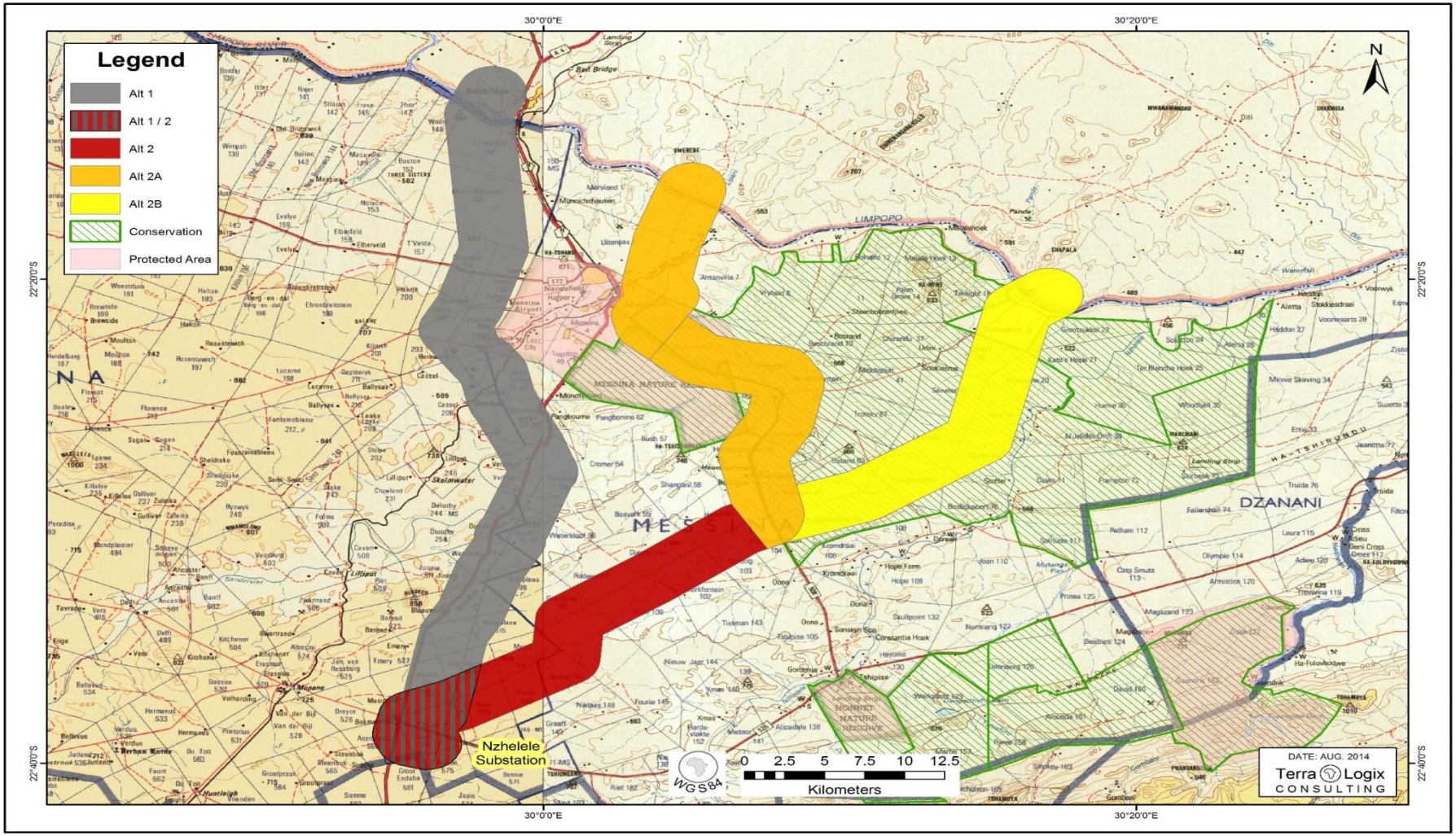

Figure 10: Distribution of the final route alternatives, with the preferred alternative being alternative 1 (grey colour) (Source: Baagi EC, March 2016)

