
Community one (Table no 11)


Community one (Table no 18)


Community two (Table no 1)


Community two (Table no 15)


Community three (Table no 13)


Community three (Table no 20)


Community four (Table no 12)


Community four (Table no 19)

Photo plate 1: Overview of the appearance of the four vegetation communities present in the study area at a large scale.

Table 10: Overview of the average quantitative environmental attributes recorded per vegetation community

Source		SRTM DEM	SRTM DEM	Fieldwork	SRTM DEM	Fieldwork	Fieldwork	Fieldwork				
Average Values		Actual	Actual	Estimated	GIS model	Estimated	Actual	Estimated % Cover				
Community no	No of plots	Altitude (m)	Slope (°)	Slope (%)	Wetness index	A-horizon: % Clay	Soil depth (mm)	Gravel	Small stones	Medium stones	Large stones	Rock
1.1	2	1738	3	4	15	27	250	0	0	0	0	0
1.2	5	1725	3	4	14	13	450	0	0	0	3	10
2	6	1679	5	7	13	20	592	2	1	3	5	8
3	7	1764	2	3	14	13	507	0	0	0	0	0
4	4	1787	4	10	12	8	100	0	1	4	13	38

Table 11: Overview of the lithological units associated with the vegetation communities

Community	Lithological Units	Frequency	% per study area	% per community
1	Diamictite (polymictic clasts, set in a poorly sorted, fine-grained matrix) with varved shale, mudstone with dropstones and fluvioglacial gravel common in the north	1	4%	14%
	Fine- to coarse-grained sandstone, shale, coal seams	3	13%	43%
	Metamorphosed mudstone and shale with minor quartzite, dolomite and chert	1	4%	14%
	Mudrock	2	9%	29%
2	Diabase	1	4%	17%
	Mudrock	5	22%	83%
3	Fine- to coarse-grained sandstone, shale, coal seams	4	17%	67%
	Mudrock	1	4%	17%
	Quartzite, minor shale;	1	4%	17%
4	Quartzite, feldspathic quartzite, arkose	2	9%	50%
	Quartzite, minor shale;	2	9%	50%
	TOTALS	23	100%	

Table 12: Overview of the average quantitative vegetation characteristics per vegetation community collected during the fieldwork

Community no	No of plots	Estimated % Cover						Estimated height values						
		Total	Tree layer	Shrub layer	Herb layer	Grass layer	Forb layer	Highest trees (m)	Lowest trees (m)	Highest shrub (m)	Lowest shrubs (m)	High herbs (cm)	Lowest herbs (cm)	Maximum height (cm)
1.1	2	98	0	0	98	85	13	0.0	0.0	0.0	0.0	40	15	75
1.2	5	84	0	7	77	53	25	0.0	0.0	0.3	0.2	35	9	110
2	6	84	0	8	76	58	18	0.0	0.0	1.3	0.2	33	7	118
3	7	87	0	1	86	62	22	0.0	0.0	0.1	0.1	21	5	75
4	4	79	0	5	73	56	16	0.0	0.0	0.4	0.1	29	6	83

Centella asiatica, *Chaetacanthus costatus, Commelina africana, Conyza bonariensis, Conyza podocephala, Crabbea acaulis, Crepis hypochaeridea, Cucumis zeyheri, Dicoma zeyheri, Eucomis autumnalis, Gladiolus crassifolius,* ***Helichrysum aureonitens***, *Helichrysum callicomum, Helichrysum coriaceum, Helichrysum rugulosum, Helichrysum setosum, Hermannia transvaalensis, Hibiscus trionum, Hypericum lalandii, Hypochaeris radicata, Hypoxis rigidula, Ledebouria ovatifolia, Leonotis intermedia,* ***Lobelia flaccida***, *Lotononis eriantha,* ***Monopsis decipiens***, *Nemesia fruticans, Nesaea schinzii, Nidorella anomala, Oenothera tetraptera, Oldenlandia herbacea, Pelargonium luridum, Peucedanum magalismontanum, Plantago lanceolata, Pollichia campestris, Polygala hottentotta, Pseudognaphalium luteo-album, Pygmaeothamnus zeyheri, Rabdosiella calycina, Raphionacme hirsuta, Rumex acetosella, Sebaea leiostyla,* ***Senecio achilleifolius***, ***Senecio erubescens***, *Senecio oxyriifolius, Senecio scitus, Silene burchellii, Solanum panduriforme, Sutera caerulea, Tephrosia capensis, Tephrosia elongata, Trifolium pratense,* ***Verbena bonariensis***, ***Verbena brasiliensis***, *Verbena tenuisecta, Vernonia hirsuta, Vernonia natalensis,* ***Wahlenbergia undulata***, *Walafrida densiflora, Zornia linearis*
Woody species: *Athrixia elata, Diospyros lycioides, Felicia filifolia, Otholobium polyphyllum, Protasparagus laricinus, Rhus discolor, Rhus magalismontana, Stoebe vulgaris*

This community represents either seasonal or temporary wetland areas, occurring in the landscape either in the headwater areas of drainage systems or as hillside seeps. The species associated with surface water (**bold and italics**) represents sub-community one, and experience at least seasonal inundation, while the other species (italics only) are associated with temporary wetland areas or zones. Sub-community one (Appendix B) is also associated with finer texture soils (clayey) (Table 10), while sub-community two, who occurs most probably on the edge of sub-community one is associated with coarse textured soils. The finer material is moved out of the higher lying areas into the lowerlying area, accompanied with the exposure of surface rock. Due to the finer textured soils and the presence of moisture these areas, especially those associated with sub-community one tends to be over utilised by livestock.

2. Shrub dominated utilised grassland on sandy clay loam soils with surface rock derived from mudrock

Phytosociological name: *Brachiaria serrata - Diospyros lycioides* shrub dominated sub-climax grassland on fine textured, rocky soils derived from mudrock

This community occurs on steeper slopes, mainly in the lower lying areas of the study area towards the east, due to it steeper slopes, it is less likely for water to accumulate in it (Table 10). However due to its strong association with mudrock (Table 11), it is associated with finer texture soils (average % clay within the A-horizon: 20%) (Table 10). Due to the presence of surface rock, shrubs reaching an average height of 1.3 m are present (Table 12).

The following species were recorded within this community:
Grasses: *Abildgaardia ovata, Alloteropsis semialata,* ***Aristida bipartita***, ***Aristida congesta***, ***Aristida junciformis***, *Aristida meridionalis, Bewsia biflora, Brachiaria serrata, Cymbopogon excavatus,* ***Cynodon dactylon***, *Diheteropogon amplectens, Elionurus muticus, Eragrostis capensis, Eragrostis chloromelas, Eragrostis curvula,* ***Eragrostis plana***, *Eragrostis racemosa,* ***Heteropogon contortus***, *Hyparrhenia dregeana, Hyparrhenia filipendula,* ***Hyparrhenia hirta***, *Kyllinga alba, Melinis nerviglumis, Microchloa caffra, Monocymbium ceresiiforme, Paspalum urvillei, Schizachyrium sanguineum, Scirpus burkei, Setaria sphacelata, Sporobolus africanus, Themeda triandra, Trachypogon spicatus, Tristachya leucothrix, Tristachya rehmannii*
Forbs: *Acalypha angustata, Acalypha peduncularis, Acrotome inflata, Agapanthus inapertus, Agrimonia procera, Alepidea natalensis, Anthericum fasciculatum, Anthospermum rigidum, Aristea woodii, Aster bakerianus, Becium obovatum, Berkheya insignis, Berkheya setifera, Berkheya speciosa, Bidens pilosa,* ***Boophone disticha***, *Chaetacanthus costatus, Cheilanthes viridis, Commelina africana, Conyza bonariensis, Conyza podocephala, Corchorus confusus, Corycium nigrescens, Crabbea acaulis, Crabbea ovalifolia, Crepis hypochaeridea, Cucumis hirsutus, Cucumis zeyheri, Dichapetalum cymosum, Dicoma anomala, Dicoma zeyheri, Eriosema salignum, Eriospermum species,* ***Eucomis autumnalis***, *Gazania krebsiana, Geigeria burkei, Gerbera piloselloides,* ***Gladiolus crassifolius***, *Habenaria lithophila,* ***Haemanthus*** *species, Haplocarpha lyrata, Haplocarpha scaposa, Helichrysum acutatum, Helichrysum aureonitens, Helichrysum auriceps, Helichrysum cephaloideum, Helichrysum coriaceum, Helichrysum nudifolium, Helichrysum rugulosum, Helichrysum setosum, Hemizygia pretoriae, Hermannia depressa, Hermannia lancifolia, Hermannia transvaalensis, Hypericum aethiopicum,* ***Hypoxis hemerocallidea***, ***Hypoxis obtusa***, ***Hypoxis rigidula***, *Indigofera zeyheri, Ipomoea ommanneyi, Justicia anagalloides, Leonotis intermedia, Limeum sulcatum, Monopsis decipiens, Oldenlandia herbacea,* ***Pelargonium***

