Annexure F(iii)

FAUNA AND FLORA REPORTS

FAUNAL, FLORAL, WETLAND AND AQUATIC ASSESSMENT FOR THE PROPOSED K56 ROAD DEVELOPMENT, DAINFERN, GAUTENG.

Prepared for

Bokamoso Environmental Consultants

July 2012

Section A: Executive Summary

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Declaration

This report has been prepared according to the requirements of Section 33 (2) of the Environmental Impact Assessments EIA Regulations, 2010 (GNR 543). We (the undersigned) declare the findings of this report free from influence or prejudice.

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Wetland, aquatic and terrestrial ecology.

_____ Date: 18/05/2012
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EXECUTIVE SUMMARY

Scientific Aquatic Services (SAS) was appointed to conduct a floral, faunal and wetland assessment on the proposed development of the K56 road (Section A: Figures 1 & 2), hereafter referred to as the subject property. The total length of the proposed road development is approximately 7km. The proposed K56 is situated to the northwest of Midrand, in the vicinity of Dainfern, in the Gauteng Province.

This report, after consideration and the description of the ecological integrity of the subject property, must guide the Environmental Assessment Practitioner (EAP), regulatory authorities and potential mining proponent, by means of the presentation of results and recommendations, as to the ecological viability of the proposed road development project. Only the subject property, including a 200m area surrounding the property, was assessed during the field visit. The surrounding area was, however, also considered as part of the desktop assessment.

The section below serves to summarise the findings of the terrestrial, wetland and aquatic assessments.

FLORAL ASSESSMENT

- The study area falls within the Savanna Biome, the Bushveld Basin bioregion and Egoli Grassland Vegetation Type, which is considered to be an endangered vegetation type;
- Four habitat units were identified along the proposed development route, namely the Wetland Habitat Unit, the Rocky Outcrop Habitat Unit, the Open Grassland Habitat Unit and the Transformed Habitat Unit. The Transformed Habitat Unit encompasses the majority of the study area, while the Wetland Habitat Unit occurs within the east, west and central portions of the subject property;
- The entire subject property has been subjected to a degree of vegetation transformation as a result of urban and residential development and historic agricultural activities. Alien invasive plant species are present in all habitat units;
- The Rocky Outcrop Habitat Unit has experienced a low degree of disturbance and is considered to be highly sensitive as a result of the unique habitat it provides for faunal and floral species. It also has the potential to host RDL plant species, such as *Ilex mitis, Dicliptera magaliesbergensis* and *Freylinia tropica*;
- The Wetland Habitat Unit also has higher ecological sensitivity compared to the Open Grassland and Transformed Habitat Unit due to the potential habitat for faunal and floral species and the migratory connectivity for faunal species that these areas potentially provide;
- The Open Veld Habitat Unit is not considered to be ecologically sensitive, as a result of its isolated nature and the high numbers of alien plant species present. One RDL floral species, namely *Hypoxis hemerocallidae* ('Declining') was encountered in this Habitat Unit during the assessment and it is likely that *Boophane disticha* may also occur in this area;
- The Transformed Habitat unit is considered to be of low ecological sensitivity as a result of its impacted nature due to past development in the area;
- No RDL or protected floral species were identified during the assessment. However, the Rocky Outcrop and Wetland Habitat Units may provide suitable habitat to support such floral species;
- Levels of alien floral invasion were moderate to high within all habitat units identified, apart from within the Rocky Outcrop Habitat Unit, where alien invasive species are restricted to riparian edges;
- The VIS (Vegetation Index Score) for each Habitat Unit was calculated as follows:

Habitat unit	Score	Class	Motivation
Wetland/ Riparian	14	**C – Moderately modified**	Moderately impacted by past anthropogenic activities. Moderate levels of alien plant species invasion.
Rocky Outcrop	20	**B – Largely natural with few modifications**	Few disturbances present. Some alien invasive species present in the vicinity of wetlands
Open Grassland	15	**C – Moderately modified**	Disturbances present in the form of alien plant species, trampling and the proximity of informal roads.
Transformed	5	**E – Loss of natural habitat extensive**	Transformation levels high as a result of development and roads construction. High number of alien and landscaping plant species present.

FAUNAL ASSESSMENT

The period of investigation was undertaken during early winter/late summer and it must be noted that some faunal species may not have been identified due to natural behavioural patterns that vary from season to season. In this regard special mention is made of species which become inactive or which enter life cycle stages which are inactive

- In general there are good natural rocky ridge and woodland habitat units along with good wetland habitat units found within the subject property and are deemed to provide good faunal habitat for a diverse community of fauna. The ecological integrity of the rocky ridge and wetland areas are still largely intact, and as such the rocky ridge and wetland areas are considered to be of high ecological sensitivity.
- Yellow Mongoose (*Cynictis penicillata*) and Angoni Vlei Rat (*Otomys angoniensis*) were identified during the field survey. Other signs indicating the presence of small omnivorous predators found within the subject property such as Mole rat mounds (Genus; *Cryptomys*) and Cape Clawless Otter (*Aonyx capensis*) droppings. No other mammal species were noted possibly due to the close proximity to residential areas and the cryptic nature of most mamma species. Suitable habitat areas, such as natural rocky, woodland, grassland and wetland habitat areas were however identified in the subject property (See Section A). No GDARD and IUCN RDL threatened mammal species were observed on the subject property. It is unlikely that GDARD RDL or sensitive mammal species listed in Appendix 1 will utilise the site for habitation purposes due to the high level of urbanisation in the surrounding area. There is however a slight possibility that some mammal species, especially the RDL Bat species that are indicated in Appendix 1, may occur and utilise some points along the proposed subject property area as foraging and breeding sites, especially in the rocky outcrop habitat unit. No GDARD RDL listed bird species were noted during the site assessment. However since birds are mobile there is a good chance that some threatened bird species which occur in the GDARD RDL bird list may move through the area from time to time. The main reasons are due to the good natural rocky outcrop habitat unit as well as the wetland habitat unit (see Section A, Sensitivity Maps) which may be utilised as a migratory corridor especially during the breeding season by the Macco Duck (*Oxyura maccoa*) and African Finfoot (*Podica senegalensis*) and for feeding purposes by the African Marsh Harrier (*Circus ranivorus*), the Lesser Falcon (*Falco naumanni*) and the Lanner Falcon (*Falco biarmicus*). Thus by conserving the rocky outcrop and wetland habitat unit, the habitat of these species that have a high probability of occurrence could also be conserved.
- No RDL reptile species were encountered during the field assessment. Reptiles are notoriously difficult to detect, are well camouflaged and have good senses to hide from prey, thus making identification of reptiles difficult. The subject area does however, offer habitat for various reptile species within all the identified habitat units, however reptile species of concern, if present, will be restricted to areas with low levels of anthropogenic activities such the less disturbed rocky outcrop habitat units and wetland habitat units. Due to the good natural rocky habitat unit and wetland habitat unit found within the subject property, three threatened RDL reptile species listed by GDARD, namely the Blunt-tailed worm lizard (*Dalophia pistillum*), the Striped harlequin Snake (*Homoroselaps dorsalis*) and the Southern African Rock Python (*Python sebae*

natalensis) were considered to have a high POC for their distribution range and there being a good food and habitat percentage along these good rocky habitat units in association with the wetland habitat unit.

- Only the Common platanna (*Xenopus laevis*) amphibian species was noted during the field assessment. The low taxon identified is potentially due to the late seasonal sight survey. Amphibian species life cycles have passed the breeding period and as the water table level drops amphibian species begin to submerge and envelop themselves underground for the dry winter months and only emerge when the rainy seasons reoccur. Amphibian species, which may potentially occur here, are common and widespread species, such species include the Plain Grass Frog *(Ptychadena anchietae),* Common River frog *(Afrana angolensis),* guttural toads (*Bufo gutturalis)* and the Common Caco *(Cacosternum boettgeri).* The only threatened amphibian species of concern in Gauteng is the Giant Bullfrogs (*Pyxicephalus adspersus)* GDARD (2004), Appendix 4. No Giant Bullfrogs (*Pyxicephalus adspersus)* were found in the vicinity of the subject property. However, the Giant Bullfrog (*Pyxicephalus adspersus),* a near threatened species, is known to occur near riparian and wetland zones where bullfrog habitat is optimal. This species distribution range is within the subject property. They remain in cocoons submerged underground, preferably sandy grounds and only emerge at the start of the rainy season. They breed in shallow waters and they can occupy temporary floodplains and rapidly drying pool areas. They are also known to travel vast distances and may also utilise the wetlands as migratory corridors through the local area. They are active during the day and are able to tolerate some of the harshest environments in Africa. They are carnivorous and eat a wide variety of foods. Thus due to the distribution range data, good food availability and there being suitable wetland habitat conditions within the subject property, the likelihood of this RDL species occurring in the subject property is considered highly significant.
- The invertebrate assessment conducted was a general assessment with the purpose of identifying the invertebrate community assemblage occurring within the subject property. No GDARD RDL invertebrate species were identified during the assessment and the probability of threatened invertebrate species occurring within the area is considered low.
- No evidence was encountered of the Mygalomorph arachnids (Trapdoor and Baboon spiders) and RDL scorpions within the subject property, although it should be noted that these species are notoriously difficult to detect, however, if they do occur within the area they would be found within the rocky habitat area. Mygalomorph arachnids are highly sensitive to habitat disturbance and environmental changes and are especially sensitive to vibration pollution since mygalomorph spiders and scorpions use vibration to detect and locate their prey. Within the rocky areas specific attention was paid with the identification of suitable habitat for spiders and scorpions. After thoroughly searching and rock turning no scorpions were found and no spider burrows were identified. Little distribution data is available for most of these spider and scorpion species.
- The RDSIS assessment of the property yielded a moderate to lower score of 34%, indicating a medium-low importance with regards to RDL faunal species conservation within the region. In terms of the proposed project, the highly sensitive wetland and rocky outcrop habitat unit should be conserved, to ensure that the migratory connectivity and habitat requirements for the above species are maintained and the proposed development will have very little impact on the faunal ecology within the subject property.

WETLAND ASSESSMENT

The following general conclusions were drawn on completion of the survey:

- The subject property falls within the Highveld Aquatic Ecoregion and is located within the A21C quaternary catchment in the Limpopo catchment.
- Two wetland features were identified within the study area at the time of the assessment.
- Wetland feature 1 can be described as a Riverine system, Upper perennial, Aquatic bed wetland feature. Wetland 2 can be described as a Riverine system, Lower Perennial, Aquatic bed wetland feature.
- The wetland features comprised of a wide diversity of wetland flora within the riparian zone including both wetland grassy layer species as well as trees associated with riparian zones.
- The wetland 1 PES falls within class B – largely natural with few modifications. This is due to the fact that the surrounding urban development has not significantly impacted the wetland.

The wetland 2 PES falls within class D – largely modified - as the riparian wetland is affected by scour and sand deposition.

- Therefore, the EMC class deemed appropriate to maintain current ecology as well as functionality in wetland 1 is class B (Largely natural with few modifications) and in wetland 2 is class D (Largely modified).
- A 32m buffer in terms of the GDARD Minimum Requirements for Biodiversity Assessments (2009) is shown for areas which fall within the Urban Edge. The subject property falls within the Urban Edge and in terms of the above regulations, a 32m buffer is prescribed.
- It is recommended that the proposed activities do not encroach into wetland feature 1 and the associated buffer The proposed activities can be considered favourably, from a wetland conservation point of view within wetland 2 as long as the recommended mitigation measures are adhered to and that the relevant environmental authorisation is obtained.

After conclusion of this wetland assessment, it is the opinion of the specialists that the proposed project should not be considered favourably as the construction of a road through wetland 1 will destroy this largely unmodified wetland. Construction can however be considered favourably in order to cross wetland systems 2, 3 and 4 if the mitigation measures, as presented in this report are strictly adhered to.

AQAUTIC ASSESSMENT

Jukskei River (Site K1)
Biota specific Water quality

- General water quality can be considered to be fair, based on the results of the biota specific water quality analyses
- Limited amounts of dissolved salts present in the system although salt concentrations can be considered to be elevated form the natural conditions expected for the area. Limited osmotic stress on the aquatic community is deemed likely at the current time.
- The pH is slightly alkaline however no impact on the aquatic community due to altered pH conditions is deemed likely.
- Temperature can be regarded as normal for the time of year and time of assessment.
- Dissolved oxygen concentration in the system is low and is likely to place significant stress on the aquatic community in the system.

Habitat suitability and integrity

- From the results of the application of the IHIA to the K1 site, it is evident that there are serious impacts on the habitat integrity of the area. The most significant instream impacts included water bed modification, water quality and channel modification. Moderate impact from solid waste disposal, as well as flow and water abstraction was noted. Overall, the site achieved a 33% score for instream habitat integrity (Appendix 3).
- The most significant riparian zone impacts were alien encroachment followed by bank erosion and channel modification. Moderate level impacts observed were namely vegetation removal, water abstraction, flow modification and channel modification. The site achieved a 17% score for riparian integrity (Appendix 3).
- The site obtained an overall IHIA rating of 25%, which indicates extensively modified (class E) conditions. The site, therefore, falls outside the DEMC for the quaternary catchment A21C based on habitat conditions (Kleynhans, 1999).

Invertebrate Habitat Assessment

- Habitat diversity and structure is considered inadequate for supporting a diverse aquatic macro-invertebrate community

Macro-invertebrate community integrity

- The SASS score indicates that the aquatic macro-invertebrate community in this section of the Jukskei River has suffered a severe loss in integrity.
- At present, the site (K1) which runs through the subject property can be considered as a Class E site according to Dickens & Graham (2001) which has been severely impaired and where only tolerant taxa is present.

- Dallas 2007 classification for the lower Highveld ecoregion confirms the severe and critically impaired status (E/F) due to the low SASS score of 29.
- The site, falls below the PESC for the quaternary catchment A21C which is based on a Class D (Kleynhans, 1999).
- The system can therefore be regarded as being fairly tolerant, however due to the impact on the system care should be taken to prevent further impacts on this system from the proposed development activities.
- Careful design and construction will be required to limit the impact on the system.

The fish community

- No fish were captured during the assessment indicating that long term impacts on the system are likely. In this regard special mention is made of the water quality has a major effect on the fish assemblage as does migration barriers in the system which were observed upstream from site K1. It is for this reason that the system can be regarded as having limited sensitivity in terms of fish community dynamics, however care should still be exercised during the proposed development activities to prevent further impacts on the fish community of the system with special mention of migratory connectivity.
- Thus according to the protocol of Kleynhans (1999) Present State Classes in terms of FAII scores, the fish community at this point is critically modified (Class F).

Tributary River (Site K2)
Biota specific Water quality

- The water quality for this tributary stream can be considered to be fair, with limited amounts of dissolved salts present in the system although some elevation of salt concentrations from the natural conditions is deemed likely. Fairly limited osmotic stress on the aquatic community is deemed likely at the current time.
- The pH is 7.2 and considered relatively natural. No impact on the aquatic community due to altered pH conditions is deemed likely.
- Temperature can be regarded as normal for the time of year and time of assessment.
- Dissolved oxygen concentrations are fair but some more sensitive taxa may be absent from the system.

Habitat suitability and integrity

- From the results of the application of the IHIA to the tributary river at site K2, which falls within the study area, it is evident that there are impacts on the habitat integrity of the area. The most significant instream impacts included flow modification due to the already existing upstream impoundments that are situated along this tributary system. Overall, the site achieved a 52% score for instream habitat integrity (Appendix 3).
- The most significant riparian zone impact was flow modification. Low level impacts observed were namely vegetation removal, water abstraction, bank erosion, water quality and channel modification. The site achieved a 37% score for riparian zone integrity (Appendix 3).
- The site obtained an overall IHIA rating of 45%, which indicates largely modified (class D) conditions. The tributary site K2, therefore, falls just outside the DEMC for the quaternary catchment A21C based on habitat conditions (Kleynhans, 1999).

Invertebrate Habitat Assessment

- Habitat diversity and structure is adequate for supporting a diverse aquatic macro-invertebrate community.

Macro-invertebrate community integrity

- The SASS score indicates that the aquatic macro-invertebrate community in this section of the tributary river which flows into the Jukskei River has suffered a severe loss in integrity.
- At present, the site (K2) which runs through the subject property can be considered as a Class E site according to Dickens & Graham (2001) which has been severely impaired and where only tolerant taxa is present.

- Dallas 2007 classification for the lower Highveld ecoregion confirms the severe and critically impaired status (E/F) due to the low SASS score of 39 and ASPT of 3.5.
- The K2 site, falls outside the PESC for the quaternary catchment A21C which is based on a Class D (Kleynhans, 1999).
- The system can therefore be regarded as being fairly tolerant, however due to the impact on the system care should be taken to prevent further impacts on this system from the proposed development activities.
- Careful design and construction will be required to limit the impact on the system.

The fish community

Two fish species, the Long bearded Barb (*Barbus unitaeniatus)* and the Mozambique Tilapia (*Oreochromis mossambicus*) were captured, identified and released during the assessment. The low diversity indicates that long term impacts on the system are likely. In this regard special mention is made of migration barriers (such as dams) in the system and the water quality levels. It is for this reason that the system can be regarded as having limited sensitivity in terms of fish community dynamics, however care should still be exercised during the proposed development activities to prevent further impacts on the fish community of the system.

- The FAII data indicates that the fish community in this section of the tributary system has suffered a critical loss in integrity when compared to the expected score for a stream in this catchment with the habitat characteristics of the area.
- The absence of fish in the system is indicative of long term impacts on the system, with special mention of impacts on water flow modification and migration barriers.
- With only a low diversity and abundance of fish in the area, the fish community of the area is considered critically modified (Class F).
- Measures to improve water flow should be sought in order to allow fish species to re-establish in the system.
  It is important to ensure that no impacts on fish migration on the system occur as a result of the proposed development.

Upon completion of the survey and consideration of findings, the following recommendations are made with respect to the proposed development:

Development and operational footprint

- A sensitivity map has been developed for the study area, indicating wetland and rocky outcrop areas which are considered to be of high ecological sensitivity. It is recommended that this sensitivity map be considered during the planning/ pre-construction and construction phases of the proposed development activities in order to aid in the conservation of ecology within and adjacent to the proposed development area. The Rocky Outcrop Habitat Unit should not be disturbed due to its unique ecology.
- *Hypoxis hemerocallidae*, *Babiana hypogea* var. *hypogea*, and *Boophane disticha* (if discovered on site), occurring within the development footprint should be rescued and relocated to suitable habitat in the vicinity of the study area.
- All development footprint areas should remain as small as possible and should not encroach onto surrounding more sensitive wetland and rocky outcrop areas. The boundaries of footprint areas are to be clearly defined.
- Large trees should be maintained where possible for the length of the proposed development route.
- Proper planning of infrastructure, which avoids unnecessary barriers in migratory corridors, should be conducted during the pre-construction phase.

Wetlands

- As much of the ecological functioning and migratory connectivity of the drainage features need to be maintained.
- No topsoil, waste rock or building material should be dumped into any existing wetland and rocky outcrop areas, as these areas are considered to be of higher ecological importance.

- It must be ensured that construction-related waste and effluent do not affect the wetland resources and associated buffer zones.
- Edge effects of activities, including erosion and alien/ weed control, have to be strictly managed in more sensitive wetland and rocky outcrop areas.
- All construction vehicles should remain on designated roads with no indiscriminate driving through wetlands/ riparian or rocky outcrop areas.
- It must be ensured that flow connectivity along the riparian features is maintained.

Stormwater management

- Adequate stormwater and erosion management measures must be incorporated into the design of the proposed development route in order to prevent erosion and sedimentation of the wetland areas.
- It must be ensured that runoff from impacted areas is suitably managed and that runoff volumes and velocities are similar to pre-disturbance levels. Stormwater control methods as set out in engineering specifications are to be implemented.
- During the construction of the proposed development route, erosion berms should be installed to prevent gully formation and siltation of the wetland resources. The following points should serve to guide the placement of erosion berms:
  - Where the track has slope of less than 2%, berms every 50m should be installed.
  - Where the track slopes between 2% and 10%, berms every 25m should be installed.
  - Where the track slopes between 10%-15%, berms every 20m should be installed.
  - Where the track has slope greater than 15%, berms every 10m should be installed.

Alien plant species

- Proliferation of alien and invasive species is expected within disturbed areas. These species should be eradicated and controlled to prevent their spread beyond the site boundary. Alien plant seed dispersal within the top layers of the soil within footprint areas, that will have an impact on rehabilitation in the future, has to be controlled.
- Alien and weed species encountered on the property are to be removed in order to comply with existing legislation (amendments to the regulations under the Conservation of Agricultural Resources Act, 1983 and Section 28 of the National Environmental Management Act, 1998). Removal and control of invasive plant species should take place throughout the pre-construction, construction, operational, and rehabilitation/ maintenance phases.
- All soils compacted as a result of construction activities and falling outside of the development footprint areas should be ripped and profiled. Special attention should be paid to alien and invasive control within these areas.

Fire

- All informal fires on the property should be prohibited, specifically during the construction phase of the proposed development.

Dust

- It is to be ensured that all temporary access roads and construction areas are regularly sprayed with water or treated with other dust suppression measures in order to curb dust generation. This is particularly necessary during the dry season when increased levels of dust generation can be expected. These areas should not be over-sprayed causing water run-off and subsequent sediment loss into adjacent waterways.

Rehabilitation

- As much vegetation growth as possible should be promoted within the proposed development area in order to protect soils. In this regard special mention is made of the need to use indigenous vegetation species where hydroseeding, wetland and rehabilitation planting are to be implemented.
- Upon completion of the project, new indigenous landscaping should be implemented in all affected areas and proper rehabilitation within all impacted areas must take place.
- Banks of disturbed drainage areas must be reprofiled.
- Banks and drainage features, if affected by the proposed construction activities, are to be reinforced where necessary with reno mattresses and geotextiles.

- Any areas where earthworks have taken place, should be reseeded with indigenous vegetation to prevent erosion.
- It must be ensured that all disturbed and exposed areas are rehabilitated and covered with indigenous vegetation to prevent dust generation.

ECOLOGICAL SENSITIVITY

Wetland features, as well as the rocky outcrop area located centrally with respect to the proposed development route, are considered sensitive and were identified and delineated (refer to associated Wetland and Aquatic Ecology reports). This is mainly due to the higher diversity of faunal and floral species expected to occur within these areas and the potential of these areas to host RDL species, as well as the unique habitat the wetland and rocky outcrop areas provide for both faunal and floral species. It is therefore deemed important that these areas be excluded form the proposed development.

The Open Grassland Habitat Unit is not deemed to be sensitive, as a result of high levels of alien plant species invasion. The transformed areas are deemed to be of low sensitivity as a result of the high levels of transformation present. These areas are not likely to support any RDL or sensitive faunal or floral species.

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Glossary of Terms & Acronyms

Alien vegetation – Plants that do not occur naturally within the area but have been introduced either intentionally or unintentionally.

Biome – A broad ecological unit representing major life zones of large natural areas – defined mainly by vegetation structure and climate.

Bush encroachment – A state where undesirable woody elements gain dominance within grassland, leading to depletion of the grass component. Typically due to disturbances and transformations as a consequence of veldt mismanagement (overgrazing, incorrect burning, etc.).

Decrease grass – Grass abundant in veldt in good condition, which decreases when veldt is under- or over-utilized.

°*C* – Degrees Celsius.

Endangered – Organisms in danger of extinction if causal factors continue to operate.

Endemic species – Species that are only found within a pre-defined area. There can therefore be sub-continental (e.g. southern Africa), national (South Africa), provincial, regional or even within a particular mountain range.

Exotic vegetation – Vegetation species that originate from outside of the borders of the biome - usually international in origin.

Ex situ conservation – Where a plant (or community) cannot be allowed to remain in its original habitat and is removed and cultivated to allow for its ongoing survival.

Extrinsic – Factors that have their origin outside of the system.

GDACE – Gauteng Department of Agriculture, Conservation and Environment

ha – Hectares.

Indigenous vegetation – Vegetation occurring naturally within a defined area.

Increaser 1 grass – Grass species that increase in density when veld is under-utilized.

Increaser 2 grass – Grass species that increase in density in over-utilized, trampled or disturbed veld.

Increaser 3 grass – Grass species that increase in density in over and under-utilized veld.

In situ conservation – Where a plant (or community) is allowed to remain in its natural habitat with an allocated buffer zone to allow for its ongoing survival.

Karoid vegetation – A shrub-type vegetation that dominates in grasslands that have seen historical disturbances. Mainly due to over-grazing and mismanaged burning regimes. The shrubby vegetation eventually becomes dominant and out-competes the grassy layer.

m – Metres.

mm – Millimetres.

MAMSL – Metres above mean sea level.

MAP – Mean annual precipitation.

MAPE – Mean annual potential for evaporation.

MASMS – Mean annual soil moisture stress.

MAT – Mean annual temperature.

Orange Listed – Species that are not Red Data Listed, but are under threat and at risk of becoming RDL in the near future. Usually allocated to species with conservation status of *Near Threatened (NT), Least Concern (LC), Rare* and *Data Deficient (DD)*.

PES – Present Ecological State.

POC – Probability of occurrence.

PRECIS – Pretoria Computer Information Systems.

Pioneer species – A plant species that is stimulated to grow after a disturbance has taken place. This is the first step in natural veld succession after a disturbance has taken place.

QDS – Quarter degree square (1:50,000 topographical mapping references).

Rare – Organisms with small populations at present.

RDL (Red Data listed) species – Organisms that fall into the *Extinct in the Wild (EW), critically endangered (CR), Endangered (EN), Vulnerable (VU)* categories of ecological status.

RDSIS – Red Data Sensitivity Index Score.

SANBI – South African National Biodiversity Institute.

Veld retrogression – The ongoing and worsening ecological integrity state of a veld.

1 INTRODUCTION

1.1 Background

Scientific Aquatic Services (SAS) was appointed to conduct a floral, faunal, wetland and aquatic assessment on the proposed development of the K56 road (Section A: Figures 1 & 2), hereafter referred to as the subject property. The total length of the proposed road development is approximately 7km. The proposed K56 is situated to the northwest of Midrand, in the vicinity of Dainfern, in the Gauteng Province.

This report, after consideration and the description of the ecological integrity of the subject property, must guide the developer, Environmental Assessment Practitioner (EAP) and regulatory authorities, by means of the presentation of results and recommendations, as to the ecological viability of the proposed road development route. Only the subject property, including its immediate surroundings, was assessed during the field visits. The surrounding properties were, however, also considered as part of the desktop assessment.

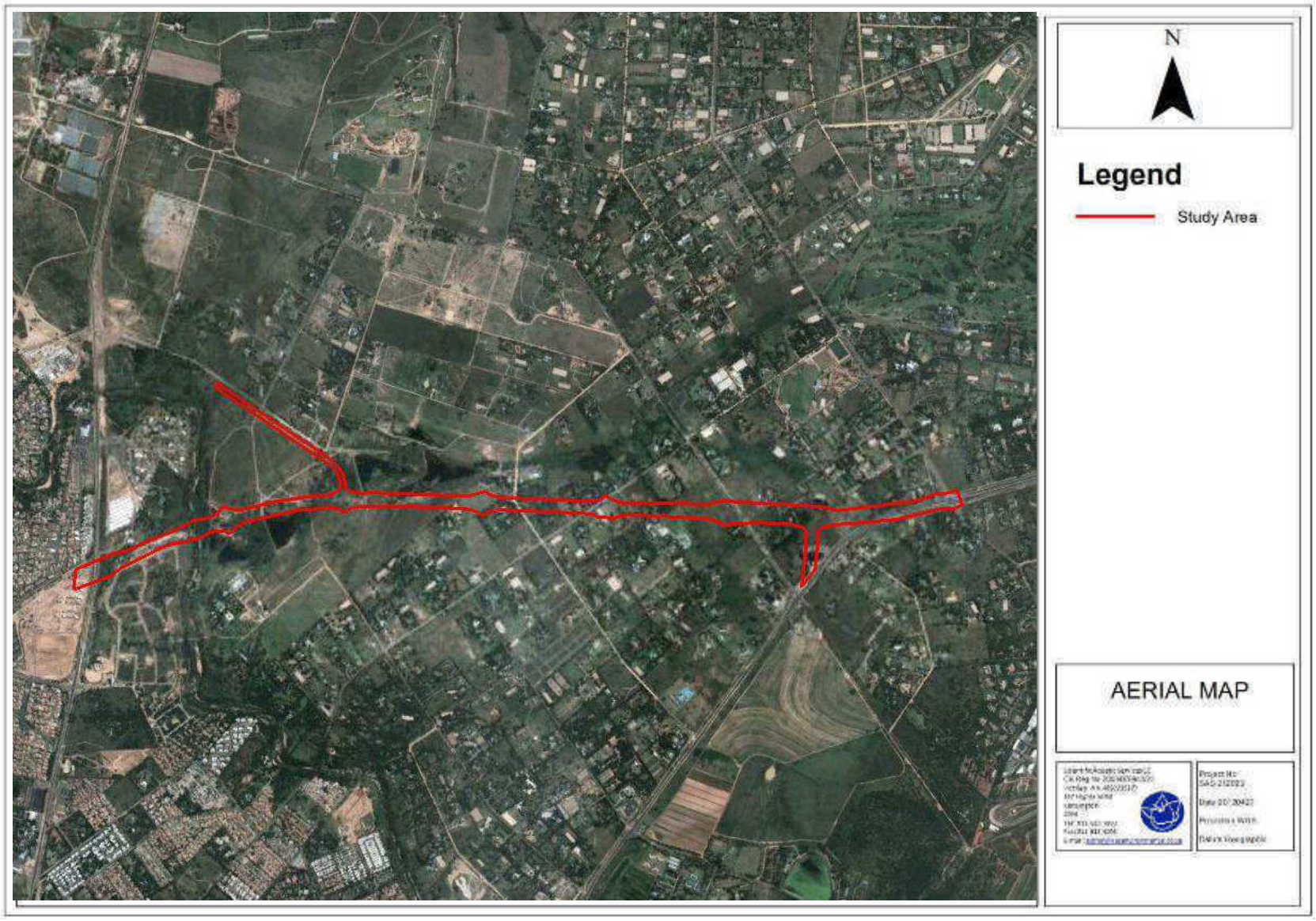

Figure 1: Aerial photograph depicting the location of the subject property.

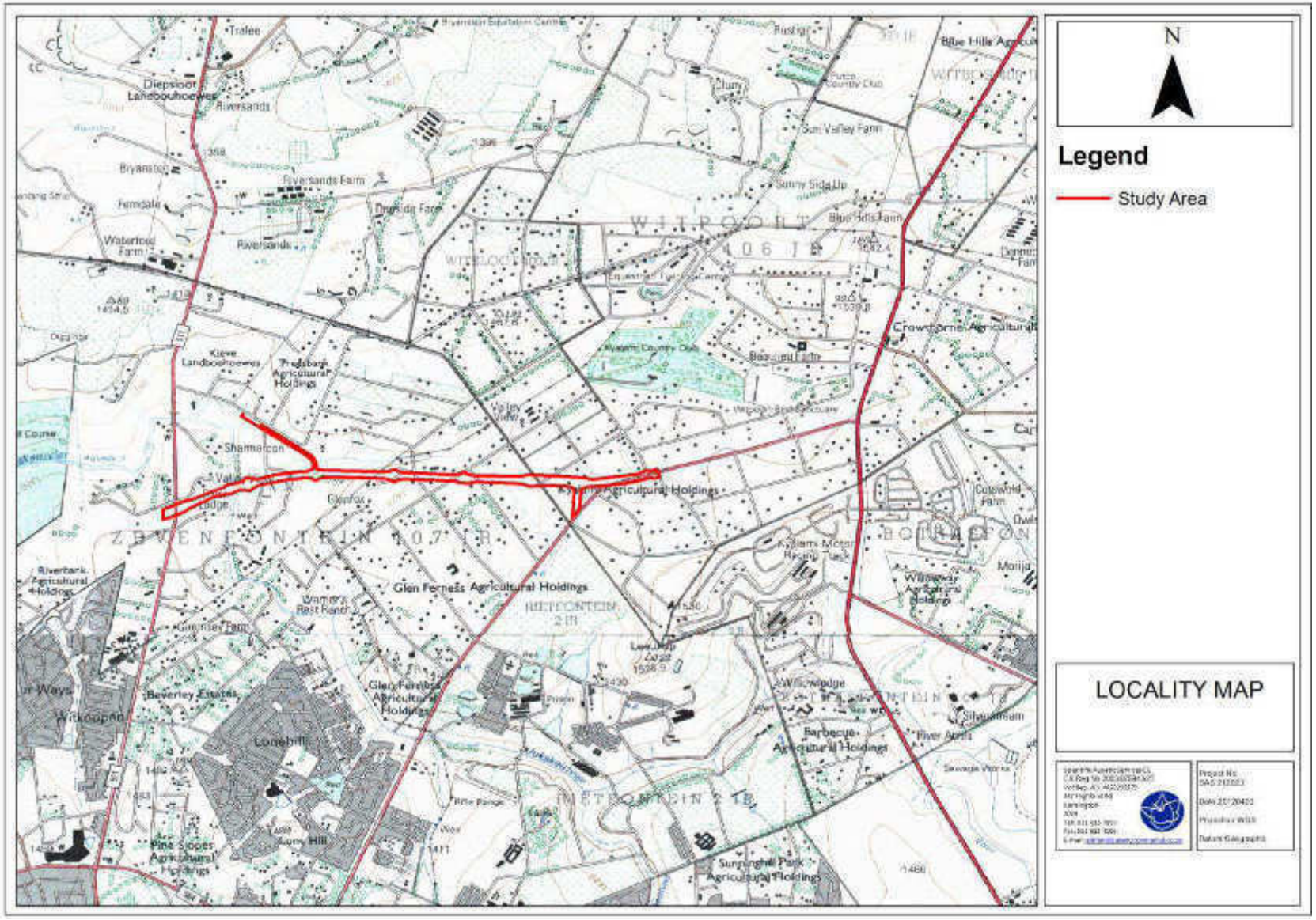

Figure 2: Subject property depicted on a 1:50 000 map in relation to its surrounding area.

1.2 Scope

Specific outcomes in terms of this report are as follow:

Terrestrial Assessment (Fauna and Flora):

- Red Data Listed (RDL) species assessment, including potential for species to occur on the subject property and the implementation of a Red Data Sensitivity Index Score (RDSIS) for the study area;
- provide faunal and floral inventories of species as encountered on site;
- determine and describe habitats, communities and ecological state of the study area and
- describe the spatial significance of the subject property with regards to surrounding natural areas.

Aquatic and Wetland Assessment:

- define the Present Ecological State (PES) of each wetland system within the study area;
- determine the functioning of each system and the environmental and socio-cultural services that the system provide;
- advocate a Recommended Ecological Category (REC) for each wetland feature;
- delineate all wetlands or riparian zones occurring within the assessment site and
- determine the environmental impacts of the proposed mining activity on the wetland areas within the proposed subject property.

1.3 Assumptions and Limitations

The following assumptions and limitations are applicable to this report:

- The subject property is surrounded by properties of which agricultural and residential development are the dominant land use, leaving the surrounding areas largely transformed. Therefore, the ecological assessment was confined to the subject property and only included the ecological assessment of surrounding properties where relevant. The surrounding area was however considered as part of the desktop assessment of the area.
- Due to the nature and habits of most faunal taxa it is unlikely that all species would have been observed during a site assessment of limited duration. Therefore, site observations are compared with literature studies where necessary.
- With ecology being dynamic and complex, some aspects (some of which may be important) may have been overlooked. A more accurate assessment would require that assessments take place in all seasons of the year however by undertaking assessments in the spring period it is deemed likely that most faunal and floral communities would have been adequately assessed and/or considered.

- Sampling by its nature, means that not all individuals are assessed and identified. Some species and taxa on the subject property may therefore been missed during the assessment.
- The wetland delineation as presented in this report is regarded as a best estimate of the wetland boundary based on the site conditions present at the time of assessment.
- Wetlands and terrestrial areas form transitional areas where an ecotone is formed as vegetation species change from terrestrial species to facultative and obligate wetland species. Within this transition zone some variation of opinion on the wetland boundary may occur, however if the DWAF 2005 method is followed, all assessors should get largely similar results.

2 METHODOLOGY

2.1 General Methodology

In order to accurately determine the Present Ecological State (PES) of the study area and capture comprehensive data with respect to faunal and floral taxa the following methodology was used:

- Maps, aerial photographs and digital satellite images were consulted prior to the field assessment in order to determine broad habitats, vegetation types and potentially sensitive sites. An initial visual on-site assessment of the subject property was made in order to confirm the assumptions made during consultation of the maps.
- Literature review with respect to habitats, vegetation types and species distribution was conducted.
- Relevant data bases considered during the assessment of the study area included SANBI [Threatened species programme (TSP) and PRECIS] and the SANBI Biodiversity GIS database (BGIS).
- Specific methodologies for the assessment of faunal, floral, wetland and aquatic ecological assemblages will be presented in the relevant sections along with the methodologies for assessing the integrity and function of wetland systems.

3 ECOLOGICAL DESCRIPTION OF THE PROPERTY

4 FLORAL DESCRIPTION

4.1 Biome and bioregion

Biomes are broad ecological units that represent major life zones extending over large natural areas (Rutherford 1997). This assessment site falls within the Grassland Biome (Figure 3). Biomes are further divided into bioregions, which are spatial terrestrial units possessing similar biotic and physical features, and processes at a regional scale. This assessment site is situated within the Mesic Highveld Grassland Bioregion (Musina & Rutherford, 2006) (Figure 4).

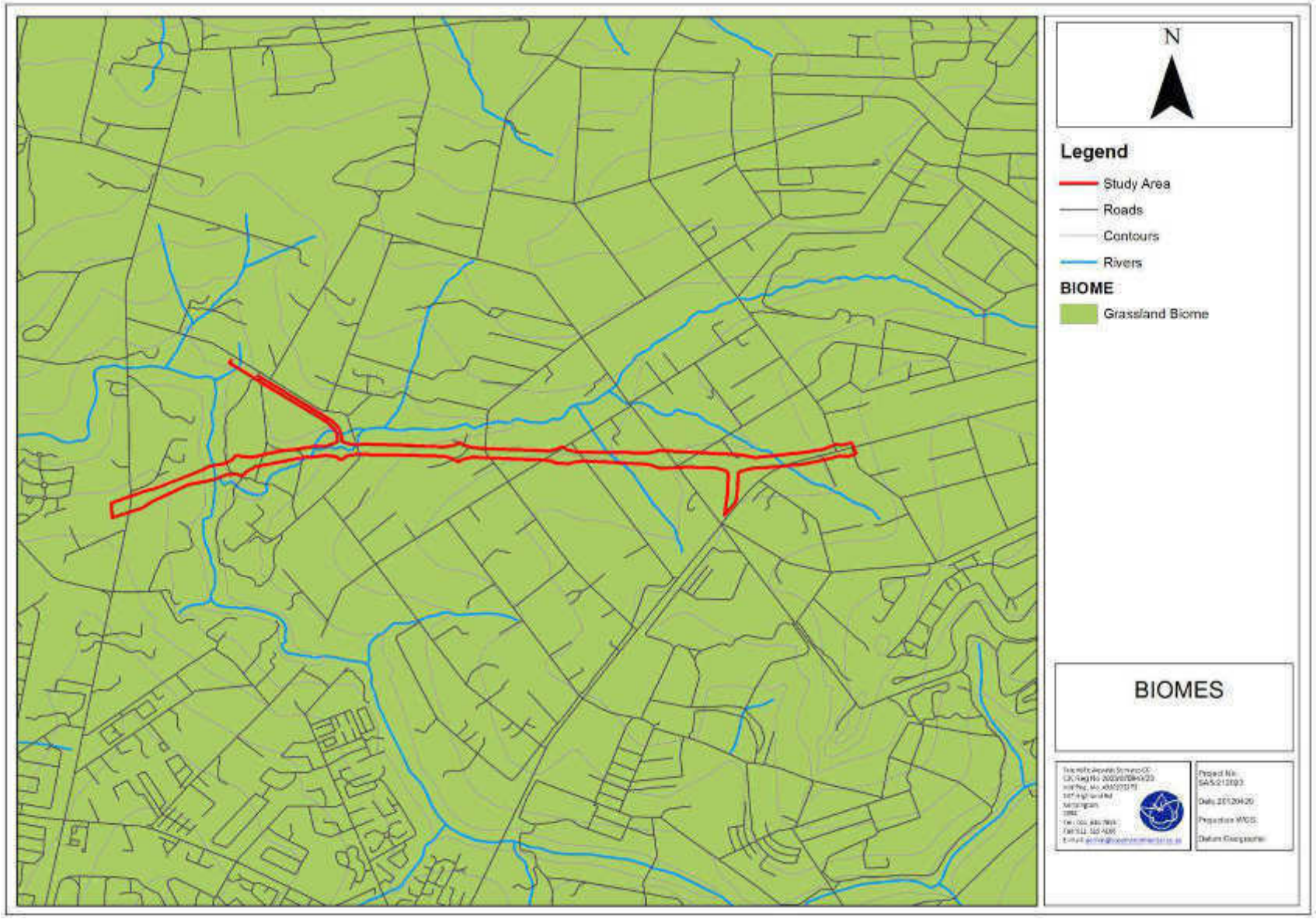

Figure 3: Biome associated with the subject property.

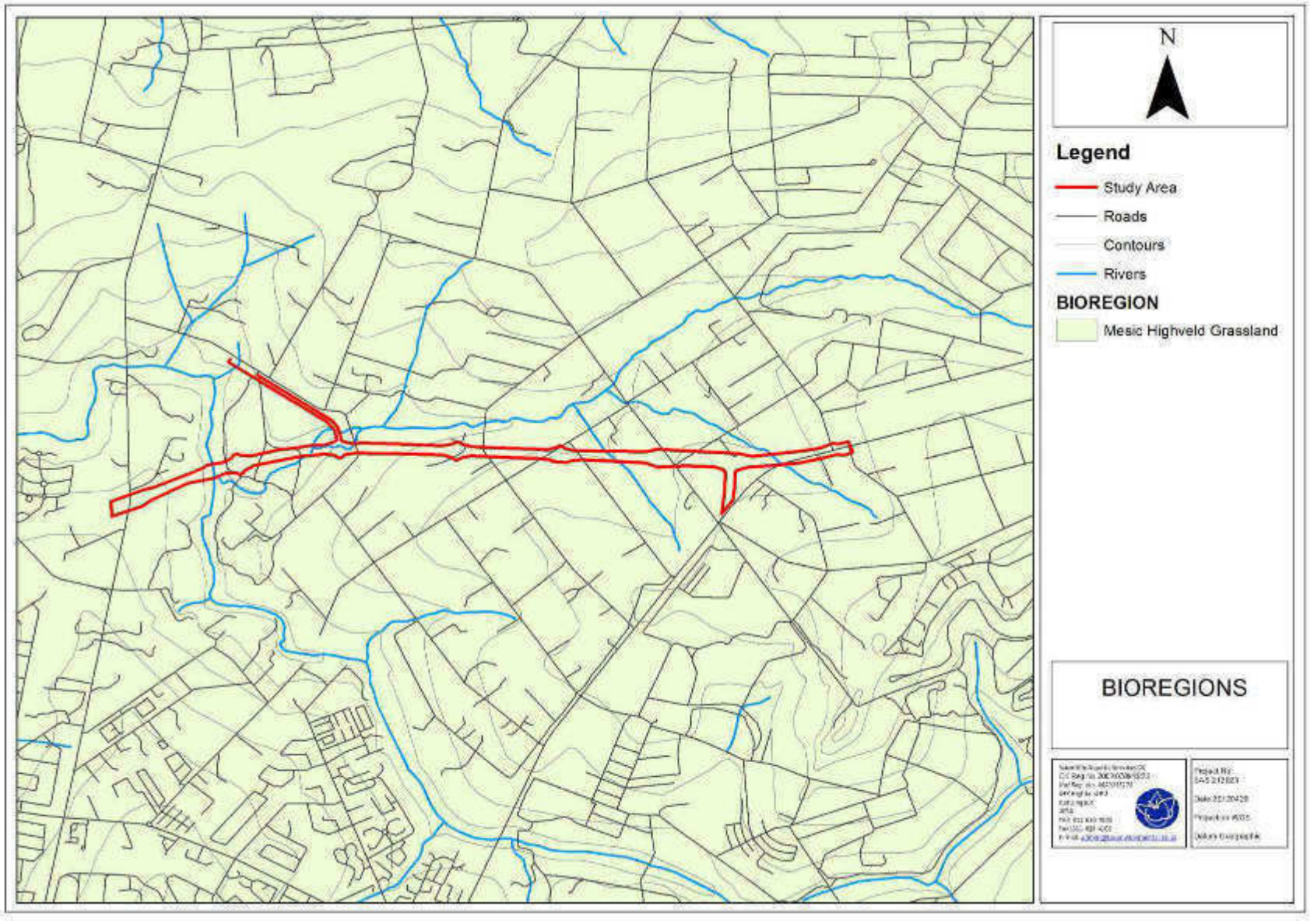

Figure 4: Bioregions associated with the study area (Mucina & Rutherford, 2006).

4.2 Vegetation type and Landscape Characteristics

While biomes and bioregions are valuable as they describe broad ecological patterns, they provide limited information on the actual species that are expected to be found in an area. Knowing which vegetation type an area belongs to provides an indication of the floral composition that would be found if the assessment site was in a pristine condition, which can then be compared to the observed floral list and so give an accurate and timely description of the ecological integrity of the assessment site. When the boundary of the assessment site is superimposed on the vegetation types of the surrounding area (Figure 3), it is evident that the subject property falls within the Egoli Granite Grassland vegetation type (Musina & Rutherford, 2006).

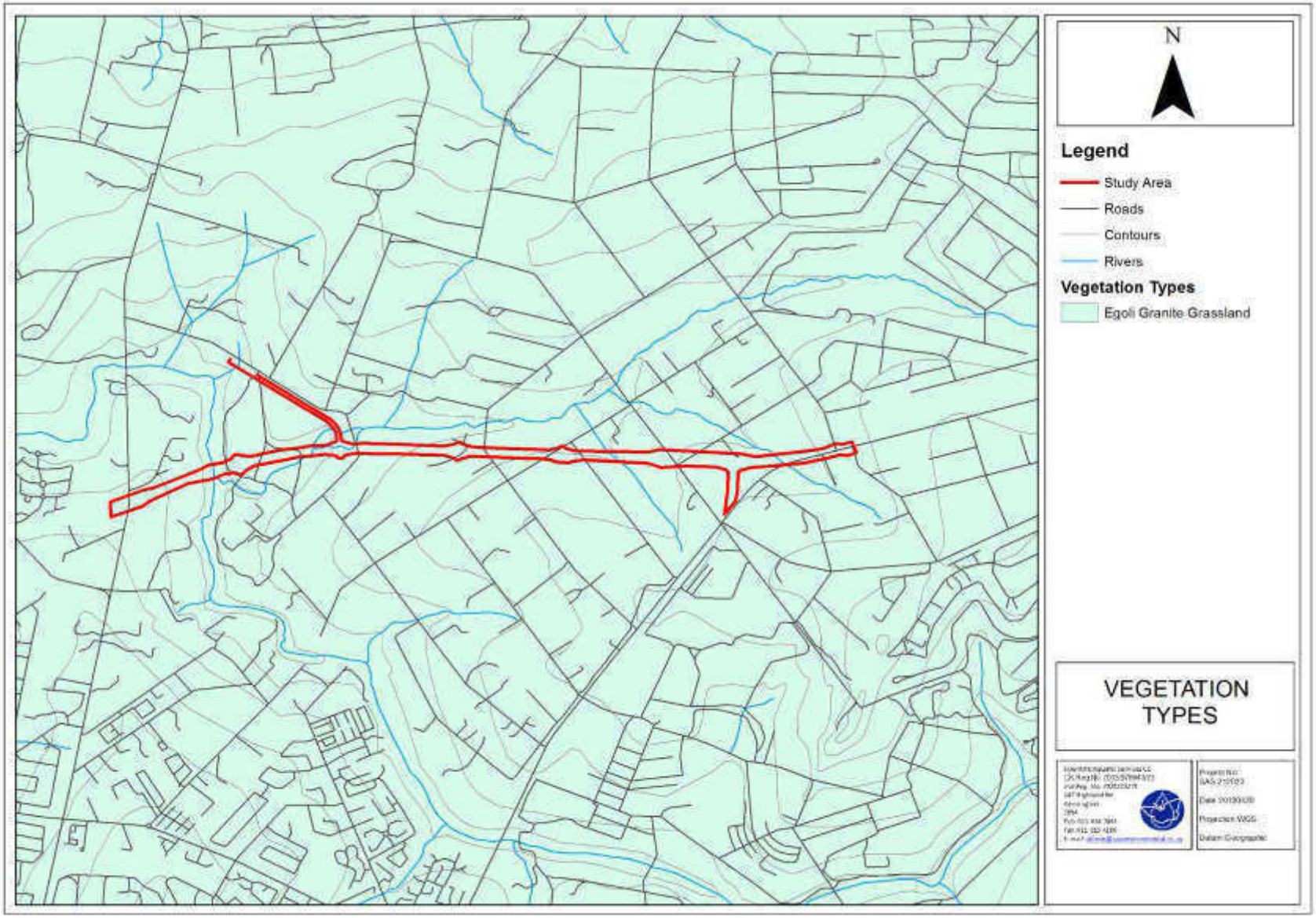

Figure 5: Vegetation types associated with the subject property (Mucina & Rutherford, 2006).

4.3 Distribution

The distribution of Egoli Highveld Grassland is limited to Gauteng Province, and occurs within the Johannesburg Dome, extending in the region between northern Johannesburg (in the south), and from near Lanseria Airport and Centurion (south of Pretoria) to the north, westwards to about Muldersdrif and eastwards to Tembisa (Musina & Rutherford, 2006).

4.4 Climate

Egoli Granite Grassland falls within a strongly-seasonal summer-rainfall region, with very dry winters. The mean annual precipitation (MAP) is 620-800mm (overall average of 682mm) (Table below). The variation of the MAP is from 24-27% across the unit, showing the variation and unreliability of the rainfall. Incidences of frost are frequent within the vegetation type, being higher in the southern than in the northern areas (Mucina & Rutherford, 2006).

Average climatic values shows the region to have an average precipitation value of 682mm. The MASMS value for the region is 75%. These values, when compared to the MAT and MAPE averages of 16.0°C and 2,194mm, respectively, show the region to be a relatively water-stressed area. Conservation of surface (and ground) water resources is therefore imperative to biodiversity conservation within the region.

Table 1: General climatic information for Egoli Granite Grassland (Mucina & Rutherford, 2006).

Bioregion	Vegetation types	Altitude (m)	MAP* (mm)	MAT* (°C)	MAPE* (mm)	MASMS* (%)
Mesic Highveld Grassland	Egoli Granite Grassland	1,280-1,660	682	16.0	2,194	75

***MAP – Mean annual precipitation; MAT – Mean annual temperature; MAPE – Mean annual potential evaporation; MASMS – Mean annual soil moisture stress (% of days when evaporative demand was more than double the soil moisture supply).**

4.5 Geology and soils

The geology of Egoli Granite Grassland is dominated by Archaean Granite and Gneiss of the Halfway House granites at the core of the Johannesburg Dome, supporting leached, shallow, coarsely-grained and sandy soil poor in nutrients of the Glenrosa form. Small areas are built by ultramafics (DEAT, 2001; Mucina & Rutherford, 2006). The lithology for the area is also dominated by Iron, Jaspilite, Syenite, Hornblende Granite, Foskorite, Gabro, Potassic Granite and Dionite (ENPAT, 2001).

4.6 Conservation

This vegetation type is formally classified as an Endangered vegetation type that has only approximately 3% (provincial conservation target is 24%) of it conserved in statutory reserves (Diepsloot and Melville Koppies Nature Reserve). Other conserved areas include the Walter Sisulu National Botanical Gardens. More than two thirds of the vegetation unit has already undergone transformation mostly due to urbanisation, cultivation or by road construction. Current rates of transformation threaten most of the remaining unconserved areas. There is no serious alien infestation in this unit, although species such as *Eucalyptus grandis*, *Eucalyptus camaldulensis* and *Eucalyptus sideroxylon*, as well as exotic *Acacia* species, are commonly found. Erosion is moderate and very low.

4.7 Important Taxa of Egoli Granite Grassland

The proposed development site falls within the Grassland Biome and Mesic Highveld Grassland Bioregion of Gauteng. It is represented by one vegetation unit, namely Egoli Granite Grassland, which is an Endangered vegetation type. It occurs on moderately to strongly undulating plains and low hills supporting tall, usually *Hyparrhenia hirta*-dominated grasslands, with some woody species on rocky outcrops or rock sheets. The rocky habitat show a high diversity of woody species, which occur in the form of scattered shrub groups or solitary small trees. The dominant and typical floral species of Egoli Granite Grassland are presented in the table below.

Table 2: Dominant and typical floristic species of Egoli Granite Grassland (Mucina & Rutherford, 2006).

Grass species	Forb species	Tree/Shrub Species
Aristida canescens (d)	*Acalypha angustata*	*Vangueria infausta*
Aristida congesta (d)	*Acalypha peduncularis*	*Rhus pyroides*
Cynodon dactylon (d)	*Becium obovatum*	*Anthospermum hispidulum*
Digitaria monodactyla (d)	*Berkheya insignis*	*Anthospermum rigidum*
Eragrostis capensis (d)	*Crabbea hirsute*	subsp. *pumilum*
Eragrostis chloromelas (d)	*Cyanotis speciosa*	*Helichrysum kraussii*
Eragrostis curvula (d)	*Dicoma anomala*	*Ziziphus zeyheriana*
Eragrostis racemosa (d)	*Gnidia capitata*	*Lopholaena coriifolia*
Heteropogon contortus (d)	*Helichrysum rugulosum*	
Hyparrhenia hirta (d)	*Justicia anagalloides*	
Melinis repens subsp. *repens* (d)	*Kohautia amatymbica*	
Monocymbium ceresiiforme (d)	*Nidorella hottentotica*	
Setaria sphacelata (d)	*Pentanisia prunelloides* subsp. *latifolia*	
Themeda triandra (d)	*Pseudognaphalium luteo-album*	
Tristachya leucothrix (d)	*Senecio venosus*	
Andropogon eucomus (c)		
Aristida aequiglumis (c)	Geophytic herbs:	
Aristida diffusa (c)	*Cheilanthes deltoidea*	
Aristida scabrivalvis subsp.	*Cheilanthes hirta*	

Grass species	Forb species	Tree/Shrub Species
borumensis (c) *Bewsia biflora* (c) *Brachiaria serrata* (c) *Bulbostylis burchelli* (c) *Cymbopogon caesius* (c) *Digitaria tricholaeoides* (c) *Diheteropogon amplectens* (c) *Eragrostis gummiflua* (c) *Eragrostis sclerantha* (c) *Panicum natalense* (c) *Schizachyrium sanguineum* (c) *Setaria nigrirostris* (c) *Tristachya rehmannii* (c) *Urelytrum agropyroides* (c)		

***(d) – Dominant species for the vegetation type; (c) – Common species for the vegetation type.**

5 GENERAL IMPORTANCE OF SUBJECT PROPERTY

5.1 Importance According to Gauteng Conservation Plan

The Gauteng Urban Edge (2010) indicates the western portion of the proposed route alignment to fall within the Gauteng Urban Edge (Figure 6), while the remainder of the route development falls outside the urban edge. Where possible, development within the province should be contained within the Gauteng Urban Edge in order to prevent urban sprawl and to encourage and enforce a compact urban form.

According to the Gauteng C-Plan (Version 2), which focuses on the mapping and management of biodiversity priority areas within Gauteng, indicates the western portion of the proposed development route as being an 'Important Site' (Figure 8). The C-Plan includes protected areas, irreplaceable and important sites due to the presence of Red Data species, endemic species and potential habitat for these species to occur. An 'Important Site' refers to a site designated as important in meeting targets set for the conservation of biodiversity, the significance of which is subject to ground truthing. The site is important to protect in some way, but not essential and can be replaced by a similar site, but a trade-off in the efficiency of the conservation plan may be the result.

All wetland and associated wetland buffer areas are considered to be ecologically protected (Figure 7) and should be excluded from development where possible. No protected areas, apart from the wetland buffer areas, or irreplaceable sites were indicated by the C-Plan.

Figure 9 indicates that ridges are present in the north and east of the study area. The ridge area bordering the proposed route alignment in the east is considered to be transformed, but the ridge in the north of the study area is not considered to be transformed. According to the Gauteng Ridges Policy ridges play an important role in conservation of faunal and floral species and development should be limited in these areas.

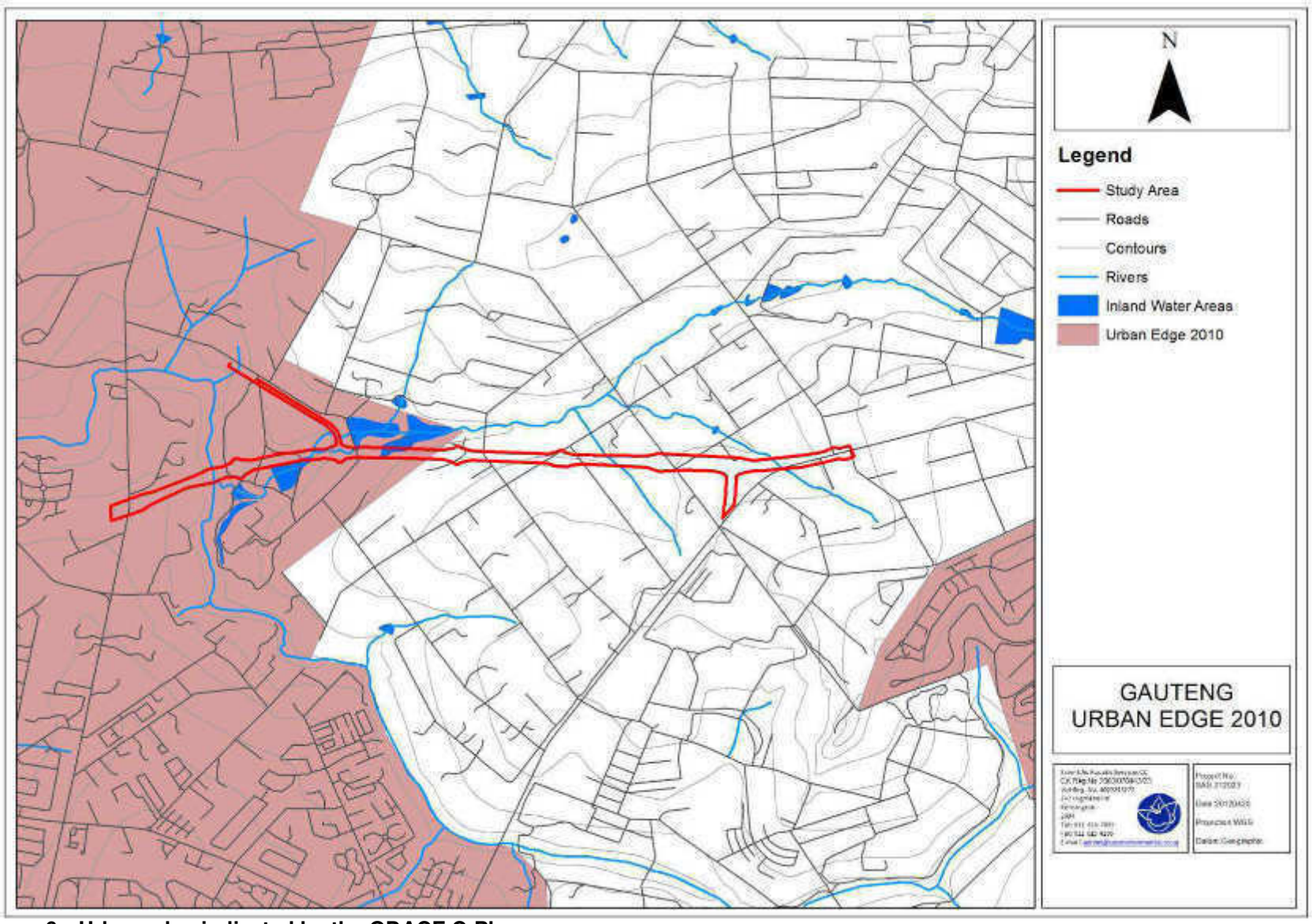

Figure 6: Urban edge indicated by the GDACE C-Plan.

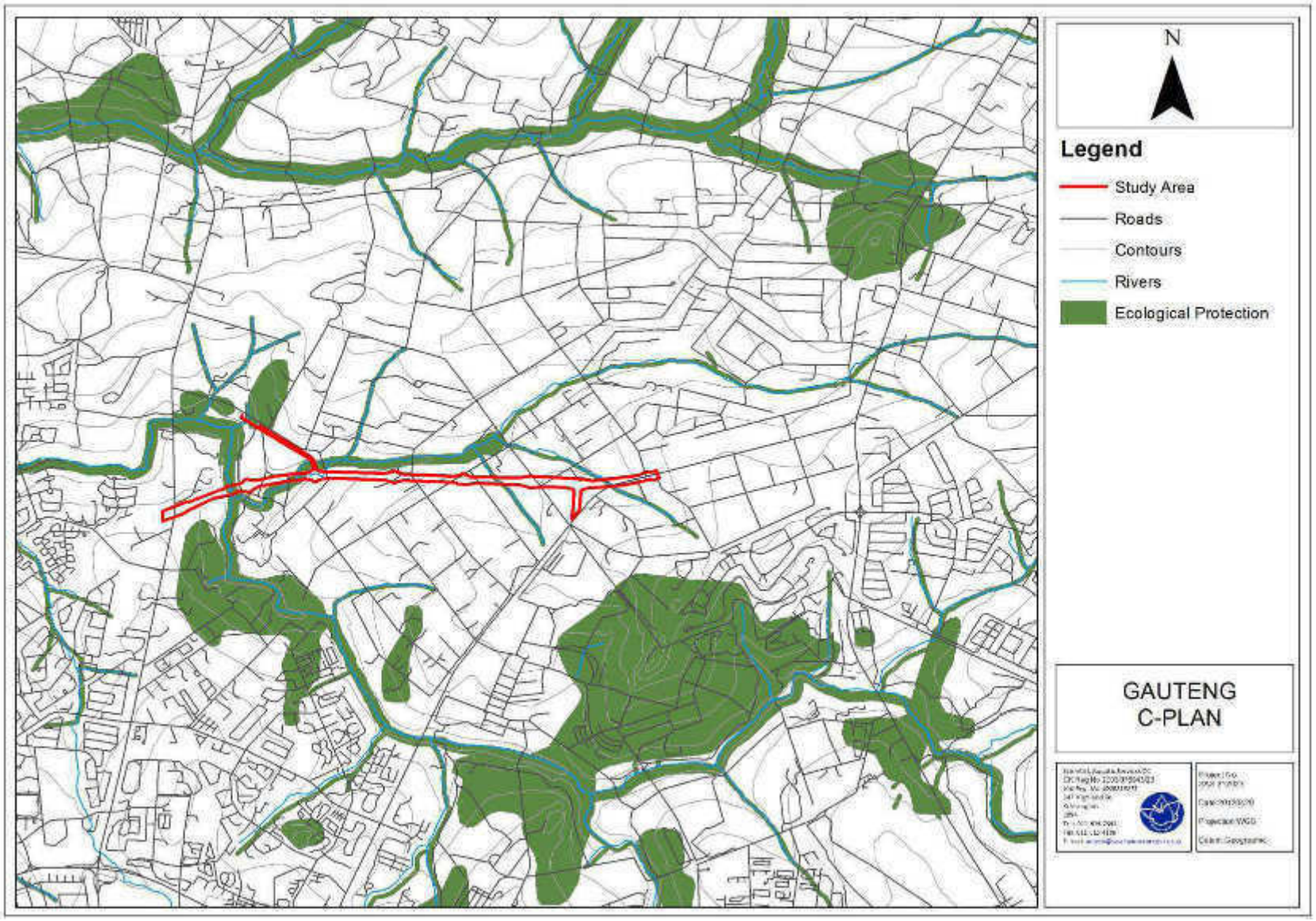

Figure 7: Areas of ecological protection indicated by the GDACE C-Plan

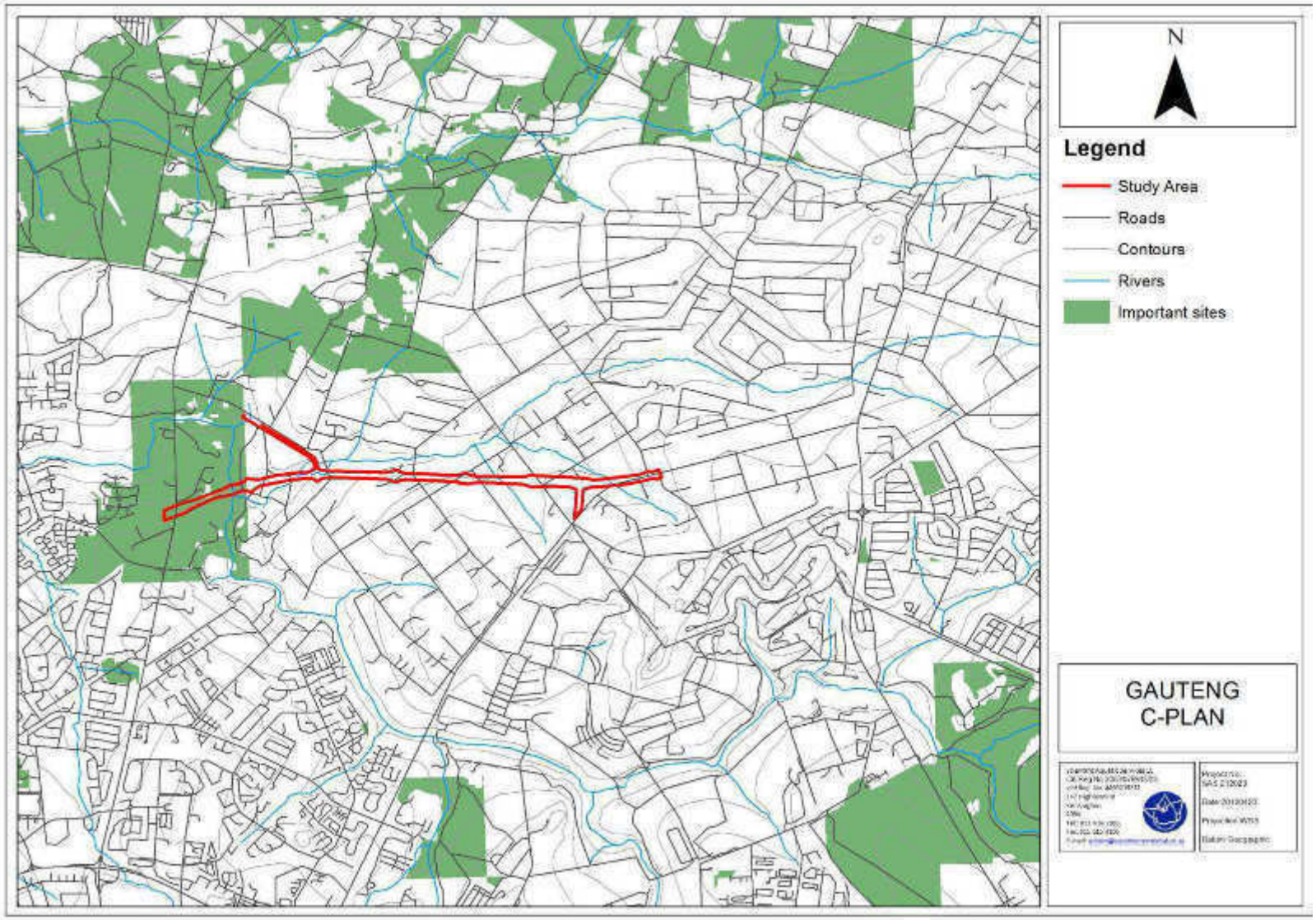

Figure 8: Important sites indicated by the GDACE C-Plan.

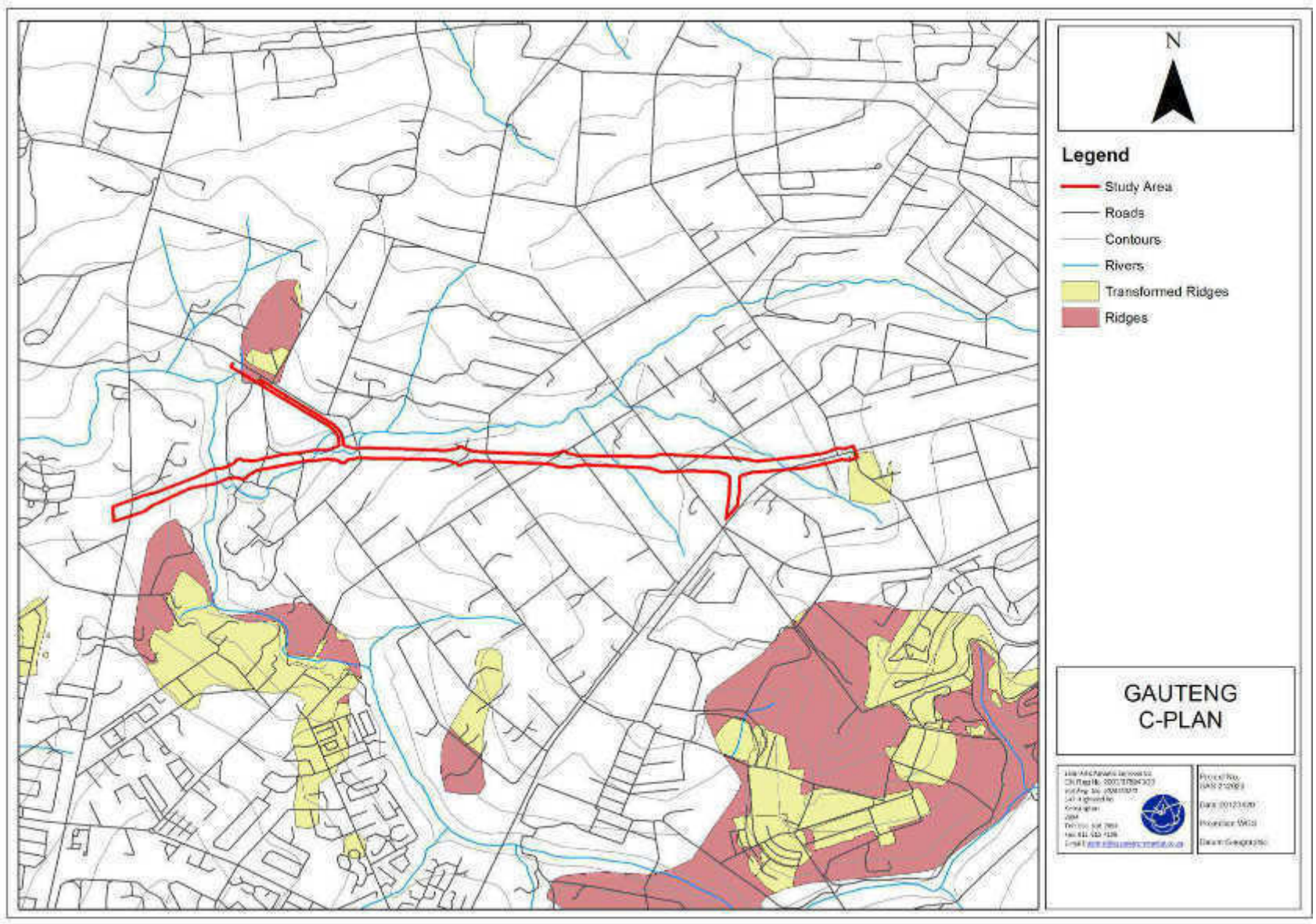

Figure 9: Ridge areas indicated by the GDACE C-Plan

6 AQUATIC ECOLOGICAL CHARACTERISTICS OF THE STUDY AREA

6.1 Ecoregions

When assessing the ecology of any area (aquatic or terrestrial), it is important to know which ecoregion the study area is located within. This knowledge allows for improved interpretation of data to be made, since reference information and representative species lists are often available on this level of assessment, which aids in guiding the assessment.

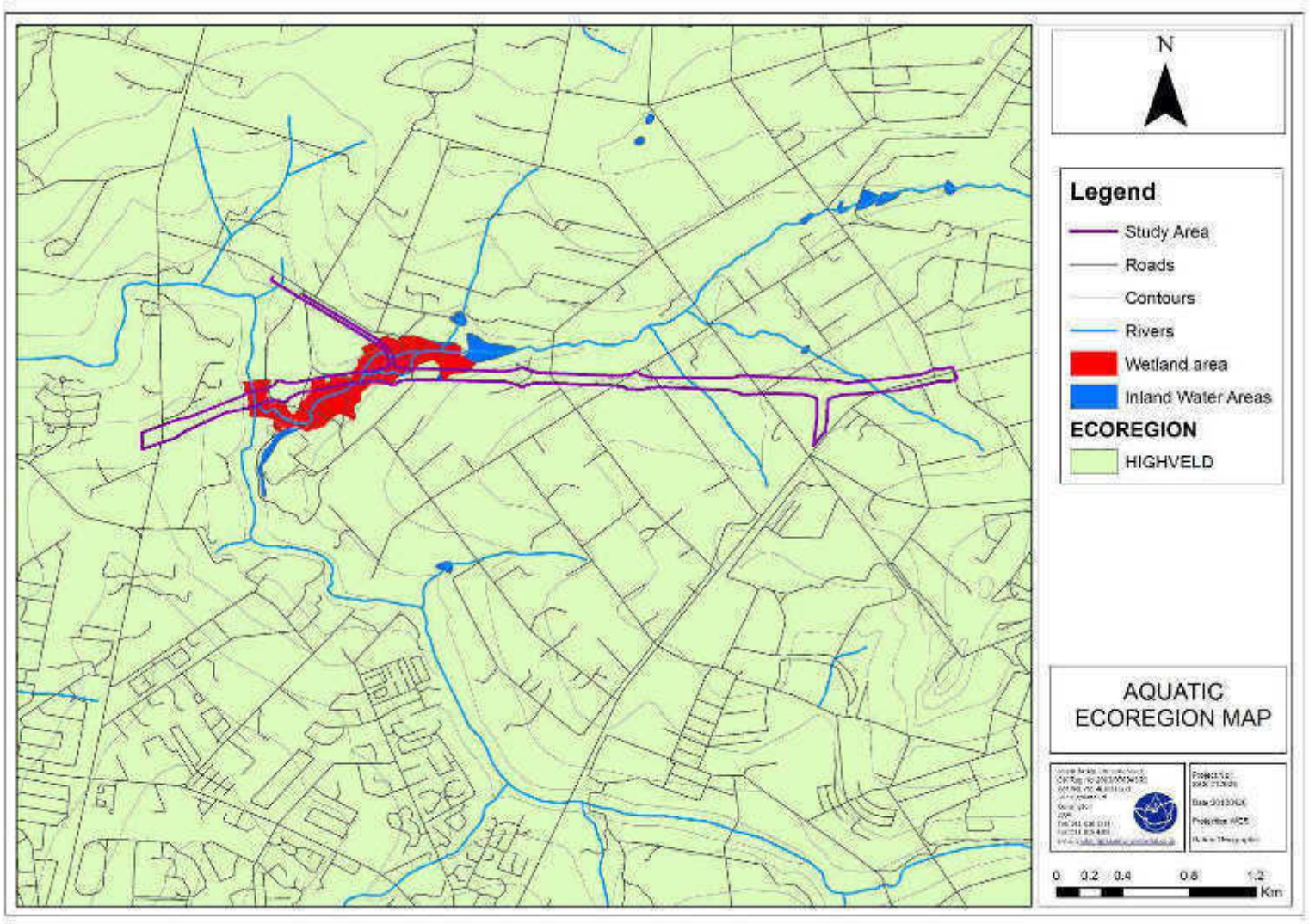

Figure 10: Aquatic Ecoregions associated with the subject property

6.2 Ecostatus

Water resources are generally classified according to the degree of modification or level of impairment. The classes, used by the South African River Health Program (RHP), are presented in the table below and will be used as the basis of classification of the systems in this desktop study, as well as future field studies.

Table 3: Classification of river health assessment classes in line with the RHP

Class	Description
A	Unmodified, natural.
B	Largely natural, with few modifications.
C	Moderately modified.
D	Largely modified.
E	Extensively modified.
F	Critically modified.

Studies undertaken by the Institute for Water Quality Studies assessed all quaternary catchments as part of the Resource Directed Measures for Protection of Water Resources. In these assessments, the Ecological Importance and Sensitivity (EIS), Present Ecological Management Class (PEMC) and Desired Ecological Management Class (DEMC) were defined and serve as a useful guideline in determining the importance and sensitivity of aquatic ecosystems, prior to assessment or as part of a desktop assessment.

This database was searched for the four catchments of concern in order to define the EIS, PEMC and DEMC. The results of the assessment are summarised in the table below.

Table 4: Location of the catchment with co-ordinates and descriptions of the site in relation to surrounding features

Catchment	Resource	EIS	DEMC	PESC	PESC with rules as for desktop WBM
A21C	Jukskei River	Moderate	C: Moderately sensitive system	Class C	Class D: Largely Modified

The points below summarise the impacts on the aquatic resources in the A21C quaternary catchment (Kleynhans 1999):

- The aquatic resources within this quaternary catchment have been moderately affected by bed modification.
- A moderate impact on the flow regime of the system has occurred due to larger floods and a Mean Annual Runoff (MAR) which is 17% larger than natural.
- A low impact from introduction of fish species to the system has occurred with special mention of *GAFF and CCAR*.

- Impacts as a result of inundation are low, inundation which does occur occurs as a result of weirs.
- Riparian zones and stream bank conditions have been moderately impacted due to the effects of exotics.
- High impacts on water quality are noted.

In terms of ecological functions, importance and sensitivity, the following points summarise the conditions in the A21C quaternary catchment (Kleynhans 1999):

- The riverine system in this catchment has a high diversity of habitat types, including wetlands, cascades, riffles and pools.
- The site has a moderate importance in terms of conservation with the Ebenezer reserve nearby.
- Biota in this system has a moderate sensitivity to flow requirements with special mention of the invertebrate community as well as the fish species *Amphilius uranosccopus* and *Barbus eutaenia*.
- This area has a moderate importance in terms of migration of aquatic species.
- This area is considered to have a very high importance in terms of rare and endangered species, however, in terms of endemic species conservation the area is considered important with special mention of *Amphilius uranosccopus* and *Barbus eutaenia*.
- This area is important in terms of providing refuge areas for aquatic taxa.
- The ecology of this area is considered to have a moderate sensitivity to changes in water quality with special mention of concerns over altered temperature regimes and dissolved oxygen concentrations.
- The ecology of the area is sensitive to changes in flows with special mention of the need to have perennial rapids present with good water quality.
- The system has a high diversity of fish species and it is suspected that the aquatic macro-invertebrate community was more diverse in the past

7 SURROUNDING PROPERTIES/LAND USES

The greater area surrounding the subject property is located within a district primarily utilised for agricultural activities. The proposed road development meanders through agricultural and residential areas where varying levels of transformation were encountered.

8 SENSITIVITY MAPPING

All the ecological features of the study area were considered and sensitive areas were delineated with the use of a Global Positioning System (GPS). A geographic Information System (GIS) was used to project these features onto aerial photographs and topographic maps. The sensitivity map should guide the design and layout of the proposed development (See figure below).

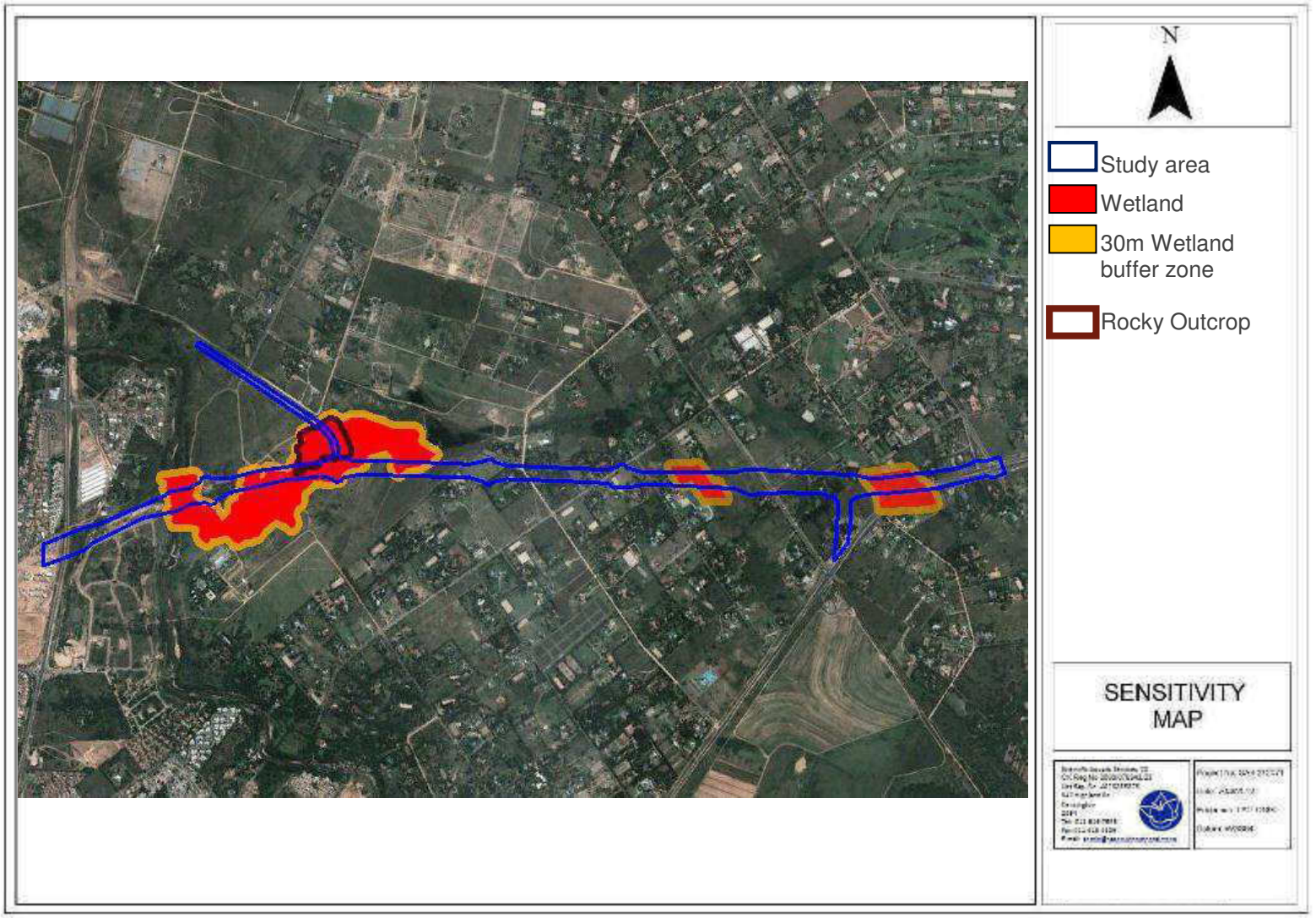

Figure 11: Sensitive areas of the subject property.

9 STRUCTURE OF THE REPORT

Section A of this report served to provide an introduction to the subject property, the general approach to the study as well as the method of impact assessment. Section A also presents the results of general desktop information reviewed as part of the study including the information generated by the relevant authorities as well as the context of the site in relation to the surrounding anthropogenic activities and ecological character. The section also indicates that the requirements for mitigation, monitoring and rehabilitation are addressed in each section.

Section B addresses all the issues pertaining to the assessment of the floral ecology of the subject property.

Section C addresses all the issues pertaining to the assessment of the floral ecology of the subject property.

Section D addresses all the issues pertaining to the assessment of the wetland ecology of the subject property.

Section E addresses all the issues pertaining to the assessment of the aquatic ecology of the subject property.

10 REFERENCES

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The South African National Biodiversity Institute (SANBI) is thanked for the use of data from the National Herbarium, Pretoria (PRE) **Computerised Information System (PRECIS)**

The South African National Biodiversity Institute - Biodiversity GIS (BGIS) *[online].* URL: http://bgis.sanbi.org.

FAUNAL, FLORAL, WETLAND AND AQUATIC ASSESSMENT FOR THE PROPOSED K56 ROAD DEVELOPMENT, DAINFERN, GAUTENG.

Prepared for

Bokamoso Environmental Consultants

July 2012

Section B: Floral Assessment

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1. INTRODUCTION

1.1 Background

Scientific Aquatic Services (SAS) was appointed to conduct a floral, faunal, wetland and aquatic assessment on the proposed development of the K56 road (Section A: Figures 1 & 2), hereafter referred to as the subject property. The total length of the proposed road development is approximately 7km. The proposed K56 is situated to the northwest of Midrand, in the vicinity of Dainfern, in the Gauteng Province.

This report, after consideration and the description of the ecological integrity of the subject property, must guide the Environmental Assessment Practitioner (EAP) and regulatory authorities, by means of the presentation of results and recommendations, as to the ecological viability of the proposed road development route. Only the subject property, including its immediate surroundings, was assessed during the field visits. The surrounding properties were, however, also considered as part of the desktop assessment.

2. GENERAL SITE SURVEY

Two site visits were undertaken during April 2012 to determine the ecological status of the proposed development site and the surrounding area. A reconnaissance 'walkabout' was initially undertaken in order to determine the general habitat types found throughout the subject property and, following this, specific study sites were chosen that were representative of the habitats found within the area. Special emphasis was placed on areas that may potentially support RDL species. Sites were investigated on foot to identify the occurrence of the dominant plant communities, species and habitat diversities.

3. FLORAL ASSESSMENT METHODOLOGY

3.1 Red and Orange Data Listed Flora

Prior to the field visit, a record of Red Data List plant species and their habitat requirements was acquired from SANBI for the quarter degree grid 2528CC (Appendix B). Throughout the floral assessment, specific attention was paid to the identification of any of these RDL species as well as the identification of suitable habitat that could potentially sustain these species.

The probability of occurrence (POC) for each floral species of concern (2528CC) was determined using the following calculations wherein the habitat requirements and habitat

disturbance were considered. The accuracy of the calculation is based on the available knowledge about the species in question, with many of the species lacking in-depth habitat research. Therefore, it is important that the literature available is also considered during the calculation.

Each factor contributes an equal value to the calculation.

Literature availability

	No Literature available					Literature available
Site score						
Score	0	1	2	3	4	5

Habitat availability

	No Habitat available					Habitat available
Site score						
Score	0	1	2	3	4	5

Habitat disturbance

	0	Very Low	Low	Moderately	High	Very High
Site score						
Score	5	4	3	2	1	0

[Literature availability + Habitat availability + Habitat disturbance] / 15 x 100 = POC%

3.2 Habitat Units

The overall vegetation survey was conducted by first identifying different habitat units and then analysing the floral species composition. Vegetation analyses were conducted within areas that were perceived to best represent the various plant communities. Species were recorded and a species list was compiled for each habitat unit. These species lists were also compared with the vegetation expected to be found within the Egoli Granite Grassland vegetation type, which serves to provide an accurate indication of the ecological integrity and conservational value of each habitat unit.

3.3 Vegetation Index Score

The Vegetation Index Score (VIS) was designed to determine the ecological state of each habitat unit defined within an assessment site. This enables an accurate and consistent description of the present ecological state (PES) concerning the subject property in question. The information gathered during these assessments also significantly contributes to sensitivity mapping, leading to a more truthful representation of ecological value and sensitive habitats.

Each defined habitat unit is assessed using separate data sheets (Appendix B) and all the information gathered then contributes to the final VIS score. The VIS is derived using the following formulas:

VIS = [(EVC)+((SIxPVC)+(RIS))]

Where:

1. **EVC** is extent of vegetation cover;
2. **SI** is structural intactness;
3. **PVC** is percentage cover of indigenous species and
4. **RIS** is recruitment of indigenous species.

Each of these contributing factors is individually calculated as discussed below. All scores and tables indicated in blue are used in the final score calculation for each contributing factor.

1. EVC=[(EVC1+EVC2)/2]

EVC 1 - Percentage natural vegetation cover:

Vegetation cover % Site score	0%	1-5%	6-25%	26-50%	51-75%	76-100%
EVC 1 score	0	1	2	3	4	5

EVC2 - Total site disturbance score:

Disturbance score Site score	0	Very Low	Low	Moderately	High	Very High
EVC 2 score	5	4	3	2	1	0

2. *SI=(SI1+SI2+SI3+SI4)/4)*

	Trees (SI1)		Shrubs (SI2)		Forbs (SI3)		Grasses (SI4)	
Score:	Present State	Perceived Reference State	Present State	Perceived Reference State	Present State	Perceived Reference State	Present State	Perceived Reference State
Continuous								
Clumped								
Scattered								
Sparse								

Present State (P/S) = Currently applicable for each habitat unit
Perceived Reference State (PRS) = If in pristine condition

Each SI score is determined with reference to the following scoring table of vegetation distribution for present state versus perceived reference state.

	Present state (P/S)			
Perceived Reference state (PRS)	Continuous	Clumped	Scattered	Sparse
Continuous	3	2	1	0
Clumped	2	3	2	1
Scattered	1	2	3	2
Sparse	0	1	2	3

3. *PVC=[(EVC)-((exotic x 0.7) + (bare ground x 0.3))*

Percentage vegetation cover (exotic):

Vegetation cover %	0%	1-5%	6-25%	26-50%	51-75%	76-100%
PVC Score	0	1	2	3	4	5

Percentage vegetation cover (bare ground):

Vegetation cover %	0%	1-5%	6-25%	26-50%	51-75%	76-100%
PVC Score	0	1	2	3	4	5

4. RIS

Extent of indigenous species recruitment	0	Very Low	Low	Moderate	High	Very High
RIS	0	1	2	3	4	5

The final VIS scores for each habitat unit are then categorised as follows:

Vegetation Index Score	Assessment Class	Description
22 to 25	A	Unmodified, natural
18 to 22	B	Largely natural with few modifications.
14 to 18	C	Moderately modified
10 to 14	D	Largely modified
5 to 10	E	The loss of natural habitat extensive
<5	F	Modified completely

4. RESULTS OF FLORAL INVESTIGATION

4.1 Ecological condition and functioning

Ecological functioning and the condition of the study area range from high within wetland areas to low within the transformed areas. The subject property can be divided into four habitat units namely the Wetland Habitat Unit, occurring in the east and west of the subject property, the Rocky Outcrop Habitat Unit, occurring in the west of the subject property, and the Open Grassland and Transformed Habitat Units occurring throughout the remainder of the subject property (Figure 1).

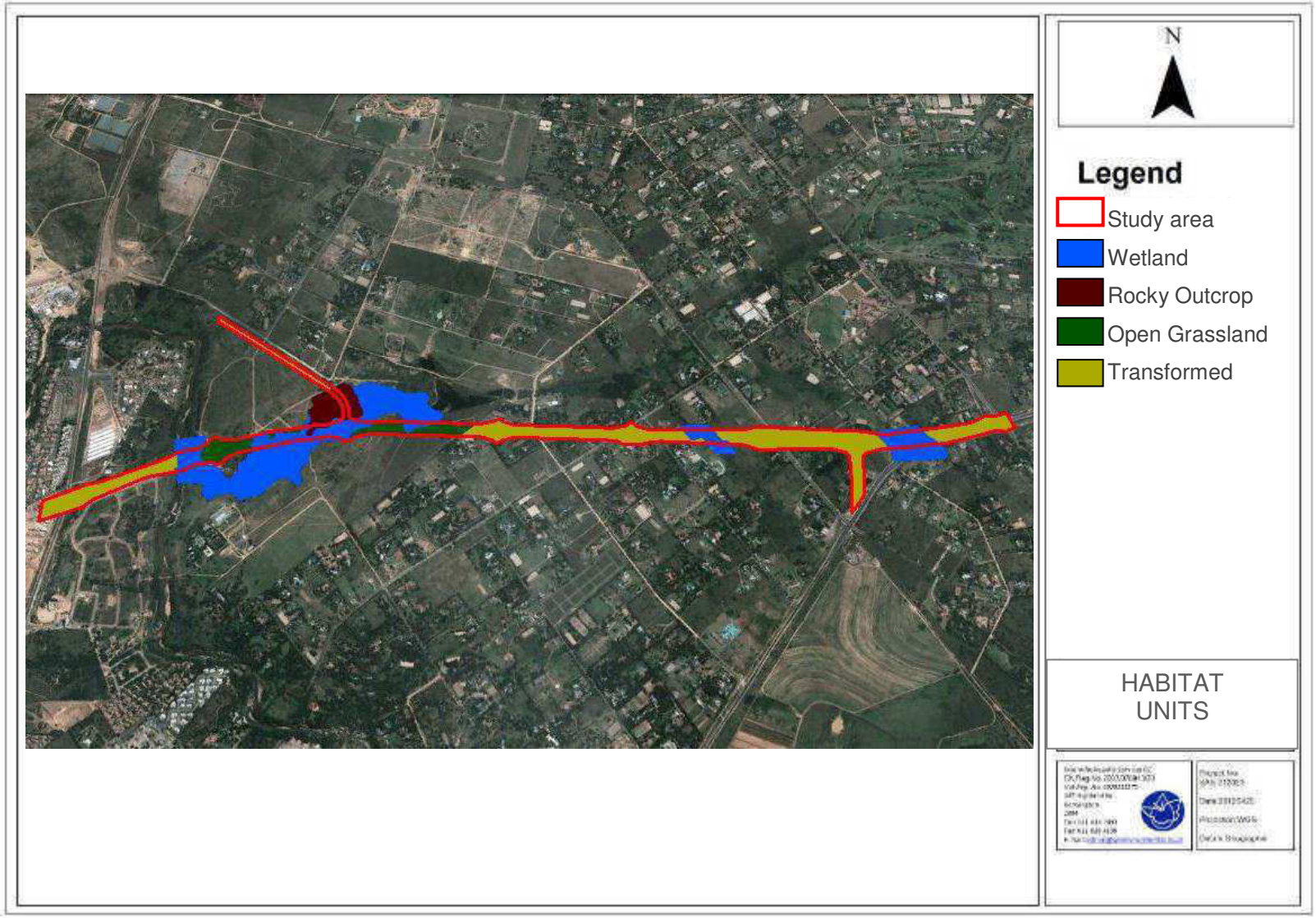

Figure 1: Conceptual mapping of Habitat Units encountered on the subject property.

4.2 Habitat descriptions

4.2.1 Habitat Unit 1: Wetland and Riparian Areas

The Wetland Habitat Unit covers a relatively large portion of the subject property. It is present in the eastern, western and central portion of the proposed development route and includes a number of artificial impoundments.

Figure 2: Wetland features encountered within the assessment site.

Several wetland and drainage features were encountered along the proposed development route. Although anthropogenic activities, in particular urban and residential development, as well as historic agricultural activities, have impacted the ecological integrity of some of these wetland features, the majority of the riparian and wetland areas

have remained reasonably undisturbed and are in a largely natural state, apart from the dam areas. These areas are considered to be of high ecological sensitivity and have high potential to support an increased diversity of faunal and floral species. The wetland areas are also important in terms of faunal migratory connectivity.

Moderate to high floral species diversity was observed in wetland and riparian areas. The dominant species encountered within the wetland areas are represented in the table below.

Table 1: Dominant species encountered in the Wetland Habitat Unit. Alien species are indicated with an asterisk.

Grass/sedge/reed species	Forb species	Tree/Shrub Species
Aristida junciformis	*Buchnera reducta*	*Diospyros lycioides*
*Conyza podocephala**	*Persicaria lapathifolia**	*Ligustrum japonicum**
Cynodon dactylon	*Senna didimobotrya**	*Searsia lancea*
*Cyperus esculentus**	*Solanum mauritiuanum**	*Combretum erythrophyllum*
Cyperus ruprestis	*Verbena bonariensis**	*Searsia pyroides*
Eragrostis gummiflua		
Hyparrhenia hirta		
Imperata cylindrica		
Kylinga alba		
Panicum schinzii		
*Pennisetum clandestinum**		
Phragmites australis		
Schoenoplectus corymbosus		
Setaria megaphylla		
Sporobolus africanus		
Themeda triandra		
Typha capensis		

Section C of this report illustrates representative sections of the wetland and riparian zones. Overall fair to excellent levels of ecological functioning were observed, and as such these areas are deemed ecologically valuable. Please refer to the aquatic and wetland reports for further details on the ecological importance and functioning of the wetland and instream features.

4.2.2 Habitat Unit 2: Rocky Outcrop Areas

The Rocky Outcrop Habitat Unit is located in the west of the subject property. This habitat unit consists mainly of rocky boulders which protrude from the wetlands in areas. The tree layer is dominated by very large specimens of *Combretum erythrophyllum*, with *Searsia pyroides, Celtis africana, Euclea crispa, Olea europaea* subsp *africana* and *Diospyros lycioides* trees also identified. The forb layer is dominated by *Cheilanthes virides* ferns.

Figure 3: The Rocky Outcrop Habitat Unit encountered within the assessment site.

A large portion of this habitat unit is located within the footprint of the proposed development route, Due to the high ecological functionality, unique habitat and intact habitat integrity of the rocky ridge areas, the conservation value of this habitat unit is considered to be high and the Rocky Outcrop Habitat Unit should be excluded from the development activity. This habitat unit could also provide suitable habitat for Red Data Listed floral species, namely *Ilex mitis, Dicliptera magaliesbergensis* and *Freylinia tropica.* Furthermore, the Rocky Outcrop Habitat Unit provides important habitat for faunal species that move through the area and unique habitat for a number of floral species. This Habitat Unit is therefore deemed to be of high ecological sensitivity.

The dominant species encountered within the wetland areas are represented in the table below.

Table 2: Dominant species encountered in the Rocky Outcrop Habitat Unit. Alien species are indicated with an asterisk.

Grass/sedge/reed species	Forb species	Tree/Shrub Species
Asparagus laricinus	*Cheilanthes viridis*	*Celtis africana*
Opuntia ficus-indica	*Nidorella hottentotica*	*Combretum erythrophyllum*
Searsia lancea	*Pellaea calomelanos var*	*Dichapetalum cymosum*
Searsia pyroides	*calomelanos*	*Euclea crispa*
Viscum rotundifolium	*Salvia tiliifolia**	*Olea europaea subsp. africana*
		Ximenia americana
		Ziziphus mucronata
		Diospyros lycioides

Overall high levels of ecological functioning were observed within the Rocky Outcrop Habitat Unit, and as such this area is deemed ecologically valuable.

4.2.3 Habitat Unit 3: Open Grassland

The Open Grassland Habitat Unit covers part of the central portion of the proposed development route not affected by current urban development. The figure below represent typical open grassland habitat encountered in the study area.

Figure 4: The Open Grassland Habitat Unit encountered within the assessment site.