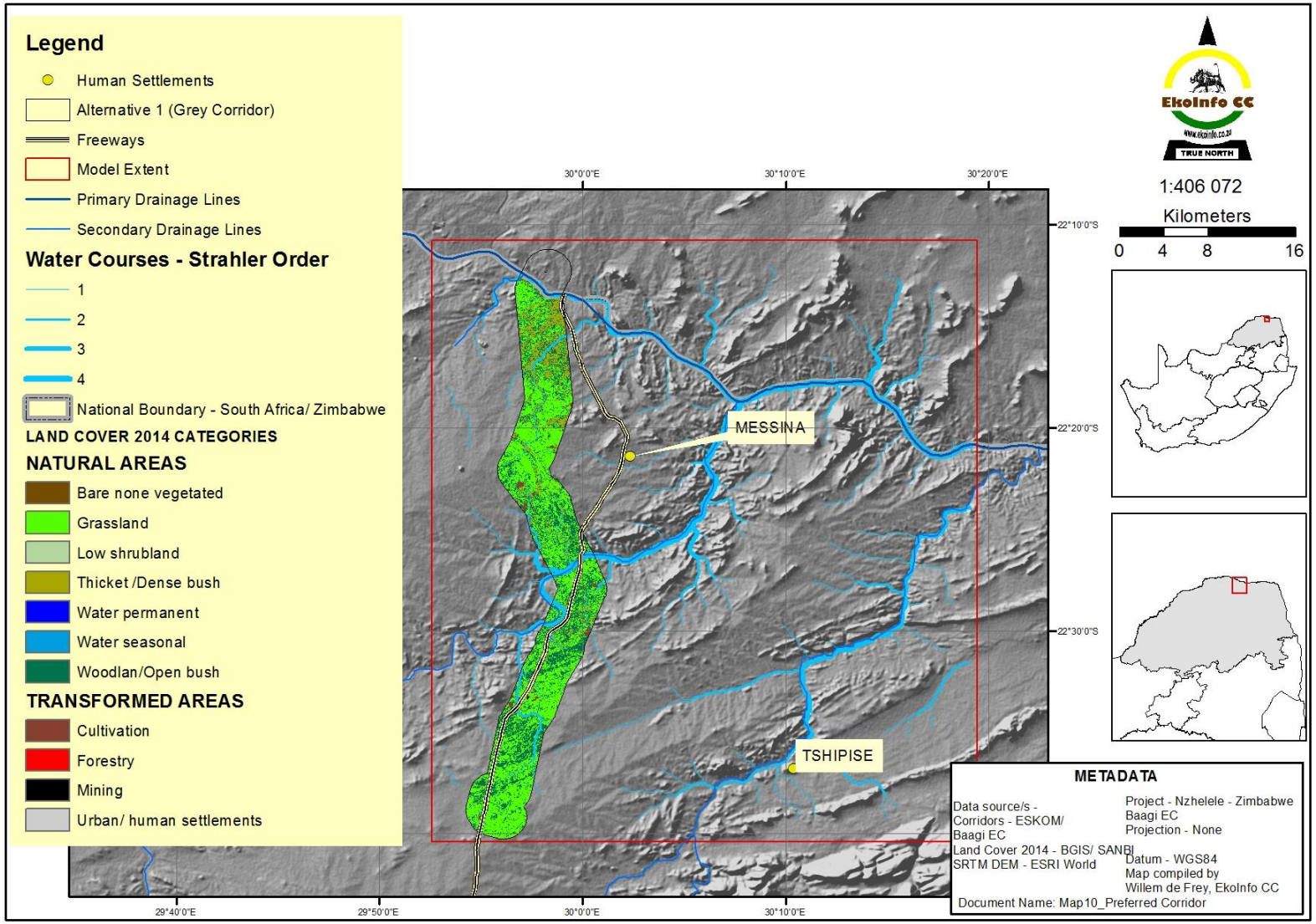

Figure 11: Overview of the 2014 land cover categories present within the preferred corridor – Alternative One (Grey Corridor – Figure 10)

Table 20: Overview of the extent (ha) of 2014 land cover categories within the alternative one (grey corridor) and the percentage natural and transformed areas

LAND COVER 2014 CATEGORIES	Surface (ha)	RSA only	% Cover
Natural	**21 436**	**21 436**	**99%**
Bare none vegetated	69		
Grassland	11 695		
Low shrubland	37		
Thicket /Dense bush	2 221		
Water permanent	14		
Water seasonal	2		
Woodlan/Open bush	7 398		
No Data	**1 170**		
No Data	1 170		
Transformed	**277**	**277**	**1%**
Cultivation	219		
Forestry	1		
Mining	12		
Urban/ Human Settlements	45		
Grand Total	**22 883**	**21 713**	**100%**