***luridum**, Pellaea calomelanos, Pentanisia angustifolia, Pentanisia prunelloide, Phyllanthus parvulus, Plantago lanceolata, Pollichia campestris, Polygala hottentotta, Rabdosiella calycina, Raphionacme species, Satureja biflora, Scabiosa columbaria, Sebaea leiostyla, Senecio coronatus, Senecio erubescens, Senecio inornatus, Senecio lydenburgensis, Senecio scitus, Senecio venosus, Silene burchellii, Striga asiatica, Tephrosia capensis, Tephrosia elongata, Thesium utile, Thunbergia atriplicifolia, Verbena brasiliensis, Vernonia natalensis, Vernonia oligocephala, Wahlenbergia undulata, Walafrida densiflora, Zaluzianskya maritima, Zornia linearis*
Woody species: *Athrixia elata, Diospyros lycioides, Erythrina zeyheri, Protasparagus laricinus, Pyrenacantha grandiflora, Rhus discolor, Rhus tumulicola, Stoebe vulgaris*

This community at a landscape level presents sweetveld due to the presence of finer material, and should therefore be favoured by livestock. The source of the finer material is the *in situ* weathering of the mudrock on which it occurs. The presence of the grass species associated with grazing pressure (**bold & italic**) supports this statement, while the presence of the geophytes (bulbous forbs – **bold & italic**) indicates that the area is in general to steep and too shallow to plough. The presence of surface rock also protects the area from cultivation.

3. Shrub Climax grassland on loamy sand soils derived from sandstone

Phytosociological name: *Helichrysum acutatum - Themeda triandra climax* grassland on coarse textured soils derived from sandstone

This community occurs on gentler slopes, mainly in the higher lying areas of the study area towards the west, due to its gentler slopes, it is more likely for water to accumulate in it (Table 10). However due to its strong association with sandstone (Table 11), it is associated with coarser texture soils (average % clay within the A-horizon: 13%) (Table 10). This community contains no surface rock (Table 10). This is a predominantly grassland community (Table 12).

The following species were recorded within this community:
Grasses: *Agrostis montevidensis, Alloteropsis semialata, Andropogon schirensis, Aristida congesta, Aristida junciformis, Aristida meridionalis, Aristida stipitata, Cyperus esculentus, Digitaria eriantha, Digitaria monodactyla, Diheteropogon amplectens, Elionurus muticus, Eragrostis capensis, Eragrostis chloromelas, Eragrostis curvula, **Eragrostis gummiflua**, Eragrostis nindensis, Eragrostis plana, Eragrostis racemosa, **Harpochloa falx**, Helictotrichon turgidulum, Heteropogon contortus, Kyllinga alba, Loudetia simplex, Microchloa caffra, Miscanthus junceus, Monocymbium ceresiiforme, Panicum natalense, Setaria sphacelata, Themeda triandra, **Trachypogon spicatus**, **Trichoneura grandiglumis**, **Tristachya leucothrix**, **Tristachya rehmannii***
Forbs: *Acalypha angustata, Acrotome hispida, Aeschynomene rehmannii, Anthericum cooperi, Anthospermum rigidum, Babiana hypogaea, Becium obovatum, Berkheya setifera, Boophone disticha, Chamaecrista mimosoides, Chlorophytum transvaalense, Commelina africana, Conyza bonariensis, Conyza podocephala, Crabbea acaulis, Crassula vaginata, Crepis hypochaeridea, Crocosmia paniculata, Cucumis hirsutus, Delosperma ashtonii, Dicoma anomala, Elephantorrhiza elephantina, Eriosema salignum, Eucomis autumnalis, Geigeria burkei, Gnidia caffra, Gnidia capitata, Haplocarpha lyrata, Helichrysum acutatum, Helichrysum aureonitens, Helichrysum callicomum, Helichrysum cephaloideum, Helichrysum nudifolium, Helichrysum rugulosum, Hermannia lancifolia, Hermannia transvaalensis, Hibiscus aethiopicus, Hibiscus trionum, Hypericum aethiopicum, Hypoxis hemerocallidea, Hypoxis obtusa, Hypoxis rigidula, Indigofera hedyantha, Indigofera zeyheri, Ipomoea bathycolpos, Ipomoea ommanneyi, Justicia anagalloides, Kohautia amatymbica, Ledebouria cooperi, Ledebouria ovatifolia, Lobelia flaccida, Lotononis eriantha, Manulea parviflora, Monopsis decipiens, Moraea species, Nidorella hottentotica, Pelargonium luridum, Pentanisia angustifolia, Pollichia campestris, Pygmaeothamnus zeyheri, Raphionacme hirsuta, Rhynchosia totta, Rumex acetosella, Scabiosa columbaria, Sebaea grandis, Sebaea leiostyla, Senecio achilleifolius, Senecio coronatus, Senecio erubescens, Striga asiatica, Striga bilabiata, Sutera caerulea, Sutera neglecta, Tephrosia capensis, Tephrosia purpurea, Thunbergia atriplicifolia, Vernonia natalensis, Vernonia oligocephala, Wahlenbergia undulata, Watsonia densiflora, Zornia linearis*
Woody species: *Diospyros lycioides, Stoebe vulgaris*

This community at a landscape level are transitional between the lowlying sweetveld and highlying sourveld due to the presence of coarser material, it is utilised by livestock during the summer monhts. The source of the coarser material is the *in situ* weathering of the sandstone on which it occurs. The presence of the grass species associated with lower grazing pressure (**bold & italic**) and climax

conditions supports this statement. Due to the absence of surface rock and less steep slopes, this community is most likely to be used for cultivation in the future.

4. Short climax grassland on highlying areas associated with very shallow, sandy soils large rocks and boulders on quartzite rock

Phytosociological name: *Stachys natalensis - Monocymbium ceresiiforme* short grassland on large outcrops with very shallow, very coarse textured soils derived from quartzite

This community occurs on the higher lying areas, mainly crests of the study area (Table 10). The quartzite is more resistant to weathering (Table 11), while its position in the landscape results in the removal of finer materials, resulting in coarser textured soils being present (average % clay within the A-horizon: 8% - Table 10). This community contains the most surface rock, specifically large boulders and rock sheets and its soil depth is the shallowest (Table 10). Due to the presence of surface rock, shrubs are present (Table 12).

The following species were recorded within this community:
Grasses: *Abildgaardia ovata, Alloteropsis semialata, Aristida congesta, Aristida junciformis, Aristida meridionalis, Brachiaria serrata, Cymbopogon excavatus, Cyperus rupestris, Diheteropogon amplectens, Elionurus muticus, Eragrostis chloromelas, Eragrostis curvula, Eragrostis nindensis, Eragrostis plana, Eragrostis racemosa, Harpochloa falx, Heteropogon contortus, Loudetia simplex, Melinis nerviglumis, Melinis repens, Microchloa caffra, Monocymbium ceresiiforme, Panicum natalense, Schizachyrium sanguineum, Sporobolus pectinatus, Trachypogon spicatus, Tristachya leucothrix, Tristachya rehmannii, Urelytrum agropyroides*
Forbs: *Acalypha angustata, Achyranthes aspera, Aeschynomene rehmannii, Anthericum cooperi, Anthospermum hispidulum, Anthospermum rigidum, Aristea woodii, Aster peglerae, Babiana hypogaea, Castalis spectabilis, Chamaecrista mimosoides, Cheilanthes viridis, Commelina africana, Crassula setulosa, Crepis hypochaeridea, Delosperma ashtonii, Elephantorrhiza elephantina, Gladiolus ecklonii, Gnidia caffra, Gnidia capitata, Helichrysum acutatum, Helichrysum callicomum, Helichrysum nudifolium, Helichrysum setosum, Hemizygia pretoriae, Hermannia lancifolia, Hermannia transvaalensis, Hypoxis obtusa, Indigofera hedyantha, Ipomoea ommanneyi, Kalanchoe thyrsiflora, Manulea parviflora, Monsonia angustifolia, Nerine rehmannii, Oldenlandia herbacea, Oxygonum dregeanum, Pellaea calomelanos, Pentanisia angustifolia, Pygmaeothamnus zeyheri, Rabdosiella calycina, Raphionacme species, Rumex acetosella, Scabiosa columbaria, Sebaea leiostyla, Selaginella dregei, Senecio lydenburgensis, Senecio oxyriifolius, Senecio scitus, Senecio venosus, Silene burchellii, Stachys natalensis, Tephrosia elongata, Tetraselago natalensis, Ursinia nana, Vernonia galpinii, Wahlenbergia epacridea, Wahlenbergia undulata, Walafrida densiflora, Zornia linearis*
Woody species: *Diospyros lycioides, Felicia filifolia, Lopholaena coriifolia, Parinari capensis, Protea welwitschii, Rhus tumulicola*

This community occurs on the ridges within the landscape, more specifically on the crests. Due to its very coarse texture, it represents sourveld. Its shallow soils and very steep slopes protect it from exploitation, whether for grazing or cultivation. This community represents the driest unit in the landscape because the low tendency for water to accumulate in the landscape. However the ruggedness of the terrain (rockiness) does favour localised infiltration of rain water, which enables the establishment of woody species, while protecting them from intensive veld fires.