This habitat unit consists of a well-developed grass layer, interspersed with clumps of indigenous tree specimens, dominated by *Combretum erythrophyllum*, *Ziziphus mucronata* and *Searsia pyroides*. A number of alien plant species are present within this habitat unit, but the overall ecological functionality of these areas remains intact. *Babiana hypogea* var *hypogea*, as well as *Hypoxis hemerocallidae*, (the latter being IUCN listed as 'Declining') have been encountered in this area and the overall forb layer is well-represented. The grass layer is dominated by *Heteropogon contortus, Themeda triandra, Hyparrhenia hirta* and *Melinis repens*, the latter two species being indicative of disturbance. A number of graminoid species encountered are representative of the expected vegetation type, Egoli Granite Grassland. The relatively high number of alien plant species present, and disturbance in the form of trampling and informal roads, however lowers the ecological sensitivity thereof. Dominant alien species include *Lantana camara, Schkuria pinnata, Tagetes minuta, Bidens pilosa, Stoebe vulgaris* and *Zinnia peruviana*.

The dominant species encountered within the Open Grassland Habitat Unit are represented in the table below.

Table 3: Dominant species encountered in the Open Grassland Habitat Unit. Alien species are indicated with an asterisk.

Grass/sedge/reed species	Forb species	Tree/Shrub Species
Andropogon eucomus	*Aloe zebrina*	*Combretum erythrophyllum*
Aristida junciformis	*Aruijia sericifera**	*Melia azederach*
Chloris virgata	*Babiana hypogea* var	*Searsia pyroides*
Cynodon dactylon	*hypogea*	*Tipuana tipu**
Eragrostis curvula	*Bidens pilosa**	*Ziziphus mucronata*
Eragrostis gummiflua	*Chamaecrista mimosoides*	
Harpochloa falx	*Commelina africana*	
Heteropogon contortus	*Convolvulus sagittatus*	
Hyparrhenia hirta	*Felicia muricata*	
Melinis repens	*Helichrysum nudifolium*	
Panicum schinzii	*Helichrysum rugulosum*	
Perotis patens	*Hypochaeris radicata**	
Pogonarthria squarrosa	*Hypoxis hemerocallidae*	
Setaria megaphylla	*Lantana camara**	
Sporobolus africanus	*Ledebouria revoluta*	
Themeda triandra	*Leonotis dysophylla*	
	Monsonia angustifolia	
	Nidorella anomala	
	Polygala hottentotta	
	*Schkuhria pinnata**	
	Senecio inaequidens	
	*Stoebe vulgaris**	
	Striga elegans	
	*Tagetes minuta**	
	Turbina oblongata	
	*Verbena bonariensis**	
	*Verbena tenuisecta**	
	Vernonia poskeana	
	Wahlenbergia caledonica	
	Walafrida densiflora	
	*Zinnia peruviana**	

4.2.4 Habitat Unit 4: Transformed Areas

The Transformed Habitat Unit includes areas directly adjacent to the road reserves, that have been impacted or transformed by historic construction activities, as well as areas associated with urban development, including residential gardens. The majority of areas associated with this habitat unit are situated within the east of the subject property. Although some indigenous plant species occur within this habitat unit, the majority of species are typical of urban habitats and include a number of invasive species.

Figure 5: The Transformed Habitat Unit encountered within the assessment site

In terms of tree and shrub species, this habitat unit (Figure 5) consists mainly of landscaping specimens within residential properties located along the proposed development route. Dominant tree species include *Melia azedarach* and *Tipuana tipu.*
The forb layer within the Transformed Habitat Unit consists of typical roadside weeds and landscaping specimens/ garden ornamentals, such as *Agapanthus praecox*, *Dietes grandoflora* and *Tulbaghia violacea*. Grasses in this habitat unit comprise largely of *Pennisetum clandestinum* lawns and other grasses indicative of disturbance including *Melinis repens* and *Cynodon nlemfluensis*.

No plant species of concern were encountered within this habitat unit, and it highly unlikely that any such specimens will occur, due to the lack of suitable habitat and high levels of transformation.

The dominant species encountered within the Transformed Habitat Unit are presented in the table below:

Table 4: Dominant species encountered in the Transformed Habitat Unit. Alien species are indicated with an asterisk.

Grass/sedge/reed species	Forb species	Tree/Shrub Species
Chloris gayana	*Agapnthus praecox*	*Acacia karroo*
Cynodon nlemfluensis	*Bidens pilosa**	*Acacia sueberiana* var *woodii*
Cyperus ruprestis	*Dietes grandfilora*	*Combretum erythrophyllum*
Eragrostis pseudosclerantha	*Gomphrena celosioides**	*Eucalyptus* sp.
Melinis repens	*Ipomoea purpurea**	*Euphorbia* sp
Panicum maximum	*Lantana camara**	*Melia azedarach**
*Pennisetum clandestinum**	*Leonotis leonurus*	*Morus alba*
Themeda triandra	*Richardia brasiliensis**	*Olea europaea* subsp *africana*
	Ricinus communis	*Opuntia ficus-indica**
	*Schkuhria pinnata**	*Pinus pinaster*
	*Tagetes minuta**	*Quercus robusta**
	Tulbaghia violacea	*Searisa lancea*
	Wahlenbergia caledonica	*Tipuana tipu**
	*Xanthium strumarium**	

The ecological functionality and habitat integrity of the Transformed Habitat Unit is regarded as being limited. The high diversity of alien plant species, high levels of vegetation transformation and deviation from the expected vegetation type, adds to this habitat unit having a low ecological sensitivity and little conservation value from an ecological perspective.

5. FLORAL ASSESSMENT

5.1 RDL Floral Status Assessments

An assessment considering the presence of any RDL plant species, as well as suitable habitat to support any such species, was undertaken. The complete PRECIS (Pretoria Computer Information Systems) red data plant list for the grid reference (2528CC) was enquired from SANBI (South African National Biodiversity Institute).

Table 5: IUCN Red Data List Categories – Version 3.1 as supplied by SANBI.

Category	Definition
EX	Extinct
EW	Extinct in the wild
CR	Critically endangered
EN	Endangered
VU	Vulnerable
NT	Near threatened
LC	Least concern
DD	Data deficient
NE	Not evaluated

Table 6: PRECIS red data plant list for the QDS 2528CC (Raimondo *et al.*, 2009; SANBI, www.sanbi.org).

Family	Species	Threat status	Growth forms
ACANTHACEAE	*Dicliptera magaliesbergensis K.Balkwill*	VU	Herb, shrub
AMARYLLIDACEAE	*Boophone disticha (L.f.) Herb.*	Declining	Geophyte, succulent
AQUIFOLIACEAE	*Ilex mitis (L.) Radlk. var. mitis*	Declining	Shrub, tree
ASTERACEAE	*Callilepis leptophylla Harv.*	Declining	Herb
CAPPARACEAE	*Cleome conrathii Burtt Davy*	NT	Herb
FABACEAE	*Melolobium subspicatum Conrath*	VU	Dwarf shrub
HYACINTHACEAE	*Bowiea volubilis Harv. ex Hook.f. subsp. volubilis*	VU	Climber, geophyte, succulent
HYACINTHACEAE	*Drimia sanguinea (Schinz) Jessop*	NT	Geophyte
HYPOXIDACEAE	*Hypoxis hemerocallidea Fisch., C.A.Mey. & Avé-Lall.*	Declining	Geophyte
MESEMBRYANTHEMACEAE	*Lithops lesliei (N.E.Br.) N.E.Br. subsp. lesliei*	NT	Succulent
ORCHIDACEAE	*Brachycorythis conica (Summerh.) Summerh. subsp. transvaalensis Summerh.*	EN	Geophyte, herb
ORCHIDACEAE	*Habenaria barbertoni Kraenzl. & Schltr.*	NT	Geophyte, herb
ORCHIDACEAE	*Habenaria kraenzliniana Schltr.*	NT	Geophyte, herb
ORCHIDACEAE	*Habenaria mossii (G.Will.) J.C.Manning*	EN	Geophyte, herb
ORCHIDACEAE	*Holothrix randii Rendle*	NT	Geophyte, herb
SCROPHULARIACEAE	*Freylinia tropica S.Moore*	Rare	Shrub

Table 7: POC for floral species of concern (Raimondo *et al*. 2009).

Species	Habitat	POC	Motivation
Dicliptera magaliesbergensis K.Balkwill	Forest, Savanna, Riverine forest and bush	60%	Suitable habitat is available for this species within the Rocky Outcrop Habitat Unit
Boophone disticha (L.f.)	Dry grassland and rocky areas	80%	Suitable habitat is available for this species, particularly within the Open Grassland Habitat Unit
Ilex mitis (L.) Radlk. var. *mitis*	Along rivers and streams in forest and thickets, sometimes in the open. Found from sea level to inland mountain slopes	60%	Suitable habitat is available for this species within the Rocky Outcrop or Wetland Habitat Units
Callilepis leptophylla Harv.	Grassland or open woodland, often on rocky outcrops or rocky hill slopes	54%	Limited habitat is available for this species, as the Open Grassland Habitat Unit is considered too disturbed to host these species
Cleome conrathii Burtt Davy	Stony quartzite slopes, usually in red sandy soil, grassland or deciduous woodland, all aspects	54%	Limited habitat is available for this species, as the Open Grassland Habitat Unit is considered too disturbed to host these species.
Melolobium subspicatum Conrath	Grassland	40%	Limited undisturbed habitat is available for this species.
Bowiea volubilis Harv. ex Hook.f. subsp. volubilis	Low and medium altitudes, usually along mountain ranges and in thick vegetated river valleys, often in bushclumps and under bolder screes. Often found in open woodland and on steep rocky hills	47%	If present, this species will occur within the Rocky Outcrop or Wetland Habitat Units
Drimia sanguinea (Schinz) Jessop	Open veld and scrubby woodland in a variety of soil types	40%	Limited habitat is available for this species, as the Open Grassland Habitat Unit is considered too disturbed to host these species.
Hypoxis hemerocallidea Fisch., C.A.Mey. & Avé-Lall.	Occurs in a wide range of habitats, including sandy hills on the margins of dune forests, open, rocky grassland, dry, stony, grassy slopes, mountain slopes and plateaus. Appears to be drought and fire tolerant	100%	This species has been encountered within the subject property, in the Open Grassland Habitat Unit.
Lithops lesliei (N.E.Br.) N.E.Br. subsp. lesliei	Primarily in arid grasslands, usually in rocky places, growing under the protection of forbs and grasses	33%	No suitable soils and no arid grasslands are available for this species
Brachycorythis conica (Summerh.) Summerh. subsp. transvaalensis Summerh.	Short, open grassland and wooded grassland, on sandy gravel overlying dolomite, sometimes also on quartzite, 1 000-1 705 m	33%	No suitable soils are available for this species

Habenaria barbertoni Kraenzl. & Schltr.	Rocky hillsides, in bushveld in association with acacias, 1000-1500 m	47%	Limited habitat is available for this species.
Habenaria kraenzliniana Schltr	Stony, grassy hillsides, 1000-1400 m	54%	Limited habitat is available for this species. No grassy hillside habitat available.
*Habenaria mossii (*G.Will.) J.C.Manning	Open grassland on dolomite or in black, sandy soil	40%	Limited habitat is available for this species within the Open Grassland Habitat Unit.
Holothrix randii Rendle	Grassy slopes and rock ledges, usually southern aspects	33%	Limited habitat is available for this species.
Freylinia tropica S.Moore	Riverbanks and stream sides, 1800 m	73%	If present, this species will occur within the Rocky Outcrop or Wetland Habitat Units

From the above assessment, it is evident that two species have a POC of more than 80%, namely *Boophone disticha* and *Hypoxis hemerocallidae*. Of these species, *Hypoxis hemerocallidae* has been positively identified on the subject property and *Boophane disticha* is considered highly likely to occur with the Open Grassland Habitat Unit as well as within less disturbed portions of the Wetland Habitat Unit. Other floral species of concern that are considered to have a high probability of occurring in the subject property, particularly within the Rocky Outcrop Habitat Unit, include *Freylinia tropica*, *Ilex mitis* and *Dicliptera magaliesbergensis*, although none of these species were encountered. They were however specifically searched for where suitable habitat was present.

5.2 Vegetation Index Score

The information gathered during the assessment of the subject property was used to determine the Vegetation Index Score (VIS) - see Appendix B for calculations. Due to variation between the different habitat units within each site, all habitat units were assessed separately. The table below lists the results of each habitat unit.

Table 8: Scoring for the Vegetation Index Score

Vegetation Index Score	Assessment Class	Description
22 to 25	**A**	Unmodified, natural
18 to 22	**B**	Largely natural with few modifications.
14 to 18	**C**	Moderately modified
10 to 14	**D**	Largely modified
5 to 10	**E**	The loss of natural habitat extensive
<5	**F**	Modified completely

Table 9: Vegetation Index Score

Habitat unit	Score	Class	Motivation
Wetland/ Riparian	14	**C – Moderately modified**	Moderately impacted by past anthropogenic activities. Moderate levels of alien plant species invasion.
Rocky Outcrop	20	**B – Largely natural with few modifications**	Few disturbances present. Some alien invasive species present in the vicinity of wetlands
Open Grassland	15	**C – Moderately modified**	Disturbances present in the form of alien plant species, trampling and the proximity of informal roads.
Transformed	5	**E – Loss of natural habitat extensive**	Transformation levels high as a result of development and roads construction. High number of alien and landscaping plant species present.

From the Vegetation Index Score result outlined in Table 9, it is evident that the Rocky Outcrop Habitat Unit falls within Class B (Largely natural with few modifications), while the Wetland/ Riparian and Open Grassland Habitat Unit fall within Class C (Moderately Modified). The Transformed Habitat Unit received a low VIS of 5, and falls within Class 5 (Loss of natural habitat extensive).

5.3 Exotic and Invader Species

Alien invaders are plants that are of exotic origin and are invading previously pristine areas or ecological niches (Bromilow, 2001). Not all weeds are exotic in origin, but as these exotic plant species have very limited natural "check" mechanisms within the natural environment, they are often the most opportunistic and aggressively-growing species within the ecosystem. Therefore, they are often the most dominant and noticeable within an area. Disturbances of the ground through trampling, excavations or landscaping often leads to the dominance of exotic pioneer species that rapidly dominate the area. Under natural conditions, these pioneer species are overtaken by sub-climax and climax species through natural veld succession. This process, however, takes many years to occur, with the natural vegetation never reaching the balanced, pristine species composition prior to the disturbance. There are many species of indigenous pioneer plants, but very few indigenous species can out-compete their more aggressively growing exotic counterparts.

Alien vegetation invasion causes degradation of the ecological integrity of an area, causing (Bromilow, 2001):

- a decline in species diversity;
- local extinction of indigenous species;
- ecological imbalance;
- decreased productivity of grazing pastures; and
- increased agricultural input costs.

As a result of current and historical disturbance from human settlement, agriculture, roads and overgrazing, alien invasive species are well represented, particularly within the Transformed, Open Grassland and Wetland Habitat Units. During construction and rehabilitation, it is thus especially important that alien floral management takes place to prevent further establishment. The table below indicates the dominant alien species encountered during the assessment.

Table 10: Dominant exotic vegetation species identified during the general area assessment.

Species	English name	Type or Origin	Category*
Trees/ shrubs			
Ligustrum japonicum	Privet	China	1
Melia azedarach	Syringa	India	3
Opuntia ficus-indica	Prickly pear	South America	1
Solanum mauritiuanum	Bugweed	South America	1
Tipuana tipu	Tipu tree	Bolivia and Brazil	3
Forbs			
Aruijia sericifera	Mothcatcher	Peru	1
Bidens pilosa	Common blackjack	South America	N/A
Conyza bonariensis	Flax leaved fleabane	America	N/A
Cyperus esculentus	Yellow nutsedge	Uncertain	M/A
Datura stramonium	Common thornapple	North America	1
Gomphrena celosioides	Globe amaranth	South America	N/A
Hypochaeris radicata	Hairy wild lettuce	Europe	N/A
Ipomoea purpurea	Morning glory	Tropical America	3
Lantana camara	Lantana	Tropical America	1
Pennisetum clandestinum	Kikuyu	East Africa	N/A
Richardia brasiliensis	Mexican richardia	South America	N/A
Salvia tiliifolia	Linderleaf sage	Uncertain	1
Schkuhria pinnata	Dwarf marigold	South America	N/A
Stoebe vulgaris	Bankrupt bush	Indigenous	N/A
Tagetes minuta	Tall khakiweed	South America	N/A
Verbena bonariensis	Purple top	South America	N/A
Verbena tenuisecta	Fine-leaved verbena	South America	N/A
Xanthium strumarium	Large cocklebur	South America	1
Zinnia peruviana	Redstar zinnia	South America	N/A

*__Category 1__ – Declared weeds. Prohibited plants, which must be controlled or eradicated.
*__Category 2__ – Declared invader plants with a value. "Invaders" with certain useful qualities (i.e. commercial). Only allowed in controlled, demarcated areas.
*__Category 3__ – Mostly ornamental plants. Alien plants presently growing in, or having escaped from, areas such as gardens, but are proven invaders. No further planting or trade in propagative material is allowed (Bromilow, 2001).

5.4 Medicinal plants

Medicinal plant species are not necessarily indigenous species, with many of them being regarded as alien invasive weeds. The majority of the medicinal plant species are located are not restricted the Wetland, Open Grassland and Rocky Outcrop Habitat Units..

Table 11: Traditional medicinal plants identified during the field assessment. Medicinal applications and application methods are also presented (van Wyk, et al., 1997; van Wyk and Gericke, 2000; van Wyk and Wink, 2004; van Wyk, Oudtshoorn, Gericke, 2009).

Species	Name	Plant parts used	Medicinal uses
Datura stramonium	Thornapple	Leaves and rarely the green fruit.	Generally as asthma treatment and pain reduction.
Conyza bonariensis	Flax leaved fleabane	Herb	Astringent, diarrhoea, diuretic, colds, insect repellent.
Helichrysum nudifolium	Hottentot's tea	Leaves and twigs mainly used, sometimes roots.	General remedy – coughs, colds, fever, infections, headaches, menstrual pain and wound dressing.
Hypoxis hemerocallidae	African potato/ Star flower	Tuberous rootstock	Used as an emetic to treat dizziness, bladder disorders and insanity.
Ziziphus mucronata	Buffalo thorn	Roots, Leaves and Bark	Treatment of boils and wounds; allegedly sedative.

6. SENSITIVITY MAPPING

NOTE: Please refer to associated shapefiles for localities and extents of sensitive areas.

Wetland features, as well as the rocky outcrop area located centrally with respect to the proposed development route, are considered sensitive and were identified and delineated (refer to Wetland Ecology report – Section D). This is mainly due to the higher diversity of faunal and floral species expected to occur within these areas and the potential of these areas to host RDL species, as well as the unique habitat the wetland and rocky outcrop areas provide for both faunal and floral species. It is therefore deemed important that these areas be excluded from the proposed development.

The Open Grassland Habitat Unit is not deemed to be sensitive, as a result of high levels of alien plant species invasion, while the transformed areas are deemed to be of low sensitivity as a result of the high levels of transformation present. The Transformed Habitat Unit is not likely to support any RDL or sensitive faunal or floral species, while the Open Grassland and Wetland Habitat Units may hosts RDL floral species such as *Hypoxis hemerocallidae* (positively identified on site) and *Boophane distcha*.

Figure 11 (Section A) indicates the position of the ecologically sensitive wetland and rocky outcrop areas.

7. CONCLUSIONS AND RECOMMENDATIONS

The study area can be broadly divided into four habitat units. Each is considered different with regards to ecological condition and functioning. Only the Wetland and Rocky Outcrop Habitat Units can be considered of increased ecological importance. These areas have the highest potential of supporting a variety floral and faunal species when compared to the remainder of the subject property. One RDL floral species, namely *Hypoxis hemerocallidae* ('Declining') was encountered during the assessment.

The following general conclusions were drawn on completion of the survey:

- The study area falls within the Savanna Biome, the Bushveld Basin bioregion and Egoli Grassland Vegetation Type, which is considered to be an endangered vegetation type;
- Four habitat units were identified along the proposed development route, namely the Wetland Habitat Unit, the Rocky Outcrop Habitat Unit, the Open Grassland Habitat Unit and the Transformed Habitat Unit. The Transformed Habitat Unit encompasses the majority of the study area, while the Wetland Habitat Unit occurs within the east, west and central portions of the subject property;
- The entire subject property has been subjected to a degree of vegetation transformation as a result of urban and residential development and historic agricultural activities. Alien invasive plant species are present in all habitat units;
- The Rocky Outcrop Habitat Unit has experienced a low degree of disturbance and is considered to be highly sensitive as a result of the unique habitat it provides for faunal and floral species. It also has the potential to host RDL plant species, such as *Ilex mitis, Dicliptera magaliesbergensis* and *Freylinia tropica*;
- The Wetland Habitat Unit also has higher ecological sensitivity compared to the Open Grassland and Transformed Habitat Unit due to the potential habitat for faunal and floral species and the migratory connectivity for faunal species that these areas potentially provide;
- The Open Veld Habitat Unit is not considered to be ecologically sensitive, as a result of its isolated nature and the high numbers of alien plant species present;
- The Transformed Habitat unit is considered to be of low ecological sensitivity as a result of its impacted nature due to past development in the area;
- No RDL or protected floral species were identified during the assessment. However, the Rocky Outcrop and Wetland Habitat Units may provide suitable habitat to support such floral species;

- Levels of alien floral invasion were moderate to high within all habitat units identified, apart from within the Rocky Outcrop Habitat Unit, where alien invasive species are restricted to riparian edges;
- The VIS (Vegetation Index Score) for each Habitat Unit was calculated as follows:

Habitat unit	Score	Class	Motivation
Wetland/ Riparian	14	**C – Moderately modified**	Moderately impacted by past anthropogenic activities. Moderate levels of alien plant species invasion.
Rocky Outcrop	20	**B – Largely natural with few modifications**	Few disturbances present. Some alien invasive species present in the vicinity of wetlands
Open Grassland	15	**C – Moderately modified**	Disturbances present in the form of alien plant species, trampling and the proximity of informal roads.
Transformed	5	**E – Loss of natural habitat extensive**	Transformation levels high as a result of development and roads construction. High number of alien and landscaping plant species present.

After conclusion of this floral assessment, the following recommendations are provided:

Development and operational footprint

- A sensitivity map has been developed for the study area, indicating wetland and rocky outcrop areas which are considered to be of high ecological sensitivity. It is recommended that this sensitivity map be considered during the planning/ pre-construction and construction phases of the proposed development activities in order to aid in the conservation of ecology within and adjacent to the proposed development area. The Rocky Outcrop Habitat Unit should not be disturbed due to its unique ecology.
- *Hypoxis hemerocallidae*, *Babiana hypogea* var. *hypogea*, and *Boophane disticha* (if discovered on site), occurring within the development footprint should be rescued and relocated to suitable habitat in the vicinity of the study area.
- All development footprint areas should remain as small as possible and should not encroach onto surrounding more sensitive wetland and rocky outcrop areas. The boundaries of footprint areas are to be clearly defined.
- Large trees should be maintained where possible for the length of the proposed development route.
- Proper planning of infrastructure, which avoids unnecessary barriers in migratory corridors, should be conducted during the pre-construction phase.

Wetlands

- As much of the ecological functioning and migratory connectivity of the drainage features need to be maintained.
- No topsoil, waste rock or building material should be dumped into any existing wetland and rocky outcrop areas, as these areas are considered to be of higher ecological importance.
- It must be ensured that construction-related waste and effluent do not affect the wetland resources and associated buffer zones.
- Edge effects of activities, including erosion and alien/ weed control, have to be strictly managed in more sensitive wetland and rocky outcrop areas.
- All construction vehicles should remain on designated roads with no indiscriminate driving through wetlands/ riparian or rocky outcrop areas.
- It must be ensured that flow connectivity along the riparian features is maintained.

Stormwater management

- Adequate stormwater and erosion management measures must be incorporated into the design of the proposed development route in order to prevent erosion and sedimentation of the wetland areas.
- It must be ensured that runoff from impacted areas is suitably managed and that runoff volumes and velocities are similar to pre-disturbance levels. Stormwater control methods as set out in engineering specifications are to be implemented.
- During the construction of the proposed development route, erosion berms should be installed to prevent gully formation and siltation of the wetland resources. The following points should serve to guide the placement of erosion berms:
  - Where the track has slope of less than 2%, berms every 50m should be installed.
  - Where the track slopes between 2% and 10%, berms every 25m should be installed.
  - Where the track slopes between 10%-15%, berms every 20m should be installed.
  - Where the track has slope greater than 15%, berms every 10m should be installed.

Alien plant species

- Proliferation of alien and invasive species is expected within disturbed areas. These species should be eradicated and controlled to prevent their spread beyond the site boundary. Alien plant seed dispersal within the top layers of the soil within footprint areas, that will have an impact on rehabilitation in the future, has to be controlled.

- Alien and weed species encountered on the property are to be removed in order to comply with existing legislation (amendments to the regulations under the Conservation of Agricultural Resources Act, 1983 and Section 28 of the National Environmental Management Act, 1998). Removal and control of invasive plant species should take place throughout the pre-construction, construction, operational, and rehabilitation/ maintenance phases.
- All soils compacted as a result of construction activities and falling outside of the development footprint areas should be ripped and profiled. Special attention should be paid to alien and invasive control within these areas.

Fire

- All informal fires on the property should be prohibited, specifically during the construction phase of the proposed development.

Dust

- It is to be ensured that all temporary access roads and construction areas are regularly sprayed with water or treated with other dust suppression measures in order to curb dust generation. This is particularly necessary during the dry season when increased levels of dust generation can be expected. These areas should not be over-sprayed causing water run-off and subsequent sediment loss into adjacent waterways.

Rehabilitation

- As much vegetation growth as possible should be promoted within the proposed development area in order to protect soils. In this regard special mention is made of the need to use indigenous vegetation species where hydroseeding, wetland and rehabilitation planting are to be implemented.
- Upon completion of the project, new indigenous landscaping should be implemented in all affected areas and proper rehabilitation within all impacted areas must take place.
- Banks of disturbed drainage areas must be reprofiled.
- Banks and drainage features, if affected by the proposed construction activities, are to be reinforced where necessary with reno mattresses and geotextiles.
- Any areas where earthworks have taken place, should be reseeded with indigenous vegetation to prevent erosion.
- It must be ensured that all disturbed and exposed areas are rehabilitated and covered with indigenous vegetation to prevent dust generation.

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APPENDIX A

Table 12: Expected floral species list for the QDS *2528CC* supplied by SANBI Precis Database.

Family	Species	Threat status	Growth forms
ACANTHACEAE	*Barleria macrostegia Nees*	LC	Herb
ACANTHACEAE	*Blepharis innocua C.B.Clarke*	LC	Herb
ACANTHACEAE	*Blepharis squarrosa (Nees) T.Anderson*	LC	Dwarf shrub, herb
ACANTHACEAE	*Chaetacanthus costatus Nees*	LC	Dwarf shrub, herb
ACANTHACEAE	*Chaetacanthus setiger (Pers.) Lindl.*	LC	Dwarf shrub, herb, shrub
ACANTHACEAE	*Crabbea angustifolia Nees*	LC	Herb
ACANTHACEAE	*Crabbea hirsuta Harv.*	LC	Herb
ACANTHACEAE	*Crabbea ovalifolia Ficalho & Hiern*	LC	Herb
ACANTHACEAE	*Dicliptera magaliesbergensis K.Balkwill*	VU	Herb, shrub
ACANTHACEAE	*Justicia anagalloides (Nees) T.Anderson*	LC	Herb
ACANTHACEAE	*Justicia flava (Vahl) Vahl*	LC	Dwarf shrub, herb
ACANTHACEAE	*Ruellia cordata Thunb.*	LC	Dwarf shrub, herb
ACANTHACEAE	*Sclerochiton harveyanus Nees*	LC	Shrub
ACANTHACEAE	*Thunbergia atriplicifolia E.Mey. ex Nees*	LC	Dwarf shrub, herb
ACANTHACEAE	*Thunbergia neglecta Sond.*	LC	Herb, scrambler
ACHARIACEAE	*Kiggelaria africana L.*	LC	Shrub, tree
ALLIACEAE	*Nothoscordum borbonicum Kunth*	NE	Geophyte
ALLIACEAE	*Tulbaghia acutiloba Harv.*	LC	Herb
ALLIACEAE	*Tulbaghia leucantha Baker*	LC	Herb
ALLIACEAE	*Tulbaghia pretoriensis Vosa & Condy*	DDT	Herb
AMARANTHACEAE	*Achyranthes aspera L. var. aspera*	NE	Herb
AMARANTHACEAE	*Achyranthes aspera L. var. sicula L.*	NE	Herb
AMARANTHACEAE	*Aerva leucura Moq.*	LC	Herb
AMARANTHACEAE	*Amaranthus deflexus L.*	NE	Herb
AMARANTHACEAE	*Amaranthus hybridus L. subsp. hybridus var. erythrostachys Moq.*	NE	Herb
AMARANTHACEAE	*Amaranthus hybridus L. subsp. hybridus var. hybridus*	NE	Herb
AMARANTHACEAE	*Cyathula uncinulata (Schrad.) Schinz*	LC	Climber, herb
AMARANTHACEAE	*Gomphrena celosioides Mart.*	NE	Herb
AMARANTHACEAE	*Guilleminea densa (Willd. ex Roem. & Schult.) Moq.*	NE	Herb
AMARANTHACEAE	*Pupalia lappacea (L.) A.Juss. var. lappacea*	LC	Herb
AMARYLLIDACEAE	*Boophone disticha (L.f.) Herb.*	Declining	Geophyte, succulent
AMARYLLIDACEAE	*Crinum graminicola I.Verd.*	LC	Geophyte
AMARYLLIDACEAE	*Cyrtanthus contractus N.E.Br.*	LC	Geophyte
AMARYLLIDACEAE	*Nerine gaberonensis Bremek. & Oberm.*	LC	Geophyte
AMARYLLIDACEAE	*Nerine rehmannii (Baker) L.Bolus*	LC	Geophyte
AMARYLLIDACEAE	*Scadoxus puniceus (L.) Friis & Nordal*	LC	Geophyte, herb
ANACARDIACEAE	*Lannea edulis (Sond.) Engl. var. edulis*	LC	Dwarf shrub
ANACARDIACEAE	*Searsia discolor (E.Mey. ex Sond.) Moffett*	LC	Dwarf shrub, shrub
ANACARDIACEAE	*Searsia leptodictya (Diels) T.S.Yi, A.J.Mill. & J.Wen forma leptodictya*	NE	Shrub, tree
ANACARDIACEAE	*Searsia pyroides (Burch.) Moffett var. gracilis*	LC	Shrub, tree

Family	Species	Threat status	Growth forms
	(Engl.) Moffett		
ANACARDIACEAE	*Searsia pyroides (Burch.) Moffett var. integrifolia (Engl.) Moffett*	LC	Shrub, tree
ANACARDIACEAE	*Searsia pyroides (Burch.) Moffett var. pyroides*	LC	
ANACARDIACEAE	*Searsia rigida (Mill.) F.A.Barkley var. rigida*	LC	Shrub
ANACARDIACEAE	*Searsia zeyheri (Sond.) Moffett*	LC	Shrub
ANEMIACEAE	*Mohria vestita Baker*	LC	Geophyte, herb, lithophyte
ANTHERICACEAE	*Chlorophytum bowkeri Baker*	LC	Herb
ANTHERICACEAE	*Chlorophytum cooperi (Baker) Nordal*	LC	Herb
ANTHERICACEAE	*Chlorophytum fasciculatum (Baker) Kativu*	LC	Herb
ANTHERICACEAE	*Chlorophytum trichophlebium (Baker) Nordal*	LC	Herb
APIACEAE	*Afrosciadium magalismontanum (Sond.) P.J.D.Winter*	LC	Herb
APIACEAE	*Heteromorpha arborescens (Spreng.) Cham. & Schltdl. var. abyssinica (Hochst. ex A.Rich.) H.Wolff*	LC	Shrub, tree
APIACEAE	*Pastinaca sativa L.*	NE	Herb
APOCYNACEAE	*Acokanthera oppositifolia (Lam.) Codd*	LC	Shrub, tree
APOCYNACEAE	*Ancylobotrys capensis (Oliv.) Pichon*	LC	Climber, shrub
APOCYNACEAE	*Araujia sericifera Brot.*	NE	Climber
APOCYNACEAE	*Asclepias adscendens (Schltr.) Schltr.*	LC	Herb
APOCYNACEAE	*Asclepias albens (E.Mey.) Schltr.*	LC	Herb
APOCYNACEAE	*Asclepias aurea (Schltr.) Schltr.*	LC	Herb
APOCYNACEAE	*Asclepias brevipes (Schltr.) Schltr.*	LC	Herb
APOCYNACEAE	*Asclepias densiflora N.E.Br.*	LC	Herb
APOCYNACEAE	*Asclepias eminens (Harv.) Schltr.*	LC	Herb
APOCYNACEAE	*Asclepias fallax (Schltr.) Schltr.*	LC	Herb
APOCYNACEAE	*Asclepias gibba (E.Mey.) Schltr. var. media N.E.Br.*	LC	Herb
APOCYNACEAE	*Asclepias stellifera Schltr.*	LC	Herb
APOCYNACEAE	*Aspidoglossum lamellatum (Schltr.) Kupicha*	LC	Herb, succulent
APOCYNACEAE	*Brachystelma barberae Harv. ex Hook.f.*	LC	Geophyte, succulent
APOCYNACEAE	*Brachystelma circinatum E.Mey.*	LC	Geophyte, succulent
APOCYNACEAE	*Brachystelma foetidum Schltr.*	LC	Geophyte, succulent
APOCYNACEAE	*Carissa bispinosa (L.) Desf. ex Brenan*	LC	Shrub
APOCYNACEAE	*Ceropegia rendallii N.E.Br.*	LC	Climber, succulent
APOCYNACEAE	*Cryptolepis oblongifolia (Meisn.) Schltr.*	LC	Scrambler, shrub
APOCYNACEAE	*Cynanchum virens (E.Mey.) D.Dietr.*	LC	Climber
APOCYNACEAE	*Gomphocarpus fruticosus (L.) Aiton f. subsp. decipiens (N.E.Br.) Goyder & Nicholas*	LC	Herb, shrub
APOCYNACEAE	*Gomphocarpus fruticosus (L.) Aiton f. subsp. fruticosus*	NE	Herb, shrub
APOCYNACEAE	*Gomphocarpus glaucophyllus Schltr.*	LC	Herb
APOCYNACEAE	*Huernia loeseneriana Schltr.*	LC	Succulent
APOCYNACEAE	*Orbea lutea (N.E.Br.) Bruyns subsp. lutea*	LC	Succulent
APOCYNACEAE	*Orthanthera jasminiflora (Decne.) Schinz*	LC	Creeper
APOCYNACEAE	*Pachycarpus schinzianus (Schltr.) N.E.Br.*	LC	Herb, succulent

Family	Species	Threat status	Growth forms
APOCYNACEAE	*Parapodium costatum E.Mey.*	LC	Herb, succulent
APOCYNACEAE	*Pentarrhinum insipidum E.Mey.*	LC	Climber
APOCYNACEAE	*Raphionacme hirsuta (E.Mey.) R.A.Dyer*	LC	Geophyte, herb, succulent
APOCYNACEAE	*Raphionacme velutina Schltr.*	LC	Geophyte, herb, succulent
APOCYNACEAE	*Riocreuxia burchellii K.Schum.*	LC	Climber
APOCYNACEAE	*Stapelia gigantea N.E.Br.*	LC	Succulent
APOCYNACEAE	*Xysmalobium brownianum S.Moore*	LC	Herb, succulent
APOCYNACEAE	*Xysmalobium undulatum (L.) Aiton f. var. undulatum*	LC	Herb, succulent
AQUIFOLIACEAE	*Ilex mitis (L.) Radlk. var. mitis*	Declining	Shrub, tree
ARACEAE	*Zantedeschia albomaculata (Hook.) Baill. subsp. albomaculata*	LC	Geophyte, herb
ARACEAE	*Zantedeschia albomaculata (Hook.) Baill. subsp. macrocarpa (Engl.) Letty*	LC	Geophyte, herb
ARALIACEAE	*Cussonia paniculata Eckl. & Zeyh. subsp. sinuata (Reyneke & Kok) De Winter*	LC	Succulent, tree
ASPARAGACEAE	*Asparagus cooperi Baker*	LC	Dwarf shrub, shrub
ASPARAGACEAE	*Asparagus flavicaulis (Oberm.) Fellingham & N.L.Mey. subsp. flavicaulis*	LC	Shrub
ASPARAGACEAE	*Asparagus laricinus Burch.*	LC	Shrub
ASPARAGACEAE	*Asparagus setaceus (Kunth) Jessop*	LC	Shrub
ASPARAGACEAE	*Asparagus suaveolens Burch.*	LC	Shrub
ASPARAGACEAE	*Asparagus virgatus Baker*	LC	Shrub
ASPHODELACEAE	*Aloe greatheadii Schönland var. davyana (Schönland) Glen & D.S.Hardy*	LC	Herb, succulent
ASPHODELACEAE	*Aloe zebrina Baker*	LC	Herb, succulent
ASPHODELACEAE	*Bulbine capitata Poelln.*	LC	Geophyte, herb, succulent
ASPHODELACEAE	*Kniphofia ensifolia Baker subsp. ensifolia*	LC	Herb
ASPHODELACEAE	*Kniphofia porphyrantha Baker*	LC	Herb
ASPHODELACEAE	*Trachyandra asperata Kunth var. asperata*	LC	Geophyte, succulent
ASPHODELACEAE	*Trachyandra asperata Kunth var. basutoensis (Poelln.) Oberm.*	LC	Geophyte, succulent
ASPHODELACEAE	*Trachyandra saltii (Baker) Oberm. var. saltii*	LC	Geophyte, succulent
ASPLENIACEAE	*Asplenium aethiopicum (Burm.f.) Bech.*	LC	Epiphyte, geophyte, herb, lithophyte
ASPLENIACEAE	*Asplenium capense (Kunze) Bir, Fraser-Jenk. & Lovis*		
ASPLENIACEAE	*Asplenium varians Wall. ex Hook. & Grev. subsp. fimbriatum (Kunze) Schelpe*	LC	Geophyte, herb, lithophyte
ASTERACEAE	*Acanthospermum glabratum (DC.) Wild*	NE	Herb
ASTERACEAE	*Achillea millefolium L.*	NE	Herb
ASTERACEAE	*Adenostemma caffrum DC. var. caffrum*	LC	Herb, hydrophyte
ASTERACEAE	*Artemisia afra Jacq. ex Willd. var. afra*	LC	Herb, shrub
ASTERACEAE	*Aster bakerianus Burtt Davy ex C.A.Sm.*	LC	Herb
ASTERACEAE	*Aster harveyanus Kuntze*	LC	Herb
ASTERACEAE	*Aster peglerae Bolus*	LC	Herb
ASTERACEAE	*Athrixia elata Sond.*	LC	Dwarf shrub
ASTERACEAE	*Berkheya radula (Harv.) De Wild.*	LC	Herb
ASTERACEAE	*Berkheya zeyheri Oliv. & Hiern subsp. zeyheri*	LC	Herb

Family	Species	Threat status	Growth forms
ASTERACEAE	*Callilepis laureola DC.*	LC	Herb
ASTERACEAE	*Callilepis leptophylla Harv.*	Declining	Herb
ASTERACEAE	*Campuloclinium macrocephalum (Less.) DC.*	NE	Herb
ASTERACEAE	*Cineraria parvifolia Burtt Davy*	LC	Herb
ASTERACEAE	*Cirsium vulgare (Savi) Ten.*	NE	Herb
ASTERACEAE	*Conyza aegyptiaca (L.) Aiton*	LC	Herb
ASTERACEAE	*Conyza pinnata (L.f.) Kuntze*	LC	Herb
ASTERACEAE	*Conyza podocephala DC.*	LC	Herb
ASTERACEAE	*Conyza scabrida DC.*	LC	Shrub
ASTERACEAE	*Conyza ulmifolia (Burm.f.) Kuntze*	LC	Herb
ASTERACEAE	*Crassocephalum x picridifolium (DC.) S.Moore*	NE	Herb
ASTERACEAE	*Crepis hypochaeridea (DC.) Thell.*	NE	Herb
ASTERACEAE	*Dicoma anomala Sond. subsp. gerrardii (Harv. ex F.C.Wilson) S.Ortíz & Rodr.Oubiña*	LC	Herb
ASTERACEAE	*Euryops chrysanthemoides (DC.) B.Nord.*	LC	Shrub
ASTERACEAE	*Felicia muricata (Thunb.) Nees subsp. muricata*	LC	Shrub
ASTERACEAE	*Flaveria bidentis (L.) Kuntze*	NE	Herb
ASTERACEAE	*Galinsoga parviflora Cav.*	NE	Herb
ASTERACEAE	*Gamochaeta coarctata (Willd.) Kerguélen*	NE	Herb
ASTERACEAE	*Gamochaeta subfalcata (Cabrera) Cabrera*	NE	Herb
ASTERACEAE	*Gazania krebsiana Less. subsp. serrulata (DC.) Roessler*	LC	Herb
ASTERACEAE	*Geigeria burkei Harv. subsp. burkei var. burkei*	LC	Herb
ASTERACEAE	*Geigeria burkei Harv. subsp. burkei var. intermedia (S.Moore) Merxm.*	LC	Herb
ASTERACEAE	*Gerbera ambigua (Cass.) Sch.Bip.*	LC	Herb
ASTERACEAE	*Gerbera piloselloides (L.) Cass.*	LC	Herb
ASTERACEAE	*Gerbera viridifolia (DC.) Sch.Bip.*	LC	Herb
ASTERACEAE	*Haplocarpha scaposa Harv.*	LC	Herb
ASTERACEAE	*Helichrysum acutatum DC.*	LC	Herb
ASTERACEAE	*Helichrysum argyrosphaerum DC.*	LC	Herb
ASTERACEAE	*Helichrysum aureonitens Sch.Bip.*	LC	Herb
ASTERACEAE	*Helichrysum caespititium (DC.) Harv.*	LC	Herb
ASTERACEAE	*Helichrysum chionosphaerum DC.*	LC	Herb
ASTERACEAE	*Helichrysum difficile Hilliard*	LC	Herb
ASTERACEAE	*Helichrysum harveyanum Wild*	LC	Herb
ASTERACEAE	*Helichrysum mixtum (Kuntze) Moeser var. mixtum*	LC	Herb
ASTERACEAE	*Helichrysum nudifolium (L.) Less. var. nudifolium*	LC	Herb
ASTERACEAE	*Helichrysum oreophilum Klatt*	LC	Herb
ASTERACEAE	*Helichrysum rugulosum Less.*	LC	Herb
ASTERACEAE	*Helichrysum setosum Harv.*	LC	Herb, shrub
ASTERACEAE	*Hilliardiella aristata (DC.) H.Rob.*		Herb
ASTERACEAE	*Hilliardiella hirsuta (DC.) H.Rob.*		Herb

Family	Species	Threat status	Growth forms
ASTERACEAE	*Hypochaeris radicata L.*	NE	Herb
ASTERACEAE	*Lactuca inermis Forssk.*	LC	Herb
ASTERACEAE	*Litogyne gariepina (DC.) Anderb.*	LC	Dwarf shrub, herb
ASTERACEAE	*Macledium zeyheri (Sond.) S.Ortíz subsp. zeyheri*	LC	Herb
ASTERACEAE	*Nidorella anomala Steetz*	LC	Herb
ASTERACEAE	*Nidorella hottentotica DC.*	LC	Herb
ASTERACEAE	*Nolletia rarifolia (Turcz.) Steetz*	LC	Suffrutex
ASTERACEAE	*Osteospermum muricatum E.Mey. ex DC. subsp. muricatum*	LC	Herb
ASTERACEAE	*Pseudognaphalium luteo-album (L.) Hilliard & B.L.Burtt*	NE	Herb
ASTERACEAE	*Pseudognaphalium oligandrum (DC.) Hilliard & B.L.Burtt*	LC	Herb
ASTERACEAE	*Pulicaria scabra (Thunb.) Druce*	LC	Herb
ASTERACEAE	*Schistostephium heptalobum (DC.) Oliv. & Hiern*	LC	Shrub
ASTERACEAE	*Schkuhria pinnata (Lam.) Kuntze ex Thell.*	NE	Herb
ASTERACEAE	*Senecio affinis DC.*	LC	Herb
ASTERACEAE	*Senecio coronatus (Thunb.) Harv.*	LC	Herb
ASTERACEAE	*Senecio erubescens Aiton var. crepidifolius DC.*	LC	Herb
ASTERACEAE	*Senecio erubescens Aiton var. erubescens*	LC	Herb
ASTERACEAE	*Senecio glanduloso-pilosus Volkens & Muschl.*	LC	Herb
ASTERACEAE	*Senecio gregatus Hilliard*	LC	Herb
ASTERACEAE	*Senecio inaequidens DC.*	LC	Herb
ASTERACEAE	*Senecio inornatus DC.*	LC	Herb
ASTERACEAE	*Senecio laevigatus Thunb. var. integrifolius Harv.*	LC	Herb
ASTERACEAE	*Senecio lydenburgensis Hutch. & Burtt Davy*	LC	Herb
ASTERACEAE	*Senecio oxyriifolius DC. subsp. oxyriifolius*	LC	Herb, succulent
ASTERACEAE	*Senecio pentactinus Klatt*	LC	Herb, shrub
ASTERACEAE	*Senecio ruwenzoriensis S.Moore*	LC	Herb, succulent
ASTERACEAE	*Senecio serratuloides DC.*	LC	Herb
ASTERACEAE	*Senecio venosus Harv.*	LC	Herb
ASTERACEAE	*Sonchus nanus Sond. ex Harv.*	LC	Herb
ASTERACEAE	*Sonchus oleraceus L.*	NE	Herb
ASTERACEAE	*Sonchus wilmsii R.E.Fr.*	LC	Herb
ASTERACEAE	*Tagetes erecta L.*	NE	Herb
ASTERACEAE	*Tithonia rotundifolia (Mill.) S.F.Blake*	NE	Herb
ASTERACEAE	*Tolpis capensis (L.) Sch.Bip.*	LC	Herb
ASTERACEAE	*Tripteris aghillana DC. var. aghillana*	LC	Herb, succulent
ASTERACEAE	*Vernonia galpinii Klatt*	LC	Herb
ASTERACEAE	*Vernonia staehelinoides Harv.*	LC	Shrub, suffrutex
ASTERACEAE	*Xanthium spinosum L.*	NE	Herb
ASTERACEAE	*Zinnia peruviana (L.) L.*	NE	Herb
AYTONIACEAE	*Plagiochasma rupestre (J.R.& G.Forst.)*		Bryophyte

Family	Species	Threat status	Growth forms
	Steph. var. rupestre		
BEGONIACEAE	*Begonia sutherlandii Hook.f. subsp. sutherlandii*	LC	Herb, succulent
BIGNONIACEAE	*Macfadyena unguis-cati (L.) A.H.Gentry*	NE	Climber
BORAGINACEAE	*Buglossoides arvensis (L.) I.M.Johnst.*	NE	Herb
BORAGINACEAE	*Cynoglossum hispidum Thunb.*	LC	Herb
BORAGINACEAE	*Cynoglossum lanceolatum Forssk.*	LC	Herb
BORAGINACEAE	*Ehretia rigida (Thunb.) Druce subsp. rigida*	LC	Shrub, tree
BORAGINACEAE	*Lithospermum cinereum A.DC.*	LC	Herb
BRASSICACEAE	*Capsella bursa-pastoris (L.) Medik.*	NE	Herb
BRASSICACEAE	*Lepidium africanum (Burm.f.) DC. subsp. africanum*	LC	Herb
BRASSICACEAE	*Lepidium bonariense L.*	NE	Herb
BRASSICACEAE	*Lepidium transvaalense Marais*	LC	Herb
BRASSICACEAE	*Rorippa nudiuscula Thell.*	LC	Herb
BRASSICACEAE	*Sisymbrium orientale L.*	NE	Herb
BRYACEAE	*Bryum argenteum Hedw.*		Bryophyte
BUDDLEJACEAE	*Buddleja saligna Willd.*	LC	Shrub, tree
BUDDLEJACEAE	*Gomphostigma virgatum (L.f.) Baill.*	LC	Dwarf shrub, herb, shrub
BUDDLEJACEAE	*Nuxia congesta R.Br. ex Fresen.*	LC	Shrub, tree
CAMPANULACEAE	*Wahlenbergia androsacea A.DC.*	LC	Herb
CAMPANULACEAE	*Wahlenbergia banksiana A.DC.*	LC	Herb
CAMPANULACEAE	*Wahlenbergia denticulata (Burch.) A.DC. var. transvaalensis (Adamson) W.G.Welman*	LC	Herb
CAMPANULACEAE	*Wahlenbergia krebsii Cham. subsp. krebsii*	LC	Herb
CAMPANULACEAE	*Wahlenbergia undulata (L.f.) A.DC.*	LC	Herb
CAPPARACEAE	*Cleome conrathii Burtt Davy*	NT	Herb
CAPPARACEAE	*Cleome monophylla L.*	LC	Herb
CAPPARACEAE	*Maerua cafra (DC.) Pax*	LC	Shrub, tree
CARYOPHYLLACEAE	*Agrostemma githago L. subsp. githago*	NE	Herb
CARYOPHYLLACEAE	*Corrigiola litoralis L. subsp. litoralis var. litoralis*	LC	Herb
CARYOPHYLLACEAE	*Dianthus mooiensis F.N.Williams subsp. mooiensis var. mooiensis*	NE	Herb
CARYOPHYLLACEAE	*Paronychia brasiliana DC. var. pubescens Chaudhri*	NE	Herb
CARYOPHYLLACEAE	*Pollichia campestris Aiton*	LC	Herb
CARYOPHYLLACEAE	*Silene burchellii Otth var. angustifolia Sond.*	NE	Herb
CARYOPHYLLACEAE	*Silene undulata Aiton*	LC	Herb
CELASTRACEAE	*Gymnosporia buxifolia (L.) Szyszyl.*	LC	Shrub, tree
CELASTRACEAE	*Gymnosporia maranguensis (Loes.) Loes.*	LC	Shrub, tree
CELASTRACEAE	*Salacia rehmannii Schinz*	LC	Dwarf shrub
CELTIDACEAE	*Celtis africana Burm.f.*	LC	Shrub, tree
CHENOPODIACEAE	*Chenopodium album L.*	NE	Herb
CHENOPODIACEAE	*Chenopodium ambrosioides L.*	NE	Herb
CHENOPODIACEAE	*Chenopodium carinatum R.Br.*	NE	Herb
CHENOPODIACEAE	*Chenopodium schraderianum Roem. & Schult.*	NE	Herb

Family	Species	Threat status	Growth forms
CHRYSOBALANACEAE	*Parinari capensis Harv. subsp. capensis*	LC	Dwarf shrub
CLADONIACEAE	*Cladonia glauca Flörke*		Lichen
COMBRETACEAE	*Combretum erythrophyllum (Burch.) Sond.*	LC	Shrub, tree
COMBRETACEAE	*Combretum molle R.Br. ex G.Don*	LC	Tree
COMBRETACEAE	*Combretum zeyheri Sond.*	LC	Shrub, tree
COMMELINACEAE	*Commelina africana L. var. barberae (C.B.Clarke) C.B.Clarke*	LC	Herb
COMMELINACEAE	*Commelina africana L. var. lancispatha C.B.Clarke*	LC	Herb
COMMELINACEAE	*Commelina livingstonii C.B.Clarke*	LC	Herb
COMMELINACEAE	*Commelina modesta Oberm.*	LC	Herb
COMMELINACEAE	*Cyanotis speciosa (L.f.) Hassk.*	LC	Herb, succulent
CONVOLVULACEAE	*Convolvulus farinosus L.*	LC	Climber, herb
CONVOLVULACEAE	*Convolvulus ocellatus Hook.f. var. ocellatus*	LC	Herb
CONVOLVULACEAE	*Convolvulus sagittatus Thunb.*	LC	Herb
CONVOLVULACEAE	*Convolvulus thunbergii Roem. & Schult.*	LC	Herb
CONVOLVULACEAE	*Cuscuta campestris Yunck.*	NE	Herb, parasite
CONVOLVULACEAE	*Evolvulus alsinoides (L.) L.*	LC	Herb
CONVOLVULACEAE	*Ipomoea adenioides Schinz var. adenioides*	LC	Dwarf shrub, shrub
CONVOLVULACEAE	*Ipomoea bathycolpos Hallier f.*	LC	Herb
CONVOLVULACEAE	*Ipomoea bolusiana Schinz*	LC	Dwarf shrub, herb, succulent
CONVOLVULACEAE	*Ipomoea crassipes Hook. var. crassipes*	LC	Herb, succulent
CONVOLVULACEAE	*Ipomoea oblongata E.Mey. ex Choisy*	LC	Herb, succulent
CONVOLVULACEAE	*Ipomoea obscura (L.) Ker Gawl. var. obscura*	LC	Herb
CONVOLVULACEAE	*Ipomoea ommanneyi Rendle*	LC	Herb, succulent
CONVOLVULACEAE	*Ipomoea papilio Hallier f.*	LC	Herb
CONVOLVULACEAE	*Ipomoea purpurea (L.) Roth*	NE	Climber, herb
CONVOLVULACEAE	*Ipomoea simplex Thunb.*	LC	Herb, succulent
CONVOLVULACEAE	*Merremia verecunda Rendle*	LC	Herb
CONVOLVULACEAE	*Xenostegia tridentata (L.) D.F.Austin & Staples subsp. angustifolia (Jacq.) Lejoly & Lisowski*	LC	Herb
CRASSULACEAE	*Cotyledon orbiculata L. var. oblonga (Haw.) DC.*	LC	Dwarf shrub, succulent
CRASSULACEAE	*Crassula alba Forssk. var. alba*	LC	Herb, succulent
CRASSULACEAE	*Crassula capitella Thunb. subsp. nodulosa (Schönland) Toelken*	LC	Herb, succulent
CRASSULACEAE	*Crassula lanceolata (Eckl. & Zeyh.) Endl. ex Walp. subsp. transvaalensis (Kuntze) Toelken*	LC	Herb, succulent
CRASSULACEAE	*Crassula natans Thunb. var. natans*	LC	Hydrophyte, succulent
CRASSULACEAE	*Crassula pellucida L. subsp. alsinoides (Hook.f.) Toelken*	LC	Herb, scrambler, succulent
CRASSULACEAE	*Crassula setulosa Harv. var. setulosa forma setulosa*	NE	Herb, succulent
CUCURBITACEAE	*Coccinia adoensis (A.Rich.) Cogn.*	LC	Climber, herb, succulent
CUCURBITACEAE	*Coccinia rehmannii Cogn.*	LC	Climber, herb, succulent
CUCURBITACEAE	*Coccinia sessilifolia (Sond.) Cogn.*	LC	Climber, herb, succulent
CUCURBITACEAE	*Cucumis hirsutus Sond.*	LC	Herb, succulent

Family	Species	Threat status	Growth forms
CUCURBITACEAE	*Cucumis metuliferus E.Mey. ex Naudin*	LC	Climber, herb
CUCURBITACEAE	*Cucumis myriocarpus Naudin subsp. myriocarpus*	LC	Herb
CUCURBITACEAE	*Cucumis zeyheri Sond.*	LC	Herb
CUCURBITACEAE	*Kedrostis africana (L.) Cogn.*	LC	Climber, herb, succulent
CUCURBITACEAE	*Kedrostis hirtella (Naudin) Cogn.*	LC	Climber, herb, succulent
CUCURBITACEAE	*Trochomeria macrocarpa (Sond.) Hook.f. subsp. macrocarpa*	LC	Climber, herb, succulent
CUCURBITACEAE	*Zehneria marlothii (Cogn.) R.& A.Fern.*	LC	Climber
CUCURBITACEAE	*Zehneria parvifolia (Cogn.) J.H.Ross*	LC	Climber
CUCURBITACEAE	*Zehneria scabra (L.f.) Sond. subsp. scabra*	LC	Climber, herb
CYPERACEAE	*Abildgaardia ovata (Burm.f.) Kral*	LC	Cyperoid, helophyte, herb, mesophyte
CYPERACEAE	*Bulbostylis burchellii (Ficalho & Hiern) C.B.Clarke*	LC	Cyperoid, herb, mesophyte
CYPERACEAE	*Bulbostylis densa (Wall.) Hand.-Mazz. subsp. afromontana (Lye) R.W.Haines*	LC	Cyperoid, herb, mesophyte
CYPERACEAE	*Bulbostylis hispidula (Vahl) R.W.Haines subsp. pyriformis (Lye) R.W.Haines*	LC	Cyperoid, herb, mesophyte
CYPERACEAE	*Bulbostylis oritrephes (Ridl.) C.B.Clarke*	LC	Cyperoid, herb, mesophyte
CYPERACEAE	*Carex acutiformis Ehrh.*	NE	Cyperoid, emergent hydrophyte, helophyte, herb
CYPERACEAE	*Carex glomerabilis Krecz.*	LC	Cyperoid, helophyte, herb
CYPERACEAE	*Cladium mariscus (L.) Pohl subsp. jamaicense (Crantz) Kük.*	LC	Cyperoid, emergent hydrophyte, helophyte, herb
CYPERACEAE	*Cyperus albostriatus Schrad.*	LC	Cyperoid, herb, mesophyte
CYPERACEAE	*Cyperus congestus Vahl*	LC	Cyperoid, helophyte, herb
CYPERACEAE	*Cyperus denudatus L.f. var. denudatus*	LC	Cyperoid, emergent hydrophyte, helophyte, herb
CYPERACEAE	*Cyperus difformis L.*	LC	Cyperoid, helophyte, herb, mesophyte
CYPERACEAE	*Cyperus eragrostis Lam.*	NE	Cyperoid, helophyte, herb
CYPERACEAE	*Cyperus esculentus L. var. esculentus*	LC	Cyperoid, geophyte, herb, mesophyte
CYPERACEAE	*Cyperus fastigiatus Rottb.*	LC	Cyperoid, helophyte, herb
CYPERACEAE	*Cyperus haematocephalus C.B.Clarke*	LC	Cyperoid, helophyte, herb, mesophyte
CYPERACEAE	*Cyperus latifolius Poir.*	LC	Cyperoid, helophyte, herb
CYPERACEAE	*Cyperus leptocladus Kunth*	LC	Cyperoid, herb, mesophyte
CYPERACEAE	*Cyperus longus L. var. tenuiflorus (Rottb.) Boeck.*	LC	Cyperoid, helophyte, herb
CYPERACEAE	*Cyperus margaritaceus Vahl var. margaritaceus*	LC	Cyperoid, herb, mesophyte
CYPERACEAE	*Cyperus obtusiflorus Vahl var. flavissimus (Schrad.) Boeck.*	LC	Cyperoid, herb, mesophyte
CYPERACEAE	*Cyperus obtusiflorus Vahl var. obtusiflorus*	LC	Cyperoid, herb, mesophyte
CYPERACEAE	*Cyperus procerus Rottb.*	LC	Cyperoid, helophyte, herb
CYPERACEAE	*Cyperus rupestris Kunth var. rupestris*	LC	Cyperoid, herb, mesophyte
CYPERACEAE	*Cyperus semitrifidus Schrad.*	LC	Cyperoid, herb, mesophyte
CYPERACEAE	*Cyperus sexangularis Nees*	LC	Cyperoid, emergent hydrophyte, helophyte, herb
CYPERACEAE	*Cyperus sphaerospermus Schrad.*	LC	Cyperoid, herb, mesophyte

Family	Species	Threat status	Growth forms
CYPERACEAE	*Cyperus usitatus Burch.*	LC	Cyperoid, geophyte, herb, mesophyte
CYPERACEAE	*Eleocharis dregeana Steud.*	LC	Cyperoid, helophyte, herb
CYPERACEAE	*Fimbristylis complanata (Retz.) Link*	LC	Cyperoid, helophyte, herb
CYPERACEAE	*Fuirena pubescens (Poir.) Kunth var. pubescens*	LC	Cyperoid, helophyte, herb, mesophyte
CYPERACEAE	*Isolepis cernua (Vahl) Roem. & Schult. var. cernua*	LC	Cyperoid, helophyte, herb
CYPERACEAE	*Isolepis costata Hochst. ex A.Rich.*	LC	Cyperoid, helophyte, herb
CYPERACEAE	*Isolepis fluitans (L.) R.Br. var. fluitans*	LC	Cyperoid, emergent hydrophyte, helophyte, herb
CYPERACEAE	*Kyllinga alata Nees*	LC	Cyperoid, helophyte, herb, mesophyte
CYPERACEAE	*Kyllinga alba Nees*	LC	Cyperoid, herb, mesophyte
CYPERACEAE	*Kyllinga erecta Schumach. var. erecta*	LC	Cyperoid, helophyte, herb
CYPERACEAE	*Kyllinga melanosperma Nees*	LC	Cyperoid, helophyte, herb
CYPERACEAE	*Mariscus uitenhagensis Steud.*	LC	Cyperoid, herb, mesophyte
CYPERACEAE	*Pycreus macranthus (Boeck.) C.B.Clarke*	LC	Cyperoid, helophyte, herb
CYPERACEAE	*Pycreus nitidus (Lam.) J.Raynal*	LC	Cyperoid, helophyte, herb, sudd hydrophyte
CYPERACEAE	*Schoenoplectus brachyceras (Hochst. ex A.Rich.) Lye*	LC	Cyperoid, emergent hydrophyte, helophyte, herb
CYPERACEAE	*Schoenoplectus corymbosus (Roth ex Roem. & Schult.) J.Raynal*	LC	Cyperoid, emergent hydrophyte, helophyte, herb
CYPERACEAE	*Schoenoplectus leucanthus (Boeck.) J.Raynal*	LC	Cyperoid, helophyte, herb
CYPERACEAE	*Schoenoplectus muricinux (C.B.Clarke) J.Raynal*	LC	Cyperoid, emergent hydrophyte, helophyte, herb
CYPERACEAE	*Schoenoplectus muriculatus (Kük.) Browning*	LC	Cyperoid, emergent hydrophyte, helophyte, herb
CYPERACEAE	*Schoenoplectus pulchellus (Kunth) J.Raynal*	LC	Cyperoid, emergent hydrophyte, helophyte, herb
CYPERACEAE	*Schoenoxiphium lehmannii (Nees) Steud.*	LC	Cyperoid, herb, mesophyte
CYPERACEAE	*Scirpoides burkei (C.B.Clarke) Goetgh., Muasya & D.A.Simpson*	LC	Cyperoid, herb, mesophyte
DICHAPETALACEAE	*Dichapetalum cymosum (Hook.) Engl.*	LC	Dwarf shrub
DIOSCOREACEAE	*Dioscorea retusa Mast.*	LC	Climber, geophyte, succulent
DIPSACACEAE	*Cephalaria zeyheriana Szabó*	LC	Herb
DIPSACACEAE	*Scabiosa columbaria L.*	LC	Herb
DRYOPTERIDACEAE	*Dryopteris athamantica (Kunze) Kuntze*	LC	Geophyte, herb, lithophyte
EBENACEAE	*Diospyros austro-africana De Winter var. microphylla (Burch.) De Winter*	LC	Shrub
EBENACEAE	*Diospyros lycioides Desf. subsp. guerkei (Kuntze) De Winter*	LC	Shrub, tree
EBENACEAE	*Diospyros lycioides Desf. subsp. lycioides*	LC	Shrub
EBENACEAE	*Diospyros whyteana (Hiern) F.White*	LC	Shrub, tree
EBENACEAE	*Euclea crispa (Thunb.) Gürke subsp. crispa*	LC	Shrub, tree
ELATINACEAE	*Bergia decumbens Planch. ex Harv.*	LC	Dwarf shrub
EQUISETACEAE	*Equisetum ramosissimum Desf. subsp. ramosissimum*	LC	Herb, hydrophyte
ERIOSPERMACEAE	*Eriospermum cooperi Baker var. cooperi*	LC	Geophyte
ERIOSPERMACEAE	*Eriospermum flagelliforme (Baker)*	LC	Geophyte

Family	Species	Threat status	Growth forms
	J.C.Manning		
ERIOSPERMACEAE	*Eriospermum porphyrium Archibald*	LC	Geophyte
ERIOSPERMACEAE	*Eriospermum porphyrovalve Baker*	LC	Geophyte
EUPHORBIACEAE	*Acalypha angustata Sond.*	LC	Dwarf shrub, herb
EUPHORBIACEAE	*Acalypha caperonioides Baill. var. caperonioides*	DDT	Dwarf shrub, herb
EUPHORBIACEAE	*Acalypha peduncularis E.Mey. ex Meisn.*	LC	Dwarf shrub, herb
EUPHORBIACEAE	*Acalypha villicaulis Hochst.*	LC	Dwarf shrub, herb, shrub
EUPHORBIACEAE	*Euphorbia clavarioides Boiss. var. truncata (N.E.Br.) A.C.White, R.A.Dyer & B.Sloane*	LC	Dwarf shrub, shrub, succulent
EUPHORBIACEAE	*Euphorbia heterophylla L.*	NE	Herb
EUPHORBIACEAE	*Euphorbia peplus L.*	NE	Herb
EUPHORBIACEAE	*Euphorbia pseudotuberosa Pax*	LC	Dwarf shrub, succulent
EUPHORBIACEAE	*Euphorbia schinzii Pax*	LC	Dwarf shrub, shrub, succulent
EUPHORBIACEAE	*Euphorbia striata Thunb. var. striata*	LC	Dwarf shrub, herb
EUPHORBIACEAE	*Jatropha lagarinthoides Sond.*	LC	Dwarf shrub, herb, succulent
EUPHORBIACEAE	*Tragia minor Sond.*	LC	Dwarf shrub, herb
EUPHORBIACEAE	*Tragia rupestris Sond.*	LC	Climber, dwarf shrub, herb, shrub
EXORMOTHECACEAE	*Exormotheca holstii Steph.*		Bryophyte
FABACEAE	*Acacia cyclops A.Cunn. ex G.Don*	NE	Shrub, tree
FABACEAE	*Acacia galpinii Burtt Davy*	LC	Tree
FABACEAE	*Acacia karroo Hayne*	LC	Shrub, tree
FABACEAE	*Acacia podalyriifolia A.Cunn. ex G.Don*	NE	Shrub, tree
FABACEAE	*Acacia robusta Burch. subsp. robusta*	LC	Tree
FABACEAE	*Argyrolobium pauciflorum Eckl. & Zeyh.*	LC	Herb
FABACEAE	*Astragalus atropilosulus (Hochst.) Bunge subsp. burkeanus (Harv.) J.B.Gillett var. burkeanus*	LC	Herb
FABACEAE	*Bolusanthus speciosus (Bolus) Harms*	LC	Tree
FABACEAE	*Calpurnia aurea (Aiton) Benth. subsp. aurea*	LC	Shrub, tree
FABACEAE	*Chamaecrista biensis (Steyaert) Lock*	LC	Herb
FABACEAE	*Chamaecrista capensis (Thunb.) E.Mey. var. capensis*	LC	Herb
FABACEAE	*Chamaecrista comosa E.Mey. var. capricornia (Steyaert) Lock*	LC	Herb
FABACEAE	*Chamaecrista mimosoides (L.) Greene*	LC	Herb
FABACEAE	*Crotalaria agatiflora Schweinf. subsp. agatiflora*	NE	Herb, shrub
FABACEAE	*Crotalaria brachycarpa (Benth.) Burtt Davy ex I.Verd.*	LC	Herb
FABACEAE	*Crotalaria capensis Jacq.*	LC	Shrub, tree
FABACEAE	*Crotalaria eremicola Baker f. subsp. eremicola*	LC	Herb
FABACEAE	*Crotalaria sphaerocarpa Perr. ex DC. subsp. sphaerocarpa*	LC	Herb
FABACEAE	*Dichilus strictus E.Mey.*	LC	Dwarf shrub, herb, shrub
FABACEAE	*Dichrostachys cinerea (L.) Wight & Arn. subsp. africana Brenan & Brummitt var.*	LC	Shrub, tree

Family	Species	Threat status	Growth forms
	africana		
FABACEAE	*Dipogon lignosus (L.) Verdc.*	LC	Climber, herb
FABACEAE	*Dolichos angustifolius Eckl. & Zeyh.*	LC	Herb
FABACEAE	*Dolichos trilobus L. subsp. transvaalicus Verdc.*	LC	Climber, herb
FABACEAE	*Elephantorrhiza elephantina (Burch.) Skeels*	LC	Dwarf shrub, shrub, suffrutex
FABACEAE	*Eriosema burkei Benth. ex Harv. var. burkei*	LC	Herb
FABACEAE	*Eriosema cordatum E.Mey.*	LC	Herb
FABACEAE	*Eriosema squarrosum (Thunb.) Walp.*	LC	Herb
FABACEAE	*Erythrina caffra Thunb.*	LC	Tree
FABACEAE	*Erythrina lysistemon Hutch.*	LC	Tree
FABACEAE	*Erythrina zeyheri Harv.*	LC	Dwarf shrub, shrub, succulent
FABACEAE	*Indigastrum burkeanum (Benth. ex Harv.) Schrire*	LC	Herb
FABACEAE	*Indigofera confusa Prain & Baker f.*	LC	Herb
FABACEAE	*Indigofera filipes Benth. ex Harv.*	LC	Dwarf shrub, herb, shrub
FABACEAE	*Indigofera hedyantha Eckl. & Zeyh.*	LC	Herb
FABACEAE	*Indigofera heterotricha DC.*	LC	Dwarf shrub, herb
FABACEAE	*Indigofera hilaris Eckl. & Zeyh. var. hilaris*	LC	Herb
FABACEAE	*Indigofera melanadenia Benth. ex Harv.*	LC	Herb, shrub
FABACEAE	*Indigofera oxalidea Welw. ex Baker*	LC	Herb
FABACEAE	*Indigofera zeyheri Spreng. ex Eckl. & Zeyh.*	LC	Dwarf shrub, herb
FABACEAE	*Lablab purpureus (L.) Sweet subsp. uncinatus Verdc.*	LC	Climber, herb
FABACEAE	*Lessertia stricta L.Bolus*	LC	Herb
FABACEAE	*Lotononis bainesii Baker*	LC	Climber, creeper, herb
FABACEAE	*Lotononis calycina (E.Mey.) Benth.*	LC	Herb
FABACEAE	*Lotononis eriantha Benth.*	LC	Herb
FABACEAE	*Lotononis foliosa Bolus*	LC	Herb
FABACEAE	*Lotononis laxa Eckl. & Zeyh.*	LC	Herb
FABACEAE	*Lotononis listii Polhill*	LC	Creeper, herb
FABACEAE	*Lotononis mucronata Conrath*	LC	Herb
FABACEAE	*Lotononis wilmsii Dummer*	LC	Herb
FABACEAE	*Lotus discolor E.Mey. subsp. discolor*	LC	Herb
FABACEAE	*Medicago laciniata (L.) Mill. var. laciniata*	NE	Herb
FABACEAE	*Medicago lupulina L.*	NE	Herb
FABACEAE	*Melilotus officinalis (L.) Pall.*	NE	Herb
FABACEAE	*Melolobium subspicatum Conrath*	VU	Dwarf shrub
FABACEAE	*Mundulea sericea (Willd.) A.Chev. subsp. sericea*	LC	Shrub, tree
FABACEAE	*Neonotonia wightii (Wight. ex Arn.) J.A.Lackey*	LC	Climber
FABACEAE	*Neorautanenia ficifolia (Benth. ex Harv.) C.A.Sm.*	LC	Climber, herb, succulent
FABACEAE	*Otholobium polyphyllum (Eckl. & Zeyh.) C.H.Stirt.*	LC	Dwarf shrub

Family	Species	Threat status	Growth forms
FABACEAE	*Pearsonia bracteata (Benth.) Polhill*	LC	Herb
FABACEAE	*Pearsonia cajanifolia (Harv.) Polhill subsp. cajanifolia*	LC	Herb, shrub
FABACEAE	*Pearsonia sessilifolia (Harv.) Dummer subsp. sessilifolia*	LC	Dwarf shrub, herb
FABACEAE	*Peltophorum africanum Sond.*	LC	Tree
FABACEAE	*Rhynchosia adenodes Eckl. & Zeyh.*	LC	Herb
FABACEAE	*Rhynchosia caribaea (Jacq.) DC.*	LC	Climber, herb
FABACEAE	*Rhynchosia crassifolia Benth. ex Harv.*	LC	Climber, herb
FABACEAE	*Rhynchosia monophylla Schltr.*	LC	Herb
FABACEAE	*Rhynchosia nervosa Benth. ex Harv. var. nervosa*	LC	Herb
FABACEAE	*Rhynchosia nitens Benth. ex Harv.*	LC	Shrub
FABACEAE	*Rhynchosia pentheri Schltr. ex Zahlbr. var. pentheri*	LC	Herb
FABACEAE	*Rhynchosia totta (Thunb.) DC. var. totta*	LC	Climber, herb
FABACEAE	*Rhynchosia venulosa (Hiern) K.Schum.*	LC	Climber, herb
FABACEAE	*Robinia pseudoacacia L.*	NE	Shrub, tree
FABACEAE	*Sesbania punicea (Cav.) Benth.*	NE	Shrub, tree
FABACEAE	*Sphenostylis angustifolia Sond.*	LC	Dwarf shrub, herb
FABACEAE	*Stylosanthes fruticosa (Retz.) Alston*	LC	Dwarf shrub, herb
FABACEAE	*Tephrosia capensis (Jacq.) Pers. var. capensis*	LC	Dwarf shrub, herb, shrub
FABACEAE	*Tephrosia elongata E.Mey. var. elongata*	LC	Dwarf shrub, herb, shrub
FABACEAE	*Tephrosia longipes Meisn. subsp. longipes var. longipes*	LC	Dwarf shrub, herb, shrub
FABACEAE	*Tephrosia lupinifolia DC.*	LC	Herb
FABACEAE	*Tephrosia multijuga R.G.N.Young*	LC	Dwarf shrub, herb, shrub
FABACEAE	*Tephrosia reptans Baker var. reptans*	LC	Herb, shrub
FABACEAE	*Tephrosia retusa Burtt Davy*	LC	Herb
FABACEAE	*Tephrosia semiglabra Sond.*	LC	Herb
FABACEAE	*Trifolium africanum Ser. var. lydenburgense J.B.Gillett*	LC	Herb
FABACEAE	*Trifolium hybridum L. var. hybridum*	NE	Herb
FABACEAE	*Trifolium pratense L. var. pratense*	NE	Herb
FABACEAE	*Trigonella foenum-graecum L.*	NE	Herb
FABACEAE	*Tylosema esculentum (Burch.) A.Schreib.*	LC	Shrub, succulent
FABACEAE	*Vicia sativa L. subsp. sativa*	NE	Climber, herb
FABACEAE	*Vigna schlechteri Harms*		Climber, herb
FABACEAE	*Vigna unguiculata (L.) Walp. subsp. stenophylla (Harv.) Maréchal, Mascherpa & Stainier*	LC	Climber, herb
FABACEAE	*Vigna vexillata (L.) A.Rich. var. vexillata*	LC	Climber, herb
FABACEAE	*Zornia capensis Pers. subsp. capensis*	LC	Herb
FABACEAE	*Zornia linearis E.Mey.*	LC	Herb
FABACEAE	*Zornia milneana Mohlenbr.*	LC	Herb
FABRONIACEAE	*Fabronia pilifera Hornsch.*		Bryophyte, epiphyte
FISSIDENTACEAE	*Fissidens bryoides Hedw.*		Bryophyte

Family	Species	Threat status	Growth forms
FUNARIACEAE	*Funaria hygrometrica Hedw.*		Bryophyte
GENTIANACEAE	*Chironia palustris Burch. subsp. palustris*	LC	Herb
GENTIANACEAE	*Chironia palustris Burch. subsp. transvaalensis (Gilg) I.Verd.*	LC	Herb
GENTIANACEAE	*Chironia purpurascens (E.Mey.) Benth. & Hook.f. subsp. humilis (Gilg) I.Verd.*	LC	Herb
GENTIANACEAE	*Sebaea grandis (E.Mey.) Steud.*	LC	Herb
GENTIANACEAE	*Sebaea junodii Schinz*	LC	Herb
GERANIACEAE	*Erodium cicutarium (L.) L'Hér.*	NE	Herb
GERANIACEAE	*Monsonia angustifolia E.Mey. ex A.Rich.*	LC	Herb
GERANIACEAE	*Monsonia burkeana Planch. ex Harv.*	LC	Herb
GERANIACEAE	*Monsonia luederitziana Focke & Schinz*	LC	Herb
GERANIACEAE	*Pelargonium luridum (Andrews) Sweet*	LC	Geophyte, succulent
GISEKIACEAE	*Gisekia africana (Lour.) Kuntze var. africana*	LC	Herb
GREYIACEAE	*Greyia sutherlandii Hook. & Harv.*	LC	Shrub, tree
HALORAGACEAE	*Myriophyllum aquaticum (Vell.) Verdc.*	NE	Herb, hydrophyte
HYACINTHACEAE	*Albuca baurii Baker*		Geophyte
HYACINTHACEAE	*Albuca fastigiata Dryand. var. fastigiata*	LC	Geophyte
HYACINTHACEAE	*Bowiea volubilis Harv. ex Hook.f. subsp. volubilis*	VU	Climber, geophyte, succulent
HYACINTHACEAE	*Dipcadi marlothii Engl.*	LC	Geophyte
HYACINTHACEAE	*Dipcadi viride (L.) Moench*	LC	Geophyte
HYACINTHACEAE	*Drimia calcarata (Baker) Stedje*	LC	Geophyte
HYACINTHACEAE	*Drimia depressa (Baker) Jessop*	LC	Geophyte
HYACINTHACEAE	*Drimia elata Jacq.*	DDT	Geophyte
HYACINTHACEAE	*Drimia multisetosa (Baker) Jessop*	LC	Geophyte
HYACINTHACEAE	*Drimia sanguinea (Schinz) Jessop*	NT	Geophyte
HYACINTHACEAE	*Eucomis autumnalis (Mill.) Chitt. subsp. clavata (Baker) Reyneke*	NE	Geophyte
HYACINTHACEAE	*Ledebouria cooperi (Hook.f.) Jessop*	LC	Geophyte
HYACINTHACEAE	*Ledebouria inquinata (C.A.Sm.) Jessop*	LC	Geophyte
HYACINTHACEAE	*Ledebouria leptophylla (Baker) S.Venter*		
HYACINTHACEAE	*Ledebouria luteola Jessop*	LC	Geophyte
HYACINTHACEAE	*Ledebouria ovatifolia (Baker) Jessop*	LC	Geophyte
HYACINTHACEAE	*Ledebouria revoluta (L.f.) Jessop*	LC	Geophyte
HYACINTHACEAE	*Ornithogalum tenuifolium F.Delaroche subsp. tenuifolium*	LC	Geophyte
HYACINTHACEAE	*Schizocarphus nervosus (Burch.) Van der Merwe*	LC	Geophyte
HYDROCHARITACEAE	*Lagarosiphon muscoides Harv.*	LC	Herb, hydrophyte
HYDROCHARITACEAE	*Ottelia ulvifolia (Planch.) Walp.*	LC	Herb, hydrophyte
HYPERICACEAE	*Hypericum aethiopicum Thunb. subsp. sonderi (Bredell) N.Robson*	LC	Herb
HYPERICACEAE	*Hypericum lalandii Choisy*	LC	Herb
HYPOXIDACEAE	*Hypoxis argentea Harv. ex Baker var. argentea*	LC	Geophyte
HYPOXIDACEAE	*Hypoxis argentea Harv. ex Baker var. sericea Baker*	LC	Geophyte

Family	Species	Threat status	Growth forms
HYPOXIDACEAE	*Hypoxis hemerocallidea Fisch., C.A.Mey. & Avé-Lall.*	Declining	Geophyte
HYPOXIDACEAE	*Hypoxis interjecta Nel*	LC	Geophyte
HYPOXIDACEAE	*Hypoxis iridifolia Baker*	LC	Geophyte
HYPOXIDACEAE	*Hypoxis multiceps Buchinger ex Baker*	LC	Geophyte
HYPOXIDACEAE	*Hypoxis rigidula Baker var. pilosissima Baker*	LC	Geophyte
HYPOXIDACEAE	*Hypoxis rigidula Baker var. rigidula*	LC	Geophyte, herb
IRIDACEAE	*Babiana bainesii Baker*	LC	Geophyte, herb
IRIDACEAE	*Freesia grandiflora (Baker) Klatt*	LC	Geophyte, herb
IRIDACEAE	*Freesia laxa (Thunb.) Goldblatt & J.C.Manning subsp. laxa*	LC	Geophyte, herb
IRIDACEAE	*Gladiolus antholyzoides Baker*	LC	Geophyte, herb
IRIDACEAE	*Gladiolus crassifolius Baker*	LC	Geophyte, herb
IRIDACEAE	*Gladiolus elliotii Baker*	LC	Geophyte, herb
IRIDACEAE	*Gladiolus papilio Hook.f.*	LC	Geophyte, herb
IRIDACEAE	*Gladiolus permeabilis D.Delaroche subsp. edulis (Burch. ex Ker Gawl.) Oberm.*	LC	Geophyte, herb
IRIDACEAE	*Gladiolus pretoriensis Kuntze*	LC	Geophyte, herb
IRIDACEAE	*Gladiolus woodii Baker*	LC	Geophyte, herb
IRIDACEAE	*Hesperantha longicollis Baker*	LC	Geophyte, herb
IRIDACEAE	*Moraea pallida (Baker) Goldblatt*	LC	Geophyte, herb
IRIDACEAE	*Moraea stricta Baker*	LC	Geophyte, herb
IRIDACEAE	*Tritonia nelsonii Baker*	LC	Geophyte, herb
JUNCACEAE	*Juncus exsertus Buchenau*	LC	Helophyte, herb
JUNCACEAE	*Juncus oxycarpus E.Mey. ex Kunth*	LC	Helophyte, herb
JUNCACEAE	*Juncus punctorius L.f.*	LC	Helophyte, herb
LAMIACEAE	*Leucas martinicensis (Jacq.) R.Br.*	LC	Herb
LAMIACEAE	*Mentha longifolia (L.) Huds. subsp. polyadena (Briq.) Briq.*	LC	Herb
LAMIACEAE	*Ocimum obovatum E.Mey. ex Benth. subsp. obovatum var. obovatum*	LC	Herb
LAMIACEAE	*Plectranthus cylindraceus Hochst. ex Benth.*	LC	Herb, succulent
LAMIACEAE	*Plectranthus neochilus Schltr.*	LC	Herb, succulent
LAMIACEAE	*Pycnostachys reticulata (E.Mey.) Benth.*	LC	Herb
LAMIACEAE	*Rotheca hirsuta (Hochst.) R.Fern.*	LC	Herb
LAMIACEAE	*Rotheca louwalbertsii (P.P.J.Herman) P.P.J.Herman & Retief*	LC	Herb
LAMIACEAE	*Salvia coccinea Etl.*	NE	Herb
LAMIACEAE	*Salvia runcinata L.f.*	LC	Herb
LAMIACEAE	*Salvia tiliifolia Vahl*	NE	Herb
LAMIACEAE	*Stachys caffra E.Mey. ex Benth.*	LC	Shrub
LAMIACEAE	*Stachys natalensis Hochst. var. galpinii (Briq.) Codd*	LC	Herb
LAMIACEAE	*Teucrium trifidum Retz.*	LC	Herb
LEMNACEAE	*Spirodela punctata (G.Mey.) C.H.Thomps.*	LC	Herb, hydrophyte, pleustophyte
LENTIBULARIACEAE	*Utricularia stellaris L.f.*	LC	Carnivore, herb, pleustophyte

Family	Species	Threat status	Growth forms
LINACEAE	*Linum thunbergii Eckl. & Zeyh.*	LC	Herb
LOBELIACEAE	*Lobelia erinus L.*	LC	Herb
LOBELIACEAE	*Monopsis decipiens (Sond.) Thulin*	LC	Herb
LYTHRACEAE	*Galpinia transvaalica N.E.Br.*	LC	Shrub, tree
MALPIGHIACEAE	*Sphedamnocarpus pruriens (A.Juss.) Szyszyl. subsp. galphimiifolius (A.Juss.) P.D.de Villiers & D.J.Botha*	LC	Climber, shrub
MALPIGHIACEAE	*Sphedamnocarpus pruriens (A.Juss.) Szyszyl. subsp. pruriens*	LC	Climber, shrub
MALPIGHIACEAE	*Triaspis hypericoides (DC.) Burch. subsp. nelsonii (Oliv.) Immelman*	LC	Climber, shrub
MALVACEAE	*Anoda cristata (L.) Schltdl.*	NE	Dwarf shrub, herb
MALVACEAE	*Corchorus asplenifolius Burch.*	LC	Herb
MALVACEAE	*Corchorus confusus Wild*	LC	Herb
MALVACEAE	*Dombeya rotundifolia (Hochst.) Planch. var. rotundifolia*	LC	Shrub, tree
MALVACEAE	*Grewia flava DC.*	LC	Shrub
MALVACEAE	*Grewia occidentalis L. var. occidentalis*	LC	Shrub, tree
MALVACEAE	*Hermannia boraginiflora Hook.*	LC	Dwarf shrub
MALVACEAE	*Hermannia burkei Burtt Davy*	LC	Climber, herb
MALVACEAE	*Hermannia cordata (E.Mey. ex E.Phillips) De Winter*	LC	Herb
MALVACEAE	*Hermannia depressa N.E.Br.*	LC	Herb
MALVACEAE	*Hermannia grandistipula (Buchinger ex Hochst.) K.Schum.*	LC	Herb
MALVACEAE	*Hermannia lancifolia Szyszyl.*	LC	Herb
MALVACEAE	*Hibiscus aethiopicus L. var. ovatus Harv.*	LC	Herb
MALVACEAE	*Hibiscus calyphyllus Cav.*	LC	Dwarf shrub, herb
MALVACEAE	*Hibiscus microcarpus Garcke*	LC	Herb
MALVACEAE	*Hibiscus pedunculatus L.f.*	LC	Herb
MALVACEAE	*Hibiscus trionum L.*	NE	Herb
MALVACEAE	*Malva parviflora L. var. parviflora*	NE	Herb
MALVACEAE	*Malvastrum coromandelianum (L.) Garcke*	NE	Dwarf shrub
MALVACEAE	*Modiola caroliniana (L.) G.Don*	NE	Herb
MALVACEAE	*Pavonia burchellii (DC.) R.A.Dyer*	LC	Dwarf shrub
MALVACEAE	*Sida chrysantha Ulbr.*	LC	Dwarf shrub
MALVACEAE	*Sida cordifolia L. subsp. cordifolia*	LC	Dwarf shrub
MALVACEAE	*Sida dregei Burtt Davy*	LC	Dwarf shrub, herb
MALVACEAE	*Sida rhombifolia L. subsp. rhombifolia*	LC	Dwarf shrub, herb, shrub
MALVACEAE	*Sida ternata L.f.*	LC	Herb
MALVACEAE	*Triumfetta rhomboidea Jacq. var. rhomboidea*	LC	Herb, shrub
MALVACEAE	*Triumfetta sonderi Ficalho & Hiern*	LC	Dwarf shrub
MALVACEAE	*Waltheria indica L.*	LC	Herb
MARCHANTIACEAE	*Marchantia debilis K.I.Goebel*		Bryophyte
MELASTOMATACEAE	*Antherotoma debilis (Sond.) Jacq.-Fél.*	LC	Herb
MENISPERMACEAE	*Antizoma angustifolia (Burch.) Miers ex Harv.*	LC	Climber
MENISPERMACEAE	*Cissampelos torulosa E.Mey. ex Harv.*	LC	Climber

Family	Species	Threat status	Growth forms
MESEMBRYANTHEMACEAE	*Aptenia cordifolia (L.f.) Schwantes*	LC	Succulent
MESEMBRYANTHEMACEAE	*Lithops lesliei (N.E.Br.) N.E.Br. subsp. lesliei*	NT	Succulent
MOLLUGINACEAE	*Limeum viscosum (J.Gay) Fenzl subsp. transvaalense Friedrich*	LC	Herb
MOLLUGINACEAE	*Mollugo cerviana (L.) Ser. ex DC. var. cerviana*	LC	Herb
MOLLUGINACEAE	*Psammotropha mucronata (Thunb.) Fenzl var. foliosa Adamson*	LC	Herb
MOLLUGINACEAE	*Psammotropha myriantha Sond.*	LC	Herb
MORACEAE	*Ficus ingens (Miq.) Miq.*	LC	Tree
MORACEAE	*Ficus salicifolia Vahl*	LC	Tree
MYRTACEAE	*Syzygium cordatum Hochst. ex C.Krauss subsp. cordatum*	LC	Shrub, tree
NYMPHAEACEAE	*Nymphaea nouchali Burm.f. var. caerulea (Savigny) Verdc.*	LC	Epihydate, herb, hydrophyte
OCHNACEAE	*Ochna pulchra Hook.f.*	LC	Shrub, tree
OLEACEAE	*Ligustrum japonicum Thunb.*	NE	Shrub
OLEACEAE	*Ligustrum sinense Lour.*	NE	Shrub, tree
OLEACEAE	*Menodora africana Hook.*	LC	Dwarf shrub, herb
OLEACEAE	*Olea europaea L. subsp. africana (Mill.) P.S.Green*	LC	Shrub, tree
OLINIACEAE	*Olinia emarginata Burtt Davy*	LC	Tree
ONAGRACEAE	*Epilobium hirsutum L.*	LC	Herb
ONAGRACEAE	*Epilobium tetragonum L. subsp. tetragonum*	LC	Herb
ONAGRACEAE	*Oenothera rosea L'Hér. ex Aiton*	NE	Herb
ONAGRACEAE	*Oenothera tetraptera Cav.*	NE	Herb
OPHIOGLOSSACEAE	*Ophioglossum polyphyllum A.Braun*	LC	Geophyte, herb
ORCHIDACEAE	*Bonatea antennifera Rolfe*	LC	
ORCHIDACEAE	*Brachycorythis conica (Summerh.) Summerh. subsp. transvaalensis Summerh.*	EN	Geophyte, herb
ORCHIDACEAE	*Brachycorythis ovata Lindl. subsp. ovata*	LC	Geophyte, herb
ORCHIDACEAE	*Brachycorythis pubescens Harv.*	LC	Geophyte, herb
ORCHIDACEAE	*Brachycorythis tenuior Rchb.f.*	LC	Geophyte, herb
ORCHIDACEAE	*Disperis micrantha Lindl.*	LC	Geophyte, herb
ORCHIDACEAE	*Eulophia clitellifera (Rchb.f.) Bolus*	LC	Geophyte, herb, succulent
ORCHIDACEAE	*Eulophia hians Spreng. var. hians*	LC	Geophyte, herb
ORCHIDACEAE	*Eulophia hians Spreng. var. nutans (Sond.) S.Thomas*	LC	Geophyte, herb
ORCHIDACEAE	*Eulophia leontoglossa Rchb.f.*	LC	Geophyte, herb
ORCHIDACEAE	*Eulophia ovalis Lindl. var. bainesii (Rolfe) P.J.Cribb & la Croix*	LC	Geophyte, herb
ORCHIDACEAE	*Eulophia ovalis Lindl. var. ovalis*	LC	Geophyte, herb
ORCHIDACEAE	*Eulophia tuberculata Bolus*	LC	Geophyte, herb, succulent
ORCHIDACEAE	*Eulophia welwitschii (Rchb.f.) Rolfe*	LC	Geophyte, herb
ORCHIDACEAE	*Habenaria barbertoni Kraenzl. & Schltr.*	NT	Geophyte, herb
ORCHIDACEAE	*Habenaria dregeana Lindl.*	LC	Geophyte, herb
ORCHIDACEAE	*Habenaria epipactidea Rchb.f.*	LC	Geophyte, herb
ORCHIDACEAE	*Habenaria falcicornis (Burch. ex Lindl.) Bolus subsp. caffra (Schltr.) J.C.Manning*	LC	Geophyte, herb

Family	Species	Threat status	Growth forms
ORCHIDACEAE	*Habenaria kraenzliniana Schltr.*	NT	Geophyte, herb
ORCHIDACEAE	*Habenaria mossii (G.Will.) J.C.Manning*	EN	Geophyte, herb
ORCHIDACEAE	*Habenaria nyikana Rchb.f. subsp. nyikana*	LC	Geophyte, herb
ORCHIDACEAE	*Habenaria schimperiana Hochst. ex A.Rich.*	LC	Geophyte, herb
ORCHIDACEAE	*Holothrix randii Rendle*	NT	Geophyte, herb
ORCHIDACEAE	*Satyrium hallackii Bolus subsp. ocellatum (Bolus) A.V.Hall*	LC	Geophyte, herb
OROBANCHACEAE	*Alectra orobanchoides Benth.*	LC	
OROBANCHACEAE	*Alectra sessiliflora (Vahl) Kuntze var. sessiliflora*	LC	Herb, parasite
OROBANCHACEAE	*Cycnium adonense E.Mey. ex Benth.*	LC	Herb, parasite
OROBANCHACEAE	*Cycnium tubulosum (L.f.) Engl. subsp. tubulosum*	LC	Herb
OROBANCHACEAE	*Graderia subintegra Mast.*	LC	Herb, parasite, suffrutex
OROBANCHACEAE	*Striga asiatica (L.) Kuntze*	LC	Herb, parasite
OROBANCHACEAE	*Striga bilabiata (Thunb.) Kuntze subsp. bilabiata*	LC	Herb, parasite
OROBANCHACEAE	*Striga elegans Benth.*	LC	Herb, parasite
OXALIDACEAE	*Oxalis obliquifolia Steud. ex A.Rich.*	LC	Geophyte
PAPAVERACEAE	*Papaver aculeatum Thunb.*	LC	Herb
PASSIFLORACEAE	*Adenia digitata (Harv.) Engl.*	LC	Climber, dwarf shrub, shrub, succulent
PASSIFLORACEAE	*Passiflora coerulea L.*	NE	Climber
PEDALIACEAE	*Harpagophytum zeyheri Decne. subsp. zeyheri*	LC	Herb
PHYLLANTHACEAE	*Phyllanthus incurvus Thunb.*	LC	Dwarf shrub, herb
PHYLLANTHACEAE	*Phyllanthus parvulus Sond. var. parvulus*	LC	Dwarf shrub, herb
PHYTOLACCACEAE	*Phytolacca octandra L.*	NE	Herb, succulent
PITTOSPORACEAE	*Pittosporum viridiflorum Sims*	LC	Shrub, tree
PLANTAGINACEAE	*Plantago lanceolata L.*	LC	Herb
PLANTAGINACEAE	*Plantago longissima Decne.*	LC	Herb
PLANTAGINACEAE	*Plantago major L.*	NE	Herb
POACEAE	*Agrostis eriantha Hack. var. eriantha*	LC	Graminoid
POACEAE	*Agrostis eriantha Hack. var. planifolia Gooss. & Papendorf*	DDT	Graminoid
POACEAE	*Agrostis lachnantha Nees var. lachnantha*	LC	Graminoid
POACEAE	*Alloteropsis semialata (R.Br.) Hitchc. subsp. eckloniana (Nees) Gibbs Russ.*	LC	Graminoid
POACEAE	*Alloteropsis semialata (R.Br.) Hitchc. subsp. semialata*	LC	Graminoid
POACEAE	*Andropogon appendiculatus Nees*	LC	Graminoid
POACEAE	*Andropogon chinensis (Nees) Merr.*	LC	Graminoid
POACEAE	*Andropogon schirensis Hochst. ex A.Rich.*	LC	Graminoid
POACEAE	*Anthephora pubescens Nees*	LC	Graminoid
POACEAE	*Aristida adscensionis L.*	LC	Graminoid
POACEAE	*Aristida canescens Henrard subsp. canescens*	LC	Graminoid
POACEAE	*Aristida congesta Roem. & Schult. subsp. barbicollis (Trin. & Rupr.) De Winter*	LC	Graminoid

Family	Species	Threat status	Growth forms
POACEAE	*Aristida congesta Roem. & Schult. subsp. congesta*	LC	Graminoid
POACEAE	*Aristida diffusa Trin. subsp. burkei (Stapf) Melderis*	LC	Graminoid
POACEAE	*Aristida scabrivalvis Hack. subsp. scabrivalvis*	LC	Graminoid
POACEAE	*Aristida stipitata Hack. subsp. graciliflora (Pilg.) Melderis*	LC	Graminoid
POACEAE	*Aristida transvaalensis Henrard*	LC	Graminoid
POACEAE	*Arundinella nepalensis Trin.*	LC	Graminoid
POACEAE	*Bewsia biflora (Hack.) Gooss.*	LC	Graminoid
POACEAE	*Brachiaria brizantha (A.Rich.) Stapf*	LC	Graminoid
POACEAE	*Brachiaria eruciformis (Sm.) Griseb.*	LC	Graminoid
POACEAE	*Brachiaria serrata (Thunb.) Stapf*	LC	Graminoid
POACEAE	*Bromus catharticus Vahl*	NE	Graminoid
POACEAE	*Bromus leptoclados Nees*	LC	Graminoid
POACEAE	*Calamagrostis epigejos (L.) Roth var. capensis Stapf*	LC	Graminoid
POACEAE	*Cenchrus ciliaris L.*	LC	Graminoid
POACEAE	*Chloris pycnothrix Trin.*	LC	Graminoid
POACEAE	*Chloris virgata Sw.*	LC	Graminoid
POACEAE	*Cymbopogon pospischilii (K.Schum.) C.E.Hubb.*	NE	Graminoid
POACEAE	*Cynodon dactylon (L.) Pers.*	LC	Graminoid
POACEAE	*Dichanthium aristatum (Poir.) C.E.Hubb.*	NE	Graminoid
POACEAE	*Digitaria argyrograpta (Nees) Stapf*	LC	Graminoid
POACEAE	*Digitaria debilis (Desf.) Willd.*	LC	Graminoid
POACEAE	*Digitaria diagonalis (Nees) Stapf var. diagonalis*	LC	Graminoid
POACEAE	*Digitaria didactyla Willd.*	NE	Graminoid
POACEAE	*Digitaria eriantha Steud.*	LC	Graminoid
POACEAE	*Digitaria eylesii C.E.Hubb.*	LC	Graminoid
POACEAE	*Digitaria monodactyla (Nees) Stapf*	LC	Graminoid
POACEAE	*Digitaria ternata (A.Rich.) Stapf*	LC	Graminoid
POACEAE	*Digitaria tricholaenoides Stapf*	LC	Graminoid
POACEAE	*Diheteropogon amplectens (Nees) Clayton var. amplectens*	LC	Graminoid
POACEAE	*Ehrharta erecta Lam. var. erecta*	LC	Graminoid
POACEAE	*Elionurus muticus (Spreng.) Kunth*	LC	Graminoid
POACEAE	*Enneapogon cenchroides (Licht. ex Roem. & Schult.) C.E.Hubb.*	LC	Graminoid
POACEAE	*Enneapogon scoparius Stapf*	LC	Graminoid
POACEAE	*Eragrostis capensis (Thunb.) Trin.*	LC	Graminoid
POACEAE	*Eragrostis chloromelas Steud.*	LC	Graminoid
POACEAE	*Eragrostis cilianensis (All.) Vignolo ex Janch.*	LC	Graminoid
POACEAE	*Eragrostis curvula (Schrad.) Nees*	LC	Graminoid
POACEAE	*Eragrostis gummiflua Nees*	LC	Graminoid
POACEAE	*Eragrostis heteromera Stapf*	LC	Graminoid
POACEAE	*Eragrostis inamoena K.Schum.*	LC	Graminoid