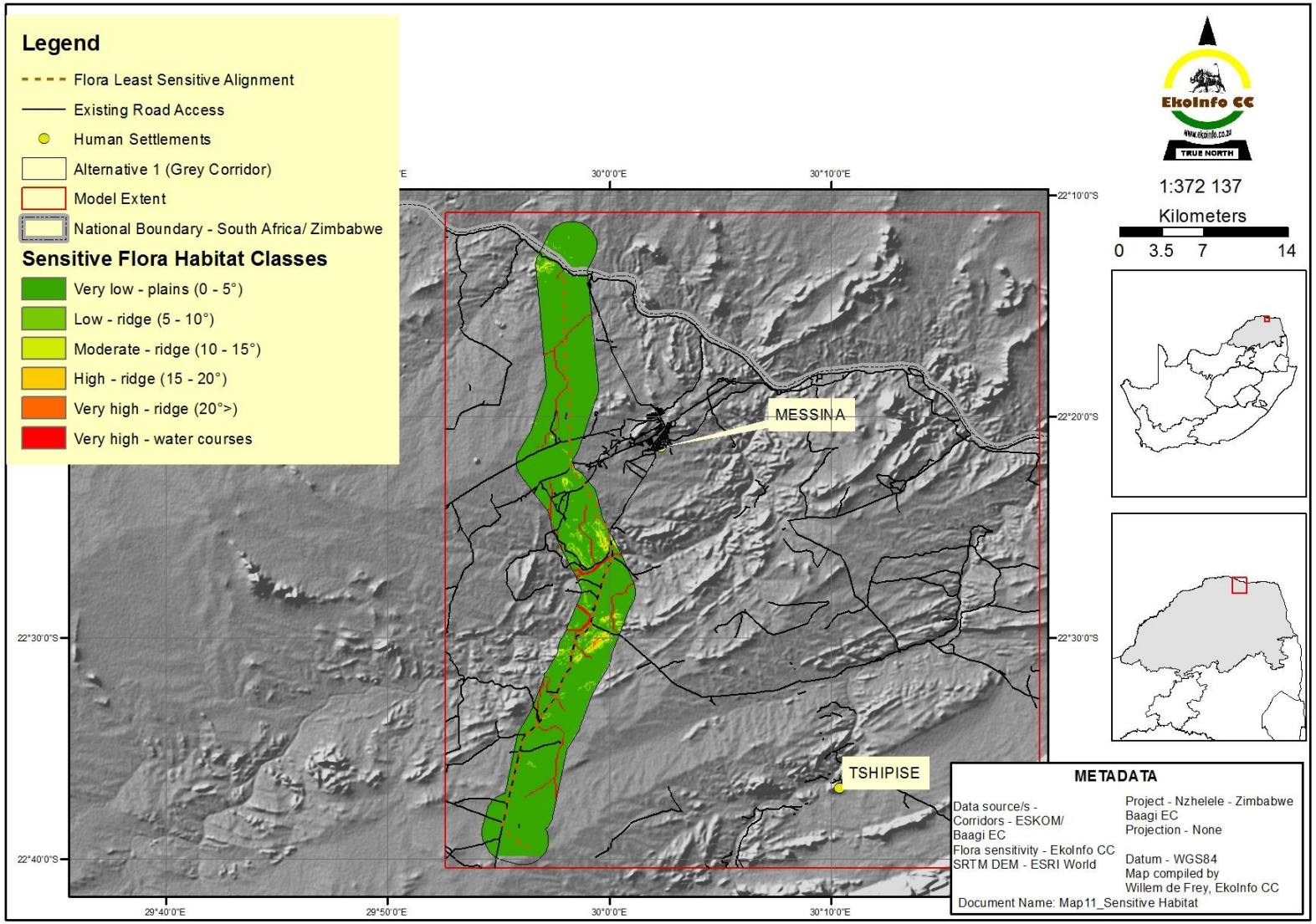

Figure 12: Distribution and extent of sensitive habitats (watercourse, ridges) within the preferred corridor (alternative 1 – grey corridor (Figure 10)) and existing road infrastructure along which the alignment could be placed to reduce direct and indirect impacts

3. Care should be especially taken during the late winter/ early spring months (June, July, August, September).

If successfully mitigated, the impact on the vegetation could be considered low on a local scale in the long term.

IMPACT: Construction of access roads
The construction of access roads will also result in the removal of natural vegetation especially in rugged terrain to obtain access. This would have a high negative impact on a local scale in the long term.
MITIGATION: Where possible existing routes into rugged terrain should be used and enhanced. If the access roads are required to cross green fields (untransformed) areas, it is strongly recommended that the plants present be surveyed, collected for documentation at SANBI, medicinal plants rescued instead of being destroyed and rare or threatened species moved to nurseries for re-establishment after construction or used for rehabilitation in areas where construction activities had result in the significant loss of natural vegetation. If successfully mitigated, the impact on the vegetation could be considered moderate on a local scale in the long term.

IMPACT: Alien vegetation control at construction camps, within servitudes and along access roads
MITIGATION: Where encountered, declared alien vegetation should be controlled and the spread thereof proactively managed. Declared alien vegetation should be controlled and removed in compliance with the Conservation of Agricultural Resource Act and the National Environmental Management Biodiversity Act. If successfully implemented, the impact on the vegetation could be considered moderately positive on a local scale in the long term.

Table 21 provides a semi-quantitative assessment of the impacts associated with the construction and operation of a power line of this nature.