Overall it can be concluded that these four communities are typical of the remaining grassland in the landscape, which has not been ploughed because they are either to wet, to shallow, to steep, to rocky or a combination of these factors. It is expected that the remaining grassland in the west will experience higher grazing pressure than the grassland to the east, where the landscape is more intact (Figure 11). The increase in estimated cover abundance of grass species associated low grazing pressure (decreaser species) from west to east and an decrease in increaser species (high grazing pressure)(, supports this statement.

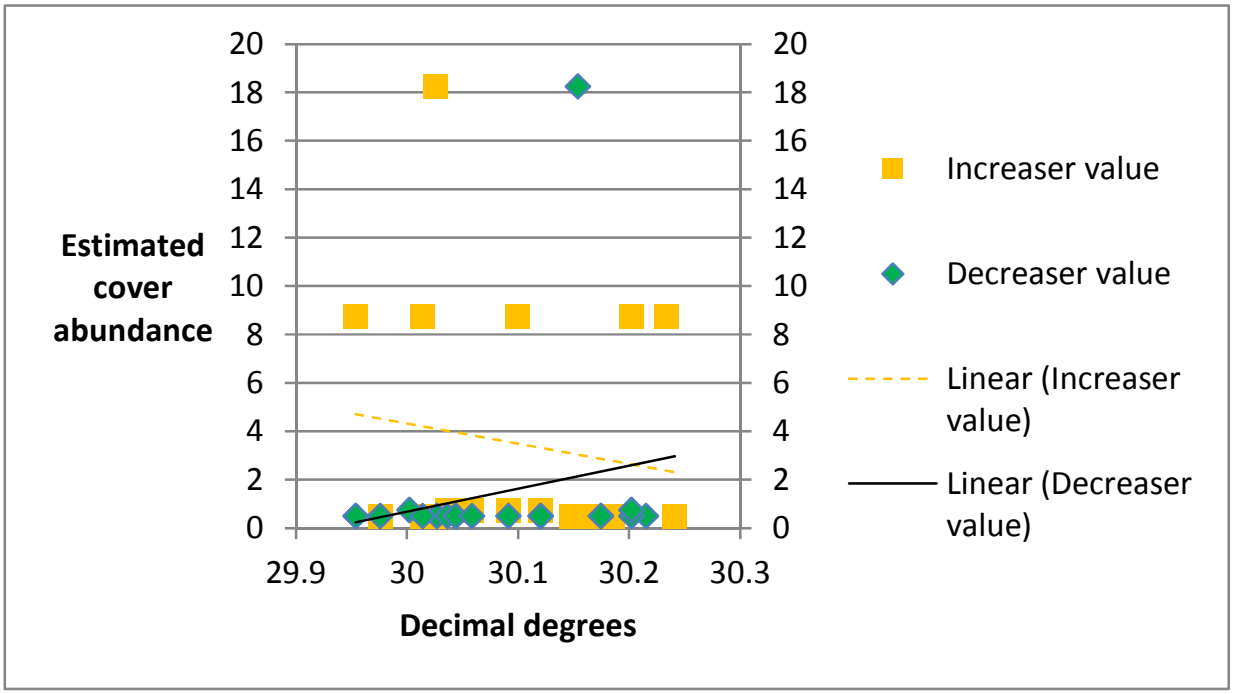

Figure 13: Overview of the grazing pressure experienced by the grassland areas within the study area from west to east based on the estimated cover abundance of increaser and decreaser grass species.

5.2.2 Species diversity

Species richness

A total of 245 species were recorded during the survey, representing 57 plant families, of which 165 species (68%) are forbs, 63 species (26%) are grasses/ gramnnoids and 14 species (6%) are woody species (Table 13).

It is evident that forbs form a significant component of the herbaceous layer, in terms of species richness at forb: grass ratio of 3:1 (Table 13). Therefore forbs should form a critical component of the rehabilitation mixture especially species from the Asteraceae and Fabaceae families (Appendix C).

Threatened and protected species

Two threatened (Vulnerable, Endangered, Critical Endangered) plant species according to the latest Red Data flora assessment from SANBI[5], was recorded during the survey, namely *Crassula setulosa* Harv. var. *deminuta* (Diels) Toelken (Vulnerable) and *Helichrysum aureum* (Houtt.) Merr. var. *argenteum* Hilliard (Vulnerable). *Crassula setulosa* was observed in community 4. However, these two species were not positively identified by taxonomic specialists and therefore their identity and status should be verified prior to construction. In addition provision was made for the presence of other threatened Red Data flora in the flora sensitivity model, because obviously it was not possible to cover every square metre of the study area within the current scope of the project.

The following twelve species, which are protected in terms of the Mpumalanga Nature Conservation Ordinance, were recorded during the survey; they are *Agapanthus campanulatus, Agapanthus inapertus, Eucomis autumnalis, Gladiolus crassifolius, Gladiolus ecklonii, Haemanthus species, Watsonia densiflora, Corycium nigrescens, Habenaria lithophila, Protea welwitschii, Boophane disticha, Haemanthus species*. It should be noted that all species from the genera *Agapanthus, Eucomis, Gladiolus, Haemanthus* and *Watsonia* are protected as well as all species from the families Orchidaceae (*Habenaria* species and others) and Proteaceae. It is evident that these species occur throughout the study area where natural vegetation is remaining (Table 14). **Protected species in terms of the Conservation Ordinance requires a permit for their removal/ translocation and if used in commercial activities**.

Medicinal Plants

Nine species with medicinal properties were recorded within the survey; they are *Centella asiatica, Elephantorrhiza elephantina, Eucomis autumnalis subsp. autumnalis, Hypoxis hemerocallidea, Pelargonium luridum, Pellaea calomelanos var. calomelanos, Pentanisia prunelloides subsp. prunelloides, Scabiosa columbaria* and *Vernonia oligocephala.* These species were present throughout the study area (Table 15); they do not have specific conservation status, but do run the risk of being exploited during the construction phase in the vicinity of construction camps.

Alien invasive species

No alien invasive species were recorded in the natural areas that were sampled during the survey. However, declared alien invasive woody species are present within the landscape, mainly associated with forestry for example Acacia mearnsii (Wattle) and *Eucalyptus* species (Bluegum) and *Pinus* (Pine). Other weeds and/ declared invasive species will occur in the cultivated lands or old fields.

Localised biodiversity hotspots

Based on the observation made during the survey, it is apparent that rocky areas present localised biodiversity hotspots, containing (Figure 14):

1. between 10% and 70% more species than was recorded on average per plot (35 species) (Table 16)

[5] http://posa.sanbi.org/searchspp.php

Table 13: Overview of the plant families and growth forms recorded during the survey

Plant family	Growth Forms			Plant Family Statistics		
	Forbs	Grasses	Woody species	Species per family	% Frequency	Cumulative % Frequency
Poaceae		53		53	22%	22%
Asteraceae	44		4	48	20%	42%
Fabaceae	13		2	15	6%	48%
Cyperaceae		9		9	4%	52%
Lamiaceae	8			8	3%	55%
Rubiaceae	7			7	3%	58%
Scrophulariaceae	7			7	3%	61%
Iridaceae	6			6	2%	63%
Malvaceae	6			6	2%	66%
Acanthaceae	5			5	2%	68%
Anthericaceae	4			4	2%	69%
Anacardiaceae			3	3	1%	71%
Apiaceae	3			3	1%	72%
Crassulaceae	3			3	1%	73%
Hyacinthaceae	3			3	1%	74%
Hypoxidaceae	3			3	1%	76%
Verbenaceae	3			3	1%	77%
Agapanthaceae	2			2	1%	78%
Amaryllidaceae	2			2	1%	79%
Asphodelaceae	2			2	1%	79%
Campanulaceae	2			2	1%	80%
Caryophyllaceae	2			2	1%	81%
Convolvulaceae	2			2	1%	82%
Cucurbitaceae	2			2	1%	83%
Euphorbiaceae	2			2	1%	83%
Gentianaceae	2			2	1%	84%
Geraniaceae	2			2	1%	85%
Hypericaceae	2			2	1%	86%
Lobeliaceae	2			2	1%	87%
Orchidaceae	2			2	1%	88%
Orobanchaceae	2			2	1%	88%
Polygonaceae	2			2	1%	89%
Pteridaceae	2			2	1%	90%
Thymelaeaceae	2			2	1%	91%
Amaranthaceae	1			1	0%	91%
Apocynaceae	1			1	0%	92%
Asparagaceae			1	1	0%	92%
Chrysobalanaceae			1	1	0%	93%
Commelinaceae	1			1	0%	93%