Family	Species	Threat status	Growth forms
POACEAE	*Eragrostis patentipilosa Hack.*	LC	Graminoid
POACEAE	*Eragrostis plana Nees*	LC	Graminoid
POACEAE	*Eragrostis planiculmis Nees*	LC	Graminoid
POACEAE	*Eragrostis racemosa (Thunb.) Steud.*	LC	Graminoid
POACEAE	*Eustachys paspaloides (Vahl) Lanza & Mattei*	LC	Graminoid
POACEAE	*Festuca arundinacea Schreb.*	NE	Graminoid
POACEAE	*Harpochloa falx (L.f.) Kuntze*	LC	Graminoid
POACEAE	*Helictotrichon turgidulum (Stapf) Schweick.*	LC	Graminoid
POACEAE	*Hemarthria altissima (Poir.) Stapf & C.E.Hubb.*	LC	Graminoid
POACEAE	*Heteropogon contortus (L.) Roem. & Schult.*	LC	Graminoid
POACEAE	*Hyparrhenia anamesa Clayton*	LC	Graminoid
POACEAE	*Hyparrhenia cymbaria (L.) Stapf*	LC	Graminoid
POACEAE	*Hyparrhenia dregeana (Nees) Stapf ex Stent*	LC	Graminoid
POACEAE	*Hyparrhenia filipendula (Hochst.) Stapf var. pilosa (Hochst.) Stapf*	LC	Graminoid
POACEAE	*Hyparrhenia hirta (L.) Stapf*	LC	Graminoid
POACEAE	*Hyparrhenia quarrei Robyns*	LC	Graminoid
POACEAE	*Hyparrhenia tamba (Steud.) Stapf*	LC	Graminoid
POACEAE	*Imperata cylindrica (L.) Raeusch.*	LC	Graminoid
POACEAE	*Koeleria capensis (Steud.) Nees*	LC	Graminoid
POACEAE	*Leersia hexandra Sw.*	LC	Graminoid
POACEAE	*Lolium multiflorum Lam.*	NE	Graminoid
POACEAE	*Lolium temulentum L.*	NE	Graminoid
POACEAE	*Loudetia flavida (Stapf) C.E.Hubb.*	LC	Graminoid
POACEAE	*Loudetia simplex (Nees) C.E.Hubb.*	LC	Graminoid
POACEAE	*Melinis nerviglumis (Franch.) Zizka*	LC	Graminoid
POACEAE	*Melinis repens (Willd.) Zizka subsp. repens*	LC	Graminoid
POACEAE	*Microchloa caffra Nees*	LC	Graminoid
POACEAE	*Microchloa kunthii Desv.*	LC	Graminoid
POACEAE	*Monocymbium ceresiiforme (Nees) Stapf*	LC	Graminoid
POACEAE	*Panicum maximum Jacq.*	LC	Graminoid
POACEAE	*Panicum miliaceum L.*	NE	Graminoid
POACEAE	*Panicum natalense Hochst.*	LC	Graminoid
POACEAE	*Panicum repentellum Napper*	LC	Graminoid
POACEAE	*Panicum schinzii Hack.*	LC	Graminoid
POACEAE	*Panicum stapfianum Fourc.*	LC	Graminoid
POACEAE	*Paspalum dilatatum Poir.*	NE	Graminoid
POACEAE	*Paspalum distichum L.*	LC	Graminoid
POACEAE	*Paspalum notatum Flüggé*	NE	Graminoid
POACEAE	*Paspalum scrobiculatum L.*	LC	Graminoid
POACEAE	*Pennisetum thunbergii Kunth*	LC	Graminoid
POACEAE	*Pennisetum villosum R.Br. ex Fresen.*	NE	Graminoid
POACEAE	*Poa annua L.*	NE	Graminoid
POACEAE	*Poa pratensis L.*	NE	Graminoid

Family	Species	Threat status	Growth forms
POACEAE	*Pogonarthria squarrosa (Roem. & Schult.) Pilg.*	LC	Graminoid
POACEAE	*Sacciolepis typhura (Stapf) Stapf*	LC	Graminoid
POACEAE	*Schizachyrium sanguineum (Retz.) Alston*	LC	Graminoid
POACEAE	*Setaria lindenbergiana (Nees) Stapf*	LC	Graminoid
POACEAE	*Setaria megaphylla (Steud.) T.Durand & Schinz*	LC	Graminoid
POACEAE	*Setaria nigrirostris (Nees) T.Durand & Schinz*	LC	Graminoid
POACEAE	*Setaria plicatilis (Hochst.) Hack. ex Engl.*	LC	Graminoid
POACEAE	*Setaria pumila (Poir.) Roem. & Schult.*	LC	Graminoid
POACEAE	*Setaria sphacelata (Schumach.) Stapf & C.E.Hubb. ex M.B.Moss var. sphacelata*	LC	Graminoid
POACEAE	*Setaria sphacelata (Schumach.) Stapf & C.E.Hubb. ex M.B.Moss var. torta (Stapf) Clayton*	LC	Graminoid
POACEAE	*Sorghum bicolor (L.) Moench subsp. arundinaceum (Desv.) de Wet & Harlan*	LC	Graminoid
POACEAE	*Sorghum halepense (L.) Pers.*	NE	Graminoid
POACEAE	*Sorghum versicolor Andersson*	LC	Graminoid
POACEAE	*Sporobolus africanus (Poir.) Robyns & Tournay*	LC	Graminoid
POACEAE	*Sporobolus discosporus Nees*	LC	Graminoid
POACEAE	*Sporobolus fimbriatus (Trin.) Nees*	LC	Graminoid
POACEAE	*Sporobolus natalensis (Steud.) T.Durand & Schinz*	LC	Graminoid
POACEAE	*Sporobolus nitens Stent*	LC	Graminoid
POACEAE	*Sporobolus stapfianus Gand.*	LC	Graminoid
POACEAE	*Stipagrostis uniplumis (Licht.) De Winter var. neesii (Trin. & Rupr.) De Winter*	LC	Graminoid
POACEAE	*Stipagrostis zeyheri (Nees) De Winter subsp. sericans (Hack.) De Winter*	LC	Graminoid
POACEAE	*Themeda triandra Forssk.*	LC	Graminoid
POACEAE	*Trachypogon spicatus (L.f.) Kuntze*	LC	Graminoid
POACEAE	*Tragus berteronianus Schult.*	LC	Graminoid
POACEAE	*Tripogon minimus (A.Rich.) Steud.*	LC	Graminoid
POACEAE	*Triraphis andropogonoides (Steud.) E.Phillips*	LC	Graminoid
POACEAE	*Tristachya biseriata Stapf*	LC	Graminoid
POACEAE	*Tristachya rehmannii Hack.*	LC	Graminoid
POACEAE	*Urelytrum agropyroides (Hack.) Hack.*	LC	Graminoid
POACEAE	*Urochloa brachyura (Hack.) Stapf*	LC	Graminoid
POACEAE	*Urochloa mosambicensis (Hack.) Dandy*	LC	Graminoid
POACEAE	*Urochloa panicoides P.Beauv.*	NE	Graminoid
POLYGALACEAE	*Polygala amatymbica Eckl. & Zeyh.*	LC	Herb
POLYGALACEAE	*Polygala gracilenta Burtt Davy*	LC	Herb
POLYGALACEAE	*Polygala hottentotta C.Presl*	LC	Dwarf shrub, herb
POLYGALACEAE	*Polygala houtboshiana Chodat*	LC	Herb
POLYGALACEAE	*Polygala krumanina Burch. ex Ficalho & Hiern*	LC	Shrub
POLYGALACEAE	*Polygala myrtifolia L. var. myrtifolia*	LC	Shrub
POLYGALACEAE	*Polygala rehmannii Chodat*	LC	Herb

Family	Species	Threat status	Growth forms
POLYGALACEAE	*Polygala transvaalensis Chodat subsp. transvaalensis*	LC	Herb
POLYGALACEAE	*Polygala uncinata E.Mey. ex Meisn.*	LC	Dwarf shrub, herb
POLYGONACEAE	*Persicaria attenuata (R.Br.) Soják subsp. africana K.L.Wilson*	LC	Helophyte, herb, hydrophyte
POLYGONACEAE	*Persicaria decipiens (R.Br.) K.L.Wilson*	LC	Helophyte, herb
POLYGONACEAE	*Persicaria lapathifolia (L.) Gray*	NE	Helophyte, herb, hydrophyte
POLYGONACEAE	*Persicaria limbata (Meisn.) H.Hara*	NE	Helophyte, herb
POLYGONACEAE	*Rumex acetosella L. subsp. angiocarpus (Murb.) Murb.*	NE	Herb
POLYGONACEAE	*Rumex conglomeratus Murb.*	LC	Herb
POLYGONACEAE	*Rumex crispus L.*	NE	Herb
POLYGONACEAE	*Rumex lanceolatus Thunb.*	LC	Herb
POLYGONACEAE	*Rumex sagittatus Thunb.*	LC	Climber, herb
POLYGONACEAE	*Rumex woodii N.E.Br.*	LC	Herb
POLYPODIACEAE	*Pleopeltis macrocarpa (Bory ex Willd.) Kaulf.*	LC	Epiphyte, herb, lithophyte
PORTULACACEAE	*Talinum caffrum (Thunb.) Eckl. & Zeyh.*	LC	Dwarf shrub, herb, succulent
POTAMOGETONACEAE	*Potamogeton pusillus L.*	LC	Herb, hydrophyte
PRIMULACEAE	*Anagallis pumila Sw.*	NE	Herb
PROTEACEAE	*Protea caffra Meisn. subsp. caffra*	LC	Shrub, tree
PROTEACEAE	*Protea welwitschii Engl.*	LC	Dwarf shrub, shrub
PTERIDACEAE	*Adiantum capillus-veneris L.*	LC	Geophyte, herb, lithophyte
PTERIDACEAE	*Pteris cretica L.*	LC	Geophyte, herb, lithophyte
RANUNCULACEAE	*Clematis brachiata Thunb.*	LC	Climber
RANUNCULACEAE	*Ranunculus multifidus Forssk.*	NE	Herb
RHAMNACEAE	*Berchemia zeyheri (Sond.) Grubov*	LC	Tree
RHAMNACEAE	*Helinus integrifolius (Lam.) Kuntze*	LC	Climber, shrub
RHAMNACEAE	*Rhamnus prinoides L'Hér.*	LC	Shrub, tree
RHAMNACEAE	*Ziziphus mucronata Willd. subsp. mucronata*	LC	Shrub, tree
RHAMNACEAE	*Ziziphus zeyheriana Sond.*	LC	Dwarf shrub
RICCIACEAE	*Riccia atropurpurea Sim*		Bryophyte
RICCIACEAE	*Riccia congoana Steph.*		Bryophyte
RICCIACEAE	*Riccia okahandjana S.W.Arnell*		Bryophyte
RICCIACEAE	*Riccia volkii S.W.Arnell*		Bryophyte
ROSACEAE	*Agrimonia procera Wallr.*	LC	Herb
ROSACEAE	*Duchesnea indica (Andrews) Focke*	NE	Herb
RUBIACEAE	*Anthospermum rigidum Eckl. & Zeyh. subsp. rigidum*	LC	Dwarf shrub
RUBIACEAE	*Galium capense Thunb. subsp. capense*	LC	Herb
RUBIACEAE	*Galopina circaeoides Thunb.*	LC	Herb
RUBIACEAE	*Kohautia amatymbica Eckl. & Zeyh.*	LC	Herb
RUBIACEAE	*Kohautia caespitosa Schnizl. subsp. brachyloba (Sond.) D.Mantell*	LC	Herb
RUBIACEAE	*Kohautia virgata (Willd.) Bremek.*	LC	Herb
RUBIACEAE	*Oldenlandia herbacea (L.) Roxb. var. herbacea*	LC	Herb

Family	Species	Threat status	Growth forms
RUBIACEAE	*Pachystigma pygmaeum (Schltr.) Robyns*	LC	Dwarf shrub
RUBIACEAE	*Pavetta gardeniifolia A.Rich. var. gardeniifolia*	LC	Shrub, tree
RUBIACEAE	*Pentanisia angustifolia (Hochst.) Hochst.*	LC	Herb
RUBIACEAE	*Pentanisia prunelloides (Klotzsch ex Eckl. & Zeyh.) Walp. subsp. prunelloides*	LC	Herb
RUBIACEAE	*Pygmaeothamnus zeyheri (Sond.) Robyns var. zeyheri*	LC	Dwarf shrub
RUBIACEAE	*Richardia brasiliensis Gomes*	NE	Herb
RUBIACEAE	*Richardia scabra L.*	NE	Herb
RUBIACEAE	*Rothmannia capensis Thunb.*	LC	Tree
RUBIACEAE	*Vangueria infausta Burch. subsp. infausta*	LC	Tree
RUBIACEAE	*Vangueria parvifolia Sond.*		Tree
RUTACEAE	*Zanthoxylum capense (Thunb.) Harv.*	LC	Shrub, tree
SALICACEAE	*Dovyalis zeyheri (Sond.) Warb.*	LC	Shrub, tree
SALICACEAE	*Salix babylonica L. var. babylonica*	NE	Tree
SALICACEAE	*Salix mucronata Thunb. subsp. woodii (Seemen) Immelman*	LC	Tree
SALICACEAE	*Scolopia zeyheri (Nees) Harv.*	LC	Shrub, tree
SANTALACEAE	*Thesium costatum A.W.Hill var. juniperinum A.W.Hill*	LC	Herb, parasite
SANTALACEAE	*Thesium magalismontanum Sond.*	LC	Herb, parasite, shrub
SANTALACEAE	*Thesium spartioides A.W.Hill*	LC	Herb, parasite
SANTALACEAE	*Thesium transvaalense Schltr.*	LC	Dwarf shrub, herb, parasite
SANTALACEAE	*Thesium utile A.W.Hill*	LC	Herb, parasite
SAPINDACEAE	*Pappea capensis Eckl. & Zeyh.*	LC	Shrub, tree
SAPOTACEAE	*Englerophytum magalismontanum (Sond.) T.D.Penn.*	LC	Shrub, tree
SCROPHULARIACEAE	*Aptosimum indivisum Burch. ex Benth.*	LC	Dwarf shrub
SCROPHULARIACEAE	*Craterostigma plantagineum Hochst.*	LC	Herb, succulent
SCROPHULARIACEAE	*Freylinia tropica S.Moore*	Rare	Shrub
SCROPHULARIACEAE	*Halleria lucida L.*	LC	Shrub, tree
SCROPHULARIACEAE	*Jamesbrittenia burkeana (Benth.) Hilliard*	LC	Shrub, suffrutex
SCROPHULARIACEAE	*Melanospermum foliosum (Benth.) Hilliard*	LC	Herb
SCROPHULARIACEAE	*Mimulus gracilis R.Br.*	LC	Helophyte, herb, hydrophyte
SCROPHULARIACEAE	*Nemesia fruticans (Thunb.) Benth.*	LC	Dwarf shrub, suffrutex
SCROPHULARIACEAE	*Selago canescens L.f.*	LC	Dwarf shrub
SEMATOPHYLLACEAE	*Sematophyllum brachycarpum (Hampe) Broth.*		Bryophyte, epiphyte
SEMATOPHYLLACEAE	*Sematophyllum subpinnatum (Brid.) E.Britton*		Bryophyte, epiphyte
SINOPTERIDACEAE	*Cheilanthes dolomiticola (Schelpe) Schelpe & N.C.Anthony*	LC	Herb, lithophyte
SINOPTERIDACEAE	*Cheilanthes hirta Sw. var. hirta*	LC	Geophyte, herb, lithophyte
SINOPTERIDACEAE	*Cheilanthes involuta (Sw.) Schelpe & N.C.Anthony var. obscura (N.C.Anthony) N.C.Anthony*	LC	Geophyte, herb, lithophyte
SINOPTERIDACEAE	*Cheilanthes pentagona Schelpe & N.C.Anthony*	LC	Herb, lithophyte
SINOPTERIDACEAE	*Cheilanthes viridis (Forssk.) Sw. var. glauca (Sim) Schelpe & N.C.Anthony*	LC	Geophyte, herb, lithophyte

Family	Species	Threat status	Growth forms
SINOPTERIDACEAE	*Cheilanthes viridis (Forssk.) Sw. var. viridis*	LC	Geophyte, herb, lithophyte
SINOPTERIDACEAE	*Doryopteris concolor (Langsd. & Fisch.) Kuhn*	LC	Geophyte, herb
SINOPTERIDACEAE	*Pellaea calomelanos (Sw.) Link var. calomelanos*	LC	Geophyte, herb, lithophyte
SOLANACEAE	*Physalis viscosa L.*	NE	Herb
SOLANACEAE	*Solanum lichtensteinii Willd.*	LC	Dwarf shrub, shrub
SOLANACEAE	*Solanum nigrum L.*	NE	Herb
SOLANACEAE	*Solanum panduriforme E.Mey.*	LC	Dwarf shrub, herb, shrub
SOLANACEAE	*Solanum pseudocapsicum L.*	NE	Shrub
SOLANACEAE	*Solanum sisymbriifolium Lam.*	NE	Herb, shrub
SOLANACEAE	*Withania somnifera (L.) Dunal*	LC	Dwarf shrub, herb, shrub
STRYCHNACEAE	*Strychnos pungens Soler.*	LC	Shrub, tree
TELOSCHISTACEAE	*Caloplaca subunicolor (Nyl.) Zahlbr.*		Lichen
THELYPTERIDACEAE	*Thelypteris confluens (Thunb.) C.V.Morton*	LC	Geophyte, herb, hydrophyte
THYMELAEACEAE	*Gnidia caffra (Meisn.) Gilg*	LC	Dwarf shrub, shrub
THYMELAEACEAE	*Gnidia capitata L.f.*	LC	Dwarf shrub, shrub
THYMELAEACEAE	*Gnidia kraussiana Meisn. var. kraussiana*	LC	Dwarf shrub, shrub
THYMELAEACEAE	*Gnidia sericocephala (Meisn.) Gilg ex Engl.*	LC	Dwarf shrub, shrub
TYPHACEAE	*Typha capensis (Rohrb.) N.E.Br.*	LC	Herb, hydrophyte, hyperhydate
ULMACEAE	*Ulmus parvifolia Jacq.*	NE	Tree
ULMACEAE	*Ulmus procera Salisb.*	NE	Tree
VALERIANACEAE	*Valeriana capensis Thunb. var. capensis*	LC	Herb
VELLOZIACEAE	*Xerophyta retinervis Baker*	LC	Herb
VERBENACEAE	*Chascanum pinnatifidum (L.f.) E.Mey. var. pinnatifidum*	LC	Herb
VERBENACEAE	*Lantana camara L.*	NE	Shrub
VERBENACEAE	*Lantana rugosa Thunb.*	LC	Shrub
VERBENACEAE	*Lippia javanica (Burm.f.) Spreng.*	LC	Shrub
VERBENACEAE	*Lippia wilmsii H.Pearson*	LC	Shrub
VERBENACEAE	*Priva cordifolia (L.f.) Druce var. abyssinica (Jaub. & Spach) Moldenke*	LC	Herb
VERBENACEAE	*Priva meyeri Jaub. & Spach var. meyeri*	LC	Herb
VERBENACEAE	*Verbena bonariensis L.*	NE	Herb
VERBENACEAE	*Verbena brasiliensis Vell.*	NE	Herb
VISCACEAE	*Viscum rotundifolium L.f.*	LC	Parasite, shrub, succulent
VISCACEAE	*Viscum verrucosum Harv.*	LC	Parasite, shrub, succulent
VITACEAE	*Rhoicissus tridentata (L.f.) Wild & R.B.Drumm. subsp. tridentata*	NE	Shrub
XYRIDACEAE	*Xyris obscura N.E.Br.*	LC	Helophyte, herb, hydrophyte
ZYGOPHYLLACEAE	*Tribulus terrestris L.*	LC	Herb

APPENDIX B

Vegetation Index Score

Vegetation Index Score – Wetland Habitat Unit

1. *EVC=[[(EVC1+EVC2)/2]*

EVC 1 - Percentage natural vegetation cover:

Vegetation cover %	0%	1-5%	6-25%	26-50%	51-75%	76-100%
Site score						X
EVC 1 score	0	1	2	3	4	5

EVC2 - Total site disturbance score:

Disturbance score	0	Very Low	Low	Moderately	High	Very High
Site score				X		
EVC 2 score	5	4	3	2	1	0

2. *SI=(SI1+SI2+SI3+SI4)/4)*

	Trees (SI1)		Shrubs (SI2)		Forbs (SI3)		Grasses (SI4)	
Score:	Present State	Perceived Reference State	Present State	Perceived Reference State	Present State	Perceived Reference State	Present State	Perceived Reference State
Continuous								X
Clumped	X			X			X	
Scattered		X	X		X	X		
Sparse								

Present State (P/S) = Currently applicable for each habitat unit
Perceived Reference State (PRS) = If in pristine condition

Each SI score is determined with reference to the following scoring table of vegetation distribution for present state versus perceived reference state.

	Present state (P/S)			
Perceived Reference state (PRS)	Continuous	Clumped	Scattered	Sparse
Continuous	3	2	1	0
Clumped	2	3	2	1
Scattered	1	2	3	2
Sparse	0	1	2	3

3. *PVC=[(EVC)-((exotic x 0.7) + (bare ground x 0.3))*

Percentage vegetation cover (exotic):

	0%	1-5%	6-25%	26-50%	51-75%	76-100%
Vegetation cover %					X	
PVC Score	0	1	2	3	4	5

Percentage vegetation cover (bare ground):

Vegetation cover %	0%	1-5%	6-25%	26-50%	51-75%	76-100%
			X			
PVC Score	0	1	2	3	4	5

4. RIS

Extent of indigenous species recruitment	0	Very Low	Low	Moderate	High	Very High
				X		
RIS	**0**	**1**	**2**	**3**	**4**	**5**

VIS = [(EVC)+((SIxPVC)+(RIS))] =14

Vegetation Index Score – Rocky Outcrop Habitat Unit

1. *EVC=[[(EVC1+EVC2)/2]*

EVC 1 - Percentage natural vegetation cover:

Vegetation cover %	0%	1-5%	6-25%	26-50%	51-75%	76-100%
Site score				X		
EVC 1 score	0	1	2	3	4	5

EVC2 - Total site disturbance score:

Disturbance score	0	Very Low	Low	Moderately	High	Very High
Site score		X				
EVC 2 score	5	4	3	2	1	0

2. *SI=(SI1+SI2+SI3+SI4)/4)*

	Trees (SI1)		Shrubs (SI2)		Forbs (SI3)		Grasses (SI4)	
Score:	Present State	Perceived Reference State	Present State	Perceived Reference State	Present State	Perceived Reference State	Present State	Perceived Reference State
Continuous								
Clumped	X	X	X	X			X	X
Scattered					X	X		
Sparse								

Present State (P/S) = Currently applicable for each habitat unit
Perceived Reference State (PRS) = If in pristine condition

Each SI score is determined with reference to the following scoring table of vegetation distribution for present state versus perceived reference state.

	Present state (P/S)			
Perceived Reference state (PRS)	Continuous	Clumped	Scattered	Sparse
Continuous	3	2	1	0
Clumped	2	3	2	1
Scattered	1	2	3	2
Sparse	0	1	2	3

3. *PVC=[(EVC)-((exotic x 0.7) + (bare ground x 0.3))*

Percentage vegetation cover (exotic):

	0%	1-5%	6-25%	26-50%	51-75%	76-100%
Vegetation cover %			X			
PVC Score	0	1	2	3	4	5

Percentage vegetation cover (bare ground):

Vegetation cover %	0%	1-5%	6-25%	26-50%	51-75%	76-100%
			X			
PVC Score	0	1	2	3	4	5

4. RIS

Extent of indigenous species recruitment	0	Very Low	Low	Moderate	High	Very High
						X
RIS	**0**	**1**	**2**	**3**	**4**	**5**

VIS = [(EVC)+((SIxPVC)+(RIS)] = 20

Vegetation Index Score – Open Grassland Habitat Unit

1. *EVC=[[(EVC1+EVC2)/2]*

EVC 1 - Percentage natural vegetation cover:

Vegetation cover %	0%	1-5%	6-25%	26-50%	51-75%	76-100%
Site score						X
EVC 1 score	0	1	2	3	4	5

EVC2 - Total site disturbance score:

Disturbance score	0	Very Low	Low	Moderately	High	Very High
Site score				X		
EVC 2 score	5	4	3	2	1	0

2. *SI=(SI1+SI2+SI3+SI4)/4)*

	Trees (SI1)		Shrubs (SI2)		Forbs (SI3)		Grasses (SI4)	
Score:	Present State	Perceived Reference State	Present State	Perceived Reference State	Present State	Perceived Reference State	Present State	Perceived Reference State
Continuous							X	X
Clumped	X	X	X	X				
Scattered					X	X		
Sparse								

Present State (P/S) = Currently applicable for each habitat unit
Perceived Reference State (PRS) = If in pristine condition

Each SI score is determined with reference to the following scoring table of vegetation distribution for present state versus perceived reference state.

	Present state (P/S)			
Perceived Reference state (PRS)	Continuous	Clumped	Scattered	Sparse
Continuous	3	2	1	0
Clumped	2	3	2	1
Scattered	1	2	3	2
Sparse	0	1	2	3

3. *PVC=[(EVC)-((exotic x 0.7) + (bare ground x 0.3))*

Percentage vegetation cover (exotic):

	0%	1-5%	6-25%	26-50%	51-75%	76-100%
Vegetation cover %				X		
PVC Score	0	1	2	3	4	5

Percentage vegetation cover (bare ground):

Vegetation cover %	0%	1-5%	6-25%	26-50%	51-75%	76-100%
			X			
PVC Score	0	1	2	3	4	5

4. RIS

Extent of indigenous species recruitment	0	Very Low	Low	Moderate	High	Very High
					X	
RIS	**0**	**1**	**2**	**3**	**4**	**5**

VIS = [(EVC)+((SIxPVC)+(RIS))] = 15

The final VIS scores for each habitat unit are then categorised as follows:

Vegetation Index Score – Transformed Habitat Unit

1. *EVC=[[(EVC1+EVC2)/2]*

EVC 1 - Percentage natural vegetation cover:

Vegetation cover %	0%	1-5%	6-25%	26-50%	51-75%	76-100%
Site score					X	
EVC 1 score	0	1	2	3	4	5

EVC2 - Total site disturbance score:

Disturbance score	0	Very Low	Low	Moderately	High	Very High
Site score						X
EVC 2 score	5	4	3	2	1	0

2. *SI=(SI1+SI2+SI3+SI4)/4)*

	Trees (SI1)		Shrubs (SI2)		Forbs (SI3)		Grasses (SI4)	
Score:	Present State	Perceived Reference State	Present State	Perceived Reference State	Present State	Perceived Reference State	Present State	Perceived Reference State
Continuous								X
Clumped		X		X	X		X	
Scattered	X		X			X		
Sparse								

Present State (P/S) = Currently applicable for each habitat unit
Perceived Reference State (PRS) = If in pristine condition

Each SI score is determined with reference to the following scoring table of vegetation distribution for present state versus perceived reference state.

	Present state (P/S)			
Perceived Reference state (PRS)	Continuous	Clumped	Scattered	Sparse
Continuous	3	2	1	0
Clumped	2	3	2	1
Scattered	1	2	3	2
Sparse	0	1	2	3

3. *PVC=[(EVC)-((exotic x 0.7) + (bare ground x 0.3))*

Percentage vegetation cover (exotic):

	0%	1-5%	6-25%	26-50%	51-75%	76-100%
Vegetation cover %						X
PVC Score	0	1	2	3	4	5

Percentage vegetation cover (bare ground):

Vegetation cover %	0%	1-5%	6-25%	26-50%	51-75%	76-100%
			X			
PVC Score	0	1	2	3	4	5

4. RIS

Extent of indigenous species recruitment	0	Very Low	Low	Moderate	High	Very High
			X			
RIS	**0**	**1**	**2**	**3**	**4**	**5**

VIS = [(EVC)+((SIxPVC)+(RIS))] = 5

The final VIS scores for each habitat unit are then categorised as follows:

Vegetation Index Score	Assessment Class	Description
22 to 25	**A**	Unmodified, natural
18 to 22	**B**	Largely natural with few modifications.
14 to 18	**C**	Moderately modified
10 to 14	**D**	Largely modified
5 to 10	**E**	The loss of natural habitat extensive
<5	**F**	Modified completely

ECOLOGICAL AND WETLAND ASSESSMENT FOR THE PROPOSED DEVELOPMENT OF THE K56 ROAD, IN NORTHERN JOHANNESBURG, GAUTENG.

Prepared for

Bokomaso Landscape Architects and Environmental Consultants

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Section C: Faunal Assessment

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EXECUTIVE SUMMARY

- Yellow Mongoose (*Cynictis penicillata*) and Angoni Vlei Rat (*Otomys angoniensis*) were identified during the field survey. Other signs indicating the presence of small omnivorous predators found within the subject property such as Mole rat mounds (Genus; *Cryptomys*) and Cape Clawless Otter (*Aonyx capensis*) droppings. No other mammal species were noted possibly due to the close proximity to residential areas and the cryptic nature of most mamma species. Suitable habitat areas, such as natural rocky, woodland, grassland and wetland habitat areas were however identified in the subject property (See Section A). No GDARD and IUCN RDL threatened mammal species were observed on the subject property. It is unlikely that GDARD RDL or sensitive mammal species listed in Appendix 1 will utilise the site for habitation purposes due to the high level of urbanisation in the surrounding area. There is however a slight possibility that some mammal species, especially the RDL Bat species that are indicated in Appendix 1, may occur and utilise some points along the proposed subject property area as foraging and breeding sites, especially in the rocky outcrop habitat unit. No GDARD RDL listed bird species were noted during the site assessment. However since birds are mobile there is a good chance that some threatened bird species which occur in the GDARD RDL bird list may move through the area from time to time. The main reasons are due to the good natural rocky outcrop habitat unit as well as the wetland habitat unit (see Section A, Sensitivity Maps) which may be utilised as a migratory corridor especially during the breeding season by the Macco Duck (*Oxyura maccoa*) and African Finfoot (*Podica senegalensis*) and for feeding purposes by the African Marsh Harrier (*Circus ranivorus*), the Lesser Falcon (*Falco naumanni*) and the Lanner Falcon (*Falco biarmicus*). Thus by conserving the rocky outcrop and wetland habitat unit, the habitat of these species that have a high probability of occurrence could also be conserved.
- No RDL reptile species were encountered during the field assessment. Reptiles are notoriously difficult to detect, are well camouflaged and have good senses to hide from prey, thus making identification of reptiles difficult. The subject area does however, offer habitat for various reptile species within all the identified habitat units, however reptile species of concern, if present, will be restricted to areas with low levels of anthropogenic activities such the less disturbed rocky outcrop habitat units and wetland habitat units. Due to the good natural rocky habitat unit and wetland habitat unit found within the subject property, three threatened RDL reptile species listed by GDARD, namely the Blunt-tailed worm lizard (*Dalophia pistillum*), the Striped harlequin Snake (*Homoroselaps dorsalis*) and the Southern African Rock Python (*Python sebae natalensis*) were considered to have a high POC for their distribution range and there being a good food and habitat percentage along these good rocky habitat units in association with the wetland habitat unit.

- Only the Common platanna (*Xenopus laevis*) amphibian species was noted during the field assessment. The low taxon identified is potentially due to the late seasonal sight survey. Amphibian species life cycles have passed the breeding period and as the water table level drops amphibian species begin to submerge and envelop themselves underground for the dry winter months and only emerge when the rainy seasons reoccur. Amphibian species, which may potentially occur here, are common and widespread species, such species include the Plain Grass Frog *(Ptychadena anchietae),* Common River frog *(Afrana angolensis),* guttural toads (*Bufo gutturalis)* and the Common Caco *(Cacosternum boettgeri).* The only threatened amphibian species of concern in Gauteng is the Giant Bullfrogs (*Pyxicephalus adspersus)* GDARD (2004), Appendix 4. No Giant Bullfrogs (*Pyxicephalus adspersus)* were found in the vicinity of the subject property. However, the Giant Bullfrog (*Pyxicephalus adspersus),* a near threatened species, is known to occur near riparian and wetland zones where bullfrog habitat is optimal. This species distribution range is within the subject property. They remain in cocoons submerged underground, preferably sandy grounds and only emerge at the start of the rainy season. They breed in shallow waters and they can occupy temporary floodplains and rapidly drying pool areas. They are also known to travel vast distances and may also utilise the wetlands as migratory corridors through the local area. They are active during the day and are able to tolerate some of the harshest environments in Africa. They are carnivorous and eat a wide variety of foods. Thus due to the distribution range data, good food availability and there being suitable wetland habitat conditions within the subject property, the likelihood of this RDL species occurring in the subject property is considered highly significant.
- The invertebrate assessment conducted was a general assessment with the purpose of identifying the invertebrate community assemblage occurring within the subject property. No GDARD RDL invertebrate species were identified during the assessment and the probability of threatened invertebrate species occurring within the area is considered low.
- No evidence was encountered of the Mygalomorph arachnids (Trapdoor and Baboon spiders) and RDL scorpions within the subject property, although it should be noted that these species are notoriously difficult to detect, however, if they do occur within the area they would be found within the rocky habitat area. Mygalomorph arachnids are highly sensitive to habitat disturbance and environmental changes and are especially sensitive to vibration pollution since mygalomorph spiders and scorpions use vibration to detect and locate their prey. Within the rocky areas specific attention was paid with the identification of suitable habitat for spiders and scorpions. After thoroughly searching and rock turning no scorpions were found and no spider burrows were identified. Little distribution data is available for most of these spider and scorpion species.

- The RDSIS assessment of the property yielded a moderate to lower score of 34%, indicating a medium-low importance with regards to RDL faunal species conservation within the region. In terms of the proposed project, the highly sensitive wetland and rocky outcrop habitat unit should be conserved, to ensure that the migratory connectivity and habitat requirements for the above species are maintained and the proposed development will have very little impact on the faunal ecology within the subject property.

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Glossary of Terms & Acronyms

Alien vegetation – Plants that do not occur naturally within the area but have been introduced either intentionally or unintentionally.

Biome – A broad ecological unit representing major life zones of large natural areas – defined mainly by vegetation structure and climate.

Bush encroachment – A state where undesirable woody elements gain dominance within grassland, leading to depletion of the grass component. Typically due to disturbances and transformations as a consequence of veldt mismanagement (overgrazing, incorrect burning, etc.).

Decrease grass – Grass abundant in veldt in good condition, which decreases when veldt is under- or over-utilized.

°*C* – Degrees Celsius.

Endangered – Organisms in danger of extinction if causal factors continue to operate.

Endemic species – Species that are only found within a pre-defined area. There can therefore be sub-continental (e.g. southern Africa), national (South Africa), provincial, regional or even within a particular mountain range.

Exotic vegetation – Vegetation species that originate from outside of the borders of the biome - usually international in origin.

Ex situ conservation – Where a plant (or community) cannot be allowed to remain in its original habitat and is removed and cultivated to allow for its ongoing survival.

Extrinsic – Factors that have their origin outside of the system.

GDACE – Gauteng Department of Agriculture, Conservation and Environment

ha – Hectares.

Indigenous vegetation – Vegetation occurring naturally within a defined area.

Increaser 1 grass – Grass species that increase in density when veld is under-utilized.

Increaser 2 grass – Grass species that increase in density in over-utilized, trampled or disturbed veld.

Increaser 3 grass – Grass species that increase in density in over and under-utilized veld.

In situ conservation – Where a plant (or community) is allowed to remain in its natural habitat with an allocated buffer zone to allow for its ongoing survival.

Karoid vegetation – A shrub-type vegetation that dominates in grasslands that have seen historical disturbances. Mainly due to over-grazing and mismanaged burning regimes. The shrubby vegetation eventually becomes dominant and out-competes the grassy layer.

m – Metres.

mm – Millimetres.

MAMSL – Metres above mean sea level.

MAP – Mean annual precipitation.

MAPE – Mean annual potential for evaporation.

MASMS – Mean annual soil moisture stress.

MAT – Mean annual temperature.

Orange Listed – Species that are not Red Data Listed, but are under threat and at risk of becoming RDL in the near future. Usually allocated to species with conservation status of *Near Threatened (NT), Least Concern (LC), Rare* and *Data Deficient (DD)*.

PES – Present Ecological State.

POC – Probability of occurrence.

PRECIS – Pretoria Computer Information Systems.

Pioneer species – A plant species that is stimulated to grow after a disturbance has taken place. This is the first step in natural veld succession after a disturbance has taken place.

QDS – Quarter degree square (1:50,000 topographical mapping references).

Rare – Organisms with small populations at present.

RDL (Red Data listed) species – Organisms that fall into the *Extinct in the Wild (EW), critically endangered (CR), Endangered (EN), Vulnerable (VU)* categories of ecological status.

RDSIS – Red Data Sensitivity Index Score.

SANBI – South African National Biodiversity Institute.

Veld retrogression – The ongoing and worsening ecological integrity state of a veld.

1. INTRODUCTION

1.1 Background

Scientific Aquatic Services (SAS) was appointed to conduct terrestrial, wetland and aquatic ecological assessment on the route of the proposed development of the K56 road (Figure 1). The total length of the proposed road portion is approximately 7km and is situated to the northwest of Fourways on the Helderfontien estate grounds between Kyalami and Dainfern, Gauteng.

1.2 Desktop Study

Initially a desktop study was undertaken to gather background information regarding the site and its surrounding areas. All relevant authorities were consulted regarding conservational species lists, as well as all the latest available literature utilised to gain a thorough understanding of the area and its surrounding habitats. This information and further literature reviews were then used to determine the potential biodiversity lists for the proposed development site and surrounding areas. This information incorporated (amongst others) data on vegetation types, habitat suitability and biodiversity potential coupled to this information.

Two site visits were undertaken to determine the ecological status of the proposed development sites and the surrounding area (see Section A for site maps). A reconnaissance 'drive around' followed then by a thorough 'walk through' were undertaken to determine the general habitat types found throughout the study area and, following this, specific study sites or habitat regions were chosen that were representative of the habitats found within the area. Special emphasis was placed on potential areas that may support RDL faunal species. Sites were investigated on foot to identify the occurrence of the *dominant* communities, species and habitat diversities. The presence of any faunal inhabitants of the study area was also assessed through direct visual observation or identifying them through calls, tracks, scats and burrows, with emphasis being placed on determining if any RDL faunal species occur within the study area.

1.3 Scope

Specific outcomes in terms of this report are as follow:

Ecological Assessment:

- Red data species assessment, including potential for species to occur on the subject property and the application of the Red Data Sensitivity Index for the study area in order to define the importance of the subject property for the conservation of Red Data Listed Fauna;
- provide faunal inventories of species as encountered on site;
- determine and describe habitats, communities and ecological state of the study area; and
- describe the spatial significance of the subject property with regards to surrounding natural areas.

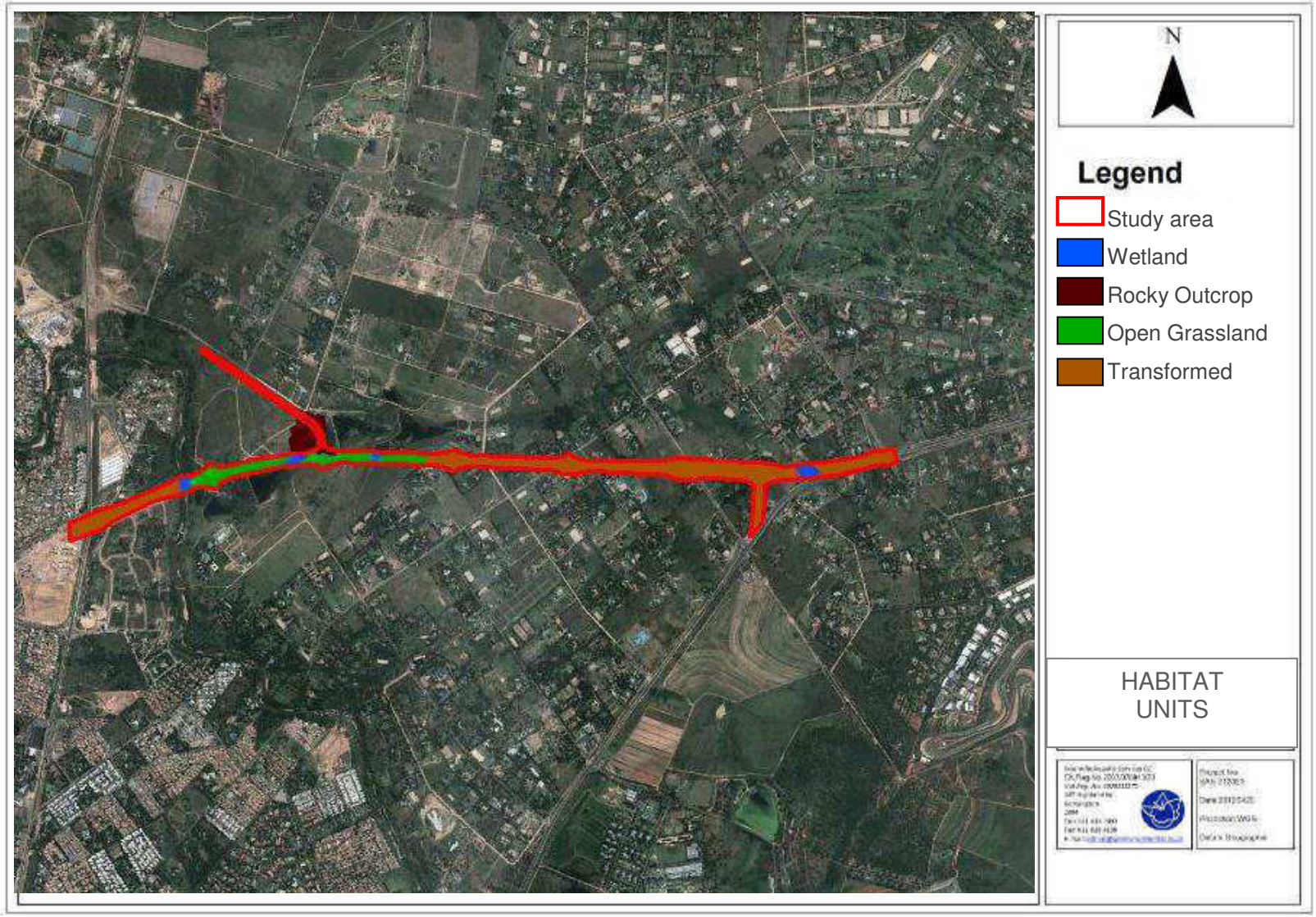


Figure 1: Subject property depicted on a digital Satellite Image.

2. METHODOLOGY

The faunal categories covered are: Mammals, Avifauna, Reptiles, Amphibians, Invertebrates, Spiders and Scorpions. It must be noted that studies undertaken on invertebrates were undertaken as a general survey although thorough searching and trapping techniques to capture both flying and ground dwelling taxa was undertaken.

Mammals

Small mammals are unlikely to be directly observed in the field because of their nocturnal/crepuscular and cryptic nature. A simple and effective solution to this problem is to use Sherman traps. A Sherman trap is a small aluminium box with a spring-loaded door. Once the animal is inside the trap, it steps on a small plate that causes the door to snap shut, thereby capturing the individual. Trapping took place within relatively undisturbed small mammal habitat identified throughout the study area. In the event of capturing a small mammal during the night, the animal would be photographed and then set free unharmed early the following morning. Traps were baited with a universal mixture of oats, peanut butter and syrup

Figure 2: Pictures of Sherman trap and bait.

Larger faunal species were recorded during the subject property assessment with the use of visual identification, spoor, call, dung and positively identification. It is important to note that due to the nature and habits of fauna, varied stages of life cycles, adverse weather or seasonal and temporal fluctuations along with other external factors, it is unlikely that all faunal species will have been recorded during the site assessment. In addition the levels of anthropogenic activity in the study area and surrounding area may determine whether species will be observed.

Birds

The Roberts (Roberts Multimedia Birds of Southern Africa) list for the quarter degree square (Appendix 1) was used to correlate with the recent field survey database of birds identified in the subject property. Recent field surveys where undertaken using a pair of Vespa 7x50 binoculars and bird call identification practices were utilised during the site visit.

Reptiles

Reptiles were physically identified whilst the field surveys were in progress in the area. Rocks were overturned and inspected. Abandoned termitaria were also inspected for reptiles dwelling within them.

Amphibians

Amphibians have been identified wherever encountered during the ongoing field surveys in the area. Amphibian species were recorded during the study area assessment with the use of direct visual identification along with other identification aids such as call identification. Amphibian species flourish in and around wetland and riparian areas. It is in these areas that specific attention was placed in searching for amphibian species. However, it is unlikely that all amphibian species will have been recorded during the site assessment, due to their cryptic nature and habits, varied stages of life cycles, weather conditions at the time of assessment or seasonal and temporal fluctuations along with other external factors.

Invertebrates as well as Arachnids and Scorpions

A list of visually identified and observed invertebrate species was compiled during the field surveys. Sweep nets were used to capture and identify invertebrate species. Insects were placed inside an emergence box enabling easy identification. An emergence box is a black plastic box which holds all invertebrate species captured. The box is sealed with a lid thus making the box dark. At one side of the box there is a hole there sunlight filters into the box. At this hole there is a transparent plastic container which contains 30% ethanol concentrate. The captured insects seek out the sunlight and are captured in the plastic container. This method ensures diverse and allows for comprehensive invertebrate collection.

Figure 3: Picture of emergence box. Spiders and Scorpions

Specific and most suitable habitat areas were searched. Rocks were over turned and searched for visual identification of Arachnids and Scorpions. Specific attention was aimed at searching for Mygalomorphae arachnids (Trapdoor and Baboon spiders) in the study area.

It is important to note that due to the nature and habits of fauna, varied stages of life cycles, adverse weather or seasonal and temporal fluctuations along with other external factors, it is unlikely that all faunal species will have been recorded during the site assessment. In addition the levels of anthropogenic activity in the study area and surrounding area may further influence whether species will be observed.

2.1 Faunal Red Data Sensitivity Index Score (RDSIS)

Given the restrictions of field assessments to identify all the faunal species that possibly occur on a particular property, the Red Data Sensitivity Index Score (RDSIS) has been developed to provide an indication of the potential red data faunal species that could reside in the area, while simultaneously providing a quantitative measure of the subject property's' value in terms of conserving faunal diversity. The RDSIS is based on the principles that when the knowledge of the specie's historical distribution is combined with a field assessment that identifies the degree to which the property supports a species habitat and food requirements, inferences can be made about the chances of that particular specie residing on the property. Repeating this procedure for all the potential red data faunal species of the area and collating this information

then provides a sensitivity measure of the property that has been investigated. The detailed methodology to determine the RDSIS of the property is presented below:

Probability of Occurrence (POC): Known distribution range (D), habitat suitability of the site (H) and availability of food sources (F) on site were determined for each of the species. Each of these variables is expressed a percentage (where 100% is a perfect score). The average of these scores provided a Probability of Occurrence (POC) score for each species. The POC value was categorised as follows:

- **0-20% = Low;**
- **21-40% = Low to Medium;**
- **41-60% = Medium;**
- **60-80% = Medium to High; and**
- **81-100% = High**

POC = (D+H+F)/3

Total Species Score (TSS): Species with POC of more than 60% (High-medium) were considered when applying the RDSIS. A weighting factor was assigned to the different IUCN categories providing species with a higher conservation status, a higher score. This weighting factor was then multiplied with the POC to calculate the total species score (TSS) for each species. The weighting as assigned to the various categories is as follows:

- **Data Deficient = 0.2;**
- **Rare = 0.5;**
- **Near Threatened = 0.7;**
- **Vulnerable = 1.2;**
- **Endangered = 1.7; and**
- **Critically Endangered = 2.0**.

TSS = (IUCN weighting*POC) where POC > 60%

Average Total Species (Ave TSS) and Threatened Taxa Score (Ave TT): The average of all TSS potentially occurring on the site is calculated. The average of all the Threatened taxa (TT) (*Near threatened*, *Vulnerable*, *Endangered* and *Critically Endangered)* TSS scores are also calculated. The average of these two scores (Ave

TSS and Ave TT) was then calculated in order to add more weight to threatened taxa with POC higher than 60%.

Ave = Ave TSS [TSS/No of Spp] + Ave TT [TT TSS/No of Spp]/2

Red Data Sensitivity Index Score (RDSIS): The average score obtained above and the sum of the percentage of species with a POC of 60% or higher of the total number of Red Data Listed species listed for the area was then calculated. The average of these two scores, expressed as a percentage, gives the RDSIS for the area investigated.

RDSIS = Ave + [Spp with POC>60%/Total no Of Spp*100]/2

RDSIS interpretation:

Table 1: RDSIS value interpretation with regards to RDL mammal importance on the subject property.

RDSIS Score	RDL mammal importance
0-20%	**Low**
21-40%	**Low-Medium**
41-60%	**Medium**
60-80%	**High-Medium**
81-100%	**High**

3. RESULTS OF FAUNAL INVESTIGATION

3.1 Surrounding properties/land uses and general habitat visual orientation

The greater area surrounding the subject property and proposed development route is located within a district primarily utilised for residential and recreational activities.

General faunal habitat visual indications	
	
Good natural rocky habitat areas within the subject property	**Good natural woodland vegetation providing good faunal habitat for foraging and shelter purposes**

Figure 4: Representative views of natural rocky and woodland habitat within the subject property.

General faunal habitat visual indications	
	
Dam, stream and wetland areas which provide habitat areas within the subject property	**Grassland vegetation providing good faunal habitat for foraging and habituation purposes**

Figure 5: Representative views of aquatic and grassland habitat within the subject property.

Subject area current usages (Recreational)	
	
Horse (Equu*s sp*) trails on subject property	**Mountain bike trails along dirt road network**

Figure 6: Evidential representative views of other land uses within the subject property.

In general there is good natural rocky outcrop and woodland habitat units along with good wetland units found within the subject property and are deemed to provide good faunal habitat for a diverse community of fauna. There habitat unit areas are visually displayed in Section A, Sensitivity Mapping.

The faunal assessment included field observations (visual identification, spoor, call or dung) in conjunction with an extensive literature referencing. This is done due to the fact that many faunal species are nocturnal and many species are shy and avoid human contact. Climatic conditions during the assessment were suitable to enable observations to occur. Mention must be made however that many faunal species possess migratory behaviour traits due to many uncontrollable variables such as habitat availability, food availability and water quality. These factors and the changing of the seasons play a significant role in the faunal species that may occur at any given time within the subject property. In addition the levels of anthropogenic activity in the subject property and surrounding area may determine whether species will be observed. A detailed discussion of the different faunal taxa follows in the sections below.

3.2 Mammals

A list of the updated Mammal Red Data list of Gauteng February 2011 according to GDARD threatened mammal species (GDARD SoER, 2004) is in Appendix 1 (personal communication with Lihle Dumalisile from GDARD).

Field sightings of Yellow Mongoose (*Cynictis penicillata*) and Angoni Vlei Rat (*Otomys angoniensis*) were made during the field survey. Other signs indicating the presence of small omnivorous predators found within the subject property were Mole rat mounds (Genus; *Cryptomys*), Cape Clawless Otter (*Aonyx capensis*) droppings and small rodents that are associated with domestic and urban areas and domestic waste products. No other mammal species were noted possibly due to the close proximity to residential areas and the cryptic nature of most mamma species. Suitable habitat areas, such as natural rocky, woodland, grassland and wetland habitat areas were however identified in the subject property (See Section A). These natural areas, especially the rocky outcrop and wetland areas are deemed to provide good intact habitat for many mammal species. The rocky outcrop and wetland areas were also the habitat units where nearly all evidence of the mammal species were encountered.

Baited Sherman traps were utilised to capture small mammals which may inhabit the subject property. Traps were placed in areas where suitable small mammal habitat was observed. One small mammal species was successfully trapped during the exercise, the Angoni Vlei Rat (*Otomys angoniensis*). The presence of raptors such as the Black-Shouldered Kite (*Elanus caeruleus*), Barn Owl (*Tyto alba*) and the Lanner Falcon (*Falco biarmicus*) as identified (See 3.2, Birds) indicates that a small mammal population is likely to be present in the vicinity of the subject property.

No GDARD and IUCN RDL threatened mammal species were found in the subject property. It is unlikely that these GDARD RDL or sensitive mammal species listed in Appendix 1 will utilise the site for habitation purposes due to the high level of urbanisation in the surrounding area. There is however a slight possibility that some mammal species, especially the RDL Bat species that are indicated in Appendix 1, may occur and utilise some points along the proposed subject property area as foraging and breeding sites, especially in the rocky outcrop habitat unit. Thus it is advised that a specific specialist bat survey study be conducted within the good rocky habitat unit to confirm whether or not there are RDL bats present within the subject property and the good natural rocky outcrop habitat unit.

Mammal sightings

Common Molerat (*Crytomys hottentotus*)

Angoni Vlei Rat (*Otomys angoniensis*)

Figure 7: Evidential representative views of common molerat and Angoni vlei rat within the subject property.

Mammal sightings

Horse (*Equus sp*)

Striped mouse (*Rhabdomys pumilio*)

Figure 8: Evidential representative views of horse and striped mouse within the subject property.

Mammal sightings

Yellow Mongoose (*Cynitis penicillata*)

Cape Clawless Otter (*Aonyx capensis*)

Figure 9: Evidential representative views of yellow mongoose and Cape clawless otter within the subject property.

3.3 Avifauna

The species of conservational interest to Gauteng, as noted by GDARD (2004), are presented in Appendix 2a. No GDARD RDL listed bird species were noted during the site assessment.

All bird species seen or heard during the time of the assessment were recorded. Surveys were conducted along the entire subject property and in the immediate surroundings.

The table below lists all the bird species identified during the assessment. The complete list of bird species expected for the QDS 2528CC (Roberts Multimedia Birds of Southern Africa) is included in Appendix 2b.

Table 2: Bird species recorded during the field survey.

Common Name	Scientific Name
Common Fiscal Shrike	*Lanius collaris*
Egyptian goose	*Alopochen aegyptiacus*
Cape Turtle Dove	*Streptopelia capicola*
Laughing dove	*Stigmatopelia senegalensis*
Dark Capped Bulbul	*Pycnonotus tricolor*
Sacred ibis	*Threskiornis aethiopicus*
Hadeda ibis	*Bostrychia hagedash*
Black Shouldered Kite	*Elanus caeruleus*
Reed Cormorant	*Phalacrocorax africanus*
African Black Duck	*Anas sparsa*
Black headed heron	*Ardea melanocephala*
White faced Duck	*Dendrocygna viduata*
Pied Kingfisher	*Ceryle rudis*
Malachite kingfisher	*Alcedo Cristata*
African Grey Hornbill	*Tockus nasutus*
Green (Redbilled) Wood Hoopoe	*Phoeniculus purpureus*
Grey Go Away Bird (Lourie)	*Corythaixoides concolor*
Little Sparrowhawk	*Accipiter minullus*
Swainson's Spurfowl (Francolin)	*Pternistes swainsonii*
Sabota Lark	*Calendulauda sabota*
Southern Masked Weaver	*Ploceus velatus*
Red-knobbed coot	*Fulicia cristata*
Blacksmith Plover	*Vanellus armatus*

Common Name	Scientific Name
Barn Owl	*Tyto alba*
Crowned Plover	*Vanellus coronatus*
Spotted dikkop	*Burhinus capensis*
Indian myna	*Acridotheres tristis*

However since birds are mobile there is a good chance that some threatened RDL bird species which occur in the GDARD RDL bird list may occur within the subject property. The main reasons are due to the good natural rocky outcrop habitat unit as well as the wetland habitat unit (see Section A, Sensitivity Maps) which may be utilised as a migratory corridor especially during the breeding season by the Macco Duck (*Oxyura maccoa*) and African Finfoot (*Podica senegalensis*) and for feeding purposes by the African Marsh Harrier (*Circus ranivorus*), the Lesser Falcon (*Falco naumanni*) and the Lanner Falcon (*Falco biarmicus*). Thus by conserving the rocky outcrop and wetland habitat unit, the habitat of these species that have a high probability of occurrence could also be conserved.

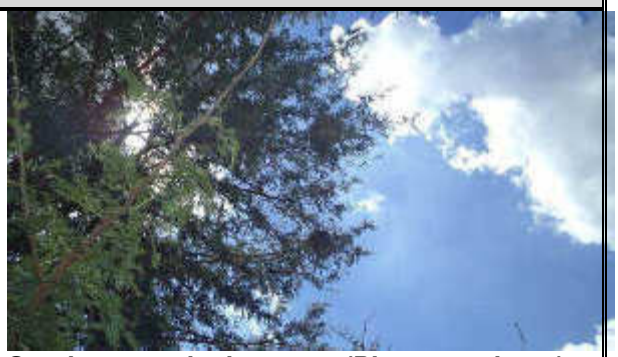
Table 3: Gauteng (GDARD) Bird species RDL avifauna species with a POC of more than 60%

Common name	Scientific name	GDARD status	POC
African Marsh Harrier	*Circus ranivorus*	VU	63
Lesser Kestrel	*Falco naumanni*	VU	65
Lanner Falcon	*Falco biarmicus*	NT	69
Maccoa duck	*Oxyura maccoa*	NT	61
African Finfoot	*Podica senegalensis*	VU	61

VU = Vulnerable, NT = Near threatened

Avifauna sightings

Barn Owl (*Tyto alba*) dropping



Southern masked weaver *(Ploceus velatus)* nests

Figure 10: Evidential representation of Barn owl and weavers within the subject property.

3.4 Reptiles

Threatened reptile species of concern in Gauteng, as noted by GDARD (2004), are presented in Appendix 3.

One non RDL reptile species was identified during the assessment of the rocky outcrop habitat unit, namely the Striped Skink (*Trachylepis striata;* synonym *Mabuya striata*). Apart from the Striped Skink (*Mabuya striata*), it is anticipated that other commonly occurring reptile species may reside within the subject property, which include the Spotted Sandveld Lizard (*Nucras intertexta)* and Rough-scaled Plated Lizard (*Gerrhosaurus major*) along with several common snake species, such as the Highveld Garter Snake (*Elapsoidea sundevalli*) and Transvaal worm snake (*Leptotyphlops distanti*) that may be found in the subject property.

No RDL reptile species were encountered during the field assessment. Reptiles are notoriously difficult to detect, are well camouflaged and have good senses to hide from prey, thus making identification of reptiles difficult. The subject area does however, offer habitat for various reptile species within all the identified habitat units, however reptile species of concern, if present, will be restricted to areas with low levels of anthropogenic activities such the less disturbed rocky outcrop habitat units and wetland habitat units. Due to the good natural rocky habitat unit and wetland habitat unit found within the subject property, three threatened RDL reptile species listed by GDARD, namely the Blunt-tailed worm lizard (*Dalophia pistillum*), the Striped harlequin Snake (*Homoroselaps dorsalis*) and the Southern African Rock Python (*Python sebae natalensis*) were considered to have a high POC for their distribution range and there being a good food and habitat percentage along these good rocky habitat units in association with the wetland habitat unit.

Thus it is recommended that the rocky outcrop area as well as the wetland areas be kept undisturbed to conserve and protect possible habitats for reptile species.

Table 4: Reptile RDL species list that has a high POC to be found within the subject property.

Common Name	Scientific Name	GDARD Status	POC
Blunt-tailed worm lizard	*Dalophia pistillum*	DD	61
Striped harlequin Snake	*Homoroselaps dorsalis*	R	63
Southern African Rock Python	*Python sebae natalensis*	VU	65

VU = Vulnerable, DD = Data Deficient; R = Rare

Reptile sightings

Striped Skink (*Trachylepis striata;* synonym *Mabuya striata*)

Striped Skink (*Trachylepis striata;* synonym *Mabuya striata*)

Figure 11: Evidential representative views of Striped Skink (*Trachylepis striata;* synonym *Mabuya striata*) within the subject property.

3.5 Amphibians

Only the Common platanna (*Xenopus laevis*) amphibian species was noted during the field assessment. The low taxon identified is potentially due to the late seasonal sight survey. Amphibian species life cycles have passed the breeding period and as the water table level drops amphibian species begin to submerge and envelop themselves underground for the dry winter months and only emerge when the rainy seasons reoccur. Amphibian species, which may potentially occur here, are common and widespread species, such species include the Plain Grass Frog *(Ptychadena anchietae),* Common River frog *(Afrana angolensis),* guttural toads (*Bufo gutturalis)* and the Common Caco *(Cacosternum boettgeri).*

The only threatened amphibian species of concern in Gauteng is the Giant Bullfrogs (*Pyxicephalus adspersus)* GDARD (2004), Appendix 4. No Giant Bullfrogs

(*Pyxicephalus adspersus)* were found in the vicinity of the subject property. However, the Giant Bullfrog (*Pyxicephalus adspersus),* a near threatened species, is known to occur near riparian and wetland zones where bullfrog habitat is optimal. This species distribution range is within the subject property. They remain in cocoons submerged underground, preferably sandy grounds and only emerge at the start of the rainy season. They breed in shallow waters and they can occupy temporary floodplains and rapidly drying pool areas. They are also known to travel vast distances and may also utilise the wetlands as migratory corridors through the local area. They are active during the day and are able to tolerate some of the harshest environments in Africa. They are carnivorous and eat a wide variety of foods. Thus due to the distribution range data, good food availability and there being suitable wetland habitat conditions within the subject property, the likelihood of this RDL species occurring in the subject property is considered significant.

Table 5: Amphibian RDL species list that has a high POC which may be associated to the subject property.

Common Name	Scientific Name	GDARD Status	POC
Giant Bullfrog	Pyxicephalus adspersus	NT	69

NT = Near Threatened

3.6 Invertebrates

The invertebrate assessment conducted was a general assessment with the purpose of identifying the invertebrate community assemblage occurring within the subject property. As such, the invertebrate assessment will not be an indication of the complete invertebrate diversity potential of the subject property and surrounding area. A presentation of the encountered families in the Insecta class that were observed during the assessment is listed in the table below.

Threatened invertebrate species list for Gauteng is in Appendix 5 GDARD (2004). No GDARD RDL invertebrate species were identified during the assessment and the probability of threatened invertebrate species occurring within the area is considered low.

Table 6: General results from invertebrate collecting during the assessment of the subject property

Insects	Comments
Order: Lepidoptera (Butterflies & Moths)	These are all commonly occurring species typical of the locality and habitat
Family: Nymphalidae Subfamily: Danainae *Danaus chrysippus aegyptius* (African monarch)	Visual observations
Subfamily: Nimphalinae *Junonia hierta* (Yellow pansy) *Byblia ilythia* (Spotted joker)	Visual observations
Family: Pieridae *Eurema hecabe* (Common grass Yellow) *Beleonis creona* (African Common White) *Leptotes pirithous* (Common Blue)	Visual observations
Family: Hepialidae *Eudalaca exul* (Brown swift moths)	Visual observations
Family: Geometridae *Rhodometra sacrarial* (Vestal moths)	Visual observations
Family: Saturniidae *Bunaea alcinoe* (Emperor moth)	Visual observations
Family: Sphingidae *Pseudoclanis postica* (Mulberry Hawk moths)	Visual observations
Order: Orthoptera (Grasshoppers, Crickets & Locusts)	These are all commonly occurring species typical of the locality and habitat
Family: Anostostomatidae *Onosandrus* sp	Visual observations and sweep net
Family: Gryllidae *Gryllus bimaculatus* (Common garden cricket)	Visual observations
Family: Tettigoniidae *Phaneroptera* sp (Leaf katydids)	Visual observations
Family: Acrididae *Oedaleus* sp (Yellow wings) *Cyrtacanthacris aeruginosa* (Green tree locust)	Visual observations and sweep net
Order: Hymenoptera & Isoptera (Ants, Bees, Termites &Wasps)	These are all commonly occurring species typical of the locality and habitat
Family: Apidae *Apis mellifera scutellata* (African honey bee)	Visual observations
Family: Vespidae *Vespula germanica* (Hornet wasps)	Visual observations
Family: Termitidae *Trinervitermes trinervoides* (Snouted Harvester) Odontotermes latericus (Harvester Termites)	Visual observations
Order: Coleoptera (Beetles)	These are all commonly occurring species typical of the locality and habitat

Family: Meloidae *Decapotoma lunata* (Lunate blister beetle)	Visual observations
Family: Coccinellidae *Hippodamia variegata* (Spotted amber ladybird)	Visual observations and sweep net
Family: Carabidae *Tefflus* sp (Peaceful giant ground beetle)	Visual observations
Order: Phasmatodea **(Stick insects)**	These are all commonly occurring species typical of the locality and habitat
Family: Heteronemiidae *Maransis* rufolineatus (Grass stick insect)	Visual observations and sweep net
Order: Mantodea **(Mantids)**	These are all commonly occurring species typical of the locality and habitat
Family: Mantidae *Sphodromantis lineola* (African Praying mantis)	Visual observations and sweep net
Order: Odonata **(Damselflies, Dragonflies, Skimmers)**	These are all commonly occurring species typical of the locality and habitat
Family: Libellulidae *Trithemis arteriosa* (Red veined Dropwing)	Visual observations

Invertebrate sightings

African monarch (*Danaus chrysippus aegyptius*)

African Praying mantis (*Sphodromantis lineola*)

Figure 12: Evidential representative views of the African monarch butterfly and an African Praying mantis within the subject property.

3.7 Arachnids and Scorpions

Gauteng Province Threatened, Rare and of conservation concern Spiders and Scorpions (GDARD SoER, 2004) are listed in Appendix 5.

No evidence was encountered of the Mygalomorph arachnids (Trapdoor and Baboon spiders) and RDL scorpions within the subject property, although it should be noted that these species are notoriously difficult to detect, however, if they do occur within the area they would be found within the rocky habitat area. Mygalomorph arachnids are highly sensitive to habitat disturbance and environmental changes and are especially sensitive to vibration pollution since mygalomorph spiders and scorpions use vibration to detect and locate their prey.

Within the rocky areas specific attention was paid with the identification of suitable habitat for spiders and scorpions. After thoroughly searching and rock turning no scorpions were found and no spider burrows were identified. Little distribution data is available for most of these spider and scorpion species.

Non RDL Funnel web spider (*Angelena* sp) individuals were encountered during the site survey. These species are considered common and not threatened

Arachnid sightings

Funnel web spider (*Angelena* sp)

Figure 13: Evidential representative views of a Funnel web spider within the subject property.

4. FAUNAL RED DATA SPECIES ASSESSMENT

No threatened RDL faunal species were identified during the site surveys which are included in the Gauteng Province State of the Environment Reports. Nine threatened RDL species did however indicate to have a 60% or greater probability of being found on the subject property are presented in the table below. These species have a high probability of utilising the subject property as a migration corridor and an area to forage and maybe breed in if the conditions are favourable.

Table 7: Threatened faunal species with a 60% or greater Probability of Occurrence (POC) on the subject property.

Common Name	Scientific Name	IUCN	GDARD Status	POC
Lanner Falcon	*Falco biarmicus*	LC	NT	69
Lesser Kestrel	*Falco naumanni*	LC	VU	65
African Marsh Harrier	Circus ranivorus	LC	VU	63
African Finfoot	Podica senegalensis	LC	VU	61
Maccoa duck	*Oxyura maccoa*	NT	NT	61
Blunt-tailed worm lizard	*Dalophia pistillum*	Na	DD	61
Striped harlequin Snake	*Homoroselaps dorsalis*	NT	R	63
Southern African Rock Python	*Python sebae natalensis*	Na	VU	65
Giant Bullfrog	Pyxicephalus adspersus	LC	NT	69

Na = not assessed by the IUCN, LC = Least Concerned, R = Rare, DD = Data Deficient, NT = Near Threatened and VU = Vulnerable.

The species presented in the table above were then used to calculate the RDSIS for the site, the results of which are presented in the following table.

Table 8: Red Data Sensitivity Index Score calculated for the subject property.

Red Data Sensitivity Index Score	
Average Total Species Score	**54**
Average Threatened Taxa Score	**63**
Average (Ave TSS + Ave TT/2)	**59**
% Species greater than 60% POC	**10%**
RDSIS of Site	**34%**

The RDSIS assessment of the property yielded a moderate to lower score of 34%, indicating a medium-low importance with regards to RDL faunal species conservation within the region. In terms of the proposed project, the highly sensitive wetland and rocky outcrop habitat unit should be conserved, to ensure that the migratory connectivity and habitat requirements for the above species are maintained and the proposed development will have very little impact on the faunal ecology within the subject property.

5. SENSITIVITY MAPPING

All the ecological features of the subject properties were considered and sensitive areas were delineated with the use of a Global Positioning System (GPS). A Geographic Information System (GIS) was used to project these features onto aerial photographs and topographic maps. The sensitivity map should guide the design and layout of the proposed development with regards to all sensitive areas. Sensitivity maps are displayed in Section A attached with this report.

6. CONCLUSIONS AND RECOMMENDATIONS

Two site visits were undertaken during March and April 2012 to determine the ecological status of the subject property to undertake a general faunal biodiversity assessment, with emphasis being placed on the potential occurrence of any threatened RDL faunal species which are highlighted for Gauteng Province (GDARD, 2004).

The following general conclusions were drawn on completion of the survey:

FAUNAL ASSESSMENT CONCLUSIONS

In general there is good natural rocky outcrop and woodland habitat units along with good wetland units found within the subject property and are deemed to provide good faunal habitat for a diverse community of fauna. There habitat unit areas are visually displayed in Section A, Sensitivity Mapping.

- Yellow Mongoose (*Cynictis penicillata*) and Angoni Vlei Rat (*Otomys angoniensis*) were identified during the field survey. Other signs indicating the presence of small omnivorous predators found within the subject property such as Mole rat mounds (Genus; *Cryptomys*) and Cape Clawless Otter (*Aonyx capensis*) droppings. No other mammal species were noted possibly due to the close proximity to residential areas and the cryptic nature of most mamma species. Suitable habitat areas, such as natural rocky, woodland, grassland and wetland habitat areas were however identified in the subject property (See Section A). No GDARD and IUCN RDL threatened mammal species were found in the subject property. It is unlikely that GDARD RDL or sensitive mammal species listed in Appendix 1 will utilise the site for habitation purposes due to the high level of urbanisation in the surrounding area. There is however a slight possibility that some mammal species, especially the RDL Bat species that are indicated in Appendix 1, may occur and utilise some points along the proposed subject property area as foraging and breeding sites, especially in the rocky outcrop habitat unit.
- No GDARD RDL listed bird species were noted during the site assessment. However since birds are mobile there is a good chance that some threatened bird species which occur in the GDARD RDL bird list may occur within the subject property. The main reasons are due to the good natural rocky outcrop habitat unit as well as the wetland habitat unit (see Section A, Sensitivity Maps) which may be utilised as a migratory corridor especially during the breeding season by the Macco Duck *(Oxyura maccoa*) and African Finfoot *(Podica senegalensis*) and for feeding purposes by the

African Marsh Harrier *(Circus ranivorus*), the Lesser Falcon *(Falco naumanni*) and the Lanner Falcon *(Falco biarmicus*). Thus by conserving the rocky outcrop and wetland habitat unit, the habitat of these species that have a high probability of occurrence could also be conserved.

- No RDL reptile species were encountered during the field assessment. Reptiles are notoriously difficult to detect, are well camouflaged and have good senses to hide from prey, thus making identification of reptiles difficult. The subject area does however, offer habitat for various reptile species within all the identified habitat units, however reptile species of concern, if present, will be restricted to areas with low levels of anthropogenic activities such the less disturbed rocky outcrop habitat units and wetland habitat units. Due to the good natural rocky habitat unit and wetland habitat unit found within the subject property, three threatened RDL reptile species listed by GDARD, namely the Blunt-tailed worm lizard (*Dalophia pistillum*), the Striped harlequin Snake (*Homoroselaps dorsalis*) and the Southern African Rock Python (*Python sebae natalensis*) were considered to have a high POC for their distribution range and there being a good food and habitat percentage along these good rocky habitat units in association with the wetland habitat unit.
- Only the Common platanna (*Xenopus laevis*) amphibian species was noted during the field assessment. The low taxon identified is potentially due to the late seasonal sight survey. Amphibian species life cycles have passed the breeding period and as the water table level drops amphibian species begin to submerge and envelop themselves underground for the dry winter months and only emerge when the rainy seasons reoccur. Amphibian species, which may potentially occur here, are common and widespread species, such species include the Plain Grass Frog *(Ptychadena anchietae),* Common River frog *(Afrana angolensis),* guttural toads (*Bufo gutturalis)* and the Common Caco *(Cacosternum boettgeri).* The only threatened amphibian species of concern in Gauteng is the Giant Bullfrogs (*Pyxicephalus adspersus)* GDARD (2004), Appendix 4. No Giant Bullfrogs (*Pyxicephalus adspersus)* were found in the vicinity of the subject property. However, the Giant Bullfrog (*Pyxicephalus adspersus),* a near threatened species, is known to occur near riparian and wetland zones where bullfrog habitat is optimal. This species distribution range is within the subject property. They remain in cocoons submerged underground, preferably sandy grounds and only emerge at the start of the rainy season. They breed in shallow waters and they can occupy temporary floodplains and rapidly drying pool areas. They are also known to travel vast distances and may also utilise the wetlands as migratory corridors through the local area. They are

active during the day and are able to tolerate some of the harshest environments in Africa. They are carnivorous and eat a wide variety of foods. Thus due to the distribution range data, good food availability and there being suitable wetland habitat conditions within the subject property, the likelihood of this RDL species occurring in the subject property is considered significant.

- The invertebrate assessment conducted was a general assessment with the purpose of identifying the invertebrate community assemblage occurring within the subject property. No GDARD RDL invertebrate species were identified during the assessment and the probability of threatened invertebrate species occurring within the area is considered low.
- No evidence was encountered of the Mygalomorph arachnids (Trapdoor and Baboon spiders) and RDL scorpions within the subject property, although it should be noted that these species are notoriously difficult to detect, however, if they do occur within the area they would be found within the rocky habitat area. Mygalomorph arachnids are highly sensitive to habitat disturbance and environmental changes and are especially sensitive to vibration pollution since mygalomorph spiders and scorpions use vibration to detect and locate their prey. Within the rocky areas specific attention was paid with the identification of suitable habitat for spiders and scorpions. After thoroughly searching and rock turning no scorpions were found and no spider burrows were identified. Little distribution data is available for most of these spider and scorpion species.
- The RDSIS assessment of the property yielded a moderate to lower score of 34%, indicating a medium-low importance with regards to RDL faunal species conservation within the region. In terms of the proposed project, the highly sensitive wetland and rocky outcrop habitat unit should be conserved, to ensure that the migratory connectivity and habitat requirements for the above species are maintained and the proposed development will have very little impact on the faunal ecology within the subject property.

After the conclusion of this biodiversity assessment, it is the opinion of the ecologists that from an ecological viewpoint, the proposed development be permitted provided that the recommendations below are strictly adhered to:

- The defined areas of high sensitivity habitat (wetland and rocky out crop habitat unit) areas should remain undeveloped as public or private open space. A sensitivity map has been developed for the study area, indicating wetland and rocky outcrop areas which are considered to be of high ecological sensitivity. It is recommended that this

sensitivity map be considered during the planning and construction phases of the proposed development activities to aid in the conservation of ecological processes within the subject property. It is highly recommended that the proposed inter Section Ae moved away from the wetland and unique rocky habitat unit areas since this intersection development will have the largest impact on the ecology of all the development areas and is currently located within and adjacent to the most sensitive area along the entire proposed development route within the subject property.

- All footprint areas should remain as small as possible and should not encroach into the wetland and rocky outcrop habitat units. This can be achieved by fencing footprint areas to contain all activities within designated areas. However, all fencing material should be removed and disposed of in an appropriate manner when activities are completed. In addition fencing should be constructed in such a way as to still ensure free movement of smaller faunal taxa through the area.
- Proliferation of alien and invasive floral species is expected within disturbed areas such as next to the gravel road. These exotic flora species should be eradicated and controlled to prevent their spread beyond the site boundary as well as seed dispersal within the top layers of the soil within footprint areas that will have an impact, habitat and food availability as well as on rehabilitation in the future.
- In order to preserve faunal habitat, the recommended faunal management and mitigation plans as in the floral report (Section A) should be taken into consideration to prevent any loss of faunal habitat as well as any further establishment of alien flora.
- Construction vehicles should be restricted to travelling only on the existing road servitudes to limit the ecological footprint of the proposed development activities.
- Ensure that construction boundaries are clearly marked and no vehicles are to encroach upon the wetland and other sensitive habitat unit areas. If this is unavoidable, ensure that these areas are suitably rehabilitated with special mention of ensuring habitat connectivity and re-establishment of natural conditions as far as possible.
- Ensure that all roads and construction areas are regularly sprayed with water in order to curb dust generation. This is particularly necessary during the dry season when increased levels of dust generation can be expected.
- Planning of gravel roads that will be utilised during the pre-construction and construction phases should consider the site sensitivity plan. If possible roads should be constructed a distance from the wetland areas and not directly adjacent to these areas. Mainly to prevent any impact on the proposed open space areas due to dust

generation, erosion and sedimentation from gravel roads situated next to these areas considered of increased ecological sensitivity.

- Adequate sanitation facilities should be provided for labourers to avoid the informal usage of the veld.
- No fires should be lit whatsoever within designated sensitive areas during the construction phase of the development.
- Edge effects of project related activities in these areas including erosion and alien floral species establishment need to be strictly managed in these areas.
- Compare the positions of planned infrastructure to the areas of mapped sensitivity.
- No dumping of waste should take place within any area of the subject property. If any spills or waste deposits occur, they should be immediately cleaned up.
- During the construction phase, no vehicles should be allowed to indiscriminately drive through the wetland areas.
- As much of the grassland is to be left undisturbed as possible to allow for the ongoing conservation of invertebrate species which may inhabit the proposed development site.
- As much vegetation growth, thus faunal habitat areas, as possible should be promoted within the proposed development area in order to protect soils and to reduce the percentage of the surface area which is paved. In this regard special mention is made of the need to use indigenous vegetation species as the first choice during landscaping to ensure that there is adequate natural faunal habitat.
- If any threatened RDL faunal species are identified within the proposed development route and subject property during construction activities, the proponent and contractors should ensure effective relocation of individuals to suitable offset areas or within designated open space on the subject property.
- All rescue and relocation plans should be overseen by a suitably qualified specialist.
- Designated sensitive areas must be off-limits to construction personnel.
- No trapping or hunting of fauna is to take place. Access control must be implemented to ensure that no illegal trapping or poaching takes place.
- All soils compacted as a result of construction activities falling outside development footprint areas should be ripped and profiled. Special attention should be paid to alien and invasive control within these areas. Alien and invasive vegetation control should take place throughout the all phases of the development.
- Ensure that all disturbed and exposed areas are rehabilitated and covered with vegetation to prevent post-rehabilitation dust generation.

- Ensure that all hazardous storage containers comply with the relevant SABS standards to prevent leakage.
- Regularly inspect all construction vehicles for leaks.
- Re-fuelling must take place on a sealed surface area to prevent ingress of hydrocarbons into topsoil.
- Erosion management measures must be implemented to prevent soils from eroding into surface water resources.

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FAUNAL APPENDICES

Appendix 1: Wild Mammals of Gauteng considered to be threatened according to the IUCN Species Survival Commission and species that are endemic to South Africa (GDARD SoER, 2004) Updated list of February 2011 according to Lihle Dumalishile from GDARD.

Species	English Name	IUCN Status	South African Red Data Book Status
Neamblysomus julianae	Juliana's golden mole	VU [B2 ab (ii,iii)]	CR [B1 ab (iii,iv) + 2ab (iii,iv)]
Chrysospalax villosus	Rough-haired golden mole	VU B2 ab (I,ii,iii,iv)	CR
Cloeotis percivali	Short-eared Trident bat	LC	CR
Ourebia ourebi	Oribi	LC	EN
Mystromys albicaudatus	White-tailed mouse	EN (A3c)	EN
Damaliscus lunatus lunatus	Tsessebe	LC	EN
Crocidura maquassiensis	Maquassie musk shrew	LC	VU
Rhinolophus blasii	Peak-saddle horseshoe bat	LC	VU
Hippotragus equinus	Roan antelope	LC	VU
Hippotragus niger	Sable antelope	LC	VU
Hyaena brunnea	Brown hyaena	NT	NT
Rhinolophus darlingi	Darling's horseshoe bat	LC	NT
Rhinolophus clivosus	Geoffroy's horseshoe bat	LC	NT
Mellivora capensis	Honey badger	LC	NT
Pipistrellus rusticus	Rusty bat	LC	NT
Miniopterus schreibersii	Schreibers' long-fingered bat	NT	NT
Leptailurus serval	Serval	LC	NT
Atelerix frontalis	Southern African hedgehog	LC	NT
Lutra maculicollis	Spotted-necked otter	LC	NT
Myotis tricolor	Temminck's hairy bat	LC	NT
Dasymys incomtus	African marsh rat	LC	NT
Myotis welwitschii	Welwitsch's hairy bat	LC	NT

Appendix 2a: Threatened bird species that are priorities in Gauteng (GDARD SoER, 2004; Avibase, 2006)

English name	Species	Threatened Status
Cape Vulture	*Gyps coprotheres*	VU
Blue Crane	*Anthropoides paradiseus*	VU
Lesser Kestrel	*Falco naumanni*	VU
Grass Owl	*Tyto capensis*	VU
African Marsh Harrier	*Circus ranivorus*	VU
White-backed Night Heron	*Gorsachius leuconotus*	VU
White-bellied Korhaan	*Eupodotis cafra*	VU
Martial Eagle	*Polemaetus bellicosus*	VU
African Finfoot	*Podica senegalensis*	VU
Blue Korhaan	*Eupodotis caerulescens*	NT
Melodious Lark	*Mirafra cheniana*	NT
Lesser Flamingo	*Phoenicopterus minor*	NT
Secretary bird	*Sagittarius serpentarius*	NT
Black Stork	*Ciconia nigra*	NT
Lanner Falcon	*Falco biarmicus*	NT
Half-collared Kingfisher	*Alcedo semitorquata*	NT
Greater Flamingo	*Phoenicopterus ruber*	NT
Yellow-billed Stork	*Mycteria ibis*	NT
Red-billed Oxpecker	*Buphagus erythrorhynchus*	NT
Maccoa duck	*Oxyura maccoa*	NT
Bald ibis	*Geronticus calvus*	VU
White-backed vulture	*Gyps africanus*	NT
Cape griffon	*Gyps coprotheres*	VU
Black Harrier	*Circus maurus*	VU
Pallid Harrier	*Circus macrourus*	NT
Red-footed Falcon	*Falco vespertinus*	NT
Stanley Bustard	*Neotis denhami*	NT
Blue Bustard	*Eupodotis caerulescens*	NT
White-winged Fluff tail	*Sarothrura ayresi*	EN
Corn Crake	*Crex crex*	NT
Wattled Crane	*Bugeranus carunculatus*	VU
Chestnut-banded Plover	*Charadrius pallidus*	NT
Eurasian Curlew	*Numenius arquata*	NT
Black-tailed Godwit	*Limosa limosa*	NT
Black-winged Pratincole	*Glareola nordmanni*	NT
African Skimmer	*Rynchops flavirostris*	NT
European Roller	*Coracias garrulus*	NT
Rudd's Lark	*Heteromirafra rudd*	VU
Botha's Lark	*Spizocorys fringillaris*	NT
Blue Swallow	*Hirundo atrocaerulea*	VU
Bush Blackcap	*Lioptilus nigricapillus*	NT

Appendix 2b: Avifaunal species list for SA quadrant 2528CC (Roberts Multimedia Birds of Southern Africa).

English name	Species	Threatened Status
Abdim's Stork	*Ciconia abdimii*	NBM-U
African Black Duck	*Anas sparsa*	R-C
African Crake	*Crecopsis egregia*	BM-U
African Finfoot	*Podica senegalensis*	R-U
African Fish Eagle	*Haliaeetus vocifer*	R-U
African Green Pigeon	*Treron calva*	R-U
African Hawk Eagle	*Hieraaetus spilogaster*	R-C
African Hoopoe	*Upupa africana*	R-VC
African Jacana	*Actophilornis africanus*	R-U
African Marsh Harrier	*Circus ranivorus*	R-U
African Marsh Warbler	*Acrocephalus baeticatus*	BM-C
African Pied Wagtail	*Motacilla aguimp*	R-U
African Rail	*Rallus caerulescens*	R-C
African Scops Owl	*Otus senegalensis*	R-C
African Sedge Warbler	*Bradypterus baboecala*	R-C
African Skimmer	*Rynchops flavirostris*	V #
African Spoonbill	*Platalea alba*	R-U/C
Alpine Swift	*Tachymarptis melba*	BM-U
Anteating Chat	*Myrmecocichla formicivora*	E-U
Arrowmarked Babbler	*Turdoides jardineii*	R-VC
Ashy Tit	*Parus cinerascens*	E-C
Ayres' Cisticola	*Cisticola ayresii*	R-U
Ayres' Eagle	*Hieraaetus ayresii*	NBM-U
Baillon's Crake	*Porzana pusilla*	R-U
Banded Martin	*Riparia cincta*	BM-C
Barn Owl	*Tyto alba*	R-C
Barthroated Apalis	*Apalis thoracica*	R-U
Bearded Woodpecker	*Dendropicos namaquus*	R-U
Bennett's Woodpecker	*Campethera bennettii*	R-U
Bittern	*Botaurus stellaris*	R-U
Black Crake	*Amaurornis flavirostris*	R-C
Black Crow	*Corvus capensis*	R-VC
Black Cuckoo	*Cuculus clamosus*	BM-U
Black Cuckooshrike	*Campephaga flava*	R-C
Black Eagle	*Aquila verreauxii*	R-C
Black Egret	*Egretta ardesiaca*	R-C
Black Flycatcher	*Melaenornis pammelaina*	R-C
Black Harrier	*Circus maurus*	NBM-U
Black Kite	*Milvus migrans*	NBM-U
Black Sparrowhawk	*Accipiter melanoleucus*	R-U
Black Stork	*Ciconia nigra*	R-U/C
Black Sunbird	*Chalcomitra amethystina*	R-VC
Black Swift	*Apus barbatus*	BM-U
Black Widowfinch	*Vidua funerea*	R-U
Blackbreasted Snake Eagle	*Circaetus pectoralis*	R-C
Blackcheeked Waxbill	*Estrilda erythronotos*	R-U
Blackchested Prinia	*Prinia flavicans*	E-VC
Blackcollared Barbet	*Lybius torquatus*	R-VC
Blackcrowned Night Heron	*Nycticorax nycticorax*	R-U
Blackcrowned Tchagra	*Tchagra senegala*	R-VC
Blackeyed Bulbul	*Pycnonotus tricolor*	R-A
Blackheaded Heron	*Ardea melanocephala*	R-VC
Blackheaded Oriole	*Oriolus larvatus*	R-VC

Blacknecked Grebe	*Podiceps nigricollis*	R-U
Blackshouldered Kite	*Elanus caeruleus*	R-VC
Blacksmith Plover	*Vanellus armatus*	R-VC/A
Blacktailed Godwit	*Limosa limosa*	Rare
Blackthroated Canary	*Serinus atrogularis*	R-VC
Blackwinged Pratincole	*Glareola nordmanni*	NBM-C
Blackwinged Stilt	*Himantopus himantopus*	R-C
Blue Crane	*Anthropoides paradisea*	E-U
Blue Waxbill	*Uraeginthus angolensis*	R-VC/A
Bluebilled Firefinch	*Lagonosticta rubricata*	R-U
Bluecheeked Bee-eater	*Merops persicus*	NBM-U
Bokmakierie	*Telophorus zeylonus*	E-VC
Booted Eagle	*Hieraaetus pennatus*	NBM-U
Bronze Mannikin	*Lonchura cucullata*	R-U/VC
Brown Snake Eagle	*Circaetus cinereus*	R-C
Brownhooded Kingfisher	*Halcyon albiventris*	R-C/VC
Brownthroated Martin	*Riparia paludicola*	R-C
Brubru	*Nilaus afer*	R-U
Buffy Pipit	*Anthus vaalensis*	R-U
Burchell's Coucal	*Centropus burchellii*	R-VC
Burchell's Starling	*Lamprotornis australis*	E-VC
Burntnecked Eremomela	*Eremomela usticollis*	R-C
Cape Bunting	*Emberiza capensis*	R-U
Cape Eagle Owl	*Bubo capensis*	R-U
Cape Penduline Tit	*Anthoscopus minutus*	E-U
Cape Reed Warbler	*Acrocephalus gracilirostris*	R-C
Cape Robin	*Cossypha caffra*	R-VC
Cape Rockthrush	*Monticola rupestris*	E-C
Cape Shoveller	*Anas smithii*	E-VC
Cape Sparrow	*Passer melanurus*	E-A
Cape Teal	*Anas capensis*	R-U
Cape Turtle Dove	*Streptopelia capicola*	R-A
Cape Vulture	*Gyps coprotheres*	E-U/C
Cape Wagtail	*Motacilla capensis*	R-VC
Cape Weaver	*Ploceus capensis*	E-VC
Cape White-eye	*Zosterops virens*	E-VC
Capped Wheatear	*Oenanthe pileata*	R-U/C
Cardinal Woodpecker	*Dendropicos fuscescens*	R-U/C
Caspian Plover	*Charadrius asiaticus*	NBM-U
Caspian Tern	*Sterna caspia*	R-U
Cattle Egret	*Bubulcus ibis*	R-A
Chestnutbacked Finchlark	*Eremopterix leucotis*	R-C
Chestnutbanded Plover	*Charadrius pallidus*	R-U
Chinspot Batis	*Batis molitor*	R-C
Cloud Cisticola	*Cisticola textrix*	R-C
Common Moorhen	*Gallinula chloropus*	R-C
Common Quail	*Coturnix coturnix*	R-U
Common Sandpiper	*Actitis hypoleucos*	NBM-C
Common Waxbill	*Estrilda astrild*	R-VC
Coqui Francolin	*Peliperdix coqui*	R-C
Corncrake	*Crex crex*	NBM-U
Crested Barbet	*Trachyphonus vaillantii*	R-VC
Crested Francolin	*Dendroperdix sephaena*	R-U
Crimsonbreasted Shrike	*Laniarius atrococcineus*	E-VC
Crowned Plover	*Vanellus coronatus*	R-VC
Cuckoo Hawk	*Aviceda cuculoides*	R-U
Cuckoofinch	*Anomalospiza imberbis*	BM-U
Curlew	*Numenius arquata*	NBM-U
Curlew Sandpiper	*Calidris ferruginea*	NBM-C
Cutthroat Finch	*Amadina fasciata*	R-C

Dabchick	*Tachybaptus ruficollis*	R-VC
Darter	*Anhinga rufa*	R-C
Desert Barred Warbler	*Calamonastes fasciolatus*	E-U
Desert Cisticola	*Cisticola aridulus*	R-C
Diederik Cuckoo	*Chrysococcyx caprius*	BM-C
Eastern Clapper Lark	*Mirafra fasciolata*	E-U
Eastern Longbilled Lark	*Certhilauda semitorquata*	E-U
Eastern Redfooted Kestrel	*Falco amurensis*	NBM-C
Egyptian Goose	*Alopochen aegyptiacus*	R-VC
Ethiopian Snipe	*Gallinago nigripennis*	R-C
Eurasian Bee-eater	*Merops apiaster*	NBM-VC
Eurasian Cuckoo	*Cuculus canorus*	NBM-U
Eurasian Golden Oriole	*Oriolus oriolus*	NBM-U
Eurasian Marsh Harrier	*Circus aeruginosus*	NBM-U
Eurasian Marsh Warbler	*Acrocephalus palustris*	NBM-U
Eurasian Nightjar	*Caprimulgus europaeus*	NBM-U
Eurasian Roller	*Coracias garrulus*	NBM-U
Eurasian Sedge Warbler	*Acrocephalus schoenobaenus*	NBM-U
Eurasian Swallow	*Hirundo rustica*	NBM-VC
Eurasian Swift	*Apus apus*	NBM-U
Fairy Flycatcher	*Stenostira scita*	NBM-C
Familiar Chat	*Cercomela familiaris*	R-C
Fantailed Cisticola	*Cisticola juncidis*	R-C
Fantailed Flycatcher	*Myioparus plumbeus*	R-U
Fawncoloured Lark	*Calendulauda africanoides*	R-U
Feral Pigeon	*Columba livia*	R-C
Fierynecked Nightjar	*Caprimulgus pectoralis*	R-C
Fiscal Flycatcher	*Sigelus silens*	E-VC
Fiscal Shrike	*Lanius collaris*	R-A
Flappet Lark	*Mirafra rufocinnamomea*	R-U
Forktailed Drongo	*Dicrurus adsimilis*	R-VC/A
Freckled Nightjar	*Caprimulgus tristigma*	R-VC
Fulvous Duck	*Dendrocygna bicolor*	R-U
Gabar Goshawk	*Melierax gabar*	R-U
Garden Warbler	*Sylvia borin*	NBM-U
Giant Eagle Owl	*Bubo lacteus*	R-U
Giant Kingfisher	*Megaceryle maxima*	R-U
Glossy Ibis	*Plegadis falcinellus*	R-C
Glossy Starling	*Lamprotornis nitens*	E-VC
Golden Bishop	*Euplectes afer*	R-C
Golden Pipit	*Tmetothylacus tenellus*	V #
Goldenbreasted Bunting	*Emberiza flaviventris*	R-U/VC
Goldentailed Woodpecker	*Campethera abingoni*	R-U
Goliath Heron	*Ardea goliath*	R-C
Grass Owl	*Tyto capensis*	R-U
Grassbird	*Sphenoeacus afer*	E-C
Grassveld Pipit	*Anthus cinnamomeus*	R-VC
Great Crested Grebe	*Podiceps cristatus*	R-C
Great Reed Warbler	*Acrocephalus arundinaceus*	NBM-U
Great Sparrow	*Passer motitensis*	R-C
Great Spotted Cuckoo	*Clamator glandarius*	BM-U
Great White Egret	*Egretta alba*	R-C
Greater Doublecollared Sunbird	*Cinnyris afra*	E-U
Greater Flamingo	*Phoenicopterus ruber*	R-U
Greater Honeyguide	*Indicator indicator*	R-C
Greater Kestrel	*Falco rupicoloides*	R-U
Greater Striped Swallow	*Hirundo cucullata*	BM-VC
Green Sandpiper	*Tringa ochropus*	NBM-U
Greenbacked Heron	*Butorides striatus*	R-U
Greenshank	*Tringa nebularia*	NBM-C

Greenspotted Dove	*Turtur chalcospilos*	R-A
Grey Heron	*Ardea cinerea*	R-C
Grey Hornbill	*Tockus nasutus*	R-C
Grey Lourie	*Corythaixoides concolor*	R-A
Grey Plover	*Pluvialis squatarola*	NBM-U
Greybacked BleatingWarbler	*Camaroptera brevicaudata*	R-VC
Greyheaded Bush Shrike	*Malaconotus blanchoti*	R-VC
Greyheaded Gull	*Larus cirrocephalus*	R-C
Groundscraper Thrush	*Psophocichla litsipsirupa*	R-VC
Gymnogene	*Polyboroides typus*	R-C
Hadeda Ibis	*Bostrychia hagedash*	R-A
Halfcollared Kingfisher	*Alcedo semitorquata*	R-U
Hamerkop	*Scopus umbretta*	R-VC
Harlequin Quail	*Coturnix delegorguei*	BM-U
Helmeted Guineafowl	*Numida meleagris*	R-VC
Honey Buzzard	*Pernis apivorus*	NBM-U #
Horus Swift	*Apus horus*	BM-U
Hottentot Teal	*Anas hottentota*	R-U/C
House Martin	*Delichon urbica*	NBM-U
House Sparrow	*Passer domesticus*	R-VC
Icterine Warbler	*Hippolais icterina*	NBM-U
Indian Myna	*Acridotheres tristis*	R-VC
Jackal Buzzard	*Buteo rufofuscus*	E-U
Jacobin Cuckoo	*Clamator jacobinus*	BM-C
Jameson's Firefinch	*Lagonosticta rhodopareia*	R-U
Kalahari Robin	*Cercotrichas paena*	E-VC
Karoo Thrush	*Turdus smithi*	E-VC
Kittlitz's Plover	*Charadrius pecuarius*	R-C
Klaas's Cuckoo	*Chrysococcyx klaas*	BM-U
Knobbilled Duck	*Sarkidiornis melanotos*	R-U
Kurrichane Buttonquail	*Turnix sylvatica*	R-U
Kurrichane Thrush	*Turdus libonyanus*	R-U/VC
Lanner Falcon	*Falco biarmicus*	R-U
Larklike Bunting	*Emberiza impetuani*	E-U
Laughing Dove	*Streptopelia senegalensis*	R-A
Lazy Cisticola	*Cisticola aberrans*	R-U
Lesser Flamingo	*Phoenicopterus minor*	R-C
Lesser Grey Shrike	*Lanius minor*	NBM-U
Lesser Honeyguide	*Indicator minor*	R-U
Lesser Kestrel	*Falco naumanni*	NBM-U/C
Lesser Masked Weaver	*Ploceus intermedius*	R-U
Lesser Striped Swallow	*Hirundo abyssinica*	BM-VC
Levaillant's Cisticola	*Cisticola tinniens*	R-VC
Little Banded Goshawk	*Accipiter badius*	R-U
Little Bee-eater	*Merops pusillus*	R-VC
Little Bittern	*Ixobrychus minutus*	R-U
Little Egret	*Egretta garzetta*	R-C
Little Sparrowhawk	*Accipiter minullus*	R-U
Little Stint	*Calidris minuta*	NBM-C
Little Swift	*Apus affinis*	R-VC
Lizard Buzzard	*Kaupifalco monogrammicus*	R-C
Longbilled Crombec	*Sylvietta rufescens*	R-VC
Longbilled Pipit	*Anthus similis*	R-U
Longtailed Shrike	*Corvinella melanoleuca*	R-U/VC
Longtailed Widow	*Euplectes progne*	R-VC/A
Maccoa Duck	*Oxyura maccoa*	R-U
Malachite Kingfisher	*Alcedo cristata*	R-U
Malachite Sunbird	*Nectarinia famosa*	R-U
Mallard	*Anas platyrhynchos*	R-U
Marabou Stork	*Leptoptilos crumeniferus*	R-U

Marico Flycatcher	*Bradornis mariquensis*	E-C
Marico Sunbird	*Cinnyris mariquensis*	R-VC
Marsh Owl	*Asio capensis*	R-C
Marsh Sandpiper	*Tringa stagnatilis*	NBM-C
Martial Eagle	*Polemaetus bellicosus*	R-U
Masked Weaver	*Ploceus velatus*	R-VC
Melba Finch	*Pytilia melba*	R-U
Melodious Lark	*Mirafra cheniana*	E-U
Mocking Chat	*Thamnolaea cinnamomeiventris*	R-C
Monotonous Lark	*Mirafra passerina*	E-U
Montagu's Harrier	*Circus pygargus*	NBM-U
Mountain Chat	*Oenanthe monticola*	E-C/VC
Namaqua Dove	*Oena capensis*	R-VC
Natal Francolin	*Pternistis natalensis*	E-U
Neddicky	*Cisticola fulvicapillus*	R-C
Northern Hobby Falcon	*Falco subbuteo*	NBM-U
Old World Painted Snipe	*Rostratula benghalensis*	R-U/C
Orange River Francolin	*Scleroptila levaillantoides*	R-U
Orangebreasted Bush Shrike	*Telophorus sulfureopectus*	R-U
Orangebreasted Waxbill	*Amandava subflava*	R-C
Orangethroated Longclaw	*Macronyx capensis*	E-VC
Osprey	*Pandion haliaetus*	NBM-U
Ostrich	*Struthio camelus*	R-C
Ovambo Sparrowhawk	*Accipiter ovampensis*	R-U
Pale Chanting Goshawk	*Melierax canorus*	E-U
Pallid Flycatcher	*Bradornis pallidus*	R-C
Pallid Harrier	*Circus macrourus*	NBM-U
Palm Swift	*Cypsiurus parvus*	R-C
Paradise Flycatcher	*Terpsiphone viridis*	BM-VC
Paradise Whydah	*Vidua paradisaea*	R-U/VC
Pearlbreasted Swallow	*Hirundo dimidiata*	R-U
Pearlspotted Owl	*Glaucidium perlatum*	R-C
Peregrine Falcon	*Falco peregrinus*	NBM-U
Pied Avocet	*Recurvirostra avosetta*	R-U/C
Pied Babbler	*Turdoides bicolor*	E-VC
Pied Barbet	*Tricholaema leucomelas*	E-U
Pied Crow	*Corvus albus*	R-A
Pied Kingfisher	*Ceryle rudis*	R-C
Pied Starling	*Spreo bicolor*	E-C
Pinkbacked Pelican	*Pelecanus rufescens*	R-U
Pinkbilled Lark	*Spizocorys conirostris*	E-C
Pintailed Whydah	*Vidua macroura*	R-VC
Plainbacked Pipit	*Anthus leucophrys*	R-U
Plumcoloured Starling	*Cinnyricinclus leucogaster*	BM-U/VC
Puffback	*Dryoscopus cubla*	R-A
Purple Gallinule	*Porphyrio madagascariensis*	R-C
Purple Heron	*Ardea purpurea*	R-C
Purple Roller	*Coracias naevia*	R-C
Purple Widowfinch	*Vidua purpurascens*	R-U
Quail Finch	*Ortygospiza atricollis*	R-C
Rameron Pigeon	*Columba arquatrix*	R-U
Rattling Cisticola	*Cisticola chinianus*	R-C
Red Bishop	*Euplectes orix*	R-VC
Redbacked Shrike	*Lanius collurio*	NBM-VC
Redbilled Firefinch	*Lagonosticta senegala*	R-U
Redbilled Hornbill	*Tockus erythrorhynchus*	R-VC
Redbilled Quelea	*Quelea quelea*	R-VC
Redbilled Teal	*Anas erythrorhyncha*	R-C
Redbilled Woodhoopoe	*Phoeniculus purpureus*	R-VC
Redbreasted Swallow	*Hirundo semirufa*	BM-C

Redcapped Lark	*Calandrella cinerea*	R-C
Redchested Cuckoo	*Cuculus solitarius*	BM-C
Redchested Flufftail	*Sarothrura rufa*	R-U
Redcollared Widow	*Euplectes ardens*	R-VC
Redcrested Korhaan	*Eupodotis ruficrista*	E-VC
Redeyed Bulbul	*Pycnonotus nigricans*	E-VC
Redeyed Dove	*Streptopelia semitorquata*	R-VC
Redfaced Mousebird	*Urocolius indicus*	R-VC
Redheaded Finch	*Amadina erythrocephala*	E-U/VC
Redheaded Weaver	*Anaplectes rubriceps*	R-U
Redknobbed Coot	*Fulica cristata*	R-VC
Redthroated Wryneck	*Jynx ruficollis*	R-C
Redwing Francolin	*Scleroptila levaillantii*	R-U
Redwinged Starling	*Onychognathus morio*	R-VC
Reed Cormorant	*Phalacrocorax africanus*	R-VC
Ringed Plover	*Charadrius hiaticula*	NBM-U
River Warbler	*Locustella fluviatilis*	V #
Rock Bunting	*Emberiza tahapisi*	R-VC
Rock Kestrel	*Falco rupicolis*	R-U
Rock Martin	*Hirundo fuligula*	R-VC
Rock Pigeon	*Columba guinea*	R-VC
Roseringed Parakeet	*Psittacula krameri*	R-U
Ruddy Turnstone	*Arenaria interpres*	NBM-U
Ruff	*Philomachus pugnax*	NBM-U/C
Rufouscheeked Nightjar	*Caprimulgus rufigena*	BM-C
Rufousnaped Lark	*Mirafra africana*	R-VC
Sabota Lark	*Calendulauda sabota*	E-U
Sacred Ibis	*Threskiornis aethiopicus*	R-VC
Sand Martin	*Riparia riparia*	NBM-U
Sanderling	*Calidris alba*	NBM-U
Scalyfeathered Finch	*Sporopipes squamifrons*	E-VC
Scimitarbilled Woodhoopoe	*Rhinopomastus cyanomelas*	R-VC
Secretarybird	*Sagittarius serpentarius*	R-U
Shafttailed Whydah	*Vidua regia*	E-U
Sharpbilled Honeyguide	*Prodotiscus regulus*	R-U
Shelley's Francolin	*Scleroptila shelleyi*	R-C
Shorttoed Rockthrush	*Monticola brevipes*	E-U
South African Cliff Swallow	*Hirundo spilodera*	BM-C
South African Shelduck	*Tadorna cana*	E-U
Southern Black Tit	*Parus niger*	E-VC
Southern Boubou	*Laniarius ferrugineus*	E-VC
Southern Greyheaded Sparrow	*Passer diffusus*	E-VC
Southern Pochard	*Netta erythrophthalma*	R-C
Southern Yellowbilled Hornbill	*Tockus leucomelas*	E-VC
Speckled Mousebird	*Colius striatus*	R-VC
Spikeheeled Lark	*Chersomanes albofasciata*	E-VC
Spotted Crake	*Porzana porzana*	Rare
Spotted Dikkop	*Burhinus capensis*	R-C
Spotted Eagle Owl	*Bubo africanus*	R-C
Spotted Flycatcher	*Muscicapa striata*	NBM-C
Spottedbacked Weaver	*Ploceus cucullatus*	R-U
Spurwinged Goose	*Plectropterus gambensis*	R-VC
Squacco Heron	*Ardeola ralloides*	R-C
Steelblue Widowfinch	*Vidua chalybeata*	R-U
Steppe Buzzard	*Buteo vulpinus*	NBM-C
Steppe Eagle	*Aquila nipalensis*	NBM-U
Stonechat	*Saxicola torquata*	R-VC
Streakyheaded Canary	*Serinus gularis*	R-C
Striped Cuckoo	*Clamator levaillantii*	BM-U
Striped Kingfisher	*Halcyon chelicuti*	R-VC

Striped Pipit	*Anthus lineiventris*	R-U
Swainson's Francolin	*Pternistis swainsonii*	E-VC
Swallowtailed Bee-eater	*Merops hirundineus*	R-U
Swee Waxbill	*Estrilda melanotis*	E-U
Tawnyflanked Prinia	*Prinia subflava*	R-VC
Temminck's Courser	*Cursorius temminckii*	R-U
Thickbilled Weaver	*Amblyospiza albifrons*	R-U
Threebanded Plover	*Charadrius tricollaris*	R-VC
Threestreaked Tchagra	*Tchagra australis*	R-U
Titbabbler	*Parisoma subcaeruleum*	E-C
Tree Pipit	*Anthus trivialis*	NBM-U
Violeteared Waxbill	*Granatina granatina*	E-U
Wailing Cisticola	*Cisticola lais*	R-C
Wattled Plover	*Vanellus senegallus*	R-VC
Wattled Starling	*Creatophora cinerea*	R-U/VC
Western Redfooted Kestrel	*Falco vespertinus*	NBM-U
Whimbrel	*Numenius phaeopus*	NBM-U
Whiskered Tern	*Chlidonias hybridus*	BM-C
White Helmetshrike	*Prionops plumatus*	R-VC
White Pelican	*Pelecanus onocrotalus*	R-U
White Stork	*Ciconia ciconia*	NBM-C
Whitebacked Duck	*Thalassornis leuconotus*	R-U
Whitebacked Mousebird	*Colius colius*	E-C
Whitebacked Night Heron	*Gorsachius leuconotus*	R-U
Whitebacked Vulture	*Gyps africanus*	R-U
Whitebellied Korhaan	*Eupodotis barrowii*	E-U/C
Whitebellied Sunbird	*Cinnyris talatala*	R-VC
Whitebreasted Cormorant	*Phalacrocorax lucidus*	R-VC
Whitebrowed Robin	*Cercotrichas leucophrys*	R-U
Whitebrowed Sparrowweaver	*Plocepasser mahali*	R-U
Whitefaced Duck	*Dendrocygna viduata*	R-VC
Whitefaced Owl	*Ptilopsus granti*	R-U
Whitefronted Bee-eater	*Merops bullockoides*	R-C
Whiterumped Swift	*Apus caffer*	BM-C
Whitethroat	*Sylvia communis*	NBM-U
Whitethroated Robin	*Cossypha humeralis*	E-C
Whitethroated Swallow	*Hirundo albigularis*	BM-C
Whitewinged Korhaan	*Eupodotis afraoides*	E-VC
Whitewinged Tern	*Chlidonias leucopterus*	NBM-C
Whitewinged Widow	*Euplectes albonotatus*	R-C
Willow Warbler	*Phylloscopus trochilus*	NBM-C
Wood Sandpiper	*Tringa glareola*	NBM-C
Woodland Kingfisher	*Halcyon senegalensis*	BM-U
Yellow Wagtail	*Motacilla flava*	NBM-C
Yellowbellied Eremomela	*Eremomela icteropygialis*	R-C
Yellowbilled Duck	*Anas undulata*	R-VC
Yellowbilled Egret	*Egretta intermedia*	R-C
Yellowbilled Kite	*Milvus aegyptius*	BM-U
Yellowbilled Stork	*Mycteria ibis*	NBM-U
Yelloweyed Canary	*Serinus mozambicus*	R-U
Yellowfronted Tinker Barbet	*Pogoniulus chrysoconus*	R-VC
Yellowrumped Widow	*Euplectes capensis*	R-U
Yellowthroated Sandgrouse	*Pterocles gutturalis*	R-U
Yellowthroated Sparrow	Petronia superciliaris	R-C

Appendix 3: RDL Reptile species that occur in the Gauteng Province (GDARD SoER, 2004).