Table 21: The assessment of impacts relevant to the flora aspect of the project. Impacts are assessed separately for construction camps, burrow pits, the power line and access roads

CONSTRUCTION CAMPS									
Nature of Impact	**Management Measures**	**Extent**	**Duration**	**Intensity**	**Frequency**	**Probability**	**Significance**	**Status**	**Confidence**
Loss of natural vegetation	Without management	2	3	3	1	4	moderate	negative	85%
	With management	2	3	2	1	2	low	negative	75%
Degradation of vegetation	Without management	2	3	3	1	4	moderate	negative	85%
	With management	2	3	3	1	2	low	negative	75%
Harvesting of medicinal plants and wood	Without management	2	3	3	1	4	moderate	negative	75%
	With management	2	3	3	1	2	low	negative	85%
Erosion associated with off-road driving and poor storm water management	Without management	2	3	3	2	3	high	negative	85%
	With management	2	3	3	2	2	low	negative	75%
BURROW PITS									
Nature of Impact	**Management Measures**	**Extent**	**Duration**	**Intensity**	**Frequency**	**Probability**	**Significance**	**Status**	**Confidence**
Loss of natural vegetation	Without management	2	3	3	1	4	moderate	negative	85%
	With management	2	3	2	1	2	low	negative	75%
Degradation of vegetation	Without management	2	3	3	1	4	moderate	negative	85%
	With management	2	3	3	1	2	low	negative	75%
Erosion associated with off-road driving and poor storm water management	Without management	2	3	3	2	3	high	negative	85%
	With management	2	3	3	2	2	low	negative	75%
POWER LINE									
Nature of Impact	**Management Measures**	**Extent**	**Duration**	**Intensity**	**Frequency**	**Probability**	**Significance**	**Status**	**Confidence**
Loss of natural vegetation	Without management	2	3	3	1	4	low	negative	85%
	With management	2	3	2	1	2	Very	negative	75%
Degradation of vegetation	Without management	2	3	3	1	4	moderate	negative	85%
	With management	2	3	3	1	2	low	negative	75%
Erosion associated with off-road driving and poor storm water management	Without management	2	3	3	2	3	high	negative	85%
	With management	2	3	3	2	2	low	negative	75%

Control of alien vegetation	Without management	2	3	3	4	3	high	negative	85%
	With management	2	3	3	4	3	moderate	positive	75%
ACCESS ROADS									
Nature of Impact	**Management Measures**	**Extent**	**Duration**	**Intensity**	**Frequency**	**Probability**	**Significance**	**Status**	**Confidence**
Loss of natural vegetation	Without management	2	3	3	1	4	high	negative	85%
	With management	2	3	2	1	2	moderate	negative	75%
Degradation of vegetation	Without management	2	3	3	1	4	moderate	negative	85%
	With management	2	3	3	1	2	low	negative	75%
Erosion associated with off-road driving and poor storm water management	Without management	2	3	3	2	3	high	negative	85%
	With management	2	3	3	2	2	low	negative	75%
Infringement on rare or sensitive flora habitat	Without management	2	4	4	2	3	high	negative	85%
	With management	1	4	4	2	3	moderate	negative	75%
Control of alien vegetation	Without management	2	3	3	4	3	high	negative	85%
	With management	2	3	3	4	3	moderate	positive	75%

8 FLORA GENERIC ENVIRONMENTAL MANAGEMENT PLAN

Although in the absence of a walk down and detail assessment of potential sensitive areas, it is not possible to conclude whether the construction activities will negatively affect any threatened flora, however the natural vegetation is used for grazing. Therefore dust should be controlled.

The footprint of the construction activity should be kept to the minimal; especially uncontrolled off-road driving should be curtailed. Infrastructure and storage facilities such as the construction camp should preferably be located on existing transformed areas such as cultivated land, where these areas are not within 350 m of the temporal zones of any wetlands, whether drainage line associated or hillsides.

Unlawful harvesting of medicinal plants and woody species, especially protected species, should be prevented.

Any declared weeds and invasive species encountered during the construction phase, should be eradicated and controlled according to the guidelines of the Conservation of Agricultural Resources Act No 43 of 1985. The management and controlling of declared weeds and invasive species should be an ongoing process during the operational phase.

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10 APPENDIX A – ABRIDGE CV, PRINCIPLE CONSULTANT

Name of firm: EkoInfo cc Environmental and Wildlife Management Consultancy
Name of staff: WILLEM HENDRIK DE FREY
Profession: Environmental and Wildlife Management consultant
Years with firm: Since 1995
Nationality: RSA
Membership of professional societies:
The South African Council for Natural Scientific Professions (Reg no 400100/02)
Categories: Botanical Science and Ecological Science
Currently in the process of affiliating to:
South African Association of Botanist (SAAB)
Grassland Society of Southern Africa
South African Institute of Ecologist and Environmental Scientists (SAIE)

KEY QUALIFICATIONS:

Mr W de Frey has been involved in the discipline of ecology since 1989. During this period he prepared himself for a profession in environmental and wildlife management, by attending courses in chemistry, geology, pedology and statistics, while majoring in Botany and Zoology. His working knowledge was obtained while completing projects for his post-graduate studies in wildlife management in both the Savanna and Grassland Biomes. In addition to his academic publications, he has contributed to numerous reports regarding EMPR's, EIA's, vegetation - and soil surveys and monitoring since the registration of his own consultation close corporation in 1995. He is actively involved in the management and marketing of his close corporation while completing tasks in his field of expertise namely soil, vegetation science and Geographical Information Systems. Mr W de Frey is task orientated with consideration of people's needs and safety. He beliefs in a holistic approach to environmental and wildlife management and has therefore established a network with individuals in related fields. He is also assisting previously disadvantaged persons in establishing a presence in the environmental industry, namely Lordwick Makhura of Baagi Environmental Consultancy CC and a joint venture company Bonolo Biodiversity And Environmental Management consisting of Baagi Environmental Consultancy CC and Disa Mphago Community Helpers CC.