Dichapetalaceae	1			1	0%	93%
Dipsacaceae	1			1	0%	94%
Ebenaceae			1	1	0%	94%
Icacinaceae			1	1	0%	95%
Juncaceae		1		1	0%	95%
Lythraceae	1			1	0%	95%
Mesembryanthemaceae	1			1	0%	96%
Molluginaceae	1			1	0%	96%
Onagraceae	1			1	0%	97%
Phyllanthaceae	1			1	0%	97%
Plantaginaceae	1			1	0%	98%
Polygalaceae	1			1	0%	98%
Proteaceae			1	1	0%	98%
Rosaceae	1			1	0%	99%
Santalaceae	1			1	0%	99%
Selaginellaceae	1			1	0%	100%
Solanaceae	1			1	0%	100%
Grand Total	**165**	**63**	**14**	**242**	**100%**	
	68%	26%	6%			
Forbs: grasses	3					

Table 14: Overview of the plant communities in which the Mpumalanga protected species were recorded

Botanical Name	Community Name				Grand Total
	1	2	3	4	
Agapanthus campanulatus subsp. campanulatus	1				1
Agapanthus inapertus subsp. inapertus	1	2			3
Eucomis autumnalis subsp. autumnalis	1	2	1		4
Gladiolus crassifolius	3	3			6
Gladiolus ecklonii				1	1
Habenaria lithophila		1			1
Protea welwitschii				2	2
Watsonia densiflora			3		3
Grand Total	**6**	**8**	**4**	**3**	**21**

Table 15: Overview of the medicinal plants recorded within the study area

Botanical Name	Vegetation community				
	1	2	3	4	Grand Total
Centella asiatica	1				1
Elephantorrhiza elephantina			1	1	2
Eucomis autumnalis subsp. autumnalis	1	1	1		3
Hypoxis hemerocallidea		1	1		2
Pelargonium luridum	1	1	1		3
Pellaea calomelanos var. calomelanos		1		1	2
Pentanisia prunelloides subsp. prunelloides		1			1
Scabiosa columbaria		1	1	1	3
Vernonia oligocephala		1	1		2
Grand Total	**3**	**7**	**6**	**3**	**19**

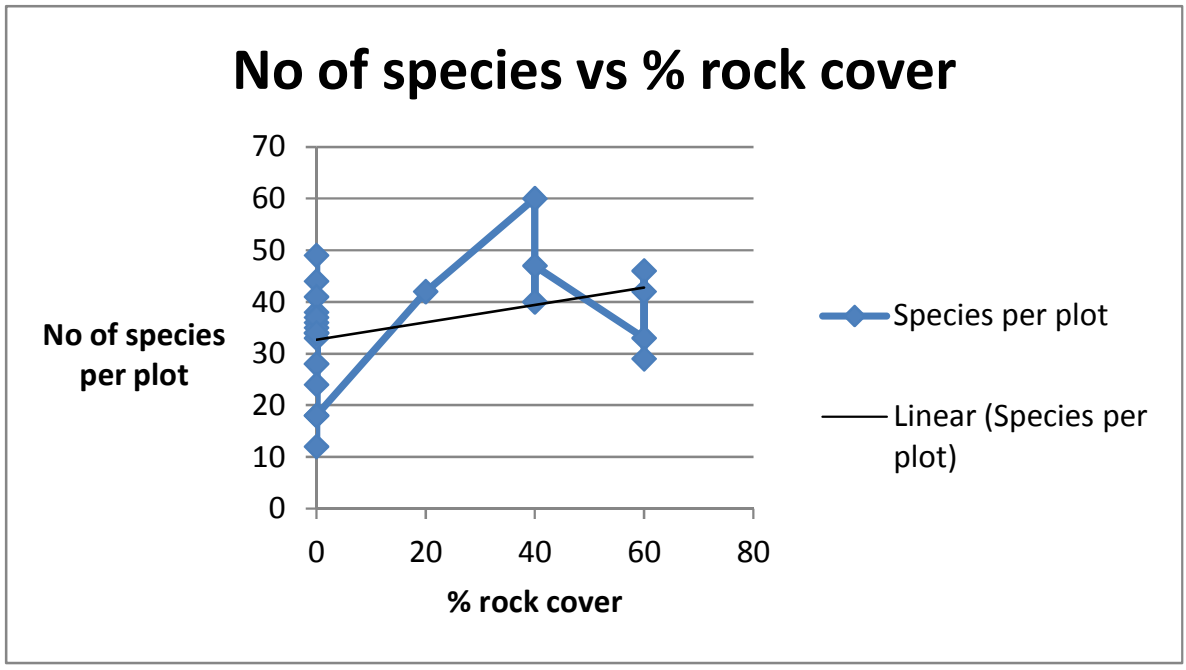

Figure 14: Line graph reflecting the increase in no of species per plot with an increase in the percentage rock cover

Table 16: Overview of the increase of number of species with an increase of percentage surface rock

% Large rocks	Species per plot	Fraction of average species per plot
0	38	1.08
0	28	0.79
0	33	0.93
0	49	1.39
0	36	1.02
0	34	0.96
0	12	0.34
0	44	1.25
0	41	1.16
0	35	0.99
0	28	0.79
0	37	1.05
0	24	0.68
0	18	0.51
0	34	0.96
0	18	0.51
20	42	1.19
40	60	1.70
40	40	1.13
40	47	1.33
60	33	0.93
60	46	1.30
60	42	1.19
60	29	0.82
Average value	**35**	

6 EVALUATION OF THE PROPOSED ROUTE ALTERNATIVES

The ensure objectivity and transparency two models of sensitivity were used to evaluate the three proposed route alternatives in terms of which of the three proposed route alternatives will:

1. cross the most least sensitive areas
2. avoid the most sensitive areas.

The one model was derived from the results of the literature review, taking in consideration the sensitive ecosystems and threatened species present in the area (Figure 11). The second model is the KwaZulu-Natal Ezemvelo's Conservation Plan (C-Plan) (Figure 5).

6.1 Flora Sensitivity Model

This model was compiled by rating/ weighting landscape features obtained from small-scale datasets (refer to the Ecosystem Diversity Section) and associated with potential habitat for threatened flora a value of between one (1) and five (5). The landscape features that were used where:

1. Geology
2. Altitudinal Classes
3. Landform
4. Topography
5. Landtype
6. National land cover 2000
7. Vegmap 2006

The different layers were cumulatively combined and then divide by the number of layers to produce the flora sensitivity layer. This layer was then incorporated into the total sensitivity layer. However for the purpose of this document, the extent/ percentage cover of very low, low, moderate, high and very high sensitivity areas were extracted per route alternative's two kilometre (2 km) corridor from the flora sensitivity layer (Figure 7, Table 17).

Based on the flora sensitivity model, alternative 5 associated with the least cost model, is the least sensitivity and the most suitable for the construction of the power line from a flora perspective. Alternative 1 is the most sensitive and therefore the least suitable for the construction of the power line.

6.2 Mpumalanga Parks Board Conservation Plan

Analysis of the Mpumalanga Conservation Plan supports/ confirms the results at scoping level from the flora sensitivity analysis that route alternative five is the least environmental sensitive alignment and therefore the preferred alignment in terms of vegetation (Table 18). This statement is based on the following factors:

1. Route alternative five includes the highest percentage of no natural habitat remaining (50%)
2. Route alternative five includes no irreplaceable areas

In addition to the above two models which provided similar results, two more parameters were evaluated, namely:

1. Ruggedness, which correlates with slope and therefore rockiness, which during the field survey was associated with localised areas of high species diversity
2. The ratio of natural vegetation, which represent potential habitat for threatened flora against the transformed areas.

Table 17: Overview of the extent and percentage cover of sensitive flora habitat within the landscape per two kilometre route alternative corridor

Route Corridors		Alternative 01	Alternative 03	Alternative 05
Source		ESKOM	ESKOM	Environmental Least Cost
Vegetation Sensitivity Qualitative	Sensitivity Class	Hectares	Hectares	Hectares
Very low	1	52	186	585
Low	2	5518	5783	6215
Moderate	3	5070	5623	3456
High	4	989	630	237
Very high	5	5	4	
	TOTAL	11634	12226	10492
		Hectares	Hectares	Hectares
Very low	1	0%	2%	6%
Low	2	47%	47%	59%
Moderate	3	44%	46%	33%
High	4	9%	5%	2%
Very high	5	0%	0%	0%
		100%	100%	100%
Sensitivity		Most		Least
Suitability		Least		Most

Table 18: Overview of the extent and percentage cover of conservation priority areas within the landscape per two kilometre route alternative corridor based on Mpumalanga's Conservation Plan

Route corridors	**Alternative 01**	**Alternative 03**	**Alternative 05**
Source	**ESKOM**	**ESKOM**	**Environmental Least Cost**
ASSESSMENT	**Surface (ha)**	**Surface (ha)**	**Surface (ha)**
No Natural Habitat Remaining	2734	4670	5275
Least Concern	3408	3974	3155
Important & Necessary	1106	1643	1187
Highly Significant	3283	761	850
Irreplaceable	184	114	
TOTALS	10715	11163	10468
ASSESSMENT	**Surface (ha)**	**Surface (ha)**	**Surface (ha)**
No Natural Habitat Remaining	26%	42%	50%
Least Concern	32%	36%	30%
Important & Necessary	10%	15%	11%
Highly Significant	31%	7%	8%
Irreplaceable	2%	1%	0%
TOTALS	100%	100%	100%
Sensitivity	Most		Least
Suitability	Least		Most

Slopes of more than 5° are associated with ridges and geological formations often outcrops or represents these ridges, the presence of the rock provides microhabitat for species to colonise/ inhabit, resulting in the increase presence of species in general. With regards to ruggedness the least sensitive and therefore the most suitable route corridor is corridor three, with alternative one remaining the most sensitive and therefore the least suitable (Table 19).