English Name	Species	Current IUCN Status
Striped harlequin Snake	*Homoroselaps dorsalis*	R
South African Python	*Python natalensis*	V
Blunt tailed worm lizard	*Dalophi apistillum*	DD
Nile Crocodile	*Crocodylus niloticus*	V

Appendix 4: RDL Amphibians species that occur in the Gauteng Province (GDARD SoER, 2004).

English Name	Species	Current IUCN Status
African Giant Bullfrog	*Pyxicephalas adspersus*	NT

Appendix 5: Gauteng Province Threatened, Rare and of conservation concern Invertebrates including Spiders and Scorpions (GDARD SoER, 2004)

Species	Taxon	IUCN Red List Status	SA Red Data Book Status*	Preliminary Regional Assessment	Gauteng endemic
			Butterflies		
Aloeides dentatis dentatis	Butterfly	VUD2	Endangered/CD		Yes
Chrysoritis aureus	Butterfly	LR/nt	Endangered/CD		Near (Gauteng, OFS)
Metisella meninx	Butterfly	NE	Vulnerable		No
Gegenes hottentota	Butterfly	NE	Data deficient		No
			Spiders		
Harpactirella flavipilosa	Baboon spider	NE	NE	Data Deficient	No
Harpactira hamiltoni	Baboon spider	NE	NE: In Nature Conservation Ordinance 1983	Rare	Near (Gauteng, OFS, KZN)
Pycnacantha tribulus	Spider	NE	NE	Very Rare	No
Brachionopus pretoriae	Trapdoor spider	NE	NE	Data Deficient	Yes
Idiops fryi	Trapdoor spider	NE	NE	Rare	Near (Gauteng, OFS)
Idiops pretoriae	Trapdoor spider	NE	NE	Rare	Yes
Idiops gunningi	Trapdoor spider	NE	NE	Rare	Yes
Homostola pardalina	Trapdoor spider	NE	NE	Rare	Near (Gauteng, Mpumalanga)
Homostola zebrina	Trapdoor spider	NE	NE	Data Deficient	No
Galeosoma hirsutum	Trapdoor spider	NE	NE	Rare	Yes
Galeosoma pilosum	Trapdoor spider	NE	NE	Rare	Yes
Galeosoma robertsi	Trapdoor spider	NE	NE	Rare	Yes
Galeosoma planiscutatum	Trapdoor spider	NE	NE	Rare	Yes
Galeosoma pallidum	Trapdoor spider	NE	NE	Rare	Yes
Galeosoma scutatum	Trapdoor spider	NE	NE	Rare	Yes
Segregara monticola	Trapdoor spider	NE	NE	Rare	Yes
Segregara transvaalensis	Trapdoor spider	NE	NE	Rare	No
Moggridgea paucispina	Trapdoor spider	NE	NE	Rare	No
Ancylotrypa nuda	Trapdoor spider	NE	NE	Data deficient	Near (Gauteng, NW province)
Ancylotrypa rufescens	Trapdoor spider	NE	NE	Rare	Yes
Ancylotrypa brevipalpis	Trapdoor spider	NE	NE	Rare	Near (Gauteng, NW province)
Ancylotrypa pretoriae	Trapdoor spider	NE	NE	Data deficient	Near (Gauteng, NW province)
Gorgyrella schreineri minor	Trapdoor spider	NE	NE	Data deficient	Yes
Stasimopus robertsi	Trapdoor spider	NE	NE	Rare	No
Stasimopus suffucus	Trapdoor spider	NE	NE	Rare	Yes
Stasimopus oculatus	Trapdoor spider	NE	NE	Rare	No
Calommata simoni	Trapdoor spider	NE	NE	Very Rare	Yes
			Scorpions		
Hadogenes gunningi	Scorpion	NE	NE	Threatened	Near (Gauteng, NW province)
Hadogenes gracilis	Scorpion	NE	NE	Threatened	Marginal in Gauteng (NW province species)
Hadogenes longimanus	Scorpion	NE		Threatened	Marginal in Gauteng (Mpumalanga species)
Opistophthalmus pugnax	Scorpion	NE	NE	Endangered	Near (Gauteng, NW province)

NE = Not Evaluated – these species have not yet been assessed against the criteria for extinction risk (IUCN Red List or SA Red Data Book).
Data Deficient: Insufficient data to determine the degree of threat/extinction risk.
Preliminary Regional Assessment: These species depict the preliminary assessment of extinction risk regionally done by Gauteng Nature Conservation/ Specialists using the Global IUCN Red List Criteria as guidelines.

WETLAND DELINEATION AND PES DETERMINATION OF THE AQUATIC RESOURCES IN THE VICINITY OF THE PROPOSED K56 ROAD NEAR DAINFERN IN NORTHERN JOHANNESBURG

Prepared for:

Bokamoso Environmental Consultants

Section D: Wetland Assessment

Prepared by:	**Scientific Aquatic Services**
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Report Reference:	**SAS 212023**
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EXECUTIVE SUMMARY

Scientific Aquatic Services was appointed by Bokamoso Landscape Architects and Environmental Consultants to conduct a wetland delineation, PES determination and WET Ecoservices assessment for the proposed K56 road through an area of the Dainfern suburb in Northern Johannesburg. This document presents the results obtained during the function and Present Ecological State assessment of the aquatic ecosystems and the wetland delineations in the vicinity of the study area in April 2012. A summary of the conclusions is presented below;

- The subject property falls within the Highveld Aquatic Ecoregion and is located within the A21C quaternary catchment in the Limpopo catchment.
- Four wetland features were identified within the study area at the time of the assessment.
- The wetland features can be described as a riverine system, upper perennial, aquatic bed wetland feature, a riverine system, lower perennial, aquatic bed feature, and the final two as palustrine, valley bottom, aquatic bed features.
- The wetland features comprised a wide range of indigenous and alien vegetation within the riparian zone, some of which is protected.
- The terrain units comprised a perennial river within the riparian zone boundary.
- The wetland 1 PES falls within class B – largely natural with few modifications. This area is in a very good condition, despite being within a busy, northern Johannesburg suburb. The wetland water quality is good, and there are few unnatural hydrological alterations or incisions. Some alien vegetation does exist within the wetland. The wetland 2 PES falls within a class D – largely modified. This riparian wetland is formed along the banks of the Jukskei River where scouring of boulders under conditions of heavy floods cause deposition of sand along the river banks during low flow periods, highly modifying the aquatic habitat and water quality. The wetlands 3 and 4 also fall within a class D – largely modified – as the wetlands have been canalised to make way for a school.
- The EMC class deemed appropriate to maintain current ecology as well as functionality of wetland 1 is class B – largely natural with few modifications. In order to achieve this, it is recommended that no activities associated with the construction of the K56 road be allowed within the wetland and associated buffer zone. The EMC class considered appropriate for wetland 2 is class D- largely modified, largely due to aquatic habitat and water quality modification. Construction may occur within this area as long as correct mitigation measures are followed and given compliance with all relevant legislation obtained. The EMC class considered appropriate for wetlands 3 and 4 is class D- largely modified, largely due to canalisation of the wetland. It is recommended that no activities associated with the K56 road be allowed within this wetland and buffer zone as the road would run directly through a school.
- A 32m buffer in terms of the GDARD Minimum Requirements for Biodiversity Assessments (2009), prescribed for areas which fall within the Urban Edge has been listen within the document. The subject property falls within the Urban Edge and in terms of the above regulations, a 32m buffer is prescribed.

Recommendations

- No construction should occur within wetlands 1, 3 or 4 or the 32m buffer area.
- Construction may occur within wetland 2 as long as the recommendations listed at the end of this document are followed and all necessary legislative approval is obtained.

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1. PROJECT OBJECTIVES AND SCOPE

Scientific Aquatic Services was appointed by Bokamoso Landscape Architects and Environmental Consultants to conduct a wetland delineation and PES determination for the proposed development of the K56 road through a portion of the Dainfern suburb in northern Johannesburg. This document presents the results obtained during the ecological survey of the wetland systems in the study area in April 2012.

In the study it was endeavored to determine the boundary of the wetland areas and to determine the extent to which a large road constructed in the area would impact on the wetland. In order to manage these features and understand the Environmental importance and sensitivity, it is important to define the Present Ecological State of the system and understand the functioning of the system and the environmental and socio-cultural services that the systems provide. Once these aspects have been considered, the Recommended Ecological Category (REC) can be defined. This document presents the results obtained during the assessment of the wetlands in the vicinity of the proposed study area.

Four wetland features were identified within the study area located within the Highveld Aquatic Ecoregion (quaternary catchment A21C). One of these is a wetland in a good condition, not far from a residential development, the second is the more degraded riparian wetland alongside the banks of the Jukskei River and the third and fourth are also degraded owing to canalisation. The wetland features were assessed to ascertain suitable buffers to minimise any impact the proposed development will have on wetland and riparian zone habitat.

It is the objective of the study to provide detailed information to guide the development on the subject property in the vicinity of wetland areas to ensure that the ongoing functioning of the wetlands is facilitated with specific mention of the following:

- To ensure that connectivity of the wetland areas is maintained between the areas upstream and downstream of the proposed development;
- To ensure on-going, existing functioning of the wetland areas in the vicinity of the proposed development;
- To ensure that existing permanent, seasonal and temporary wetland zone functionality is maintained through provision of measures to ensure that soil wetting conditions are maintained; and

- To ensure that no incision and canalisation of the wetland systems takes place as a result of the proposed development.

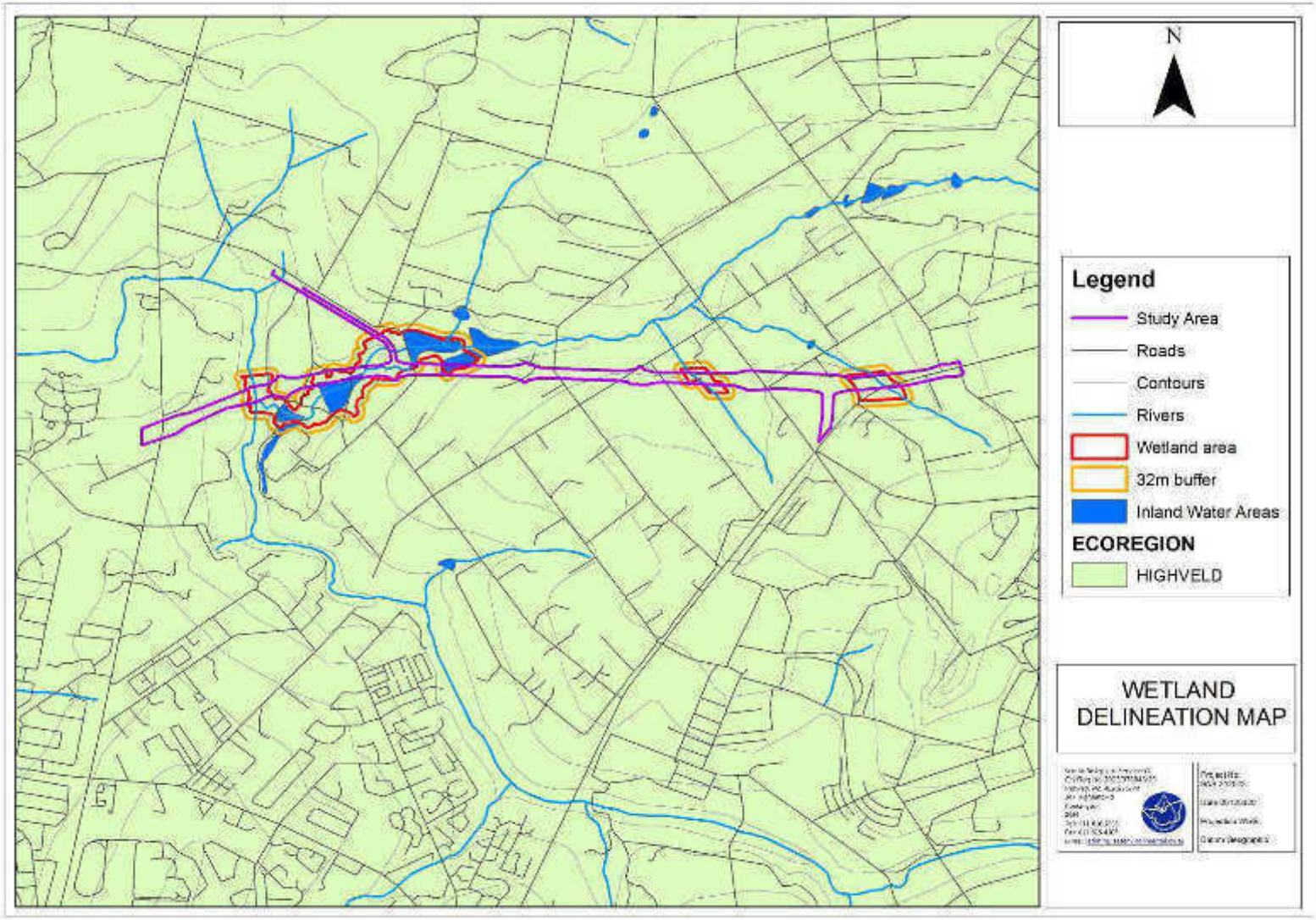

Figure 1: Ecoregions in the vicinity of the study area.

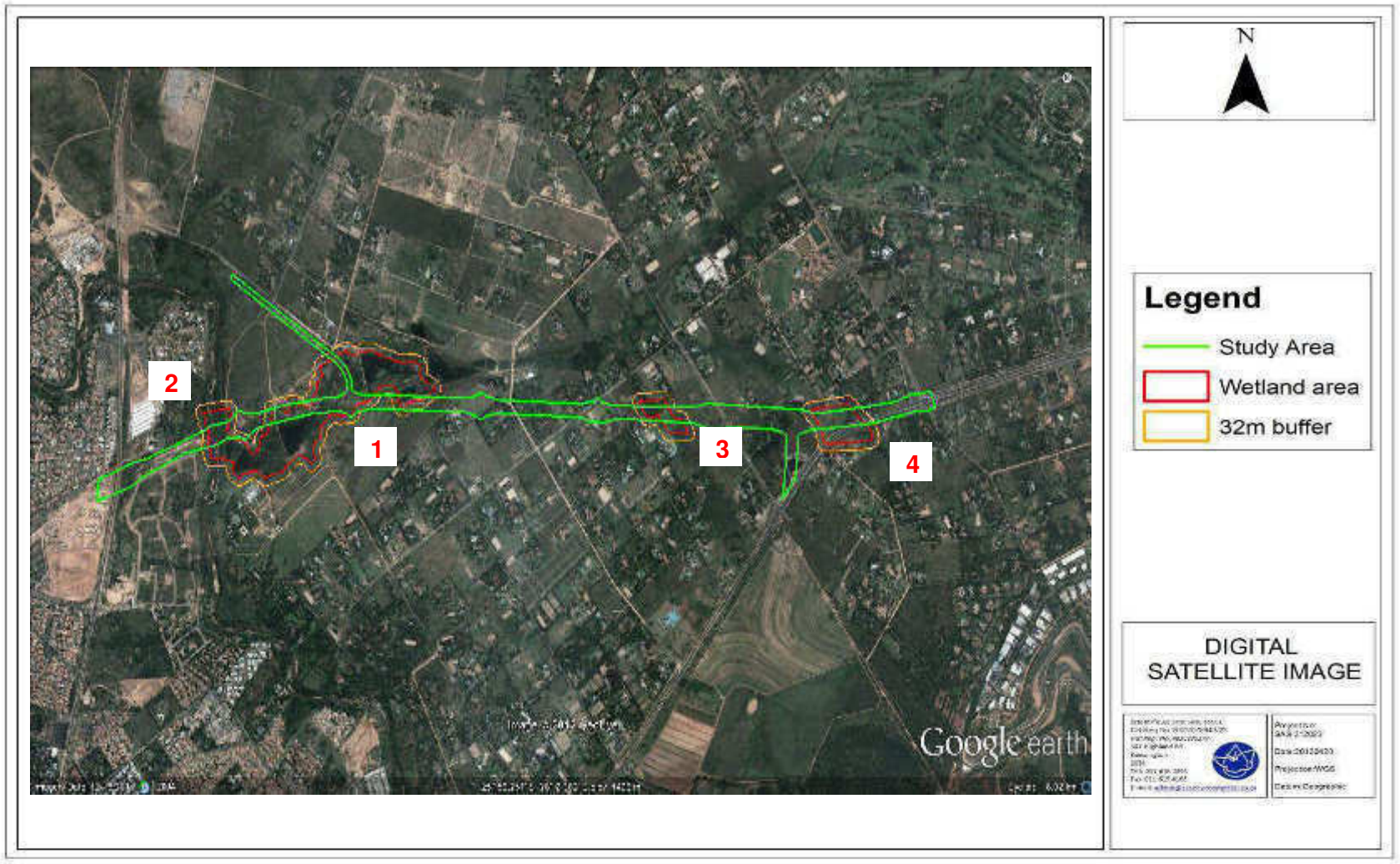

Figure 2: Aerial photograph depicting subject property boundaries (green).

1.1 Legislative requirements

Gauteng Department of Agriculture and Rural Development (GDARD) requirements as stipulated in *GDACE Requirements for Biodiversity Assessments Version 2*, February 2009:

- Wetland buffer requirements:
  - 30 meters from the temporary zone for wetlands occurring inside the urban edge;
  - 50 meters from the temporary zone for wetlands occurring outside the urban edge and
  - Larger buffer areas for wetlands supporting sensitive faunal or floral species.
- Rivers (non-perennial/perennial) buffer requirements:
  - A 100 meter buffer zone from the edge of the temporary zone outside the urban edge;
  - A 32 meter buffer zone from the edge of the temporary zone inside the urban edge and
  - Larger buffer areas for aquatic ecosystems supporting sensitive species.
- All wetland and riparian zones with protective buffer zones must be clearly demarcated as sensitive and illustrated with a sensitivity map.
- If the wetland is degraded, appropriate rehabilitation measures should be included.

National Water Act

- The water act recognises that the entire ecosystem and not just the water itself in any given water resource constitutes the resource and as such needs to be conserved.
- No activity may therefore take place within a water course unless it is authorised by the Department of Water Affairs and Environment (DWAE).
- Any area within a wetland or riparian zone is therefore excluded from development unless authorisation is obtained from DWAE in terms of Section 21 (C&I).

National Environmental Management Act

- The National Environmental Management Act (Act 107 of 1998) and the associated Regulations (No R. 544 and No R. 545) as amended in June 2010, states that prior to any development taking place within a wetland or riparian area, an environmental authorisation process needs to be followed. This could follow either the Basic assessment process or the EIA assessment process depending on the scale of the impact.

City of Johannesburg Wetland Mapping

Below has been included a City of Johannesburg (CoJ) wetland map to illustrate how it overlaps with the wetland mapping performed within this project;

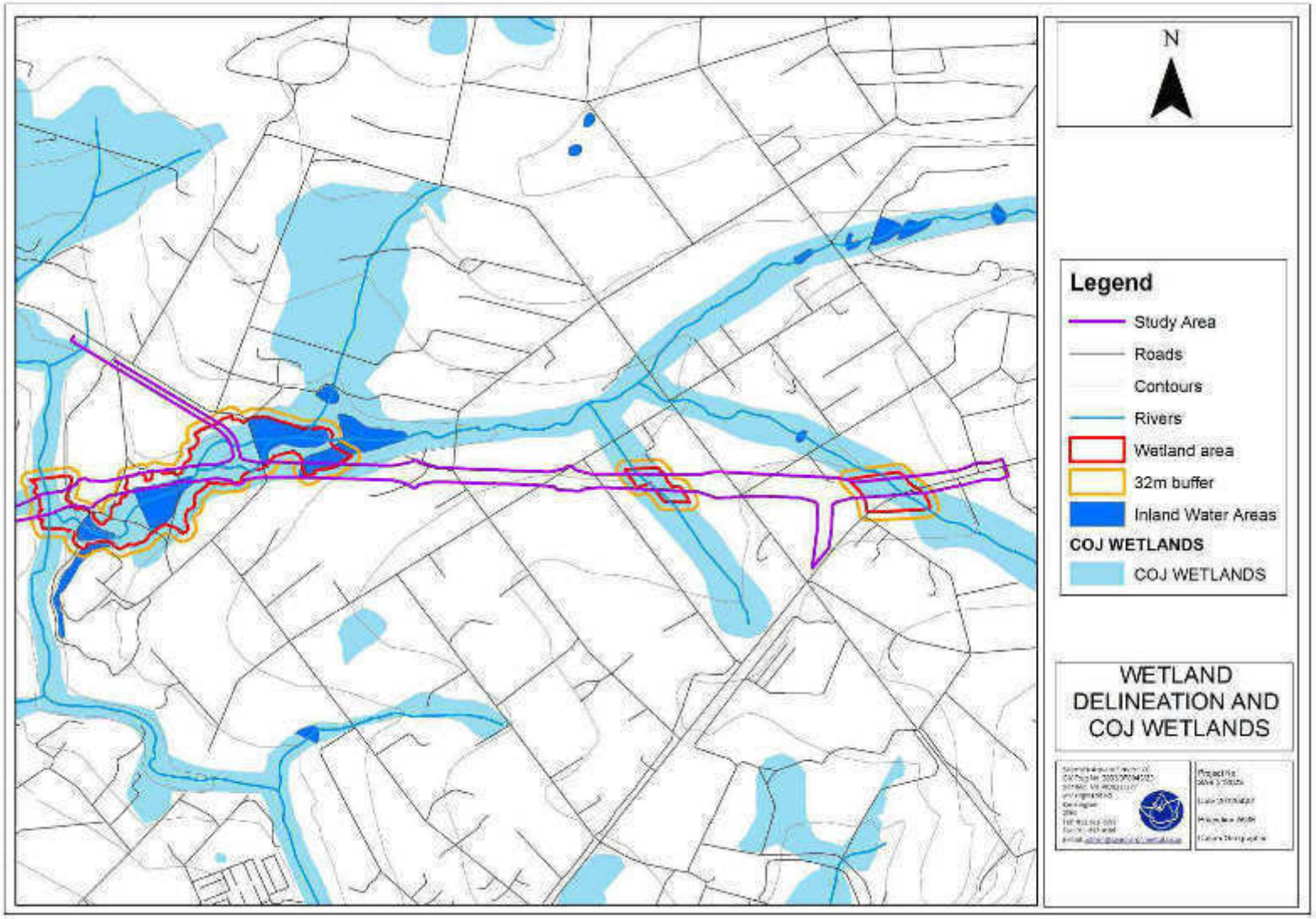

Figure 3: City of Johannesburg Wetland Areas in relation to the projects and delineated wetlands

2. WETLAND ASSESSMENT METHODOLOGY

2.1 South African Wetland Assessment Classification System

All wetland and riparian features encountered within the study area were assessed using *the South African Wetland Classification System* as ascribed within the *Resource Directed Measures for Protection of Water Resources* (1999). This was done in order to achieve the Recommended Ecological Category (REC) of the wetland features. The methodology followed is illustrated in the figure below, followed by a detailed discussion of each section.

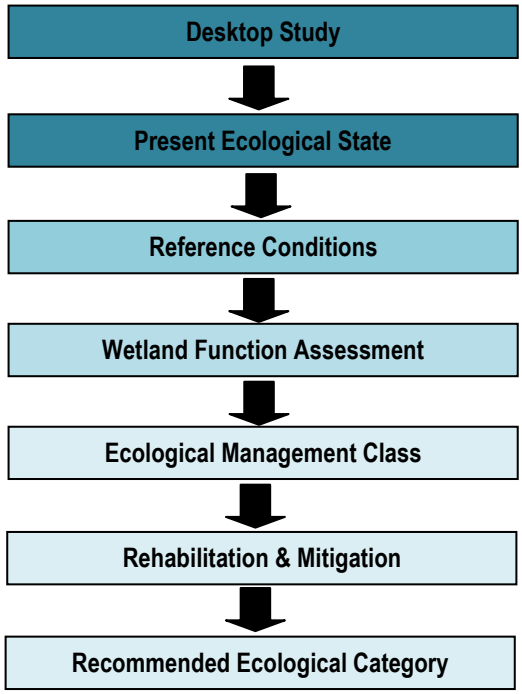

Figure 4: Wetland determination flow chart.

2.2 Present Ecological State (PES)

A site visit was undertaken in order to identify all natural characteristics of the wetland features within the subject property, followed by characterisation of all wetland systems using the flow chart with definitions as stipulated below.

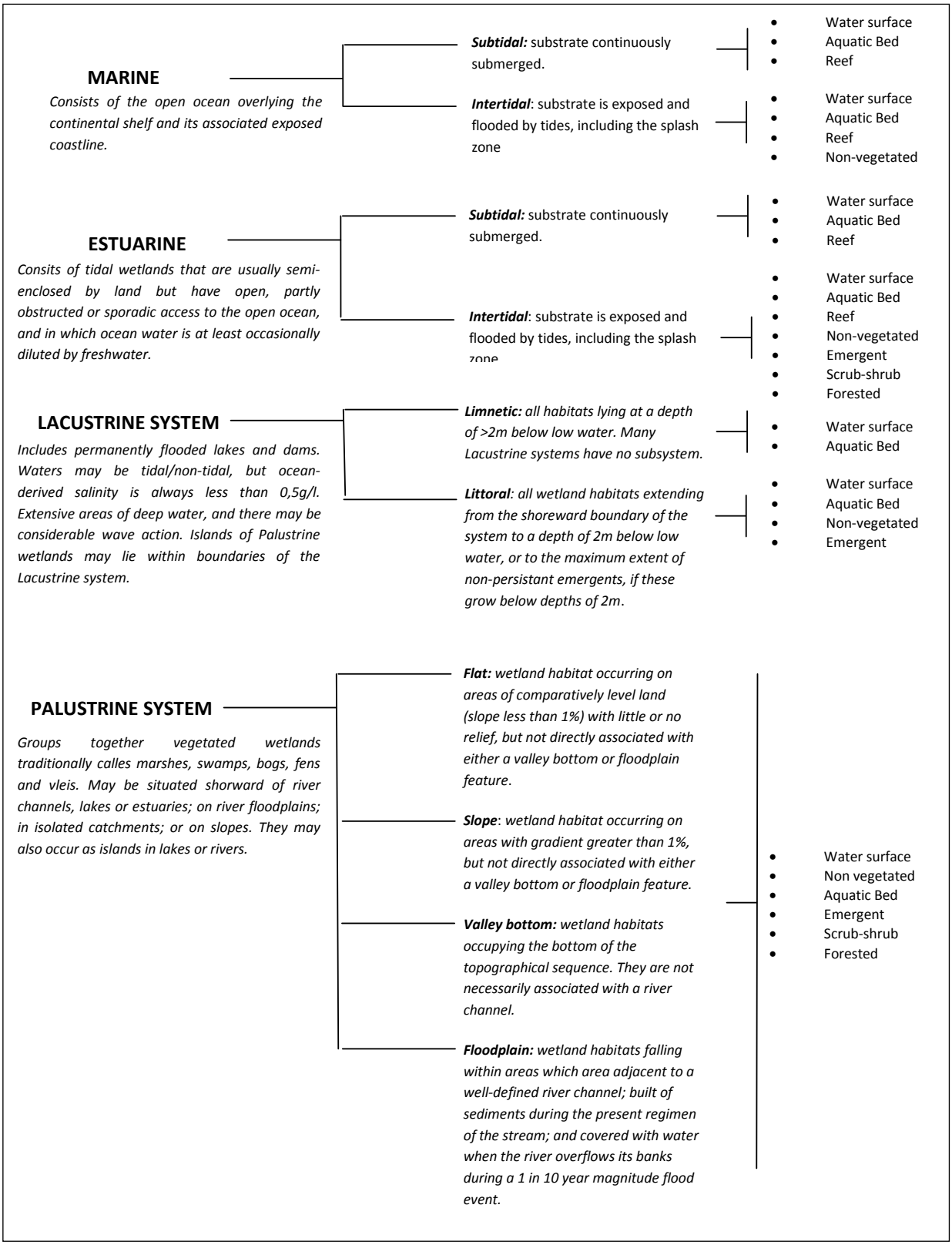

Figure 5: Wetland system characterisation.

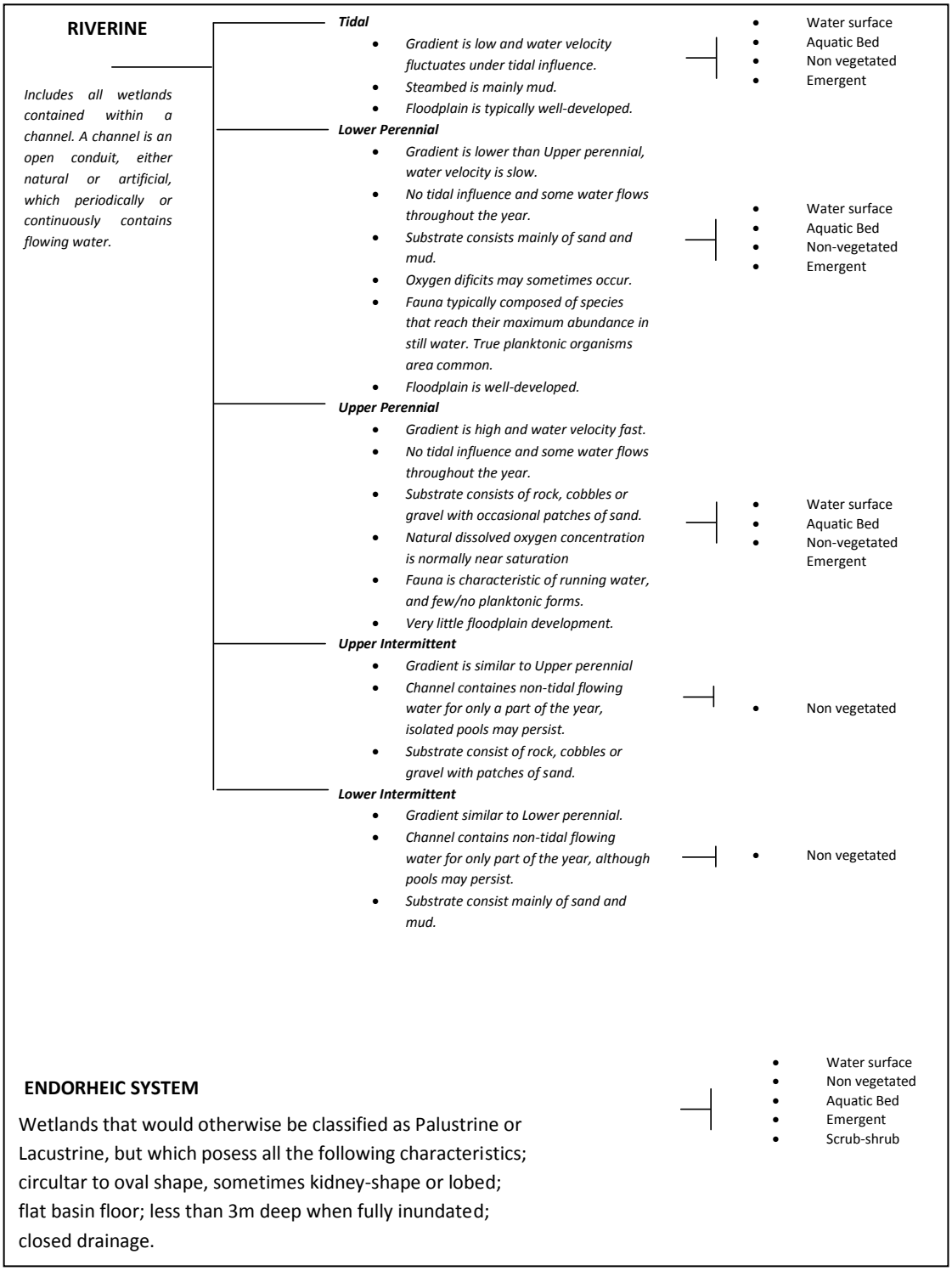

Figure 6: Wetland system characterisation[1] (continued).

After wetland systems have been classified according to the characteristics stipulated above, it is important to determine any modifying aspects that may have altered the natural ecological state of the wetland system. *Resource Directed Measures (*RDM) (Dini, J; Cowan, G. & Goodman, P. First

Department of Water Affairs and Forestry, South Africa *Version 1.0 of Resource Directed Measures for Protection of Water Resources, 1999* [Appendix W1][1]

Draft: DWAF, *Version 1.0, 1999*) identifies three groups of modifiers: Water Regime Modifiers, Water Chemistry Modifiers, and Artificial Modifiers. A desktop study as well as the field assessment was used in order to determine any of these modifiers present at the subject property.

All the information gathered as well as hydrology-, hydraulic/geomorphic-, biological criteria and water quality were then used to assign a Present Ecological Status (PES) for the wetland features. The table below lists the attributes as well as criteria assessed during the PES assessment.

Table 1: Criteria and attributes assessed during the determination of the PES.

Criteria and attributes	
Hydrologic	**Hydraulic/Geomorphic**
Flow modification	Canalisation
Permanent Inundation	Topographic Alteration
Water Quality	**Biota**
Water Quality Modification	Terrestrial Encroachment
Sediment load modification	Indigenous Vegetation Removal
	Invasive plant encroachment
	Alien fauna
	Over utilization of biota

Each of the attributes where given a score according to ecological state observed during the site visit, as well as a confidence score to indicate areas of uncertainty (table below).

Table 2: Scoring guidelines.

Scoring guidelines		Relative confidence score	
Natural, unmodified	**5**	Very high	**4**
Largely natural	**4**	High	**3**
Moderately modified	**3**	Moderate	**2**
Largely modified	**2**	Low	**1**
Seriously modified	**1**		
Critically modified	**0**		

A mean score for all attributes were then calculated and the final score was then used in the Present Ecological Status category determination as indicated in the table below.

Table 3: Present Ecological Status Category descriptions[2]

Score	Class	Description
>4	A	Unmodified, natural
>3 and <=4	B	Largely natural with few modifications
>2 and <=3	C	Moderately modified
2	D	Largely modified
>0 and <2	E	Seriously modified
0	F	Critically modified

2.3 Wetland function assessment

"The importance of a water resource, in ecological social or economic terms, acts as a modifying or motivating determinant in the selection of the management class".[3] The assessment of the ecosystem services supplied by the identified wetlands was conducted according to the guidelines as described by Kotze *et al* (2005). An assessment was undertaken that examines and rates the following services according to their degree of importance and the degree to which the service is provided:

- Flood attenuation
- Stream flow regulation
- Sediment trapping
- Phosphate trapping
- Nitrate removal
- Toxicant removal
- Erosion control
- Carbon storage
- Maintenance of biodiversity
- Water supply for human use
- Natural resources
- Cultivated foods
- Cultural significance
- Tourism and recreation
- Education and research

[2] Department of Water Affairs and Forestry, South Africa *Version 1.0 of Resource Directed Measures for Protection of Water Resources, 1999* [Table G2].

[3] Department of Water Affairs and Forestry, South Africa *Version 1.0 of Resource Directed Measures for Protection of Water Resources, 1999*

The characteristics were used to quantitatively determine the value, and by extension sensitivity, of the wetlands. Each characteristic was scored to give the likelihood that the service is being provided. The scores for each service were then averaged to give an overall score to the wetland.

Table 4: Classes for determining the likely extent to which a benefit is being supplied.

Score	Rating of the likely extent to which the benefit is being supplied
<0.5	Low
0.6-1.2	Moderately low
1.3-2	Intermediate
2.1-3	Moderately high
>3	High

2.4 Ecological Management Class

"A high management class relates to the flow that will ensure a high degree of sustainability and a low risk of ecosystem failure. A low management class will ensure marginal maintenance of sustainability, but carries a higher risk of ecosystem failure." [4]

The Ecological Management Class (EMC) was determined based on the results obtained from the PES, reference conditions and Ecological Importance and Sensitivity of the resource (sections above). Followed by realistic recommendations, mitigation, and rehabilitation measures to achieve the desired EMC.

A wetland may receive the same class for the PES, as the EMC if the wetland is deemed in good condition, and therefore must stay in good condition. Otherwise, an appropriate EMC should be assigned in order to prevent any further degradation as well as to enhance the PES of the wetland feature.

Table 5: Description of EMC classes.

Class	Description
A	Unmodified, natural
B	Largely natural with few modifications
C	Moderately modified
D	Largely modified

[4] Department of Water Affairs and Forestry, South Africa *Version 1.0 of Resource Directed Measures for Protection of Water Resources 1999*

2.5 Wetland delineation

For the purposes of this investigation, a wetland habitat is defined in the National Water Act (1998) as including the physical structure and associated vegetation of the areas associated with a watercourse which are commonly characterised by alluvial soils, and which are inundated or flooded to an extent and with a frequency sufficient to support vegetation of species with a composition and physical structure distinct from those of adjacent areas.

The wetland zone delineation took place according to the method presented in the final draft of "A practical field procedure for identification and delineation of wetlands and riparian areas" published by the department of Water Affairs in February 2005. The foundation of the method is based on the fact that wetlands and riparian zones have several distinguishing factors including the following:

- The presence of water at or near the ground surface;
- Distinctive hydromorphic soils;
- Vegetation adapted to saturated soils and
- The presence of alluvial soils in stream systems.

By observing the evidence of these features, in the form of indicators, wetlands and riparian zones can be delineated and identified. If the use of these indicators and the interpretation of the findings are applied correctly, then the resulting delineation can be considered accurate (DWAF 2005).

Riparian and wetland zones can be divided into three zones (DWAF 2005). The permanent zone of wetness is nearly always saturated. The seasonal zone is saturated for a significant part of the rainy season and the temporary zone surrounds the seasonal zone and is only saturated for a short period of the year, but is saturated for a sufficient period, under normal circumstances, to allow for the formation of hydromorphic soils and the growth of wetland vegetation. The object of this study was to identify the outer boundary of the temporary zone and then to identify a suitable buffer zone around the wetland area.

3. RESULTS OF INVESTIGATION

3.1 South African Wetland Assessment Classification System

3.1.1 Ecoregions

When assessing the ecology of any area (aquatic or terrestrial), it is important to know which ecoregion the subject property is located within. This knowledge allows for improved interpretation of data to be made, since reference information and representative species lists are often available on this level of assessment, which aids in guiding the assessment.

The subject property falls within the Highveld Aquatic Ecoregion and is located within the A21C quaternary catchment in the Limpopo drainage system.

Studies undertaken by the Institute for Water Quality Studies assessed all quaternary catchments as part of the Resource Directed Measures for Protection of Water Resources. In these assessments, the Ecological Importance and Sensitivity (EIS), Present Ecological Management Class (PEMC) and Desired Ecological Management Class (DEMC) were defined and serve as a useful guideline in determining the importance and sensitivity of aquatic ecosystems prior to assessment or as part of a desktop assessment.

This database was searched for the quaternary catchment of concern in order to define the EIS, PEMC and DEMC. The findings are based on a study undertaken by Kleynhans (1999) as part of "A procedure for the determination of the ecological reserve for the purpose of the national water balance model for South African rivers". The results of the assessment are summarised in the table below.

Table 6: Summary of the ecological status of quaternary catchments based on Kleynhans 1999

Catchment	Resource	EIS	DEMC	PESC	PESC with rules as for desktop WBM
A21C	Jukskei River	Moderate	C: Moderately sensitive system	Class C	Class D: Largely Modified

The points below summarise the impacts on the aquatic resources in the A21C quaternary catchment (Kleynhans 1999):

- The aquatic resources within this quaternary catchment have been moderately affected by bed modification.

- A moderate impact on the flow regime of the system has occurred due to larger floods and a Mean Annual Runoff (MAR) which is 17% larger than natural.
- A low impact from introduction of fish species to the system has occurred with special mention of *GAFF and CCAR*.
- Impacts as a result of inundation are low, inundation which does occur occurs as a result of weirs.
- Riparian zones and stream bank conditions have been moderately impacted due to the effects of exotics.
- High impacts on water quality are noted.

In terms of ecological functions, importance and sensitivity, the following points summarise the conditions in the A21C quaternary catchment (Kleynhans 1999):

- The riverine system in this catchment has a high diversity of habitat types, including wetlands, cascades, riffles and pools.
- The site has a moderate importance in terms of conservation with the Ebenezer reserve nearby.
- Biota in this system has a moderate sensitivity to flow requirements with special mention of the invertebrate community as well as the fish species *Amphilius uranosccopus* and *Barbus eutaenia*.
- This area has a moderate importance in terms of migration of aquatic species.
- This area is considered to have a very high importance in terms of rare and endangered species, however, in terms of endemic species conservation the area is considered important with special mention of *Amphilius uranosccopus* and *Barbus eutaenia*.
- This area is important in terms of providing refuge areas for aquatic taxa.
- The ecology of this area is considered to have a moderate sensitivity to changes in water quality with special mention of concerns over altered temperature regimes and dissolved oxygen concentrations.
- The ecology of the area is sensitive to changes in flows with special mention of the need to have perennial rapids present with good water quality.
- The system has a high diversity of fish species and it is suspected that the aquatic macro-invertebrate community was more diverse in the past

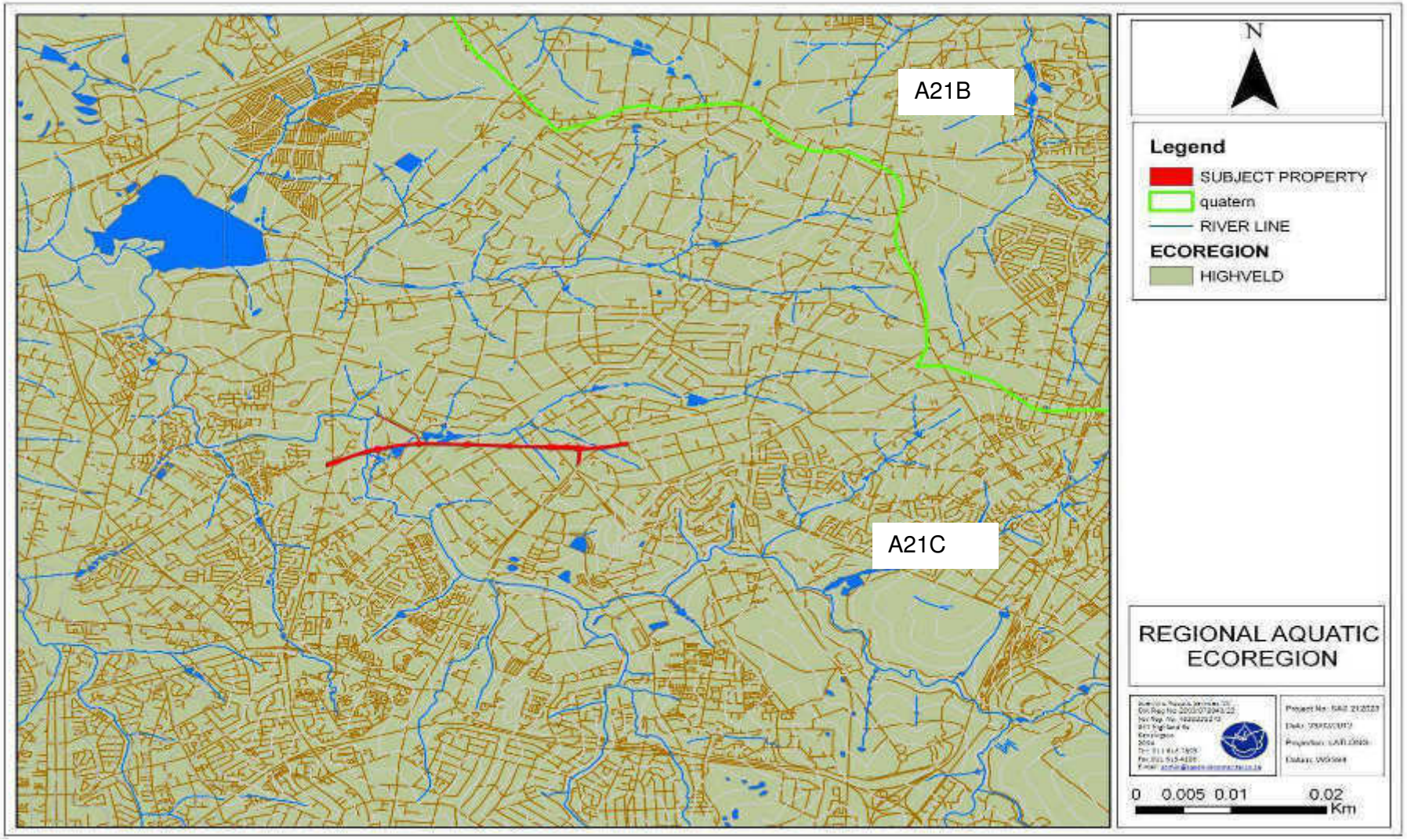

Figure 7: Quaternary catchments in the vicinity of the study area

3.1.2 Wetland System Characterisation

The wetland features identified during the assessment of the study area were categorised with the use of the Wetland System Characterisation Methodology and results illustrated in the figures below.

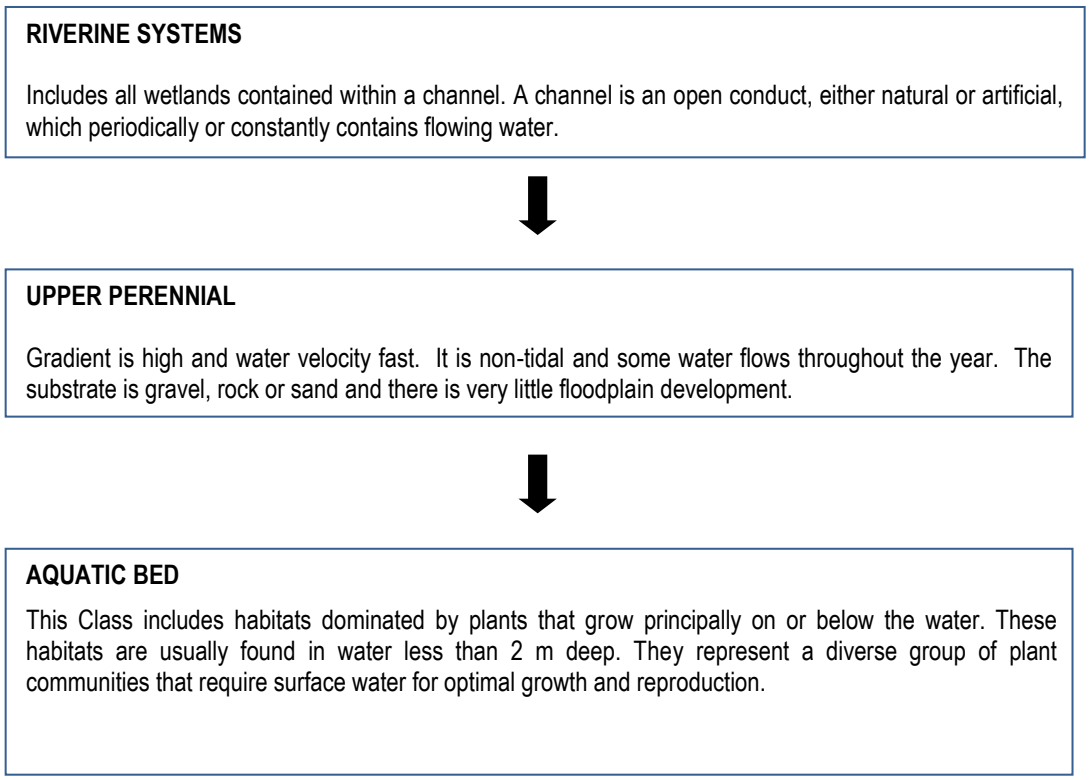

Figure 8: Wetland categorisation for the first wetland feature.

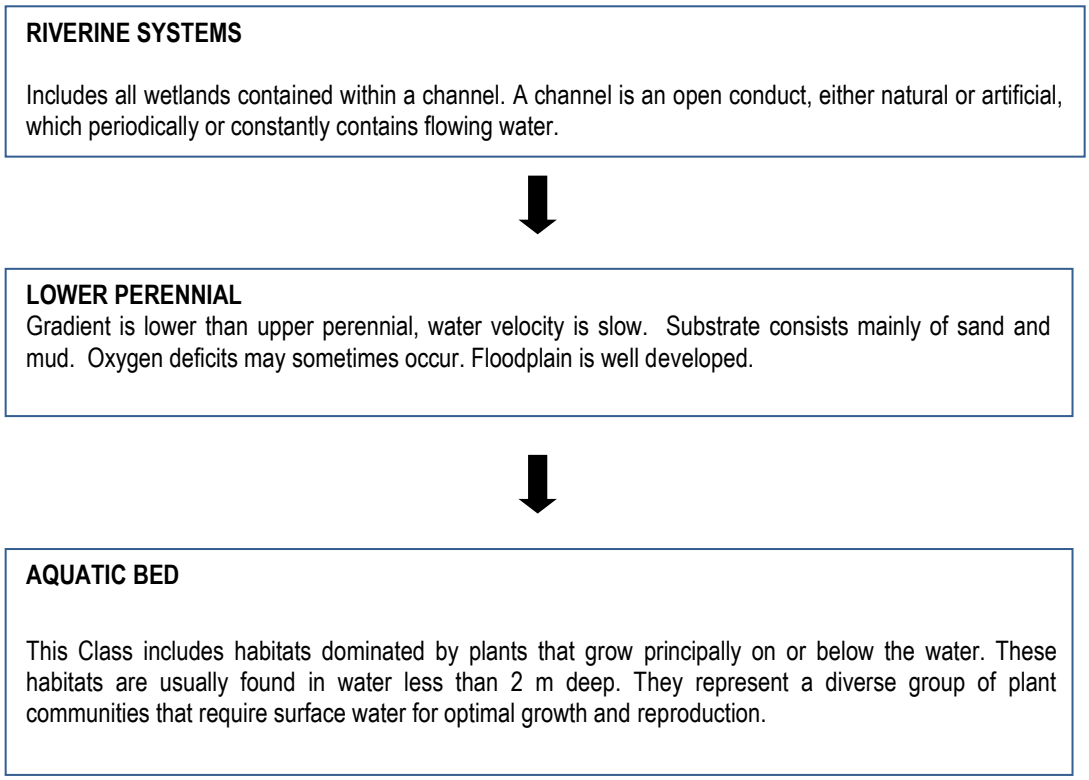

Figure 9: Wetland categorisation for the second wetland feature.

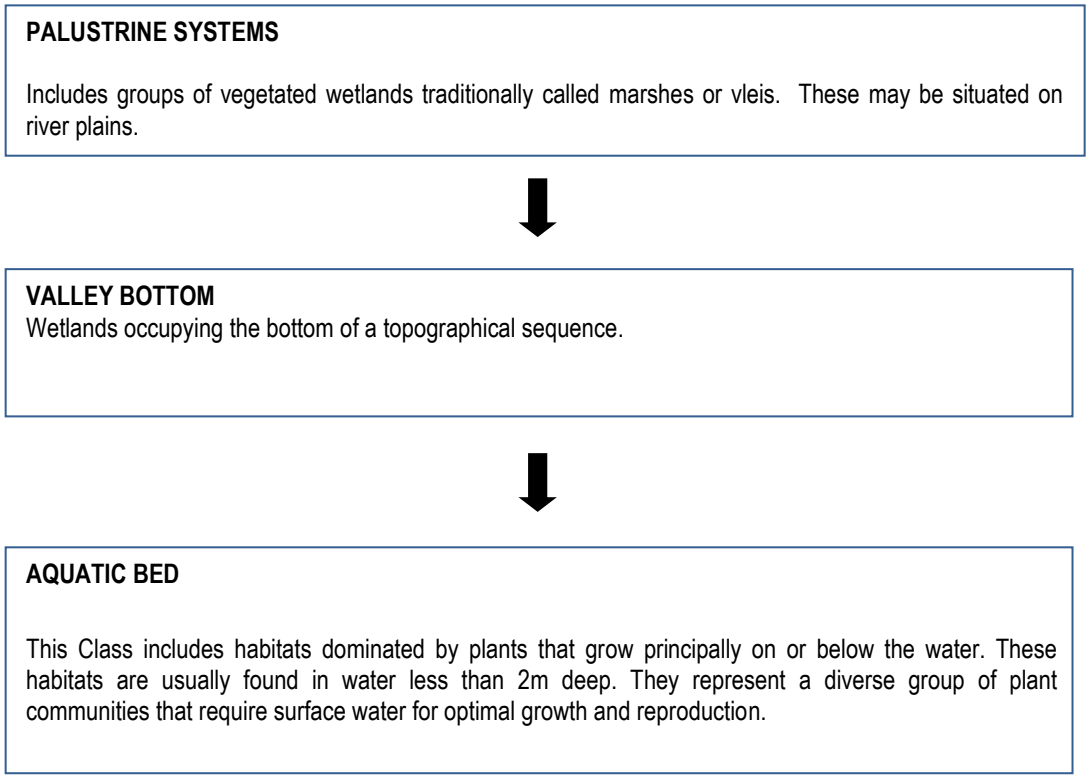

Figure 10: Wetland categorisation for the third and fourth wetland features.

- The three, abovementioned wetland features types identified within the study area at the time of the assessment can be described as; wetland 1; a Riverine system, upper perennial, Aquatic bed wetland feature, wetland 2; a Riverine system, lower perennial, Aquatic bed wetland feature and wetlands 3 and 4; Palustrine, valley bottom, Aquatic bed features. Gradient of the Lower Perennial System is lower than that of the Upper Perennial Subsystem and water velocity is slow.
- The wetland features comprised of a wide range of typical wetland flora within the riparian zone at the time of the assessment.

3.1.3 Wetland Function Assessment

Wetland function and service provision were assessed for the 4 wetland features within the subject property, but wetlands 3 and 4 are similar enough to have been considered together for this analysis. The average score for the wetlands are presented in the following table as well as the radar plot in the figure that follows the table.

Table 7: Wetland functions and service provision for the wetlands

Ecosystem service	Wetland 1	Wetland 2	Wetlands 3 & 4
Flood attenuation	2.0	1.3	1.6
Streamflow regulation	2.5	1.8	1.8
Sediment trapping	2.8	1.4	1.2
Phosphate assimilation	2.8	1.2	1.2
Nitrate assimilation	3.3	1.5	1.3
Toxicant assimilation	3.0	1.6	1.4
Erosion control	3.1	0.0	0.5
Biodiversity maintenance	3.0	0.9	0.6
Carbon Storage	2.3	2.0	1.0
Water Supply	1.3	1.0	1.0
Harvestable resources	0	0.2	0.8
Cultivated foods	0	0.2	0.8
Cultural significance	0	0	0
Tourism and recreation	2.1	0.1	0.1
Education and resource	1.8	0.5	0.5
SUM	**30.1**	**13.7**	**13.9**
Average score	**2.0**	**0.9**	**0.9**

From the results of the assessment, it is evident that wetland feature 1 has a moderately high level of ecological function and service provision. The wetland feature is the most important in terms of nitrate assimilation and erosion control. It also plays a significant role in streamflow regulation,

sediment trapping, phosphate assimilation, toxicant assimilation, biodiversity maintenance and carbon storage. The results obtained can be attributed to the fact that the wetland feature has not been affected by the urban development in the area. The results also indicate that the system has no value in terms of socio-cultural, tourism and harvestable resources, but is attractive enough to encourage recreation and could serve as an educational aid.

From the results of the assessment, it is evident that wetland feature 2 has a moderately low level of ecological function and service provision. The wetland feature is moderately important in terms of flood attenuation, streamflow regulation, sediment trapping, nitrate assimilation and carbon storage. The results obtained can be attributed to the fact that the wetland feature is severely eroded. This is caused by dam overflows. There are weirs all along the Jukskei River, and flood waters scour the rocks along the system and then deposit sand along the river banks, causing serious habitat and water quality issues. The results also indicate that the system has no value in terms of socio-cultural, tourism, harvestable resources, recreation and as an educational aid.

From the results of the assessment, it is evident that wetland features 3 and 4 also have a moderately low level of ecological function and service provision. The wetland feature is moderately important in terms of flood attenuation, streamflow regulation, and nitrate assimilation. The results obtained can be attributed to the fact that the wetland feature has been canalised in order to build a school and is now dominated by kikuyu grass (*Pennisetum clandestinum*). Power cables pass directly overhead these wetlands. The results also indicate that the system has no value in terms of socio-cultural, tourism, harvestable resources, recreation and as an educational aid.

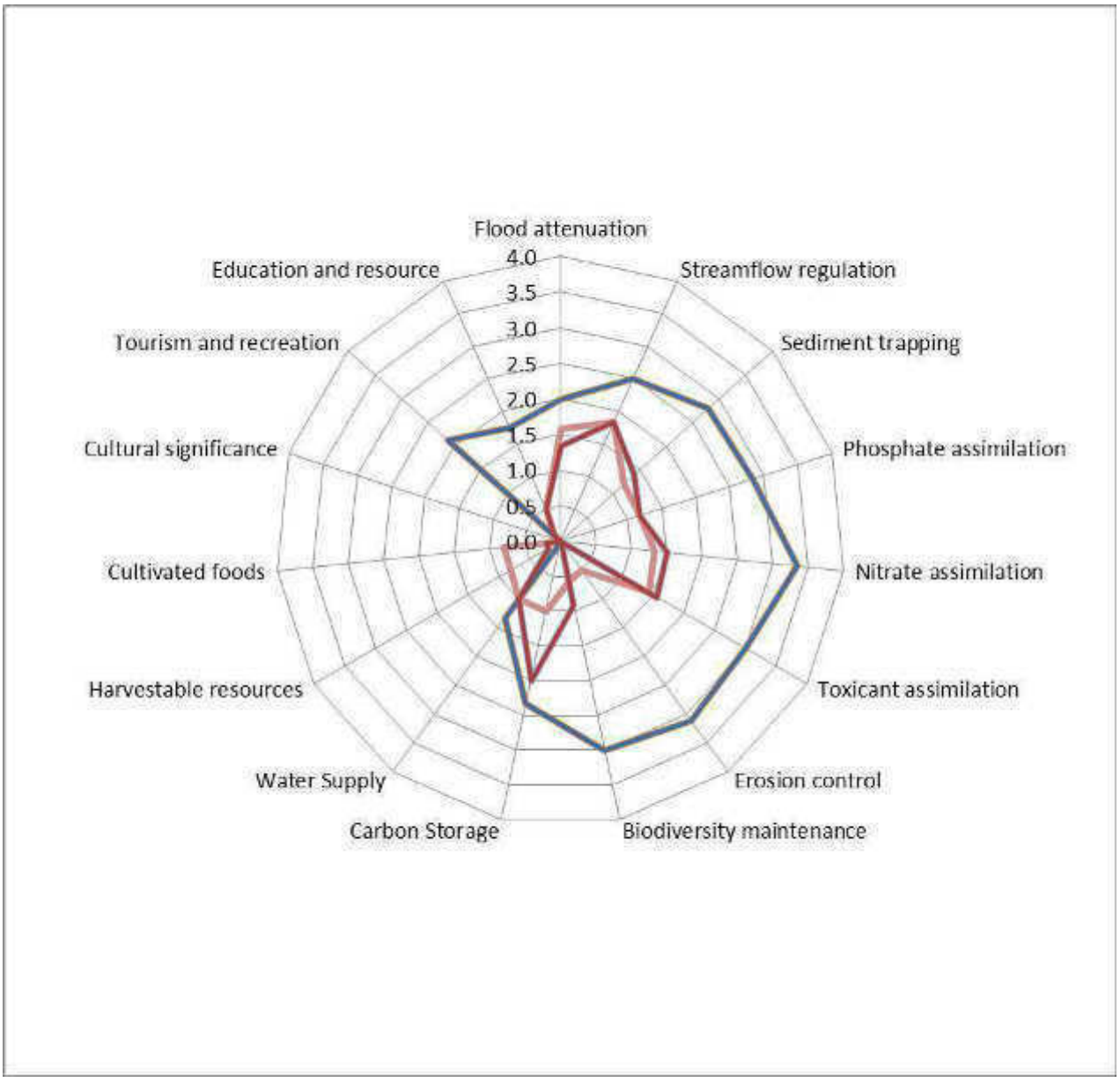

Figure 11: Radar plot of wetland services provided.

3.1.4 Present Ecological State

The result for the criteria and attributes used for the calculation of the PES is stipulated in the table below.

Table 8: Criteria and Attributes used with the calculation of the PES of wetland 1.

Criteria and Attributes	Score	Confidence
Hydrological		
Flow modification	4	4
Permanent Inundation	3	3
Water quality		
Water Quality Modification	4	4
Sediment load modification	4	4
Geomorphic		
Canalisation	4	4
Topographic Alteration	4	4
Biota		
Terrestrial Encroachment	3	3
Indigenous Vegetation Removal	4	3
Invasive plant encroachment	3	3
Alien fauna	3	3
Over utilization of biota	4	4
Total	40	
Mean	3.6	
PES Class	B	

The mean score obtained for wetland 1 was calculated as 3.6, indicating the PES of the wetland feature falls within class B – largely natural with few modifications. This is owing to the fact that the wetland has not been significantly affected by the surrounding urban development. The water quality is good, the wetland hydrology and geomorphology have not been altered and indigenous species were identified within the wetland.

Table 9: Criteria and Attributes used with the calculation of the PES of wetland 2.

Criteria and Attributes	Score	Confidence
Hydrological		
Flow modification	2	4
Permanent Inundation	3	3
Water quality		
Water Quality Modification	1	4
Sediment load modification	1	4
Geomorphic		
Canalisation	2	3
Topographic Alteration	2	3
Biota		
Terrestrial Encroachment	2	3
Indigenous Vegetation Removal	2	3
Invasive plant encroachment	3	3
Alien fauna	2	3
Over utilization of biota	2	3
Total	22	
Mean	2	
PES Class	D	

The mean score obtained for wetland 2 was calculated as 2, indicating the PES of the wetland feature falls within class D – largely modified. This is owing to the fact that the riparian wetland is severely scoured, leading to sand deposition and poor habitat and water quality values.

Table 10: Criteria and Attributes used with the calculation of the PES of wetland 2.

Criteria and Attributes	Score	Confidence
Hydrological		
Flow modification	2	4
Permanent Inundation	2	3
Water quality		
Water Quality Modification	2	4
Sediment load modification	2	4
Geomorphic		
Canalisation	1	4
Topographic Alteration	2	4
Biota		
Terrestrial Encroachment	2	3
Indigenous Vegetation Removal	2	3
Invasive plant encroachment	3	3
Alien fauna	2	4
Over utilization of biota	2	3
Total	22	
Mean	2	
PES Class	D	

The mean score obtained for wetlands 3 and 4 was calculated as 2, indicating the PES of the wetland feature falls within class D – largely modified. This is owing to the fact that the wetland has been totally canalised to make way for a school and is thus severely disturbed and dominated by alien vegetation.

3.1.5 Ecological Management Class

All results obtained from the South African Wetland Assessment Classification System that were used in the determination of the appropriate EMC class for wetland 1, are indicated in the table below. The results obtained from the wetland assessment indicate low transformation on all levels of ecology and functionality for the wetland unit. Therefore, the EMC class deemed appropriate to maintain current ecology as well as functionality is class B (largely natural with few modifications).

Table 11: Summary of results of the South African Assessment Classification System for wetland 1.

Name	Type	System Modifiers	PES	Wetland Function Assessment	EMC
Wetland 1	Riverine, Upper perennial, Aquatic bed	Invasive plant encroachment	Class B – Largely natural with few modifications	Moderately high level of function and service provision	Class B – Largely natural with few modifications

All results obtained from the South African Wetland Assessment Classification System that were used in the determination of the appropriate EMC class for wetland 2, are indicated in the table below. The results obtained from the wetland assessment indicate significant transformation on all levels of ecology and functionality for the wetland unit. Therefore, the EMC class deemed appropriate to maintain current ecology as well as functionality is class D (largely modified).

Table 12: Summary of results of the South African Assessment Classification System for wetland 2.

Name	Type	System Modifiers	PES	Wetland Function Assessment	EMC
Wetland 2	Riverine, Lower perennial, Aquatic bed	Geomorphological – scour and sand deposition	Class D – Largely modified	Moderately low level of function and service provision	Class D – Largely modified

All results obtained from the South African Wetland Assessment Classification System that were used in the determination of the appropriate EMC class for wetlands 3 and 4, are indicated in the table below. The results obtained from the wetland assessment indicate significant transformation on all levels of ecology and functionality for the wetland unit. Therefore, the EMC class deemed appropriate to maintain current ecology as well as functionality is class D (largely modified).

Table 13: Summary of results of the South African Assessment Classification System for wetlands 3 and 4.

Name	Type	System Modifiers	PES	Wetland Function Assessment	EMC
Wetlands 3 and 4	Palustrine Valley bottom, Aquatic bed	Canalisation, alien vegetation	Class D – Largely modified	Moderately low level of function and service provision	Class D – Largely modified

3.1.6 Wetland delineation and sensitivity mapping

Upon the assessment of the area, the various riparian vegetation components were assessed. Dominant species were characterised as either wetland/riparian or terrestrial species. The wetland species were then further categorised as temporary, seasonal and permanent zone species. This characterisation is presented in the table below, including the terrestrial species identified on the subject property.

Table 14: Floral species identified during the wetland zone delineation

Permanent	Seasonal	Temporary	Terrestrial Species
*Cyperus esculentus**	*Aristida junciformis*	*Buchnera reducta*	*Combretum erythrophyllum*
Cyperus ruprestis	*Conyza podocephala**	*Conyza podocephala**	*Cynodon dactylon*
Imperata cylindrica	*Cynodon dactylon*	*Cynodon dactylon*	*Diospyros lycioides*
Kylinga alba	*Eragrostis gummiflua*	*Eragrostis gummiflua*	*Hyparrhenia hirta*
Panicum schinzii	*Imperata cylindrica*	*Hyparrhenia hirta*	*Ligustrum japonicum**
*Pennisetum clandestinum**	*Pennisetum clandestinum**	*Pennisetum clandestinum**	*Pennisetum clandestinum**
*Persicaria lapathifolia**		*Senna didimobotrya**	*Searsia lancea*
Phragmites australis		*Setaria megaphylla*	*Searsia pyroides*
Schoenoplectus corymbosus		*Solanum mauritiuanum**	*Setaria megaphylla*
Sporobolus africanus		*Themeda triandra*	*Themeda triandra*
Typha capensis		*Verbena bonariensis**	

The figures below show the largely natural wetland 1 area and wetland 2.

Figure 12: Wooded riparian area where the proposed intersection is planned

Figure 13: The rocky stream where the proposed intersection is planned

Figure 14: General view of the wetland area

Figure 15: An artificial dam which will be affected by the proposed roadway development

Figure 16: Downstream view of the Jukskei River in the vicinity of the proposed crossing

Figure 17: Upstream view of the Jukskei River in the vicinity of the proposed crossing

After consideration of the findings during the wetland assessment, a 32m buffer has been indicated in the drawings below. A 32m buffer in terms of the GDARD Minimum Requirements for Biodiversity Assessments (2009) is prescribed for areas which fall within the Urban Edge. The subject property falls within the Urban Edge and in terms of the above regulations, a 32m buffer is generally prescribed.

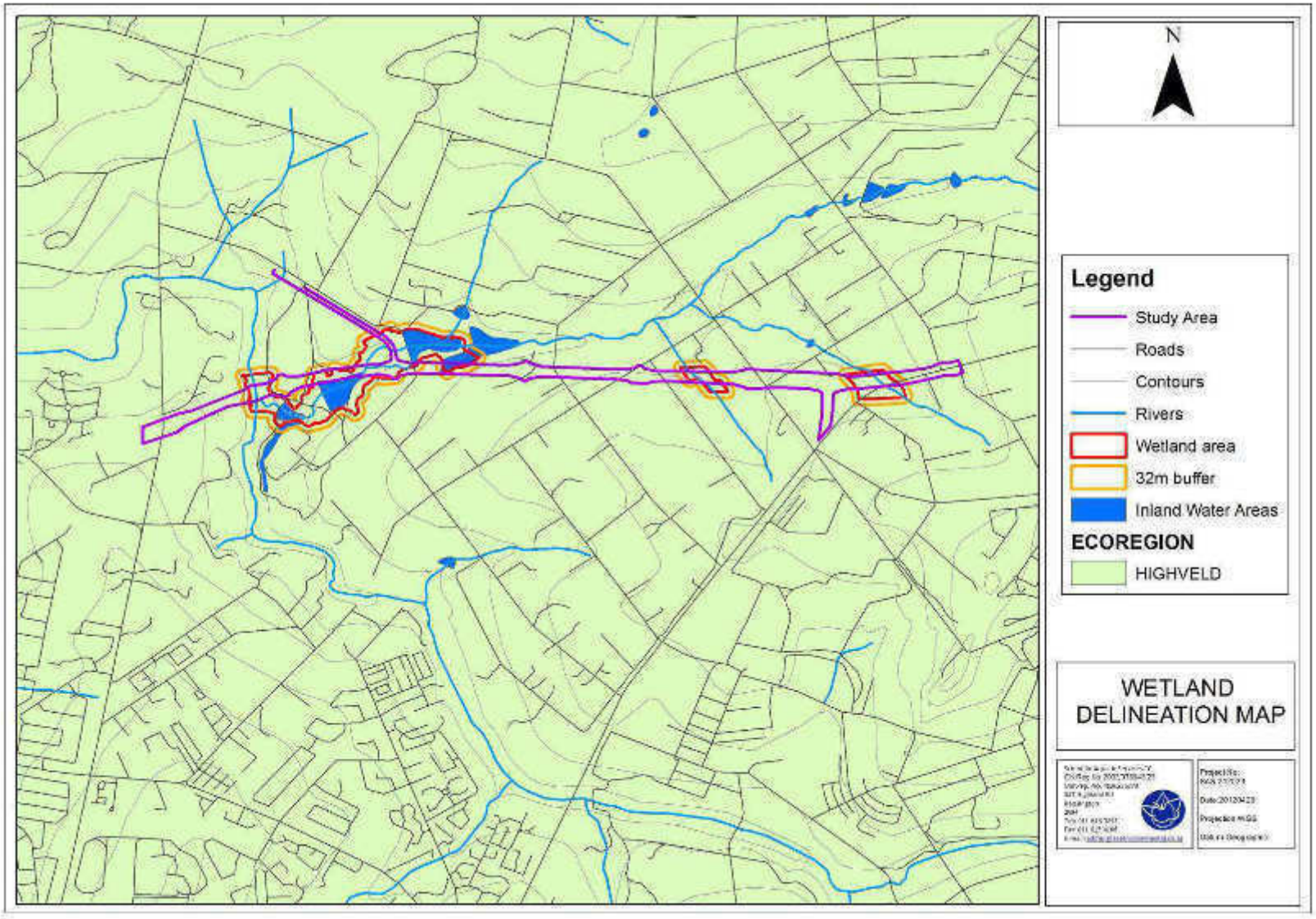

Figure 18: 32m wetland buffer (orange) presented on a map of the area

Table 15: Summary of wetland system characteristics.

Item	Description
Quaternary catchment	A21C
Aquatic ecoregion	Highveld Ecoregion
System Modifiers	Invasive plant encroachment, scour in wetland 2, canalisation in wetlands 3 and 4
Wetland system characterisation	Wetland 1: Riverine system, Upper perennial, Aquatic bed. Wetland 2: Riverine system, Lower perennial, aquatic bed Wetland 3: Channelled valley bottom wetland Wetland 4: Unchannelled valley bottom wetland
Wetland function and service provision	Wetland 1: Moderately high Wetland 2: Moderately low Wetland 3 and 4: Moderately low
Present Ecological State	Wetland 1: Class B – Largely natural with few modifications Wetland 2: Largely modified Wetland 3 and 4: Largely modified
Ecological Management Class	Wetland 1: Class B – Largely natural with few modifications Wetland 2: Largely modified Wetland 3 and 4: Largely modified
Soil form indicator	Gleying and mottling
Vegetation	Wetland vegetation dominated *pennisetum clandestinum* within the riparian zone

4. RECOMMENDATIONS AND IMPACT MINIMISATION

CONCLUSION AND RECOMMENDATIONS

The following general conclusions were drawn on completion of the survey:

- The subject property falls within the Highveld Aquatic Ecoregion and is located within the A21C quaternary catchment in the Limpopo catchment.
- Four wetland features were identified within the study area at the time of the assessment.
- Wetland feature 1 can be described as a Riverine system, Upper perennial, Aquatic bed wetland feature. Wetland 2 can be described as a Riverine system, Lower Perennial, Aquatic bed wetland feature. Wetland features 3 and 4 can be described as Palustrine system, Valley bottom, Aquatic bed features.
- The wetland features comprised of a range of wetland flora within the riparian zone as shown in Table 14.
- The wetland 1 PES falls within class B – largely natural with few modifications. This is due to the fact that the surrounding urban development has not significantly impacted the wetland. The wetland 2 PES falls within class D – largely modified - as the riparian wetland is affected by scour and sand deposition. Wetland 3 and 4 PES also falls within a class D – largely modified – as the wetland has been canalised.
- Therefore, the EMC class deemed appropriate to maintain current ecology as well as functionality in wetland 1 is class B (Largely natural with few modifications) and in wetlands 2, 3 and 4 is class D (Largely modified).
- A 32m buffer in terms of the GDARD Minimum Requirements for Biodiversity Assessments (2009) is shown for areas which fall within the Urban Edge. The subject property falls within the Urban Edge and in terms of the above regulations, a 32m buffer is prescribed.
- It is recommended that the proposed activities do not go ahead within wetland 1. The proposed activities may go ahead within wetland 2 as long as the recommended mitigation measures are adhered to and legal authorisation is

obtained. It is also recommended that the proposed activities do not go ahead in wetlands 3 and 4 as the proposed road will go directly through a school.

After conclusion of this wetland assessment, it is the opinion of the specialists that the proposed project should not be considered favourably as the construction of a road through wetland 1 will destroy this largely unmodified wetland. Construction of a road through wetlands 3 and 4 will destroy a school. Construction may occur within wetland 2 if the following recommendations are followed;

- Ensure that development related waste and effluent do not affect the wetland boundaries and associated buffer zones. In this regard special mention is made of construction vehicles. All servicing and refuelling of construction vehicles should take place in a designated area or off site.
- No dumping of waste material should be allowed within wetland or associated buffer zones at any stage of the development. No temporary storage of building material should be allowed within wetland areas or the associated buffer zones.
- As far as possible existing roads should be used for access to the proposed development sites. If the need is identified to construct additional access roads the shortest path through wetland and buffer zones should be used.
- Ensure that wetland areas are clearly marked and no vehicles indiscriminately drive through or encroach upon these areas. If disturbance is unavoidable, ensure that these areas are suitably rehabilitated.
- Edge effects of activities, including erosion and alien/weed control need to be strictly managed in wetland areas as well as their associated buffer zones.
- All spills within wetland zones should be immediately cleaned up and treated accordingly. An emergency and spill action plan should form part of the method statement developed by the contractor undertaking the construction.
- Appropriate sanitation facilities must be provided for the duration of the proposed development and all waste removed to an appropriate facility. These facilities must be located outside of the wetland features and associated buffers and must be regularly serviced.

- Ensure that all proposed development activities take the wetland boundaries and associated buffer zones into account.
- Reprofiling of the banks of disturbed drainage areas to a maximum gradient of 1:3 to ensure bank stability.
- Reinforce banks and drainage features where necessary with gabions, reno mattresses and geotextiles.
- Reseed any areas where earthworks have taken place with indigenous grasses to prevent further erosion.
- Ensure that all activities impacting on geohydrological resources of the property are managed according to the relevant DWA Licensing regulations and groundwater monitoring and management requirements.
- Ensure that all construction activities take the wetland boundaries into account. No activities are to infringe upon the wetland boundaries unless absolutely unavoidable.
- Commission a suitably qualified specialist to design and implement a comprehensive rehabilitation plan. During the development of the rehabilitation plan, a suitably qualified wetland ecologist should be included in the team developing the plan to ensure that wetland rehabilitation targets are met.
- Identify activities, which are causing erosion and incision of any of the wetland features and mitigate these impacts immediately.
- Obtain relevant legislative approval for any activities to be undertaken within the wetland features to rectify excessive erosion.
- Ensure that effective rehabilitation takes place in order to restore wetland service provision.
- Ensure that project related waste and effluent do not affect the wetland areas.

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AQUATIC PRESENT ECOLOGICAL STATE ASSESSMENT IN THE JUKSEI RIVER AND ASSOCIATED TRIBUTARY IN THE VICINITY OF THE PROPOSED K56 HIGHWAY UPGRADE, GAUTENG

Bokamoso Landscape Architects and Environmental Consultants:

July 2012

Section E: Aquatic Report

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EXECUTIVE SUMMARY

Scientific Aquatic Services was appointed by Bokamoso Landscape Architects and Environmental consultants to conduct an aquatic ecological assessment prior to the proposed upgrade of the K56 road in the vicinity of Dainfern near Fourways in the north of Johannesburg. This document presents the results obtained during the ecological survey of the Jukskei River and an associated tributary which flows through the area where the K56 roadway is proposed. The subject property is located between two urban areas and runs through the Helderfontein Estate small holdings. The aquatic ecological assessment took place in April 2012 and as such represents the conditions in the system during autumn at a time when moderate to low flows are experienced in the system.

The purpose of the aquatic ecological assessment was to survey the general habitat integrity, habitat conditions for aquatic macro-invertebrates, aquatic macro-invertebrate community integrity and fish community integrity. The protocols of applying the necessary indices were strictly adhered to and all work was undertaken by a South African River Health Program (SA RHP) accredited assessor.

The following key findings are highlighted pertaining to the study:

Jukskei River (Site K1)
Biota specific Water quality

- General water quality can be considered to be fair, based on the results of the biota specific water quality analyses
- Limited amounts of dissolved salts present in the system although salt concentrations can be considered to be elevated form the natural conditions expected for the area. Limited osmotic stress on the aquatic community is deemed likely at the current time.
- The pH is slightly alkaline however no impact on the aquatic community due to altered pH conditions is deemed likely.
- Temperature can be regarded as normal for the time of year and time of assessment.
- Dissolved oxygen concentration in the system is low and is likely to place significant stress on the aquatic community in the system.

Habitat suitability and integrity

- From the results of the application of the IHIA to the K1 site, it is evident that there are serious impacts on the habitat integrity of the area. The most significant instream impacts included water bed modification, water quality and channel modification. Moderate impact from solid waste disposal, as well as flow and water abstraction was noted. Overall, the site achieved a 33% score for instream habitat integrity (Appendix 3).
- The most significant riparian zone impacts were alien encroachment followed by bank erosion and channel modification. Moderate level impacts observed were namely vegetation removal, water abstraction, flow modification and channel modification. The site achieved a 17% score for riparian integrity (Appendix 3).
- The site obtained an overall IHIA rating of 25%, which indicates extensively modified (class E) conditions. The site, therefore, falls outside the DEMC for the quaternary catchment A21C based on habitat conditions (Kleynhans, 1999).

Invertebrate Habitat Assessment

- Habitat diversity and structure is considered inadequate for supporting a diverse aquatic macro-invertebrate community

Macro-invertebrate community integrity

- The SASS score indicates that the aquatic macro-invertebrate community in this section of the Jukskei River has suffered a severe loss in integrity.
- At present, the site (K1) which runs through the subject property can be considered as a Class E site according to Dickens & Graham (2001) which has been severely impaired and where only tolerant taxa is present.

- Dallas 2007 classification for the lower Highveld ecoregion confirms the severe and critically impaired status (E/F) due to the low SASS score of 29.
- The site, falls below the PESC for the quaternary catchment A21C which is based on a Class D (Kleynhans, 1999).
- The system can therefore be regarded as being fairly tolerant, however due to the impact on the system care should be taken to prevent further impacts on this system from the proposed development activities.
- Careful design and construction will be required to limit the impact on the system.

The fish community

- No fish were captured during the assessment indicating that long term impacts on the system are likely. In this regard special mention is made of the water quality has a major effect on the fish assemblage as does migration barriers in the system which were observed upstream from site K1. It is for this reason that the system can be regarded as having limited sensitivity in terms of fish community dynamics, however care should still be exercised during the proposed development activities to prevent further impacts on the fish community of the system with special mention of migratory connectivity.
- Thus according to the protocol of Kleynhans (1999) Present State Classes in terms of FAII scores, the fish community at this point is critically modified (Class F).

Tributary River (Site K2)

Biota specific Water quality

- The water quality for this tributary stream can be considered to be fair, with limited amounts of dissolved salts present in the system although some elevation of salt concentrations from the natural conditions is deemed likely. Fairly limited osmotic stress on the aquatic community is deemed likely at the current time.
- The pH is 7.2 and considered relatively natural. No impact on the aquatic community due to altered pH conditions is deemed likely.
- Temperature can be regarded as normal for the time of year and time of assessment.
- Dissolved oxygen concentrations are fair but some more sensitive taxa may be absent from the system.

Habitat suitability and integrity

- From the results of the application of the IHIA to the tributary river at site K2, which falls within the study area, it is evident that there are impacts on the habitat integrity of the area. The most significant instream impacts included flow modification due to the already existing upstream impoundments that are situated along this tributary system. Overall, the site achieved a 52% score for instream habitat integrity (Appendix 3).
- The most significant riparian zone impact was flow modification. Low level impacts observed were namely vegetation removal, water abstraction, bank erosion, water quality and channel modification. The site achieved a 37% score for riparian zone integrity (Appendix 3).
- The site obtained an overall IHIA rating of 45%, which indicates largely modified (class D) conditions. The tributary site K2, therefore, falls just outside the DEMC for the quaternary catchment A21C based on habitat conditions (Kleynhans, 1999).

Invertebrate Habitat Assessment

- Habitat diversity and structure is adequate for supporting a diverse aquatic macro-invertebrate community.

Macro-invertebrate community integrity

- The SASS score indicates that the aquatic macro-invertebrate community in this section of the tributary river which flows into the Jukskei River has suffered a severe loss in integrity.
- At present, the site (K2) which runs through the subject property can be considered as a Class E site according to Dickens & Graham (2001) which has been severely impaired and where only tolerant taxa is present.
- Dallas 2007 classification for the lower Highveld ecoregion confirms the severe and critically impaired status (E/F) due to the low SASS score of 39 and ASPT of 3.5.

- The K2 site, falls outside the PESC for the quaternary catchment A21C which is based on a Class D (Kleynhans, 1999).
- The system can therefore be regarded as being fairly tolerant, however due to the impact on the system care should be taken to prevent further impacts on this system from the proposed development activities.
- Careful design and construction will be required to limit the impact on the system.

The fish community

Two fish species, the Long bearded Barb (*Barbus unitaeniatus)* and the Mozambique Tilapia (*Oreochromis mossambicus*) were captured, identified and released during the assessment. The low diversity indicates that long term impacts on the system are likely. In this regard special mention is made of migration barriers (such as dams) in the system and the water quality levels. It is for this reason that the system can be regarded as having limited sensitivity in terms of fish community dynamics, however care should still be exercised during the proposed development activities to prevent further impacts on the fish community of the system.

- The FAII data indicates that the fish community in this section of the tributary system has suffered a critical loss in integrity when compared to the expected score for a stream in this catchment with the habitat characteristics of the area.
- The absence of fish in the system is indicative of long term impacts on the system, with special mention of impacts on water flow modification and migration barriers.
- With only a low diversity and abundance of fish in the area, the fish community of the area is considered critically modified (Class F).
- Measures to improve water flow should be sought in order to allow fish species to re-establish in the system.
  It is important to ensure that no impacts on fish migration on the system occur as a result of the proposed development.

The Jukskei River	
Site K1	
Biota Specific Water Quality pH 7.9 DO 5.1 Conductivity (ms/m) 61 Temperature (℃) 21	
Habitat Assessment and Suitability *Integrated Habitat Assessment* Class Inadequate IHAS Score 45 *Intermediate Habitat Integrity Index* Class E (Extensively modified) Overall IHIA Score 29	
Aquatic Macro-invertebrate community assessment Class E (Severely impaired) SASS5 Score 26 ASPT Score 5.2	
Fish Assemblage Integrity Index No fish sampled Relative FAII score 0% FAII classification CLASS F (Critically modified)	
Current impacts Bed modification, impaired water quality and water flow	

Tributary River	
Site K2	
Biota Specific Water Quality pH 7.2 DO 6.2 Conductivity (ms/m) 56 Temperature (ºC) 17	
Habitat Assessment and Suitability *Integrated Habitat Assessment* Class Adequate IHAS Score 58 *Intermediate Habitat Integrity Index* Class D (Largely modified) Overall IHIA Score 45	
Aquatic Macro-invertebrate community assessment Class E (Severely impaired) SASS5 Score 39 ASPT Score 3.5	
Fish Assemblage Integrity Index Relative FAII score 10% FAII classification CLASS F (Critically modified)	
Current impacts Flow modification, impaired water quality and migratory barriers	

Recommendations

- Measures to control seepage and sedimentation into the riparian areas especially during the construction phase on site should be considered to prevent further sedimentation from reaching the receiving surface water environment.
- Sediment analyses within the Jukskei River and associated stormwater systems should take place on a two yearly basis and compared to historical data.
- As much of the ecological functioning and natural connectivity of the riparian features drainage systems need to be maintained.
- All construction vehicles should remain on designated roads with no indiscriminate driving through riparian areas.
- No construction vehicles are to be allowed to cross through riparian areas.
- Where construction vehicles need to cross over riparian areas (natural rivers) a bridge should be constructed over the riparian areas in order to preserve the aquatic habitat integrity and connectivity.
- Vehicles are to be regularly serviced to ensure minimal hydrocarbon spillages occur.
- If there is a hydrocarbon spill, a clean-up plan should be implemented immediately.
- No topsoil, waste rock or building material should be dumped into any existing riparian area, as these areas are considered to be of higher ecological importance.
- It must be ensured that construction-related waste and effluent do not affect the aquatic resources and associated buffer zones.
- Edge effects of activities, including erosion and sedimentation, have to be strictly managed along the riparian areas.
- It must be ensured that flow connectivity along the riparian features is maintained.

Stormwater management

- Adequate stormwater, erosion and sedimentation management measures must be incorporated into the design of the proposed development route in order to prevent erosion and sedimentation of the riparian areas.

- It must be ensured that runoff from impacted areas is suitably managed and that runoff volumes and velocities are similar to pre-disturbance levels. Stormwater control methods as set out in engineering specifications are to be implemented.
- During the construction of the proposed development route, erosion berms should be installed to prevent gully formation and siltation of the riparian areas. The following points should serve to guide the placement of erosion berms:
  - Where the track has slope of less than 2%, berms every 50m should be installed.
  - Where the track slopes between 2% and 10%, berms every 25m should be installed.
  - Where the track slopes between 10%-15%, berms every 20m should be installed.
  - Where the track has slope greater than 15%, berms every 10m should be installed.

Rehabilitation

- As much vegetation growth as possible should be promoted within the proposed development area in order to protect soils and the riparian areas. In this regard special mention is made of the need to use indigenous vegetation species where rehabilitation planting is to be implemented.
- Upon completion of the project, new indigenous landscaping should be implemented in all affected areas and proper rehabilitation within all impacted areas must take place.
- Banks of disturbed drainage areas must be reprofiled.
- Banks and drainage features, if affected by the proposed construction activities, are to be reinforced where necessary with reno mattresses and geotextiles.
- Any areas where earthworks have taken place should be reseeded with indigenous vegetation to prevent erosion and sedimentation.
- It must be ensured that all disturbed and exposed areas are rehabilitated and covered with indigenous vegetation to prevent dust generation and sedimentation.