EDUCATION:

1992 BSc Botany & Zoology, University of Pretoria

Course	Content	Level
Chemistry	Organic and Inorganic chemistry	1st year
Geology	Introduction/ Geomorphology, Stratigraphy, Structural, Sedimentology Palaeontology, Crystallography	1st and 2nd year
Pedology	Introduction, soil classification, soil fertility, soil ecology, soil physics	1st and 2nd year
Botany	Morphology, Anatomy, Physiology, Taxonomy, Mycology, Ecology, Reproductive biology	1st, 2nd and 3rd year
Zoology	Taxonomy (Vertebrates and Invertebrates), Physiology (mainly vertebrates), Ecology (mainly vertebrates), Animal behaviour (mainly vertebrates)	1st, 2nd and 3rd year
Statistics	Sampling methods, Statistical Analysis, Probabilities	1st year

1993 BSc (Hons) (Cum laude) Wildlife Management, University of Pretoria
Dissertation: 'N HOLISTIESE EKOLOGIESE BENADERING TOT DIE DRAKRAGBEPALING VAN 'N GEMENGDE WILD- EN BEESBOERDERY IN DIE UBOMBO DISTRIK, MET ENKELE BESTUURS AANBEVELINGS, 1993
1999 MSc (Cum laude) Wildlife Management, University of Pretoria
Thesis: PHYTOSOCIOLOGY OF THE MPUMALANGA HIGH ALTITUDE GRASSLANDS, 1999

COURSES/ WORKSHOPS ATTENDED

1. Red List And Threatened Species Assessment Training Workshop, Hosted by the Conservation Breeding Specialist Group Southern Africa & Endangered Wildlife Trust, December 2003
2. National State of the Environment Workshop, Hosted by DEAT and SRK, ESKOM Convention Centre – November 2004
3. Gauteng Red Data Flora Workshop, Hosted by SANBI and GDACE – November 2005
4. Gauteng Flora Minimum Requirement Workshop, Hosted by GDACE Nature Conservation – August 2007

EMPLOYMENT RECORD:

1986 – 1987
5 Signals Regiment, SADF

1998 – 1993 – Partime
Council of Geoscience, Palaeontology Section
University of Pretoria, Botany Department
Academy of Marksmanship, Range Officer
U Huisoppasser, Own enterprise
1994 – 1995
University of Pretoria, Botany Department, Assistant researcher

1995 – present

EkoInfo cc Environmental and Wildlife Management Consultancy, Founding member and consultant

Overall EkoInfo CC's principal consultant completed or administrated more than 58 vegetation studies as part of Environmental Impact Assessments within all of South Africa's nine provinces and adjacent countries such as Botswana and Mozambique with a focus on either terrestrial vegetation and/ or wetlands. Some projects were on provincial level such as the Mpumalanga and Gauteng Degradation Projects coordinated by the Institute for Soil, Climate and Water and sponsored by National Department of Agriculture. The majority of projects were on local scale from 5 ha to 50 000 ha or more for local developers and corporate institutions (SASOL, Anglo Coal, BHP Billington, Ingwe Coal, Deneys Rietz Attorneys, ESKOM) facilitated independently or as a subcontractor/ specialist for the following institutions: Oryx Environmental CC, African EPA, Arcuss Gibb, Digby Wells and Associates, Nature and Business Alliance and Eyethu Engineers, Strategic Environmental Focus.

COMMUNITY SERVICE

1. Substitute lecture – 2nd & 3rd year Botany Practical (Vegetation Survey Methods), University of Pretoria -1994 & 1995
2. Guest lecture – Wetland Vegetation Communities (2nd year students), Department of Landscape Architecture, University of Pretoria – 1996 & 1997
3. Guest lecture – Principles of Ecology (1st year students), Department of Landscape Architecture, University of Pretoria – 2002
4. Guest lecture – Principles of vegetation survey and mapping for EIA's (3rd year students), Department of Landscape Architecture, University of Pretoria – 2003
5. Referee – ILASA Merits Awards (Environmental Planning), Institute for Landscape Architects of South Africa - 2003

LANGUAGES:

Language	Capability
English & Afrikaans	Speak, Read, Write - sufficient
Sepedi (Northern Sotho)	Speak, Read, Write – insufficient

11 APPENDIX B – LIST OF THREATENED RED DAT FLORA

Note: Red Data threatened categories: VU = Vulnerable, EN = Endangered, CR = Critical Endangered