When considering the ratio of natural to transformed areas per route corridor alternative, alternative five (5) is once again the least sensitive and therefore the most suitable (Table 20) because it contains the highest percentage of transformed land at 70%.

7 CONCLUSION

The proposed power line will transect mainly grassland, the literature – and desktop review indicated that these grassland areas are sensitive and threatened.

Of the three proposed route alternatives, route alternative five is the least sensitive in terms of the vegetation and therefore the preferred route alignment, with route alternative one the overall most sensitive and should therefore be avoided from a floristic perspective (Table 21) in a green fields scenario.

However, the weighted difference between alternative 5 and 3 is not as large as between alternative 5 and 1, and therefore alternative 3 could be considered because it occurs in an area where existing impacts are present. International literature indicates that it is preferable to keep impacts together rather than spreading it through the landscape, by keeping impacts together especially linear infrastructure, habitat loss and – fragmentation is reduced (Forman *et al* 2003, Hilty *et al* 2006).

Table 19: Overview of the percentage steep sloped areas as an indicator of ruggedness/ rockiness per proposed 2 km route alternative

Route corridors	Alternative 01	Alternative 03	Alternative 05
Source	**ESKOM**	**ESKOM**	**Environmental Least Cost**
Category	Hectares	Hectares	Hectares
0 - 5°	9195	11204	9199
5 - 10°	1916	922	1105
10 - 15°	431	76	146
15 - 20°	81	11	41
20°+	18	1	6
TOTALS	11642	12213	10498
Category	Hectares	Hectares	Hectares
0 - 5°	79.0%	91.7%	87.6%
5 - 10°	16.5%	7.5%	10.5%
10 - 15°	3.7%	0.6%	1.4%
15 - 20°	0.7%	0.1%	0.4%
20°+	0.2%	0.0%	0.1%
TOTALS	100.0%	100.0%	100.0%
Sensitivity	Most	Least	
Suitability	Least	Most	

Table 20: Overview of the ratio between natural and transformed areas per proposed route corridor alternative obtained from the National Land Cover 2000 dataset

Route corridors	Alternative 01	Alternative 03	Alternative 05
Source	**ESKOM**	**ESKOM**	**Environmental Least Cost**
Category	Hectares	Hectares	Hectares
Natural	9896	8721	7308
Transformed	1746	3492	3190
TOTALS	11642	12213	10498
Category	Hectares	Hectares	Hectares
Natural	85%	71%	70%
Transformed	15%	29%	30%
TOTALS	100%	100%	100%
Sensitivity	Most		Least
Suitability	Least		Most

Table 21: Summary of sensitivity results from various sources

Alternative	Flora Sensitivity	Ruggedness	Transformation	C-Plan	Total	Sensitivity	Suitability
1	3	3	3	3	12	Highest	Lowest
3	2	1	2	2	7		
5	1	2	1	1	5	Lowest	Highest

8 ENVIRONMENTAL IMPACT ASSESSMENT

The impacts associated with the proposed project relevant to the flora of the study were assessed in terms of the following criteria:

- ~ Nature
- ~ Extent
- ~ Duration
- ~ Intensity
- ~ Frequency of occurrence
- ~ Probability of occurrence
- ~ Significance
- ~ Status
- ~ Degree of confidence

Where relevant, criteria were scored in terms of severity and the significance of each criterion estimated based on the total score of each impact.

The following classes and scores were used during the scoring of impacts:

1. Nature of impact: a description of each impact. No scoring relevant.
2. Extent: 1 = limited to the immediate study area; 2 = including a 2 km radius surrounding the immediate study area; 3 = a major portion of an area or province affected; 4 = impact has a national or international relevance.
3. Duration: 1 = impact has a short-term implication (0-3 years); 2 = impact has a medium-term implication (4-10 years); 3 = impact has a long-term implication (10+ years); 4 = permanent.
4. Intensity: 1 = very low; 2 = low; 3 = medium; 4 = high.
5. Frequency of occurrence: 1 = Time-linked; 2 = periodic; 3 = intermittent; 4 = continuous.
6. Probability of occurrence: 1 = improbable; 2 = probable; 3 = highly probable; 4 = definite.
7. Significance: based on above-mentioned scores, on of three classes: low, moderate, high.
8. Status: positive, negative or neutral.
9. Degree of confidence: estimated percentage (in classes of 5%) of confidence in estimating the significance of each impact.

Impacts were assessed separately for four activities related to the proposed project, based on their differing associated impacts and impact levels (or significance):

- ~ Construction camps
- ~ Burrow pits
- ~ Power line itself
- ~ Access roads

It had been observed that once established the power lines have no to very low impact on the vegetation within the study area. This had been confirmed during various EIA studies of the power lines in the grassland over the past 17 years. Evidence of soil erosion or other disturbance due to the power line are seldom observed, exploitation of the veld in terms of grazing and quarries has much more significant impact than established power lines. The major concern is in terms of the edge effects of the construction phase:

1. Unauthorised off-road driving
2. Removal of medicinal or aesthetic plants
3. The harvesting of wood from drainage lines or outcrops or bush clumps for warming and cooking

If these activities could be strictly controlled, the mitigation will be highly effective and the impact of the proposed power lines, irrespective of the alternative will be definitely very low in the long term.

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, as the area is prone to large fires on a regular basis (Figure 15). 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.

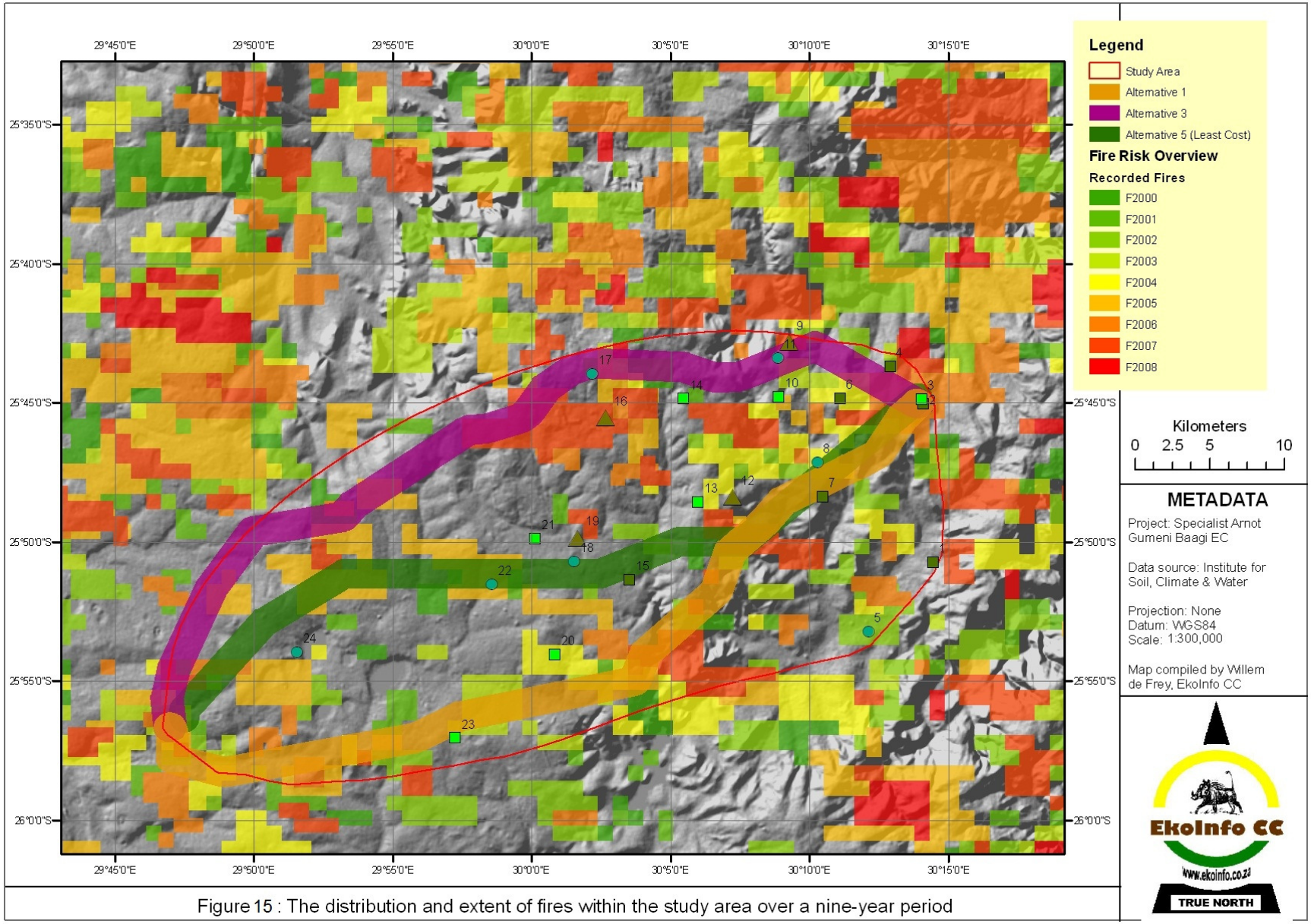

Figure 15 : The distribution and extent of fires within the study area over a nine-year period