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1. PROJECT OBJECTIVES AND SCOPE

Scientific Aquatic Services was appointed by Bokamoso Landscape Architects and Environmental Consultants to conduct an aquatic ecological assessment prior to the proposed upgrade of the K56 road in the vicinity of Dainfern near Fourways in the north of Johannesburg. This document presents the results obtained during the ecological survey of the Jukskei River and associated tributary which flows through the proposed K56 project area. The subject property is located between two urban areas and runs through the Helderfontein Estate small holdings. The aquatic ecological assessment took place in April 2012 and as such represents the conditions in the system during autumn at a time when moderate to low flows are experienced in the system.

The purpose of the aquatic ecological assessment was to survey the general aquatic habitat integrity, habitat conditions for aquatic macro-invertebrates, aquatic macro-invertebrate community integrity and fish community integrity.

The following was considered in the selection of a suitable site for assessing the level of aquatic ecological integrity within the subject property which comprised of a section along the Jukskei River and an unnamed tributary of the Jukskei River:

- The site location in relation to the subject property.
- Consideration was given to the position of the proposed K56 road development site in order to assist in defining the Present Ecological State and any impacts in this area.
- Accessibility with a vehicle in order to allow for the transport of equipment.
- The site was selected where there were good habitat conditions with a good level of diversity, suitable for supporting a diverse aquatic community within the subject property.

One assessment point on the Jukskei River (K1) was assessed and one tributary assessment point (K2) was identified within the subject property. See figure 1, assessment points are indicated in red.

Table 1: Geographic information pertaining to the aquatic assessment sites

Site	Description	GPS co-ordinates	
		South	East
K1	Representative of the Jukskei River within the subject property of the proposed K56 expansion	S25°59' 14.98"	E28°01' 14.91"
K2	Representative of tributary river within the subject property of the proposed K56 expansion	S25°59' 07.03"	E28°01' 38.40"

It is the objective of the study to provide detailed information to guide the development of the proposed K56 road upgrade in the vicinity of riparian areas to ensure that the ongoing functioning of the areas aquatic systems in conjunction with the wetlands (See Section E for wetland report) is facilitated with specific mention of the following:

- To ensure that connectivity of the riparian areas is maintained between the areas upstream and downstream of the portions of the K56 Roadway designated for the upgrade ;
- To ensure ongoing functioning of the riparian areas in the vicinity K56 Roadway;
- To ensure that the risks to the instream ecology are adequately understood and that suitable mitigatory measures are presented to minimise impacts on these resources.
- To ensure that no incision and canalisation of the riparian system takes place as a result of the K56 Roadway upgrade.

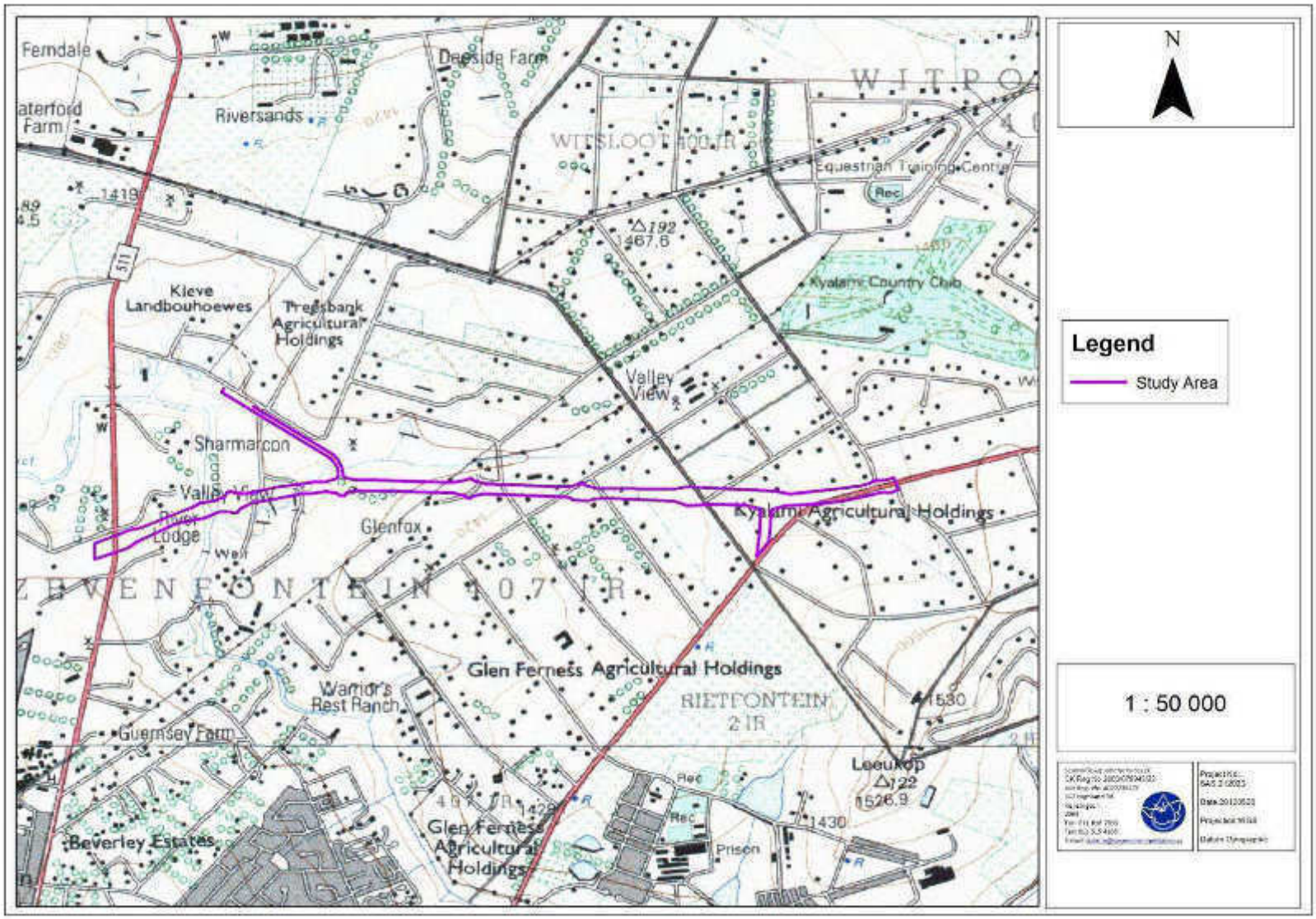

Figure 1: Subject area depicted on a 1:50 000 map in relation to its surrounding area.

2. AQUATIC ECOLOGICAL DESCRIPTION

2.1 Ecoregions

Prior to the field assessment being completed, a desktop study was undertaken to gather background information regarding the site and its surrounding areas.

When assessing the ecology of any area (aquatic or terrestrial), it is important to know which ecoregion the study area is located within. This knowledge allows for improved interpretation of data, since reference information and representative species lists are often available on this level of assessment to guide the assessment. The subject property lies within the Highveld aquatic ecoregion.

Table 2: Description of the Highveld Aquatic Ecoregion characteristics (Kleynhans *et al,* 2005)

Main Attributes	**Highveld Basin**
Terrain Morphology: Broad division (dominant types in bold) (Primary)	**Plains; Low Relief;** Plains; Moderate Relief; Lowlands; Hills and Mountains: Moderate and High Relief; Open Hills; Lowlands; Mountains: Moderate to High Relief; Closed Hills; Moderate and High Relief (limited)
Vegetation types; (dominant types in bold) (Primary)	Mixed Bushveld (limited); Rocky Highveld Grassland; **Dry Sandy Highveld Grassland;** North Eastern Mountain Grassland; **Moist Cool Highveld Grassland;** Moist Clay Highveld Grassland; Moist Sandy Highveld Grassland; Dry Clay Highveld Grassland; Patches Afromontane Forest (very limited)
Altitude (m a.m.s.l) (Secondary)	1100-2100, 2100-2300 (very limited)
MAP (mm) (modifying)	400-1000
Coefficient of Variation (% of annual precipitation)	<20-35
Rainfall concentrate index	45-65
Rainfall seasonality	Early to late summer
Mean annual temp. (◦C)	12-20
Mean daily max. temp. (◦C): Feb	20-32
Mean daily max. temp. (◦C): July	14-22
Mean daily min. temp. (◦C): Feb	10-18
Mean daily min. temp. (◦C): July	-2-4
Median annual simulated runoff (mm) for quaternary catchment	5->250

2.2 Ecostatus

Studies undertaken by the Institute for Water Quality Studies assessed all quaternary catchments as part of the Resource Directed Measures for Protection of Water Resources. In these assessments, the Ecological Importance and Sensitivity (EIS), Present Ecological Management Class (PEMC) and Desired Ecological Management Class (DEMC) were defined, and serve as a useful guideline in determining the importance and sensitivity of aquatic ecosystems prior to assessment, or as part of a desktop assessment.

Water resources are generally classified according to the degree of modification or level of impairment. The classes used by the South African River Health Program (RHP) are presented in the table below and will be used as the basis of classification of the systems in this field, and desktop study.

Table 3: Classification of river health assessment classes in line with the RHP

Class	Description
A	Unmodified, natural.
B	Largely natural, with few modifications.
C	Moderately modified.
D	Largely modified.
E	Extensively modified.
F	Critically modified.

This database was searched for the quaternary catchments of concern (A21C) in order to define the EIS, PEMC and DEMC. The findings are based on a study undertaken by Kleynhans (1999) as part of "A procedure for the determination of the ecological reserve for the purpose of the national water balance model for South African rivers". The results of the assessment are summarised in the table below.

Table 4: Summary of the ecological status of quaternary catchments (A21C) based on Kleynhans 1999

Catchment	Resource	EIS	DEMC	PESC	PESC with rules as for desktop WBM
A21C	Jukskei River	Moderate	C: Moderately sensitive system	Class C	Class D: Largely Modified

The points below summarise the impacts on the aquatic resources and the ecological functions, importance and sensitivities of these systems in the A21C quaternary catchment basin which falls within the subject property (Kleynhans, 1999):

The following points summarise the impacts known to occur within the catchment:

- A high impact on bed structure has occurred at this point in time.
- A very high impact from flow modification has occurred due to urban and storm water runoff and sewage effluent discharge.
- There has been a very high impact in the catchment from the introduction of Carp (*Cyprinus carpio)* has occurred in the catchment.
- A very high impact from inundation is evident at the present time due to small weirs in the drainage systems.
- High level impacts on the riparian zone have occurred due to encroachment of activities into the riparian zones of many streams. Riparian vegetation of the area is highly affected by the encroachment of alien vegetation.

The following points summarise the most important aspects in terms of the classification of the Environmental Importance and Sensitivity (EISC) of the system:

- The system has very little importance in terms of natural area conservation.
- The area provides a moderate diversity of habitat with riffles and pools occurring along the system.
- The aquatic community of the area has a moderate sensitivity to changes in flow and water quality.
- The system is regarded as having a moderate importance for rare and endangered species conservation.
- The site is of some importance to the conservation of unique or endemic species.
- The area is considered to have some importance in terms of provision of migration routes in the instream and riparian environments.
- The system has a moderate importance in terms of providing refugia for aquatic community members.
- The site is of moderate importance in terms of species richness.

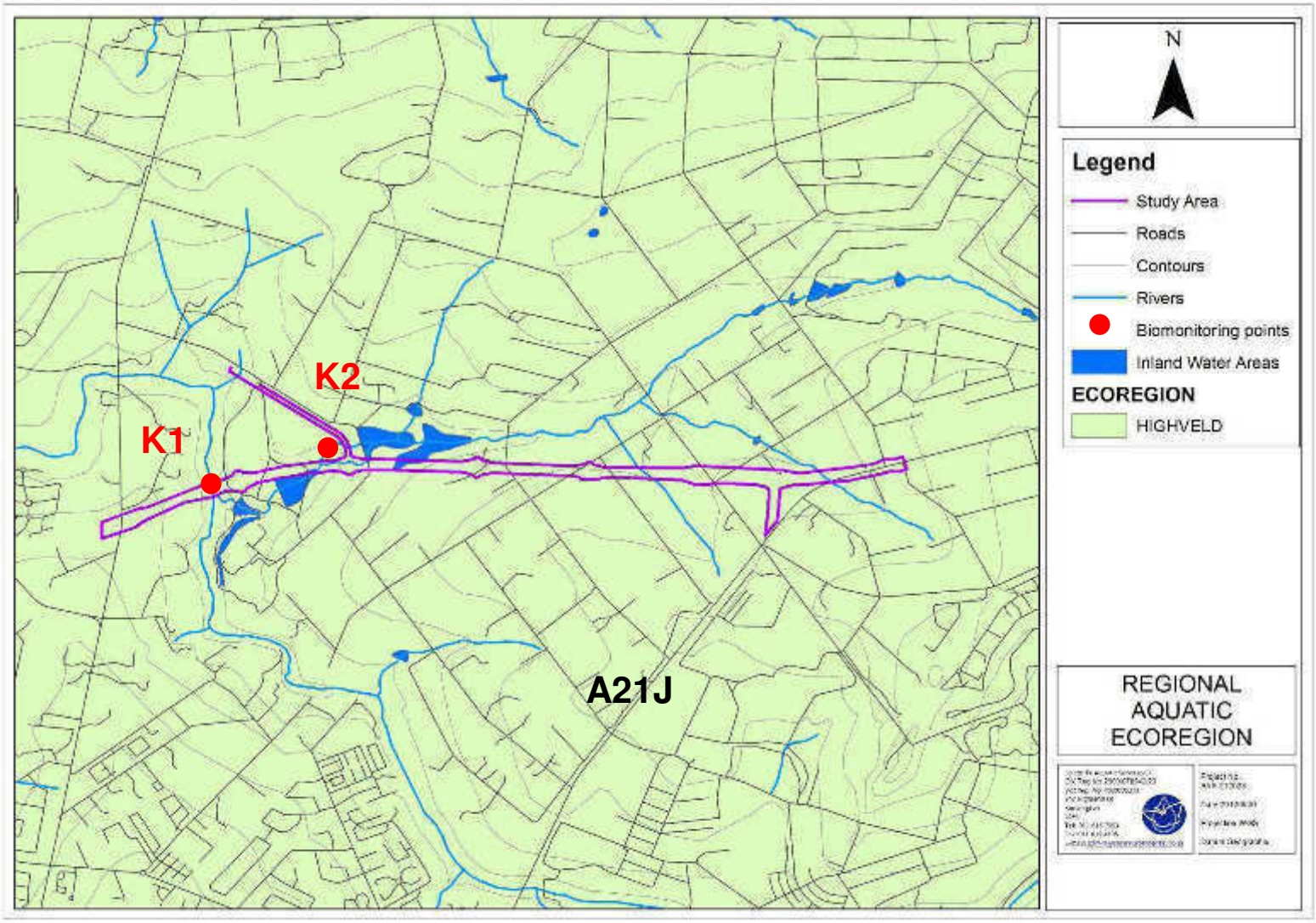

Figure 2: Quaternary catchments in the vicinity of the subject area

3. METHOD OF INVESTIGATION

The assessment of the PES of the system, as well as possible impacts due to the proposed development, was based on comparisons between observed conditions and the theoretical reference conditions based on desktop information reviews, and from historical data for the area.

The sections below describe the methodology used to assess the aquatic ecological integrity of the various sites based on water quality, instream and riparian habitat condition and biological impacts and integrity.

3.1 Visual Assessment

The assessment site was investigated in order to identify visible impacts on the site, with specific reference to impacts from surrounding activities and any effects activities occurring upstream in the catchment. Both natural constraints placed on ecosystem structure and function, as well as anthropogenic alterations to the system, was identified by observing conditions and relating them to professional experience. Photographs of each site were taken to provide visual indications of the conditions at the time of assessment. Factors which were noted in the site specific visual assessments included the following:

- Stream morphology;
- Instream and riparian habitat diversity;
- Stream continuity;
- Erosion potential;
- Depth flow and substrate characteristics;
- Signs of physical disturbance of the area and
- Other life forms reliant on aquatic ecosystems.

3.2 Physico Chemical Water Quality Data

On site testing of biota specific water quality variables took place. Parameters measured include pH, electrical conductivity, dissolved oxygen concentration and temperature. The results of on-site biota specific water quality analyses were used to aid in the interpretation of the data obtained by the biomonitoring. Results are discussed against the guideline water quality values for aquatic ecosystems (DWAF 1996 vol. 7).

3.3 Habitat Integrity (IHIA)

It is important to assess the habitat of each site, in order to aid in the interpretation of the results of the community integrity assessments by taking habitat conditions and impacts into consideration. The general habitat integrity of the site should be discussed based on the application of the Intermediate Habitat Integrity Assessment for (Kemper; 1999). The Intermediate Habitat Integrity Assessment (IHIA) protocol, as described by Kemper (1999), should be used for site specific assessments. This is a simplified procedure, which is based on the Habitat Integrity approach developed by Kleynhans (1996). The IHIA is conducted as a first level exercise, where a comprehensive exercise is not practical. The Habitat Integrity of each site should be scored according to 12 different criteria which represent the most important (and easily quantifiable) anthropogenically induced possible impacts on the system. The instream and riparian zones should be analysed separately, and the final assessment should be made separately for each, in accordance with Kleynhans' (1999) approach to Habitat Integrity Assessment. Data for the riparian zone are, however, primarily interpreted in terms of the potential impact on the instream component. The assessment of the severity of impact of modifications is based on six descriptive categories with ratings. Analysis of the data should be carried out by weighting each of the criteria according to Kemper (1999). By calculating the mean of the instream and riparian Habitat Integrity scores, an overall Habitat Integrity score can be obtained for each site. This method describes the Present Ecological State (PES) of both the in-stream and riparian habitats of the site. The method classifies Habitat Integrity into one of six classes, ranging from unmodified/natural (Class A), to critically modified (Class F).

Table 5: Classification of Present State Classes in terms of Habitat Integrity [Based on Kemper 1999]

Class	Description	Score (% of total)
A	Unmodified, natural.	90-100
B	Largely natural, with few modifications. A small change in natural habitats and biota may have taken place but the basic ecosystem functions are essentially unchanged.	80-90
C	Moderately modified. A loss and change of natural habitat and biota have occurred, but the basic ecosystem functions are still predominantly unchanged.	60-79
D	Largely modified. A large loss of natural habitat, biota and basic ecosystem functions has occurred.	40-59
E	Extensively modified. The loss of natural habitat, biota and basic ecosystem functions is extensive.	20-39
F	Critically modified. Modifications have reached a critical level and the lotic system has been modified completely with an almost complete loss of natural habitat and biota. In the worst instances, basic ecosystem functions have been destroyed and the changes are irreversible.	<20

3.4 Habitat Suitability (IHAS)

The Invertebrate Habitat Assessment System (IHAS) was applied according to the protocol of McMillan (1998). This index was used to determine specific habitat suitability for aquatic macro-invertebrates, as well as to aid in the interpretation of the results of the South African Scoring System version 5 (SASS5) scores. Scores for the IHAS index were interpreted according to the guidelines of McMillan (1998) as follows:

- <55%: habitat diversity and structure is inadequate for supporting a diverse aquatic macro-invertebrate community.
- 55%-65%: habitat diversity and structure is adequate for supporting a diverse aquatic macro-invertebrate community.
- >65% habitat diversity and structure is highly suited for supporting a diverse aquatic macro-invertebrate community.

3.5 Aquatic Macro-Invertebrates (SASS)

Aquatic Macro-invertebrates were sampled using the qualitative kick sampling method called SASS5 (South African Scoring System version 5) (Dickens and Graham, 2001). The SASS5 method has been specifically designed to comply with international accreditation protocols. This method is based on the British Biological Monitoring Working Party (BMWP) method and has been adapted for South African conditions by Dr. F. M. Chutter. The assessment was undertaken according to the protocol as defined by Dickens & Graham (2001). All work was overseen by an accredited SASS5 practitioner.

The SASS5 method was designed to incorporate all available biotypes at a given site and to provide an indication of the integrity of the of the aquatic macro-invertebrate community through recording the presence of various macro-invertebrate families at each site, as well as consideration of abundance of various populations, community diversity and community sensitivity. Each taxon is allocated a score according to its level of tolerance to river health degradation (Dallas, 1997).

This method relies on churning up the substrate with your feet and sweeping a finely meshed SASS net, with a pore size of 1000 micron mounted on a 300 mm square frame, over the churned up area several times. In stony bottomed flowing water biotopes (rapids, riffles, runs, etc.) the net downstream of the assessor and the area immediately upstream of the net is disturbed by kicking the stones over and against each other to dislodge benthic invertebrates. The net was also swept under the edge of marginal and aquatic vegetation to cover from 1-2

meters. Identification of the organisms was made to family level (Thirion *et al*., 1995; Davies & Day, 1998; Dickens & Graham, 2001; Gerber & Gabriel, 2002).

Interpretation of the results of biological monitoring depends, to a certain extent, on interpretation of site-specific conditions (Thirion *et.al*, 1995). In the context of this investigation it would be best not to use SASS5 scores in isolation, but rather in comparison with relevant habitat scores. The reason for this is that some sites have a less desirable habitat or fewer biotopes than others do. In other words, a low SASS5 score is not necessarily regarded as poor in conjunction with a low habitat score. Also, a high SASS5 score, in conjunction with a low habitat score, can be regarded as better than a high SASS5 score in conjunction with a high habitat score. A low SASS5 score, together with a high habitat score, would be indicative of poor conditions. The IHAS Index is valuable in helping to interpret SASS5 scores and the effects of habitat variation on aquatic macro-invertebrate community integrity.

Classification of the system took place by comparing the present community status to reference conditions which reflect the best conditions that can be expected in rivers and streams within a specific area and reflect natural variation over time. SASS and ASPT reference conditions were obtained from Dallas (2007), as presented in Figure 3 below. Reference conditions are stated as a SASS score of 124 and an ASPT score of 5.6 for the Highveld – Lower ecoregion (Figure 3). Sites were classified the classification system of Dickens & Graham 2001 (Table 5).

Table 6: :Definition of Present State Classes in terms of SASS scores as presented in Dickens & Graham (2001)

Class	Description	SASS Score%	ASPT
A	Unimpaired. High diversity of taxa with numerous sensitive taxa.	90-100 80-89	Variable >90
B	Slightly impaired. High diversity of taxa, but with fewer sensitive taxa.	80-89 70-79 70-89	<75 >90 76-90
C	Moderately impaired. Moderate diversity of taxa.	60-79 50-59 50-79	<60 >75 60-75
D	Largely impaired. Mostly tolerant taxa present.	50 - 59 40-49	<60 Variable
E	Severely impaired. Only tolerant taxa present.	20-39	Variable
F	Critically impaired. Very few tolerant taxa present.	0-19	Variable

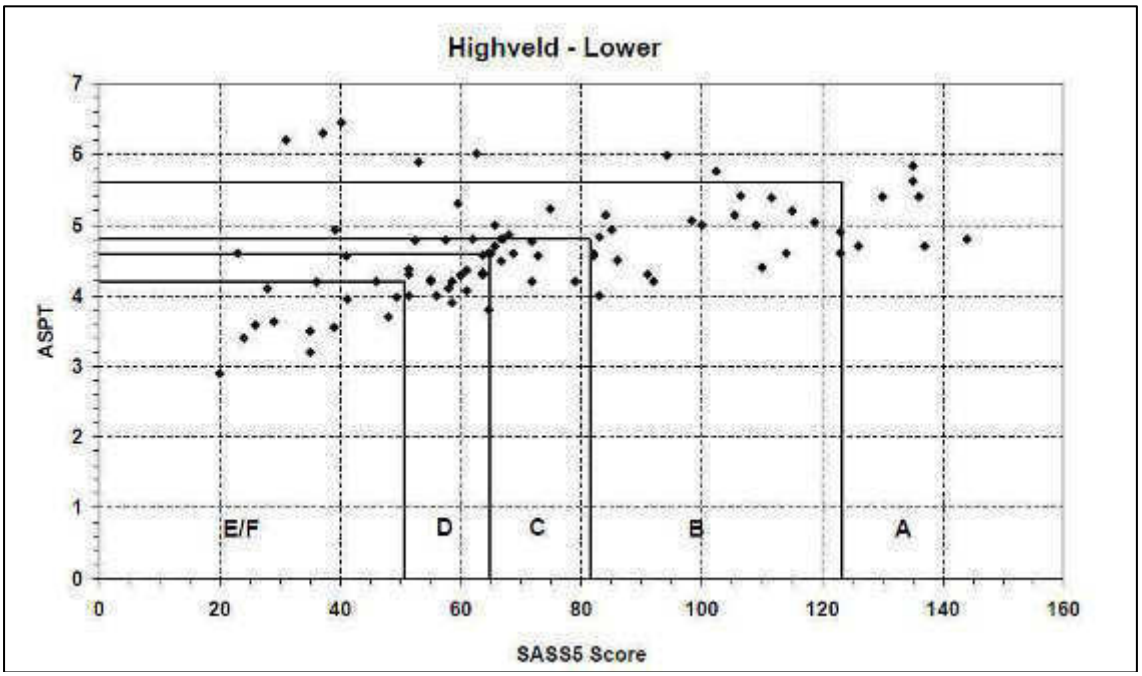

Figure 3: Biological bands generated in terms of SASS scores for the Highveld – Lower spatial group as presented in Dallas (2007)

3.6 Fish Community Integrity (FAII)

Whereas macro-invertebrate communities are good indicators of localised conditions in a river over the short-term, fish being relatively long-lived and mobile;

- are good indicators of long-term influences;
- are good indicators of general habitat conditions;
- integrate effects of lower trophic levels and
- are consumed by humans (Uys *et al*., 1996).

The Fish Assemblage Integrity Index (FAII) was applied according to the protocol of Kleynhans (1999). Fish species identified were compared to those expected to be present at the site, which were compiled from a literature survey including Skelton 2007. Fish samples were collected by means of a fixed generator-driven electro fishing device (DC 200V 0.8A pulsating). Electro fishing is the use of electricity to catch fish. The electricity is generated by a system whereby a high voltage potential is applied between two electrodes, which are placed in the water (USGS, 2004).

All fish were identified in the field and released at the point of capture. Fish species were identified using the guide Freshwater Fishes of Southern Africa (Skelton, 2001). Based on a survey of available literature, an expected species list for the Crocodile River catchment was

compiled. 17 fish species are expected to occur in the catchment and of these, one species is introduced, namely Carp (*Cyprinus carpio*). None of the expected species are listed as being endangered, vulnerable or rare according to the 1996 IUCN Red List (Skelton, 2001).

The FAII Index was designed based on the concept of the biological segment which has been described as a portion of a stream in which the fish community remains generally homogenous due to the relatively uniform nature of the physical habitat (Ramm, 1988; as quoted by Kleynhans, 1999). Evaluation of the FAII for site specific use, i.e. based on the comparison of the results from single sites rather than multiple sites, is currently underway. Until the results of this evaluation are available, results generated by the FAII on a point specific basis, i.e. comparisons between single sites should be treated with caution.

Intolerance refers to the degree to which an indigenous species is unable to withstand changes in the environmental conditions at which it occurs (Kleynhans, 1999). Four components were considered in estimating the intolerance of fish species, i.e. habitat preferences and specialization (HS), food preferences and specialization (TS), requirement for flowing water during different life stages (FW) and association with habitats with unmodified water quality (WQ). Each of these aspects was scored for a species according to low requirement/specialization (rating = 1), moderate requirement/specialization (rating = 3) and high requirement/specialization (rating = 5). The total intolerance (IT) of a fish species is estimated as follows:

IT = (HS + TS + FW + WQ)/4

Table 7: Definition of Present State Classes in terms of FAII scores according to the protocol of Kleynhans (1999)

Class	Description	Relative FAII score (% of expected)
A	Unmodified, or approximates natural conditions closely.	90-100
B	Largely natural, with few modifications.	80-89
C	Moderately modified. A lower than expected species richness and the presence of most intolerant species.	60-79
D	Largely modified. A clearly lower than expected species richness and absence of intolerant and moderately tolerant species	40-59
E	Seriously modified. A strikingly lower than expected species richness and a general absence of intolerant and moderately intolerant species	20-39
F	Critically modified. An extremely lowered species richness and an absence of intolerant and moderately intolerant species	<20

Table 8: Intolerance ratings for naturally occurring indigenous fish species expected to occur in the area (Kleynhans, 2003)

SPECIES NAME	COMMON NAME	INTOLERANCE RATING
Barbus paludinosus	Straight fin barb	1.8
Barbus anoplus	Chubby head barb	2.6
Barbus motebensis	Marico barb	3.1
Barbus trimaculatus	Three spot barb	2.2
Barbus unitaeniatus	Long beard barb	1.7
Chiloglanis pretoriae	Short spine sucker mouth	4.6
Pseudocrenilabrus philander	Southern mouth brooder	1.3
Tilapia sparrmanii	Banded Tilapia	1.3
Oreochromis mossambicus	Mozambique Tilapia	1.3
Clarias gariepinus	Sharptooth catfish	1.2
Cyprinus carpio	Carp	1.4
Labeobarbus marequensis	Large scale Yellow fish	2.6
Labeobarbus polylepis	Small scale Yellow fish	3.1
Labeo molybdinus	Redeye Labeo	3.2
Labeo cylindricus	Leaden labeo	3.1
Gambusia affinis	Mosquito fish	2.0
Mesobola brevianalis	River sardine	2.3

Tolerant: 1-2 moderately tolerant :> 2-3 Moderately Intolerant: >3-4 Intolerant: >4

The health and conditioning of selected fish species were evaluated by applying a similar protocol to that described by DWAF (1997). Individuals with disease, tumors, fin damage and skeletal abnormalities occur infrequently or are absent. For the purpose of this study, the fish health assessment was based on an external examination of the skin and fins, eyes, gills, opercula and the presence of ecto-parasites. This approach ensured the minimization of stress and allowed fish to be released unharmed.

The FAII consists of the calculation of an expected value, which serves as the baseline or reference, the calculation of an observed value and the comparison of the expected and observed scores that provide a relative FAII score. The expected FAII rating for a fish habitat segment is calculated as follows (Kleynhans, 1999): FAII value (Exp) = ΣIT x ((F + H)/2)

Where:

Exp = expected for a fish habitat segment

IT = Intolerance rating for individual species expected to be present in a fish habitat segment and in habitats that were sampled

H = Expected health rating for a species expected to be present.

The observed situation is calculated on a similar basis, but is based on information collected during the survey:

FAII value (Obs) = ΣIT x ((F + H)/2)

Where:

Obs = observed for a fish habitat segment

The relative FAII score is calculated by:

Relative FAII score = FAII value (Obs)/FAII value (exp) x 100

Interpretation of the relative FAII values is based on the FAII Assessment Classes (Kleynhans, 1996, 1999).

For the purposes of applying the FAII, species which were considered unlikely to occur at the site due to habitat and cover conditions, flow conditions and due to historic impacts, were excluded from the reference list of fish species for the site.

4. RESULTS AND INTERPRETATION

4.1 Jukskei River (Site K1)

4.1.1 Visual assessment

A photographic record of each site was made in order to provide visual record of the condition of each assessment site as observed during the field assessment. The photographs taken at each site are presented below (Figure 4 and 5). The tables below summarises the observations for the various criteria made during the visual assessment undertaken on the site.

Figure 4: Upstream view of the K1 site, indicating shallow low flowing system.

Figure 5: Downstream view of the K1 site showing the severe sedimentation with no stones in current.

Table 9: Description of the location of the assessment site in the subject property

SITE	K1
Riparian zone characteristics	The riparian zone is in fair condition although some impact alien encroachment is evident.
Algal presence	Some algal proliferation was evident at the time of assessment.
Visual indication of and impact on aquatic fauna	A significant impact from litter was evident in the stream.
Depth characteristics	Under low flow conditions, the stream consists of shallow runs.
Flow condition	Flow in this system is highly variable as a result of upstream runoff (urban and natural), there is a fair diversity of flow types with slow flowing runs, and moderately fast flowing runs and riffles during the rainy season.
Water clarity	Water was clear at the time of assessment.
Water odour	No odours were evident.
Erosion potential	Little potential for erosion is present under high flow conditions.

4.1.2 Physico-Chemical Water Quality

The table below records the biota specific water quality of the assessment site.

Table 10: Biota specific water quality data along the main drainage feature.

SITE	COND mS/m	pH	TEMP ^{o}C	Dissolved oxygen
K1	61	7.9	21	5.1

Key findings

- General water quality can be considered to be fair, based on the results of the biota specific water quality analyses
- Limited amounts of dissolved salts present in the system although salt concentrations can be considered to be elevated form the natural conditions expected for the area. Limited osmotic stress on the aquatic community is deemed likely at the current time.
- The pH is slightly alkaline however no impact on the aquatic community due to altered pH conditions is deemed likely.
- Temperature can be regarded as normal for the time of year and time of assessment.
- Dissolved oxygen concentration in the system is low and is likely to place significant stress on the aquatic community in the system.

4.1.3 Habitat Assessment (IHIA)

- From the results of the application of the IHIA to the K1 site, it is evident that there are serious impacts on the habitat integrity of the area. The most significant instream impacts included water bed modification, water quality and channel modification. Moderate impact from solid waste disposal, as well as flow and water abstraction was noted. Overall, the site achieved a 33% score for instream habitat integrity (Appendix 3).
- The most significant riparian zone impacts were alien encroachment followed by bank erosion and channel modification. Moderate level impacts observed were namely vegetation removal, water abstraction, flow modification and channel modification. The site achieved a 17% score for riparian integrity (Appendix 3).
- The site obtained an overall IHIA rating of 25%, which indicates extensively modified (class E) conditions. The site, therefore, falls outside the DEMC for the quaternary catchment A21C based on habitat conditions (Kleynhans, 1999).

4.1.4 Invertebrate Habitat Assessment (IHAS)

Table 11 is a summary of the results obtained from the application of the IHAS Index to the assessment site on the Jukskei River. This index determines habitat suitability, with particular reference to the requirements of aquatic macro-invertebrates. The results obtained from this assessment will aid in defining the habitat condition.

Table 11: A summary of the results obtained from the application of the IHAS index to the assessment site.

SITE	K1
IHAS score	45
IHAS Adjustment score (illustrative purposes only)	+34
McMillan, 1998 IHAS description	Habitat diversity and structure is inadequate for supporting a diverse aquatic macro-invertebrate community.
Stones habitat characteristics	No areas of cobble are present both in and out of current. The lack of rocky habitat decreases the habitat areas suitable for supporting a diverse and sensitive aquatic macro-invertebrate community. There is a fair amount of sedimentation due to the slow flow conditions at the time of the assessment.
Vegetation habitat characteristics	A limited amount of marginal vegetation was present out of current, with a relatively low percentage being overhanging leafy vegetation. The lack of good overhanging and in current vegetation is inadequate to provide suitable habitat for the establishment of a diverse aquatic community.
Other habitat characteristics	There were only sand and gravel deposits present throughout the substrate with no muddy deposits which will limit the habitat for a select few adapted aquatic macro-invertebrate community members.
IHAS general stream characteristics	A shallow, wide, slow-flowing stream consisting of a long glide. The water in the system was clear at the time of assessment.

4.1.5 Aquatic Macro-invertebrates (SASS)

The results of the aquatic macro-invertebrate assessment according to the SASS5 index are summarised in the tables below. Table 12 indicates the results obtained at each site per biotope sampled. Table 13 summarises the findings of the SASS assessment based on the analyses of the data for each site, as well as interpretation of the data for each site.

Table 12: Biotope specific summary of the results obtained from the application of the SASS5 index to the K1 site.

PARAMETER	STONES	VEGETATION	GRAVEL, SAND AND MUD	TOTAL
SASS5 Score	0	26	15	26
Taxa	0	5	3	5
ASPT	0	5.2	5	5.2

Table 13: A summary of the results obtained from the application of the SASS5 and IHAS indices to the K1 site.

Type of Result	K1
Biotopes sampled	Sand, Gravel and vegetation.
Sensitive taxa present	*Nil*
Sensitive taxa absent	*Perlidae; Tricorythidae; Chlorocyphidae; Heptageniidae; Leptophlebiidae; Elmidae; Aeshnidae; Hydracarina; Chlorolestidae; Psephenidae; Athericidae; Naucoridae; Atyidae*
Adjusted SASS5 score	60
SASS5 % of reference score (124)	21%
ASPT % of reference score (5.6)	92%
Dickens and Graham, 2001 classification	Class E (Severely impaired. Only tolerant taxa present.)
Dallas 2007	Class E/F

- The SASS score indicates that the aquatic macro-invertebrate community in this section of the Jukskei River has suffered a severe loss in integrity.
- At present, the site (K1) which runs through the subject property can be considered as a Class E site according to Dickens & Graham (2001) which has been severely impaired and where only tolerant taxa is present.
- Dallas 2007 classification for the lower Highveld ecoregion confirms the severe and critically impaired status (E/F) due to the low SASS score of 29.
- The site, falls below the PESC for the quaternary catchment A21C which is based on a Class D (Kleynhans, 1999).
- The system can therefore be regarded as being fairly tolerant, however due to the impact on the system care should be taken to prevent further impacts on this system from the proposed development activities.
- Careful design and construction will be required to limit the impact on the system.

4.1.6 The fish community

- No fish were captured during the assessment indicating that long term impacts on the system are likely. In this regard special mention is made of the water quality has a major effect on the fish assemblage as does migration barriers in the system which were observed upstream from site K1. It is for this reason that the system can be regarded as having limited sensitivity in terms of fish community dynamics, however care should still be exercised during the proposed development activities to prevent further impacts on the fish community of the system with special mention of migratory connectivity.
- Thus according to the protocol of Kleynhans (1999) Present State Classes in terms of FAII scores, the fish community at this point is critically modified (Class F).

Figure 6: General view of the K1 site showing sandy substrate with no stones in current, poor vegetation habitat and limited flow.

4.2 Tributary to Jukskei River (Site K2)

4.2.1 Visual assessment

A photographic record of each site was made in order to provide visual record of the condition of each assessment site as observed during the field assessment. The photographs taken at each site are presented below (Figure 7 and 8). The tables below summarises the observations for the various criteria made during the visual assessment undertaken on the site.

Figure 7: Upstream view of the K2 site, indicating stones in current, good vegetation habitat and low flowing system.

Figure 8: Downstream view of the K2 site showing gravel and sandy substrate habitat as well.

Table 14: Description of the location of the assessment site in the subject property

SITE	K2
Riparian zone characteristics	The riparian zone is in good condition with limited alien encroachment evident.
Algal presence	No algal proliferation was evident at the time of assessment.
Visual indication of and impact on aquatic fauna	A significant impact of water flow was evident in the stream due to upstream dams.
Depth characteristics	Under low flow conditions, the stream consists of shallow runs and pools.

SITE	K2
Flow condition	Flow in this system is highly variable as a result of an upstream impoundments and runoff (urban and natural), there is a fair diversity of flow types with slow flowing runs, and moderately fast flowing runs and riffles during the rainy season.
Water clarity	Water was clear at the time of assessment.
Water odour	No odours were evident.
Erosion potential	Little potential for erosion is present under high flow conditions.

4.2.2 Physico-Chemical Water Quality

The table below records the biota specific water quality of the assessment site.

Table 15: Biota specific water quality data along the main drainage feature.

SITE	COND mS/m	pH	TEMP °C	Dissolved oxygen
K2	56	7.2	17	6.2

Key findings

- The water quality for this tributary stream can be considered to be fair, with limited amounts of dissolved salts present in the system although some elevation of salt concentrations from the natural conditions is deemed likely. Fairly limited osmotic stress on the aquatic community is deemed likely at the current time.
- The pH is 7.2 and considered relatively natural. No impact on the aquatic community due to altered pH conditions is deemed likely.
- Temperature can be regarded as normal for the time of year and time of assessment.
- Dissolved oxygen concentrations are fair but some more sensitive taxa may be absent from the system.

4.2.3 Habitat Assessment (IHIA)

- From the results of the application of the IHIA to the tributary river at site K2, which falls within the study area, it is evident that there are impacts on the habitat integrity of the area. The most significant instream impacts included flow modification due to the already existing upstream impoundments that are situated along this tributary system. Overall, the site achieved a 52% score for instream habitat integrity (Appendix 3).
- The most significant riparian zone impact was flow modification. Low level impacts observed were namely vegetation removal, water abstraction, bank erosion, water quality and channel modification. The site achieved a 37% score for riparian zone integrity (Appendix 3).
- The site obtained an overall IHIA rating of 45%, which indicates largely modified (class D) conditions. The tributary site K2, therefore, falls just outside the DEMC for the quaternary catchment A21C based on habitat conditions (Kleynhans, 1999).

4.2.4 Invertebrate Habitat Assessment (IHAS)

Table 16 is a summary of the results obtained from the application of the IHAS Index to the assessment site (K2) on the tributary system which flows into the Jukskei River. This index determines habitat suitability, with particular reference to the requirements of aquatic macro-invertebrates. The results obtained from this assessment will aid in defining the habitat condition.

Table 16: A summary of the results obtained from the application of the IHAS index to the assessment site.

SITE	K2
IHAS score	58
IHAS Adjustment score (illustrative purposes only)	+21
McMillan, 1998 IHAS description	Habitat diversity and structure is adequate for supporting a diverse aquatic macro-invertebrate community.
Stones habitat characteristics	Some areas of cobble are present both in and out of current. Fair rocky habitat increases the habitat areas suitable for supporting a diverse and sensitive aquatic macro-invertebrate community. There is a fair amount of sedimentation due to the slow flow conditions at the time of the assessment.
Vegetation habitat characteristics	A fair amount of marginal vegetation was present out of current, with a good percentage being overhanging leafy vegetation. The good vegetation habitat is adequate to provide suitable habitat for the establishment of a diverse aquatic community.
Other habitat characteristics	There was sand and gravel deposits present throughout the stream bed with no muddy deposits which will limit the habitat for a select few adapted aquatic macro-invertebrate community members.
IHAS general stream characteristics	A shallow, narrow, slow-flowing stream consisting of long glides and pools. The water in the system was clear at the time of assessment.

4.2.5 Aquatic Macro-invertebrates

The results of the aquatic macro-invertebrate assessment according to the SASS5 index are summarised in the tables below. Table 17 indicates the results obtained at each site per biotope sampled. Table 18 summarises the findings of the SASS assessment based on the analyses of the data for each site, as well as interpretation of the data for each site.

Table 17: Biotope specific summary of the results obtained from the application of the SASS5 index to the K2 site.

PARAMETER	STONES	VEGETATION	GRAVEL, SAND AND MUD	TOTAL
SASS5 Score	26	37	32	39
Taxa	7	9	9	11
ASPT	3.7	4.1	3.6	3.5

Table 18: A summary of the results obtained from the application of the SASS5 and IHAS indices to the K2 site.

Type of Result	K2
Biotopes sampled	GSM, SIC and vegetation.

Sensitive taxa present	*Nil*
Sensitive taxa absent	*Perlidae; Tricorythidae; Chlorocyphidae; Heptageniidae; Leptophlebiidae; Elmidae; Aeshnidae; Hydracarina; Chlorolestidae; Psephenidae; Athericidae; Naucoridae; Atyidae*
Adjusted SASS5 score	65
SASS5 % of reference score (124)	31%
ASPT % of reference score (5.6)	62%
Dickens and Graham, 2001 classification	Class E (Severely impaired. Only tolerant taxa present.)
Dallas 2007	Class E/F

- The SASS score indicates that the aquatic macro-invertebrate community in this section of the tributary river which flows into the Jukskei River has suffered a severe loss in integrity.
- At present, the site (K2) which runs through the subject property can be considered as a Class E site according to Dickens & Graham (2001) which has been severely impaired and where only tolerant taxa is present.
- Dallas 2007 classification for the lower Highveld ecoregion confirms the severe and critically impaired status (E/F) due to the low SASS score of 39 and ASPT of 3.5.
- The K2 site, falls outside the PESC for the quaternary catchment A21C which is based on a Class D (Kleynhans, 1999).
- The system can therefore be regarded as being fairly tolerant, however due to the impact on the system care should be taken to prevent further impacts on this system from the proposed development activities.
- Careful design and construction will be required to limit the impact on the system.

4.2.6 The fish community

- Two fish species, the Long Bearded Barb (*Barbus unitaeniatus)* and the Mozambique Tilapia (*Oreochromis mossambicus*) were captured, identified and released during the assessment. The low diversity indicates that long term impacts on the system are likely. In this regard special mention is made of migration barriers (such as dams) in the system and the water quality levels. It is for this reason that the system can be regarded as having limited sensitivity in terms of fish community dynamics, however care should still be exercised during the proposed development activities to prevent further impacts on the fish community of the system.

Table 19: A summary of the results obtained from the application of the FAII index to the site.

Type of Result	**K2**	
Species present and number of individuals obtained	*Barbus unitaeniatus*	*6*
	Oreochromis mossambicus	*3*
Health and condition	No impairment of fish health observed	

Expected FAII score	150
Observed FAII score	15
Relative FAII score	10%
FAII classification (Kleynhans, 1999)	"Class F". Critically modified.

- The FAII data indicates that the fish community in this section of the tributary system has suffered a critical loss in integrity when compared to the expected score for a stream in this catchment with the habitat characteristics of the area.
- The absence of fish in the system is indicative of long term impacts on the system, with special mention of impacts on water flow modification and migration barriers.
- With only a low diversity and abundance of fish in the area, the fish community of the area is considered critically modified (Class F).
- Measures to improve water flow should be sought in order to allow fish species to re-establish in the system.
- It is important to ensure that no impacts on fish migration on the system occur as a result of the proposed development.

Figure 9: Long Bearded Barb (*Barbus unitaeniatus)* found at site K2.

5. CONCLUSION AND RECOMMENDATIONS

Jukskei River (Site K1)

Water quality

- General water quality can be considered to be fair, based on the results of the biota specific water quality analyses
- Limited amounts of dissolved salts present in the system although salt concentrations can be considered to be elevated form the natural conditions expected for the area. Limited osmotic stress on the aquatic community is deemed likely at the current time.
- The pH is slightly alkaline however no impact on the aquatic community due to altered pH conditions is deemed likely.
- Temperature can be regarded as normal for the time of year and time of assessment.
- Dissolved oxygen concentration in the system is low and is likely to place significant stress on the aquatic community in the system.

Habitat suitability and integrity

- From the results of the application of the IHIA to the K1 site, it is evident that there are serious impacts on the habitat integrity of the area. The most significant instream impacts included water bed modification, water quality and channel modification. Moderate impact from solid waste disposal, as well as flow and water abstraction was noted. Overall, the site achieved a 33% score for instream habitat integrity (Appendix 3).
- The most significant riparian zone impacts were alien encroachment followed by bank erosion and channel modification. Moderate level impacts observed were namely vegetation removal, water abstraction, flow modification and channel modification. The site achieved a 17% score for riparian integrity (Appendix 3).
- The site obtained an overall IHIA rating of 25%, which indicates extensively modified (class E) conditions. The site, therefore, falls outside the DEMC for the quaternary catchment A21C based on habitat conditions (Kleynhans, 1999).

Invertebrate Habitat Assessment

- Habitat diversity and structure is considered inadequate for supporting a diverse aquatic macro-invertebrate community

Macro-invertebrate community integrity

- The SASS score indicates that the aquatic macro-invertebrate community in this section of the Jukskei River has suffered a severe loss in integrity.

- At present, the site (K1) which runs through the subject property can be considered as a Class E site according to Dickens & Graham (2001) which has been severely impaired and where only tolerant taxa is present.
- Dallas 2007 classification for the lower Highveld ecoregion confirms the severe and critically impaired status (E/F) due to the low SASS score of 29.
- The site, falls below the PESC for the quaternary catchment A21C which is based on a Class D (Kleynhans, 1999).
- The system can therefore be regarded as being fairly tolerant, however due to the impact on the system care should be taken to prevent further impacts on this system from the proposed development activities.
- Careful design and construction will be required to limit the impact on the system.

The fish community

- No fish were captured during the assessment indicating that long term impacts on the system are likely. In this regard special mention is made of the water quality has a major effect on the fish assemblage as does migration barriers in the system which were observed upstream from site K1. It is for this reason that the system can be regarded as having limited sensitivity in terms of fish community dynamics, however care should still be exercised during the proposed development activities to prevent further impacts on the fish community of the system with special mention of migratory connectivity.
- Thus according to the protocol of Kleynhans (1999) Present State Classes in terms of FAII scores, the fish community at this point is critically modified (Class F).

Tributary River (Site K2)

Water quality

- The water quality for this tributary stream can be considered to be fair, with limited amounts of dissolved salts present in the system although some elevation of salt concentrations from the natural conditions is deemed likely. Fairly limited osmotic stress on the aquatic community is deemed likely at the current time.
- The pH is 7.2 and considered relatively natural. No impact on the aquatic community due to altered pH conditions is deemed likely.
- Temperature can be regarded as normal for the time of year and time of assessment.
- Dissolved oxygen concentrations are fair but some more sensitive taxa may be absent from the system.

Habitat suitability and integrity

- From the results of the application of the IHIA to the tributary river at site K2, which falls within the study area, it is evident that there are impacts on the habitat integrity of the area. The most significant instream impacts included flow modification due to the already

existing upstream impoundments that are situated along this tributary system. Overall, the site achieved a 52% score for instream habitat integrity (Appendix 3).

- The most significant riparian zone impact was flow modification. Low level impacts observed were namely vegetation removal, water abstraction, bank erosion, water quality and channel modification. The site achieved a 37% score for riparian zone integrity (Appendix 3).
- The site obtained an overall IHIA rating of 45%, which indicates largely modified (class D) conditions. The tributary site K2, therefore, falls just outside the DEMC for the quaternary catchment A21C based on habitat conditions (Kleynhans, 1999).

Invertebrate Habitat Assessment

- Habitat diversity and structure is adequate for supporting a diverse aquatic macro-invertebrate community.

Macro-invertebrate community integrity

- The SASS score indicates that the aquatic macro-invertebrate community in this section of the tributary river which flows into the Jukskei River has suffered a severe loss in integrity.
- At present, the site (K2) which runs through the subject property can be considered as a Class E site according to Dickens & Graham (2001) which has been severely impaired and where only tolerant taxa is present.
- Dallas 2007 classification for the lower Highveld ecoregion confirms the severe and critically impaired status (E/F) due to the low SASS score of 39 and ASPT of 3.5.
- The K2 site, falls outside the PESC for the quaternary catchment A21C which is based on a Class D (Kleynhans, 1999).
- The system can therefore be regarded as being fairly tolerant, however due to the impact on the system care should be taken to prevent further impacts on this system from the proposed development activities.
- Careful design and construction will be required to limit the impact on the system.

The fish community

Two fish species, the Longbeared Barb (*Barbus unitaeniatus)* and the Mozambique Tilapia (*Oreochromis mossambicus*) were captured, identified and released during the assessment. The low diversity indicates that long term impacts on the system are likely. In this regard special mention is made of migration barriers (such as dams) in the system and the water quality levels. It is for this reason that the system can be regarded as having limited sensitivity in terms of fish community dynamics, however care should still be exercised during the proposed development activities to prevent further impacts on the fish community of the system.

- The FAII data indicates that the fish community in this section of the tributary system has suffered a critical loss in integrity when compared to the expected score for a stream in this catchment with the habitat characteristics of the area.
- The absence of fish in the system is indicative of long term impacts on the system, with special mention of impacts on water flow modification and migration barriers.
- With only a low diversity and abundance of fish in the area, the fish community of the area is considered critically modified (Class F).
- Measures to improve water flow should be sought in order to allow fish species to re-establish in the system.

  It is important to ensure that no impacts on fish migration on the system occur as a result of the proposed development.

After conclusion of this aquatic assessment, the following recommendations are provided:

Recommendations

- Ongoing monitoring of the trends in ecological integrity of the (riparian areas) Jukskei River and the tributary system that could be affected by the activities at the proposed new development is deemed essential, in order to monitor the impacts of the proposed new development activities on this system especially during the construction phase.
- Regular physico-chemical monitoring of the water systems must continue to keep track of the water quality entering the receiving environment during the construction phase of the proposed project.
- Results should be compared spatially and temporally to the results of this document and previous biomonitoring studies. If it is observed through biomonitoring information that significant negative changes are taking place in ecological integrity (Change of Class), it should be taken as an indication that the system is suffering stress and mitigation actions should be identified and where possible, implemented.
- Measures to control seepage and sedimentation into the riparian areas especially during the construction phase on site should be considered to prevent further sedimentation from reaching the receiving surface water environment.
- Sediment analyses within the Jukskei River and associated stormwater systems should take place on a two yearly basis and compared to historical data.
- As much of the ecological functioning and natural connectivity of the riparian features drainage systems need to be maintained.
- All construction vehicles should remain on designated roads with no indiscriminate driving through riparian areas.
- No construction vehicles are to be allowed to cross through riparian areas.

- Where construction vehicles need to cross over riparian areas (natural rivers) a bridge should be constructed over the riparian areas in order to preserve the aquatic habitat integrity and connectivity.
- Vehicles are to be regularly serviced to ensure minimal hydrocarbon spillages occur.
- If there is a hydrocarbon spill, a clean-up plan should be implemented immediately.
- No topsoil, waste rock or building material should be dumped into any existing riparian area, as these areas are considered to be of higher ecological importance.
- It must be ensured that construction-related waste and effluent do not affect the aquatic resources and associated buffer zones.
- Edge effects of activities, including erosion and sedimentation, have to be strictly managed along the riparian areas.
- It must be ensured that flow connectivity along the riparian features is maintained.

Stormwater management

- Adequate stormwater, erosion and sedimentation management measures must be incorporated into the design of the proposed development route in order to prevent erosion and sedimentation of the riparian areas.
- It must be ensured that runoff from impacted areas is suitably managed and that runoff volumes and velocities are similar to pre-disturbance levels. Stormwater control methods as set out in engineering specifications are to be implemented.
- During the construction of the proposed development route, erosion berms should be installed to prevent gully formation and siltation of the riparian areas. The following points should serve to guide the placement of erosion berms:
  - Where the track has slope of less than 2%, berms every 50m should be installed.
  - Where the track slopes between 2% and 10%, berms every 25m should be installed.
  - Where the track slopes between 10%-15%, berms every 20m should be installed.
  - Where the track has slope greater than 15%, berms every 10m should be installed.

Rehabilitation

- As much vegetation growth as possible should be promoted within the proposed development area in order to protect soils and the riparian areas. In this regard special mention is made of the need to use indigenous vegetation species where rehabilitation planting is to be implemented.
- Upon completion of the project, new indigenous landscaping should be implemented in all affected areas and proper rehabilitation within all impacted areas must take place.
- Banks of disturbed drainage areas must be reprofiled.
- Banks and drainage features, if affected by the proposed construction activities, are to be reinforced where necessary with reno mattresses and geotextiles.

- Any areas where earthworks have taken place should be reseeded with indigenous vegetation to prevent erosion and sedimentation.
- It must be ensured that all disturbed and exposed areas are rehabilitated and covered with indigenous vegetation to prevent dust generation and sedimentation.

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Appendix 1: IHAS score sheet April 2012

INVERTEBRATE HABITAT ASSESSMENT SYSTEM (IHAS)

River Name: Jukskei
Site Name: K1
Date: 12/04/2012

SAMPLING HABITAT	0	1	2	3	4	5
STONES IN CURRENT (SIC)						
Total length of white water rapids (i.e.: bubbling water) (in meters)	none	0-1	>1-2	>2-3	>3-5	>5
Total length of submerged stones in current (run) (in meters)	none	0-2	>2-5	>5-10	>10	
Number of separate SIC area's kicked (not individual stones)	0	1	2-3	4-5	6+	
Average stone size's kicked (cm's) (gravel is <2, bedrock is >20)	none	<2>20	2-10	11-20	2-20	
Amount of stone surface clear (of algae, sediment, etc) (in %)*	n/a	0-25	26-50	51-75	>75	
PROTOCOL: time spent actually kicking stones (in minutes) (gravel/bedrock = 0 min)	0	<1	>1-2	2	>2-3	>3
(* NOTE: up to 25% of stone is usually embedded in the stream bottom)						
				SIC Score (max 20):	**0**	
VEGETATION	**0**	**1**	**2**	**3**	**4**	**5**
Length of fringing vegetation sampled (river banks) (PROTOCOL - in meters)	none	0-½	>½-1	>1-2	2	>2
Amount of aquatic vegetation sampled (underwater) (in square meters)	none	0-½	>½-1	>1		
Fringing vegetation sampled in: ('still' = pool/still water only; 'run' = run only)	none		run	pool		mix
Type of vegetation (% leafy veg. As opposed to stems/shoots) (aq. Veg. Only = 49%)	none		1-25	26-50	51-75	>75
				Vegetation Score (max 15):	**6**	
OTHER HABITAT/GENERAL	**0**	**1**	**2**	**3**	**4**	**5**
Stones out of current (SOOC) sampled: (PROTOCOL - in square meters)	none	0-½	>½-1	1	>1	
Sand sampled: (PROTOCOL - in minutes) ('under' = present, but only under stones)	none	under	0-½	>½-1	1	>1
Mud sampled: (PROTOCOL - in minutes) ('under' = present, but only under stones)	none	under	0-½	½	>½	
Gravel sampled: (PROTOCOL - in minutes) (if all gravel, SIC stone size = <2)**	none	0-½	½	>½**		
Bedrock sampled: ('all' = no SIC, sand, or gravel then SIC stone size = >20)**	none	some			all**	
Algae present: ('1-2m² = algal bed; 'rocks' = on rocks; 'isol' = isolated clumps)***	>2m²	rocks	1-2m²	<1m²	isol	none
Tray identification: (PROTOCOL - using time: 'coor' = correct time)		under		corr		over
(** NOTE: you must still fill in the SIC section)						
				Other Habitat Score (max 20):	**15**	
				HABITAT TOTAL (MAX 55):	**21**	
STREAM CONDITION	**0**	**1**	**2**	**3**	**4**	**5**
PHYSICAL						
River make up: ('pool' = pool/still/dam only; 'run' only; etc)	pool		run	rapid	2mix	3mix
Average width of stream: (in meters)		>10	>5-10	<1	1-2	>2-5
Average depth of stream: (in meters)	>1	1	>½-1	½	<½-¼	<¼
Approximate velocity of stream: ('slow' = <½m/s; 'fast' = >1m/s) (use twig to test)	still	slow	fast	med		mix
Water colour: ('disc' = discoloured with visible colour but still transparent)	silty	opaque		disc		clear
Recent disturbance due to: ('const.' = construction; 'fl/dr' = flood or drought)***	fl/dr	fire	constr	other		none
Bank/riparian vegetation is: ('grass' = includes reeds; 'shrubs' = include trees)	none		grass	shrubs	mix	
Surrounding impacts: ('erosn' = erosion/shear bank; 'farm' = farmland/settlement)***	erosn	farm	trees	other		open
Left bank cover: (rocks and vegetation) (in %)	0-50	51-80	81-95	>95		
Right bank cover: (rocks and vegetation) (in %)	0-50	50-80	81-95	>95		
(*** NOTE: if more than one option, choose the lowest)						
				STREAM CONDITIONS TOTAL (MAX	**24**	
				TOTAL IHAS SCORE (%):	**45**	

INVERTEBRATE HABITAT ASSESSMENT SYSTEM (IHAS)

River Name: Jukskei Tributary
Site Name: K2
Date: 12/04/2012

SAMPLING HABITAT	0	1	2	3	4	5
STONES IN CURRENT (SIC)						
Total length of white water rapids (i.e.: bubbling water) (in meters)	none	0-1	>1-2	>2-3	>3-5	>5
Total length of submerged stones in current (run) (in meters)	none	0-2	>2-5	>5-10	>10	
Number of separate SIC area's kicked (not individual stones)	0	1	2-3	4-5	6+	
Average stone size's kicked (cm's) (gravel is <2, bedrock is >20)	none	<2>20	2-10	11-20	2-20	
Amount of stone surface clear (of algae, sediment, etc) (in %)*	n/a	0-25	26-50	51-75	>75	
PROTOCOL: time spent actually kicking stones (in minutes) (gravel/bedrock = 0 min)	0	<1	>1-2	2	>2-3	>3
(* NOTE: up to 25% of stone is usually embedded in the stream bottom)						
				SIC Score (max 20):	**6**	
VEGETATION	**0**	**1**	**2**	**3**	**4**	**5**
Length of fringing vegetation sampled (river banks) (PROTOCOL - in meters)	none	0-½	>½-1	>1-2	2	>2
Amount of aquatic vegetation sampled (underwater) (in square meters)	none	0-½	>½-1	>1		
Fringing vegetation sampled in: ('still' = pool/still water only; 'run' = run only)	none		run	pool		mix
Type of vegetation (% leafy veg. As opposed to stems/shoots) (aq. Veg. Only = 49%)	none		1-25	26-50	51-75	>75
				Vegetation Score (max 15):	**7**	
OTHER HABITAT/GENERAL	**0**	**1**	**2**	**3**	**4**	**5**
Stones out of current (SOOC) sampled: (PROTOCOL - in square meters)	none	0-½	>½-1	1	>1	
Sand sampled: (PROTOCOL - in minutes) ('under' = present, but only under stones)	none	under	0-½	>½-1	1	>1
Mud sampled: (PROTOCOL - in minutes) ('under' = present, but only under stones)	none	under	0-½	½	>½	
Gravel sampled: (PROTOCOL - in minutes) (if all gravel, SIC stone size = <2)**	none	0-½	½	>½**		
Bedrock sampled: ('all' = no SIC, sand, or gravel then SIC stone size = >20)**	none	some			all**	
Algae present: ('1-2m² = algal bed; 'rocks' = on rocks; 'isol' = isolated clumps)***	>2m²	rocks	1-2m²	<1m²	isol	none
Tray identification: (PROTOCOL - using time: 'coor' = correct time)		under		corr		over
(** NOTE: you must still fill in the SIC section)						
				Other Habitat Score (max 20):	**16**	
				HABITAT TOTAL (MAX 55):	**29**	
STREAM CONDITION	**0**	**1**	**2**	**3**	**4**	**5**
PHYSICAL						
River make up: ('pool' = pool/still/dam only; 'run' only; etc)	pool		run	rapid	2mix	3mix
Average width of stream: (in meters)		>10	>5-10	<1	1-2	>2-5
Average depth of stream: (in meters)	>1	1	>½-1	½	<½-¼	<¼
Approximate velocity of stream: ('slow' = <½m/s; 'fast' = >1m/s) (use twig to test)	still	slow	fast	med		mix
Water colour: ('disc' = discoloured with visible colour but still transparent)	silty	opaque		disc		clear
Recent disturbance due to: ('const.' = construction; 'fl/dr' = flood or drought)***	fl/dr	fire	constr	other		none
Bank/riparian vegetation is: ('grass' = includes reeds; 'shrubs' = include trees)	none		grass	shrubs	mix	
Surrounding impacts: ('erosn' = erosion/shear bank; 'farm' = farmland/settlement)***	erosn	farm	trees	other		open
Left bank cover: (rocks and vegetation) (in %)	0-50	51-80	81-95	>95		
Right bank cover: (rocks and vegetation) (in %)	0-50	50-80	81-95	>95		
(*** NOTE: if more than one option, choose the lowest)						
				STREAM CONDITIONS TOTAL (MAX	**29**	
				TOTAL IHAS SCORE (%):	**58**	

Appendix 2: SASS5 score sheet April 2012

RIVER HEALTH PROGRAMME - SASS 5 SCORE SHEET

DATE: 12/04/2012	TAXON		S	VG	GSM	TOT	TAXON		S	VG	GSM	TOT	TAXON		S	VG	GSM	TOT
GRID REFERENCE:	**PORIFERA**	5					**HEMIPTERA:**						**DIPTERA:**					
S:°	**COELENTERATA**	1					Belostomatidae*	3					Athericidae	10				
E:°	**TURBELLARIA**	3					Corixidae*	3					Blepharoceridae	15				
SITE CODE: K1	**ANNELIDA:**						Gerridae*	5					Ceratopogonidae	5				
RIVER: Jukskei	Oligochaeta	1					Hydrometridae*	6					Chironomidae	2		**A**	**A**	**A**
SITE DESCRIPTION:	Leeches	3					Naucoridae*	7					Culicidae*	1		**A**	**A**	**A**
WEATHER CONDITION: Cool & Sunny	**CRUSTACEA:**						Nepidae*	3					Dixidae*	10				
TEMP: 21 °C	Amphipoda	13					Notonectidae*	3					Empididae	6				
Ph: 7.9	Potamonautidae*	3					Pleidae*	4					Ephydridae	3				
DO: mg/l	Atyidae	8					Veliidae/M..veliidae*	5					Muscidae	1				
Cond: 61 mS/m	Palaemonidae	10					**MEGALOPTERA:**						Psychodidae	1				
BIOTOPES SAMPLED:	**HYDRACARINA**	8					Cordalidae	8					Simuliidae	5		**1**		**1**
SIC: TIME: minutes	**PLECOPTERA:**						Sialidae	6					Syrphidae*	1				
SOOC:	Notonemouridae	14					**TRICHOPTERA**						Tabanidae	5				
BEDROCK:	Perlidae	12					Dipseudopsidae	10					Tipulidae	5				
AQUATIC VEG: DOM SP:	**EPHEMEROPTERA**						Ecnomidae	8					**GASTROPODA**					
M VEG IC: DOM SP:	Baetidae 1sp	4					Hydropsychidae 1sp	4					Ancylidae	6				
M VEG OOC: DOM SP:	Baetidae 2 sp	6					Hydropsychidae 2 sp	6					Bulininae*	3				
GRAVEL:	Baetidae >2 sp	12		**B**	**A**	**B**	Hydropsychidae >2 sp	12					Hydrobiidae*	3				
SAND:	Caenidae	6		**A**		**A**	Philopotamidae	10					Lymnaeidae*	3				
MUD:	Ephemeridae	15					Polycentropodidae	12					Physidae*	3				
HAND PICKING/VISUAL OBS:	Heptageniidae	13					Psychomyiidae/Xiphocen.	8					Planorbidae*	3				
FLOW: Medium	Leptophlebiidae	9					**CASED CADDIS:**						Thiaridae*	3				
TURBIDITY: Medium	Oligoneuridae	15					Barbarochthonidae SWC	13					Viviparidae* ST	5				
RIPARIAN LAND USE:	Polymitarcyidae	10					Calamoceratidae ST	11					**PELECYPODA**					
	Prosopistomatidae	15					Glossosomatidae SWC	11					Corbiculidae	5				
	Teloganodidae SWC	12					Hydroptilidae	6					Sphaeriidae	3				
	Tricorythidae	9					Hydrosalpingidae SWC	15					Unionidae	6				
	ODONATA:						Lepidostomatidae	10					**SASS SCORE:**		0	26	15	26
DISTURBANCE IN RIVER:	Calopterygidae ST,T	10					Leptoceridae	6					**NO OF TAXA:**		0	5	3	5
	Chlorocyphidae	10					Petrothrincidae SWC	11					**ASPT:**		0.00	5.20	5.00	5.20
	Chlorolestidae	8					Pisuliidae	10					**IHAS**:		45%			
	Coenagrionidae	4					Sericostomatidae SWC	13					**OTHER BIOTA**:					
	Lestidae	8					**COLEOPTERA:**						Dapnia					
SIGNS OF POLLUTION:	Platycnemidae	10					Dytiscidae*	5					**COMMENTS**:					
Rubble & Refuse dumping	Protoneuridae	8					Elmidae/Dryopidae*	8					* = airbreathers					
	Zygoptera juvs.	6					Gyrinidae*	5					SWC = South Western Cape					
	Aeshnidae	8					Halipidae*	5					T = Tropical					
	Corduliidae	8					Helodidae	12					ST = Sub-tropical					
OTHER OBSERVATIONS:	Gomphidae	6					Hydraenidae*	8					S = Stone & rock					
High sedimentation	Libellulidae	4					Hydrophilidae*	5					VG = all vegetation					
	LEPIDOPTERA:						Limnichidae	10					GSM = gravel, sand & mud					
	Pyralidae	12					Psephenidae	10					1=1, A=2-10, B=10-100, C=100-1000, D=>1000					

RIVER HEALTH PROGRAMME - SASS 5 SCORE SHEET

DATE: 12/04/2012	TAXON		S	VG	GSM	TOT	TAXON		S	VG	GSM	TOT	TAXON		S	VG	GSM	TOT
GRID REFERENCE:	**PORIFERA**	5					**HEMIPTERA:**						**DIPTERA:**					
S:°	**COELENTERATA**	1					Belostomatidae*	3	**A**	**B**	**B**	**B**	Athericidae	10				
E:°	**TURBELLARIA**	3					Corixidae*	3		**A**	**A**	**A**	Blepharoceridae	15				
SITE CODE: K2	**ANNELIDA:**						Gerridae*	5					Ceratopogonidae	5				
RIVER: Jukskei Trib	Oligochaeta	1	**1**		**A**	**A**	Hydrometridae*	6					Chironomidae	2	**A**	**A**	**A**	**A**
SITE DESCRIPTION:	Leeches	3					Naucoridae*	7					Culicidae*	1			**A**	**A**
WEATHER CONDITION: Cool & Sunny	**CRUSTACEA:**						Nepidae*	3					Dixidae*	10				
TEMP: 17.7 °C	Amphipoda	13					Notonectidae*	3		**A**		**A**	Empididae	6				
Ph: 7.17	Potamonautidae*	3					Pleidae*	4					Ephydridae	3				
DO: mg/l	Atyidae	8					Veliidae/M..veliidae*	5	**1**	**1**	**A**	**A**	Muscidae	1				
Cond: 56 mS/m	Palaemonidae	10					**MEGALOPTERA:**						Psychodidae	1				
BIOTOPES SAMPLED:	**HYDRACARINA**	8					Cordalidae	8					Simuliidae	5	**1**	**A**	**A**	**A**
SIC: TIME: minutes	**PLECOPTERA:**						Sialidae	6					Syrphidae*	1				
SOOC:	Notonemouridae	14					**TRICHOPTERA**						Tabanidae	5				
BEDROCK:	Perlidae	12					Dipseudopsidae	10					Tipulidae	5				
AQUATIC VEG: 10% DOM SP:	**EPHEMEROPTERA**						Ecnomidae	8					**GASTROPODA**					
M VEG IC: DOM SP:	Baetidae 1sp	4					Hydropsychidae 1sp	4					Ancylidae	6				
M VEG OOC: DOM SP:	Baetidae 2 sp	6	**A**	**A**	**A**	**A**	Hydropsychidae 2 sp	6					Bulininae*	3				
GRAVEL: 80%	Baetidae >2 sp	12					Hydropsychidae >2 sp	12					Hydrobiidae*	3				
SAND: 20%	Caenidae	6		**A**	**A**	**A**	Philopotamidae	10					Lymnaeidae*	3				
MUD:	Ephemeridae	15					Polycentropodidae	12					Physidae*	3				
HAND PICKING/VISUAL OBS:	Heptageniidae	13					Psychomyiidae/Xiphocen.	8					Planorbidae*	3				
FLOW: Low	Leptophlebiidae	9					**CASED CADDIS:**						Thiaridae*	3				
TURBIDITY: Low	Oligoneuridae	15					Barbarochthonidae SWC	13					Viviparidae* ST	5				
RIPARIAN LAND USE:	Polymitarcyidae	10					Calamoceratidae ST	11					**PELECYPODA**					
	Prosopistomatidae	15					Glossosomatidae SWC	11					Corbiculidae	5				
	Teloganodidae SWC	12					Hydroptilidae	6					Sphaeriidae	3				
	Tricorythidae	9					Hydrosalpingidae SWC	15					Unionidae	6				
	ODONATA:						Lepidostomatidae	10					**SASS SCORE:**		26	37	32	39
DISTURBANCE IN RIVER:	Calopterygidae ST,T	10					Leptoceridae	6					**NO OF TAXA:**		7	9	9	11
	Chlorocyphidae	10					Petrothrincidae SWC	11					**ASPT:**		3.71	4.11	3.56	3.55
	Chlorolestidae	8					Pisuliidae	10					**IHAS**:	58%				
	Coenagrionidae	4	**1**	**A**		**A**	Sericostomatidae SWC	13					**OTHER BIOTA**:					
	Lestidae	8					**COLEOPTERA:**											
SIGNS OF POLLUTION:	Platycnemidae	10					Dytiscidae*	5					**COMMENTS**:					
	Protoneuridae	8					Elmidae/Dryopidae*	8					* = airbreathers					
	Zygoptera juvs.	6					Gyrinidae*	5					SWC = South Western Cape					
	Aeshnidae	8					Halipidae*	5					T = Tropical					
	Corduliidae	8					Helodidae	12					ST = Sub-tropical					
OTHER OBSERVATIONS:	Gomphidae	6					Hydraenidae*	8					S = Stone & rock					
Low flowing stream	Libellulidae	4					Hydrophilidae*	5					VG = all vegetation					
	LEPIDOPTERA:						Limnichidae	10					GSM = gravel, sand & mud					
	Pyralidae	12					Psephenidae	10					1=1, A=2-10, B=10-100, C=100-1000, D=>1000					

Appendix 3: IHIA score sheet April 2012

In stream Habitat Integrity

Weights	14	13	13	13	14	10	9	8	2		
SITE	Water abstraction	Flow modification	Bed modification	Channel modification	Water quality	Inundation	Exotic macrophytes	Exotic fauna	Solid waste disposal	Total Score (%)	Classification
K1	9	8	12	10	10	4	0	0	6	33	E Extensively modified
K2	3	6	4	3	3	0	0	0	0	52	D Largely modified

None	Small	Moderate	Large	Serious	Critical

Riparian Zone Habitat Integrity

Weights	13	12	14	12	13	11	12	13		
SITE	Vegetation removal	Alien encroachment	Bank erosion	Water abstraction	Flow modification	Channel modification	Water quality	Inundation	Total Score (%)	Classification
K1	8	14	10	9	8	10	3	4	17	F Critically modified
K2	4	4	2	3	6	3	3	0	37	E Extensively modified

None	small	Moderate	Large	Serious	Critical

SITE	*INSTREAM HABITAT*	*RIPARIAN ZONE*	*IHI SCORE*	*CLASS*
K1	33	17	25	E Extensively modified
K2	52	37	45	D Largely modified

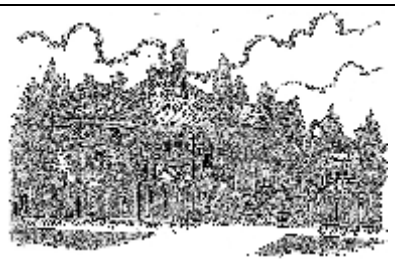
Appendix 4: FAll score sheet April 2012

EXPECTED DATA	Tolerance rating	Health rating	Expected score
SPECIES	K2	K2	K2
Austroglanis sclateri	2.7		
Barbus paludinosus	1.8		
Barbus anoplus	2.6		
Barbus unitaeniatus	1.7		
Labeobarbus aeneus	2.5		
Labeobarbus kimberleyensis	2.5		
Labeo capensis	3.2		
Labeo umbratus	2.3		
Pseudocrenilabrus philander	1.3		
Oreochromis mossambicus	1.3		
Tilapia Sparrmanii	1.3		
Clarias gariepinus	1.2		
Cyprinus carpio	1.4		
Micropterus salmoides	2.2		
Gambussia affinis	2		
SUM	30	5	150
OBSERVED DATA			
SPECIES	K2	K2	K2
Austroglanis sclateri	0		
Barbus paludinosus	0		
Barbus anoplus	0		
Barbus unitaeniatus	1.7		
Labeobarbus aeneus	0		
Labeobarbus kimberleyensis	0		
Labeo capensis	0		
Labeo umbratus	0		
Pseudocrenilabrus philander	0		
Oreochromis mossambicus	1.3		
Tilapia Sparrmanii	0		
Clarias gariepinus	0		
Cyprinus carpio	0		
Micropterus salmoides	0		
Gambussia affinis	0		
SUM	3	5	15.0
			10.0

Annexure F(iv)

HERITAGE IMPACT
ASSESSEMENT

PHASE 1 HERITAGE IMPACT ASSESSMENT FOR THE PROPOSED NEW ROAD K56 (STUDY AREA: ERLING ROAD BETWEEN THE K46 AND K56 AND THE K56 BETWEEN K46 AND MAIN ROAD) MIDRAND, GAUTENG PROVINCE

	
Archaetnos Archaeologists and Heritage Consultants Dr A.C. van Vollenhoven Zurethe Collins PO Box 55 GROENKLOOF 0027 Mobile: 083 291 6104 E-mail: antonv@archaetnos.co.za	Leonie Marais-Botes Heritage Practitioner 868 Endeman Street Wonderboom South Pretoria 0084 Mobile: 082 576 6253 E-mail: leoniembotes@gmail.com
BA, BA (Hons), DTO, NDM, MA (Archaeology) [UP], MA (Culture History) [US], DPhil (Archaeology) [UP], Man Dip [TUT], DPhil (History)[US], L Akad [SA]	*BA (Cultural History and Archaeology) (UP), BA (Hons) Cultural History (UP), Post Grad Dip Museology (UP), Cert Conservation of Traditional Buildings (Univ of Canberra) Post Grad Dip: Heritage (Wits)*
Accredited member: SA Society for Cultural History (CH001) *Accredited member: ASAPA*	*Accredited member: SA Society for Cultural History (CH002)*

For:

Bokamoso Environmental
PO Box 11375
MAROELANA
0161

March 2014

DISCLAIMER:

Although all possible care is taken to identify/find all sites of cultural importance during the initial survey of the study area, the nature of archaeological and historical sites are as such that it is always possible that hidden or sub-surface sites could be overlooked during the study. Leonie Marais-Botes Heritage Practitioner/ Archaetnos Archaeologists and Heritage Consultants will not be held liable will not be held liable for such oversights or for the costs incurred as a result thereof.

ACKNOWLEDGEMENTS

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The National Archives databases.

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ABOUT THIS REPORT

The heritage report must reflect that consideration has been given to the history and heritage significance of the study area and that the proposed work is sensitive towards the heritage resources and does not alter or destroy the heritage significance of the study area.

The heritage report must refer to the heritage resources currently in the study area.

The opinion of an independent heritage consultant is required to evaluate if the proposed work generally follows a good approach that will ensure the conservation of the heritage resources.

The National Heritage Resources Act (Act 25 of 1999) and the National Environmental Management Act (Act 107 of 1998) are the guideline documents for a report of this nature.

Leonie Marais-Botes Heritage Practitioner/Archaetnos Archaeologists and Heritage Consultants was appointed by Bokamoso Environmental to carry out a Phase 1 Heritage Impact Assessment (HIA) for the proposed new road K56 Midrand, Gauteng Province. The site investigation was conducted on 31 March 2014.

EXECUTIVE SUMMARY

This project may impact on any types and ranges of heritage resources that are outlined in Section 3 of the National Heritage Resources Act (Act 25 of 1999). Consequent a Heritage Impact Assessment was commissioned by Bokamoso Environmental and conducted by Leonie Marais-Botes/Archaetnos Archaeologists and Heritage Consultants.

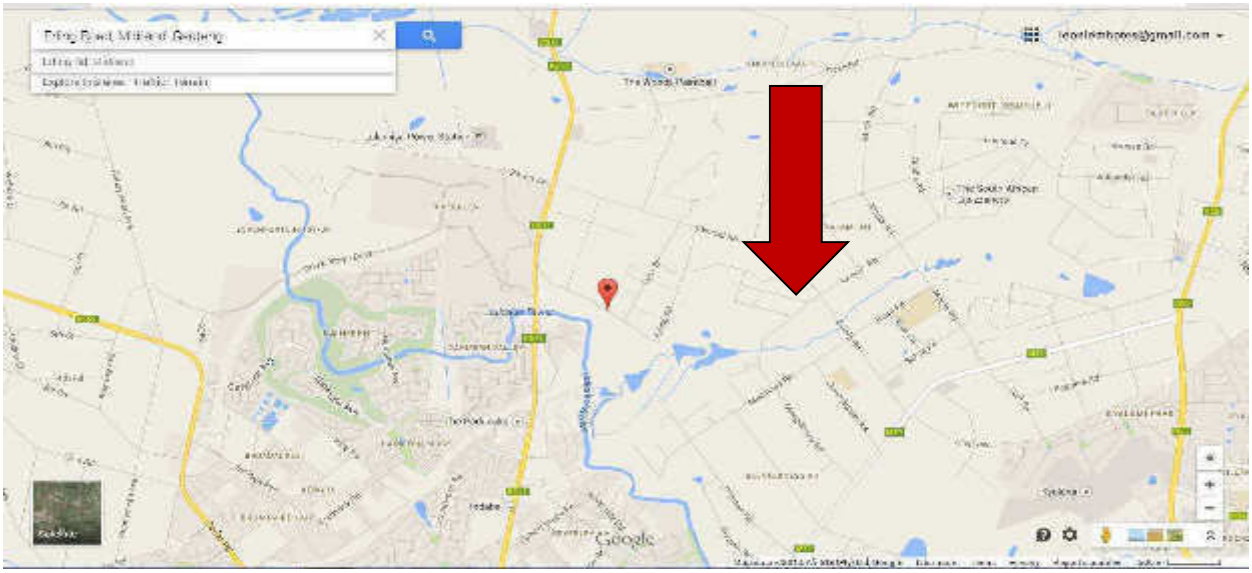
It is important to note that all graves and cemeteries are of high significance and are protected by various laws. Legislation with regard to graves includes the National Heritage Resources Act (Act 25 of 1999) whenever graves are 60 years and older. Other legislation with regard to graves includes those when graves are exhumed and relocated, namely the Ordinance on Exhumations (no 12 of 1980) and the Human Tissues Act (Act 65 of 1983 as amended).

1.1 INTRODUCTION

The proposed development entails the construction of a new road.

1.2 LOCATION

The study area is situated between William Nicol Drive and Main Road, Midrand, Gauteng Province.



1.3 METHOD

The objective of this Phase 1 Heritage Impact Assessment (HIA) was to gain an overall understanding of the heritage sensitivities of the area and indicate how they may be impacted on through development activities. The survey took place on 31 March 2014.

In order to establish heritage significance the following method was followed:

- Investigation of primary resources (archival information)
- Investigation of secondary resources (literature and maps)
- Physical evidence (site investigation)
- Determining Heritage Significance

1.4 BACKGROUND HISTORY OF THE GREATER STUDY AREA

Midrand was established cc 1980's on various farm portions. Originally and still at present many smallholdings are situated here.

1.5 PHOTOGRAPHIC RECORD OF AREA EARMARKED FOR DEVELOPMENT

The area earmarked for development consists mainly of small holdings

Main and Ash Road Crossing (eastern access point)

Near Erling Rd William Nicol acces point (western access point) an area suggesting that it was previously farmland/small holdings with homesteads, Currently abonded.

2. FINDINGS

2.1 PRE-COLONIAL HERITAGE SITES

Possibilities: Greater study area taken into account.

Stone Age

The Stone Age is the period in human history when stone material was mainly used to produce tools[1]. In South Africa the Stone Age can be divided in three periods[2];

- Early Stone Age 2 000 000 – 150 000 years ago
- Middle Stone Age 150 000 – 30 000 years ago
- Late Stone Age 40 000 years ago - +/- 1850 AD

Iron Age

The Iron Age is the period in human history when metal was mainly used to produce artefacts[3]. In South Africa the Iron Age can be divided in three periods;

- Early Iron Age 250-900 AD
- Middle Iron Age 900-1300 AD
- Late Iron Age 1300-1840 AD[4]

---

[1] P. J. Coertze & R.D. Coertze, Verklarende vakwoordeboek vir Antropologie en Argeologie.
[2] S.A. Korsman & A. Meyer, *Die Steentydperk en rotskuns* in J.S. Bergh (red) Geskiedenisatlas van Suid-Afrika. Die vier noordelike provinsies.
[3] P.J. Coertze & R.D. Coertze, Verklarende vakwoordeboek vir Antropologie en Argeologie.
[4] M.M. van der Ryst & A Meyer. *Die Ystertydperk* in J.S. Bergh (red) Geskidenisatlas van Suid-Afrika. Die vier noordelike provinsies and T.N Huffman, A Handbook to the Iron Age: The **Archaeology** of Pre-Colonial Farming Societies in Southern Africa.

There are no pre-colonial heritage sites evident in the study area. This can be attributed to previous farming and infra-structure development activities in the greater study area.

2.2 HISTORICAL PERIOD HERITAGE SITES

Possibilities: Greater study area taken into account.

- Pioneer sites (Voortrekker sites cc 1836-1850's)
- Anglo-Boer War (1899-1902) sites.
- Structures older than 60 years.
- Historical graves.

There are no historical period sites in the area earmarked for development.

2.3 ORIGINAL LANDSCAPE

Infrastructure and other development have altered the original landscape in most of the greater study area.

2.4 INTANGIBLE HERITAGE

The intangible heritage of the greater study area can be found in the stories of past and present inhabitants.

3 CATEGORIES OF HERITAGE VALUE (ACT 25 OF 1999)

The National Heritage Resources Act (Act 25 of 1999) identifies the following categories of value under section 3(1) and (2) of the Act under the heading "National Estate":

"3 (1) For the purpose of this Act, those heritage resources of South Africa which are of cultural significance or other special value for the present community and for future generations must be considered part of the national estate and fall within the sphere of operations of heritage resources authorities.

(2) Without limiting the generality of subsection (1), the national estate may include-
- (a) places, buildings, structures and equipment of cultural significance;
- (b) places which oral traditions are attached or which are associated with living heritage;
- (c) historical settlements and townscapes;
- (d) landscapes and natural features of cultural significance;
- (e) geological sites of scientific or cultural importance;
- (f) archaeological and palaeontological sites;
- (g) graves and burial grounds, including-
  - (i) ancestral graves;
  - (ii) royal graves and graves of traditional leaders;
  - (iii) graves of victims of conflict;
  - (iv) graves of individuals designated by the Minister by notice in the Gazette
  - (v) historical graves and cemeteries; and

(vi) other human remains which are not covered in terms of the Human Tissue Act, 1983 (Act No. 65 of 1983);

(h) sites of significance relating to the history in South Africa;

(i) movable objects, including-

(i) objects recovered from the soil or waters of South Africa including archaeological and palaeontological objects and material, meteorites and rare geological specimens;

(ii) objects to which oral traditions are attached or which are associated with living heritage;

(iii) ethnographic art and objects;

(iv) military objects

(v) objects of decorative or fine art;

(vi) objects of scientific or technological interests; and

(vii) books, records, documents, photographic positives and negatives, graphic, film or video material or sound recordings, excluding those that are public records as defined in section I (xiv) of the National Archives of South Africa Act, 1996 (Act No. 43 of 1996).

(3) Without limiting the generality of the subsections (1) and (2), a place or object is to be considered part of the national estate if it has cultural significance or other special value because of-

(a) It is importance in the community, or pattern of South Africa's history;

(b) Its possession of uncommon, rare or endangered aspects of South Africa's natural or cultural heritage;

(c) Its potential to yield information that will contribute to an understanding of South Africa's natural or cultural heritage;

(d) Its importance in demonstrating the principal characteristics of a particular class of South Africa's natural or cultural objects;

(e) Its importance in exhibiting particular aesthetic characteristics valued by a community or cultural group;

(f) Its importance in demonstrating a high degree of creative or technical achievement at a particular period;

(g) Its strong or special association with a particular community or cultural group for social, cultural or spiritual reasons;

(h) Its strong or special association with the life and work of a person, group or organisation of importance in the history of South Africa; and

(i) Sites of significance relating to the history of slavery in South Africa."

3.1 HERITAGE VALUE OF WEIGHED AGAINST CULTURAL SIGNIFICANCE CATEGORIES

3.1.1 Spiritual value

During the site visit/field work no indication of any spiritual activity was observed on/near the proposed site. Thus no sites of spiritual value will be impacted on by the proposed project.

3.1.2 Scientific value

No sites of scientific value was observed on or near the site earmarked for development.

3.1.3 Historical value

No historical value associated with the proposed site could be found in primary and secondary sources.[5]

3.1.4 Aesthetic value

No heritage item with exceptional aesthetic (architectural) value was identified in the study area.

3.1.5 Social value

Social value is attributed to sites that are used by the community for recreation and formal and informal meetings regarding matters that are important to the community. These sites include parks, community halls, sport fields etc. Visually none of the above is evident in the study area.

[5] Standard Encyclopaedia of Southern Africa and the Transvaalse Argiefbewaarplek (TAB) database at the National Archives, Pretoria;
J.S. Bergh (red), Geskiedenisatlas van Suid-Afrika: Die Vier Noordelike Provinsies.

3.2 SPECIFIC CATEGORIES INVESTIGATED AS PER SECTION 3 (1) AND (2) OF THE NATIONAL HERITAGE LEGISLATION (ACT 25 OF 1999)

3.2.1 Does the site/s provide the context for a wider number of places, buildings, structures and equipment of cultural significance?

The study area does not provide context for a wider number of places, buildings, structures and equipment of cultural significance. The reason is the low density of heritage structures/sites in the study area, near or on the proposed site.

3.2.2 Does the site/s contain places to which oral traditions are attached or which are associated with living heritage?

Places to which oral traditions are attached or associated with living heritage are usually find in conjunction with traditional settlements and villages which still practises age old traditions. None of these are evident near or on the proposed site.

3.2.3 Does the site/s contain historical settlements?

No historical settlements are located on or near the proposed site.

3.2.4 Does the site/s contain landscapes and natural features of cultural significance?

Due to previous infra-structure development activities the original character of the landscape have been altered significantly in the study area.

3.2.5 Does the site/s contain geological sites of cultural importance?

Geological sites of cultural importance include meteorite sites (Tswaing Crater and Vredefort Dome), fossil sites (Karoo and Krugersdorp area), important mountain ranges or ridges (Magaliesburg, Drakensberg etc.). The proposed site is not located in an area known for sites of this importance.

3.2.6 Does the site/s contain a wide range of archaeological sites?

The proposed site does not contain any surface archaeological deposits, the reason being the large scale alteration of the original landscape.

The possibility of sub-surface findings always exists and should be taken into consideration in the Environmental Management Plan.

If sub-surface archaeological material is discovered work must stop and a heritage practitioner preferably an archaeologist contacted to assess the find and make recommendations.

3.2.7 Does the site/s contain any marked graves and burial grounds?

The site does not contain marked graves. The possibility of graves not visible to the human eye always exists and this should be taken into consideration in the Environmental Management Plan.

It is important to note that all graves and cemeteries are of high significance and are protected by various laws. Legislation with regard to graves includes the National Heritage Resources Act (Act 25 of 1999) whenever graves are 60 years and older. Other legislation with regard to graves includes those when graves are exhumed and relocated, namely the Ordinance on Exhumations (no 12 of 1980) and the Human Tissues Act (Act 65 of 1983 as amended).

If sub-surface graves are discovered work should stop and a professional preferably an archaeologist contacted to assess the age of the grave/graves and to advice on the way forward.

3.2.8 Does the site/s contain aspects that relate to the history of slavery?

This is not an area associated with the history of slavery like the Western Cape Province.

3.2.9 Can the place be considered as a place that is important to the community or in the pattern of South African history?

In primary and secondary sources the proposed site is not described as important to the community or in the pattern of South African history.[6]

3.2.10 Does the site/s embody the quality of a place possessing uncommon or rare endangered aspects of South Africa's natural and cultural heritage?

The proposed site does not possess uncommon, rare or endangered aspects of South Africa's natural and cultural heritage. These sites are usually regarded as Grade 1 or World Heritage Sites.

3.2.11 Does the site/s demonstrate the principal characteristics of South Africa's natural or cultural places?

The proposed site does not demonstrate the principal characteristics of South Africa's natural or cultural places. These characteristics are usually associated with aesthetic significance.

3.2.12 Does the site/s exhibit particular aesthetic characteristics valued by the community or cultural groups?

This part of the greater study area does not exhibit particular aesthetic characteristics valued by the community or cultural groups. The reason being the low density of heritage buildings and structures located in the greater study area.

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[6] Standard Encyclopaedia of Southern Africa and the Transvaalse Argiefbewaarplek (TAB) database at the National Archives, Pretoria.
J.S. Bergh (red), Geskiedenisatlas van Suid-Afrika. Die Vier Noordelike Provinsies.

3.2.13 Does the site/s contain elements, which are important in demonstrating a high degree of creative technical achievement?

The site does not contain elements which are important in demonstrating a high degree of creative technical achievement. Reason being none of the above evident on site.

3.2.14 Does the site/s have strong and special associations with particular communities and cultural groups for social, cultural and spiritual reasons?

The proposed site does not have a strong or special association with particular communities and cultural groups for social, cultural and spiritual reasons, the reason being that the particular site is located on mainly developed land and it is evident that the site is not utilised for social, cultural or spiritual reasons.

3.2.15 Does the site/s have a strong and special association with the life or work of a person, group or organisation?

No indication of the above in primary and secondary sources.

4. OPPORTUNITIES, RESTRICTIONS, IMPACTS

- Because of the good summer rains grass is long and vegetation dense.
- There are no visible restrictions or negative impacts in terms of heritage associated with the site other than the structures older than 60 years. In terms of heritage this project can proceed.
- 3.2.6 and 3.2.7 must be taken into account in the Environmental Management Plan.

5. THE WAY FORWARD

- **Submit this report as a Section 38 application to the South African Heritage Resources Authority (SAHRA) for comment/approval.**

Annexure F(v)

GEOHYDROLOGY REPORT

BOKOMOSO

DESKTOP GEOHYDROLOGICAL STUDY

DESKSTOP GEOHYDROLOGICAL STUDY

FOR THE

UPGRADE OF ERLING ROAD IN GLENFERNESS AH

DECEMBER 2014

Compiled by

DR M LEVIN

TABLE OF CONTENTS

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1 INTRODUCTION

Bokomoso appointed Dr M Levin to perform a desktop geohydrological study for the upgrade of the Erling Road traversing Treesbank/Glenferness Agricultural Holdings north of Fourways in Johannesburg. The objective of the study is to describe the baseline geohydrological conditions within the project area on a desktop level. This will be included as part of the Environmental Impact Assessment for the upgrade.

2 AVAILABLE INFORMATION

The following information was available and was used in the study:

- 1:50 000 Geological Map 2528CC Lyttleton.
- 1:500 000 Hydrogeological Map Johannesburg 2526.
- An Explanation of the 1:500 000 General Hydrogeological Map – Johannesburg 2526. HC Barnard, October 2000.
- Vegter J R (1995) Groundwater Resources of the Republic of South Africa.
- "Groundwater Resources Directed Measures" software (Version 4.0.0.0). Department of Water Affairs & Forestry & Water Research Commission.
- R Parsons (1995). "*A South African Aquifer System Management Classification"*. Water Research Commission. Report No KV 77/95.

3 GEOLOGY & GEOHYDROLOGY

According to the published 1:50 000 geological map (2528CC Lyttleton), the project area are underlain by the Halfway House Granite Group from the Swazian Era consisting of Gneiss, Migmatite and Porphyritic Granodiorite (Figure 1).

Figure 1. Project area located within Halfway House Granite.

Aquifers within the occurring geology consist of secondary fractured aquifers and according to Barnard (2000), groundwater occurrence in these mainly granitic rocks is generally associated with zones of weathering, brecciation and jointing. Groundwater is often encountered in both the saturated weathered material below the regional groundwater rest level and in the transition zone between weathered and fresh granite. The basins of weathering normally coincide with the drainage pattern. The majority of fault and joint zones are steeply dipping structures that tend to narrow and even pinch out at depth with a corresponding decrease in permeability. The porosity is usually less than 1%, while fresh rock may be regarded as impermeable. Ferricrete is common in the Halfway House Granites and due have an impact on the groundwater movement in the wet season.

3.1 Groundwater level

The depth to groundwater rest level is generally between 5 and 30m below surface. Due to the project area's close proximity to the Jukskei River, a shallow groundwater level (less than 10m below surface) can be expected. Shallow perched water levels can be expected during the rainy season. This is due to the presence of ferricrete in the mid-slope areas.

3.2 Groundwater Yield

Based on the 1:500 000 geohydrological map (2526 Johannesburg), a successful borehole in this fractured/intergranular aquifer has a potential yield of between 1800 and 7200l/h.

3.3 Groundwater Quality

Based on data published by Barnard (2000), the groundwater water quality within the project area can be regarded as good with an average Electrical Conductivity of 38 mS/m and a mean pH value of 7.5. Only the elements chloride and sulphate indicate substantial coefficients of variation. Although this is mitigated by the relatively low maximum concentrations recorded for these two elements, potential contamination of this resource remains a threat. Both the sandy nature of the soil cover (which promotes recharge) and the depth of weathering (which promotes groundwater storage) increase the risk of contamination of these groundwater resources.

3.4 Groundwater Recharge

The study area falls within quaternary catchment A21C. The mean annual precipitation and annual recharge figures for this quaternary catchment is presented in Table 1. The values used were derived from the WR90 data set as contained in the "Groundwater Resources Directed Measures" software (Version 4.0.0.0) developed by the Department of Water Affairs & Forestry and the Water Research Commission.

Table 1. Rainfall & Recharge in Quaternary Catchment A21C

	A21C
Mean Annual Rainfall (mm)	682
Annual Recharge (mm)	41.58
Annual Recharge (%)	6

3.5 Groundwater Use

Based on aerial photo interpretation and the numerous numbers of smallholdings present within the project area, it can be assumed that boreholes are present and groundwater is used for irrigation purposes as a minimum. Groundwater being used for domestic purposes should not be excluded. This should however be verified by means of a hydrocensus.

It is further assumed that smallholdings within the project area have access to municipal water.

4 AQUIFER CLASSIFICATION

The aquifer(s) underlying the project area were classified in accordance with "A South African Aquifer System Management Classification, December 1995" by Parsons. Classification has been done in accordance with the following definitions for Aquifer System Management Classes:

- Sole Aquifer System: An aquifer which is used to supply 50% or more of domestic water for a given area, and for which there is no reasonably available alternative sources should the aquifer be impacted upon or depleted. Aquifer yields and natural water quality are immaterial.
- Major Aquifer System: Highly permeable formations, usually with a known or probable presence of significant fracturing. They may be highly productive and able to support large abstractions for public supply and other purposes. Water quality is generally very good (Electrical Conductivity of less than 150 mS/m).
- Minor Aquifer System: These can be fractured or potentially fractured rocks which do not have a high primary permeability, or other formations of variable permeability. Aquifer extent may be limited and water quality variable. Although these aquifers seldom produce large quantities of water, they are important for local supplies and in supplying base flow for rivers.
- Non-Aquifer System: These are formations with negligible permeability that are regarded as not containing groundwater in exploitable quantities. Water quality may also be such that it renders the aquifer unusable. However, groundwater flow through such rocks, although imperceptible, does take place, and needs to be considered when assessing the risk associated with persistent pollutants.

Based on published information and assumptions it can be concluded that the aquifer system in the study area can be classified as a "Major Aquifer System". Smallholdings make use of groundwater as a source of potable water and borehole yields and water quality are generally good. One can also assume that the aquifer is important for supplying base flow to local rivers and streams, more specifically the Jukskei River. In order to achieve the Groundwater Quality Management Index a points scoring system as presented in Table 2 and Table 3 was used.