Species	Threat status	SA Endemic	Lifecycle	Growth forms
VULNERABLE SPECIES (VU)				
Barleria dolomiticola M.& K.Balkwill	VU	No	Perennial	Herb
Dicliptera fionae K.Balkwill	VU	No	Perennial	Herb
Searsia batophylla (Codd) Moffett	VU	No	Perennial	Shrub
Diplolophium buchananii (Benth. ex Oliv.) C.Norman subsp. swynnertonii (Baker f.) Cannon	VU	No	Perennial	Herb
Brachystelma minor E.A.Bruce	VU	No	Perennial	Geophyte, succulent
Ceropegia cimiciodora Oberm.	VU	No	Perennial	Climber, succulent
Ceropegia stentiae E.A.Bruce	VU	No	Perennial	Geophyte, succulent
Huernia nouhuysii I.Verd.	VU	No	Perennial	Succulent
Zantedeschia jucunda Letty	VU	No	Perennial	Geophyte, herb
Asparagus fourei (Oberm.) Fellingham & N.L.Mey.	VU	No	Perennial	Shrub
Asparagus hirsutus S.M.Burrows	VU	No	[No lifecycle defined]	Dwarf shrub
Aloe chortolirioides A.Berger var. chortolirioides	VU	No	Perennial	Dwarf shrub, herb, succulent
Aloe monotropa I.Verd.	VU	No	Perennial	Herb, succulent
Commelina rogersii Burtt Davy	VU	No	Perennial	Herb
Cucumis humifructus Stent	VU	No	Annual	Herb
Cullen holubii (Burtt Davy) C.H.Stirt.	VU	No	Perennial	Shrub
Rhynchosia vendae C.H.Stirt.	VU	No	Perennial	Climber, herb
Streptocarpus longiflorus (Hilliard & B.L.Burtt) T.J.Edwards	VU	No	Perennial	Herb, lithophyte
Streptocarpus makabengensis Hilliard	VU	No	[No lifecycle defined]	Herb
Bowiea volubilis Harv. ex Hook.f. subsp. volubilis	VU	No	Perennial	Climber, geophyte, succulent
Ledebouria dolomiticola S.Venter	VU	No	Perennial	Geophyte
Ledebouria mokobulanensis Hankey & T.J.Edwards	VU	No	[No lifecycle defined]	[No lifeform defined]
Gladiolus sekukuniensis P.J.D.Winter	VU	No	Perennial	Geophyte, herb
Hesperantha saxicola Goldblatt	VU	No	Perennial	Geophyte, herb
Plectranthus porcatus Van Jaarsv. & P.J.D.Winter	VU	No	Perennial	Shrub
Ocotea kenyensis (Chiov.) Robyns & R.Wilczek	VU	No	Perennial	Tree
Marsilea farinosa Launert subsp. arrecta J.E.Burrows	VU	No	Perennial	Herb, hydrophyte
Lithops coleorum S.A.Hammer & Uijs	VU	No	Perennial	Succulent
Disa aristata H.P.Linder	VU	No	Perennial	Geophyte, herb
Eulophia coddii A.V.Hall	VU	No	Perennial	Geophyte, herb
Elytrophorus globularis Hack.	VU	No	Annual	Graminoid
Festuca dracomontana H.P.Linder	VU	No	Perennial	Graminoid
Oryza longistaminata A.Chev. & Roehr.	VU	No	Perennial	Graminoid, hydrophyte
Sartidia jucunda (Schweick.) De Winter	VU	No	Perennial	Graminoid
Prunus africana (Hook.f.) Kalkman	VU	No	Perennial	Tree
Thesium davidsonae Brenan	VU	No	Perennial	Herb, parasite
Thesium gracilentum N.E.Br.	VU	No	Perennial	Herb, parasite
Jamesbrittenia bergae P.Lemmer	VU	No	Perennial	Dwarf shrub