Table 22: 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	Without management	2	3	3	2	3	high	negative	85%

driving and poor storm water management	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%

9 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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11 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

12 APPENDIX B – VEGETATION SPECIES RECORDED SORTED ACCORDING TO TWINSPAN LEVEL ONE

TWIN01	100000	100000	100000	100000	100000	100000	100000	200000	200000	200000	200000	200000	200000	200000	200000	200000	200000	200000	200000	200000	200000	200000	200000	200000
TWIN02	110000	120000	120000	120000	120000	120000	120000	210000	210000	210000	210000	210000	210000	210000	210000	210000	210000	210000	210000	210000	220000	220000	220000	220000
TWIN03	110000	121000	122000	122000	122000	122000	122000	211000	211000	211000	211000	211000	211000	212000	212000	212000	212000	212000	212000	212000	220000	220000	220000	220000
Tabno	8	18	5	17	11	22	24	15	4	1	7	6	2	3	13	14	10	23	20	21	19	16	12	9
Clusno	1	1	2	2	2	2	2	3	3	3	3	3	3	4	4	4	4	4	4	4	5	5	5	5
Community	1				1					2						3						4		
Sub community	1.1				1.2																			
SPECIES GROUP A																								
Monopsis decipiens	+	1	+	+						r					+									
Lobelia flaccida		1		+	1										+									
SPECIES GROUP B																								
Kyllinga alba	+	+					1			+										+				
Schoenoplectus paludicola	+	+																						
Centella asiatica		1	+																					
Alepidea natalensis		+									+													
Berkheya radula	1																							
Cyperus denudatus	2																							
Fuirena pubescens	+																							
Imperata cylindrica	2																							
Pycreus nitidus	3																							
Helichrysum setosum		+						+																1
Paspalum urvillei		+						+																
Andropogon appendiculatus		+		+																				
Agrostis eriantha		1					1																	
Arundinella nepalensis		2																						
Hypericum lalandii		1																						
Juncus lomatophyllus		1																						
Nidorella anomala		+																						
Trifolium pratense		+																						
Verbena bonariensis		+																						
SPECIES GROUP C																								
Walafrida densiflora				+		1	+						+									+		
Pelargonium luridum				+	+				r						+									
Verbena brasiliensis			1		+				1															
Hypochaeris radicata			+				+																	
Oenothera tetraptera			+				+																	
Nesaea schinzii				+	+																			
SPECIES GROUP D																								
Brachiaria serrata			+						+	+	+													+
Hypoxis hemerocallidea									+	+			1			+								
Microchloa caffra								+	+	+								+				+		
Cucumis zeyheri			+					+	+		+													
Abildgaardia ovata										+		+											+	
Becium obovatum										+	+								+					
Bidens pilosa									+	+														
Geigeria burkei										+	+								+					
Crabbea ovalifolia											+		+											
Hyparrhenia filipendula					+						2		+											
Limeum sulcatum											1		+											
Eucomis autumnalis					+				+		r			+										
Acrotome inflata								+	+															
Cynodon dactylon								+	+															
Haplocarpha scaposa									+		+													

TWIN01	100000	100000	100000	100000	100000	100000	100000	200000	200000	200000	200000	200000	200000	200000	200000	200000	200000	200000	200000	200000	200000	200000	200000	200000	200000	200000	200000
TWIN02	110000	120000	120000	120000	120000	120000	120000	210000	210000	210000	210000	210000	210000	210000	210000	210000	210000	210000	210000	210000	220000	220000	220000	220000	220000	220000	220000
TWIN03	110000	121000	122000	122000	122000	122000	122000	211000	211000	211000	211000	211000	211000	212000	212000	212000	212000	212000	212000	212000	220000	220000	220000	220000	220000	220000	220000
Tabno	8	18	5	17	11	22	24	15	4	1	7	6	2	3	13	14	10	23	20	21	19	16	12	9			
Clusno	1	1	2	2	2	2	2	3	3	3	3	3	3	4	4	4	4	4	4	4	5	5	5	5			
Community	1				1					2						3						4					
Sub community	1.1				1.2																						
Sporobolus africanus			+					+	+																		
Agapanthus inapertus					+						+	r															
Chlorophytum fasciculatum											+	+															
Dicoma zeyheri					+						+	+															
Senecio lydenburgensis											+	+									+						
Senecio scitus					+						+	+									+						
Athrixia elata					+			+			1																
Rabdosiella calycina				2				1			2											2					
SPECIES GROUP E																											
Hyparrhenia hirta			3	+	3		2	2	2	2	3	2	2														
Gladiolus crassifolius			1	+	+			+	+		+																
Hermannia transvaalensis			+		+				+	+	+	1			+							+					
Plantago lanceolata			+	+				1	+	+			+														
Senecio erubescens			+		+			+			+	+		r													
Chaetacanthus costatus			+		+				+		+	+															
Rhus discolor				1	+			+			+																
SPECIES GROUP F																											
Helichrysum acutatum													+	+	+	1		1	+			+					
Elionurus muticus			+							+					+		1		+		+						
Eriosema salignum										+				+	+		+										
Raphionacme hirsuta					+									+		+	+										
Watsonia densiflora														1			1			+							
Hermannia lancifolia									+						+		+	+					+				
Tephrosia capensis			+								+				+	+	+										
Babiana hypogea															1		+	+						r			
Crassula vaginata															+	+	+										
Chlorophytum cooperi																		+	+	+			+				
Senecio coronatus													+				+		+								
Helichrysum cephaloideum											+			+			1										
Aristida congesta						+			+									+		1		+					
Nidorella hottentotica																	+	+									
Agrostis montevidensis				+											+					r							
Rhynchosia totta															+	+											
Andropogon schirensis																+		1									
Digitaria monodactyla																		+	+								
Trichoneura grandiglumis							1											+	+								
SPECIES GROUP G																											
Eragrostis racemosa					+			+		+	+	+			+			+	+	+				+			
Diheteropogon amplectens					+			+			+	+	1		+			+		+						+	
Zornia linearis				+				+		+		+	+			+	+	+					+				
Justicia anagalloides									+		+		+		+					+	+						
Helichrysum nudifolium									1	+			+			1	+						+				
Dicoma anomala											+		+			+		+	+								
Boophane disticha									r			r			+		r										
Conyza podocephala					1				+		+				+												
SPECIES GROUP H																											
Aeschynomene rehmannii																	+				+	+		1			
Cyperus rupestris																					+		+	1			
Stachys natalensis																					+		+	1			
Gnidia capitata																			+		+	+	+				