Table 2. Ratings for the Aquifer System Management and Second Variable Classifications:

Aquifer System Management Classification		
Class	Points	Study area
Sole Source Aquifer System:	6	
Major Aquifer System:	4	4
Minor Aquifer System:	2	
Non-Aquifer System:	0	
Special Aquifer System:	0 – 6	

Second Variable Classification (Weathering/Fracturing)		
Class	Points	Study area
High: Medium: Low:	3 2 1	2

Table 3. Ratings for the Groundwater Quality Management (GQM) Classification System:

Aquifer System Management Classification		
Class	Points	Study area
Sole Source Aquifer System: Major Aquifer System: Minor Aquifer System: Non-Aquifer System: Special Aquifer System:	6 4 2 0 0 - 6	4
Aquifer Vulnerability Classification		
Class	Points	Study area
High: Medium: Low:	3 2 1	2

The occurring aquifer(s), in terms of the above definitions, is classified as a major aquifer system.

The vulnerability, or the tendency or likelihood for contamination to reach a specified position in the groundwater system after introduction at some location above the uppermost aquifer, in terms of the above, is classified as medium. A relatively shallow water table (<10 mbgl) and rocks with moderately weathering underlie the site. The level of groundwater protection based on the Groundwater Quality Management Classification:

GQM Index = Aquifer System Management x Aquifer Vulnerability

= 4 X 2 = 8

Table 4. GQM index for the study area

GQM Index	Level of Protection	Study Area
<1	Limited	
1 - 3	Low Level	
3 - 6	Medium Level	
6 - 10	High Level	8
>10	Strictly Non-Degradation	

4.1 Aquifer Susceptibility

Aquifer susceptibility, a qualitative measure of the relative ease with which a groundwater body can be potentially contaminated by anthropogenic activities and which includes both aquifer vulnerability and the relative importance of the aquifer in terms of its classification, in terms of the above, is classified as high.

4.2 Aquifer Protection Classification

The ratings for the Aquifer System Management Classification and Aquifer Vulnerability Classification yield a Groundwater Quality Management Index of 8 for the study area, indicating that high level groundwater protection may be required.

Due to the high GQM index calculated for this area, a high level of protection is needed to adhere to the Department of Water & Sanitation (DWS) water quality objectives. Reasonable and sound groundwater protection measures are recommended to ensure that no cumulative pollution affects the aquifer, even in the long term.

In terms of DWS overarching water quality management objectives which is (1) protection of human health and (2) the protection of the environment, the significance of this aquifer classification is that if any potential risk exist, measures must be triggered to limit the risk to the environment, which in this case is the (1) protection of the Secondary Underlying Aquifer, (2) the Jukskei River and its tributaries which drains the subject area and (3) the external users of groundwater in the area.

5 GROUNDWATER MANAGEMENT FRAMEWORK

No major groundwater impacts other than accidental spillages of hazardous materials are expected during operation of the completed road. The highest risk of potentially impacting the geohydrological environment is expected during the construction phase of the project, and therefore the following is proposed:

- Should groundwater be used as a source of water for construction purposes, volumes and water levels in production boreholes should be monitored to ensure that no dewatering of the local aquifer occur. Furthermore, legislative requirements relevant to groundwater use for construction purposes should be adhered to (registration of boreholes, Water Use Licence Applications, etc.)
- Fuel Storage Tanks used during construction should be installed according to the relevant SABS standards, for example SABS 089, 1535, 0131, 0108 and 0400. These standards make provision for observation wells, leak detectors, overfill protectors, etc.
- The construction of the workshops, cleaning bays and fuel dispensing areas of the construction camps should be in such a way that no accidental spillages leave the site and surface and storm water run-off be diverted through an oil/water separator before leaving the site.
- Emergency Spill Response Procedures should be in place with capable people with the necessary training available at strategic locations to follow these procedures in the case of major accidents and/or accidental spillages.
- Should contamination of the soil/groundwater be suspected at any given point in time within the project area, a detailed site and consequent risk assessment is proposed. The purpose hereof would be to establish the risk that the contaminated soils and groundwater pose to the receiving environment using the Risk Based Corrective Action (RBCA) approach. The Risk Based Corrective Action (RBCA) process represents a streamlined approach for the assessment and response to subsurface contamination. It integrates risk assessment practices with traditional site investigation and remedy selection activities in order to determine cost-effective measures for the protection of human health and environmental resources. Under this integrated approach, contaminated sites are characterised in terms

of sources, transport pathways, and receptors (Figure 2). Appropriate remedial measures, based on the outcome of the risk assessment, can then be designed and implemented at the site under investigation. These risk-based corrective actions can address any of the steps in the exposure process, including but not limited to the following:

- Removing or treating the source,
- Interrupting contaminant transport mechanisms, or
- Controlling activities at the point of exposure.

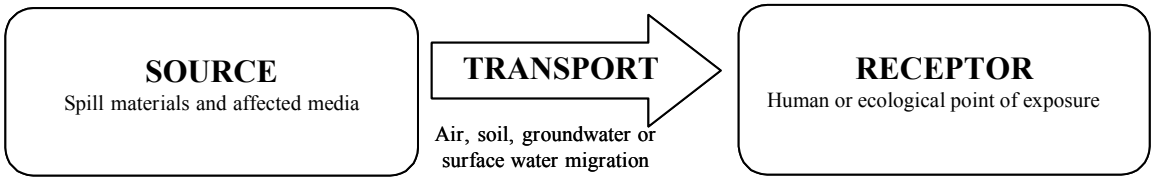

Figure 2. Conceptualisation of product migration routes

As part of the exposure assessment, all potential exposure pathways and receptors have to be identified. This needs to be done through the conceptualisation of the migration routes at the site. Thereafter risks can be calculated using commercially available software such as British Petroleum's (BP) Risk-Integrated Software for Clean-ups (RISC) or the RBCA Tier 1 Risk Based Screening Levels (RBSL) spreadsheets. It must be stated that the risk profile is dependent on the current land use (mainly agricultural/industrial). Should the land use change in future to e.g. residential, the risk profile and consequent remedial actions could change.

Annexure G

BIODIVERSITY INFROMATION
RECEIVED BY GDARD

Genevieve Tredoux

From:	Ontvangs
Sent:	05 January 2012 04:36 PM
To:	Genevieve Tredoux
Subject:	FW: Proposed K56 Biodiversity Requirements

Elsa Viviers
Namens/on behalf of
Lizelle Gregory

Environmental Consultants &
Landscape Architects
[illegible]
[illegible]

From: GDARD Biodiversity Information (GDARD) [mailto:GDACE_BiodiversityInfo@gauteng.gov.za]
Sent: 05 January 2012 03:20 PM
To: Lizelle Gregory
Subject: RE: Proposed K56 Biodiversity Requirements

Dear Lizelle

With regard to the above project, specialist biodiversity studies are required to investigate the following aspects:

* Plants, with specific reference to Brachycorythis conica, Gnaphalium nelsonii and Trachyandra erythrorrhiza.

* Vegetation.

* Wetlands.

* Rivers.

Please note that this information is relevant solely for the study site specified in your request. Red/Orange Listed plant species information relevant to a wider geographic area can be obtained from Lorraine Mills (Lorraine.Mills@gauteng.gov.za <mailto:Lorraine.Mills@gauteng.gov.za>).

All specialist studies must comply with GDARD Requirements for Biodiversity Assessments. The most recent version of this document (currently version 2) can be obtained by e-mailing GDARD_BiodiversityInfo@gauteng.gov.za.

Should the environmental assessment practitioner be of the opinion that any of the above specialist studies are unnecessary for the site/activity in question, then an ecologically-based motivation justifying why the

studies are deemed unnecessary must be submitted to GDARD as part of the application. This submission will be evaluated and either accepted or returned to the applicant for the completion of the necessary studies.

Please do not send follow up inquiries to this message as they will not be processed. For further queries please contact Phuti Matlamela (Phuti.matlamela@gauteng.gov.za).

Regards

EIA Unit

From: Lizelle Gregory [mailto:lizelleg@mweb.co.za]
Sent: Thu 2012/01/05 11:05 AM
To: GDARD Biodiversity Information (GDARD)
Subject: Proposed K56 Biodiversity Requirements

Good day,

Please find the attached shape files for the proposed K56 Road. Please provide us with the biodiversity requirements for this project.

Kind Regards

Genevieve Tredoux

Bokamoso Landscape Architects and Environmental Consultants

Office: +27 12 346 3810

E-mail: lizelleg@mweb.co.za

Annexure H

ENVIRONMENTAL
MANAGEMENT PLAN

FINAL ENVIRONMENTAL MANAGEMENT PLAN FOR THE DESIGN AND CONSTRUCTION OF ERLING ROAD BETWEEN K46 AND K56, AND THE K56 BETWEEN K46 AND MAIN ROAD

DECEMBER 2015

GAUT: 002/11-12/E0255

BOKAMOSO
LANDSCAPE ARCHITECTS &
ENVIRONMENTAL CONSULTANTS CC
P.O. BOX 11375
MAROELANA
0161
TEL: (012) 346 3810
Fax: 086 570 5659
Email: Lizelleg@mweb.co.za

1 Project Outline

1.1 Background

Bokamoso Landscape Architects and Environmental Consultants CC were appointed by ***Gauteng Department of Roads and Transport*** as ***independent consultants*** to prepare the applicable environmental reports and GDARD accepted the application that was submitted. The Reference Number issued by GDARD for the project is ***GAUT: 002/11-12/E0255.***

1.2 Project description

The application is made for authorization of the ***Design and Construction of Erling Road between Road K46 and Road K56 and Road K56 between Road K46 and Main Road, including all required access roads.*** Road K56 is a planned east-west provincial road intended to provide vital east-west connectivity in the area and to distribute traffic to the future PWV9 and K46 (William Nicol Drive). ***(Refer to Figure 1: Locality Map and Figure 2: Aerial Map).***

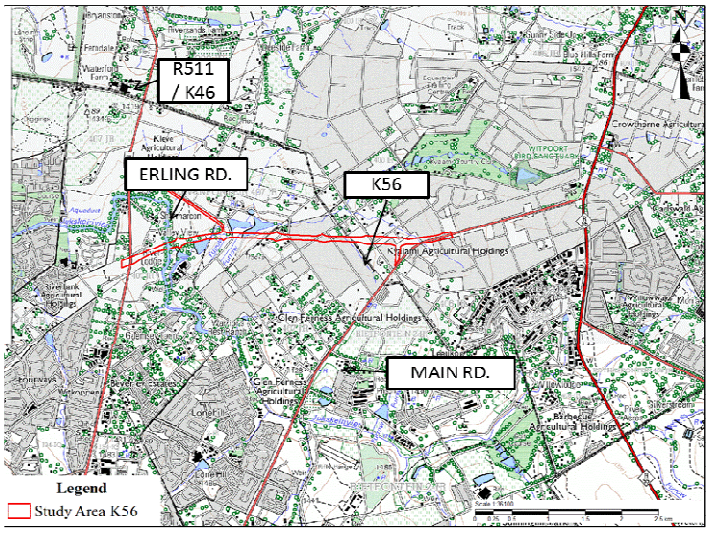

Figure 1 – Locality

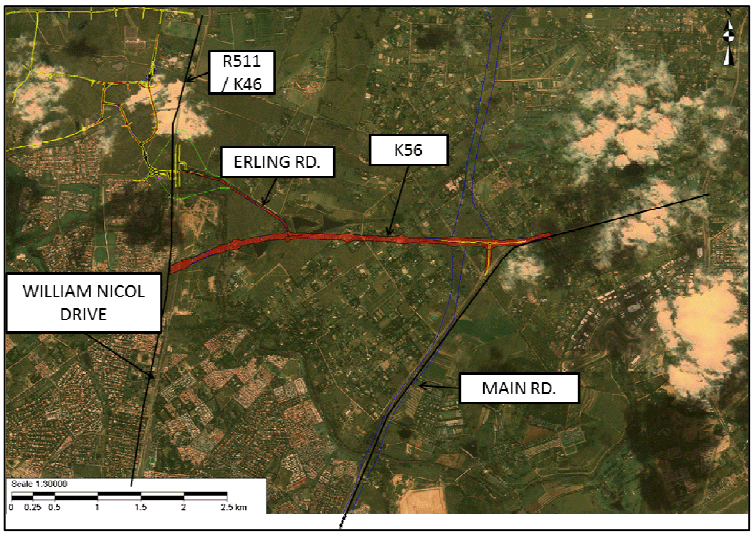

Figure 2 – Aerial Map

Timeframe for construction:

The expected timeframe for construction is approximately 18 months.

The EMP will be a binding document for purposes of compliance.

1.3 Receiving Environment

Geology:

- The route is underlain by granites and comprehensive blasting will be required. Collapsible materials and expansive materials. A perched water table can develop and slight seepage may be present during the wet season.

Hydrology:

- The proposed alignment traverses the Jukskei River and tributaries as well as wetlands. The study area falls within the Highveld Aquatic Ecoregion and is located within the A21C quaternary catchment in the Limpopo catchment.

Fauna and flora:

- Possible red data flora and fauna species: According to GDARD C-Plan 3, 2011 the proposed alignment traverses irreplaceable sites. The proposed alignment traverses Egoli Granite grasslands. Wildlife corridors affected by the proposed route.

- The study area can be broadly divided into four habitat units. Each is considered different with regards to ecological condition and functioning. Only the Wetland and Rocky Outcrop Habitat Units can be considered of increased ecological importance. These areas have the highest potential of supporting a variety floral and faunal species when compared to the remainder of the subject property. One RDL floral species, namely *Hypoxis hemerocallidae* (Declining□) was encountered during the assessment

Cultural /Historical:

- No obvious features, sites or artefacts of cultural significance that could be impacted on by the proposed development were identified.

Visual:

- The proposed alignments could have visual impacts on the surrounding view sheds during the construction and operational phases and mitigation measures should be implemented.

Noise:

- The proposed alignment of the K56 could have noise impacts on surrounding residents.

Dust:

- Dust could impact the surrounding residences if the construction will be done during the dry and windy months. It is proposed that regular damping down of the study area must be done if constructed during dry and windy months.

2 EMP Objectives and context

Objectives

The objectives of this plan are to:

- Identify the possible environmental impacts of the proposed activity;
- Develop measures to minimise, mitigate and manage these impacts;
- Meet the requirements of the Record of Decision of GDARD and other of other Authorities; and
- Monitor the project.

EMP context

This EMP fits into the overall planning process of the project by carrying out the conditions of consent set out by the GDARD. In addition, all mitigation measures recommended in the EIA report are included in the EMP.

This EMP addresses the following three phases of the development:

- Pre-construction planning phase;
- Construction phase; and
- Operational phase.

3 Monitoring

In order for the EMP to be successfully implemented all the role players involved must have a clear understanding of their roles and responsibilities in the project.

These role players may include the Authorities (A), other Authorities (OA), Developer/proponent (D), Environmental Control Officer (ECO), Project Manager (PM), Contractors (C), Environmental Assessment Practitioner (EAP) and Environmental Site Officer (ESO). Landowners interested and affected parties and the relevant environmental and project specialist's area also important role players.

3.1 Roles and responsibilities

Developer (D)

The developer is ultimately accountable for ensuring compliance with the EMP and conditions contained in the RoD. The developer must appoint an independent Environmental Control Officer (ECO), for the duration of the pre-construction and

construction phases, to ensure compliance with the requirements of this EMP. The developer must ensure that the ECO is integrated as part of the project team.

Project Manager (PM)

The project Manager is responsible for the coordination of various activities and ensures compliance with this EMP through delegation of the EMP to the contractors and monitoring of performance as per the Environmental Control Officer's monthly reports.

Environmental Control Officer (ECO)

An independent Environmental Control Officer (ECO) shall be appointed, for the duration of the pre-construction and construction phase of the services and bulk infrastructure, by the developer to ensure compliance with the requirements of this EMP.

Contact details of appointed ECO

ECO details will be available as soon as developer appointed a company.

- The Environmental Control Officer shall ensure that the contractor is aware of all the specifications pertaining to the project.
- Any damage to the environment must be repaired as soon as possible after consultation between the Environmental Control Officer, Consulting Engineer and Contractor.
- The Environmental Control Officer shall ensure that the developer staff and/or contractor are adhering to all stipulations of the EMP.
- The Environmental Control Officer shall be responsible for monitoring the EMP throughout the project by means of site visits and meetings. This should be documented as part of the site meeting minutes.
- The Environmental Control Officer shall be responsible for the environmental training program.
- The Environmental Control Officer shall ensure that all clean up and rehabilitation or any remedial action required, are completed prior to transfer of properties.
- A post construction environmental audit is to be conducted to ensure that all conditions in the EMP have been adhered to.

Contractor (C):

The contractors shall be responsible for ensuring that all activities on site are undertaken in accordance with the environmental provisions detailed in this document and that sub-contractor and laborers are duly informed of their roles and responsibilities in this regard.

The contractor will be required, where specified to provide Method Statements setting out in detail how the management actions contained in the EMP will be implemented.

The contractors will be responsible for the cost of rehabilitation of any environmental damage that may result from non-compliance with the environmental regulations.

Environmental Site Officer (ESO):

The ESO is appointed by the developer as his/her environmental representative to monitor, review and verify compliance with the EMP by the contractor. The ESO is not an independent appointment but must be a member of the contractor's management team. The ESO must ensure that he/she is involved at all phases of the construction (from site clearance to rehabilitation).

Authority (A):

The authorities are the relevant environmental department that has issued the Environmental Authorization. The authorities are responsible for ensuring that the monitoring of the EMP and other authorization documentation is carried out by means of reviewing audit reports submitted by the ECO and conducting regular site visits.

Other Authorities (OA):

Other authorities are those that may be involved in the approval process of the EMP.

Environmental Assessment Practitioner (EAP):

According to section 1 of NEMA the definition of an environmental assessment practitioner is "the individual responsible for the planning, management and coordination of environmental impact assessments, strategic environmental assessments, environmental management plans or any other appropriate environmental instruments through regulations".

3.2 Lines of Communication

The Environmental Control Officer in writing should immediately report any breach of the EMP to the Project Manager. The Project Manager should then be responsible for rectifying the problem on-site after discussion with the contractor. Should this require additional cost, then the developer should be notified immediately before any additional steps are taken.

3.3 Reporting Procedures to the Developer

Any pollution incidents must be reported to the Environmental Control Officer immediately (within 12 hours). The Environmental Control Officer shall report to the Developer on a regular basis (site meetings).

3.4 Site Instruction Entries

The site instruction book entries will be used for the recording of general site instructions as they relate to the works on site. There should be issuing of stop work order for the purposes of immediately halting any activities of the contractor that may pose environmental risk.

3.5 ESA/ESO (Environmental Site Officer) Diary Entries

Each of these books must be available in duplicate, with copies for the Engineer and Environmental Site Officer. These books should be available to the authorities for inspection or on request. All spills are to be recorded in the ESA/Environmental Site Officer's dairy.

3.6 Methods Statements

Methods statements from the contractor will be required for specific sensitive actions on request of the authorities or ESA/ESO (Environmental Site Officer). All method statements will form part of the EMP documentation and are subject to all terms and conditions contained within the EMP document. For each instance wherein it is requested that the contractor submit a method statement to the satisfaction of ESA/ESO, the format should clearly indicate the following:

- What – a brief description of the work to be undertaken
- How- a detailed description of the process of work, methods and materials
- Where- a description / sketch map of the locality of work; and
- When- the sequencing of actions with due commencement dates and completion date estimate.

The contractor must submit the method statement before any particular construction activity is due to start. Work may not commence until the method statement has been approved by the ESA/ESO.

3.7 Record Keeping

All records related to the implementation of this management plan (e.g. site instruction book, ESA/ESO dairy, methods statements etc.) must be kept together in an office where it is safe and can be retrieved easily. These records should be kept for two years at any time be available for scrutiny by any relevant authorities.

3.8 Acts

1. The National Water Act, 1998 (Act No: 36 of 1998)

The purpose of this Act is to ensure that the nation's water resources are protected, used, developed, conserved, managed and controlled in ways that take into account, amongst other factors, the following:

- Meeting the basic human needs of present and future generations;
- Promoting equitable access to water;
- Promoting the efficient, sustainable and beneficial use of water in the public interest;

- Reducing and preventing pollution and degradation of water resources;
- Facilitating social and economic development; and
- Providing for the growing demand for water use.

Impact on proposed Development:

Not Significant – No water licences will be necessary for the proposed road in terms of the Section 21 of the National Water Act. The study area is affected by a perennial and non-perennial rivers and therefore by 1:50 and 1:100 year flood lines. In terms of the Section 21 of the National Water Act the 1:100 year floodline must be indicated on layout maps.

2. National Environmental Management: Air Quality Act (Act No. 39 of 2004)

This act replaced the Atmospheric Pollution Prevention Act (Act No. 45 of 1965), however Part 2 of this act is still applicable. Part 2 of the act deals with the control of noxious of offensive gases. The proposed development will not release any of the listed gases into the atmosphere and this act is therefore not applicable to the proposed development.

The purpose of the Act is "To reform the law regulating air quality in order to protect the environment by providing reasonable measures for the prevention of pollution and ecological degradation and for securing ecologically sustainable development while promoting justifiable economic and social development; to provide for national norms and standards regulating air quality monitoring, management and control by all spheres of government; for specific air quality measures; and for matters incidental thereto."
The purpose of the Act is "To provide for the prevention of the pollution of the atmosphere, for the establishment of a National Air Pollution Advisory Committee, and for matters incidental thereto".

The Atmospheric Pollution Prevention Act was traditionally administered by the Department of Health until 1995, when it was transferred to the jurisdiction of the Department of Environmental Affairs and Tourism. The Act controls four forms of air pollution:

- Part II Noxious or Offensive gases
- Part III Atmospheric Pollution by Smoke
- Part IV Dust Control
- Part V Air Pollution by Fumes Emitted by Vehicles

Impact on proposed Development:

Significant – During the construction phase dust pollution can become a significant factor, especially to the surrounding developments and landowners. Dust control would be adequately minimized during this phase by way of water spraying and possible dust-nets, when required.

The additional vehicles generated by the proposed development will have an insignificant impact on the air pollution due to emissions gasses created by any additional vehicles or traffic of the proposed development.

3. National Environmental Management Act (Act 107 of 1998)

The NEMA is primarily an enabling Act in that it provides for the development of environmental implementation plans and environmental management plans. The principles listed in the act serve as a general framework within which environmental management and implementation plans must be formulated.

The principles in essence state that environmental management must place people and their needs at the forefront of its concern and that development must be socially, environmentally and economically sustainable.

Impact on proposed road:

Significant – The proposed K56 road is listed under the activities as regulated under NEMA.

4. The Municipal Systems Act (Act 32 of 2000)

This Act was introduced to provide for the core principles, mechanisms and processes that are necessary to enable municipalities to move progressively towards the social and economic upliftment of local communities, and ensure universal access to essential services that are affordable to all.

The proposed development will support the local authority in complying with the principles of the Municipal Systems Act, by assisting in providing the community with essential services, such as water and sewage infrastructure.

Impact on proposed Development:

Not Significant – The proposed K56 road will not contribute to the Municipal system.

5. The Draft Red Data Species Policy

This policy is provided for the protection, conservation and maintenance of Red Data species within the Gauteng Province.

Impact on proposed Development:

Significant – One RDL floral species, namely Hypoxis hemerocallidae („Declining□) was encountered during the assessment.

6. National Veld and Forest Fire Act, 1998 (Act No. 101, 1998)

The purpose of this Act is to prevent and combat veld, forest and mountain fires throughout the Republic. Furthermore the Act provides for a variety of institutions, methods and practices for achieving the prevention of fires.

Impact on proposed Development:

Significant – Fires of construction workers may only be lit in the designated site camp as indicated in assistance with the ECO. It is important that a site development camp be located on a part of the application site that is already disturbed.

7. National Heritage Resources Act, 1999 (Act No. 25 of 1999)

The National Heritage Resources Act legislates the necesity and heritage impact assessment in areas earmarked for development, which exceed 0.5ha. The Act makes provision for the potential destruction to existing sites, pending the archaelogist's recommendations through permitting procedures. Permits are administered by the South African Heritage Resources Agency (SAHRA).

Impact on proposed Development:

Not significant – No features of Heritage importance are present on site.

8. Conservation of Agricultural Resources Act (Act No. 43 of 1983)

This Act provides for control over the utilization of the natural agricultural resources of the Republic in order to promote the conservation of the soil, the water sources and the vegetation and the combating of weeds and invader plants; and for matters connected therewith.

Impact on proposed Development:

Not significant – The study area is not located within an Agricultural Hub, an area identified for agricultural use by GDARD according to the **Draft Policy on the Protection of Agricultural Land (2006).**

9. Water Services Act, 1997 (Act No. 108 of 1997)

This Act provides for the minimum standards and measures of which the following Water Services should adhere to:

- Basic sanitation
- Basic water supply
- Interruption in provision of water services
- Quality of potable water
- Control of objectionable substances
- Disposal of grey water
- Use of effluent
- Quantity and quality of industrial effluent discharged into a sewerage system

- Water services audit as a component in the Water Services Development Plan
- Water and effluent balance analysis and determination of water losses
- Repair of leaks
- Consumer installations other than meters
- Pressure in reticulation system

Impact on proposed Development:

Not Significant – The proposed K56 does not apply to the water service act

10. National Environmental Management Act: Biodiversity Act (Act No. 10 of 2004)

The purpose of the Biodiversity Act is to provide for the management of South Africa's biodiversity within the Framework of the NEMA and the protection of species and ecosystems that warrant National protection. As part of the implementation strategy, the National Spatial Biodiversity Assessment was developed.

Impact on proposed Development:

Significant – One RDL floral species, namely Hypoxis hemerocallidae („Declining□) was encountered during the assessment..

11. National Spatial Biodiversity assessment

The National Spatial Biodiversity Assessment (NSBA) classifies areas as worthy of protection based on its biophysical characteristics, which are ranked according to priority levels.

Impact on proposed Development:

Significant – The Natural mixed grassland on shallow dolomite, the Natural mixed grassland and the Chert ridge vegetation were deemed sensitive.

12. Protected Species – Provincial Ordinances

Provincial ordinances were developed to protect particular plant species within specific provinces. The protection of these species is enforced through permitting requirements associated with provincial lists of protected species. Permits are administered by the Provincial Departments of Environmental Affairs.

Impact on proposed Development:

Significant – One RDL floral species, namely *Hypoxis hemerocallidae* (Declining□) was encountered during the assessment.

13. National Environmental Management: Protected Areas Act, 2003 (Act No. 57 of 2003)

The purpose of this Act is to provide for the protection, conservation and management of ecologically viable areas representative of South Africa's biological biodiversity and its natural landscapes.

Impact on proposed Development:

Not Significant – No area was identified as a system which needs protection, conservation and management.

14. Gauteng Transport Infrastructure Act, 2001

To consolidate the laws relating to roads and other transport infrastructure in Gauteng; and to provide for the planning, design, development, construction, financing, management, control, maintenance, protection and rehabilitation of provincial roads, railway lines and other transport infrastructure in Gauteng.

Impact on proposed Development:

Significant – The proposed K56 road will serve the community.

15. National Road Traffic Act, 1996 (Act No. 93 of 1996)

This Act provides for all road traffic matters which shall apply uniformly throughout the Republic and for matters connected therewith.

Impact on proposed Development:

Significant – The proposed K56 road will serve the community and applies directly to the National Road Traffic Act.

16. Environmental Conservation Act: Noise Regulations, 1989 (Act no.73 of 1989)

The purpose of this Act is to provide measures and management relating Noise levels. This Act enables Noise levels to be acceptable to standards within a specific area and community.

Impact on proposed Development:

Significant – The proposed development may include some noisy activities with the construction of the proposed interchange and also during the operational phase.

4 Project activities

4.1 Pre-Construction Phase

TYPE	*Environmental risk or issue*	*Objective or requirement*	*Mitigation measure*	*Performance indicator*	*Responsibility*	*Frequency of Action*	*Applicable Act no.*
General	**Project contract**	To make the EMP enforceable under the general conditions of the contract.	The EMP document must be included as part of the tender documentation for all contractor appointments	The EMP is included as part of the tender documentation	Developer	-	3
Design and planning	**Stability of structures and restriction of land use due to geology**	To ensure stability of structures	1) The precautionary measures and foundation design from the involved geotechnical engineers must be implemented to ensure the stability of structures and embankments.	The land uses and layout corresponds to the recommended stability zonation and development types.	Individual Developer Engineer	-	
	Storm water design	To prevent and restrict erosion, siltation and groundwater pollution	1) A detailed storm water management plan must be approved by the Local Authority prior to commencement of construction activities. Such approval must be submitted to DWA together with a copy of the original stormwater management plans. Must be implemented according to guidelines provided by the relevant Local Authority Departments. 2) The storm water design for the proposed development must be designed to: Reduce and/ or prevent siltation, erosion and water pollution. 3) Storm water runoff should not be concentrated as far as possible and sheet flow should be implemented. 5) Energy dissipaters must be installed on the study area to break the speed of the	Compilation and approval of storm water management plan	Engineer Individual Developer	-	9

TYPE	*Environmental risk or issue*	*Objective or requirement*	*Mitigation measure*	*Performance indicator*	*Responsibility*	*Frequency of Action*	*Applicable Act no.*
			water. 6) Surface storm water generated as a result of the development must not be channeled directly into any natural drainage system or wetland. 7) The storm water management plan should be designed in a way that aims to ensure that post development runoff does not exceed predevelopment values in: - Peak discharge for any given storm; - Total volume of runoff for any given storm; - Frequency of runoff; and - Pollutant and debris concentrations reaching water courses.				
Climate	**Extreme change in micro climate temperatures**	To prevent the extreme change in micro climate temperatures	The proposed road will create a warm micro climate on the application site and can be mitigated though the planning of trees next to the road by the City of Tshwane once construction has been completed.	Landscape Development Plan complies	Landscape Architect	-	
Geology and Soils	**Unsuitable Geotechnical conditions**	To prevent unsuitable Geotechnical conditions	The special precautionary measures, as indicated within the Geotechnical Report must be adhered to at all times. 1) A storm water management plan must be implemented on the study area to prevent the erosion of soil. 2) A pro-active maintenance strategy for water bearing services and other infrastructure should be implemented.	Precautionary measures implemented	Geotechnical engineer Dolomite Risk Manager	-	9
	Loss of sensitive vegetation	To ensure some of the existing natural grassland areas on the study area.	Care must be taken to ensure that construction activities remain within the boundary of the planned road reserve.	Medicinal plants rescued prior to construction	Qualified specialist		
Preparing Site Access	**Environmental integrity**	To avoid erosion and	Designated routes shall be determined for the construction vehicles and designated	Access to site is erosion free.	Contractor	Continuous	

TYPE	*Environmental risk or issue*	*Objective or requirement*	*Mitigation measure*	*Performance indicator*	*Responsibility*	*Frequency of Action*	*Applicable Act no.*
		disturbance to indigenous vegetation	areas for storage of equipment. Clearly mark the site access point and routes on site to be used by construction vehicles and pedestrians. Provide an access map to all contractors whom in turn must provide copies to the construction workers. Instruct all drivers to use access point and determined route.	Minimum disturbance to surrounding vegetation. Vehicles make use of established access routes.			
	Waste storage	To control the temporary storage of waste.	Temporary waste storage points on site shall be determined. These storage points shall be accessible by waste removal trucks and these points should not be located in sensitive areas /areas highly visible from the properties of the surrounding land-owners/tenants/in areas where the wind direction will carry bad odours across the properties of adjacent tenants or landowners.		Contractor ESO	-	
		Ensure waste storage area does not generate pollution	Build a bund around waste storage area to stop overflow into storm water and the drainage channel on the application site.		Contractor	-	

4.2 Construction Phase

TYPE	*Environmental risk or issue*	*Objective or requirement*	*Mitigation measure*	*Performance indicator*	*Responsibility*	*Frequency of Action*	*Applicable Act no.*
Contractor's Camp	**Loss of Vegetation and topsoil**	To minimize damage to and loss of vegetation and retain quality of	Site to be established under supervision of ECO/ESO.	Minimal vegetation removed/ damaged during	Contractor	Before any construction activity commences	5, 10, 11, 13

TYPE	*Environmental risk or issue*	*Objective or requirement*	*Mitigation measure*	*Performance indicator*	*Responsibility*	*Frequency of Action*	*Applicable Act no.*
		topsoil		site activities.		and as and when required	
	Surface and ground water pollution	To minimize pollution of surface and Groundwater resources.	1) Sufficient and temporary facilities including ablution facilities must be provided for construction workers operating on the site. 2) A minimum of one chemical toilet shall be provided per 10 construction workers. The contractor shall keep the toilets in a clean, neat and hygienic condition. Toilets provided by the contractor must be easily accessible and a maximum of 50m from the works area to ensure they are utilized. The contractor (who must use reputable toilet-servicing company) shall be responsible for the cleaning, maintenance and servicing of the toilets. The contractor (using reputable toilet-servicing company) shall ensure that all toilets are cleaned and emptied before the builders' or other public holidays. 3) No person is allowed to use any other area than chemical toilets. 4) No French drain systems may be installed. 5) No chemical or waste water must be allowed to contaminate the run-off on site. This could possibly contaminate the drainage channel. 6) The chemical toilets may not be placed in close proximity of the adjacent dwellings to prevent odors from causing uncomforting situations. 7) Avoid the clearing of the site camp (of specific phase) or paved surfaces with soap.	Effluents managed Effectively. No pollution of water resources from site. Workforce use toilets provided.	Contractor ESO	As and when required	
		To minimize pollution of surface and	1) Drip trays and/ or lined earth bunds must be provided under vehicles and equipment, to contain spills of hazardous materials such	No pollution of the environment	Contractor ESO	Daily	

TYPE	*Environmental risk or issue*	*Objective or requirement*	*Mitigation measure*	*Performance indicator*	*Responsibility*	*Frequency of Action*	*Applicable Act no.*
		Groundwater resources due to spilling of materials.	as fuel, oil and cement. 2) Repair and storage of vehicles only within the demarcated site area. 3) Spill kits must be available on site. 4) Oils and chemicals must be confined to specific secured areas within the site camp. These areas must be bunded with adequate containment (at least 1.5 times the volume of the fuel) for potential spills or leaks. 5) All spilled hazardous substances must be contained in impermeable containers for removal to a licensed hazardous waste site. 6) No leaking vehicle shall be allowed on site. The mechanic/ the mechanic of the appointed contractor must supply the environmental officer with a letter of confirmation that the vehicles and equipment are leak proof. 7) No bins containing organic solvents such as paints and thinners shall be cleaned on site, unless containers for liquid waste disposal are placed for this purpose on site. **8) If any pollution incident is experienced, DWA must be notified immediately.**				
		To minimize pollution of surface and groundwater resources by cement	The mixing of concrete shall only be done at specifically selected sites, as close as possible to the entrance, on mortar boards or similar structures to prevent run-off into drainage line, streams and natural vegetation.	No evidence of contaminated soil on the construction site.	Contractor ESO	Daily	
		To minimize pollution of surface and Groundwater resources due to effluent.	No effluent (including effluent from any storage areas) may be discharged into any water surface or ground water resource, especially the drainage channel on site.	No evidence of contaminated water resources.	Contractor ESO	Daily	

TYPE	*Environmental risk or issue*	*Objective or requirement*	*Mitigation measure*	*Performance indicator*	*Responsibility*	*Frequency of Action*	*Applicable Act no.*
	Pollution of the environment	To prevent unhygienic usage on the site and pollution of the natural assets.	1) Weather proof waste bins must be provided and emptied regularly. 2) The contractor shall provide laborers to clean up the contractor's camp and construction site on a daily basis. 3) Temporary waste storage points on the site should be determined. THESE AREAS SHALL BE PREDETERMINED AND LOCATED IN AREAS THAT IS ALREADY DISTURBED AND NOT WITHIN CLOSE PROXIMITY OF DRAINAGE LINES. These storage points should be accessible by waste removal trucks and these points should be located in already disturbed areas /areas not highly visible from the properties of the surrounding land-owners/ in areas where the wind direction will not carry bad odours across the properties of adjacent landowners. This site should comply with the following: • Skips for the containment and disposal of waste that could cause soil and water pollution, i.e. paint, lubricants, etc.; • Small lightweight waste items should be contained in skips with lids to prevent wind littering; • Bunded areas for containment and holding of dry building waste. 4) No solid waste may be disposed of on the site. 5) No waste materials shall at any stage be disposed of in the open veld of adjacent properties or within the drainage lines (No-Go areas). 6) The storage of solid waste on the site, until such time as it may be disposed of, must be in a manner acceptable to the local	No waste bins overflowing No litter or building waste lying in or around the site	Contractor ESO	Daily Weekly	5,13

TYPE	*Environmental risk or issue*	*Objective or requirement*	*Mitigation measure*	*Performance indicator*	*Responsibility*	*Frequency of Action*	*Applicable Act no.*
			authority and DWA. 7) Cover any wastes that are likely to wash away or contaminate storm water.				
		Recycle material where possible and correctly dispose of unusable wastes	1) Waste shall be separated into recyclable and non-recyclable waste, and shall be separated as follows: • General waste: including (but not limited to) construction rubble, • Reusable construction material. 2) Recyclable waste shall preferably be deposited in separate bins. 3) All solid waste including excess spoil (soil, rock, rubble etc) must be removed to a permitted waste disposal site on a weekly basis. 4) No bins containing organic solvents such as paints and thinners shall be cleaned on site, unless containers for liquid waste disposal are placed for this purpose on site. 5) Keep records of waste reuse, recycling and disposal for future reference. Provide information to ESO.	Sufficient containers available on site No visible signs of pollution	Contractor ESO	Daily Weekly	
	Increased fire risk to site and surrounding areas	**To decrease fire risk.**	1) Fires shall only be permitted on the application site. 2) No food vendors shall be allowed. 3) Fire extinguishers to be provided in all vehicles and fire beaters must be available on site. 4) Emergency numbers/ contact details must be available on site, where applicable.	No open fires on site that have been left unattended	Contractor	Monitor daily	6
Construction site	**Geology and soils**	To prevent the damaging of the existing soils and geology.	1) The top layer of all areas to be excavated for the purposes of construction shall be stripped and stockpiled in areas where this material will not be damaged, removed or compacted. 2) All surfaces that are susceptible to erosion, shall be protected either by cladding with	Excavated materials correctly stockpiled No signs of erosion	Contractor	Monitor daily	

TYPE	*Environmental risk or issue*	*Objective or requirement*	*Mitigation measure*	*Performance indicator*	*Responsibility*	*Frequency of Action*	*Applicable Act no.*
			biodegradable material or with the top layer of soil being seeded with grass seed/planted with a suitable groundcover.				
		To prevent the loss of topsoil To prevent siltation & water pollution.	1) Stockpiling will only be done in designated places where it will not interfere with the natural drainage paths of the environment. 2) In order to minimize erosion and siltation and disturbance to existing vegetation, it is recommended that stockpiling be done/ equipment is stored in already disturbed/exposed areas. 3) Cover stockpiles and surround downhill sides with a sediment fence to stop materials washing away. 4) Remove vegetation only in areas designated during the planning stage and for the purpose of construction. 5) Rehabilitation/ landscaping to be done immediately after the involved works are completed (will prevent erosion of the topsoil layer on site). 6) All compacted areas should be ripped prior to them being rehabilitated/landscaped by the contractor. 7) The top layer of all areas to be excavated must be stripped and stockpiled in areas where this material will not be damaged, removed or compacted. This stockpiled material should be used for the rehabilitation of the site and for landscaping purposes. 8) Strip topsoil at start of works and store in stockpiles no more than 1, 5 m high in designated materials storage area. 9) During the laying of any cables, pipelines or infrastructure (on or adjacent to the site) topsoil shall be kept aside to cover the	Excavated materials correctly stockpiled No visible signs of erosion and sedimentation Minimal invasive weed growth Vegetation only removed in designated areas	Contractor of Developer	Monitor daily	4,9

TYPE	*Environmental risk or issue*	*Objective or requirement*	*Mitigation measure*	*Performance indicator*	*Responsibility*	*Frequency of Action*	*Applicable Act no.*
			disturbed areas immediately after such activities are completed. Rehabilitation of these areas shall be done directly after infill of the trenches. No rocks shall be placed on the topsoil after re-filling.				
	Erosion and siltation	To prevent erosion and siltation	1) It is recommended that the construction of the development be done in phases. 2) Each phase should be rehabilitated immediately after the construction for that phase has been completed. The rehabilitated areas should be maintained by the appointed rehabilitation contractor until a vegetative coverage of at least 80% has been achieved. 3) Mark out the areas to be excavated. 4) Large exposed areas during the construction phases should be limited. Where possible areas earmarked for construction during later phases should remain covered with vegetation coverage until the actual construction phase. This will prevent unnecessary erosion and siltation in these areas. 5) Unnecessary clearing of flora resulting in exposed soil prone to erosive conditions should be avoided. 6) All embankments must be adequately compacted and planted with grass to stop any excessive soils erosion and scouring of the landscape if required. 7) The eradication of alien vegetation should be followed up as soon as possible by replacement with indigenous vegetation to ensure quick and sufficient coverage of exposed areas. 8) Storm water outlets shall be correctly designed to prevent any possible soil	No erosion scars No loss of topsoil All damaged areas successfully rehabilitated	Contractor ESO	Monitor daily	

TYPE	*Environmental risk or issue*	*Objective or requirement*	*Mitigation measure*	*Performance indicator*	*Responsibility*	*Frequency of Action*	*Applicable Act no.*
			erosion. 9) All surface run-offs shall be managed in such a way so as to ensure erosion of soil does not occur. 10) Implementation of temporary storm water management measures that will help to reduce the speed of surface water by the individual erf owner / developer. 11) All surfaces that are susceptible to erosion shall be covered with a suitable vegetative cover as soon as construction is completed by the individual erf owner / developer.				
	Stability of structures due to geology	To ensure stability of structures.	Preventative foundation designs shall be done Detailed foundation inspections should be carried out at the time of construction to identify any variances and adjust foundation designs accordingly if need be. The foundation recommendations and geotechnical measures from the geotechnical engineers must be adhered to.		Engineers / Contractor / Individual Developer	When required	
			The normal drainage precautionary measures and special installation measures for underground wet services, applicable to dolomitic terrain and in compliance with the Tshwane Metropolitan Municipality requirements, should be adhered to**.**	Drainage precautions implemented	Engineers Contractors		
	Hydrology	Groundwater management	1) Ongoing monitoring of groundwater levels on and in the immediate vicinity of the site is recommended.	No deviation from baseline data during regular sampling	Engineer	Monthly	
		To minimise pollution of soil, surface and groundwater	1) Increased run-off during construction must be managed using berms and other suitable structures as required to ensure flow velocities are reduced.	No visible signs of erosion. No visible signs of	Contractor	Monitor daily	

TYPE	*Environmental risk or issue*	*Objective or requirement*	*Mitigation measure*	*Performance indicator*	*Responsibility*	*Frequency of Action*	*Applicable Act no.*
			2) The contractor shall ensure that excessive quantities of sand, silt and silted water do not enter the storm water system.	pollution			
	Fauna and flora	To protect the existing fauna and flora.	1) The proposed interchange will eradicate exotic invaders. Indigenous plant species will be preserved where possible if not the species must be relocated prior to the commencing of construction.	Shall be determined by Fauna and Flora specialist.	Fauna and Flora specialist ESO?	Prior to construction.	10,11,13
		To protect the existing fauna and flora.	1) Trees that are intended to be retained shall be clearly marked on site. 2) Snaring and hunting of fauna by construction workers on or adjacent to the study area are strictly prohibited and offenders shall be prosecuted. 3)Should hedgehogs be encountered during the development, these should be relocated to natural grassland areas in the vicinity; 4) Wood harvesting of any trees or shrubs on the study area or adjacent areas shall not be allowed, especially within the Non-perennial drainage line. OFFENDERS WILL BE PROSECUTED AND A FINE WILL BE ISSUED IN ACCORDANCE WITH THE GDARD. 5) Where possible, work should be restricted to one area at a time. 6) Noise should be kept to a minimum and the development should be done in phases to allow faunal species to temporarily migrate into the conservation areas in the vicinity. 7) The contractor must ensure that no fauna species are disturbed, trapped, hunted or killed during the construction phase. Conservation-orientated clauses should be built into contracts for construction personnel, complete with penalty clauses for	No measurable signs of habitat destruction	Contractor ESO	As and when required	5,10,11,13, 16

TYPE	*Environmental risk or issue*	*Objective or requirement*	*Mitigation measure*	*Performance indicator*	*Responsibility*	*Frequency of Action*	*Applicable Act no.*
			non-compliance;				
Social	**Noise impact**	To maintain noise levels below "disturbing" as defined in the national Noise Regulations.	1) Site workers must comply with the Provincial noise requirements as outlined. 2) Noise activities shall only take place during working hours	No complaints from surrounding residents and I & AP	Contractor	Monitored daily	16
	Dust impact	Minimise dust from the site	1) Dust pollution could occur during the construction works, especially during the dry months. Regular and effective damping down of working areas (especially during the dry and windy periods) must be carried out to avoid dust pollution that will have a negative impact on the surrounding environment. 2) When necessary, these working areas should be damped down in the mornings and afternoons.	No visible signs of dust pollution No complaints from surrounding residents and I & AP	Contractor	Monitored daily	2
	Safety and security	To ensure the safety and security of the public.	1) Although regarded as a normal practice, it is important to erect proper signs indicating the operations of heavy vehicles in the vicinity of dangerous crossings and access roads or even in the development site if necessary. 2) With the exception of the appointed security personnel, no other workers, friend or relatives will be allowed to sleep on the construction site (weekends included) 3) Construction vehicles and activities to avoid peak hour traffic times 4) Presence of law enforcement officials at strategic places must be ensured 5) Following actions would assist in management of safety along the road ▪ Adequate road marking ▪ Adequate roadside recovery areas ▪ Allowance for pedestrians and	No incidences reported	Contractor ECO	Monitored daily	

TYPE	*Environmental risk or issue*	*Objective or requirement*	*Mitigation measure*	*Performance indicator*	*Responsibility*	*Frequency of Action*	*Applicable Act no.*
			cyclists where necessary Although regarded as a normal practice, it is important to erect proper signs indicating the danger of the excavation in and around the development site. Putting temporary fencing around excavations where possible.				
	Influx of people from other areas	In order to limit the influx of people from other areas	It is recommended that (where possible) only people from the local communities in and around the application site are employed.	People from local community employed.	Contractor	When required	
	Cultural Resources		Although no features of Cultural of Historical significance is located on site or in the direct vicinity, it is recommended that if any graves or archaeological sites are exposed during construction work it should immediately be reported to a museum. The report from the archaeologist must be provided to the local authorities if any graves are recovered.	No destruction of or damage to archaeological sites	Contractor ECO	Monitor daily	7
	Visual impact	In order to minimise the visual impact	1) The disturbed areas shall be rehabilitated immediately after the involved construction works are completed. 2)Shade cloth must be used to conceal and minimise the visual impact of the site camps and storage areas	Visual impacts minimized	Contractor ESO	Monitor daily	
	Vegetation	Landscaping	1) When planting trees, care should be taken to avoid the incorrect positioning of trees and other plants, to prevent the roots of trees planted in close proximity to the line of water-bearing services from causing leaking in, or malfunctioning of the services. 2) The proposed planting materials for the areas to be landscaped should preferably be endemic and indigenous. 3) All new trees and shrubs to be planted on the study area shall be inspected for pests and diseases prior to them being planted. 4) The inspection shall be carried out by the	Landscaping done according to landscape development plan	Landscape architect Contractor	When required	

TYPE	*Environmental risk or issue*	*Objective or requirement*	*Mitigation measure*	*Performance indicator*	*Responsibility*	*Frequency of Action*	*Applicable Act no.*
			maintenance contractor at the property of the supplier and not on the study area. 5) All trees to be planted shall be in 20L containers with a height of approximately 1,8 metres and a main stem diameter of approximately 300 mm.				
		Loss of plants	1) Aerate compacted soil and check and correct pH for soils affected by construction activities. 2) Make sure plant material will be matured enough and hardened off ready for planting. Water in plants immediately as planting proceeds. 3) Apply mulch to conserve moisture Plant according to the layout and planting techniques specified by the Landscape Architect in the Landscape Development plans for the site.	Landscaping done according to landscape development plan	Landscape architect Contractor	When required	
		Spread of weeds	Ensure that materials used for mulching and topsoil/ fertilisers are certified weed free. Collect certifications where available. Control weed growth that appears during construction.	Weed growth controlled	Landscape architect Contractor	When required	
		To ensure rehabilitation of the site	1) Compacted soils shall be ripped at least 200mm. 2) All clumps and rocks larger than 30mm diameter shall be removed from the soil to be rehabilitated 3) The soil shall be leveled before seeding 4) Hydro-seed the soil with Potch mixture or plant with suitable indigenous ground covering as specified) 5) Watering shall take place at least once per day for the first 14 days until germination of seeds have taken place 6) Thereafter watering should take place at least for 20 minutes every 4 days until grass	Grass have hardened off	Landscape architect Contractor	Once a day Then every 4 days	

TYPE	*Environmental risk or issue*	*Objective or requirement*	*Mitigation measure*	*Performance indicator*	*Responsibility*	*Frequency of Action*	*Applicable Act no.*
			have hardened off.				

4.3 Operational Phase

TYPE	*Environmental risk or issue*	*Objective or requirement*	*Mitigation measure*	*Responsibility*	*Frequency of Action*	*Applicable Act no.*
SITE CLEAN UP AND PREPARED FOR USE	**Storm water pollution**	Do not allow any materials to wash into the storm water system.	Remove erosion and sediment controls only if all bare soil is sealed, covered or re-vegetated. Sweep roadways clean and remove all debris from kerb and gutter areas. Do not wash into drains.	Contractor	-	
		Minimise waste	Decontaminate and collect waste in storage area ready for off-site recycling or disposal Arrange for final collection and removal of excess and waste materials.	Contractor	-	
ESTABLISHING PLANTS	**Slow or no re-vegetation to stabilise soil; loss or degradation of habitat**	To ensure re-vegetation to stabilize soil	Agreed schedule for regular follow-up watering, weed control, mulch supplements and amenity pruning, if needed. Replace all plant failures within three month period after planting.	Contractor	To be agreed	
DRAINAGE FAILURE	***On-site and downstream drainage pollution or flooding***	Storm water management plan	Inspect all site drainage works and repair any failures. Confer with design engineer and to correct site problems.	Contractor	-	
SITE AUDIT	***Eventual project failure***	Successful project establishment	Routinely audit the works and adjust maintenance schedule accordingly.	Contractor	-	
GENERAL			Open fires and smoking during maintenance works are strictly prohibited.	Contractor	-	6
GEOLOGY	**Erosion of topsoil**	Prevent topsoil erosion	Due to lose topsoil, the soil must be covered by means of re-seeding and vegetation with suitable ground covering.	Engineer / Contractor /	Once off	

TYPE	*Environmental risk or issue*	*Objective or requirement*	*Mitigation measure*	*Responsibility*	*Frequency of Action*	*Applicable Act no.*
			A dolomite risk management plan must be compiled for this township in general and copies must be submitted to the Council for Geoscience and the NHBRC. This system must be practical with detailed requirements applicable to the township. This can, however, only be done after the township established has been approved. Groundwater monitoring must form an integral part of the risk management plan. The local authority in association with the Department of Water Affairs must also ensure that the groundwater level is not drawn down. The normal drainage precautionary measures and special installation measures for underground wet services, applicable to dolomitic terrain and in compliance with the Tshwane Metropolitan Municipality requirements, should be adhered to.	Dolomite risk management plan compiled	Engineer	
Geology	**Erosion of topsoil**	Prevent topsoil erosion	Due to lose topsoil, the soil must be covered by means of re-seeding and vegetation with suitable ground covering.	Engineer/ Contractor	Once off	
	Air pollution	To mitigate air pollution	1) The air pollution impact can be mitigated by screening through the planting of trees. 2) Dust pollution could be mitigated by identifying the source and to recommend the regular dumping down during windy periods.	City of Tshwane		2

5 Procedures for environmental incidents

5.1 Leakages & spills

- Identify source of problem.
- Stop goods leaking, if safe to do so.
- Contain spilt material, using spills kit or sand.
- Notify Environmental Control Officer
- Remove spilt material and place in sealed container for disposal (if possible).
- Environmental Control Officer to follow Incident Management Plan.

5.2 Failure of erosion/sediment control devices

- Prevent further escape of sediment.
- Contain escaped material using silt fence, hay bales, pipes, etc.
- Notify ECO.
- Repair or replace failed device as appropriate.
- Dig/scrape up escaped material; take care not to damage vegetation.
- Remove escaped material from site.
- ECO to follow Incident Management plan.
- Monitor for effectiveness until re-establishment.

5.3 Bank/slope failure

- Stabilize toe of slope to prevent sediment escape using aggregate bags, silt fence, logs, hay bales, pipes, etc.
- Notify ECO.
- ECO to follow Incident Management plan.
- Divert water upslope from failed fence.
- Protect area from further collapse as appropriate.
- Restore as advised by ECO.
- Monitor for effectiveness until stabilized.

5.4 Discovery of rare or endangered species

- Stop work.
- Notify ECO.
- If a plant is found, mark location of plants.
- If an animal, mark location where sighted.
- ECO to identify or arrange for identification of species and or the relocation of the species if possible.
- If confirmed significant, ECO to liaise with Endangered Wildlife Trust.
- Recommence work when cleared by ECO.

5.5 Discovery of archeological or heritage items

- Stop work.
- Do not further disturb the area.
- Notify ECO.
- ECO to arrange appraisal of specimen.
- If confirmed significant, ECO to liaise with National, Cultural and History Museum.
  P.O. Box 28088
  SUNNYSIDE
  0132
  Contact Mr. J. van Schalkwyk

or
Mr. Naude

- Recommence work when cleared by ECO.

6 EMP review

1. The Site supervisor is responsible for ensuring the work crew is complying with procedures, and for informing the work crew of any changes. The site supervisor is responsible for ensuring the work crew is aware of changes that may have been implemented by GDARD before starting any works.

2. If the contractor cannot comply with any of the activities as described above, they should inform the ECO with reasons within 7 working days.

Annexure I

SPECIALIST LIST

Species list for Helderfontein (October 2012):

1. Black Backed Jackal *Canis mesomelas*
2. Yellow Mongoose *Cynictis penicillata*
3. Scrub Hare *Lepus saxatilus*
4. Black Musk Shrew *Crocidura mariquensis*
5. South African Hedgehog *Erinaceus frontalis*
6. Porcupine *Hystrix africae-australis*
7. Common Mole-rat *Cryptomys hottentotus*
8. Cape Terrapin *Pelomedusa subrufa*
9. Nile Monitor (Leguaan) *Varanus niloticus*
10. Rinkals *Hemachatus haemachutus*
11. Red lipped Herald *Crotaphopeltis hotamboeia*
12. Mole Snake *Pseudaspis cana*
13. Flap-necked chameleon *Chamaeleo dilepis*
14. Red Toad *Schismaderma carens*
15. Giant Bullfrog *Pyxicephalus adspersus*
16. Common River Frog *Afrana angolensis*
17. Velvet Ants Family Mutillidae
18. Sugar Ants *Campanotus maculatus*
19. Crazy Ants *Anoplolepis custodiens*
20. Driver Ants sub-family Dorylinae
21. Honey bee *Apis mellifera scutellata*
22. Emperor Moths Family Saturniidae
23. Blister Beetles Family Meloidae
24. Dynastine (Rhino) Beetles Family Scarabaeidae, sub-family Dynastinae
25. Rose Beetles Family Scarabaeidae, sub-family Melolonthinae
26. Dung Beetles Family Scarabaeidae, sub-family Scarabaeinae
27. Antlions Family Myrmeleontidae
28. Backswimmers Family Notonectidae
29. Molecrickets Family Gryllotalpidae
30. Crickets Family Gryllidae
31. Long-horned Grasshoppers Family Tettigonidae
32. Earwigs Order Dermaptera
33. Stick Insects Order Phasmatodea
34. Praying Mantids Order Mantodea
35. Termites Order Isoptera
36. Dragonflies and Damselflies Order Odonata
37. Millipedes Class Diplopoda
38. Centipedes Class Chilopoda
39. River crab Class Crustacea
40. Funnel Web Spider Family Ageleninae
41. Tilapia species
42. Barbel *Clarias gariepinus*
43. Great Crested Grebe *Podiceps cristatus*

44. Reed Cormorant *Phalacrocorax africanus*
45. Grey Heron *Ardea cinerea*
46. Cattle Egret *Bubulcus ibis*
47. Hamerkop *Scopus umbretta*
48. Sacred Ibis *Threskiornis aethiopus*
49. Hadeda *Bostrychia hagedash*
50. Yellowbilled Duck *Anas undulata*
51. Egyptian Goose *Alophochen aegyptiacus*
52. Blackshouldered Kite *Elanus caeruleus*
53. Swainson's Francolin *Francolinus swainsonii*
54. Helmeted Guineafowl *Numida meleagris*
55. Redknobbed Coot *Fulica cristata*
56. African Spoonbill *Platalae alba*
57. Fish Eagle *Haliaeetus vocifer*
58. Black Korhaan *Eupodotis afra*
59. Crowned Plover *Vanellus coronatus*
60. Blacksmith Plover *Vanellus armatus*
61. Spotted Dikkop *Burhinus capensis*
62. Grey Loerie *Corythaixoides concolor*
63. Redchested Cuckoo *Cuculus solitarius*
64. Marsh Owl *Asio capensis*
65. Pied Kingfisher *Ceryle rudis rudis*
66. Malachite Kingfisher *Alcedo cristata*
67. Hoopoe *Upupu epops*
68. Crested Barbet *Trachyphonus vaillantii*
69. Pied Crow *Corvus albas*
70. Redbilled Woodhoopoe *Phoeniculus purpureus*
71. Fiscal Shrike *Lanius collaris*
72. Red Bishop *Euplectes orix*
73. Longtailed Widow *Euplectes progne*
74. Masked Weaver *Ploceus velatus*
75. Cape White-eye *Zosterops pallidus*
76. Blackeyed Bulbul *Pycnonotus barbatus*
77. Paint-brush *Scadoxus puniceus*
78. Poison Bulb / Tumbleweed *Boophane disticha*
79. Orange River Lily *Crinum bulbisperum*
80. Wild Cucumber *Cucumis zeyheri*
81. Curry Bush *Hypericum* species
82. African Star Grass *Hypoxis hemerocallidea*
83. *Hypoxis rigidula*
84. *Hypoxis multiceps*
85. *Wahlenbergia caledonica*
86. *Pentanisia angustifolia*
87. *Mariscus congestus*
88. *Ledebouria marginate*

89. *Ledebouria ovatifolia*
90. *Helichrysum aureonitens*
91. *Haplocarpha scaposa*
92. *Gnidia capitata*
93. *Crassula capitella*
94. *Becium obovatum*
95. *Anthericum* species
96. *Aloe greatheadii* var. *davyana*
97. White Stinkwood *Celtis africana*

As you can see from this species list, its not any particular species that makes this area valuable (although there are a few red data species in the list), but rather it's the eco-system itself that deserves conservation as Egoli Granite Grassland in its climax condition.

Due to the granitically derived shallow nutrient poor soils this systems is VERY SENSITIVE and intolerant to frequent impacts such as heavy grazing, ploughing, trampling and general domestic activities. Road making would be a massive impact on this system. Degradation occurs easily resulting in a change from the climax (high species richness) vegetation to an anthropogenic *Hyparrhenia hirta* (low species richness) dominated vegetation type.

Furthermore, the bottomland areas and wetlands within the Egoli Granite Grassland provide suitable habitat for various sensitive fauna species such as the Grass Owl *Tyto capensis* (Red Listed), Marsh Sylph *Metisella meninx* (Vulnerable), and the Giant Bullfrog *Pyxicephalus adspersus* (Near Threatened).

In an area that has been largely overtaken by pastureland and gardens, where biodiversity has been significantly reduced, here we find a small (almost intact) section of primary Highveld vegetation.

This is indeed a valuable treasure. It needs to be conserved.

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Jacqueline Wetselaar

(M.Sc Zoology (Wits))

Annexure J

ATRICLE BY G.J
BRENDENKAMP, L.R. BROWN
AND M.F PFAB

Conservation value of the Egoli Granite Grassland, an endemic grassland in Gauteng, South Africa

G.J. Bredenkamp, L.R. Brown and M.F. Pfab

Bredenkamp, G.J., L.R. Brown and M.F. Pfab. 2006. Conservation value of the Egoli Granite Grassland, an endemic grassland in Gauteng, South Africa. *Koedoe* 49(2): 59–66. Pretoria. ISSN 0075-6458.

Gauteng is the most densely populated province in South Africa. Its remaining natural areas are constantly under threat from urban development and the associated impacts. Presently, the natural areas of Gauteng support a large diversity of ecosystems. One such ecosystem is the Egoli Granite Grassland, endemic to the province, poorly conserved and therefore highly threatened. This paper describes the original Egoli Granite Grassland and the anthropogenic *Hyparrhenia hirta* dominated grassland that has replaced it in many of the remnant areas. Human impacts on this sensitive ecosystem have resulted in an altered species composition, loss of many species, and a change from a species-rich grassland with high conservation value to a species-poor grassland with low conservation value. The conservation of the last remaining relicts of original Egoli Granite Grassland is essential.

Keywords: Egoli Granite Grassland; conservation value; *Hyparrhenia hirta*, Gauteng.

G.J. Bredenkamp, African Vegetation and Plant Diversity Research Centre, University of Pretoria; L.R. Brown, Applied Behavioural Ecology and Ecosystem Research Unit, University of South Africa; M.F. Pfab, Bioregional Planning, Gauteng Department of Agriculture, Conservation and Environment, Johannesburg, 2001 South Africa.

Introduction

The Egoli Granite Grassland is a type of grassland and a mapping unit (Gm10) classified under the Mesic Highveld Grassland Bioregion according to the new Vegetation Map of South Africa, Lesotho and Swaziland (Mucina *et al.* 2005). This grassland was mapped as Bankenveld (veld type 61) by Acocks (1988), and Rocky Highveld Grassland (Vegetation Type 34) by Bredenkamp & Van Rooyen (1996). Acocks (1988) describes the Bankenveld as a False Grassveld Type. The climax vegetation of this veld type should be, according to Acocks, an open savanna, that is a bushveld vegetation, but it has been changed to, and maintained as grassveld by regular veld fires. However, Bredenkamp & Brown (2003) consider Bankenveld vegetation as a mosaic of grassland and woodland communities controlled by (micro-)climatic conditions that exist in the topographically heterogeneous landscape in the transition zone between the Grassland and Savanna biomes.

From a conservation planning or urban development viewpoint, the range of structural and floristic variation is considered too large to define Bankenveld as a single unit, even on the reconnaissance level of vegetation investigation. Bredenkamp & Brown (2003) recognised 16 major vegetation types within Bankenveld. The Egoli Granite Grassland is considered as mainly belonging to the *Hyparrhenia hirta* Anthropogenic Grassland (Bredenkamp & Brown 2003).

Egoli Granite Grassland is restricted to the Gauteng Province of South Africa and is located north of the Roodepoort / Krugersdorp ridge complex and stretches over a distance of approximately 35 km to Centurion in the north. This grassland stretches over a distance of approximately 50 km in a westerly direction from the R21 highway in the east. The 28º longitude and 26º latitudi-

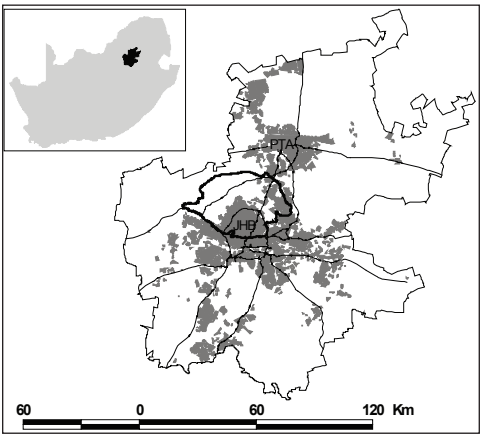

Fig. 1. Locality map of the Egoli Granite Grassland. Grey areas indicate urbanisation

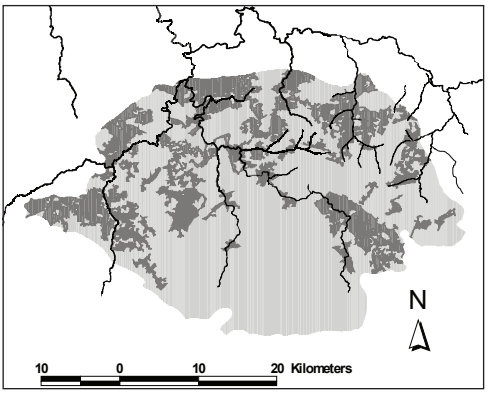

Fig. 2. Dark gray represents remnant areas of potentially original Egoli Granite Grassland; perennial rivers shown.

nal lines cross in the centre of this grassland (Fig. 1).

Due to high demand for developable land in Gauteng, and especially the Johannesburg / Pretoria corridor, the Egoli Granite Grassland is under extreme pressure. Large areas are already developed for residential, industrial and commercial purposes. This has led to the destruction of vast tracts of this grassland. At least 61% of Egoli Granite Grassland has been permanently transformed: 27% by urban development (Fig. 2); 17% by smallholdings; 12% by agriculture (cultivated lands); and 5% by other impacts such as exotic plantations, mining and planted pastures. An estimated additional 17% of Egoli Granite Grassland is degraded due to overgrazing and the influence of edge effects associated with a highly fragmented landscape (Fahrig 2003). Other effects, such as trampling, increased pollutants and the infestation of weeds and alien species also contribute to degradation of this grassland. It is therefore highly likely that the national target for conservation of this grassland type, i.e., 25% of the total extent, will never be realised.

Egoli Granite Grassland is extremely poorly conserved, with only 0.02% (26 ha) of the vegetation type currently protected, including 3 ha in Glen Austin Bird Sanctuary, 3 ha in Melville Koppies Nature Reserve, 9 ha in Ruimsig Nature Reserve, and 11 ha in the Walter Sisulu Botanical Gardens (Fig. 2). The current protection status of Egoli Granite Grassland is therefore completely inadequate, with only 0.1% of the national target actually achieved. In order to meet South Africa's international obligations, it is imperative that the Gauteng provincial government put in place measures to improve the conservation status of Egoli Granite Grassland.

Any viable remnant patch of original Egoli Granite Grassland must therefore be protected from transforming land uses. In order to assess whether a valuable remnant patch will be affected by a proposed development, environmental consultants involved in vegetation impact assessments are required by the Gauteng Department of Agriculture, Conservation and Environment (GDACE) to assess the presence and condition of Egoli Granite Grassland on any site proposed for development.

As this grassland was only recently defined with the development of the new Vegetation Map of South Africa, Lesotho and Swaziland (Mucina *et al.* 2005), very little information on its floristic composition, condition, the

extent of the grassland, and the management thereof exists, causing some confusion among nature conservationists, environmental consultants and local authorities. The aim of this paper is therefore to provide an ecological overview of this grassland.

Physical Environment

This area is generally characterised by rocky undulating plains representing crests, slopes and valley bottoms with shallow, nutrient-poor soils. Shallow drainage lines and vlei-like wetland areas occur in the valley bottoms. Rockiness of the soil surface is a further common characteristic shared by most Bankenveld areas.

Mean monthly temperature in the study area is 16.8 °C with a mean maximum of 22.6 °C and a mean minimum of 10.8 °C. The mean winter temperature is 13.8 °C and mean summer temperature, 25.6 °C (Weather Bureau 2000; Grobler *et al.* 2002). Mean annual rainfall in Gauteng is 670 mm (Gauteng 1997).

Old granitic and gneissic rocks at least 2 400 million years old (Kerfoot 1987) are exposed in the Egoli Granite Grassland area. The Halfway House Granites (Fig. 3) of the Johannesburg Dome are intensively weathered with deep drainage lines resulting in a gently rolling topography, with shallow, coarse, nutrient-poor, well-drained soils. The granite areas are mostly covered by grassland vegetation though patches of woodland vegetation are found at sheltered sites on hillslopes and rocky outcrops within this veld type (Grobler 2000; Grobler *et al.* 2002, 2006).

The Bb land type predominates over the entire region (Land Type Survey Staff 1984, 1985, 1987) (Fig. 3). The residual granitic soils are very shallow and poorly drained. The A horizon is often sandy and light in colour with little organic matter and with an increase in clay content with depth. The soils are invariably acid and very rich in silica (Kerfoot 1987).

Vegetation

Current vegetation

This tall grassland occurs over vast areas, usually on shallow, leached soils on the Johannesburg Granite Dome. Disturbed grassland or other disturbed areas such as road reserves or old fields, not cultivated for some years, are also usually *Hyparrhenia* species-dominated and low in species richness. Although some of these tall grasslands appear to be quite natural, they are mostly associated with an anthropogenic influence from recent or even iron-age times.

These grasslands are characterised by the tall-growing dominant grass *Hyparrhenia hirta* and the invader dwarf shrub *Seriphium plumosum* (*=Stoebe vulgaris)*, indicating its low successional status or degraded condition.

Dense *Hyparrhenia* species-dominated grassland mostly has low species richness, with only a few other species able to establish or survive in the shade of the dense sward of tall grass. Most of these species are relict pioneers or early seral species. The most prominent species include the grasses *Cynodon dactylon*, *Eragrostis chloromelas*, *E. racemosa*, *E. curvula* and *Aristida congesta*. Forbs are rarely encountered, though a few individuals of species such as *Anthospermum hispidulum, Pseudognaphalium luteo-album, Conyza albida, C. podocephala, Crabbea angustifolia, Helichrysum nudifolium* and *H. rugulosum* are often present. The woody layer, which has a very low cover, consists of small clumps of indigenous trees and shrubs widely scattered within this grassland. The scanty woody species include the trees *Rhus pyroides* and *Ziziphus mucronata,* together with the scandent shrub *Ziziphus zeyheriana*. Declared alien invasive species such as *Melia azedarach, Eucalyptus* species, *Pinus* species and planted ornamentals are often present.

Typical species found in anthropogenic *Hyparrhenia hirta*-dominated Egoli Granite Grassland are indicated below:

- Trees and Shrubs

Acacia caffra (Thunb.) Willd.
**Eucalyptus* species
Gymnosporia buxifolia L. Szysyal
**Melia azedarach* L.
Olea europaea L. ssp. *africana* (Mill.) P.S.Green
**Pinus* species
Rhus lancea L.f.
Rhus leptodictya Diels
Rhus pyroides Burch.
Ziziphus mucronata Willd.
Ziziphus zeyheriana Sond.

- Grasses

Aristida bipartita (Nees) Trin. & Rupr.
Aristida canescens Henrard
Aristida congesta Roem. & Schult. ssp. *barbicollis* (Trin. & Rupr.) De Winter
Aristida congesta Roem. & Schult. ssp. *congesta*
Cynodon dactylon (L.) Pers.
Diheteropogon amplectens (Nees) Clayton
Elionurus muticus (Spreng.) Kunth
Eragrostis chloromelas Steud.
Eragrostis curvula (Schrad.) Nees
Eragrostis gummiflua Nees
Eragrostis plana Nees
Eragrostis racemosa (Thunb.) Steud.
Eragrostis rigidior Pilg.
Heteropogon contortus (L.) Roem. & Schult.
Hyparrhenia filipendula (Hochst.) Stapf
Hyparrhenia hirta (L.) Stapf
Melinis repens (Willd.) Zizka
Pogonarthria squarrosa (Roem. & Schult.) Pilg.
Sporobolus africanus (Poir.) Robyns & Tournay
Trichoneura grandiglumis (Nees) Ekman

- Forbs

Acalypha angustata Sond.
Anthospermum hispidulum E.Mey. ex Sond.
Asparagus laricinus Burch.
Asparagus suaveolens Burch.
Bidens formosa (Bonato) Sch.Bip.
Bidens pilosa L.
Chamaecrista mimosoides (L.) Greene
Cirsium vulgare (Savi) Ten.
Commelina africana L.
Conyza albida Spreng.
Cucumis zeyheri Sond.
Cyperus species
Elephantorrhiza elephantina (Burch.) Skeels
Felicia muricata (Thunb.) Nees
Gazania krebsiana Less.
Geigeria burkei Harv.
Gomphocarpus fruticosus (L.) Aiton f.
Helichrysum nudifolium (L.) Less.
Helichrysum rugulosum Less.
Hermannia depressa N.E.Br.
Hibiscus aethiopicus
Hypoxis rigidula
Lactuca species
Ledebouria marginata (Baker) Jessop
Nidorella hottentotica DC.
Pseudognaphalium luteo-album (L.) Hilliard & B.L.Burtt
Schkuhria pinnata (Lam.) Cabrera
Seriphium plumosum L.
Tagetes minuta L.
Verbena bonariensis L.
Verbena brasiliensis Vell.
Vernonia oligocephala (DC.) Sch.Bip. ex Walp.
Walafrida densiflora (Rolfe) Rolfe
Zinnia peruviana (L.) L.

Original vegetation

The original vegetation is thought to be typical Bankenveld (Acocks 1988) or Rocky Highveld Grassland (Bredenkamp & Van Rooyen 1996). Bredenkamp & Brown (1998) found a few relict sites which indicate that the original vegetation on the shallow granitic soils of the Johannesburg Granite Dome could have been a variant of the *Monocymbium ceressiforme-Loudetia simplex* Grassland (Bredenkamp & Brown 2003). This vegetation is found in areas where little or no disturbance is evident.

The herbaceous layer covers approximately 80% and is dominated by the grasses *Loudetia simplex, Trachypogon spicatus, Schizachyrium sanguineum, Monocymbium ceresiiforme, Digitaria monodactyla, Eragrostis racemosa, Andropogon shirensis, Brachiaria serrata, Alloteropsis semialata, Bewsia biflora* and *Themeda triandra.*

The woody layer consists mainly of a few scattered individuals of the trees *Rhus pyroides, R. leptodictya, Ziziphus mucronata,* the dwarf shrubs *Protea welwitschii, Lopholaenia coriifolia,* and the geoxylophyte *Parinari capensis* that are locally prominent. The grasses *Panicum natalense, Urelytrum agropyroides, Tristachya leucothrix, Cymbopogon excavatus* and *Elionurus muticus* are also abundant together with the forbs *Cyanotis speciosa*, *Bulbostylis burchellii, Crabbea acaulis, Anthospermum hispidulum* and *Senecio venosus*. The grass *Hyparrhenia hirta* is often present and may become more prominent at disturbed sites.

This grassland is characterised by a high species richness with a patchy dominance of

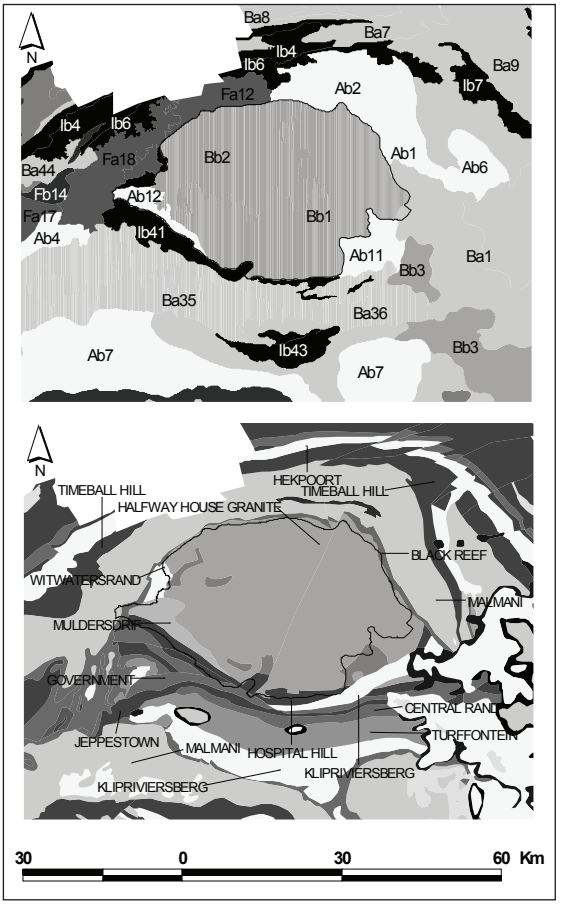

Fig. 3. Land Types (above) and Geology (bottom) within the Egoli Granite Grassland

various grass species and a large variety of forbs (Louw 1970), representing a climax or close to climax condition. Grazing by cattle is often found in this vegetation type, but the dominance of sour grass species often results in a low nutrient status of the grass during winter (Kerfoot 1987; Bredenkamp & Van Rooyen 1996).

Typical species found in the original Egoli Granite Grassland are indicated below:

- Trees and shrubs

Acacia caffra (Thunb.) Willd.
Celtis africana Burm.f.
Elephantorrhiza elephantina (Burch.) Skeels
Gymnosporia buxifolia L. Szysyal
Olea europaea L. ssp. *africana* (Mill.) P.S.Green
Rhus lancea L.f.
Rhus leptodictya Diels
Rhus pyroides Burch.
Ziziphus mucronata Willd.
Ziziphus zeyheriana Sond.

- Grasses

Andropogon schirensis A.Rich.
Aristida adscensionis L.
Aristida canescens Henrard
Aristida congesta Roem. & Schult. ssp. *congesta*
Brachiaria serrata (Thunb.) Stapf
Cymbopogon excavatus (Hochst.) Stapf ex Burtt Davy
Cymbopogon pospischilli (K.Schum.) C.E. Hubb
Cynodon dactylon (L.) Pers.
Digitaria brazzae (Franch.) Stapf
Diheteropogon amplectens (Nees) Clayton
Elionurus muticus (Spreng.) Kunth
Eragrostis chloromelas Steud.
Eragrostis curvula (Schrad.) Nees
Eragrostis racemosa (Thunb.) Steud.
Harpochloa falx (L.f.) Kuntze
Heteropogon contortus (L.) Roem. & Schult.
Hyparrhenia hirta (L.) Stapf
Melinis repens (Willd.) Zizka
Monocymbium ceresiiforme (Nees) Stapf
Panicum natalense Hochst.
Schizachyrium sanguineum (Retz.) Alston
Sporobolus pectinatus Hack.
Themeda triandra Forssk.
Trachypogon spicatus (L.f.) Kuntze
Trichoneura grandiglumis (Nees) Ekman
Tristachya leucothrix Nees
Tristachya rehmannii Hack

- Forbs

Acalypha angustata Sond.
Aloe transvaalensis Kuntze
Aloe greatheadii Schönland
Anthericum species
Anthospermum hispidulum E.Mey. ex Sond.
Asparagus suaveolens Burch.
Aster bakeranus Burtt Davy ex C.A.Sm.
Babiana hypogea Burch.
Becium obovatum (E.Mey. ex Benth.) N.E.Br.
Blepharis subvolubilis C.B.Clarke
Boophane disticha (L.f.) Herb.
Bulbostylis hispidula (Vahl) R.W.Haines
Chascanum hederaceum (Sond.) Moldenke var. *hederaceum*
Chaetacanthus burchellii Nees
Chlorophytum fasciculatum (Baker) Kativu
Crabbea acaulis N.E.Br.
Crabbea angustifolia Nees
Crassula capitella Thunb. ssp. *capitella*
Crinum bulbispermum (Burm.f.) Milne-Redh. & Schweick.

Cucumis zeyheri Sond.
Dicoma anomala Sond.
Eriosema cordatum E.Mey.
Eulophia species
Felicia muricata (Thunb.) Nees
Gladiolus crassifolius Baker
Gnidia capitata L.f.
Haplocarpha scaposa Harv.
Helichrysum aureonitens Sch.Bip.
Helichrysum miconiifolia Hilliard
Helichrysum nudifolium (L.) Less.
Hermannia depressa N.E.Br.
Hypericum aethiopicum (Bret.) N.K.B.
Hypericum lalandii Choisy
Hypoxis hemerocallidea Fisch. & Mey.
Hypoxis multiceps Buchinger ex Baker
Hypoxis rigidula Baker
Ipomoea obscura (L.) Ker Gawl.
Ipomoea ommaneyi Rendle
Justicia anagalloides (Nees) T.Anderson
Kohautia amatymbica Eckl. & Zeyh.
Ledebouria ovatifolia (Baker) Jessop
Ledebouria marginata (Baker) Jessop
Lotononis foliosa Bolus
Mariscus congestus (Vahl) C.B.Clarke
Neorautanenia ficifolius (Benth.) C.A.Sm.
Pentanisia angustifolia (Hochst.) Hochst.
Pentanisia prunelloides Klotzsch ex Eckl. & Zeyh.) Walp.
Raphionacme hirsuta (E.Mey.) R.A.Dyer ex E.Phillips
Scabiosa columbaria L.
Schistostephium crataegifolium (DC.) Fenzl ex Harv.
Senecio venosus Harv.
Tephrosia capensis (Jacq.) Pers.
Triumfetta sonderi Ficalho & Hiern
Tulbaghia acutiloba Harv.
Turbina oblongata (E.Mey. ex Choisy) A.Meeuse
Ursinia nana DC.
Vernonia natalensis Sch.Bip. ex Walp.
Vernonia oligocephala (DC.) Sch.Bip. ex Walp.

Origin of the current vegetation

The shallow, nutrient-poor soils provide a habitat suited to the climax vegetation as discussed previously. Some nutrients are available in the topsoil, supplemented from fallen leaf litter and decomposition, and also from ashes of burned herbaceous layer (if there was a fire). Nutrients are quickly utilised by plants and are furthermore also quickly leached from the very coarse sandy soils. Nutrient cycling is therefore very rapid.

The system is quite stable and fairly predictable without much change caused by normal droughts or grazing. However, if overgrazed or disturbed to such an extent that degradation proceeds beyond a threshold, then recovery is very slow, due to reduced nutrient cycling and decreased nutrient availability and the vegetation may change to another domain of attraction (Bosch 1989), different from the original climax vegetation, representing a plagioclimax (Fig. 4). A change back to the original domain of attraction is unlikely if not impossible in the short and medium term. Due to the granitically derived shallow nutrient poor soils these systems are sensitive and intolerant to frequent impacts such as heavy grazing, ploughing, trampling and general domestic activities. Thus degradation occurs easily resulting in a change from the climax (high species richness) vegetation to an anthropogenic *Hyparrhenia hirta* (low species richness) dominated vegetation type.

Very often *Hyparrhenia* species-dominated grasslands occur on ancient lands in the Central Variation of the Bankenveld (Acocks 1988) and in the surroundings of archaeological sites (Bredenkamp & Brown 2003), where the inhabitants had a mosaic of cultivated lands and grazing of domestic stock. The more recent European settlers also had a profound effect on the natural vegetation as they developed the cities of Johannesburg and Pretoria following the discovery of gold more than a century ago. It seems that the degraded sites developed into *Hyparrhenia* species-dominated grasslands, which tend to be stable for a very long time. Moll (1965) and Smits *et al.* (1999) also indicated that *Hyparrhenia* species-dominated tall grasslands are anthropogenic in origin.

Importance

The substrate of the Johannesburg Granite Dome (Halfway House Granites, Fig. 3) is suitable for development. The area is well situated between Johannesburg, the economic powerhouse of South Africa, and Pretoria the administrative capital of the country. There is an enormous demand for developable land in this area, which has resulted in the loss of large tracts of the original Egoli Granite Grassland. Due to general disturbance, ploughing and degradation, an esti-

mated 60% of the remaining original Egoli Granite Grassland has been transformed to *Hyparrhenia hirta* dominated grassland. Only relatively small scattered pockets of the original grassland are still intact and these are considered rare and highly threatened. Due to its high species richness and restricted occurrence, this endemic grassland has a high conservation value.

Furthermore, the bottomland areas and wetlands within the Egoli Granite Grassland provide suitable habitat for various sensitive fauna species such as the Grass Owl *Tyto capensis* (Red Listed), Marsh Sylph *Metisella meninx* (Vulnerable), and the Giant Bullfrog *Pyxicephalus adspersus* (Near Threatened).

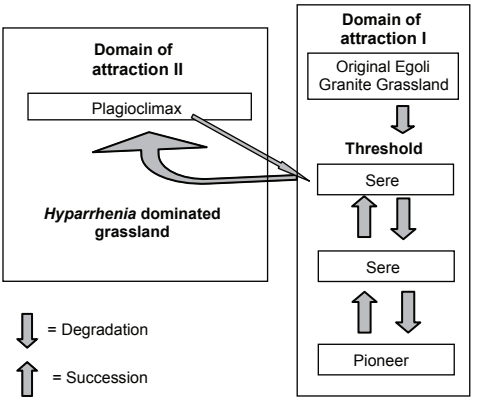

Fig. 4. A model indicating degradation of original Egoli Granite Grassland climax and succession towards a *Hyparrhenia hirta* dominated vegetation type.

Conclusion

Egoli Granite Grassland is a poorly conserved, severely transformed, highly fragmented and degraded vegetation type. It is estimated that only 22% of the original extent of Egoli Granite Grassland remains in its original state. Many of these remnant areas are likely to be destroyed in the near future due to previously authorised developments (e.g. Cosmo City to the north-west of Johannesburg) or illegal activities. It is therefore essential that any viable remnant patch of original Egoli Granite Grassland is conserved.

Areas associated with transformed grassland, where *Hyparrhenia hirta* is dominant and species richness is low, have a low value with respect to achieving the national conservation target for Egoli Granite Grassland. It should be noted however, that *Hyparrhenia hirta* dominated grassland may be valuable for the conservation of sensitive fauna, e.g. Grass Owl (*Tyto capensis*) and Giant Bullfrog (*Pyxicephalus adspersus*).

A mixture of various grasses and high forb diversity renders the original Egoli Granite Grassland with a high conservation value and conservation of remnant areas is especially important since it is unlikely that the transformed anthropogenic grassland will return to the original climax vegetation.

Since Egoli Granite Grassland is endemic to Gauteng, its protection is both a provincial and national priority. It also forms part of a global ecoregion in crisis, an area where biodiversity and ecosystem services are at greatest risk and focused on-the-ground conservation action are required (Hoekstra *et al*. 2005).

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Annexure K

COMMENTS FROM SARHA

Erling Road between the K46 and the K56 and the K56 between the K46 and Main Road (R71), access roads and infrastructure
Our Ref: 9/2/228/0001

Enquiries: Andrew Salomon
Tel: 021 462 4502
Email: asalomon@sahra.org.za
CaseID: 4283

Date: Friday December 13, 2013

Letter

In terms of Section 38 of the National Heritage Resources Act (Act 25 of 1999)

Attention: Gauteng Department of Roads and Transport

The Remainder and Portions 156,14, 5, 11, 202 and 8 of the Farm Zevenfontein 407 JR; Erf 91, 76, 75, 40, 42, 56, 74, 80, 81, 82, 83, 72 and 73 of Kyalami Agricultural Holdings; Erf 118, 116, 115, 114, 113, 110, 100 and 99; Portion 1 of Glenferness Agricultural Holdings; Erf 15, 17, 19, 20, 21, 22, 25 and 27 Glenfox and the road reserves or servitudes of Ash Road, Lynx Street, Chattan Road, Macgregor Road, Zinnia Road, Macinnes Road, Macgillivray Road, Salvia Road, Pine Road, Campoloni Road, Macintyre Road, Erling Road, William Nicol Drive (R511), Dunmaglass Road, Maple Road and Main Road (M71)

Thank you for your notification regarding this development.

In terms of the National Heritage Resources Act, no 25 of 1999, heritage resources, including archaeological or palaeontological sites over 100 years old, graves older than 60 years, structures older than 60 years are protected. They may not be disturbed without a permit from the relevant heritage resources authority. This means that prior to development it is incumbent on the developer to ensure that a **Heritage Impact Assessment** is done. This must include the archaeological component (Phase 1) and any other applicable heritage components. Appropriate (Phase 2) mitigation, which involves recording, sampling and dating sites that are to be destroyed, must be done as required.

The quickest process to follow for the archaeological component is to contract an accredited specialist (see the web site of the Association of Southern African Professional Archaeologists www.asapa.org.za) to provide a Phase 1 Archaeological Impact Assessment Report. This must be done before any large development takes place.

The Phase 1 Impact Assessment Report will identify the archaeological sites and assess their significance. It should also make recommendations (as indicated in section 38) about the process to be followed. For example, there may need to be a mitigation phase (Phase 2) where the specialist will collect or excavate material and date the site. At the end of the process the heritage authority may give permission for destruction of the sites.

Where bedrock is to be affected, or where there are coastal sediments, or marine or river terraces and in potentially fossiliferous superficial deposits, a Palaeontological Desk Top study must be undertaken to assess whether or not the development will impact upon palaeontological resources - or at least a letter of exemption from a Palaeontologist is needed to indicate that this is unnecessary. If the area is deemed sensitive, a full Phase 1 Palaeontological Impact Assessment will be required and if necessary a Phase 2 rescue operation might be necessary. Please note that a nationwide fossil sensitivity map is now available on SAHRIS to assist

with this.

If the property is very small or disturbed and there is no significant site the heritage specialist may choose to send a letter to the heritage authority to indicate that there is no necessity for any further assessment.

Any other heritage resources that may be impacted such as built structures over 60 years old, sites of cultural significance associated with oral histories, burial grounds and graves, graves of victims of conflict, and cultural landscapes or viewscapes must also be assessed.

Should you have any further queries, please contact the designated official using the case number quoted above in the case header.

Yours faithfully

Andrew Salomon
Heritage Officer: Archaeology
South African Heritage Resources Agency

Colette Scheermeyer
SAHRA Head Archaeologist
South African Heritage Resources Agency

ADMIN:
Direct URL to case: http://www.sahra.org.za/node/146432
(GDARD, Ref: Gaut: 002/11-12/E0255)

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Erling Road between the K46 and the K56 and the K56 between the K46 and Main Road (R71
Our Ref: 9/2/228/0001

Enquiries: Andrew Salomon
Tel: 021 462 4502
Email: asalomon@sahra.org.za
CaseID: 4283

Date: Friday May 16, 2014

Final Comment

In terms of Section 38 of the National Heritage Resources Act (Act 25 of 1999)

Attention: Gauteng - Department of Roads and Transport

The Remainder and Portions 156,14, 5, 11, 202 and 8 of the Farm Zevenfontein 407 JR; Erf 91, 76, 75, 40, 42, 56, 74, 80, 81, 82, 83, 72 and 73 of Kyalami Agricultural Holdings; Erf 118, 116, 115, 114, 113, 110, 100 and 99; Portion 1 of Glenferness Agricultural Holdings; Erf 15, 17, 19, 20, 21, 22, 25 and 27 Glenfox and the road reserves or servitudes of Ash Road, Lynx Street, Chattan Road, Macgregor Road, Zinnia Road, Macinnes Road, Macgillivray Road, Salvia Road, Pine Road, Campoloni Road, Macintyre Road, Erling Road, William Nicol Drive (R511), Dunmaglass Road, Maple Road and Main Road (M71)

Marais-Botes, L. March 2014. Phase 1 Heritage Impact Assessment For The Proposed New Road K56 (Study Area: Erling Road Between The K46 And K56 And The K56 Between K46 And Main Road) Midrand, Gauteng Province.

The proposed development entails the construction of a new road, within the study area between William Nicol Drive and Main Road, Midrand, Gauteng.

The assessment found no heritage resources.

The SA National Fossil Sensitivity Map indicates that the proposed road traverses an area of insignificant fossil sensitivity.

Final Comment
As there is apparently no evidence of any significant archaeological or palaeontological material in this area, the SAHRA Archaeology, Palaeontology and Meteorites Unit has no objection to the development. If any new evidence of archaeological sites or artefacts, palaeontological fossils, graves or other heritage resources is found during development, SAHRA and an archaeologist and/or palaeontologist, depending on the nature of the finds, must be alerted immediately.

Should you have any further queries, please contact the designated official using the case number quoted above in the case header.

Yours faithfully

_____

Andrew Salomon
Heritage Officer: Archaeology
South African Heritage Resources Agency

Colette Scheermeyer
SAHRA Head Archaeologist
South African Heritage Resources Agency

ADMIN:
Direct URL to case: http://www.sahra.org.za/node/146432
(GDARD, Ref: Gaut: 002/11-12/E0255)

Terms & Conditions:

1. This approval does not exonerate the applicant from obtaining local authority approval or any other necessary approval for proposed work.
2. If any heritage resources, including graves or human remains, are encountered they must be reported to SAHRA immediately.
3. SAHRA reserves the right to request additional information as required.

Annexure L

THE REGIONAL SPATIAL DEVELOPMENT FRAMEWORK

REGIONAL SPATIAL DEVELOPMENT FRAMEWORK FOR RE GION A

RSDF 2010-2011

RSDF A

CITY OF JOHANNESBURG: ADMINISTRATIVE REGION A

April 2010

ANNEXURE TO THE CITY OF JOHANNESBURG SPATIAL DEVELOPMENT FRAMEWORK - SUBMITTED AS A COMPONENT OF THE IDP IN TERMS OF THE MUNICIPAL SYSTEMS ACT, 2000

(TO BE SUBMITTED AS A COMPONENT OF THE CITY OF JOHANNESBURG'S LAND DEVELOPMENT OBJECTIVE IN TERMS OF THE DEVELOPMENT FACILITATION ACT, 1995)

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EXECUTIVE SUMMARY

EXECUTIVE SUMMARY

Region A is located on the northern periphery of the City of Johannesburg Metropolitan area, bordered by Region C and Region E to the south, Mogale City Local Municipality to the west, City of Tshwane Municipality to the north and City of Ekhurhuleni Municipality to the east.

This region is still largely undeveloped with large tracts of land still being agricultural holdings and farm portions. The predominant land uses include, but are not limited to, industries, conference and hospitality facilities, low to high-density residential areas and environmental conservation areas. There is potential for eco-tourism related activities and urban agriculture in the western part of the region, due to this area's environmental quality and its association with other regional tourism destinations, such as the Hartbeespoort Dam (in Mogale City Local Municipality).

The region's unique defining features include the N1 Development Corridor[1], Midrand Metropolitan Node, Kyalami Speciality Node, Lanseria Airport and Grand Central Airport, all of which contribute towards the region's economy. Other existing and potential prominent areas of employment include the Fourways Regional Node, the industrial areas of Kya Sands, Commercia (in the City of Ekhuruleni Municipality) and Centurion (in the City of Tshwane Municipality), the Northgate Regional Node (in Region C) as well as the Woodmead and Rivonia Regional Nodes (in Region E).

The Gautrain station at Midrand offers an opportunity for further land use intensification and urban regeneration within the Midrand CBD. Careful considerations have been made in the Midrand Gautrain Station Precinct UDF (2008) to integrate this development with the Midrand Node and surrounding proposed developments such as Zonki'zizwe. The Bus Rapid Transit (BRT) System, Phase 1 of which affects Region A in Sunninghill, is a major public transport upgrade initiative by the City. Efforts have to be made to ensure that the marginalized areas of Greater Ivory Park and Diepsloot benefit from these major public transport initiatives.

Major development pressures are experienced in Glen Austin A. H., the greater Kya Sands area and the greater Fourways and Kyalami area. There is currently a high demand for industrial storage facilities, guesthouses and religious facilities in the formalized areas in and around Glen Austin A.H. The high-density residential developments within the greater Fourways area and the pockets of informal settlements, particularly in the north and western parts of the region[2], could potentially encroach on the Urban Development Boundary and some of the region's environmentally sensitive areas. Development pressures on the city's UDB are exacerbated by developments that are taking place in the neighbouring municipality of Mogale City (for example), which are putting additional strain on the City of Johannesburg's bulk infrastructure.

Ivory Park and Diepsloot are two densely populated marginalised areas, where major backlogs still exist in terms of infrastructure and housing provision. The economic opportunities in these areas are still very limited and stronger linkages with other areas of opportunity are necessary. The negligible number of sites with business rights in these areas has resulted in the proliferation of illegal and unregulated informal sector activities.

In terms of the City's Growth Management Strategy (GMS) the area possesses each of the categories classified in the GMS. The region has large areas, which are classified as Consolidation Areas (medium priority area) as well as large areas, which fall outside of the Urban Development Boundary, which form part of the Peri Urban Management Areas (low priority area). The Greater Diepsloot and Greater Ivory Park areas are classified as Marginalised areas and are among the most prioritised areas in terms of the GMS. Together with this classification the Public Transport Management Area, which affects Sunninghill and Midrand, is also a high priority area in terms of public transport provision and transit oriented development. Expansion areas have also been identified in the region, which includes areas around Lanseria Airport, Diepsloot and Crowthorne and sections of Blue Hills.

[1] The N1 corridor is a prominent feature, consisting of office and high technology industries along this major north-south linkage.
[2] The informal settlements in the western and northern parts are mainly in the Kya Sands area and Diepsloot.

SECTION ONE

INTRODUCTION

1. INTRODUCTION

1.1 ROLE OF THE REGIONAL SPATIAL DEVELOPMENT FRAMEWORK

The Regional Spatial Development Framework (RSDF), together with the Spatial Development Framework (SDF), represents the prevailing spatial planning policy within the City of Johannesburg. These spatial planning policy documents are prepared and adopted in terms of the Municipal Systems Act, Act 32 of 2000 as an integral component of the City's Integrated Development Plan (IDP).

This Regional Spatial Development Framework must be read in conjunction with the overarching Spatial Development Framework. The SDF provides a city wide perspective of challenges and interventions within the City and the RSDFs are primarily regional and local implementation tools that:

- Contextualise development trends and challenges within a regional context.
- Prescribe localised development objectives and guidelines (e.g. density, land use etc.).
- Provide a more detailed reflection of the SDF objectives, strategies and policies as they impact on local area planning.
- Reflect localised Precinct Plans and Development Frameworks adopted through official Council protocols.
- Capture the most updated information in terms of regional developmental trends, issues and community needs.
- Add substantive value to the budgeting and spatial development processes within the City by identifying local development interventions.

The following figure illustrates the different City plans that are applicable to different scales. This range of plans is complimented by the Regional Urban Management Plans (RUMPS) that focuses on addressing urban management issues per administrative region.