Species	Threat status	SA Endemic	Lifecycle	Growth forms
Cyphostemma hardyi Retief	VU	No	Perennial	Shrub, succulent
Encephalartos paucidentatus Stapf & Burtt Davy	VU	No	Perennial	Shrub, tree
ENDANGERED SPECIES (EN)				
Plinthus rehmannii G.Schellenb.	EN	No	Perennial	Dwarf shrub
Mondia whitei (Hook.f.) Skeels	EN	No	Perennial	Climber
Asparagus sekukuniensis (Oberm.) Fellingham & N.L.Mey.	EN	No	Perennial	Shrub
Aster nubimontis W.Lippert	EN	No	Annual (occ. perennial)	Herb
Cineraria cyanomontana Cron	EN	No	Perennial	Suffrutex
Inezia speciosa Brusse	EN	No	Perennial	Herb
Warburgia salutaris (G.Bertol.) Chiov.	EN	No	Perennial	Shrub, tree
Euphorbia barnardii A.C.White, R.A.Dyer & B.Sloane	EN	No	Perennial	Shrub, succulent
Argyrolobium muddii Dummer	EN	No	Perennial	Dwarf shrub, herb
Pearsonia callistoma Campb.-Young & K.Balkwill	EN	No	[No lifecycle defined]	Dwarf shrub
Ledebouria crispa S.Venter	EN	No	Perennial	Geophyte
Ocotea bullata (Burch.) Baill.	EN	No	Perennial	Tree
Ophioglossum gracillimum Welw. ex Hook. & Baker	EN	No	Perennial	Geophyte, herb
Brachycorythis conica (Summerh.) Summerh. subsp. transvaalensis Summerh.	EN	No	Perennial	Geophyte, herb
Leucospermum saxosum S.Moore	EN	No	Perennial	Shrub
Nemesia zimbabwensis Rendle	EN	No	[No lifecycle defined]	[No lifeform defined]
Encephalartos eugene-maraisii I.Verd.	EN	No	Perennial	Shrub, tree
CRITICAL ENDANGERED SPECIES (CR)				
Chlorophytum radula (Baker) Nordal	CR	No	Perennial	Herb
Euphorbia clivicola R.A.Dyer	CR	No	Perennial	Shrub, succulent
Euphorbia groenewaldii R.A.Dyer	CR	No	Perennial	Dwarf shrub, succulent
Acacia sekhukhuniensis P.J.H.Hurter	CR	No	Perennial	Tree
Gladiolus pavonia Goldblatt & J.C.Manning	CR	No	Perennial	Geophyte, herb
Brackenridgea zanguebarica Oliv.	CR	No	Perennial	Tree
Oberonia disticha (Lam.) Schltr.	CR	No	Perennial	Epiphyte, herb, succulent
Encephalartos cupidus R.A.Dyer	CR	No	Perennial	Dwarf shrub, geophyte
Encephalartos dolomiticus Lavranos & D.L.Goode	CR	No	Perennial	Shrub, tree
Encephalartos dyerianus Lavranos & D.L.Goode	CR	No	Perennial	Tree
Encephalartos hirsutus P.J.H.Hurter	CR	No	Perennial	Tree
Encephalartos inopinus R.A.Dyer	CR	No	Perennial	Shrub, tree
Encephalartos laevifolius Stapf & Burtt Davy	CR	No	Perennial	Shrub, tree
Siphonochilus aethiopicus (Schweinf.) B.L.Burtt	CR	No	Perennial	Geophyte, herb

12 APPENDIX C – BRAUN-BLANQUET TABLE

Table no	1	6	12	10	5	14	3	4	13	7	2	8	15	9	11
	10000	10000	10000	10000	10000	10000	10000	10000	20000	20000	20000	20000	20000	20000	20000
TWINSPAN Level 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	11000	12000	12000	12000	12000	12000	12000	12000	21000	21000	21000	21000	22000	22000	22000
TWINSPAN level 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cluster number	1	2	2	2	2	2	2	2	3	3	3	3	4	4	4
SPECIES GROUP A															
Dicoma tomentosa	+	+	1	+		+	+	+					+		
Eragrostis lehmanniana	+		1	+	+	+	+	+		+					
Acacia tortilis	1	2	+	+			+	+			+			+	
Commiphora mollis	1			1	1	1	+	+		1	1				
Achyranthes aspera	+		1	+			2	+		+	+		+		
Ocimum americanum	+	+	+	+		+								+	
SPECIES GROUP B															
Aristida congesta	1														
Aristida rhiniochloa	2										+				
Cissus cornifolia	+														
Combretum imberbe	+														
Evolvulus alsinoides	+														
Grewia flavescens	1														
Lannea schweinfurthii	1														
Lantana rugosa	+														
Ledebouria cooperi	+														
Psiadia punctulata	1														
Chamaecrista absus	+					+									
Eragrostis rigidior	+			+											
Geigeria acaulis	+		+												
Kyllinga alba	+					+									

Table no	1	6	12	10	5	14	3	4	13	7	2	8	15	9	11
TWINSPAN Level 1	10000	10000	10000	10000	10000	10000	10000	10000	20000	20000	20000	20000	20000	20000	20000
TWINSPAN level 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cluster number	11000	12000	12000	12000	12000	12000	12000	12000	21000	21000	21000	21000	22000	22000	22000
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	1	2	2	2	2	2	2	2	3	3	3	3	4	4	4
Tragus berteronianus	+		+												
Acacia erubescens	1					+		+			+		+		
Boscia foetida	r			+	+	+								1	
Schmidtia pappophoroides	+	+	+			+			+						
Waltheria indica	+		+	+		+									
SPECIES GROUP C															
Stipagrostis uniplumis		1	+	+	+	+		2		+		+		+	
Ptycholobium contortum		+	1	+	+	1			+		+			1	
SPECIES GROUP D															
Hermannia boraginiflora			+	+		+			+	+	+	+			+
Commiphora merkeri									1	1	1		+		
Sterculia rogersii								+	1		+	2			
Ochna inermis				+		+			+	1		+			
SPECIES GROUP E															
Enneapogon cenchroides	+	+	1	+		+	+	+	1	+		+			2
Hibiscus micranthus	+	+	+	+		+	1		+	+	+			+	
SPECIES GROUP F															
Digitaria eriantha														1	+
Gardenia resiniflua													2		+
Poa species													2		+
Tricholaena monachne									+					2	+
Panicum maximum		2												1	+
Ximenia caffra				+									+	+	
Commiphora tenuipetiolata						+			+			+	+	+	
Kirkia acuminata				+			1		2			+	2	2	