TWIN01	100000	100000	100000	100000	100000	100000	100000	200000	200000	200000	200000	200000	200000	200000	200000	200000	200000	200000	200000	200000	200000	200000	200000	200000	200000	200000	200000
TWIN02	110000	120000	120000	120000	120000	120000	120000	210000	210000	210000	210000	210000	210000	210000	210000	210000	210000	210000	210000	210000	210000	210000	220000	220000	220000	220000	220000
TWIN03	110000	121000	122000	122000	122000	122000	122000	211000	211000	211000	211000	211000	211000	212000	212000	212000	212000	212000	212000	212000	212000	212000	220000	220000	220000	220000	220000
Tabno	8	18	5	17	11	22	24	15	4	1	7	6	2	3	13	14	10	23	20	21	19	16	12	9			
Clusno	1	1	2	2	2	2	2	3	3	3	3	3	3	4	4	4	4	4	4	4	5	5	5	5			
Community	1				1					2						3						4					
Sub community	1.1				1.2																						
Aristea woodii												r										+		r		
Aristida meridionalis											+								+				+	2		
Hypoxis iridifolia											r								+				+	1		
Anthospermum hispidulum																						+		1		
Chamaecrista mimosoides																		+					+	+		
Lopholaena coriifolia																						1		1		
Oldenlandia herbacea						+		+														+		+		
Parinari capensis																							1	+		
Protea welwitschii																							+	+		
Urelytrum agropyroides																							1	2		
Oxygonum dregeanum																					+	+				
Sporobolus pectinatus																					+	+				
Vernonia galpinii																					+	+				
SPECIES GROUP I																											
Pentanisia angustifolia													+		1	+	2	+	+		+		+				
Pygmaeothamnus zeyheri					+									+			+			+	+	+	+				
Ipomoea ommaneyi										+				+			+			+			+	+			
Tristachya rehmannii									+								+		+		3	2	3	3			
Panicum natalense																	+		+		+	1	1	+			
Harpochloa falx																	2		1		2		1	+			
SPECIES GROUP J - General Species																											
Senecio achilleifolius		+		+	+	+	+							+	+												
Heteropogon contortus		+	1	1		+		+		+	+	+	+	+	1		1	1				+	+	+			
Themeda triandra		2	2	1		+		1		+	+	+		2	2	1	+	2	2								
Eragrostis plana	1		+	2			+	3	+					+	1	2				3		+					
Tristachya leucothrix		+		1	+				+		+	+		+	+	+	+		+	+	+	+	+				
Eragrostis capensis	+		+	+							+		+	1	+												
Helichrysum aureonitens		+		1			1						+			1	+			+							
Stoebe vulgaris		+		+			2	1								+	+	+									
Helichrysum coriaceum	1				+				+			+	+														
Crepis hypochoeridea		+		1				+			+				+	+				2		+					
Polygala hottentotta		+	+							+	+																
Wahlenbergia undulata		+		+								+			+	+					+						
Monocymbium ceresiiforme		+						+	+			+	1	1	1	+		+	1		+		2	+			
Sebaea leiostyla		+							+		+	+	r			+	+						+				
Eragrostis chloromelas	1							+		+	+				+	+	+					+	+				
Tephrosia elongata		+						+													+		+				
Crabbea acaulis			+	+	+	+			+	+				+				+	+	+							
Eragrostis curvula			+		1	3	2		1				2	+				1	+		+							
Setaria sphacelata			1	+	+	+			+					+	+												
Helichrysum rugulosum			2	2	2			1	1	2	2		2		+		+		+								
Hypoxis rigidula			+	+	+				+	1		+		+	+	+	+	+	+								
Conyza bonariensis				+	+	+		+						+	+		1										
Helichrysum callicomum				+		1	1								+			1	1			r	+				
Eragrostis gummiflua			+			2	2											+		1							
Trachypogon spicatus			+		2			+	+	2	2	2	3	3	3		2		2		+			+			
Anthospermum rigidum			+		+				+	+	+		+	+	+		+	+	+			+					
Diospyros lycioides					1		+	3	+	+	+			r						+		3					
Berkheya setifera				1	+			+	+		+	1				+			+								
Vernonia natalensis				1	1				+		1	2			+	+				+							

TWIN01	100000	100000	100000	100000	100000	100000	100000	200000	200000	200000	200000	200000	200000	200000	200000	200000	200000	200000	200000	200000	200000	200000	200000	200000	200000	200000
TWIN02	110000	120000	120000	120000	120000	120000	120000	210000	210000	210000	210000	210000	210000	210000	210000	210000	210000	210000	210000	220000	220000	220000	220000	220000	220000	220000
TWIN03	110000	121000	122000	122000	122000	122000	122000	211000	211000	211000	211000	211000	211000	212000	212000	212000	212000	212000	212000	212000	220000	220000	220000	220000	220000	220000
Tabno	8	18	5	17	11	22	24	15	4	1	7	6	2	3	13	14	10	23	20	21	19	16	12	9		
Clusno	1	1	2	2	2	2	2	3	3	3	3	3	3	4	4	4	4	4	4	4	5	5	5	5		
Community	1				1					2						3						4				
Sub community	1.1				1.2																					
Commelina africana				+		+		+	+							+				1			+	+		
Acalypha angustata			+		2					1		1		+	1	+	1	+	+				+			
Aristida junciformis			+	+				+								+					+	+	+			
Rumex acetosella				+			1									+				+		+				
Melinis nerviglumis				+				+			+		+								+		+	+		
Alloteropsis semialata				+							1	1			1	2	2		+			+	1			
Cymbopogon excavatus								+	+		1											+		+		
SPECIES GROUP K - Species associated with fine textured soils																										
Indigofera zeyheri											+				+											
SPECIES GROUP L - Species associated with climax/ pristine conditions																										
Aloe boylei					+																					
Aster bakeranus												+														
Aster peglerae																								+		
Berkheya speciosa													+													
Bulbine narcissifolia						+																				
Chlorophytum transvaalense					r												1									
Corycium nigrescens												r														
Cucumis hirsutus											+				+											
Delosperma ashtonii																				+			+			
Dichapetalum cymosum									+																	
Digitaria eriantha																				+						
Dimorphotheca spectabilis																							2			
Eriospermum species												r														
Erythrina zeyheri										+																
Felicia filifolia					1																	1				
Gazania krebsiana									+																	
Gnidia caffra																	1						+			
Habenaria lithophila												r														
Haemanthus species								+																		
Helichrysum aureum									+																	
Hemizygia pretoriae											+													+		
Hermannia depressa										1																
Hibiscus aethiopicus																				+						
Hypericum aethiopicum									+							+										
Lotononis eriantha					+										+											
Manulea parviflora																		+					+			
Monsonia angustifolia																							+			
Moraea species																+										
Nemesia fruticans			+																							
Otholobium polystictum			+																							
Pentanisia prunelloides											+															
Peucedanum magalismontanum			+																							
Phyllanthus parvulus											+															
Raphionacme species											+													+		
Scabiosa columbaria										1								+					+			
Schizachyrium sanguineum											+										+					
Senecio inornatus									1																	
Senecio venosus											+										+					
Silene burchellii			+							+													+			
Striga asiatica										+								+								
Striga bilabiata														+												

TWIN01	100000	100000	100000	100000	100000	100000	100000	200000	200000	200000	200000	200000	200000	200000	200000	200000	200000	200000	200000	200000	200000	200000	200000	200000	200000	200000	200000	200000	200000	200000	200000	200000
TWIN02	110000	120000	120000	120000	120000	120000	120000	210000	210000	210000	210000	210000	210000	210000	210000	210000	210000	210000	210000	210000	210000	210000	210000	220000	220000	220000	220000	220000	220000	220000	220000	220000
TWIN03	110000	121000	122000	122000	122000	122000	122000	211000	211000	211000	211000	211000	211000	212000	212000	212000	212000	212000	212000	212000	212000	212000	212000	220000	220000	220000	220000	220000	220000	220000	220000	220000
Tabno	8	18	5	17	11	22	24	15	4	1	7	6	2	3	13	14	10	23	20	21	19	16	12	9								
Clusno	1	1	2	2	2	2	2	3	3	3	3	3	3	4	4	4	4	4	4	4	5	5	5	5								
Community	1				1					2						3						4										
Sub community	1.1				1.2																											
Sutera caerulea						+												+														
Tephrosia purpurea																	+															
Tetraselago natalensis																					2											
Thesium utile										+																						
Thunbergia atriplicifolia												+					+															
Ursinia nana																						+										
Vernonia hirsuta					+																											
Wahlenbergia epacridea																						+										
Zaluzianskya maritima										+																						
SPECIES GROUP M - Species associated with disturbance eg over grazing																																
Aristida bipartita											+																					
Asparagus laricinus				+				+																								
Hibiscus trionum				+												+																
Melinis repens																						+										
Solanum panduriforme			+																													
SPECIES GROUP N - Exotic species																																
Achyranthes aspera																						+										
Agrimonia procera									+																							
Verbena tenuisecta			+																													
SPECIES GROUP O - Ferns																																
Cheilanthes viridis								+																							+	
Pellaea calomelanos								+																							+	
SPECIES GROUP P - Species associated with moist areas																																
Aristida sciurus			1																													
Crocosmia paniculata																	1															
Cyperus esculentus			+																	+												
Haplocarpha lyrata										+										+												
Helictotrichon turgidulum				+												+																
Ledebouria cooperi																			+													
Miscanthus junceus							1							r																		
Pseudognaphalium luteo-album						+																										
Satureja biflora								+																								
Scirpus burkei								+																								
Sebaea grandis																		+														
SPECIES GROUP Q - Species associated with rockiness																																
Acalypha peduncularis				+								+																				
Acrotome hispida																		+														
Agapanthus campanulatus				+																												
Berkheya insignis											+																					
Bewsia biflora											1																					
Corchorus confusus										+																						
Crassula setulosa																						+										
Gerbera piloselloides								+																								
Gladiolus ecklonii																					+											
Hyparrhenia dregeana									2																							
Indigofera hedyantha																1						+										
Ipomoea bathycolpos																			+													
Kalanchoe thyrsiflora																															r	
Kohautia amatymbica																		+														
Ledebouria ovatifolia			+													+																
Leonotis ocymifolia v. raineriana				+				+																								