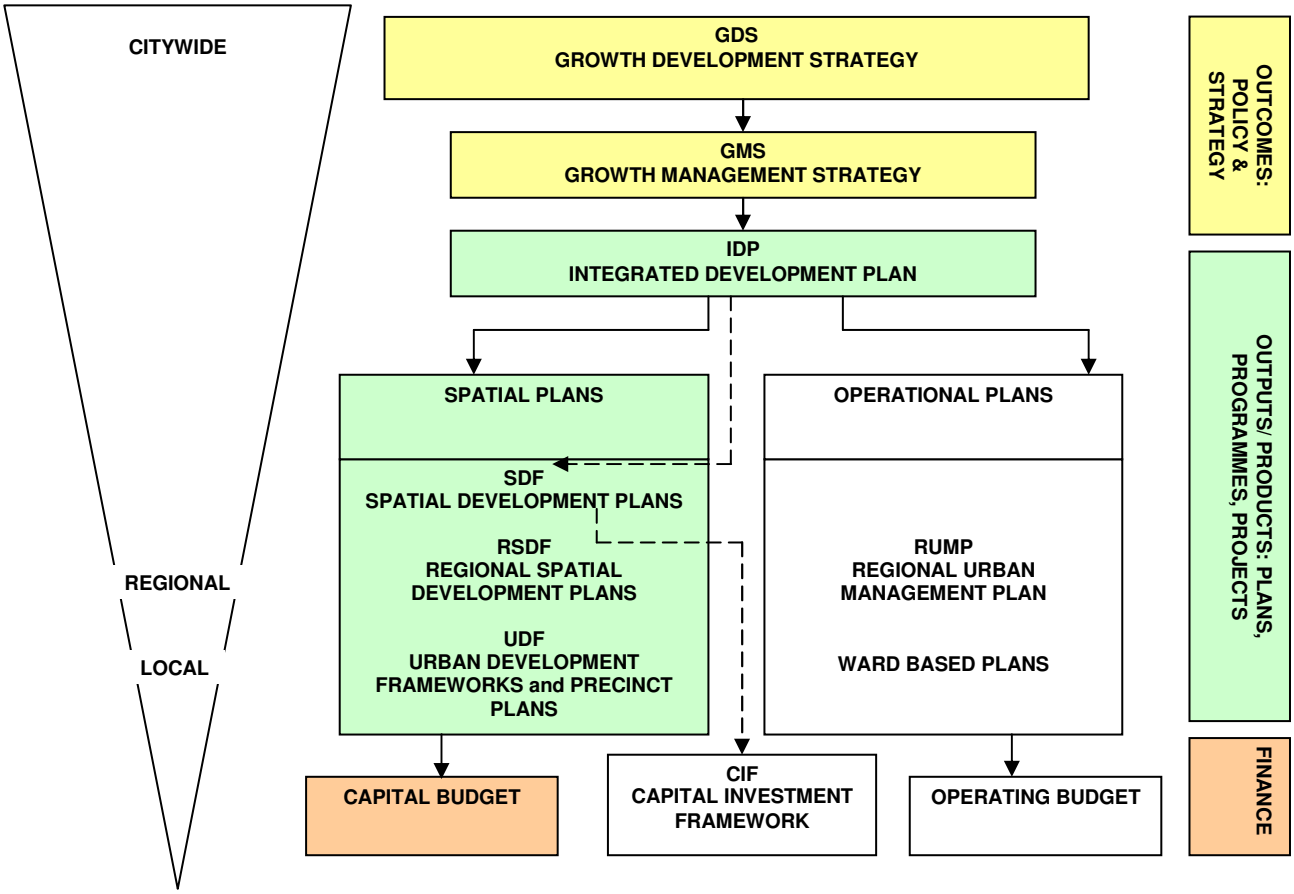


Figure 1: Hierarchy of City Plans

1.2 HOW TO USE AND INTERPRET THIS DOCUMENT?

The RSDF aims to be a concise and user-friendly document that comprises the following four (4) sections:

SECTION 1: Provides an introduction and overview to the document.

SECTION 2: Summarises the current state of the region that includes regional characteristics, issues, trends and implications.

SECTION 3: Sets outs the regional applicability of the city wide structuring elements, policies and strategies and relates this to the regional context. It also provides a short overview of approved and proposed Development Frameworks and Precinct Plans in the region.

SECTION 4: Includes the development management tables per Sub Area that prescribe localised development objectives and guidelines.

1.3 DOCUMENT PROVISOS:

To guide the interpretation and application of the contents of this RSDF document and its plans and figures the following should be noted (Document Provisos):

- Details on the generic policies and strategies of the City such as that of the Nodal and Movement Strategies, etc, are contained within the city wide SDF. The regional specific RSDF and the SDF are to be used in conjunction with one another when assessing any potential development application.
- The Assessment Framework provides a tool for evaluating any potential application and should any particular development demonstrate a meaningful contribution to the City's strategies and desired urban structure, the merits should be considered.
- The interventions and guidelines in the Sub Area management tables and the proposals in approved Precinct Plans should guide and inform the assessment of any potential development application, but should not be considered to grant any specific rights nor negate the merits of any particular proposal.
- This document is the successor to the RSDF for this region as approved in 2009.
- This document subscribes to the vision, planning principles, strategies, policies, and by-laws of the City, and where ambiguities arise these shall prevail.
- This document subscribes to the legislative prescriptions of National and Provincial tiers of Government, and where ambiguities arise these shall prevail.
- This document is submitted as an annexure to the SDF, which in turn is a component of the IDP in terms of the requirements of the Municipal Systems Act. This document is a component of the SDF, which is the (LDO) submission to DPLG in terms of the DFA.
- Development Frameworks and Precinct Plans may supersede this document, project lists and programmes, policies, studies, sub-programmes, project-business plans that may be approved by Council subsequent hereto.
- This document incorporates certain previously approved Council Policies, Development Frameworks and Precinct Plans and where ambiguity exists or more information may be required, these shall act as source documents.
- Approved Development Frameworks and Precinct Plans within this RSDF are deemed to be relevant for up to five years. At the discretion of the Directorate: Development Planning and Facilitation, the Development Framework or Precinct Plan can either be rescinded, revised or retained.
- The maps and plans contained within the RSDF are strategic and conceptual and do not suggest a site-specific representation (unless stated as such under a Precinct Plan).
- The maps / diagrams and graphic representations are merely conceptual indications of the desired future functioning within the region and in order to achieve the desired functioning / goal; projects, sub-programmes, and programmes should be accordingly rolled out / implemented.
- Any delineation of a line, which may have a perceived site-specific interpretation, should not be construed as such (unless stated as such under a Precinct Plan or cadastral delineated (e.g. Urban Development Boundary).
- The Administrative and Sub Area boundary lines are merely administrative and / or planning tools and should not be interpreted as a form of division.

1.4 UNDERSTANDING THE CONTEXT OF EACH DEVELOPMENT PROPOSAL

Understanding the potential impact of each and every development irrespective of its scale and location is key to determining a future City that is sustainable, efficient and accessible to all.

Prospective developments come in all shapes and sizes and the impact of a single development may be citywide or neighbourhood in nature.

As an example, the establishment of a single, large shopping centre may impact significantly on the spending and traffic patterns of a number of regions. The impact of the development may even be felt citywide.

Conversely, a single subdivision in a residential suburb, in line with an applicable Town-Planning Scheme, is unlikely to have a material impact on the ambience or functioning of a neighbourhood or the City as a whole. However, a proliferation of subdivisions or township establishment applications in an area may well begin to impact on the ambience, character and functioning of a suburb and ultimately the broader Region.

Where physical and social infrastructure is planned and co-ordinated in conjunction with these trends the impact should be positive and not compromise the livelihoods of existing communities. In an instance where the provision of services is outpaced by development, the impact of this change is likely to be detrimental to the neighbourhood and broader region.

The following figure illustrates a broad assessment framework for all prospective developments, irrespective of scale with a view to considering “the bigger picture” of a Johannesburg that aspires to be sustainable, efficient and accessible to all.

The assessment framework compels a prospective developer to consider this bigger picture by assessing and demonstrating the contribution of a new development to the City’s strategies and desired urban structure. The broad assessment framework is supported by the set of Development Indices based on Sustainable Human Settlement Principles that will also be used to ensure quality developments.

Table 1. An Assessment Framework for Prospective Developments

				
	CITY CONTEXT ASSESSMENT	**SITE SPECIFIC ASSESSMENT**	**OPPORTUNITIES AND CONSTRAINTS**	**DETAILED DESIGN**
OBJECTIVE	Assessing implications and demonstrating impact of development on city strategies and desired urban structure / form	Assessing implications and demonstrating impact on the neighbourhood	Recognising opportunities / mitigating against constraints	Optimising the development via application of sound urban design guidelines
EXAMPLES OF ASPECTS TO CONSIDER	Movement Nodal development Densities Open space system Sustainable neighbourhoods Corridor development Alignment with Urban Development Boundary	Availability of infrastructure (social / physical) Compatibility/ Character of surrounding areas Adequacy of access Site topography Natural features	Linkages with public transport system Opportunities for increased density Provision of open space Scale / mix of developments	Arrangement of buildings / sites Promote frontage development Indicate pedestrian links / public space provision Focus intensive development on major routes and spaces Storm water treatment
RESOURCES AVAILABLE	IDP / SDF	SDF / RSDF Inputs from respective MOEs	RSDF Sub Area Management Tables Precinct Plans	Urban Design Guidelines Site Development Plan Architectural drawings Service Agreements

1.5 IMPROVING THE QUALITY OF HUMAN SETTLEMENTS

In addition, to the broad assessment framework discussed in the previous section, the City has introduced a set of Development Indices based on Sustainable Human Settlement (SHS) Principles. These principles are considered in the following section and represent the proposed minimum "thresholds" and requirements which apply to residential development proposals resulting into 20 dwelling units and non-residential development proposal on a 2000 square metre site or more. The principles of SHS would also need to be considered in any new Precinct Plan / Development Frameworks whether commissioned by the City or privately.

In summary, the SHS Indices are aimed at the following:

- Improving the spatial, social, economic and environmental quality of human settlements.
- Promoting sustainable land-use planning and management.
- Promoting the sustainable and integrated provision of infrastructure and services.
- Promoting sustainable energy and transport systems in human settlement.

Nine key elements are identified as vital to the creation of sustainable human settlements, and they are:

- Spatial integration.
- Integrated public transport and walkability.
- Resource management and environmental sustainability.
- Open space system.
- Legibility.
- Economic opportunities.
- Safety and security.
- Adequate infrastructure and service provision.
- Security of tenure and mixed housing typologies.

The SHS indices are to be applied at the Township Establishment/Rezoning process and the Site Development Plan stage. The aforementioned SHS elements will be evaluated on each development proposal within the threshold. Under each element, there is a score and/or weighting which will determine the level of sustainability of the development on that particular element i.e. Spatial Integration and energy efficiency. The scoring and weighting incorporates both qualitative and quantitative aspects of the proposals and would become the basis for determining the level of sustainability. Should a development proposal not meet the minimum threshold, mitigating aspects would need to be negotiated to an acceptable sustainability standard between the City and the prospective developer.

SECTION TWO

REGIONAL ANALYSIS

Plan 1. Locality Plan

Plan 2. Broad Land Uses

2. REGIONAL ANALYSIS

2.1 REGIONAL CHARACTERISTICS

2.1.1 Location

Region A, as illustrated on Plan No. 1, is one of seven demarcated administrative regions that constitute the City of Johannesburg. Within the larger Gauteng metropolitan area, Region A is bordered by Mogale City Local Municipality to the west, City of Ekurhuleni to the east and City of Tshwane to the north. Within the City of Johannesburg administrative boundary, Region C and Region E form the southern boundaries of Region A.

2.1.2 Residential Development

The region includes formal townships, informal settlements, agricultural holdings and farm portions. The most urbanised areas are around the Fourways, Sunninghill and Midrand areas. Two prominent marginalized areas, Diepsloot and Greater Ivory Park (including Kaalfontein and Rabie Ridge) form part of Region A, as well as a number of informal settlements such as Kya Sands.

The marginalized areas of Diepsloot and Greater Ivory Park require integration into the broader urban network. The most prominent needs arising from these marginalized areas encompass employment opportunities, business sites and local retail, which has resulted in large scale, unregulated informal trade. As part of the Upgrading of Marginalized Areas Programmes, development frameworks (namely the Diepsloot Government Precinct UDF, Diepsloot Activity Street UDF, Bambanani Industrial Node UDF and the Swazi Inn UDF) addressing spatial, social and economic inequalities have been prepared.

Increased densities and pressure for development in many parts of the region are causing infrastructure capacity constraints and a threat to the biodiversity of the environment.

2.1.3 Nodal development

The Region has a satisfactory hierarchy of nodal developments that include Midrand Metropolitan Node, Fourways Regional Node, Sunninghill Regional Node, Carlswald District Node, San Ridge Square District Node, Cedar Square District Node and several neighbourhood nodes. Region A's speciality nodes such as Kya Sands, Lanseria Airport and Kyalami (from a tourism and industrial function perspective) play a significant role in the growth and sustainability of the region's wealth. These different nodes provide employment opportunities to populace residing within the region. Nodes in the adjacent regions and municipalities, due to their close proximity to and accessibility from Region A, present potential employment opportunities for the region's population and workforce. These nodes include Northgate Regional Node (in Region C), Strijdom Park Industrial Area (in Region B), Woodmead Regional Node (in Region E), Rivonia Regional Node (in Region E), Commercia (in the City of Ekurhuleni) and Centurion (in the City of Tshwane).

The Kyalami Speciality Node, which contributes to the region's uniqueness, has significant potential to contribute to economic growth and tourism especially with the Fifa World Cup taking place in South Africa during 2010. The node's proximity to hospitality and conference facilities, other nodes, a major freeway and the city's road network enhance the node's capability to contribute to the region's economy.

The management of Kya Sands industrial node (with particular reference to the existing informal settlements located in the surrounding area) is required to maintain the character of non-urban residential areas and prevent environmental degradation.

The eastern half of the region is characterised by high-tech developments, warehousing, distribution centres and office developments along the N1 strip, which results in a large influx of skilled labour into the region on a daily basis.

2.1.4. Water

The City is providing water infrastructure under two programmes: The Water Reservoir Upgrading Programme and the Bulk Water Distribution Programme (see Plans 5 and 6).
The legends of these aforementioned plans can be described as follows:

- No upgrading: No programme is necessary for these areas as the reservoir capacity is adequate.
- Existing: A program is being implemented currently to address current (existing) backlogs.
- Existing and ultimate: A program is being implemented currently to address current (existing) backlogs and to provide additional capacity for future demand.
- 5 Year: Reservoir upgrading programmes will be initiated in 5 years time to address capacity in these areas.
- 5 year and ultimate: Reservoir upgrading programmes will be initiated in 5 years time to address capacity in these areas, and to create additional capacity for future demand.
- Ultimate: Reservoirs that serve these areas will only be upgraded in the long term.

2.1.5 Electricity

- There are currently two electricity distribution supply authorities in this Region.
    - City of Johannesburg (in the developed area) supplies approximately 40% but sells approximately 80% of the total demand in the developed areas.
    - Eskom supplies the rest of the area, especially the areas in Diepsloot, Ivory Park and Kaalfontein. The status of electricity capacity in the Eskom supplied areas remains unconfirmed.
- The current networks in many of the rural or low-density agricultural areas were not designed to cater for the high rates of development that are currently occurring in the region.
- Although legal connections were provided for the new houses built in Diepsloot and Ivory Park, a high number of illegal connections still exist in these areas. This raises concerns from both a safety and an investment return perspective.
- In areas such as Diepsloot and Extensions, less than 25% of power capacity is reached. This means that more work still needs to be done to service these areas.
- Kya Sands, Glen Austin and parts of Kaalfontein are power capacity hot spots for the region.
- The Grand Central Substation is currently being upgraded to service the Midrand CBD.

2.1.6 Road Network

The north-south linkages such as the N1, R55, R511 and R512 link this Region to a variety of urban opportunities. Malibongwe Drive (R512), William Nicol (R511), Main road (R55), Witkoppen Road (R564), the N14 and N1 are well established and form the basis for strong mobility spines.

The general conditions of roads in Greater Ivory Park and Diepsloot are poor. These areas are also experiencing a backlog in terms of the upgrading of gravel roads.

The east-west linkages are less defined in comparison to the north-south linkages. Due to large traffic volumes travelling through the region daily, heavy congestion occurs along the region's major movement routes. The following intersections operate at a high level of congestion and this results in traffic delays:

- Olifantsfontein I/C West Terminal.
- Allandale I/C West Terminal.
- N1 Buccleuch Interchange.
- R562 (Olifantsfontein) / Lever Road.
- K 101 / K 58 West Street.
- K 101 / George Road.
- K 101 / Douglas Road.
- K 101 / Douglas Road.
- New Road / Sixteenth Road.
- K 101 / Allandale Road.
- Witkoppen Road/ Rivonia Road
- William Nicol Drive/ Fourways Boulevard

The existing road infrastructure within the region is inadequate to cater for the increased developments at the desired densities and this indicates that developments must be accompanied by road infrastructure upgrades.

2.1.7 Public Transportation

Region A has diverse transportation modes ranging from and dominated by taxis and buses that serve the residents and workers in the area. Due to a large number of people travelling through the region daily, heavy congestion occurs along the major movement routes and intersections particularly the N1 highway and William Nicol Drive. The Bus Rapid Transit system (Phase 1 affecting the Sunninghill area) and Gautrain Rapid Rail link (affecting the eastern parts of the region, particularly Midrand) are also being planned and developed to provide an alternative mode of public transport in the Region to provide citywide connectivity.

2.1.8 Waste Management

- Adequate service standards are provided in the developed suburbs including domestic, commercial, industrial, garden waste and special waste removal services.
- There are 100 skip containers servicing the informal areas within the Region.
- Enforcement of by-laws for the control of illegal dumping is ineffective and requires improvement.
- The large tracts of vacant land in the Region are vulnerable to illegal dumping.
- For disposal purposes the landfill site at Chloorkop is currently being used.
- A new landfill site is being proposed. Two potential sites are under consideration, the most likely one being situated near Northern Farm. The proposal is currently in process.
- The new site, if developed, will be large enough to service not only in Region, but will eventually be able to take over the role of the Linbro Park site in Region E.

2.1.9 Sewer

- The Western Klein Jukskei sub-catchment serves the built-up area in the western parts of the region.
- Expansion of the network will have to be investigated to supply the Blue Hills area.
- The growth in the N1 strip necessitates the urgent upgrade of the outfall sewer pipeline from the area north of Olifantsfontein Road.
- The main outfall has spare capacity to serve approximately 400 000 extra people.
- The northwest half of the region is mostly without any waterborne sanitation, both bulk and reticulation.
- The western parts of the region lie within the Northern Drainage Basin and are served by the Northern Wastewater Treatment Works, which has spare capacity to serve an approximate additional 1 075 000 persons. The controlling factor in this catchment area is the Diepsloot Outfall which can serve an approximate additional 1 000 000 people.

2.1.10 Storm-water Drainage

- An established storm-water system serves the built-up areas of the region. Further densification in the built-up areas may, in certain instances, severely impact on the existing drainage system. Improvement of the system needs to take place in a planned manner.
- The lack of adequate control measures in the marginalised areas is causing serious problems with storm-water runoff, resulting in flooding and erosion.

Plan 3. Infrastructure Hotspots (Roads and Power)

Plan 4. Infrastructure Hotspots (Storm water, Sewer and Waste)

Plan 5. Water Reservoir Upgrading Programme

Plan 6. Bulk Water Distribution Programme

2.2. KEY ISSUES

2.2.1. Spatial and Economic issues

- The formalisation of a large number of informal settlements in the Region, including Kya Sands, Lion Park and Diepsloot.
- The majority of issues facing the region are related to the mushrooming of informal settlements in the largely non-urban sections of the region requiring to be formalised.
- The incorporation of lower-income housing typologies into the broader urban fabric to directly address the existing spatial inequalities within the region, while providing a range of different housing types for various income groups.
- There is a high level of informality in the marginalized areas that needs to be addressed. Marginalized areas and informal settlements have poor levels of infrastructure, high levels of poverty and unemployment.
- There is a need for residential and business development along and around the Gautrain station to support the functionality of the station. This will ensure optimal utilisation of the services and infrastructure; infill development is required in the remaining undeveloped land parcels within this part of the region.
- Businesses in the region occur haphazardly. Proper business sites and informal trading facilities need to be identified in strategic locations.
- Formal public transport facilities need to be located where clustering of mixed land uses exist. Proper structures need to be erected in order to address the needs of commuters, the transport industry and any other affected users.
- The region is affected by the lack of spatial integration. Due to spatial inequalities, marginalized areas and informal settlements are located on the outskirts of the region, resulting in long travelling distances and costly travelling fees.
- The urban areas of the region have grown dramatically over the past few years. Typical developments have included high-tech industries and offices along the N1highway and around the Fourways Regional Node. These developments, as well as the rapid development of residential areas, place substantial pressure on the city's bulk electricity, water and road infrastructure.

2.2.2 Infrastructure and Services

- The region in general has capacity limitations in bulk electricity and water provision. Infrastructure carrying capacity must be constantly monitored and upgraded to match the rate at which development take place within the region.
- Given the under-developed and agricultural nature of a large part of the region (especially the western parts of the region), a substantial part of the region is not serviced by bulk infrastructure. The urbanised areas are also experiencing problems with regards to bulk infrastructure due to urban expansion (such as that occurring in Kya Sands, Glen Austin and Kaalfontein).
- There is a need to address service delivery in the marginalised areas.
- Efforts in Diepsloot, Ivory Park and the surrounding areas should be focused on the upgrading of social and physical infrastructure as catalysts for economic development, proper land invasion management and the implementation of current housing programmes.

SECTION THREE

DEVELOPMENT POLICIES AND STRATEGIES

3. DEVELOPMENT POLICIES AND STRATEGIES

This section provides a more detailed reflection of the Spatial Development Framework's (SDF) objectives, strategies and policies as they impact on local area planning, as well as illustrating the Growth Management Strategy. It also provides brief overviews of the region-specific Development Frameworks and Precinct Plans that have been developed to give effect to the vision for the region and the City.

3.1 DEVELOPMENT STRATEGIES

The SDF provides a comprehensive overview of the Spatial Development Strategies and the desired urban form for the City. Therefore this section should be read in conjunction with the SDF (2010/2011).

3.1.1. Growth Management Strategy

In addition to the SDF component, a Growth Management Strategy (GMS) was developed to compliment the seven other SDF strategies. The strategy is detailed in the Spatial Development Framework 2010/2011. The GMS prescribes where, and under what conditions, growth can be accommodated. The future growth of the City must ensure that population and economic growth is supported by complimentary services and infrastructure whilst also meeting spatial and socio-economic objectives. The two key objectives of the strategy are to:

- Determine priority areas for short-medium term investment and allocation of future development rights.
- Re-direct the respective capital investment programmes of the City's service providers to address the short-term hotspots and strategic priority areas.

The GMS sets high, medium and low priority areas across the City and describes specific interventions:

High Priority (i.e. 2008-2011 Capital Investment and immediate Service Upgrading)

Public Transport Priority Areas:

The locations noted below represent the backbone of a revitalised and integrated public transportation system. The multi-billion Rand investments of Gautrain and the Bus Rapid Transit System (BRT) represents the City and State's commitment to realising a world-class public transportation system that facilitates movement within and beyond the City's borders and is efficient and accessible to all communities. The expanded system being developed represents a significant and complimentary advancement of the current bus and taxi services rendered within the City.

The locations below also represent latent opportunities to restructure the current fragmented City form and to provide more inclusive environments for the City's communities. Issues relating to appropriate and effective densities, mixed-uses and infrastructure provision are foremost in the City's designation of these areas as priority areas from an infrastructure perspective. City budgets relating to infrastructure will be co-ordinated to ensure that these imperatives are met. Additionally, aspects relating to Inclusionary Housing to facilitate affordable and "gap-market" housing and incentives to facilitate socially geared developments in these locations are critical. In this regard the City has approved a density bonus incentive along the northern section of the BRT (Parktown to Sunninghill route) and is considering additional incentives such as the fast tracking of applications.

The Public Transport Priority Areas for Region A are as follows and are explained as such:

a) The Gautrain Station Precinct at Midrand

In an attempt to reduce the traffic congestion along the city's major arterials, the Gautrain Rapid Rail Link was introduced. Together with the existing north-south linkages, the Gautrain Rapid Rail Link, connect the major urban centres in the City of Johannesburg and the City of Tshwane. The UDF for the Gautrain station precinct in Midrand was prepared and it is envisaged to become a catalyst for development, thereby contributing towards the revitalization of the Midrand CBD.

The City's main objective in this area is to urgently address the backlog in traffic, and to facilitate the development of inclusionary housing and mixed-use developments within the station precinct.

The Gautrain Station UDF's main objectives are to:

- Reduce traffic congestion by promoting public transport usage.
- Encourage pedestrian movement and the use of non-motorised transport.
- Attract investments into the precinct.
- Encourage mixed economic activities within and around the precinct.
- Promote high-density residential development.

Opportunities within the Gautrain Station Precinct in Midrand

The Midrand Gautrain station precinct:

a) Has access to a good transportation network.
b) Has large numbers of vacant land suitable for development.
c) Have both urban and rural characteristics.
d) Has mixed land uses ranging from economical, residential, institutional, social to recreational uses.

Constraints within the Gautrain Station Precinct in Midrand

- Infrastructure constraints, especially in relation to water and electricity.
- Low densities to sustain major nodal developments.
- A deteriorating urban environment.
- Limited public transport facilities.

Interventions in support of the objectives of the Midrand Gautrain Station UDF

- Support nodal and high residential development around the station precinct.
- Support station related uses such as a Gautrain Visitors Center.
- Support the establishment of a formal trade market.
- Improve public transport facilities.
- Encourage pedestrian links and cycling lanes.
- Encourage the sense of place within the station precinct.
- Protect open spaces and wetland.
- Upgrade the road infrastructure, storm water drainage system and public environment.

b) <u>BRT Phase 1: Parktown-Sunninghill</u>

Opportunities within Sunninghill

- Has good transportation network that makes the area accessible.
- Has large number of vacant land suitable for development.
- Has mixed land uses ranging from economical, residential, institutional, social to recreational uses.

Constraints within Sunninghill

- Infrastructure constraints, especially in relation to water and electricity.
- Low densities to sustain major nodal development.
- Limited public transport facilities.

Interventions in support of the Land-use and Design Guidelines for the BRT

- Support high residential development along the BRT Phase 1 corridor in Sunninghill.
- Support uses such as hotels and guesthouses to facilitate the use of the BRT Station.
- Improve public transport facilities.
- Encourage pedestrian links and cycling lanes.
- Encourage the sense of place within the station precinct.
- Upgrade the road infrastructure, storm water drainage system and public environment.

<u>Marginalised Areas</u>

The continued City commitment to the upgrading and economic upliftment of the following locations places them within the highest priority category of the five Growth Management Areas and reinforces

the commitment to service upgrading (e.g. gravel roads upgrading, eradication of informal settlements etc.).

The transformation of these locations from their previous dormitory township status to vibrant, integrated communities are central to the principles of the Growth and Development Strategy such as "facilitated social mobility" and "settlement restructuring".

The City via a series of incentives and targeted infrastructure provision will support developments that foster an increased economic development and labour-intensive industries. A full suite of incentives has been developed and includes the Fast-Tracking of applications, Application Fee and Bulk Contributions exemptions.

The two marginalized areas in Region A are **Diepsloot** and **Greater Ivory Park**.

Opportunities within marginalised areas

- They are regarded as high priority areas in terms of State housing provision.
- They are regarded as high priority areas in terms of municipal infrastructure provision.
- Informal settlement upgrade is already taking place within both marginalised areas.
- There is an opportunity to have various housing typologies and to provide a range of tenure options within both marginalised areas.
- There is an opportunity to support local economic development.
- There are possibilities to encourage private sector investment in the marginalised areas.

Constraints within marginalised areas

- The presence of informal settlements.
- High population densities.
- Poor sanitation and storm water drainage.
- The presence of gravel roads.
- Unregulated small businesses.
- Limited social and institutional facilities.

Interventions

- Identify Activity streets.
- Support nodal development and recognise them as structuring elements.
- Support high residential development along activity streets.
- Support the establishment of formal trade markets and incubator businesses.
- Improve public transport facilities.
- Encourage pedestrian links and cycling lanes.
- Improve the sense of place within demarcated nodes.
- Protect natural open spaces and wetlands.
- Upgrade road infrastructure, storm water drainage and public environment.

Medium Priority (i.e. immediate remedial infrastructure upgrading. New Capital Investment 2011-2015)

Consolidation Areas

The greatest impact of the Growth Management Strategy will undoubtedly be felt in the Consolidation Areas. The primary objective of the Consolidation Areas is to prevent the compounding of the infrastructure constraints, most notably relating to energy and traffic but also noting the significant impact of large-scale and incremental developments on water and sanitation, storm water management and social amenities.

There are two sub-categories within the Consolidation Areas, namely:

- Infrastructure encumbered areas.
- Non-encumbered infrastructure areas.

Infrastructure encumbered areas: The areas are not within the public transportation "footprint" described earlier in the section and have been determined in relation to the capacity of City Power's sub-stations (where 90% or more of the design-capacity has been exceeded during Winter 2007 load-readings). The status of these localities will be re-evaluated on an annual basis in consultation with the respective Municipal Owned Entities including City Power.

It is within these localities that the City will actively limit further developments until current deficiencies are addressed (noting that they do not enjoy short-term priority status in terms of service upgrading). This limitation will apply to incremental and large-scale developments and will affect individual property owners and the development community alike.

It is acknowledged that a number of the spatial policies relating to densification will be affected by these limitations (e.g. densification along the City's mobility routes). The City remains committed to these principles and long-term objectives. However, it cannot commit to the provision of the requisite infrastructure short-term and consequently will not as a matter of course support subdivisions, rezoning or township establishment development applications in the short term, noting the provisions of the section below.

Exemptions to Limitations on Development Applications: The City would not support development applications in Encumbered Infrastructure Consolidation Areas relating to rezoning and / or township establishment and / or subdivisions unless:

- The application would necessitate less than 20% increase of the existing power and energy usage OR
- The application is able to carry the costs of the requisite bulk infrastructure upgrading at the cost of the developer AND
- The application would necessitate less than 20% of the current traffic generation of the current land use and intensity AND
- The rezoning has the implicit support of each of the Transportation / JHB Water / City Power and
- JHB Water and City Power commit to reserving capacity for the development

The provisions of the above can be set-aside if energy efficient designs / components of the development can reduce the energy demands to standards prescribed by City Power.

When the reserve capacity for each City Power depot is reached NO further Township Establishment approvals or rezoning to be approved until new reserves are made available.

In the case of the **non-encumbered infrastructure areas** the prevailing provisions of the Regional Spatial Development Framework Sub Area Management Tables will apply.

Region A has a large number of consolidation areas – please refer to the Sub Area management tables in Section 4.

Expansion Areas

To the north and south of the City, potential land resources presently beyond the Urban Development Boundary (UDB) have been identified and the proposal to include them within the UDB are included in the SDF and RSDFs for Regions A and G. Conditions relating to Consolidation Areas for development applications are applicable for Expansion Areas.

Low Priority (i.e. no infrastructure upgrading / provision before 2020)

Peri Urban Areas

Localities beyond the extent of the Urban Development Boundary comprise the Peri-Urban Management Areas. There are no short or medium term obligations or plans to service these areas. Region A has Peri-Urban Areas - please refer to the Sub Area management tables in Section 4.

For details on the GMS refer to the Spatial Development Framework 2010/2011.

Plan 7. Growth Management Strategy

The following table provides a summary of the other seven Development Strategies and their instruments and the SDF objectives.

Table 2. Development Strategies, Instruments and Objectives

Spatial Development Strategies	SDF instruments	Objectives
Supporting an efficient movement system	▪ Road Hierarchy ▪ Strategic Public Transportation Network (SPTN) ▪ Gautrain Stations ▪ Existing rail network	▪ Support public transport. ▪ Reduce travel and transport cost. ▪ Promote accessibility of communities to employment, recreation and social opportunities. ▪ Protect the mobility function of major arterials and roads. ▪ Ensure that the movement system links with and is supported by strong high intensity nodes and higher density residential development.
Ensuring Strong Viable Nodes	▪ Nodal Hierarchy ▪ Nodal Profiles and Boundaries ▪ Management guidelines	▪ Ensure clustering of various activities (work, live, play and pray) at appropriate locations. ▪ Support viable public transport. ▪ Maximise opportunities and diversity at accessible points.
Strategic Densification	▪ Strategic Densification Priority Areas ▪ Base and minimum density guidelines proposals	▪ Promote appropriate densities and densification. ▪ Promote the optimal use of existing and future infrastructure and resources.
Initiating and Implementing Corridor Development	▪ East West Development Corridor (EWDC) ▪ North South Development Corridor (NSDC)	▪ Determine appropriate interventions. ▪ Maximise opportunities. ▪ Facilitate linkages. ▪ Manage new developments in a co-ordinated fashion.
Supporting Sustainable Environmental Management	▪ Johannesburg Metropolitan Open Space System ▪ Design Guidelines	▪ Create a network of open spaces ▪ Support sustainable storm water catchment practices. ▪ Protect important environmental areas. ▪ Promote the prevention and reduction of pollution.
Facilitating sustainable housing environments in appropriate locations	▪ Spatial location and database of the City's informal settlements ▪ Housing Programme ▪ Pilot Projects	▪ Develop appropriate housing typologies. ▪ Promote adequate provision of social and economic amenities.
Managing Urban Growth and Delineating an	▪ Land use guidelines ▪ Subdivision of Land Table ▪ Amendment Procedures	▪ Combat urban sprawl. ▪ Create economies of urbanisation. ▪ Focus on in-fill and

Spatial Development Strategies	SDF instruments	Objectives
Urban Development Boundary		redevelopment. ▪ Support efficient infrastructure provision (capital investment). ▪ Provide a mechanism for effective growth management. ▪ Support a more efficient urban form that is public transport orientated. ▪ Protect environmentally sensitive areas, agricultural land and open space. ▪ Support a multi-modal transportation system.

3.1.2 Supporting an Efficient Movement System

The Movement Strategy is premised on the provision and maintenance of a highly accessible movement system and network that supports a range of modes (road, rail and non-motorised transport modes, public and private) and activities at various levels, intensity and scale. It specifically endorses the promotion of public transport as the means to increase accessibility of opportunities to all City users.

Road Network Hierarchy and Management Guidelines

In order to develop an appropriate and functional movement network for the City, a study was commissioned by the Johannesburg Roads Agency and Transportation Planning and Management Directorate, in 2004. The Transportation Department has recently updated this study (February 2010) in order to reflect the current status of the network as well as to align the classification of the City's roads with the official roads policy for planning and development of road infrastructure in South Africa; Road Infrastructure Strategic Framework for South Africa (RISFSA). The updated study focuses on the following elements:

1. Road Reclassification: according to the RISFSA classification scheme
2. A Proposed future Road Network based on 5 and 10 year scenarios which include:
    - Priorities for implementation (upgrades and implementation of new roads)
    - Land acquisition associated with the future road network
    - Protection of road development corridors
    - City's Freight Network

Roads provide two types of services, namely the provision of traffic mobility and access. The relationship between these two factors differs depending on the functionality of the road and is further classified in Table 3 below.

The reclassification of roads under the RISFSA classification system has resulted in a number of roads being downgraded from Mobility Spines and Mobility Roads. This has a direct impact on the permissible densities applied to the properties formally located on Mobility Spines and Mobility Roads.

Table 3. Network of Road Hierarchy

FUNCTIONAL ROAD CLASSIFICATION	LAND USE	FUNCTION AND DESIGN	REGION A
Highway (Class 1)	• No direct access to land uses.	• Accommodates mainly national, regional and longer distance metropolitan trips. • Access is restricted to the interchanges only.	N1 N14/R28
Mobility Spines (Class 2) A Mobility Spine is an arterial along which through traffic flows with minimum interruption (focus on providing mobility). Development abutting the spine is in terms of specific policy criteria relating to the type of land use to be accommodated and to level of access. More often than not it will be the main arterial road between major nodes or between nodes and the freeway and motorway system.	• Mixed land uses at identified intersection nodal points • Predominantly higher density residential • Non-residential uses to be determined by the relevant RSDF Sub-area table, or if not specifically dealt with in the applicable RSDF then by **Table 5.7:** Ancillary Uses Guidelines for Mobility Spines	• Mainly for inter regional and metropolitan trips. • No direct access should be allowed. • Access intersections provided at designated roads (highways and mobility roads) • Access from side roads or service roads. • . • Restrictions on frontage access to be controlled. • Provide public transport facilities at designated locations to ensure safe pedestrian access • Incorporate designated SPTN / BRT routes. • Ensure managed pedestrian access • Consider pedestrian movement, NMT and public transport services. • Provision for pedestrian safety.	Sixth Road Cedar Road William Nicol Drive Witkoppen Road Pelindaba Road Malibongwe Drive Main Road – Pitts – Main Fifth Avenue Pitts Road Allandale – Kyalami Walton Road – New Road Old Pretoria Main Road Republic Road (Proposed BRT) R562 K101 (Proposed BRT) Rivonia Road Woodmead Drive/K71 Dale Road K27/Olifantsfontein Road
Mobility Roads (Class 3) A Mobility Road carries mainly intra regional traffic i.e. traffic of a local nature. . It is of a lower order than a mobility spine but maintains the focus on mobility along the route. It often connects mobility spines or neighbourhood nodes.	• Local nodal development • Predominantly higher density residential • Non-residential uses to be determined by the relevant RSDF Sub-area table, or if not specifically dealt with in the applicable RSDF then by **Table 5.8**: Ancillary Uses Guidelines for Mobility Roads	• Shorter distance distribution and mainly metropolitan trips. • Performs a collector and distributor function, by collecting and distributing trips onto the mobility spine network and to and from neighbourhood nodes. • Incorporate future SPTN / BRT feeder and distribution routes. • Must safely accommodate public transport and pedestrian movement • Limited direct access. • Provision of pavements and cycle lanes for pedestrians and cyclists.	Uranium Street Zanneblom Lane Fourways Boulevard Garden Road – Seventh Road Lever Road – Harry Galaun 6th Road-Smuts Drive – Baker – Janadel Avenue Church Street Alexander Avenue Old Olifantsfontein Road Makhaya Drive (Ivory Park)
Activity Street (Class 4) An Activity Street is a local street where access to the activity along the street is of paramount importance. Mobility is compromised in favour of the activity.	• Residential • Business • Retail • All uses to be of a local and fine grain nature	• Accommodate pedestrian intensive uses with active frontages at street level. • High level of (direct) access. • Speed calming. • Must safely accommodate public transport and pedestrian movement • Provide public transport facilities. • Priority for pedestrians and cyclists in traffic management. • Activity preferably one erf deep.	Malibongwe Drive (Ivory Park) Makhanya Drive (Ivory Park Twenty/Ninth September/Acacia/Archerfish Roads (Ebony Park, Ivory Park, Kaalfontein) JB Marks Informal Settlement/ Diepsloot Road (Diepsloot Activity Street)
Local Residential Street (Class 5) A local Residential Street is a local road that serves primarily local traffic accessing the served area.	• Residential uses • Low intensity non-residential uses, as per relevant RSDF Sub-area table.	• Provides direct access to residential property. • Facilitates mixed traffic within neighbourhoods safely and at low speed. • Provision of pavements for pedestrians. • Feeds into arterial roads and used to access Activity Streets. • Vehicle and Pedestrian conflicts to be addressed safely. Consider pedestrian movement and NMT	

Table 4: Ancillary Use Guidelines for Mobility Spines

No. of Storeys	2	3	4
Permissible developable ground floor area for non-residential use*	7.5%	10%	15%

***Not exceeding 500m^2**

Table 5: Ancillary Use Guidelines for Mobility Roads

No. of Storeys	2	3	4
Permissible developable ground floor area for non-residential use*	5%	7.5%	10%

***Not exceeding 500m^2**

The east-west link between Ivory Park and the Midrand CBD is limited and needs to be addressed to ensure better spatial integration. The mobility function is critical for the existing east-west routes. It must be a primary consideration when reviewing applications pertaining to erven along Mobility Roads.

There are specific cases where non-residential development or the allocation of rights for non-residential uses on affected erven along identified Mobility Spines and Roads pre-date the implementation of the Movement Strategy. This has given rise to situations where existing rights are not recognised in terms of Council policy and applications to reinforce or improve these rights are rejected.

Generally, major roads in Region A are overburdened and the construction of the following proposed major roads would in future enhance better mobility within the region:

Proposed K46: North-south route that will follow the alignment of William Nicol Drive, which currently forms the eastern boundary of the Diepsloot settlement.

Proposed K56: East-west link that connects the Region to Ekurhuleni and Mogale City. The road will also connect several significant nodes in the Region.

Proposed K54/R562: East-west route that will run through the centre of the Diepsloot settlement. This route is critical towards the effective functioning of the Diepsloot/Tanganani areas

Proposed K27: East-west route that ends at William Nicol Drive and is likely to have an impact on the expansion of Diepsloot.

Proposed K33: North South route that traverses the western parts of the Region along Kya Sands toward Lanseria

Proposed PWV 5 & PWV 9: East west and north south routes respectively through the region.

The final category of road identified is the local residential street. These include the vast majority of the roads within Region A.

Public Transport Infrastructure and Initiatives in Region A

Strategic Public Transport Network (SPTN)
The high car ownership levels within Region A constitute some of the factors that contribute towards the severe traffic congestion and car related pollution within the region. The other factors include the region's central location between Johannesburg and Pretoria and; the region's major nodes that provide employment opportunities thereby attracting traffic from beyond the regional and municipal boundaries.

The Strategic Public Transport Network is one of the initiatives by the City to improve accessibility, mobility, encourage the use of public transport and, reduce traffic congestion. The SPTN is based on a network of routes along the City's primary mobility spines linking and enhancing accessibility between residential departure points and nodal destination points. The physical features of the SPTN include:

- Dedicated lanes if traffic volumes warrant it.
- A network to give priority to public transport, e.g. High Occupancy Vehicle Lanes.
- Park and ride facilities.
- Public transport facilities focussed at nodes.
- Transfers at identified interchange nodes.

Roads in Region A where public transport routes are proposed in terms of the SPTN include:

- Pelindaba Road
- K101
- William Nicol Drive

These routes are identified in the Sub Area Management Tables in Section 4. No additional density will be applied for erven affected by the proposed SPTN routes. Additional densities in terms of the SDF guidelines will be considered along Rivonia Road Phase 1 BRT route.

Bus Rapid Transit (BRT)
In November 2006 the City approved the upgrading of the SPTN to a Bus Rapid Transit (BRT) System which is defined as a "high quality bus-based transit system that delivers fast, comfortable and cost-effective urban mobility through the provision of segregated right-of-way infrastructure, rapid and frequent operations, and excellence in marketing and consumer service" (Wright and Hook, 2006 in Rea Vaya Scoping Study).

BRT is not a move away from the SPTN, but a more aggressive system based on similar principles to the SPTN. Aspects of the SPTN have been retained to work in conjunction with BRT systems and routes.

The long-term vision of the BRT is to have a transport system that places more than 80% of the population of the City within 500m of the BRT route or its feeder system. This will achieve a goal the City has of improving the quality of life of citizens of the City by providing them with a high quality and affordable public transport system.

The BRT system consists of a hierarchy of three routes, namely BRT trunk routes, complimentary routes and feeder routes.

The full phase 1 BRT routes impacting on Region A are:

1. Lenasia to Sunninghill.

To support the BRT initiative, the City will actively support higher density residential development proposals along the routes and at nodal destination points. The City has approved land use and design principles in February 2008, for the northern extent of phase 1, i.e. Parktown to Sunninghill (see plan and relevant Sub Area Management Tables in Section 4). Most of the BRT station locations have been finalised and further work on the BRT Land Use guidelines has been completed for the entire phase 1. Rivonia Road is the only road in Region A that is affected by the BRT system. The

implementation of the BRT Phase 1B, which affects the Region, has been refined and as such the route from Parktown to Sunninghill is planned for implementation in the longer term.

Gautrain
Currently Region A has no rail transport system. This is to change with the current construction of Gautrain Rapid Railway Link that will connect the Johannesburg Central Business District, Rosebank, Sandton and Midrand with OR Tambo International Airport and the City of Tshwane. The introduction of a high-speed rail system will add great economic value and will assist in alleviating traffic congestion in the region.

The minimum frequency of trips between Johannesburg and Tshwane will initially be six trains per hour in each direction and will operate approximately 18 hours per day. This public transport service will include dedicated, exclusive bus services to transport passengers to and from stations along defined routes.

One station is to be constructed in Region A at Midrand along K101. It is foreseen that the link between Sandton and the City of Tshwane, affecting the Region at Midrand, will be completed by March 2011.

The development of the station will concentrate commuters in the nodes concerned and will provide impetus for further economic opportunities and growth within these areas. Furthermore, opportunities will arise within the node to accommodate commuters who rely upon the Gautrain to access other parts of the province.

The physical, spatial and economic integration of the Gautrain Station precinct with surrounding areas and initiatives such as Greater Ivory Park and the proposed Zonkizizwe development on the Old Mutual Property land is crucial for its success. The Urban Development Framework addresses the strategic integration of the Gautrain Station at Midrand into the existing urban environment.

The stations and the proposed road based distribution network will align closely to the Strategic Public Transport Network. The Gautrain will provide another alternative to car-based transport and will contribute directly to addressing traffic congestion in Region A, specifically along the N1 highway.

Non Motorised Transport
A framework for Non-Motorised Transport (NMT) was adopted in February 2008, which seeks to guide the planning and implementation of programmes and facilities for the multiple needs of NMT users.

NMT includes all forms of transportation that is human powered. This includes walking, cycling, rickshaws, wheelchairs, animal-drawn carts and recreational activities such as equestrian sports, rollerblading, skating and scooters. In Johannesburg, non-motorised forms of transport are predominantly represented by walking and cycling modes.

The strategic objectives of the NMT framework are to:

- Establish a dedicated network of high quality pedestrian and cycling routes across the city.
- Establish pedestrian and cycling modes of transport as preferred modes for short distance and convenience related trips within the City.
- Increase the percentage modal split of cycling and walking as preferred modes of transport.
- Facilitate access to the city for marginalized and low income communities.
- Integrate NMT modes with other strategic public transportation initiatives within the city including the Gautrain, Metrorail and BRT.
- Promote increased access to educational institutions by NMT modes.
- Place NMT at the forefront of congestion and environmental management plans within the city.
- Maximise local economic development opportunities related to cycling.
- Maximise tourism opportunities related to NMT.

NMT is recognised as an important factor in supporting public transport, functioning both as a feeder to public transport nodes and enabling safe and easy access to key activities surrounding public transport nodes. It is acknowledged that good linkages to stations and a high quality public environment are crucial in supporting the investment currently being made in public transport infrastructure. A good public environment encourages people to use public transport and facilitates walking to and from the station and instils a sense of permanence, therefore economic investment in the City.

The framework for NMT identifies numerous priority areas throughout the city including all Gautrain stations and BRT phase 1 stations. These align with GMS priority areas for infrastructure investment and densification.

The priority areas in Region A are illustrated on the strategic route maps in Section 3 and includes:

- Diepsloot to Fourways Route along William Nicol Drive.
- Ivory Park to Schools and Midrand Route.

Plan 8. Movement

Plan 9. Proposed Roads – Region A

Plan 10. Non Motorised Transport

3.1.3. Ensuring Strong Viable Nodes

The Nodal Strategy is premised on the clustering of various activities at appropriate and accessible nodal locations to provide the City with a network of opportunity centres. Nodes are locations of concentrated activity. They are associated with the concentration of employment opportunities and high-density residential developments that are located along Mobility Roads and Spines. As such, nodes act as destinations points for public transport.

The Nodal Strategy uses a Nodal Hierarchy to define the City's nodes and to describe the management approach to these nodes.

Specific aspects of the nodal management guidelines are detailed below in the discussion pertaining to the major nodes in Region A and in the relevant Sub Area Management Tables.

The nodes in Region A are critical in maintaining the economic prominence enjoyed by the City. The table below considers the metropolitan, regional, district and specialist nodes located within Region A as defined in terms of the Nodal Hierarchy.

Table 6: Application of the Nodal Hierarchy in relation to Region A

. **Metropolitan Node**	**Regional Nodes**	**District Nodes**	**Specialist Nodes**
▪ Midrand	▪ Sunninghill ▪ Fourways ▪ Waterfall City (emerging)	▪ San Ridge Square ▪ Carlswald Lifestyle Centre ▪ Cedar Square ▪ Diepsloot	▪ Kya Sands ▪ Lanseria ▪ Diepsloot Government Node ▪ Bambanani

A further category of nodes that affects Region A is neighbourhood nodes. These serve the immediate residential area wherein they are located, and are often located on Mobility Roads. In Region A there are a large number of such nodes (Table 7).

Metropolitan Nodes

These nodes are of metropolitan significance in terms of attracting people from areas beyond the metropolitan boundaries of the City. They have a distinct urban profile and are situated on Mobility Spines supported by Mobility Roads with access to highways. A variety of goods, services and speciality products are offered at these nodes.

The ongoing redevelopment of these nodes is paramount. It is critical that the growth of the metropolitan node is managed in order to ensure access and circulation and to ensure that the interface with neighbouring areas is protected.

Midrand is the only Metropolitan Node in Region A.

Midrand

The Midrand node is identified as a metropolitan node in the SDF. It is characterised by a wide range of land uses such as residential, industrial, retail and commercial developments that are supported by civic and service amenities. The node is located along two major arterials connecting the City of Johannesburg and the City of Tshwane. It has, in the last decade, seen significant growth in the information and telecommunications industries, high-tech and light industries, the corporate office market, and a relatively smaller retail component. The residential component of the node is increasing on an annual basis.

In terms of mobility, roads are performing at peak capacity with extreme congestion experienced along the major north-south links. The increasing residential infill developments west of the N1

warrant the need to improve the east-west linkages in order to encourage the maximum utilization of the node. For this reason a development framework has been formulated to provide development direction for the Midrand Station Precinct, namely the Midrand Gautrain Urban Development Framework (2008).

The critical strategic planning issues for the Midrand node are:

- The implementation of the Midrand Gautrain Station Development Framework
- The lack of a defined core of the node.
- The decline in the number of shopping centres within the node.
- The need to increase infrastructure capacity to promote intense residential densities west of the N1 within the metropolitan node.
- Improving and expanding pedestrian connections within the node.
- Integrating the Gautrain Station development with the Midrand node.
- Upgrading the public environment.
- Integrating the disparate precincts that comprise the node.
- Promoting high-density residential development within the node.
- Addressing traffic congestion within the metropolitan node.
- Improving public transport facilities as part of the SPTN.
- The confinement of large-scale retail facilities within the nodal boundary.

Regional Nodes

These nodes serve specific regions or sub-regional areas. These nodes are situated on Mobility Spines supported by Mobility Roads and fulfil a variety of functions.

Current regional nodes in Region A are Sunninghill and Fourways.

Sunninghill

The Sunninghill node is characterised by a large concentration of offices, mainly in the form of office parks, including Sunninghill Office Park, Unisys Park, The Crescent and Ariel Office Park. A growing residential demand has seen a number of high-density residential developments emerging in the Node. Sunninghill Hospital as well as religious facilities, post office and pre-schools are also located within the node.

The critical strategic planning issues for the Sunninghill node are:

- Limited Social Facilities.
- Improving and expanding pedestrian connections within the node.
- Roads upgrade to address congestion.
- Promote high-density residential development within the node.
- Improve public Transport Facilities in relation to BRT and its integration with other modes of transport.

Fourways

The Fourways node is characterised by major office developments such as Fourways Office Park, Fourways Golf Park, and Fourways Boulevard as well as retail and residential uses. Commercial developments include Fourways Crossing shopping centre, Fourways Mall regional shopping centre, Fourways Value Mart, Pine Slopes and the Monte Casino Gaming and Entertainment centre.

The critical strategic planning issues for the Fourways node are:

- Define the southeastern extent of the Fourways node.
- Contain non-residential development to the node.
- Protect against non-residential intrusion into residential areas.
- Support residential densification within the nodal boundary.
- Support the development of an internal shuttle for the Fourways node.
- Support the development of a network of pedestrian walkways within the three quadrants that make up Fourways node.
- Promote high-density residential development within the node.
- Facilitate the implementation of non-motorised transport route.

District Nodes

These nodes serve one or more neighbourhoods (Sub Areas). They are predominantly located on Mobility Roads. Activities are of a local nature providing for convenience, daily needs and social services. Pedestrian access is relatively easy.

The City of Johannesburg's policy towards district nodes in Region A is to ensure that they are contained within their delineated boundaries. Access to nodes via public transport and residential densification in support of public transport will be a critical guiding factor. Intensification of non-residential uses will be permitted in district nodes in conjunction with ongoing revitalisation of the node.

The district nodes within Region A are:

- San Ridge Square.
- Carlswald Lifestyle Centre.
- Cedar Square.

The guidelines for the development of district nodes are as follows:

- In support of the SPTN ensure that adequate provision is made for public transport in District Nodes and that development is integrated with the public transport facilities.
- Non-residential development to occur within nodes (offices, retail, institutional) and must be strengthened and encouraged in order to give further legibility to the node so that the node is developed as a destination.
- Residential densification in nodes will be supported in order to contribute to the development of vibrant nodes, and if applicable, the development of the proposed public transport network.
- Intensification of uses within district nodes is subject to the availability of services and infrastructure.

The bulk infrastructure and height requirements should be applied to proposed developments in accordance with the site-specific requirements of the development applications, any precinct plan and town-planning scheme that may be applicable.

Neighbourhood Nodes

Mixed-use neighbourhood nodes are nodes that serve a neighbourhood (township) and may even serve adjacent neighbourhoods. Neighbourhood nodes provide for daily needs, based primarily on convenience related services and products such as:

- Social and community facilities (i.e., libraries, crèches, etc).
- Open space.
- Doctor's consulting rooms.
- Convenience related shopping/services, which may include but are not limited to uses such as convenience grocers, dry cleaners, butchers, local fruit and vegetable shops, Laundromat and video rental stores.
- Public garages.
- Restaurants, coffee shops and take-away shops.
- Hairdressers/beauty parlours.

Region A has a number of neighbourhood nodes, which vary in size and function. The Spatial Development Framework 2010/2011 (Section 5.2) outlines some of the current challenges for this nodal type across the City, which the RSDF is attempting to address.

The following principles as outlined in the nodal guidelines of the SDF detail the City's approach towards neighbourhood nodes:

- Discourage the development of new neighbourhood nodes beyond identified locations.
- Support the redevelopment of existing neighbourhood nodes.
- Integrate new nodal development with public transport and the SPTN where possible.
- Ensure a balance between parking at the node and public transport infrastructure.

- Residential densification is encouraged within, adjacent and contiguous to an existing neighbourhood node.

The list below illustrates the neighbourhood nodes, which are not in any way exhaustive. Section 4 provides more detail information relating to the management guidelines for neighbourhood nodes and include, but are not limited to:

- Design guidelines.
- Guidelines on whether to expand or contain the nodes.
- Desired land uses within the nodes and land use controls where appropriate.
- Desired land uses in the surrounding area.
- Land use controls.
- Specific density requirements around the nodes

Where reference is made to neighbourhood nodes in the Sub Area Management Tables, cognisance should be given to the above-mentioned principles and management guidelines. The neighbourhood nodes which have not been discussed in length in the Sub Area Management Tables is part of a longer term project to identify and establish management guidelines in terms of each node's characteristics and needs, which will be incorporated into subsequent reviews.

Table 7 . Identified Neighbourhood Nodes

SUB AREA	NEIGHBOURHOOD NODE	AFFECTED TOWNSHIP
10	Kopanong Shopping Centre	Ivory Park
10	Ebony Park Mall	Ebony Park & Ivory Park
10	Rabie Ridge	Rabie Ridge
10	Lord Khanyile Sports Complex	Ivory Park
10	Swazi Inn	Ivory Park
10	Proposed Yarona Shopping Centre	Kaalfontein
10	Noordwyk Centre	Noordwyk
5	Midway Mews	Halfway House Ext 2, Halfway Gardens
6	Vorna Valley	Halfway Gardens Ext 12, 13, 7; Vorna Valley Ext 71, 75, 48, 62; Kyalami Hills Ext 3, 4
6	Halfway Gardens	Halfway Gardens Ext 40, 25, 13, 1; Vorna Valley Ext 80
6	Crowthorne	Crowthorne A. H.
11	The Bridge	Buccleuch
7	Sunninghill Village	Sunninghill & Sunninghill Ext 3
7	Sunhill Centre	Sunninghill
7	The Square	Sunninghill
7	Chilli lane Centre	Paulshof A.H. Ext 3
7	Cambridge Crossing	Paulshof Ext 1, 45
4	Fourways Gardens Centre	Fourways Ext 10; Witkoppen Ext 3
4	Waterford	Craighavon A.H.
4	Riverwalk	Maroeladal Ext 19
4	Valley Shopping Centre	Dainfern Ridge
4	Lonehill Shopping Centre	Lonehill Ext 9, 8
4	The Fern	Dainfern
3	Diepsloot	Diepsloot West
1	Hertford Junction	Farm Bultfontein 533-JQ
4 & 2	Broadacres Shopping Centre	Needwood, Stratford, Needwood Ext 4, Maroeladal Ext 8

Specialist Nodes

Specialist nodes are of a specialised nature in terms of being used for a single retail, entertainment, commercial or industrial use. Region A has three specialist nodes of an industrial nature.

The **industrial nodes** in Region A are:

- Kya Sands
- Lanseria
- Kyalami.

It is critical that the services, infrastructure and high levels of access are maintained to ensure that these nodes can maximise their economic potential. The City understands the importance of promoting the successful development of its economic base by directing industrial activities to the most competitive locations, so that these sectors may flourish and create employment opportunities for city residents.

A Study on Industrial Land has been completed and it:

- Specifies the industrial uses with growth potential in Johannesburg.
- Identifies competitive location for industrial uses to grow.
- Examines existing industrial areas and identify the highest and best uses for older industrial zones.
- Recommends policies, programmes, incentives and strategies required to resolving key issues in the supply of industrial land and in the development of older industrial zones.

The study uses four categories of industrial nodes to illustrate potential and priorities. These categories are: the expansion of existing industrial nodes, the regeneration of existing industrial nodes, and the change in zoning away from industrial to new industrial areas. Two of these categories apply to Region A. The implications for Region A's industrial nodes are as follows:

Expansion of existing industrial node/zoning: Nodes prioritised for sample assessments of potential expansion in Region A include the Kya Sands/Hoogland, which is partly in Region C.

Kya Sands/Hoogland/Mosteyn Park Area: Residential uses are rapidly filling-in to areas surrounding Kya Sand and there is the likelihood that this area will become an "island" in the near future, with all of the attendant long-term issues. There are proposals for additional industrial development in the area and if land is zoned for industry to the north and west, then there is the opportunity for expansion and greater sustainability over the long-term. Ideally, such areas on the urban fringe should not be promoted for industrial development unless they offer significant competitive advantages. Such promotion is not truly environmentally sustainable. Due to the prospective development eventually putting a strain on infrastructure capacity in this area, the Kya Sand area has been ranked lower than some of the other prospective expansion nodes.

Change of Zoning Away from Industrial: Several nodes were prioritised throughout the city for examining the potential for a change away from industrial use. Lanseria Airport in Region A was identified as one of the nodes.

Lanseria Airport Area: Lanseria's designation as an international airport has added to speculation that it could become a hub for new industrial and other development. Whilst the airport is likely to spin-off a moderate amount of industry over time (to compliment the base that is already there), there is no other competitive advantage to this location for industrial development.

It is suspected that such development would occur mainly because there are so few other "Greenfield" locations for industry. The airport is relatively isolated from other parts of the urbanised area and massive development there will exacerbate infrastructure constraints. Whilst there will be a need for employment opportunities near the emerging Cosmo City, Lanseria is located in the opposite direction from normal commuter movement patterns. Fiscal and other resources will be stretched and diverted to such newly developing areas and away from existing business nodes and urban infrastructure.

Even if the developers propose to build their own sewer system, it will require maintenance (along with roads, water, storm water, power, and other infrastructure) in perpetuity. Whilst it is extremely important to encourage the development of new industrial areas, such areas should ideally be oriented to expansion (and linkage) of existing industrial nodes, or located centrally within an existing infrastructure corridor where they help meet both economic development and planning objectives.

Locating new industrial (let alone residential) development on the urban fringe is unsustainable. There is a need to conduct a fiscal cost-benefit analysis for development in this area to ensure that it would generate a net fiscal benefit to the City of Johannesburg, if such massive developments were allowed to go ahead industrial development should be limited to aviation and agricultural-related activities within the area immediately surrounding the airport.

Plan 11. Nodes

3.1.4 Increased Densification of Strategic Locations

The City seeks to promote strategic residential densification across the regions in order to promote a more compact urban form.

Strategic densification is promoted:

- In and around acknowledged and defined nodes – as per SDF classification and relevant Development Frameworks/Precinct Plans.
- Along transport routes, notably the Phase 1 BRT routes, Gautrain Stations, Mobility Spines and Mobility Roads in support of public transport.
- Within areas of focussed public-sector investments (e.g. Midrand Station Precinct, Greater Ivory Park, Greater Diepsloot Area).
- In selected areas of strong private sector investment and economic activity as highlighted in the RSDFs.

Residential densification in Region A is promoted within nodes; along critical mobility routes; in relation to low-income housing initiatives and; in consideration of the site specifics requirements of a given application.

Densification must go hand in hand with the provision of housing solutions for low to middle income earners. Residential development must contribute to the development of a compact city.

As discussed above the mixed-use nodes in Region A are identified as key areas for residential densification.

There is a number of Mobility Roads, Spines and Activity Streets in Region A, as detailed above, where increased residential densities would be considered. Similarly, the phase 1 BRT route along Rivonia Road is eligible for increased densities. Other proposed Strategic Public Transport Network routes will not be eligible for the increased densities until such routes are in the planning and design phases.

In Region A, increased densities relating to subsidised housing will relate to the provision of housing solutions for low to middle income groups, especially in eradicating informal settlements such as Diepsloot.

Specific areas identified for the promotion of strategic residential densification relating to the GMS Priority areas in Region A are:

- Midrand Gautrain Station Precinct
- Sunninghill Node
- Diepsloot and Ivory Park (infill)

NB: Motivations for densification proposals on proposed / planned new roads will only be considered where there is Medium-Term capital commitment by the implementing authority.

For further information relating to strategic densification refer to the SDF.

3.1.5 Initiating and Implementing Corridor Development - North/South Development Corridor (NSDC)

The development of corridors has been identified as a potential instrument to restructure the City into robust, efficient and well-connected urban areas, as well as contributing to city wide economic growth and job creation. This can be achieved by unlocking inherent and under-utilised economic and social development potential with existing nodal development, (current and proposed) road and rail infrastructure.

The North South Development Corridor (NSDC) is one of two city corridor initiatives that have been developed to facilitate the social and economic restructuring of strategic sections of the City. It extends from Orange Farm, north via Lenasia and Soweto to the central anchor point of the CBD. From the CBD it continues north through Sandton to Midrand. It extends beyond the municipal boundaries to Sedibeng to the south and Tshwane to the north.

Region A forms part of the central-north section of the NSDC, which is characterised by a high degree of investment, economic development and associated employment opportunities. Private transport dominates in this section and congestion is the main constraining mobility factor. The development of the corridor in Region A will aim at facilitating private investment through strategic public spending (Midrand Gautrain Stations) (see Section 5). Major movement lines that are incorporated in the NSDC in Region A include:

- The N1 Highway.
- Rivonia Road arterial.
- Louis Botha Avenue/Eastern Service Road/Pretoria Main Road.
- The Gautrain route.

The opportunities focused upon in terms of the NSDC include:

- Utilising and upgrading existing infrastructure and amenities.
- Reinvestment and the identification and execution of development possibilities.
- Undertaking densification at strategic locations if services are available.
- Capitalising on redevelopment of Midrand and Sunninghill as a result of the development of the Gautrain and BRT respectively.
- The promotion of further economic growth and development.

3.1.6 Supporting Sustainable Environmental Management

The Environmental Strategy promotes the effective management of the City's environmental resources to develop a sustainable and quality living environment for all. Defined open spaces function as ecological, social and institutional structuring elements that contribute directly to the preservation of the City's heritage.

The guiding principles of the Integrated Environmental Management Framework apply to all land developments within the City.

The Johannesburg Metropolitan Open Space System (JMOSS) lays the foundation of an inter-connected and managed network of open spaces supporting interactions between social, economic and ecological activities, sustaining and enhancing both ecological processes and human settlements. The objectives of JMOSS are important considerations for spatial planning processes to ensure sustainable development.

In Region A, environmental management, more specifically the management and further development of open spaces, is an important issue given the region's natural environment quality. The region is host to the Greater Kyalami Conservancy (GECKO) area and stretches across the central area of the region. This conservancy area is also host to a large equine industry. Moreover, there are areas in the region such as Diepsloot and Ivory Park, where the quality of open spaces are generally poor and need to be upgraded. As such, the development and maintenance of open spaces, especially within key nodes and along key mobility roads, is critical. Similarly, the conservation of existing ecological open spaces within the region, and the identification of potential ecological open spaces are important.

The environmental policy issues relating to the management of open spaces and, to development applications close to watercourses and ridges apply.

Water Courses
The following requirements apply:

A buffer of a minimum of 32 metres each side of the watercourse edge (or greater as is necessary to maintain ecological functioning) shall be provided adjacent to all wetlands and watercourses. The 1:100 year flood-line should be respected at all times.

Wetlands are also an integral part of the ecological network and a study has been undertaken to identify wetlands in the City. Wetlands are indicated on the JMOSS plan for information purposes, to ensure that developments and development applications take them into account. The City of Johannesburg's Department of Environment can be contacted for further information.

Ridges (i.e. Rietfontein Ridge)
Development on ridges should not be allowed. Where development is considered, it should be subject to certain conditions (i.e. ecological audit or an environmental impact study). Furthermore, a 200-metre buffer should be reserved between the foot of the ridge and the proposed development.

Johannesburg Open Space Framework
As densities increase, the need to preserve and manage the finite open spaces is increasingly important. In Region A, this is an important consideration, because of rapid development and existing backlogs of open spaces.

The City has completed its Open Space Framework, which provides a policy framework that is linked to a GIS support tool for open spaces in the City. Development guidelines relating to open spaces are contained within the Open Space Framework and the SDF. Developments must address and conform to these guidelines in the conceptualisation, design and construction phases.

Environmental Management Frameworks
The City's Department of Environment has developed an Environmental Management Framework (EMF) for Kyalami and Modderfontein. The framework identifies sensitive environmental areas and prescribes parameters for the development of the areas concerned. Future development must support the protection and enhancement of environmentally sensitive areas that have been identified by the Environmental Management Framework.

Table 8 below highlights the environmentally sensitive areas in the Region.

Table 8. Environmentally Sensitive Areas in Region A

Ridges	Rietfontein Ridge.
Wetland	▪ Farm Waterval ▪ Lanseria ▪ Blue Hills ▪ Kya Sands ▪ Fourways ▪ Diepsloot
Egoli Granite grassland	▪ Farm Waterval ▪ Farm Nietgedacht ▪ Lanseria
Conservation Areas	▪ Rietfontein Ridge Conservation Area. ▪ Glen Austin Pan.
Dyke	
Dolomitic Areas	▪ Ivory Park ▪ Kaalfontein
Previously Mined Areas	
Bushbaby	▪ Craigavon Salfred

	Witkoppen Fourways
Giant Bullfrog	▪ Glen Austin Blue Hills Witpoort ▪ Farm Nietgedacht

Plan 12. Johannesburg Metropolitan Open Space System

3.1.7 Facilitating Sustainable Housing Environments in Appropriate Locations

The Housing Strategy aims to facilitate fundamental change in the City by promoting the provision of sustainable human settlements that are in close proximity to economic opportunities and social amenities. Appropriate housing typologies meeting a range of needs throughout the City are a pre-requisite to a City that is accessible, efficient and sustainable. Beyond the provision of accommodation, new housing delivery must address the provision of adequate social and economic amenities to ensure the concept of sustainable housing environments.

The City's Housing programmes form the basis of the City's delivery targets of developing 100 000 units by 2011. These units must be made available to include a range of tenure options and typologies. In Region A, the greatest housing backlogs are in Diepsloot, Ivory Park and numerous informal settlements within the region. Projects to facilitate sustainable housing environments that cater for a range of economic needs have been initiated by a range of State entities.

Part of the City's housing strategy is to develop a policy for inclusionary housing. Inclusionary housing is currently defined as "Inclusionary Housing seeks to fill gap between provision of subsidised public housing and private housing provision by leveraging off private residential developments. The provision of subsidised housing remains the core responsibility of State but is included in the definition of affordable housing and the tenets of Inclusionary Housing Policy." Due to the large number of informal settlements in the Region, private large-scale developments need to consider catering for this gap market in order to achieve sustainable housing environments in the Region. Section 5.6.4 in the SDF details the City's current position on inclusionary housing.

Table 9. Current Housing Projects in Region A

	Project Name	No. of Units
1	Diepsloot West Ext. 5	800
2	Kya Sands	2411
3	Lion Park	10239
4	Ivory Park Consolidation	14000

3.1.8 Managing Urban Growth and Delineating the Urban Development Boundary

The Urban Development Boundary is one of the growth management tools used by the City Of Johannesburg. The main purpose of this tool is to curb the costly peripheral expansion of the City and to direct growth towards the presently serviced and priority service areas of the City. The Northern Areas Development Framework proposed amendment of the UDB, which is now effected. However there are very specific conditions attached to these proposals, which are outlined below:

- Linkage to the Land Use Budget estimates for settlement expansion up to year 2020.
- Containment of urban sprawl and the promotion of infill and densification.
- The creation of corridors along primary routes.
- To allow for expansion of affordable housing projects, such as Cosmo City, and the formalisation of informal settlements, such as Nooitgedacht.
- The cost implications of establishing new infrastructure for new township developments in remote areas.
- The conservation of environmentally sensitive areas.
- The protection of high-potential agricultural land where applicable.
- Provision of inclusionary housing.
- Full provision of bulk engineering services by developers in areas of insufficient capacity.
- Social amenities that cannot be accommodated within the Urban Development (including Schools, Clinics, Cemetery, Religious facilities).

Riverglen Extensions

The City takes cognisance of the rights granted on Riverside View Ext. 9. These rights were gained via the Development Facilitation Act (DFA). The City has been active in negotiating how this development can be accommodated and developed given infrastructure and other developmental issues on the properties affected. These negotiations have included discussions with neighbouring

proposed and planned developments and the respective service utilities to ensure co-ordinated planning and infrastructure development.

For the purposes of this review, contingent on the successful outcome of discussion relating to infrastructure in the area, the properties affected will be considered as being within the UDB and considered to be an Expansion Area in terms of the City's Growth Management Strategy. The formal amendment of the UDB will be considered in the relevant SDF review once the on-going discussion and deliberation with the City and service providers has been concluded. In considering the application, the City is cognisant of the following:

- Inclusionary Units to be made available on site (and in line with the City's definition of Inclusionary housing).
- Land donations for subsidised housing initiatives in the north.
- The Developers undertaking to management of Porcupine Park.

Criteria for Development within and beyond the Urban Development Boundary
Development **within the City's UDB** will be considered in terms of their compliance with prevailing RSDF (and their inherent Sub Area Management Tables), applicable Development Frameworks, Precinct Plans and schemes for a specific area as well as the Growth Management Strategy.

Land located **beyond the City's UDB** is predominantly rural and agricultural in nature. Naturally, the concurrent land uses tend to be of a lower-intensity and density. There are however areas where the distinction between urban and rural is blurred.

Development outside the UDB will be considered in terms of compliance with the following criteria:

- Agriculture: purposes normally associated or reasonably necessary in connection with agricultural purposes. This includes only dwelling units related to the agricultural use of the property.
- Conservation Areas and Nature Reserves: Areas designated for nature conservation, which may include tourism facilities (accommodations/restaurants) and recreational facilities directly related to the main use.
- Tourism and recreational related facilities: Outdoor and tourism related activities including hiking trails, hotels, 4x4 trails, restaurants, curio markets, conference facilities, wedding venues, game lodges and other similar uses with a rural character not causing a nuisance or having a detrimental effect on the environment.
- Farm stalls.
- Rural residential uses and agricultural holdings.
- Any other related development or service, provided that the proposed development:
    - Services primarily a local market; or
    - Is located at a service delivery centre or central place to the community.

Proposed activities that conform to the above land use criteria will be further evaluated noting whether:

- The development is in an area that has been identified to be ecologically sensitive or contains Red Data Species – proposals would not generally be supported in these instances.
- The development would have a detrimental effect on the environment – applicable environmental legislation will prevail.
- Bulk infrastructure capacities would be exceeded – proposals would not generally be supported in these instances.
- The development will be in keeping with the character / ambience of the surrounds.

The subdivision of land outside the UDB will only be allowed if it complies with the following criteria and associated table:
Compliance with land use criteria noted above.

- Division is within the parameters of the subdivision of land.
- An existing second dwelling is not the primary motivation for the subdivision.

- Subdivision of productive agricultural areas with agricultural potential should only be allowed in special circumstances and only with the written consent from the National Department of Agriculture, Forestry and Fisheries.
- Where a subdivision is motivated because of a road, river or servitude physically severing land, the reason for the severance should be proven. The provision of services and registration of servitudes should be to the satisfaction of the local authority.
- There shall be no obligation on Council or MOE's to render services in any form whatsoever.

Table 10. Subdivision of Land

Category	Size	Min Portion
Minor	4ha and below	1 Morgen (+/- 0.8ha)
Intermediate	4ha - 10ha	1 ha
Major (a)	10ha - 20ha	2 ha
Major (b)	20+ha	4ha

It is important to note that once a property has been divided in terms of the criteria above, it may not be further subdivided again unless there is a material change in circumstance within the broader area that would necessitate a review of the UDB. This condition is to be included in all division of land application approvals.

Plan 13. Urban Development Boundary

3.2. Promoting Innovative Governance Solutions

In order to contribute to achieving the principles of the Growth and Development Strategy through the spatial restructuring of Region A, there are a number of processes and relationships that need to be strengthened and defined. These are:

- The relationship between the City of Johannesburg, the Province, National Government and key stakeholders in Region A, in order to ensure that the development programmes within the region achieve their key objectives.
- Strengthening the relationship between the City of Johannesburg, City of Tshwane, Mogale City Local Municipality and the City of Ekurhuleni concerning the following issues:
    - Demarcation and municipal cross border issues (e.g. the management of the Ivory Park / Tembisa interface area by the City of Johannesburg and the City of Ekurhuleni).
        - Environmental management.
        - Key municipal projects such as:
            - The development of the Swazi Inn precinct.
            - The proposed Cradle City Development.
            - The implementation of the Bus Rapid Transit
            - The introduction of the Gautrain Rapid Rail Link.
- Building relationships with developers and property owners to ensure the sustainable development of Greenfield sites.

3.3 APPROVED PRECINCT PLANS/DEVELOPMENT FRAMEWORKS APPLICABLE TO REGION A

For further details regarding these precinct plans and development frameworks, refer to the original precinct plan documents, and to the Sub Area Management Tables in Section 4 of the RSDF.
The approved precinct plans and development frameworks that are applicable to Region A are:

- The Erand Precinct Plan.
- The Glen Austin Development Plan.
- The Sunninghill Node Precinct Plan.
- The Fourways North East Precinct Plan.
- Northern Areas Development Frameworks, 2008
- Bambanani Industrial Node UDF, 2008
- Midrand Gautrain Station UDF, 2008
- Diepsloot Government Precinct UDF, 2008
- Diepsloot Activity Street UDF, 2008
- Diepsloot District Node, 2008
- Swazi Inn Development Framework, 2008

The urban development frameworks that were approved in 2008 and 2009 are summarized below:

3.3.1 Midrand Gautrain Station UDF, 2008

The Midrand Gautrain Station UDF encourages mixed land uses within and around the station precinct. It further promotes the use of public transport by providing effective public transport services with appropriate supporting vehicle and pedestrian links. The UDF supports a variety of business activities and other ancillary land uses such as a Gautrain Visitors' Centre. Strategic densification within the station precinct is supported in order to encourage the proper functionality of the rail station.

The UDF promotes the use of buses, taxis, and non-motorised transport, as well as pedestrian movement. The UDF proposes parking facilities that will enable the station to be an integrated transport hub. The UDF supports a public urban park and a market square to house a range of informal trading facilities.

3.3.2 Bambanani Industrial Node UDF, 2008

The Bambanani Industrial Node UDF promotes the concentration of mixed land uses (such as industrial and commercial land uses) within the industrial node that will contribute towards revamping the node, attracting investment into the area, supporting local economic development and, creating

employment opportunities for residents of Greater Ivory Park. The UDF supports incubator businesses, warehousing, manufacturing, offices, and retail.

The overall vision of the UDF is to establish a central business district for Greater Ivory Park that is comprised of two existing nodes, one proposed node and the Bambanani Industrial node. The UDF promotes the utilisation of public transportation, thereby proposing the taxi rank upgrading. It further promotes pedestrian and cycling movement in support of the Non-Motorised Transport strategy.

3.3.3 Diepsloot Government Precinct UDF, 2008

Diepsloot Government Precinct aims to revitalize the Diepsloot West area by giving order to the land uses within this area, enhancing the public realm, promoting safety and, effective pedestrian and vehicular flows. The UDF supports the establishment of a defined institutional node with a retail component. Social facilities such as a community youth center, clinic and a police station are among the land uses that are supported by the UDF. Strategic residential densification is also supported within the precinct.

3.3.4 Diepsloot Activity Street UDF, 2008

The Diepsloot Activity Street UDF aims at guiding development along and, providing the strategic functionality of, the activity street. The Diepsloot Activity Street forms a critical connection between the two main east-west collector routes in the northern part of Diepsloot. The activity street is lined on both sides by small business ranging from taverns, spaza shops, and telephone containers to informal trade.

The UDF supports densification along the activity street; promotes a home-based business environment and; encourages the optimum utilisation of public open spaces. It further proposes road, sidewalk, and storm water upgrading to enable easy pedestrian and vehicular flows. The interventions aimed at promoting the use of public transportation include the formalization of taxi facilities.

3.3.5 Swazi Inn UDF, 2009

The objective of the Swazi Inn Urban Development Framework is to provide a set of development principles, as well as specific development guidelines and interventions, to enable the sustainability of the Swazi Inn precinct. The Framework among other interventions identifies Swazi Inn as neighbourhood node and, encourages both first and second economy activities to co-exist. Like the Diepsloot Activity Street UDF, it promotes a home-based business environment.

The UDF proposes road and sidewalk upgrading in order to enhance pedestrian and vehicular flows. Like the Diepsloot Government Precinct UDF, the Swazi Inn UDF promotes safety by proposing increased street lighting and traffic calming measures within the precinct.

3.4 PROPOSED PRECINCT PLANS/DEVELOPMENT FRAMEWORKS APPLICABLE TO REGION A

3.4.1 Diepsloot Development Framework and Business Plan

In 2008 the Johannesburg Development Agency undertook to implement projects in Diepsloot, based on the approved development Frameworks through the National Treasury's Neighbourhood Development Partnership Grant (NDPG) fund. The initial stages of implementation presented a number of challenges due to the lack of an overall spatial and infrastructure framework for Diepsloot. It was established that projects undertaken by the JDA, MOEs and other funders are not consolidated, coordinated or prioritised and are not based on a clear long term plan for the area.

The above-mentioned issue, together with other issues regarding development in Diepsloot, has lead to the initiation of the Diepsloot Development Framework and Business Plan. The plan is to coordinate development efforts and prioritise developments through a comprehensive business plan to ensure sustainable development and expenditure in the area. The scope of work includes, but is not limited to, an overall spatial development framework, which takes cognisance of previous plans

and frameworks, urban design issues, housing and infrastructure plans and programming of capital investment projects in the area.

SECTION 4

SUB AREA DEVELOPMENT MANAGEMENT TABLES

4. SUB AREA DEVELOPMENT MANAGEMENT TABLE

The intention of the development management table is to provide guidance as to how development must take place by taking into account growth pressures within the region. A large number of areas contained in the Sub Area table are guided and managed in terms of the Northern Areas Frameworks[3]. The key components of the frameworks are as follows:

- 8 Sub Area boundaries[4];
- Land use management guidelines that have been packaged into an easy-reference land use management schedule for guiding development applications;
- Land use definitions to accompany the LUM schedule;
- An allocation table for the floor area of micro enterprises; and
- A density bonus programme.

Plan 14.

[3] The Northern Areas Development Frameworks (NAF) for Fourways, Blue Hills and Kyalami has been amended and the changes have been captured in the respective sub area management tables. These will supercede the NAF where specific development indicators/controls have been provided.
[4] The sub area boundaries are functional boundaries that were demarcated for the purposes of the 'Northern Areas Development Frameworks' study

Plan 15. Sub Areas

Plan 16. Northern Areas Development Framework

Table 11. Land Use Management Schedule

Broad Land Use Category	Land Use Category	Zone 1	Zone 2	Zone 3	Zone 4A	Zone 4B	Zone 5A	Zone 5B	Zone 6A	Zone 6B	Zone 7	Zone 8	Zone 9	Zone 10
		Medium-density residential zone	Low-density residential zone	Rural residential zone	Metropolitan mixed-use nodal core	Metropolitan mixed-use nodal periphery	Regional mixed-use nodal core	Regional mixed-use nodal periphery	District mixed-use nodal core	District mixed-use nodal periphery	Commercial and light industrial zone	Airport expansion zone	Institutional zone	Conservation zone
Residential	Very low-density			●										●
	Low-density		●											
	Medium-density	●	●											
	High-density	●			●	●	●	●	●	●				
	Accommodation	●			●	●	●	●	●	●		▼		
Community	Educational	●	●	●		●		●		●			●	
	Medical				●	●	●	●	●	●			●	
	Religious	►	►	►										
	Social			●		●		●		●			●	
Business	Retail				●	●	●	●	●	●		▼		
	Office				●	●	●	●	●	●	▲	▼		
	Entertainment				●	●	●	●	●	●				
	Motor trade					●		●		●	▲	▼		
	Micro enterprise	►		►										
Institutional	Municipal					●		●		●	▲	▼	●	
	Government					●		●		●	▲	▼	●	
Industrial	Light										▲	▼		
	Commercial					●					▲	▼		
Open space	Active	●	●	●		●		●		●			●	
	Passive	●	●	●	●	●	●	●	●	●	●	●	●	●
Agriculture	Agriculture			●									●	●
Minimum FAR		n/a	n/a	n/a	2.4 (4)	0.8 (2)	1.8 (3)	1.2 (2)	0.8 (2)	n/a	n/a	n/a	n/a	n/a
Maximum FAR		n/a	n/a	n/a	4.8	2.4	3.6	2.4	1.6	1.2	0.8	0.8	0.8	n/a
Maximum Coverage		n/a	n/a	n/a	60%	40%	60%	60%	40%	40%	40%	40%	40%	n/a
Maximum Height		4 storeys	3 storeys	2 storeys	8 storeys	6 storeys	6 storeys	4 storeys	4 storeys	3 storeys	2 storeys	2 storeys	2 storeys	n/a
Minimum Residential Density		30 u/ha	10 u/ha	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Maximum Residential Density		160 u/ha	30 u/ha	2 u/ha	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	1 u/ha

Source: Maluleke Luthuli and Associates, 2007

▲ Subject to developers providing own bulk services
▼ Subject to not impeding the future long-term expansion of Lanseria Airport
► Subject to relevant policy document

Development on Portion 119 of the farm Diepsloot (located in Zone 6A) is required to allocate 70% of its floor area for residential use Zone 1 and 3 allow for micro enterprises. Micro enterprises are defined as businesses or enterprises that are attached to and supplement a residential component. The residential component remains the primary land use associated with the property. This definition does not cater for the development of neighbourhood shopping centres. Such centres are better suited for the proposed mixed-use nodes, in particular the District Mixed-Use Nodes. District Mixed-Use Nodes have a 2km service radius, making such centres within easy reach for day-to-day shopping purposes.

Table 12. Micro Enterprise Floor Area Allocation

Land Use Management Zone	Zone 1: Medium-Density Residential Zone				Zone 3: Rural Residential Zone
Number of building storeys	1 storey	2 storeys	3 storeys	4 storeys	n/a
Maximum % of building floor area to be allocated to micro enterprises	5%	7.5%	10%	15%	20%
Ceiling building floor area to be allocated to micro enterprises	Up to a maximum floor area of 500m2 per property				

The Table above provides guidelines for the approval of micro enterprises as part of the township establishment or rezoning application process. The provision of building floor area for micro enterprises is linked to the residential component of the building; requiring the residential floor area to remain the dominant land use associated with the building. The floor area provided for micro enterprises may not exceed 500m^2 per property. Practically, this translates to the following examples:

- A single storey 120m^2 house comprising a 6m^2 hairdresser
- A 2-storey 300m^2 house comprising a 22.5m^2 home office
- A 4-storey 1500m^2 walk-up comprising a 300m^2 café
- A single storey 400m^2 rural residential property comprising a 80m^2 veterinary clinic

Table 13. Density Bonus Programme

Category	Definition	Metropolitan Mixed-Use Node		Regional Mixed-Use Node		District Mixed-Use Node	
		Zone 4A Metropolitan mixed-use nodal core	**Zone 4B** Metropolitan mixed-use node periphery	**Zone 5A** Regional mixed-use nodal core	**Zone 5B** Regional mixed-use node periphery	**Zone 6A** District mixed-use nodal core	**Zone 6B** District mixed-use nodal periphery
Middle income dwelling units	Dwelling units with a unit floor area not exceeding 80m2.	15% added to floor area if 10% of floor area is dedicated to medium-income units, with a 1.5% floor area increase for every percentage increase in floor area dedicated to medium-income dwelling units above 10% and;					
Low income dwelling units	Dwelling units with a unit floor area not exceeding 60m2.	20% added to floor area if 10% of floor area is dedicated to low income units, with a 2.0% floor area increase for every percentage increase in floor area dedicated to low-income dwelling units above 10% and;					
Very-low income dwelling units	Dwelling units qualifying for and accessing the Housing Subsidy and Restructuring Grant within a Restructuring Zone. Zones 1A, 1B, 2A and 2B are considered Restructuring Zones.	25% added to floor area if 10% of floor area is dedicated to very low income units, with a 2.5% floor area increase for every percentage increase in floor area dedicated to very low-income dwelling units above 10% and;					
Community facilities	Including a crèche, primary school, secondary school, tertiary education institution, clinic, day-hospital, hospital, community hall, library, post office, police station or emergency service centre all open to the general public for a minimum period of 15 years.	10% added to floor area if 5% of floor area is dedicated to social facilities, with a 2% density increase for every percentage increase in floor area dedicated to social facilities above 5% and;					
Pedestrian facilities	Including a pedestrian thoroughfare on the property, pedestrian mall on the property, town square on the property or a minimum 2m street-front sidewalk on the property all accessible to the general public for the life-span of the density bonus	0.5m^2 added to floor area for every 1m^2 dedicated to pedestrian facilities and;	0.5m^2 added to floor area for every 2m^2 dedicated to pedestrian facilities and;	0.5m^2 added to floor area for every 1m^2 dedicated to pedestrian facilities and;	0.5m^2 added to floor area for every 2m^2 dedicated to pedestrian facilities and;	0.5m^2 added to floor area for every 2m^2 dedicated to pedestrian facilities and;	0.5m^2 added to floor area for every 3m^2 dedicated to pedestrian facilities and;
Vehicle access	Use of a non-public transport route vehicle entrance, shared vehicle access, service road access or park and ride facility for the life-span of the density bonus	10% added to building floor area for a non-public transport route vehicle entrance or a shared vehicle access or a service road access and 2m^2 added to floor area for every 1m^2 dedicated to a park and ride facility to a;					
Maximum FAR of:		7.2	3.6	5.4	3.6	2.4	1.6
Maximum Coverage of:		60%	40%	60%	60%	40%	40%
Maximum Height of:		12 storeys	9 storeys	9 storeys	6 storeys	6 storeys	4 storeys
Parking reduction		1% parking reduction for every 0.1 FAR earned using density bonus					
Maximum parking reduction:		8%	4%	12%	4%	4%	3%

Source: Maluleke Luthuli and Associates, 2007

Table 14: Land Use Definitions – Northern Areas Framework

Broad Land Use Category	Land Use Category	Land Use Definition	Typical Land Uses
Residential	Very low-density	Land use allowing rural living on agricultural holdings using single dwelling units	Single dwelling unit
	Low-density	Land use allowing traditional suburban living using single dwelling units	Single dwelling unit
	Medium-density	Land use allowing the horizontal and vertical grouping of dwelling units up to 3 storeys in height	Group housing Second dwelling unit Backyard rental unit Semi-detached housing Commune Retirement village Children's home
	High-density	Land use allowing the horizontal and vertical grouping of dwelling units up to 4 storeys in height	Row housing Walk-up apartments Flats
	Accommodation	Land use for the purpose of letting individual rooms for residential accommodation	Boarding house Hotel Guest house Resort Hostel
Community	Educational	Land use where child-care service are provided and where children, adolescence and adults receive formal education	Crèche Pre-primary school Primary school Secondary school Technical school Technical college Skills training centre Satellite campus Adult education centre
	Medical	Land use where patients are given medical treatment or advice	Clinic Community hospital Day hospital Medical consulting rooms
	Religious	Place of worship and religious education	Church Mosque Temple
	Social	Land use that provides municipal or social services to local communities	Community hall Library Post office Pension pay-point Customer care centre Police station Fire brigade Emergency services
Business	Retail	Land use that allows the trading of retail goods	Hypermarket Supermarket Specialist retailers (e.g. clothing and furniture) Banking branches

Broad Land Use Category	Land Use Category	Land Use Definition	Typical Land Uses
	Office	Land use for the performance of administrative or professional functions	Professional offices Conference facility
	Entertainment	Place of entertainment that is usually associated with the retail industry	Entertainment centre Restaurant Fast food outlet Tavern
	Motor trade	Land use that allows the retail, repair and maintenance of motor vehicles	Filling station Vehicle service centre Vehicle showrooms
	Micro enterprise	Business or enterprise attached to and supplementing a residential component. The residential component remains the primary land use associated with the property.	Home office Home-based medical consulting room Non-disturbing home enterprise (e.g. hair dresser or day care centre) Mini market Coffee shop Farm stall
Institutional	Municipal	Land use associated with the daily operation and functioning of the municipality	Administrative offices Parking garage Taxi holding and or parking area Municipal training facilities Bus depot Electrical purpose Equipment stores
	Government	Land use associated with the daily operation and functioning of the national or provincial government	Administrative office Railway reserves and stations Telecommunication
Industrial	Light	Land use for non-pollution industries used for manufacturing purposes	Non-noxious factories Maintenance and repair workshops Engineering works Builders yard
	Commercial	Land use for the handling and storage of cargo and the wholesale of goods	Distribution centre Wholesale trade Warehousing Cartage and transport services
Open space	Active	Open space that has a recreational function linked to it	Public park Play ground Sports field Sports club Cultural heritage site Amusement park Recreation area
	Passive	Open space that has a hazard avoidance or natural resource conservation function	Private open space Conservancy Protected area River flood areas Geological unsuitable land Topographically unsuitable land Hazardous zones (e.g. pollutions areas)

Broad Land Use Category	Land Use Category	Land Use Definition	Typical Land Uses
Agriculture	Agriculture	Land use that is intended of subsistence of commercial farming purposes and uses generally associated with plants and animals.	Subsistence farming Commercial farming Communal agriculture Agriculture skills training facilities Nursery Veterinary clinic Animal kennel

4.1. SUBURBS PER SUB AREA

In order to deal with the application of the region-wide goals, objectives and development strategies regarding movement, activity and the environment, it was necessary to divide Region A into 12 Sub Areas, based on the following criteria:

- The area covered by community submissions.
- Homogeneity in residential density and character/requirements.
- Land use homogeneity.
- Natural/environmental features.
- Economic investment.

NB: Development applications should be guided and approved in line with the GMS, Movement, Nodal and Density Strategies. Where applicable, the following strategies shall apply: UDB, JMOSS, IEM, NMT, SHS and relevant UDFs.

Table 15. Sub Area Management Table – List of Townships

LIST OF TOWNSHIPS AS PER ALPHABETICAL ORDER	
Airdlin A.H.	Sub Area 7
Barbeque A.H.	Sub Area 6
Barbeque Downs	Sub Area 7
Barbeque Downs Ext 5	Sub Area 6
Beaulieu	Sub Area 6
Beverley A.H.	Sub Area 4
Bloubosrand Extensions 2, 3, 10-12, 16-18	Sub Area 4
Blue Hills	Sub Area 5
Botesdal 529-JQ	Sub Area 1
Boundary Park Ext 1	Sub Area 2
Brendavere Agricultural Holdings	Sub Area 2
Broadacres Agricultural Holdings	Sub Area 4
Broadacres Extensions 1 And 2	Sub Area 4
Buccleuch	Sub Area 11
Bultfontein 533-JQ	Sub Area 1
Carlswald A.H.	Sub Area 6
Carlswald Estate	Sub Area 6
Chartwell Agricultural Holdings	Sub Area 2
Countryview	Sub Area 5
Craigavon Agricultural Holdings	Sub Area 2
Crowthorne A.H.	Sub Area 6
Dainfern	Sub Area 4
Dainfern Ridge	Sub Area 4
Diepsloot	Sub Area 3
Diepsloot 388-JR (Diepsloot Nature Reserve)	Sub Area 1
Diepsloot Agricultural Holdings	Sub Area 3
Diepsloot Reception Area	Sub Area 3
Diepsloot West and Extensions	Sub Area 3
Ebony Park	Sub Area 10
Erand A.H.	Sub Area 9
Erand Gardens	Sub Area 9
Farm Witkoppen 194-IQ	Sub Area 2
Farmall Agricultural Holdings	Sub Area 2

Farmall Agricultural Holdings Extension 1	Sub Area 1
Fourways Extensions 8, 10, 14, 15	Sub Area 4
Fourways Gardens	Sub Area 4
Glen Austin	Sub Area 12
Glen Austin Ext 1	Sub Area 12
Glen Nerine A.H.	Sub Area 4
Glenferness A.H. & Extensions	Sub Area 8
Grand Central Airport	Sub Area 9
Halfway Gardens	Sub Area 6
Halfway House & Extensions	Sub Area 6
Halfway House Estates A.H.	Sub Area 6
Headway Hill	Sub Area 9
Houtkoppen 193-IQ	Sub Area 2
Inadan Agricultural Holdings	Sub Area 2
Ivory Park	Sub Area 10
Johannesburg North	Sub Area 2
Kaalfontein	Sub Area 10
Kengies	Sub Area 4
Kleve A.H.	Sub Area 4
Knopieslaagte	Sub Area 8
Kya Sand And Extensions	Sub Area 2
Kyalami A.H. & Extensions	Sub Area 8
Kyalami Estates	Sub Area 6
Kyalami Gardens	Sub Area 6
Kyalami Hills	Sub Area 6
Kyalami Park	Sub Area 6
Leeuwkop Prison	Sub Area 8
Lindley 528-UQ	Sub Area 1
Lonehill	Sub Area 4
Marise A H	Sub Area 7
Magaliessig Extensions 4 & 40	Sub Area 4
Maroeladal Extensions 5, 7, 8	Sub Area 2
Midridge Park	Sub Area 9
Millgate Farm Agricultural Holdings	Sub Area 2
Mostyn Park Agricultural Holdings	Sub Area 2
Needwood	Sub Area 4
Nietgedacht 535-JQ	Sub Area 1
Nooitgedacht 534 JQ	Sub Area 1
Noordwyk	Sub Area 5
North Champagne Estates Agricultural Holdings	Sub Area 2
Palmlands Agricultural Holdings	Sub Area 4
Paulshof & Extensions	Sub Area 7
Plooysville A.H.	Sub Area 7
Rabie Ridge	Sub Area 10

Randjiesfontein	Sub Area 12
Randjiespark	Sub Area 9
Randjiespark Estate	Sub Area 12
Rietvallei 538-JQ	Sub Area 4
Riverbend Agricultural Holdings	Sub Area 2
Riverglen	Sub Area 3
Saddlebrook	Sub Area 8
Sagewood	Sub Area 5
Salfred	Sub Area 2
Sandpark A.H.	Sub Area 2
Stratford	Sub Area 4
Summerset	Sub Area 5
Sunninghill	Sub Area 7
Sunninghill Park	Sub Area 7
Sunrella Agricultural Holdings	Sub Area 1
Tanganani	Sub Area 3
Treesbank A.H.	Sub Area 4
Trevallyn Agricultural Holdings	Sub Area 2
Trevallyn Agricultural Holdings Extension 1	Sub Area 2
Vorna Valley	Sub Area 6
Waterval	Sub Area 6
Willaway	Sub Area 6
Witkoppen Extensions	Sub Area 4
Zevenfontein	Sub Area 4
Zwartkop/Rooiwal 530-JQ	Sub Area 1

4.2 SUB AREA DEVELOPMENT MANAGEMENT TABLES

The tables below provide specific objectives, interventions and guidelines at a more detailed and local level, required from a Land Use Management (or other sector) perspective, in order to achieve the development objectives for the Sub Area. These interventions and guidelines should be used (in conjunction with City Policies and Precinct Plans) in considering whether development proposals would be permissible.

Development Strategies as noted in Section 3 should be applied throughout each Sub Area where appropriate and where no specific controls are proposed. Where applicable, area-based and case-specific policies and plans should inform decision-making and guide development proposals and decisions.

Plan 17. Sub Area 1 – Lanseria/Sunrella

Plan 18. Lanseria Development Framework

Plan 19. Lanseria Speciality Node

Plan 20. Cradle City Master Plan (2008)

SUB AREA 1 (LANSERIA PRECINCT)

BULTFONTEIN 533-JQ, BOTESDAL 529-JQ, DIEPSLOOT 388-JR (DIEPSLOOT NATURE RESERVE), LANSERIA, LINDLEY 528-UQ, NIETGEDACHT 535-JQ, NOOITGEDACHT 534 – JQ, SUNRELLA A.H. &ZWARTKOP/ROOIWAL 530-JQ

Mogale City Local Municipality, the City of Tshwane and the N14 highway border Sub Area 1 in the west, north and south respectively. The key-structuring element within the sub area is the Lanseria speciality node, which is surrounded by agricultural holdings and farm portions. Over half of the sub area is undevelopable due to the presence of large tracts of environmental conservation areas that are outside the Urban Development Boundary (UDB). The proposed Cradle City, which is a major development, straddles between Johannesburg, Tshwane and Mogale City. The proposed development (refer to the Cradle City Master Plan, 2008) is subject to the necessary infrastructure provision by the developer, which must be in line and adhere to GMS Principles. This Master Plan is to be treated as a guideline document in conjunction with the Lanseria Development Framework 2020 (2008).

Development applications in this sub area are to be assessed in accordance with the Lanseria Development Framework 2020 (2008), which should be read in conjunction with the Growth Management Strategy (GMS) noting that the area falls within the expansion areas and peri-urban areas.

Unless the availability of infrastructure and other bulk services can be confirmed by the relevant MOEs and core departments, applications for densification, land use intensification and / or other uses will not be supported.

DEVELOPMENT OBJECTIVE 1
Promote the development of a sustainable long-term spatial structure to ensure the efficiency of the sub area in a city and provincial wide context.