Table no	1	6	12	10	5	14	3	4	13	7	2	8	15	9	11
TWINSPAN Level 1	10000	10000	10000	10000	10000	10000	10000	10000	20000	20000	20000	20000	20000	20000	20000
TWINSPAN level 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cluster number	11000	12000	12000	12000	12000	12000	12000	12000	21000	21000	21000	21000	22000	22000	22000
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	1	2	2	2	2	2	2	2	3	3	3	3	4	4	4
Acacia nigrescens			+			+	+				2		+		2
SPECIES GROUP G															
Boscia albitrunca				1	1	+	+	1	1	+	+	+	+	+	
Aristida adscensionis			2	+	+	1	+		1	+	+			+	+
Sclerocarya birrea				r	+	+	1		2	+	2	+	+	1	2
SPECIES GROUP H - General species															
Colophospermum mopane	2	2	3	2	3	1	2	3	4	3	4	2	1	2	+
Dichrostachys cinerea	+	1	1	+	+	+	4	1		+	+	+		1	+
Grewia bicolor	2	+	1	+	+	+	+	+	+	+	1	+	1	+	+
Kyphocarpa angustifolia	+	+	+	1	+	1	1	+	+	+	+	+	+	+	
Terminalia prunioides	+	+	2	2	2	1	+	2	1	2	2	+	2		1
Combretum apiculatum	2			2		3	+	+			+	2		2	2
Grewia flava	+	+						+	+				+		+
Melinis repens	1							+			+		+	+	+
SPECIES GROUP I - Declared alien invasive species															
Opuntia ficus-indica							+								
SPECIES GROUP J - Species associated with disturbance/ exploitation															
Acrachne racemosa															+
Acrotome inflata			+				+								
Amaranthus praetermissus		+							+	+					
Aristida bipartita											+				
Asparagus cooperi												+	+		
Enteropogon macrostachyus													+		
Hirpicium bechuanense				+											
SPECIES GROUP K - Species associated with rockiness/ surface rock															

Table no	1	6	12	10	5	14	3	4	13	7	2	8	15	9	11
TWINSPAN Level 1	10000	10000	10000	10000	10000	10000	10000	10000	20000	20000	20000	20000	20000	20000	20000
TWINSPAN level 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cluster number	11000	12000	12000	12000	12000	12000	12000	12000	21000	21000	21000	21000	22000	22000	22000
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	1	2	2	2	2	2	2	2	3	3	3	3	4	4	4
Enneapogon scoparius				+	+			+					1		
Flueggea virosa							+		+		+				
Heteropogon contortus											+				
Kohautia caespitosa				+	+	+			+						
Leucas glabrata									+						
Rhigozum obovatum					+										
SPECIES GROUP L - Species associated with sandy/ coarse textured soils															
Cenchrus ciliaris		2						1							
Ceratotheca triloba		+	+	+					+						
Heliotropium steudneri								+	+						
Petalidium aromaticum												+			
SPECIES GROUP M - Species associated with thornveld/ fine textured soils															
Acacia senegal							+	+							
Hermbstaedtia fleckii				1					1						
SPECIES GROUP N - Species in close proximity to water courses															
Barleria senensis															1
Combretum microphyllum						+								2	
Crotalaria damarensis														+	
Crotalaria distans														+	
Crotalaria laburnifolia		+													
Dombeya autumnalis				r											
Monechma debile			+	+		+			+						
SPECIES GROUP O - Species associated with woodland/ bushveld															
Abutilon fruticosum						+	+	+	+						
Adansonia digitata				r										r	

Table no	1	6	12	10	5	14	3	4	13	7	2	8	15	9	11
	10000	10000	10000	10000	10000	10000	10000	10000	20000	20000	20000	20000	20000	20000	20000
TWINSPAN Level 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	11000	12000	12000	12000	12000	12000	12000	12000	21000	21000	21000	21000	22000	22000	22000
TWINSPAN level 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cluster number	1	2	2	2	2	2	2	2	3	3	3	3	4	4	4
Anthephora species														1	
Aptosimum lineare			+	+			+		+						
Barleria lancifolia								+							
Calostephane divaricata		+		+							+				
Cucumis zeyheri							+								
Ehretia rigida							+		+						
Grewia monticola				+		+									+
Grewia villosa									+						
Indigofera bainesii						+					+				
Monechma divaricatum								+							
Monsonia senegalensis														+	
Tephrosia polystachya						+								+	
Vernonia cinerascens			+						+		+				