TWIN01	100000	100000	100000	100000	100000	100000	100000	200000	200000	200000	200000	200000	200000	200000	200000	200000	200000	200000	200000	200000	200000	200000	200000	200000	200000	200000	200000	200000	200000
TWIN02	110000	120000	120000	120000	120000	120000	120000	210000	210000	210000	210000	210000	210000	210000	210000	210000	210000	210000	210000	210000	210000	210000	210000	220000	220000	220000	220000	220000	220000
TWIN03	110000	121000	122000	122000	122000	122000	122000	211000	211000	211000	211000	211000	211000	212000	212000	212000	212000	212000	212000	212000	212000	212000	212000	220000	220000	220000	220000	220000	220000
Tabno	8	18	5	17	11	22	24	15	4	1	7	6	2	3	13	14	10	23	20	21	19	16	12	9					
Clusno	1	1	2	2	2	2	2	3	3	3	3	3	3	4	4	4	4	4	4	4	5	5	5	5					
Community	1				1					2						3						4							
Sub community	1.1				1.2																								
Nerine rehmannii																					1								
Selaginella dregei																						1							
Senecio oxyriifolius				+																		+							
Sutera neglecta																	+												
Vernonia oligocephala													+						+										
SPECIES GROUP R - Species associated with coarse textured soils																													
Aristida stipitata																		+											
Elephantorrhiza elephantina																	2						1						
Eragrostis nindensis																		+					+						
Loudetia simplex														+							+								
Pogonarthria squarrosa							1																						
Pollichia campestris						+		+										+											
Rhus magalismontana					+																								
SPECIES GROUP S - Species associated with woody areas																													
Pyrenacantha grandiflora								+																					
Rhus tumulicola								+														2							

13 APPENDIX C – LIST OF FLORA SPECIES RECORDED PER FAMILY

Note: FAMILY and species in alphabetical order

ACANTHACEAE
Chaetacanthus costatus
Crabbea acaulis
Crabbea ovalifolia
Justicia anagalloides
Thunbergia atriplicifolia
AGAPANTHACEAE
Agapanthus campanulatus
Agapanthus inapertus
AMARANTHACEAE
Achyranthes aspera
AMARYLLIDACEAE
Haemanthus species
Nerine rehmannii
ANACARDIACEAE
Rhus discolor
Rhus magalismontana
Rhus tumulicola
ANTHERICACEAE
Chlorophytum cooperi
Chlorophytum fasciculatum
Chlorophytum transvaalense
APIACEAE
Alepidea natalensis
Centella asiatica
Peucedanum magalismontanum
APOCYNACEAE
Raphionacme hirsuta
Raphionacme species
ASPARAGACEAE
Asparagus laricinus
ASPHODELACEAE
Aloe boylei
Bulbine narcissifolia
ASTERACEAE
Aster bakeranus
Aster peglerae
Athrixia elata
Berkheya insignis
Berkheya radula
Berkheya setifera
Berkheya speciosa
Bidens pilosa
Conyza bonariensis
Conyza podocephala
Crepis hypochoeridea
Dicoma anomala
Dicoma zeyheri
Dimorphotheca spectabilis
Felicia filifolia
Gazania krebsiana
Geigeria burkei
Gerbera piloselloides
Haplocarpha lyrata
Haplocarpha scaposa
Helichrysum acutatum
Helichrysum aureonitens
Helichrysum aureum
Helichrysum callicomum
Helichrysum cephaloideum
Helichrysum coriaceum
Helichrysum nudifolium
Helichrysum rugulosum
Helichrysum setosum
Hypochaeris radicata
Lopholaena coriifolia
Nidorella anomala
Nidorella hottentotica
Pseudognaphalium luteo-album
Senecio achilleifolius
Senecio coronatus
Senecio erubescens
Senecio inornatus
Senecio lydenburgensis
Senecio oxyriifolius
Senecio scitus
Senecio venosus
Stoebe vulgaris
Ursinia nana
Vernonia galpinii
Vernonia hirsuta
Vernonia natalensis
Vernonia oligocephala
CAMPANULACEAE
Wahlenbergia epacridea
Wahlenbergia undulata

CARYOPHYLLACEAE
Pollichia campestris
Silene burchellii
CHRYSOBALANACEAE
Parinari capensis
COMMELINACEAE
Commelina africana
CONVOLVULACEAE
Ipomoea bathycolpos
Ipomoea ommaneyi
CRASSULACEAE
Crassula setulosa
Crassula vaginata
Kalanchoe thyrsiflora
CUCURBITACEAE
Cucumis hirsutus
Cucumis zeyheri
CYPERACEAE
Abildgaardia ovata
Cyperus denudatus
Cyperus esculentus
Cyperus rupestris
Fuirena pubescens
Kyllinga alba
Pycreus nitidus
Schoenoplectus paludicola
Scirpus burkei
DICHAPETALACEAE
Dichapetalum cymosum
DIPSACACEAE
Scabiosa columbaria
EBENACEAE
Diospyros lycioides
ERIOSPERMACEAE
Eriospermum species
EUPHORBIACEAE
Acalypha angustata
Acalypha peduncularis
FABACEAE
Aeschynomene rehmannii
Chamaecrista mimosoides
Elephantorrhiza elephantina
Eriosema salignum
Erythrina zeyheri
Indigofera hedyantha
Indigofera zeyheri
Lotononis eriantha
Otholobium polystictum
Rhynchosia totta
Tephrosia capensis
Tephrosia elongata
Tephrosia purpurea
Trifolium pratense
Zornia linearis
GENTIANACEAE
Sebaea grandis
Sebaea leiostyla
GERANIACEAE
Monsonia angustifolia
Pelargonium luridum
HYACINTHACEAE
Eucomis autumnalis
Ledebouria cooperi
Ledebouria ovatifolia
HYPERICACEAE
Hypericum aethiopicum
Hypericum lalandii
HYPOXIDACEAE
Hypoxis hemerocallidea
Hypoxis iridifolia
Hypoxis rigidula
ICACINACEAE
Pyrenacantha grandiflora
IRIDACEAE
Aristea woodii
Babiana hypogea
Crocosmia paniculata
Gladiolus crassifolius
Gladiolus ecklonii
Moraea species
Watsonia densiflora
JUNCACEAE
Juncus lomatophyllus
LAMIACEAE
Acrotome hispida
Acrotome inflata
Becium obovatum
Hemizygia pretoriae
Leonotis ocymifolia
Rabdosiella calycina
Satureja biflora
Stachys natalensis
LOBELIACEAE
Lobelia flaccida
Monopsis decipiens
LYTHRACEAE
Nesaea schinzii
MALVACEAE

Corchorus confusus
Hermannia depressa
Hermannia lancifolia
Hermannia transvaalensis
Hibiscus aethiopicus
Hibiscus trionum
MESEMBRYANTHEMACEAE
Delosperma ashtonii
MOLLUGINACEAE
Limeum sulcatum
ONAGRACEAE
Oenothera tetraptera
ORCHIDACEAE
Corycium nigrescens
Habenaria lithophila
OROBANCHACEAE
Striga asiatica
Striga bilabiata
PHYLLANTHACEAE
Phyllanthus parvulus
PLANTAGINACEAE
Plantago lanceolata
POACEAE
Agrostis eriantha
Agrostis montevidensis
Alloteropsis semialata
Andropogon appendiculatus
Andropogon schirensis
Aristida bipartita
Aristida congesta
Aristida junciformis
Aristida meridionalis
Aristida sciurus
Aristida stipitata
Arundinella nepalensis
Bewsia biflora
Brachiaria serrata
Cymbopogon excavatus
Cynodon dactylon
Digitaria eriantha
Digitaria monodactyla
Diheteropogon amplectens
Elionurus muticus
Eragrostis capensis
Eragrostis chloromelas
Eragrostis curvula
Eragrostis gummiflua
Eragrostis nindensis
Eragrostis plana
Eragrostis racemosa
Harpochloa falx
Helictotrichon turgidulum
Heteropogon contortus
Hyparrhenia dregeana
Hyparrhenia filipendula
Hyparrhenia hirta
Imperata cylindrica
Loudetia simplex
Melinis nerviglumis
Melinis repens
Microchloa caffra
Miscanthus junceus
Monocymbium ceresiiforme
Panicum natalense
Paspalum urvillei
Pogonarthria squarrosa
Schizachyrium sanguineum
Setaria sphacelata
Sporobolus africanus
Sporobolus pectinatus
Themeda triandra
Trachypogon spicatus
Trichoneura grandiglumis
Tristachya leucothrix
Tristachya rehmannii
Urelytrum agropyroides
POLYGALACEAE
Polygala hottentotta
POLYGONACEAE
Oxygonum dregeanum
Rumex acetosella
PROTEACEAE
Protea welwitschii
PTERIDACEAE
Cheilanthes viridis
Pellaea calomelanos
ROSACEAE
Agrimonia procera
RUBIACEAE
Anthospermum hispidulum
Anthospermum rigidum
Kohautia amatymbica
Oldenlandia herbacea
Pentanisia angustifolia
Pentanisia prunelloides
Pygmaeothamnus zeyheri
SANTALACEAE
Thesium utile

SCROPHULARIACEAE
Manulea parviflora
Nemesia fruticans
Sutera caerulea
Sutera neglecta
Tetraselago natalensis
Walafrida densiflora
Zaluzianskya maritima
SELAGINELLACEAE
Selaginella dregei
SOLANACEAE
Solanum panduriforme
THYMELAEACEAE
Gnidia caffra
Gnidia capitata
VERBENACEAE
Verbena bonariensis
Verbena brasiliensis
Verbena tenuisecta