Interventions	Guidelines
1.1 Promote the development of the demarcated Specialist Node in the sub area (subject to the provision of infrastructure)	1.1.1 Support suitable commercial and light industrial land uses within the node, which illustrates linkages and compatibility with airport, and transport activities. 1.1.2 No residential densification will be supported in this node, however accommodation establishments may be considered.
1.2 Promote mixed land use developments as shown and demarcated in the Lanseria Development Framework 2020 (2008).	1.2.1 Apply Land Use Management Standards as contained in Land Use Management Schedule.

1.3 Promote higher density residential development in this sub area as demarcated in the Lanseria Development Framework 2020 (2008).	1.3.1 Support densities between 30units/ha and 50units/ha along identified mobility roads. 1.3.2 Apply the Land Use Management Schedule as contained in the said framework. 1.3.3 Applications shall be assessed on their individual merits. Development controls shall be granted based on the suitability of the application within the local context as discussed in this sub area and Section 3.1.3.
DEVELOPMENT OBJECTIVE 2 **To stimulate the economic development potential of Sub Area 1.**	
Interventions	**Guidelines**
2.1 Promote hospitality services developments along Malibongwe Drive Extension (R512).	2.1.1 Integrate the hospitality corridor with Hartebeespoort Dam as a tourist destination and the International Heritage Site. 2.1.2 Permissible land uses shall include conference facilities, hotels, guesthouses and lodges, wedding facilities, eco-tourism facilities, restaurants, arts and craft markets.
DEVELOPMENT OBJECTIVE 3 **Promote the protection of open space and conservation areas in the sub area.**	
Interventions	**Guidelines**
3.1 Protect and conserve the use of the Diepsloot Nature Reserve.	3.1.1 Support low-density residential developments to buffer and protect the nature reserve. 3.1.2 Support non-residential uses promoting eco-tourism. 3.1.3 Establish public-private partnerships. 3.1.4 Preserve the natural Open Spaces according to JMOSS. 3.1.5 Integrated Environmental Management Plans (IEMP).
3.2 Formalise the landfill site in the Diepsloot Nature Reserve, with specific reference to: - Establish appropriate Integrated Environmental Management Plans (IEMP) and Systems (EMS). - Obtain approval from the relevant national department(s). - Implement an interface with the Diepsloot residential area. - Ensure proper access management off William Nicol Drive. - Disease vectors: obtain specialist input on concerns. - Risk assessment to investigate implications of sub-standard or abnormal operating conditions. - Further consultation with interested and affected parties regarding the Diepsloot cemetery.	3.2.1 Environmental Impact Assessment and Management Plan. 3.2.2 Implementation of EMF guidelines and recommendations.

Plan 21. Sub Area 2 – Millgate/Farmall/ Chartwell AH/Kya Sand

Plan 22.Kya Sands Development Framework

Plan 23. Kya Sands Speciality Node

SUB AREA 2 (KYA SAND PRECINCT)

BRENDAVERE A.H., BOUNDARY PARK EXTENSION 1, CRAIGAVON A.H., CHARTWELL A.H., FARMALL A.H., HOUTKOPPEN 193-IQ, INADAN A.H., JOHANNESBURG NORTH, KYA SAND AND EXTENSIONS, MAROELADAL EXTENSIONS 5,7 &8, MILLGATE FARM A.H. and MOSTYN PARK A.H., NORTH CHAMPAGNE ESTATES A.H., RIVERBEND A.H., SANDPARK A.H., SALFRED, TREVALLYN A.H. & TREVALLYN A.H. EXTENSION 1

The Kya Sands speciality node, which comprises mainly of industrial land uses, forms a key structuring element within Sub Area 2. The sub area is also characterised by several mixed housing projects that have been initiated by the public and private sector. The remainder of the sub area is predominantly rural in character, comprising of agricultural holdings and farm portions. Over half of the sub area falls outside the Urban Development Boundary where no further township establishments can be supported.

Development applications in this sub area are to be assessed in accordance with the Kya Sands Development Framework 2020 (2008), which should be read in conjunction with the Growth Management Strategy (GMS). In terms of the GMS the sub area has a large consolidation area, which includes Kya Sand, Trevallyn, Inadan and Riverbend. Farmall, Chartwell and North Champagne Estates are located in a Peri Urban Management Area and are also located outside of the UDB. Millgate Farm is located in an expansion area. This sub area is not viewed as a high priority area, however two informal settlements are present. The Kya Sand informal settlement is in planning phase for formalisation and redevelopment.

Unless the availability of infrastructure and other bulk services can be confirmed by the relevant MOEs and core departments, applications for densification, land use intensification and /or other uses will not be supported.

Future planned roads affect this sub area and as such any applications impacted by these future planned roads must be assessed on the merits of the application and impact of the roads to the proposed development.

DEVELOPMENT OBJECTIVE 1.
Promote the development of a sustainable spatial structure to ensure compatibility and integration of different land uses in the sub area.

Interventions		Guidelines	
1.1	Encourage investment and reinvestment of commercial and light industrial uses in the current extent of the demarcated Kya Sand Speciality Node	1.1.1	Support land uses of commercial and light industrial nature subject to the provision and/or availability of infrastructure (See the Kya Sand Development Framework 2020 of 2008)
1.2	Encourage appropriate densities for residential developments in the sub area.	1.2.1	Support densities of up to 100du/ha on the eastern boundary of the node as an interface area.
		1.2.2	Incrementally decrease residential densities in Inadan A.H and Riverbend A.H. away from the Kya Sand Speciality Node
		1.2.3	Applications shall be assessed on its individual merit and

	development control shall be granted based on suitability within the scope of the Kya Sand Precinct land use management table. 1.2.4 Applications along future proposed roads should take into consideration the impact of such roads.
1.2 Preserve the non-urban residential and agricultural related land uses and character in the Chartwell, North Champagne Estates and Farmall area, which is located outside of the UDB.	1.2.1 Support land uses that complement and protect the environmental character of the area e.g. recreational facilities of low intensity, guesthouses, nurseries, seed farming, hydroponics, equestrian facilities 1.2.2 UDB guidelines to apply
1.4 Support residential densification in Inadan, Riverbend and Milgate Farm	1.4.1 Kya Sands Development Framework 2020 (2008) 1.4.2 Scaling-down principle shall apply
DEVELOPMENT OBJECTIVE 2 **To identify and assemble land for the resettlement of the Riverbend Informal Settlement.**	
Interventions	**Guidelines**
2.1 Contain the extent of the existing Riverbend Informal Settlement.	2.1.1 Zero tolerance for "shack-farming" and land invasion. 2.1.2 Moratorium on doubling up, extension of structures and influx. 2.1.3 Implementation of the Housing Strategy.
2.2 Verification and updating of the community profile to establish the housing needs and identify potential beneficiaries, taking cognisance of Provincial Housing Waiting List.	2.2.1 Cosmo City Housing Development Initiative. 2.2.2 Develop a strategy for non-qualifiers.
2.3 Identification of suitable land for housing development.	2.3.1 Guided by the Urban Development Boundary Strategy. 2.3.2 IEMP. 2.3.3 Practice strategic densification to accommodate the housing need
DEVELOPMENT OBJECTIVE 3 **To develop Kya Sand Informal Settlement as a sustainable human settlement.**	
Interventions	**Guidelines**
3.1 Formalise the Kya Sands informal settlement	3.1.1 Zero tolerance for "shack-farming" and land invasion. 3.1.2 Support mixed housing typologies. 3.1.3 Support community facilities such as clinics, places of instruction, places of public worship and medical consulting rooms 3.1.4 Support Local Economic Development Opportunities along strategic routes in the area.

Plan 24. Sub Area 3 - Diepsloot

Plan 25. Diepsloot Development Framework

Plan 26. Diepsloot Activity Street Development Framework

Plan 27. Diepsloot Government Precinct Development Framework

Plan 28. Diepsloot District Node Urban Development Framework

SUB AREA 3 (DIEPSLOOT PRECINCT)

DIEPSLOOT, DIEPSLOOT A.H. DIEPSLOOT RECEPTION AREA DIEPSLOOT WEST AND EXTENSIONS

Sub Area 3 consists mainly of the Diepsloot Nature Reserve and the marginalized area of Diepsloot West and Extensions. The key issues within the Diepsloot marginalised area are the need to foster local economic development. The limited number of business sites and key structuring elements (e.g. activity streets and mixed use nodes) are hampering large-scale local economic development. The haphazard proliferation of unregulated small home-based businesses within the marginalised area is also as a result of the above. The remainder of the sub area includes agricultural holdings and farm portions that fall within and outside the Urban Development Boundary. A part of the Greater Kyalami Conservancy (GEKCO) falls within this sub area.

Development applications in this sub area are to be assessed in accordance with the Diepsloot Development Framework 2020, The Diepsloot Activity Street Framework, the Diepsloot Government Node Precinct and the Diepsloot District Node Framework, which should be read in conjunction with the Growth Management Strategy (GMS). Unless the availability of infrastructure and other bulk services can be confirmed by the relevant MOEs and core departments, applications for densification, land use intensification and /or other uses will not be supported.

Diepsloot is a high priority area for public investment in terms of the GMS.

DEVELOPMENT OBJECTIVE 1
To ensure socio-economic integration, infrastructure upgrading, consolidation and long-term sustainability of Diepsloot and Extensions.

Interventions	Guidelines
1.1 Promote the development of a sustainable urban environment in the sub area.	1.1.1 Implement the Diepsloot Development Framework 2020. 1.1.2 Support the development of different housing typologies, and affordable housing options for a range of income levels. 1.1.3 Encourage the provision of community facilities, nodal development, open spaces and economic activity. 1.1.4 Encourage mixed land uses in identified areas (as per the relevant frameworks)
1.2 Improve access to Diepsloot and Extensions.	1.2.1 Promote the upgrading of William Nicol Drive Extension and intersections. 1.2.2 Promote the development of Inter-modal transport facilities in the sub area. 1.2.3 Encourage the development of pedestrian crossings (William Nicol Drive Extensions and the R28). 1.2.4 Promote the upgrading of internal roads with new developments. 1.2.5 Promote the upgrading of bulk infrastructure services with new developments.

DEVELOPMENT OBJECTIVE 2 **Strengthen the economic growth and social development of Diepsloot.**	
Interventions	**Guidelines**
2.1 Strengthen the Diepsloot Government Precinct neighbourhood node.	2.1.3 Support retail and commercial land uses such as supermarkets, Internet cafés, hair salons, restaurants, chemists, drycleaners, informal trade on designated demarcated sites, offices, medical consulting rooms and any other uses listed in the Diepsloot Government Precinct Urban Development Framework (2008). 2.1.4 New developments must illustrate integration with surrounding established developments in the node through elements of design, accessibility and pedestrianisation in the precinct area. 2.1.5 Improve pedestrian access through sidewalk upgrading and the introduction of cycle lanes along a 2km radius from the node's core, in line with the approved NMT strategy (2009).
DEVELOPMENT OBJECTIVE 3 **To enable access to housing and security of tenure in the contained Diepsloot and Extensions.**	
Interventions	**Guidelines**
3.1 Implement the current housing development initiatives in support of the de-densification and upgrading of Diepsloot and Extensions.	3.1.1 Consult the City of Johannesburg's Housing Strategy and Diepsloot Marginalized Area Programme.

Plan 29. Sub Area 4 – Fourways/Dainfern

Plan 30. Fourways Development Framework

Plan 31. Fourways Regional Node

SUB AREA 4 (FOURWAYS PRECINCT)

BEVERLEY A.H., BLOUBOSRAND EXTENSION 2, 3, 10-12 & 16-18, BROADACRES A.H., BROADACRES EXTENSIONS 1, 2., BROADACRES A.H., DAINFERN, FARM WITKOPPEN 194-IQ, FOURWAYS MALL, FOURWAYS GARDENS AND EXTENSIONS 8, 10, 14 and 15. KENGIES A.H., LONEHILL, PALMLANDS A.H., RIETVALLEI 538-JQ, WITKOPPEN EXTENSIONS 3, 6 and ZEVENFONTEIN

Sub Area 4 is characterised by high-density urban residential components and well defined mixed use nodes. The Fourways regional node, together with several district and neighbourhood nodes spread throughout the sub area provide various services and employment opportunities. A well-defined Strategic Public Transport System (SPTN) connects the sub area to the rest of the City. The majority of non-residential land uses within the sub area are concentrated along William Nicol Drive, Cedar Road and Witkoppen Road, thereby generating high traffic volumes along these three mobility spines. A part of the Greater Kyalami Conservancy (GEKCO) falls within this sub area.

Development applications in this sub area are to be assessed in accordance with the relevant Spatial Development Policies (i.e. Density Policy, Mobility Policy etc) as amendments have been made in the RSDF pertaining to the Fourways Development Framework 2020 (2008).

The Growth Management Strategy (GMS, 2008) should further be consulted. The sub area falls within an identified consolidation area. Unless the availability of infrastructure and other bulk services can be confirmed by the relevant MOEs and core departments, applications for densification, land use intensification and / or other uses will not be supported.

Future planned roads affect this sub area and as such any applications impacted by these future planned roads must be assessed on the merits of the application and impact of the roads to the proposed development.

DEVELOPMENT OBJECTIVE 1
Promote the development of a sustainable spatial structure to ensure the efficiency, compatibility and integration of various land uses in the sub area.

Interventions	Guidelines
1.1 Support land use intensification and mixed-use developments within demarcated nodal areas in the sub area.	1.1.1 Contain non-residential development to the Fourways Regional Node and identified neighbourhood nodes in the sub area. 1.1.2 Support residential densification within demarcated nodes. a) Regional Nodes (no upper limit defined) – 100+ du/ha b) Neighbourhood Nodes – densities between 30-50 du/ha can be supported within the demarcated node (site specifics to be considered in the assessment of such applications) 1.1.3 Encourage the development of pedestrian movement and cycling lanes in accordance with the approved Non-Motorised transportation policy with new developments or redevelopments.

1.2 Support strategic densification (where services are available) along the SPTN o Witkoppen Road, William Nicol Drive and Cedar Road have been classified as Mobility Spines. o Further William Nicol Drive and Witkoppen Road are part of the proposed future BRT Network. o The sub area is affected by future proposed roads – K33, K56 and PWV5	1.2.1 Residential densities of between 50-70 du/ha will be supported on Mobility Spines. No direct access to be taken off Mobility Spines. However, due consideration may be given to increased densities of up to 90du/ha along the proposed BRT route. 1.2.2 Support residential densities ranging between 30–50 du/ha, within 200m radius of William Nicol Drive. 1.2.3 Applications along future proposed roads should take into consideration the impact of such roads.
1.3 Support the development of hospitality related services along William Nicol Road, north of the contained node at William Nicol/Pieter Wenning Road and south of the proposed PWV5.	1.3.1 Permissible land uses: hotels, conference facilities, and guesthouses.
1.4 Protect and support open spaces.	1.4.1 Trees and open spaces for new townships, densification and /or nodal development shall be planted. Site development plan shall be used as a tool to enforce such.
DEVELOPMENT OBJECTIVE 2 To rehabilitate land in Zevenfontein after relocation of informal settlements to Cosmo City.	
Interventions	**Guidelines**
2.1 Rehabilitate and protect the land of Zevenfontein informal settlements to prevent from further illegal invasions.	2.1.1 Zero tolerance for “shack-farming” and land invasion. 2.1.2 Implementation of the Housing Strategy.
2.2 Verify and update community profile to establish housing need and identify non-qualifiers remaining, taking cognisance of the Provincial Housing Waiting List.	2.2.1 Develop a strategy for non-qualifiers. 2.2.2 Cosmo City Housing Development Initiative.
2.3 Implement a Relocation Strategy and rehabilitation initiative.	2.3.1 Phased development. 2.3.2 Development of sustainable communities.

Plan 32.

Plan 33. Sub Area 5 – Summerset/Blue hills

SUB AREA 5 (BLUE HILLS PRECINCT)

BLUE HILLS, COUNTRYVIEW AND NOORDWYK

Sub Area 5 is characterised by a predominantly semi-rural environment in the west and dense urban townships in the east. The sub area forms the western boundary of the Midrand metropolitan node. Two potential neighbourhood nodes in Noordwyk Ext 23 and Blue Hills serve the entire sub area. Three north-south mobility routes and one east-west mobility spine connect the sub area to the rest of the region and the City of Tshwane. While most of Sub Area 5 falls within the Urban Development Boundary, the extreme western sections of Blue Hills A.H fall outside the UDB. A part of the Greater Kyalami Conservancy (GEKCO) falls within this sub area.

Development applications in this sub area are to be assessed in accordance with the relevant Spatial Development Policies (i.e. Density Policy, Mobility Policy etc) as amendments have been made in the RSDF pertaining to the Blue Hills Development Framework 2020 (2008).

The Growth Management Strategy (GMS, 2008) should further be consulted. The sub area falls within an identified consolidation area. Unless the availability of infrastructure and other bulk services can be confirmed by the relevant MOEs and core departments, applications for densification, land use intensification and / or other uses will not be supported.

Future planned roads affect this sub area and as such any applications impacted by these future planned roads must be assessed on the merits of the application and impact of the roads to the proposed development.

DEVELOPMENT OBJECTIVE 1
To retain and enhance the urban environment through the strengthening of economic growth and strategic densification within the Sub Area

Interventions	Guidelines
3.1 Support strategic densification (where services are available) along Mobility Roads and Spines o Main Road and Road R562 have been classified as Mobility Spines. o Seventh Road has been classified as a Mobility Road. o The sub area is affected by future proposed roads – PWV 5, K27, K27, K73 & K54	1.1.1 Residential densities of between 70 - 90 du/ha will be supported on properties, or any portion of a property, within a distance of 200m along a Mobility Spine. 1.1.2 No direct access to be taken off Mobility Spines. 1.1.3 Residential densities of between 30 – 50 du/ha to be supported on properties, or any portion of a property, within a distance of 200m along Mobility Roads. 1.1.4 Applications along future proposed roads should take into consideration the impact of such roads.
1.2 Support economic growth in demarcated nodal areas.	1.2.1 Develop and strengthen the Blue Hills Node by containing non residential development in the demarcated nodal area, including the Specialist Node (between proposed K73 in the east, Plantation Road in the north, ain Road in the west and two erven south of Road R562 – Refer to Plan 33) 1.2.2 Residential densities higher than 100du/ha can be supported within the Blue Hills node (as described above

	and shown on Plan 33) 1.2.3 Residential densities between 40 - 80 du/ha can be supported on land or any portion of land within 500m from the demarcated nodal boundary of the Blue Hills Node. 1.2.4 Light Industrial and Commercial uses can be supported in the demarcated Specialist Node – erven north of Plantation Road, one erf deep to the east and west of Main Road. 1.2.5 Erven contained between Road R562, Main Road and Plantation Road can be developed for Light Industrial and Commercial purposes as part of the Specialist node mentioned in 1.2.4 above.
1.3 Manage the growth of the Noordwyk Centre neighbourhood node by consolidating the non-residential uses within the Noordwyk Centre neighbourhood node (Erven 1/226, 1/225 Noordwyk Ext 19)	1.3.1 No further expansion of the existing Noordwyk Centre towards the east. 1.3.2 Restrict non-residential uses to existing building structures. Permissible land uses may include, but are not restricted to, beauty salons, real estate agents' offices, doctor's rooms and crèches. 1.3.3 Land uses not to disturb the existing residential character of the area. 1.3.4 Consider community-oriented local business uses on erven 15/1229-17/1229 and 26/1227 Noordwyk Ext 19.

Plan 34. Sub Area 6 - Kyalami

Plan 35. Kyalami Development Framework

Plan 36. Kyalami Speciality Node

SUB AREA 6 (KYALAMI PRECINCT)

BARBEQUE A.H., HALFWAY GARDENS, HALFWAY HOUSE AND EXTENSIONS, KYALAMI ESTATE, KYALAMI PARK, VORNA VALLEY AND WATERVAL, CROWTHORNE AND CARLSWALD A.H

Sub Area 6 consists of the Kyalami Speciality Node, several neighbourhood nodes, high-density residential developments, agricultural holdings and farm portions. Despite some parts of the sub area comprising low residential densities, the majority of the sub area is developed at medium to high densities. The sub area is connected to the rest of the region via several mobility roads and spines, which experience severe traffic congestion. The vast majority of the sub area falls within the Urban Development Boundary. The sub area also has an environmentally sensitive area and environmental legislation needs to be adhered to. The sub area further experiences some infrastructure difficulties, especially in the Crowthorne A.H. area. A part of the Greater Kyalami Conservancy (GEKCO) falls within this sub area.

Development applications in this sub area are to be assessed in accordance with the relevant Spatial Development Policies (i.e. Density Policy, Mobility Policy etc) as amendments have been made in the RSDF pertaining to the Kyalami Development Framework 2020 (2008).

The Growth Management Strategy (GMS, 2008) should further be consulted. The sub area falls within an identified consolidation area. Unless the availability of infrastructure and other bulk services can be confirmed by the relevant MOEs and core departments, applications for densification, land use intensification and / or other uses will not be supported.

Future planned roads affect this sub area and as such any applications impacted by these future planned roads must be assessed on the merits of the application and impact of the roads to the proposed development.

DEVELOPMENT OBJECTIVE 1
To retain and enhance the urban neighbourhood environment and character of the residential areas.

Interventions	Guidelines
3.1 Encourage strategic residential densification in the sub area.	1.1.1 Kyalami Boulevard / Allandale Road & K71 are classified as Mobility Spines. Densities between 50 – 70 du/ha may be supported. 1.1.2 Walton Road is also classified as a Mobility Spine, however a maximum density of 50du/ha may be considered adjacent to this road as per Plan 35. 1.1.3 Seventh Road is identified as a Mobility Road. Properties to the west of this road, between Harry Galaun and one erf south of Walton Road may be considered at a maximum density of 30du/ha. Properties to the north of Harry Galaun may be considered at the same density – Refer to Plan 35. 1.1.4 Carlswald A.H. (central area as shown on Plan35) may have a maximum density of 5 du/ha

	increasing to 15 – 20 du/ha on properties abutting higher residential density erven as described above and shown on the attached plan. 1.1.5 Properties to the north of Whiskin Avenue (Crowthorne A.H – area) - no densification can be supported until such time when adequate services are available, therefore it is deemed as a future residential development area.
DEVELOPMENT OBJECTIVE 2 **To manage the growth and developments of nodes within the Sub Area.**	
Interventions	**Guidelines**
2.1 Encourage the development of a concentrated node to the south of Main Road, east of Hawthorne Road and east of Pitts Avenues bordered by the Kyalami Specialist Node (Kyalami Park) in the south.	2.1.1 As per the Kyalami Development Framework 2020 plan, this node is to develop as a District Mixed Use node with Mixed Use Nodal Periphery uses on the properties adjacent to Hawthorne Road (as per Plan 35). Zone 6A and 6B are applicable as per the land use management table contained in the above-mentioned plan.
2.2 Manage the growth of Halfway Gardens neighbourhood node (Erf 242, Halfway Gardens Ext 117) by consolidating the intensive non-residential uses within the neighbourhood node.	2.2.1 No further expansion of the existing Halfway Gardens Centre towards the east and west. 2.2.2 Permissible land uses may include, but are not restricted to, beauty salons, real estate agents' offices, doctor's rooms and crèches. 2.2.3 Land uses not to disturb the existing residential character of the area. 2.2.4 Consider community-oriented local business uses in the interface areas south of Le Roux Ave, directly adjacent to Halfway Garden's Centre and north of Halfway Gardens Centre along Smuts Avenue. 2.2.5 Promote traffic calming at the intersection of Le Roux Avenue and Smuts Street. 2.2.6 Improve pedestrian access by introducing cycle lanes along a 2km stretch of Le Roux Ave (as per NMT strategy) and upgrading sidewalks along Le Roux and Smuts Streets.

Plan 37. Sub Area 7 - Sunninghill

Plan 38. Sunninghill Development Framework

Plan 39. Sunninghill Regional Node

SUB AREA 7 (SUNNINGHILL PRECINCT & FARM WATERFALL)

PAULSHOF AND SUNNINGHILL (REGIONAL NODE) AND FARM WATERFALL

The Sunninghill Regional Node features as a strong structuring element within Sub Area 7. The sub area is extensively developed to the west of K71 while, the northeastern sections comprise of vacant land parcels. Sub Area 7 is connected to the rest of the region via a network of mobility spines that experience severe traffic congestion during peak flow. The Parktown-Sunninghill Phase 1 BRT route, which affects the southern sections of this sub area at Rivonia Road, aims to address the traffic congestion experienced in the sub area.

The Farm Waterfall development falls within this sub area and small area falls in Sub Area 11. A section of this development also falls within Region E.

Development applications in this sub area are to be assessed in accordance with the Sunninghill Development Framework 2020 (2008), which should be read in conjunction with the Growth Management Strategy (GMS). The sub area is predominantly a consolidation area but the south of the sub area is a Public Transport Management Area. Unless the availability of infrastructure and other bulk services can be confirmed by the relevant MOEs and core departments, applications for densification, land use intensification and /or other uses will not be supported.

DEVELOPMENT OBJECTIVE 1
To encourage densification in the Sub Area in support of the Public Transportation and the local economy.

Interventions	Guidelines
1.1 Promote the strategic densification in and around the Sunninghill Regional Node	1.1.1 Support residential densities between 30 –50, within 200m of Mobility Spine 1.1.2 Along Mobility Spines support high densities between 50units/ha to 70 units/ha 1.1.3 Support residential densities of 100 + du/ha within the Regional Node
1.2 Support non motorised transportation	1.2.1 Developments in the Regional Node must consider NMT development to make the node accessible via all modes of transport.
1.3 Sunninghill Node is a classified Regional Node and has been demarcated as such.	1.3.1 Support mixed-uses ranging from retail, offices, residential and entertainment facilities.

1.4 Consolidate and contain the non-residential uses within the Sunninghill Centre neighbourhood node (Erf 971 Sunninghill Ext 84).	1.4.1 No further horizontal expansion of the Sunhill Centre neighbourhood node. 1.4.2 No further FAR increases to be permitted in the Sunhill Centre shopping centre. 1.4.3 Restrict non-residential uses to the node's existing building structures. Permissible land uses may include, but are not restricted to, beauty salons, real estate agents' offices, and doctor's rooms. 1.4.4 Land uses not to disturb the existing residential character of the area.
WATERVAL FARM COMPONENT **To enhance the residential character and strengthen the environmental quality of the area**	
INTERVENTIONS	**GUIDELINES**
1.1 Promote a mixed use nodal development along and to the south of Allandale Road between the N1 freeway and Maxwell Drive Extension	1.1.1 Apply the SDF Nodal Strategy 1.1.2 Permissible uses to include offices, retail uses, high density residential, institutions, value retail, motor related uses. 1.1.3 Medium density residential as an interface between nodal development and lower density residential developments. 1.1.4 No development within the 1:100 flood plain of the watercourse and on wetlands. 1.1.5 Development shall take cognizance of environmentally sensitive areas. 1.1.6 Pedestrian linkages to be provided between the nodal development and surrounding developments. 1.1.7 No noxious uses that may pollute the watercourses to be permitted.
1.2 Promote low intensity business uses along the western side of the N1 freeway.	1.2.1 Permissible uses to include offices, hotels, conference centers, training centers and limited commercial uses. 1.2.2 Permissible FAR: 0,4
1.3 Promote the development of the area between Maxwell Drive, Woodmead Drive, K60 and the N1 freeway for uses associated with the Islamic Institute.	1.3.1 Permissible land uses to include religious, educational and recreational uses and also offices at a FAR of 0,4 along the N1 freeway.
1.4 Retain the equestrian estate at a density of 2 units per hectare and develop housing in the area west of Woodmead Drive	1.4.1 Densities of 20 units per hectare will be supported on the remainder of land west of Woodmead Drive. 1.4.2 Retail and office uses for residents to be permitted at defined neighbourhood nodes.
1.5 Develop a range of housing typologies in the area	1.5.1 Support average residential

	east of Woodmead Drive, north of K60, west of the N1 freeway and south of Allandale Road.		densities of 15 units per hectare.
		1.5.2	Higher densities and minor support land uses will be considered along existing and proposed Mobility Roads and Spines.
		1.5.3	Retail and office uses for residents to be permitted at defined neighbourhood nodes.
		1.5.4	No development in the 1:100 floodline along the Jukskei River and its tributaries.
		1.5.5	Development shall take cognizance of the environmentally sensitive areas.
		1.5.6	Open space linkages to the Jukskei River and nodal developments to be provided.
		1.5.7	Buffer zones to protect environmentally sensitive areas to be provided.
		1.5.8	Landscape Management Plan to accompany land use applications.
		1.5.9	Limited crossings of watercourses.
		1.5.10	The provision of parks and open spaces for new developments in terms of City Parks Guidelines.
		1.5.11	Steps shall be taken to cater for Red Data Species.
		1.5.12	No development shall take place on wetlands.
		1.5.13	No noxious uses that may pollute the watercourses shall be permitted.
1.6	Promote a neighbourhood node at the intersection of Woodmead Drive and Maxwell Drive.	1.6.1	Permitted uses include retail, office, higher density residential, hotel and gymnasium.
		1.6.2	Retail floor area not to exceed 10 000m².
		1.6.3	FAR of 0,4 for non-residential uses.
1.7	Allandale Road is a Mobility Spine.	1.7.1	Allandale Road is part of the proposed BRT System
		1.7.2	Densities of between 70-90du/ha can be supported on properties, or any portion of a property, within 200m from the Mobility Road.
		1.7.3	Mixed-use developments can be supported, however, a residential must form part of the development proposal.
1.8	Develop Mobility Spines and Roads in order to facilitate development and to link the Sub Area with the rest of the city.	1.8.1	Construct K60 and the extension of Maxwell Drive and upgrade Allandale Road.

Plan 40. Sub Area 8 – Glenferness & Kyalami A.H.

Plan 41. Witpoort Development Framework

SUB AREA 8 (WITPOORT PRECINCT)

KYALAMI A.H., GLENFERNESS A.H. AND EXTENSIONS, KNOPIESLAAGTE, KYALAMI A.H. AND EXTENSIONS, LEEUWKOP PRISON, SADDLEBROOK

The entire sub area falls outside the Urban Development Boundary. It comprises mainly of environmentally sensitive areas, natural open spaces, agricultural holdings and farm portions. This means that no further township establishments can be supported on any erven within Sub Area 8. The entire sub area falls within the Greater Kyalami Conservancy (GEKCO) area

Development applications in this sub area are to be assessed in accordance with the Witpoort Development Framework 2020 (2008), which should be read in conjunction with the Growth Management Strategy (GMS), which identifies this area as a Peri Urban Management Area. Unless the availability of infrastructure and other bulk services can be confirmed by the relevant MOEs and core departments, applications for densification, land use intensification and /or other uses will not be supported.

Future planned roads affect this sub area and as such any applications impacted by these future planned roads must be assessed on the merits of the application and impact of the roads to the proposed development.

DEVELOPMENT OBJECTIVE 1
Protect environmental qualities and amenities in the sub area

Interventions	Guidelines
1.1 Support low densities and preserve the non-urban residential and agricultural related uses in areas outside the UDB.	1.1.1 Development of land outside the UDB to be guided by Urban Development Boundary Strategy. 1.1.2 Allow low residential density between 2units/ha as per the land use zone management table. 1.1.3 Only support non-urban residential development and compatible hospitality uses e.g. guesthouses, conference and training facilities, nurseries, seed farming, hydroponics, estates, equestrian facilities outside the UDB 1.1.4 Support institutional and community facilities development.

Plan 42. Sub Area 9 - Midrand

Plan 43. Midrand Gautrain Development Framework

Plan 44. Midrand Metropolitan Node

Plan 45. Erand Precinct Plan

SUB AREA 9 (MIDRIDGE PARK, HALFWAY HOUSE, GRAND CENTRAL AIRPORT)

MIDRIDGE PARK, HALFWAY HOUSE, RANDJIESPARK, GRAND CENTRAL AIRPORT AND ERAND A.H

The entire sub area constitutes the Midrand Metropolitan node. The Grand Central Airport, Gautrain Station, and the N1 highway are the key structuring elements within this sub area. The major challenges within this sub area include urban decay of the Midrand CBD, traffic congestion and the need to upgrade the road infrastructure. The Gautrain Station development and the Zonkizizwe Shopping Centre are two major future catalysts for development and urban regeneration. The N1 highway and the North-South Development Corridor bisect the sub area.

Development applications in this sub area are to be assessed in accordance with the Midrand Gautrain Urban Development Framework (2008), which should be read in conjunction with the Growth Management Strategy (GMS). According to the GMS the sub area is classified as a consolidation area. Unless the availability of infrastructure and other bulk services can be confirmed by the relevant MOEs and core departments, applications for densification, land use intensification and /or other uses will not be supported.

When assessing density applications, the guiding principles stipulated in the Nodal and Density Strategies (in particular the scaling-down and incremental processes), Sustainable Human Settlements indices and the Non- Motorised Transport Strategy shall apply.

DEVELOPMENT OBJECTIVE 1
To enhance existing public and private investment within the Sub Area.

Interventions	Guidelines
1.1 Promote development in the Metropolitan Node, which is guided by principles of transit-oriented development (in favour of public transport), including non-motorised transport opportunities, and sustainable human settlements.	1.1.1 Development to be guided by the N1 Corridor Employment Framework, the Erand Precinct Plans and, Midrand Gautrain Urban Development Framework. 1.1.2 Support the integration of the Gautrain Station with the Zonk 'izizwe development. 1.1.3 Support residential densification in the node, which supports transportation initiatives.
1.2 Promote protection of environmental sensitive areas and open spaces	1.2.1 Protect and enhance accessibility to the Erand Spruit conservation and recreational development area. 1.2.2 Support interface uses adjoining the Erand Spruit and in selected areas adjoining main roads within the precinct. 1.2.3 Support residential and related uses located between Lever Road and the western boundary of the Erand Spruit

SUB AREA 10 (EBONY PARK, IVORY PARK, RABIE RIDGE AND KAALFONTEIN)

EBONY PARK, IVORY PARK, RABIE RIDGE AND KAALFONTEIN

Sub Area 10 comprises of marginalized areas. The sub area falls within the high priority areas of the Growth Management Strategy, which will receive short term service upgrading and capital investment priority.

A number of key challenges have been identified in the sub area, which includes poverty associated with high levels of unemployment, housing backlogs, the lack of social and economic opportunities and limited public transport. The haphazard proliferation of unregulated small businesses points to a need for business development in the sub area.

Development applications in this sub area are to be assessed in accordance with the Bambanani Industrial Node Urban Development Framework (2008) and the Swazi Inn Urban Development Framework (2008), which should be read in conjunction with the Growth Management Strategy (GMS).

DEVELOPMENT OBJECTIVE 1
To ensure the socio-economic integration, consolidation and long-term sustainability of this Sub Area.

Interventions	Guidelines
1.1 Encourage social and institutional development.	1.1.1 Support development that encourages and supports community facilities such as nursery schools. Orphanage, clinics, medical consulting rooms, place of worship and other related uses.
1.2 Republic Road in Ivory Park has been identified as a Mobility Spine	1.2.1 Support high residential densities between 70 – 90 du/ha along the identified Mobility Spine 1.2.2 Taverns/Shebeens shall be permitted on merit and in line with the Liquor Act and Tavern/Shebeen guiding principles. 1.2.3 Applications shall be assessed on its individual merit and development control where applicable shall be granted based on suitability and on local authority's discretion in line with the mentioned policy. 1.2.4 Where an application is supported, the approval must contain strict measures/conditions to be complied with, to enable compliance and control of the small business uses in Greater Ivory.
1.3 Recognise major routes in Ivory Park as Activity streets: • Makhanya Drive	1.3.1 Support small home businesses such as hair salon; telephone containers and shops along

• Archerfish Drive • Twenty Second October Drive • Acacia Street		Activity Streets and in other strategic location such community facilities or open spaces.
1.4 Strengthen Ebony Park Mall neighbourhood node	1.2.1	Support mixed business uses such as offices, shops, medical consulting rooms, internet cafés, hair salons, restaurants, video rental stores, chemists, drycleaners, supermarkets and complementary land uses that have a distinct convenience function within the delineated boundaries of the Ebony Park Mall neighbourhood node.
	1.2.2	Support uses such as house shops, buy and braai facilities and guest house (i.e. home-based business within existing building structures) in the node's interface areas.
	1.2.3	Land uses within the Ebony Park Mall neighbourhood node to align to proposed land uses in the "mixed use precinct" of the Bambanani Industrial Node.
	1.2.4	Improve pedestrian access through sidewalk upgrading and the introduction of cycle lanes along a 2km radius from the node's core, in line with the NMT strategy.
	1.2.5	Allow for additional traffic calming mechanisms along Twenty Nine September Road and Acacia Road.
1.4 Support commercial and industrial uses	1.5.1	Support developments such as motor trade, and spray-painting, manufacturing and other related land uses in support of revitalization of Bambanani Industrial area. Development shall be in accordance with the Bambanani Industrial Node.

SUB AREA 11 (BUCCLEUCH)

BUCCLEUCH

Sub Area 11 mainly includes urban residential uses. The sub area is well connected to the rest of the city via a well defined road network, however access and traffic congestion at the main entry points to Buccleuch are key issues that need immediate response. The challenge for this sub area is to strike the appropriate balance between strategic densification and the reduction in traffic congestion.

A portion of the Farm Waterfall development falls within this sub area. Relevant information pertaining to the development is contained in Sub Area 7.

Development applications in this sub area are to be assessed in accordance with the Growth Management Strategy (GMS) and this area is classified as a consolidation area. Unless the availability of infrastructure and other bulk services can be confirmed by the relevant MOEs and core departments, applications for densification, land use intensification and /or other uses will not be supported.

DEVELOPMENT OBJECTIVE 1
To retain and contain this Sub Area as a viable and well functioning residential neighbourhood.

Interventions	Guidelines
1.1 Promote increased residential densities - Pretoria Main Road is a Mobility Spine and a proposed BRT route.	1.1.1 Base density: 20 dwelling units per hectare. 1.1.2 Manage densification in consideration of road infrastructure constraints. 1.1.3 Density Strategy to apply
1.2 Strengthen and direct non-residential uses to The Bridge neighbourhood node.	1.2.1 Maintain erf 257 Buccleuch as an active public open space that is directly accessible from The Bridge shopping centre and Buccleuch Drive 1.2.2 New developments must be integrated with established developments in the node by means of design, access points and functional pedestrian network. 1.2.3 Land uses not to disturb the existing residential character of the area. Permissible land uses include beauty salons, real estate agents' offices, doctor's rooms, chemist, drycleaners, crèches, supermarkets and all other uses that display a convenience factor and are of a local nature. 1.2.4 All development proposals within The Bridge nodal boundary are subject to access control management as determined by JRA and Transportation. 1.2.5 Improve pedestrian access through sidewalk upgrading and the introduction of cycle lanes along a

	2km radius from the node's core, in line with the NMT strategy. Support cycle lanes on stands 5/80 and RE/2/79 and along a 2km stretch of Buccleuch Drive.
1.3 Develop existing Jukskei River Open Space System, catering for needs of the residential neighbourhoods.	1.3.3 JMOSS and the IEMP guidelines.

SUB AREA 12 (GLEN AUSTIN, GLEN AUSTIN EXTENSION 1 AND RANDJIESFONTEIN)

GLEN AUSTIN, GLEN AUSTIN EXTENSION 1 AND RANDJIESFONTEIN

This Sub Area is predominantly a low-density rural residential area with pressure to provide through routes from Ivory Park to Sub Area 9. There are major infrastructure constraints that exist in the area.

This Sub Area is within the Urban Development Boundary, therefore infill development and densification can be encouraged. According to the Growth Management Strategy (GMS) the area is a consolidation area and for this reason adequate bulk services must be confirmed by the relevant MOEs and core departments prior to any developments.

DEVELOPMENT OBJECTIVE 1 **To enhance accessibility and mobility within this area.**	
Interventions	**Guidelines**
3.1 Support the development of the Sub Area in terms of the guidelines as set in terms of the Glen Austin Development Plan with specific reference to: Controlled development along edges: • Concentration of commercial development within the 65dB noise contour. • Limiting large-scale office development to erven immediately abutting the existing and proposed K-routes. Internal development along through routes: • Concentration of non-residential limited to low density, low-rise office development along certain identified internal through routes. • Downscaling of development: • A concentration of low-density development inward from non-residential edge development. Higher density residential areas: • Focussed in the area west of Allan Road. • Retention of existing rights: • Focussed within the northern and eastern portion of the Glen Austin precinct in the form of lower density residential development and agricultural and rural residential purposes. Establishment of Nodes: • Nodal development should be focussed in three identified locations. • Environmental protection: • Presumption in favour of environmental protection on submission of development proposals.	1.1.1 Glen Austin Development Plan. (Subject to infrastructure capacity)
1.2 A trend of religious facility developments has been noted in the sub area. The development of such facilities cannot occur to the detriment of the residential character of the area.	1.2.1 Religious establishments may only occur along Mobility Spines and Mobility Roads in the sub area where access and egress will be to the satisfaction of the relevant Municipal Department.
1.3 Preserve the non-urban residential and agricultural related uses within the Randjiesfontein area	1.3.1 Subdivisions to a minimum of 1 hectare. 1.3.2 Restrict densities to two main

		dwelling units per holding/subdivided portion.
	1.3.3	Subdivision guided by infrastructure capacities and geo-technical conditions.
	1.3.4	Support non-urban residential development such as compatible hospitality uses e.g. guesthouses, conference and training facilities, nurseries, seed farming, hydroponics, estates, equestrian facilities.
1.4 Support residential development on Portion 48 of the Farm Randjiesfontein (MO Africa Site).	1.4.1	Movement Strategy.
	1.4.2	ITP and BRT guidelines.

SECTION 5: DEVELOPMENT FRAMEWORK

5.1. SPATIAL STRUCTURE

5.1.1. METROPOLITAN SPATIAL PERSPECTIVE

In order to evaluate and understand the spatial structure of the Johannesburg Metropolitan Area, it is necessary to have an insight into the alternative urban structures that exist. The most common spatial alternatives can be grouped under one of three broad categories: the concentric settlement, the homogeneous settlement and the strip settlement (see Diagram below). These are briefly described as follows:

a. Concentric Settlement

Land uses within concentric cities are evenly distributed at relatively high densities. Development is contained within the boundaries of the existing urban area, with development beyond the periphery discouraged. These cities are largely dependant on public transport and generally support a radial road network that primarily serves a central core. In addition to the radial road network, this configuration can contain a ring road linking the radial roads on the periphery of the urban structure. This type of settlement is characteristic of European cities. Older South African towns and cities, such as the older parts of Johannesburg, represent elements of this spatial configuration.

b. Homogeneous Settlements

Homogeneous settlements are dispersed over a large area and consequently do not have a clear structure and identifiable nodal hierarchy. This spatial structure is supported by a grid road network and is largely dependant of private vehicles for movement. Public transport is difficult to sustain due to the low urban densities. To a large extent the Gauteng urban structure is characterized by this structure, largely because of the grid PWV network that serves it.

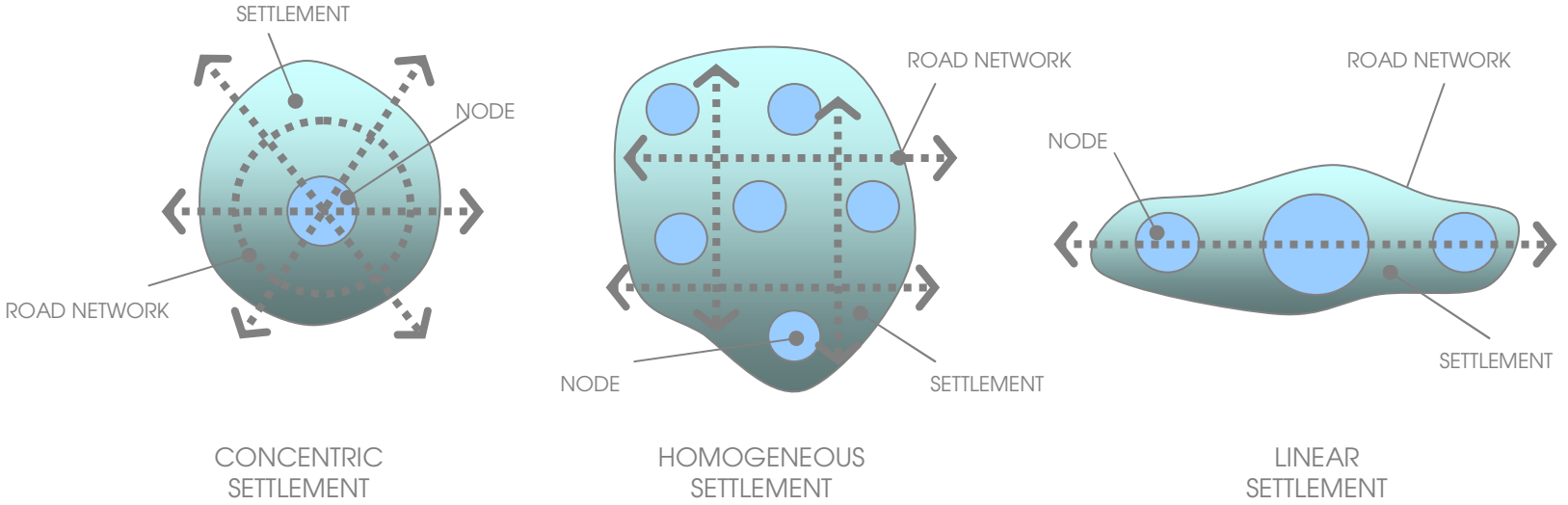


DIAGRAM 22: SETTLEMENT CONFIGURATIONS

c. Linear Settlement

Linear settlements are shaped by a public transportation line or road, or several lines or roads parallel to each other. Development takes place in a strip on both sides of this transport line, with a concentration of development at intersections or transit stops along the line or road. Consequently, this settlement configuration is ideal for the operation of public transportation systems. The scale of this settlement configuration can vary and on its largest scale can extending from one city to another. To a degree, this configuration is evident along the N1 Freeway that links Tshwane, Midrand and Johannesburg.

The settlement configurations defined above represent the typical form of each configuration. Urban areas are rarely shaped in such a pure form. Instead, a mixture of a number of these configurations, leaning more to one configuration than another, is exhibited.

The Eastern Sub-Region consists of a mixture of the radial and homogeneous configurations. It is radial in the sense that the radial network of the older Johannesburg network (comprising routes such as Main Road (K71) extending into the Eastern Sub-Region. This network is ideally suited for the public transportation network serving the Eastern Sub-Region. The homogeneous settlement characteristics are attributed to the Eastern Sub-Region by the planned PWV road network overlying the area. This road network forms a grid pattern across the Eastern Sub-Region and provides strong east-west linkages, which are absent in the older parts of Johannesburg. The homogeneous configuration tends to favour private vehicle usage and the intersections created by east-west and north-south aligned road create numerous opportunities of nodal development.

5.1.2. DEVELOPMENT CONCEPT

The aim of the Development Concept is to guide spatial development on a sub-regional level, based on the metropolitan spatial perspective set out above. In addition, as suggested by the development vision, the aim of the Development Concept should be to promote the development of a sustainable community within the Eastern Sub-Region. The Development Concept, which is illustrated by the Diagram below, guides spatial development within the Eastern Sub-Region through a set of nodes, corridors and infill areas. The Development Concept is made up of the following elements:

a. Transportation structure

The K71 is currently the central road spine linking the Eastern Sub-Region to Woodmead and the rest of Johannesburg. Other significant roads include Lever Road, which runs parallel to the N1 freeway and links the residential areas along the Midrand strip, the K55 (Alandale Road) and the K60 (Witkoppen Road). Two roads in particular will improve accessibility within the Eastern Sub-Region. The K73 will link Sunninghill to the Midrand strip and the K56 will link the Eastern Sub-Region westward to Cosmo City. The K71 and the K56 has the potential to link the Eastern Sub-Region to local and regional employment opportunities, social amenities and shopping destinations and should therefore be development as public transportation spines. Two freeway are planned that will link the Eastern Sub-Region regionally. The PWV9 will link the Eastern Sub-Region to the western parts of Tshwane and the PWV5 will link the Eastern Sub-Region to the northern parts of Ekurhuleni.

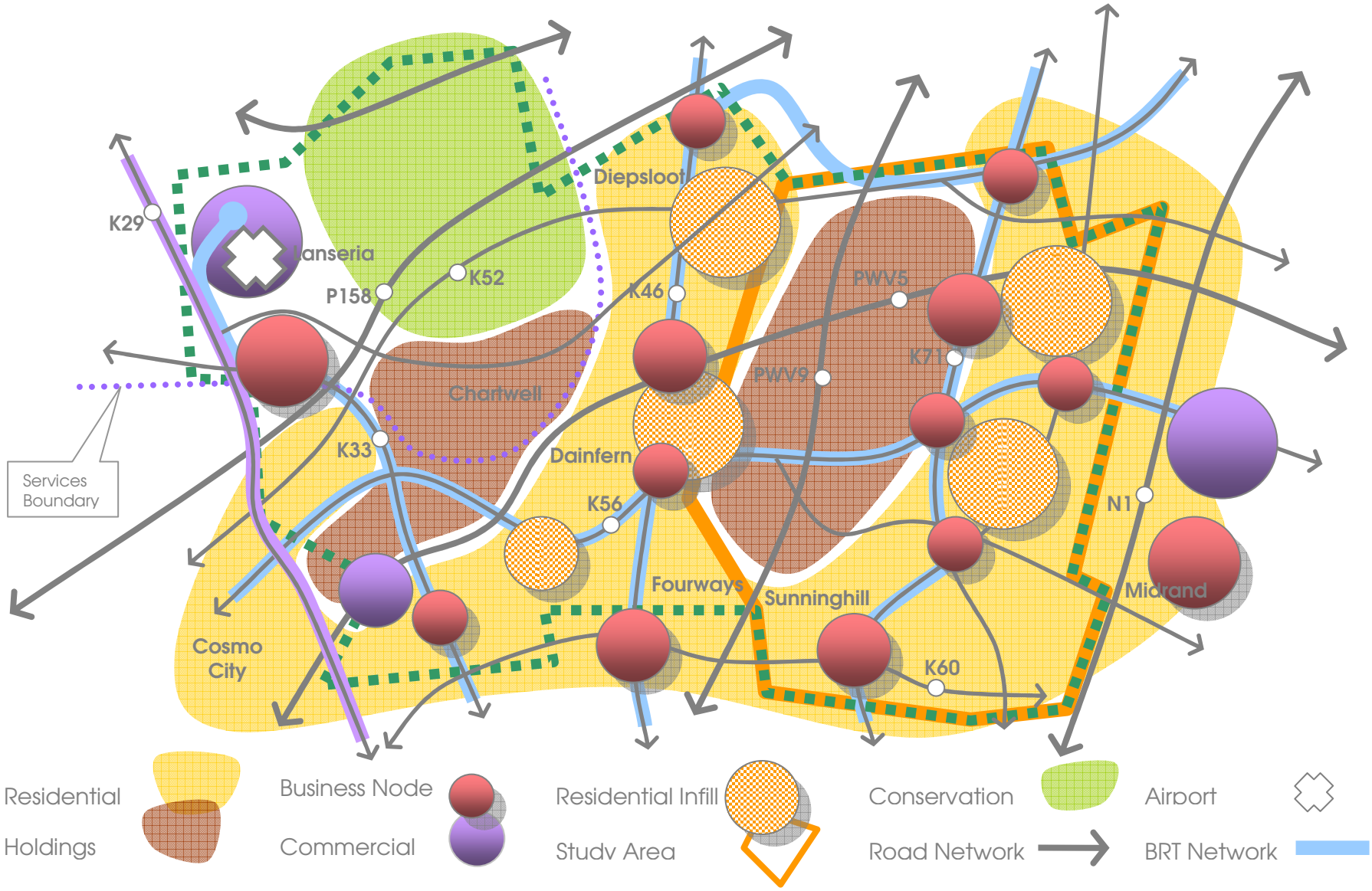


DIAGRAM 23: DEVELOPMENT CONCEPT

b. Nodal structure

A number of mixed-use nodes can be developed within the Eastern Sub-Region along the spines mentioned above. The K71 and the K56 are proposed public transportation spines and are therefore ideally suited as access spines for the nodal structure. It is also important to develop a hierarchy of node, which would provide different levels and a range of services within the Eastern Sub-Region. In addition to the existing Sunninghill regional mixed-use node, a regional mixed-use node would by suited on the intersection of the K71 and the planned PWV5 freeway. The freeway will provide regional and visual access, whereas the K71 will provide the necessary local and public transportation access.

c. Spatial structure

Currently, the Eastern Sub-Region is characterized by a number of fragmented settlements, mostly straddling the Midrand Strip. To achieve urban consolidation and create a spatial structure that would enable better land use and transportation integration, it is proposed that the existing settlements within the Eastern Sub-Region be consolidated through corridor development along the K71. This will require infill development along this corridor, with higher-density residential development being encouraged along the proposed public transportation spines and nodes within this corridor. The areas abutting the planned PWV9 freeway should preferably be left rural at this stage, until the PWV9 is constructed.

5.1.3. DEVELOPMENT SUITABLITY ANALYSIS

Figure 17 illustrates the land parcels within the Eastern Sub-Region that are suitable for urban development. This suitability index was developed taking into account environmental sensitive areas, high-potential agricultural soils and geotechnical conditions. Land categorized by C-Plan2 as irreplaceable or important site were deems unsuitable for urban development, land with high-potential agricultural soils was considered unsuitable for urban development and land with poor geotechnical conditions were considered unsuitable for urban development.

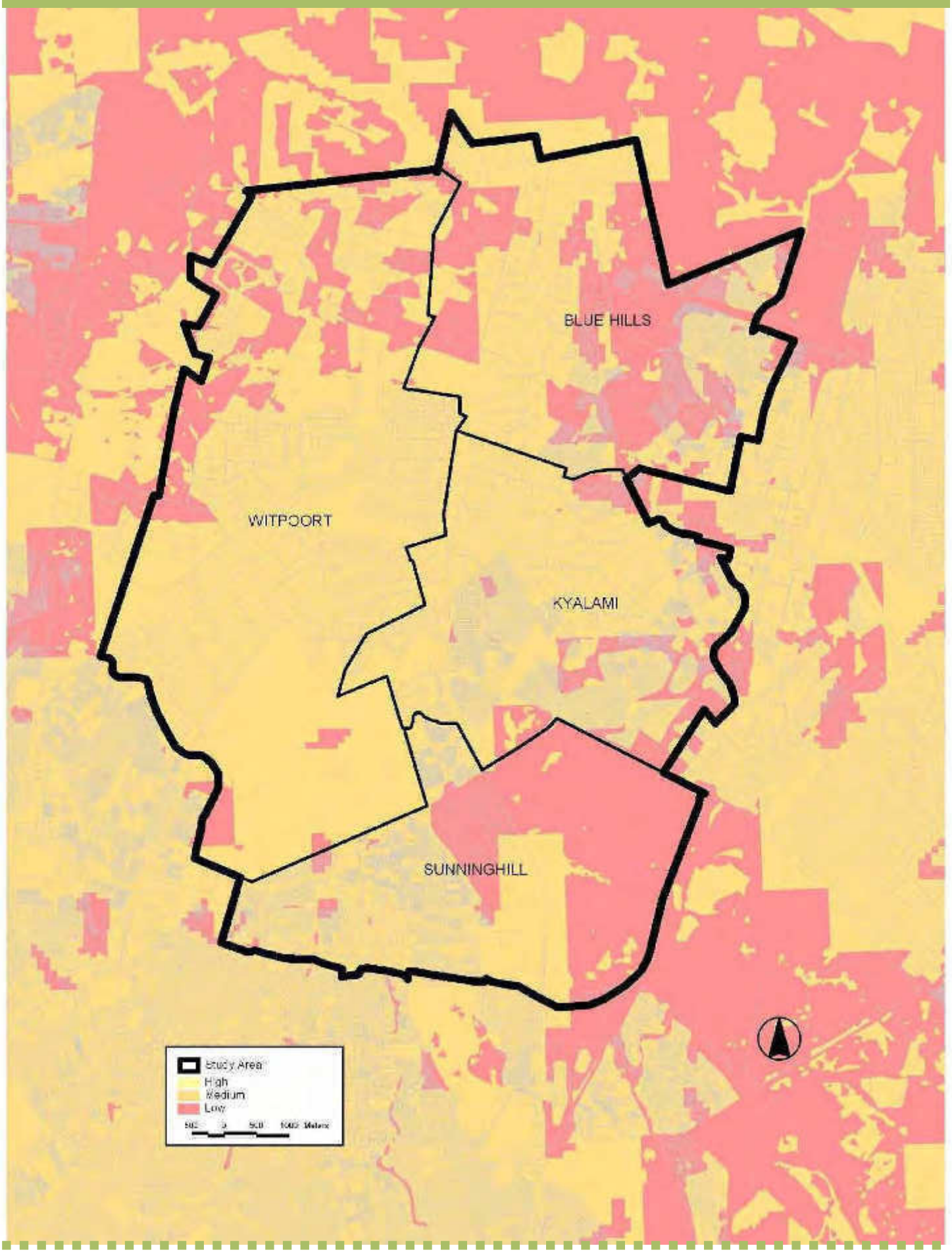


FIGURE 17
DEVELOPMENT SUITABILITY

FIGURE 17
DEVELOPMENT SUITABILITY

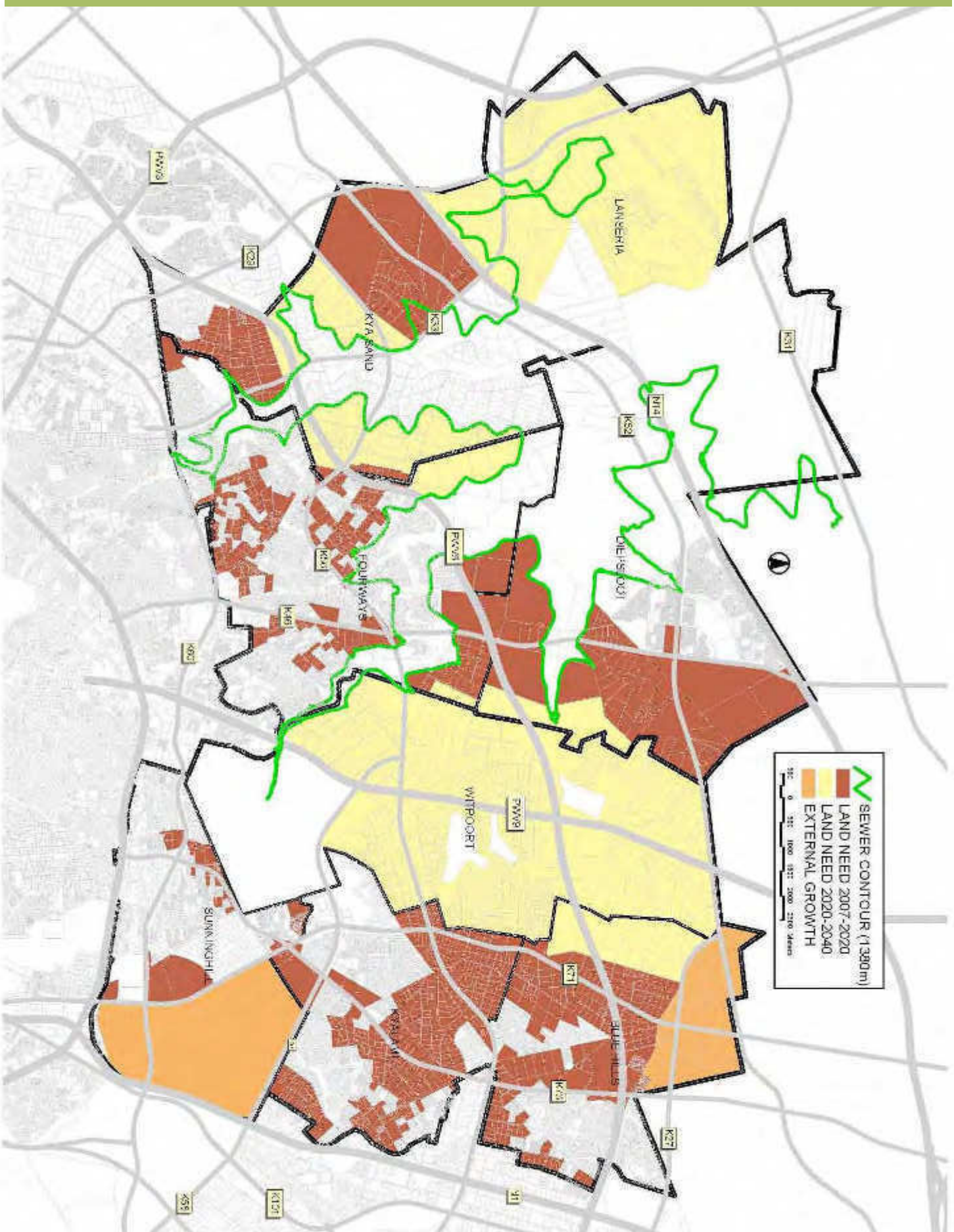


FIGURE 18
DEVELOPMENT PROGRAMMING

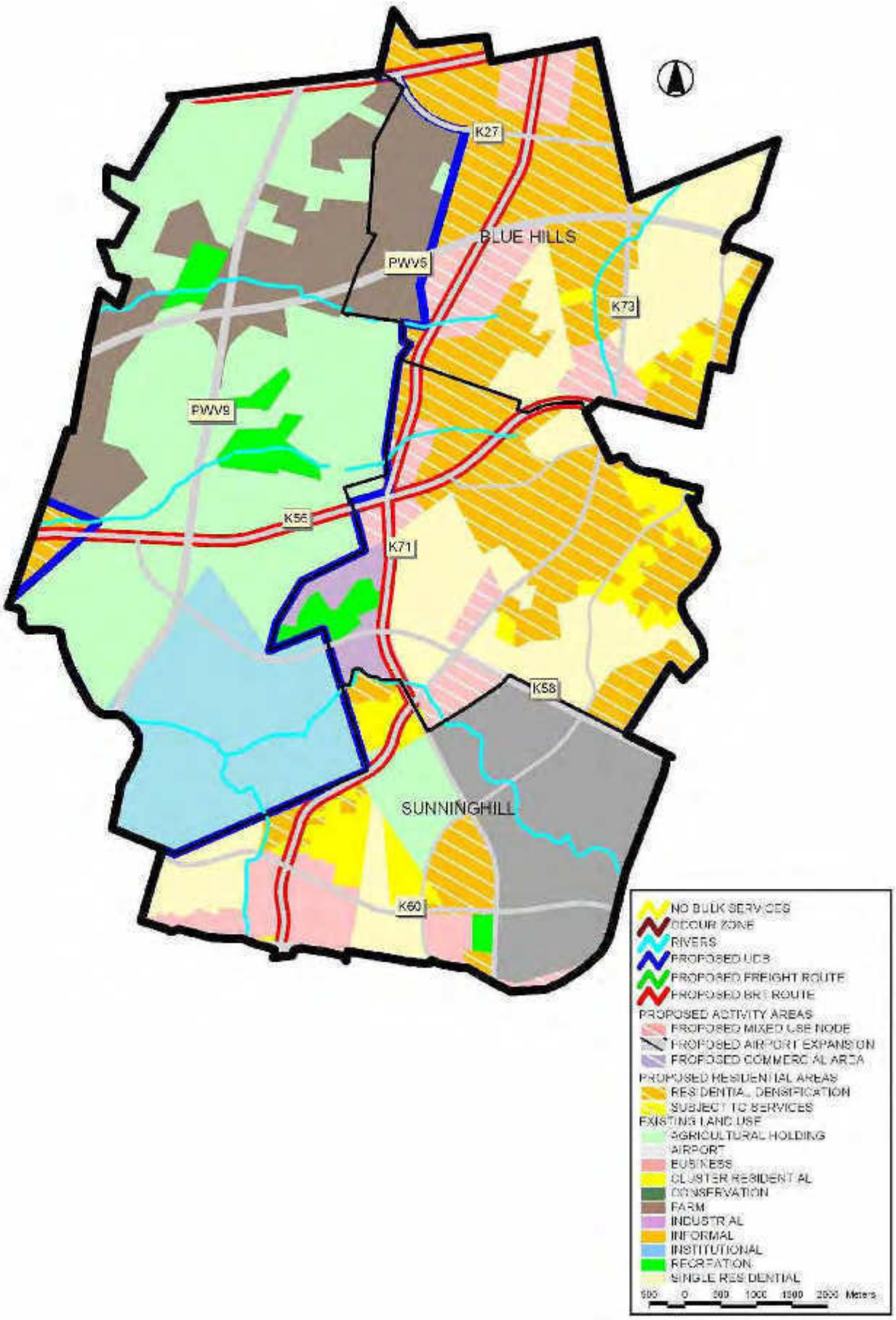


FIGURE 19
DEVELOPMENT FRAMEWORK

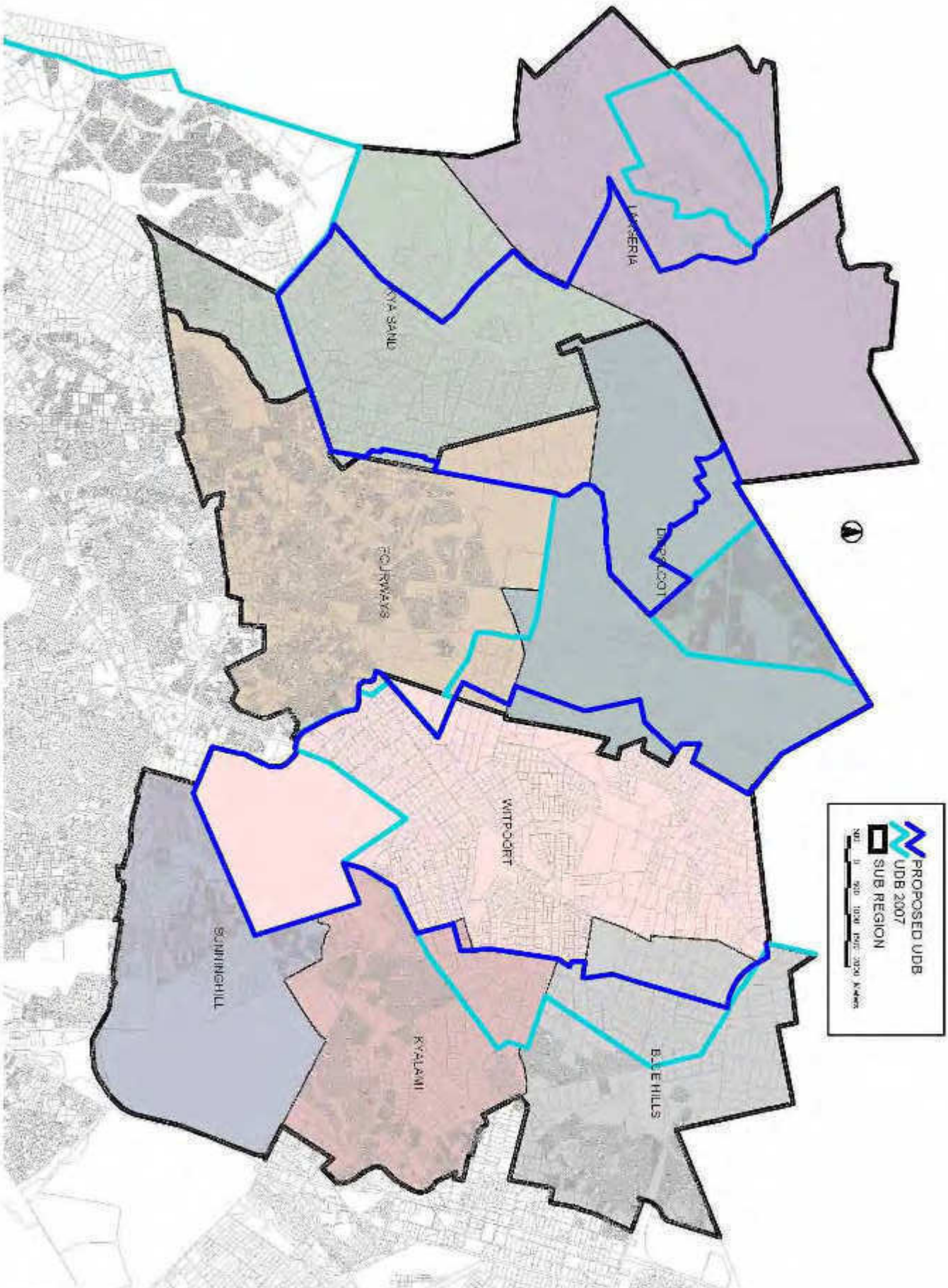


FIGURE 20
URBAN DEVELOPMENT BOUNDARY

URBAN DEVELOPMENT BOUNDARY

Based on the analysis above, most of the Eastern Sub-Region is considered either of medium to low suitability for urban development. Mia's Land, the eastern parts of Blue Hills and the northwestern part of the Eastern Sub-Region is considered to be unsuitable for urban development, mainly due to environmentally sensitive areas and to a lesser extend high-potential agricultural soils located within these areas. However, GDACE has pointed out that the environmental sensitive areas in the Blue Hills area have already been compromised, thus not providing an incentive to protect this area from urban encroachment. Mia's Land is dealt with as part of the development plan put forward by the developers of Mia's Land.

The reason why the remaining land within the Eastern Sub-Region is considered on medium development potential is due to the presence of relatively poor geotechnical conditions. However, these conditions can be overcome by through building and foundation design and does therefore not prohibit urban development within these areas.

5.1.4. SETTLEMENT EXPANSION

The land areas required for urban expansion within the Eastern Sub-Region has been calculated in the Land Use Budget set out in Section 3 of this report. The Land Use Budget calculated the land need in 10 year intervals up to the year 2050, as attached in Annexure A. The calculations have been combined to provide the total land requirements for the periods 2007-2020 and 2020-2040, as depicted by the Table below. According to the Table below, the entire northern region of Johannesburg, stretching form Midrand in the east to Lanseria in the west, requires approximately 4900ha of land for urban expansion up to the year 2020, and an additional 4300ha of land for urban expansion up to the year 2040. The Eastern Sub-Region, which form part of the aforementioned region, requires approximately 1000ha of land for urban expansion up to the year 2020, and an additional 1400ha of land for urban expansion up to the year 2040

TABLE 9: LAND NEEDED FOR URBAN EXPANSION 2020 AND 2040

Area	Period	
	2007-2020	2030-2040
Western Sub-Region	1914.8	465.9
Central Sub-Region	2046.6	2389.8
Eastern Sub-Region	964.1	1397.4
Total Area Needed	4925.6	4253.1

Source: Maluleke Luthuli and Associates, 2008

The land required for urban expansion within the Eastern Sub-Region has been allocated on Figure 18, taking into account the development suitability analysis set out in the previous section of this report. In addition, the land required for urban expansion was allocated to with the aim at strengthening the public transportation spine along the K71, as proposed in the Development Concept. The areas for urban expansion are as follows:

a. Period 2007-2020

The primary aim for the period 2007 to 2020 is to direct urban growth along the K71 corridor, in order the consolidate the fragmented settlement pattern existing within the sub-region and in so doing, creating the opportunity to development public transportation spine along the K71, stretching from Sunninghill to Olievenhoutbosch. This spatial configuration will also allow nodal development along the K71 spine. Most of the land required during 2020 (which amounts to approximately 1300ha) will be spent north of Kyalami and in the eastern parts of the Blue Hills area, thus also strengthening the larger Midrand strip.

b. Period 2020-2040

The period 2020-2040 will require the allocation of an estimated additional 1600ha of land for urban expansion within the Eastern Sub-Region. Although the time period extends beyond the lifespan of this study, this land requirement has been allocated for contextual purposed. This land will most probably be spent along the PWV9 freeway, creating an urban corridor along the PWV9 that the tailored to the needs of and opportunities presented by the PWV9 freeway. Taking into account the timeframe for the planning, financing and construction of such a freeway, the areas surrounding this freeway are not considered suitable for urban development in the short term.

c. External Growth

In addition to the growth estimated by the Land Use Budget for the periods 2020 and 2040, external growth has also been taken into account. External growth is defined and urban growth potential that is generated by settlements located outside of the Eastern Sub-Region boundary, but which is spend inside of the Eastern Sub-Region boundary. In other words, this growth potential is not created by population growth within the Eastern Sub-Region boundary.

Two areas in particular are considered to have the potential to exert external growth pressured on the Eastern Sub-Region. The first is Mia's Land, which is a large-scale new town development that is tied to the Midrand Strip and in

particular the Buckles interchange, but will use up a significant portion of the available land located within the Eastern Sub-Region. The second is Olievenhoutbosch South, which involves the southward expansion of Olievenhoutbosch over the Tshwane boundary into the Johannesburg metropolitan area. Mia's land will require approximately 800ha of land, whereas Olievenhoutbosch South has the potential to allocate 400ha of land within the Eastern Sub-Region. Both these developments will strengthen the K71 corridor, thus supporting the Development Concept set out in this report.

Although an attempt was made to point out the constraints affecting the Eastern Sub-Region, it has to be stressed that localized constraints could emerge once a site earmarked for development is investigated in more detail. Also, it may be that the constraints are more prohibitive than assumed in this report. Such issues may surface during the EIA process, during the township establishment application process, or during the construction phase, when building foundations are investigated. The following development constraints could emerge during these detailed phases:

- Geotechnical conditions: It is known that moderate geotechnical conditions underlie the Eastern Sub-Region, but that these conditions do not prohibit urban development. However, it may be that localized areas within the Eastern Sub-Region may have geotechnical conditions that are not suitable for building construction, or would require specialized building foundations that will increase building cost.
- Municipal services: Besides the bulk municipal services network capacity (which was not been determined in this study) there may be localized areas within the Eastern Sub-Region that cannot be readily linked to the bulk network due to topographical constraints. There was mention of such areas within the Blue Hills areas. To address this may require, for example the installation of sewerage pump stations, which could possibly become a condition for development in such areas.
- Flooding: Although the protection of the floor areas of river systems within the Eastern Sub-Region has been taken into account by allowing for ample passive open space in the Land Use Budget, it may be that certain rivers within the Eastern Sub-Region have flood areas that exceed the land area provide for it in the Land Use Budget.
- Land ownership: The allocation of the Land Use Budget has not and cannot take into account the ownership of the land within the Eastern Sub-Region. Because most of the land within the Eastern Sub-Region is in private ownership, would imply that the development of these land parcels are up to the owner, which could mean that the land is not developed as proposed in this study, but is rather left as it is used currently.
- Environmental constraints: Although C-Plan2 of GDACE has been taken into account; localized environmental constraints could affect the land available for development within the Eastern Sub-Region. GDACE was clear that they do not only use C-Plan2, but also supplements this data source with site visits when evaluating a specific application for land use change. The proximity of a river system of ridge heightens the changes of finding localized environmental constraints during an application for land use change, typically a township establishment application.

- High-potential agricultural soils: As was determined in this study, high-potential agricultural soils do not significantly affect the Eastern Sub-Region. However, it may be that during township establishment, localized pockets of high-potential agricultural soils are found, which could affect the manner and extent to which a property can be developed.

A development framework was drafted, based on the areas set out for urban expansion for the period 2007 to 2020. This period is considered the lifespan of the development framework. In other words, this document makes proposals for the urban expansion and land use development up to the year 2020. The development framework is presented by Figure 19.

5.1.5. URBAN DEVELOPMENT BOUNDARY

Demarcating an Urban Development Boundary has specific advantages, the primary being to prevent uncontrolled urban sprawl. Urban sprawl is undesirable since it increases pressures on the limited resource of local government, from public transport to water and sanitation infrastructure provision. Demarcating an Urban Development Boundary can also protect valuable agricultural land and ecologically sensitive areas from urban encroachment. But an Urban Development Boundary can also have drawbacks. For example, it can restrict the supply of land for urban development, which could inflate land prices within the boundary. Care should therefore be taken when demarcating an Urban Development Boundary. A balance should be reach between providing enough land for urban development and the need for sustainable and managed urban development.

The latest Urban Development Boundary is the 2007 boundary, as depicted on Figure 20. Within the Eastern Sub-Region, this boundary includes the Leeukop Correctional Services area, Sunninghill, Mia's land and Kyalami, but excludes the western parts of the Blue Hills area. The result of the later is that the northern parts of the K71 is excluded and the potential of developing this road into a corridor. Reasons for excluding this part of the Blue Hills area may be due to problems experienced in connecting localized areas within the Blue Hills area to the bulks sewer network.

A new Urban Development Boundary is proposed by this study, which is illustrated on Figure 20. The proposed Urban Development Boundary was first and foremost demarcated according to the Land Use Budget estimates for settlement expansion up to the year 2020. In other words, the Urban Development Boundary does not allow the Eastern Sub-Region to sprawl beyond the spatial limits required by the population growth of the Eastern Sub-Region up to the year 2020. Other principles used to demarcate the Urban Development Boundary include the following:

- The containment of the urban sprawl and the promotion of infill and densification
- The creation of urban corridors along public transportation routes, such as the K71
- The integration of existing and planned affordable housing projects (such as Olievenhoutbosch South) with other urban settlements
- The cost implications of establishing new infrastructure for new township developments in remote areas
- Taking into consideration unsafe geological conditions where and if applicable
- The conservation of environmentally sensitive areas
- The protection of high-potential agricultural land where and if applicable

Compared to the 2007 Urban Development Boundary, the proposed Urban Development Boundary excludes the Leeukop Correctional Services site and rather concentrates this settlement growth potential along the K71, specifically in the Blue Hills area, to establish the K71 corridor. It was argued that the Leeukop site can rather be developed as part of the PWV9 corridor, which would first require the construction of the PWV freeway.

TABLE 10: LAND USES AFFECTED BY THE URBAN DEVELOPMENT BOUNDARY

Inside Urban Development Boundary	Outside Urban Development Boundary
Urban settlements Business and office nodes Industrial and commercial areas	Extensive and intensive agriculture areas Conservation areas and nature reserves Tourism facilities and related activities Agricultural holdings Governmental uses

Source: Maluleke Luthuli and Associates, 2008

A guideline for the type of land uses to be allowed inside and outside of the Urban Development Boundary are depicted in the Table above. As a rule, the Urban Development Boundary applies to all developments requiring a township establishment application.

5.1.6. LAND USE AND TRANSPORTATION INTEGRATION

Land use and transportation integration forms the backbone of an efficient urban structure. It not only ensures the cost-effective operation of the region's public transportation system, but it also tends to limit urban sprawl by concentrating urban development at higher densities close to public transportation routes. In addition, the mixing of land uses creates a better relationship between areas of residence and employment, which can lead to shorter commuter distances and a better two-way use of transport infrastructure.

5.1.6.1. TRANSIT ORIENTATED DEVELOPMENT (TOD)

The key to successful land use and transportation integration is obtaining higher land use densities and a greater mix of land uses at transit stations, such as bus stations. These are the points where access is obtained to the public transport systems and attempts should thus be made to optimally use these strategic locations. This can be done by locating a mix of work, community and higher-density residential uses at these stations, thus creating a one-stop service area for commuters. These are known as Transit Oriented Development (TOD).

TOD design elements
• Walkable design with pedestrians as the highest priority • A commuter rail station or bus station or taxi rank as the central feature of the TOD • A mixture of land uses in close proximity, including office, residential, retail, and community uses • Higher-density, high-quality housing development within 4-10 minute walk radius (400-1000m) surrounding a commuter rail station or bus station or taxi rank

Of particular importance is the integration of housing development and public transportation. Public transportation is and must be central to housing development, specifically higher-density housing development, simply because households that typically live in higher densities are more reliant upon cheap and efficient public transport to access employment opportunities. Housing densities exceeding 20 units per hectare should be encourage within TODs, with densities exceeding 60 units per hectare encouraged close to transit stations. This will necessitate developing housing typologies that defer from conventional single

dwelling units, towards higher-density housing typologies. Higher-density housing developments need to be located walking distance of a public transportation station, generally accepted to be 400m from a station, which can also be considered the peripheral boundary of a TOD.

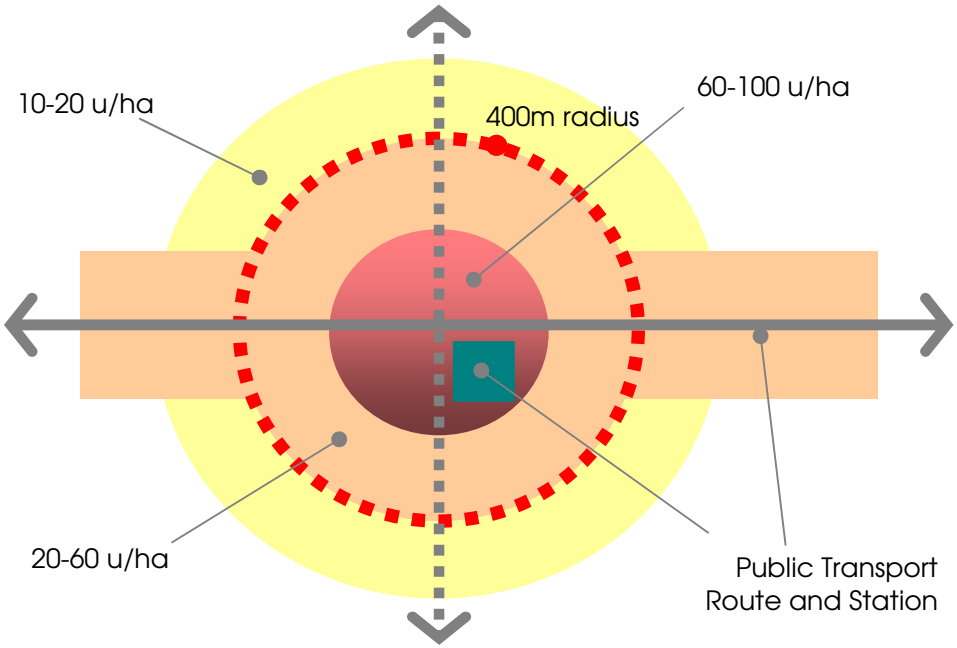


DIAGRAM 24: PROPOSED TOD HOUSING DENSITIES

Public transit is best supported if both higher densities and a land use mix are employed. Simply increasing densities in an area may do less to improve accessibility if not mixed with other uses such as shops and public amenities. Land uses can be mixed horizontally or vertically. Whereas the horizontal mixing of land uses is usually found in predominantly residential areas, the vertical mixing of land uses is predominantly found in business areas, where land is valuable and scarce, not allowing the development of certain uses on ground level. The Diagram below provides a conceptual illustration of the vertical mixing of land uses.

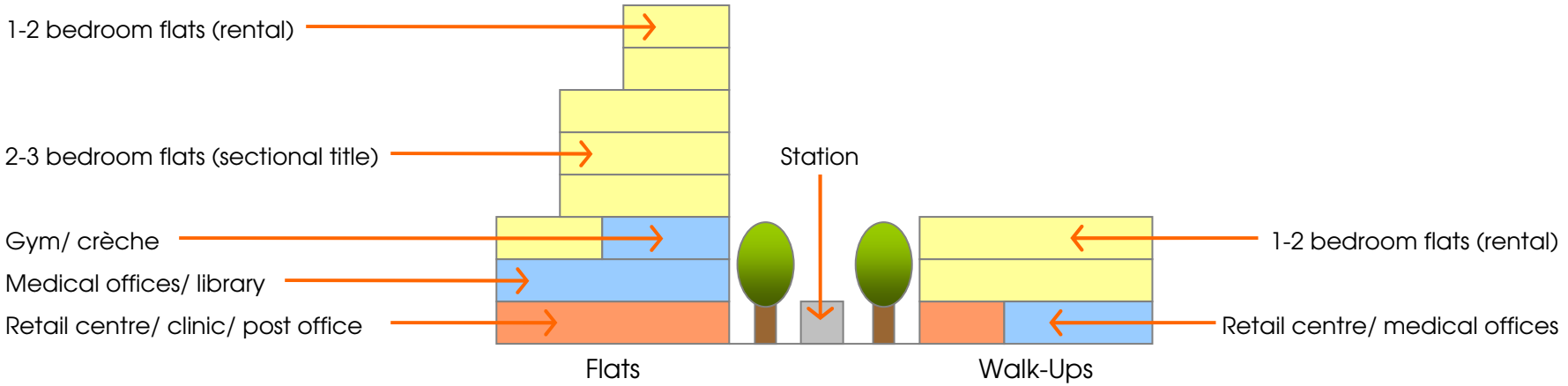


DIAGRAM 25: VERTICAL LAND USE MIXED-USE

Traditionally, certain land uses are not provided as part of a vertical mix within our cities. For example, schools are only provided on ground level and never as part of a vertical mix of buildings. In countries where land is scarce, such as Germany and Japan, schools are often provided as part of the vertical mix of buildings. In other words, excluding certain land uses from the vertical mix of buildings in our cities is often more an issues of perception than a matter of practicality. The need to mix such land uses vertically becomes a consideration when densifying parts of our cities that no longer have land available at ground level. For example, providing dwelling units within dense areas of our cities will inevitable increases the need for accessible community facilities, such as schools, requiring the provision of such land uses on the upper levels of buildings within such areas.

TODs can essentially be implemented in one of two ways: TODs located within an existing township, forming part of a brownfield development, and TODs forming part of a new town development (see Diagram below). TODs located within an existing township will involve the development of vacant stands within walking distance of public transportation termini for TOD-related uses, such as higher-density housing. TODs located within existing townships are ideal for use are part of urban renewal initiatives.

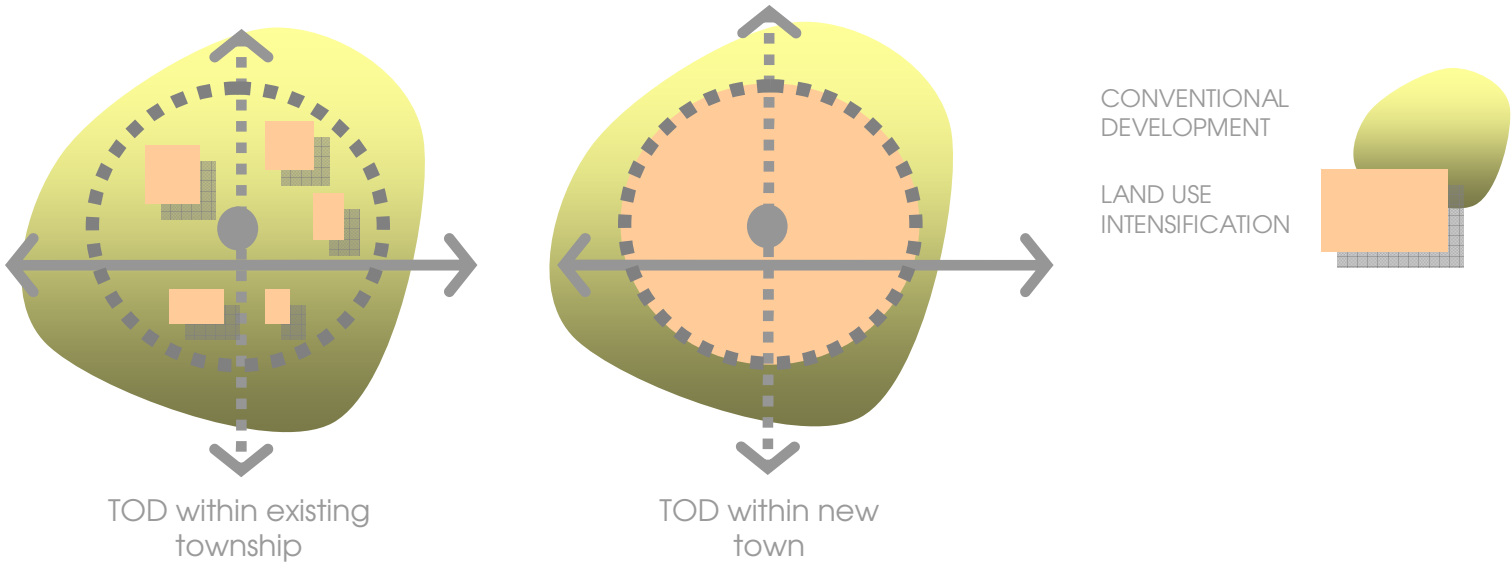


DIAGRAM 26: TOD IMPLEMENTATION ALTERNATIVES

TODs associated with new-town development involve the deliberate planning, design and construction of TOD-structures as part of a new town development. Because these TODs are new developments, the opportunity exist to apply sound TOD principle to the design from the start. Consequently, such TOD will better integrate land use and public transportation than would TOD created within existing townships.

Key to the development of TODs is the manner in which land uses within TODs are integrated with the public transportation system (bus or taxi) serving these TODs. This will involve creating pedestrian-friendly environments within TODs, using pedestrian walkways and public squares, and using these pedestrian environments as the link between the public transport stations and the surrounding land uses. A grid road and pedestrian network best suites pedestrian movement.

5.1.6.2. APPLICATION OF TODS

Transit Orientated Developments or TODs are best applied using a string-of-beads development pattern. A string-of-beads development pattern is usually shaped by a major road or commuter railway line, concentrating development (TODs) at intersections or transit stops along the spine (see Diagram below). Consequently, the string-of-beads settlement configuration is ideal for the operation of public transportation systems.

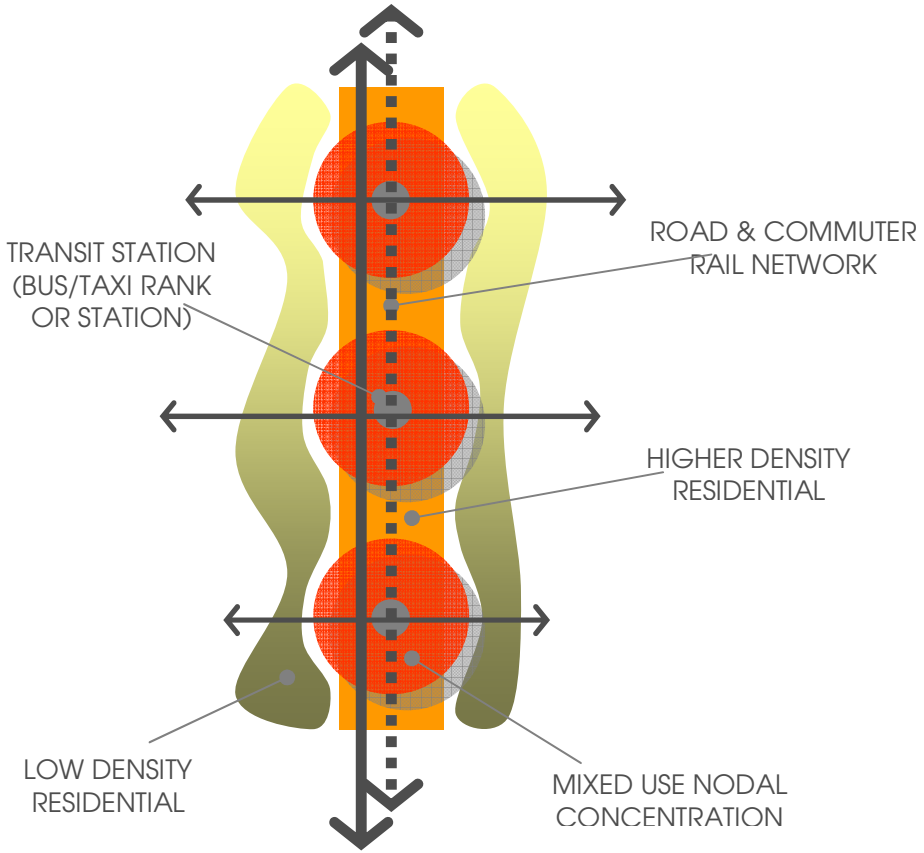


DIAGRAM 27: STRING-OF-BEADS CONFIGURATION

The scale of the string-of-beads settlement configuration can vary. On its largest scale it can extend from one city to another (which is the typical linear settlement mentioned above). The degree to which this development pattern is identifiable within a city is often dependant upon whether it is deliberately promoted through development policies or not. Policies that aim to develop a city that is centred on promoting the use of public transport, often exhibits a more defined string-of-beads development pattern, than a city that promotes the use of private vehicles.

5.1.6.3. PROPOSED TRANSIT ORIENTED DEVELOPMENTS (TODS)

The locations of TODs are governed by specific criteria, because the success of a TOD is largely depended upon its location. Based on the various aspects of TODs set out above, the following guidelines for the location of TODs are applied to determine a suitable location for TODs within Eastern Sub-Region:

- A TOD should be located on or directly connected to a public transportation route.
- A TOD should utilize existing, transit termini, such as commuter railway stations or taxi ranks.
- A TOD should be located on an area with enough vacant (non-urbanized) land for its development.
- A TOD should promote urban infill by using vacant land within existing urban area.
- If possible, a TOD should be located next to existing, planned or proposed non-residential activities. These will provide kick-start facilities for the development of these TODs.

The Diagram below illustrates the TODs proposed within the Eastern Sub-Region. These TOD locations correspond with the mixed-use nodes proposed for the Eastern Sub-Region, and are centred on the BRT stations proposed for the Eastern Sub-Region. Because the proposed TODs use the BRT station as focal points, the TOD and strung along the BRT routes in a string-of-beads pattern, as mentioned at the beginning of this Section of the report. The most notable TODs proposed within the Eastern Sub-Region are the TOD serving the proposed regional mixed use node located south of the planned PWV5 and K71 interchange, the TOD located on the intersection of the K60 and K73 in Sunninghill, and the TOD located on at the proposed commercial areas located on the K56 and PWV9 interchange.

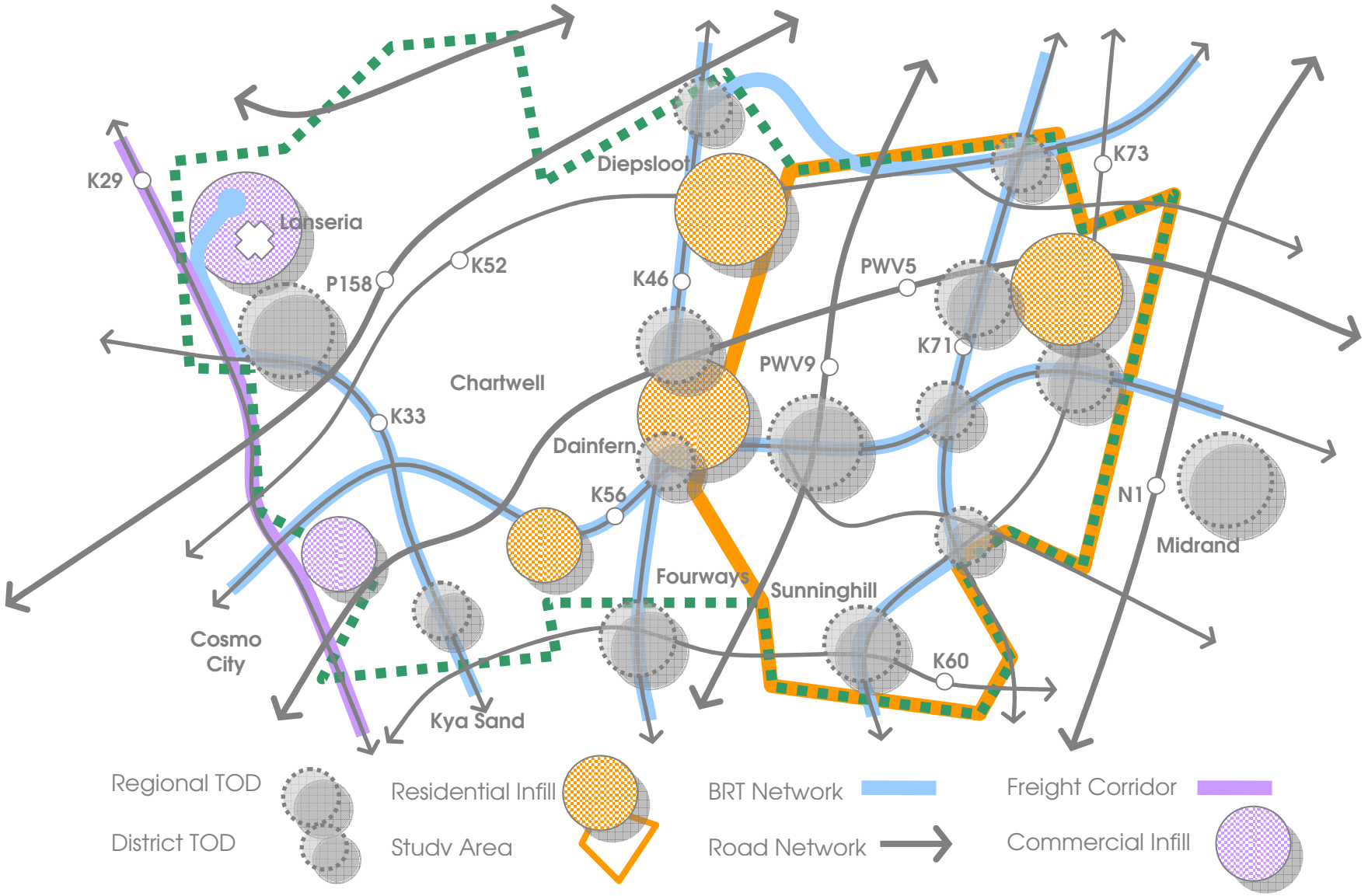


DIAGRAM 28: PROPOSED TOD DEVELOPMENT

TABLE 11: PROPOSED ROUTES, STATION AND INTEGRATION

Proposed BRT Routes	TOD Location	TOD Classification	Type of Land Uses Proposed
Sunninghill to Olievenhoutbosch	K60 and K73 intersection in Sunninghill	Regional TOD	Higher-density residential and business uses
	K73 and K71 intersection south of Kyalami	District TOD	Higher-density residential and business uses
	Directly south of the K71 and PWV5 interchange	Regional TOD	Higher-density residential and business uses
	K71 and K27 intersection south of Olievenhoutbosch	District TOD	Higher-density residential and business uses
Cosmo City to Midrand Gautrain Station	K71 and K56 intersection north of Kyalami	District TOD	Higher-density residential and business uses
	K73 and K56 intersection northeast of Kyalami	District TOD	Commercial and office uses

Source: Maluleke Luthuli and Associates, 2008

It is proposed that the TOD concept be embraced for the Eastern Sub-Region and implemented over the long term. Practically, this will involve identifying TOD area and facilitating the development of land uses that support the TOD concept. Apart from the Municipal Town Planning Departments, institutions that should be involved in developing TODs are the transit agencies (Department of Transport, taxi associations and bus companies), provincial departments (housing, health and education), private developers (e.g. retailers), financiers and the local community. Because the success of TODs requires committed stakeholders, these bodies should be involved in all the planning stages of TODs.

5.1.6.4. DENSIFICATION SPINES

A densification spine is a higher order road, typically used as a public transportation route, accommodating high-density residential development immediately adjacent to it (see Box below). The following densification spines have been identified within the Eastern Sub-Region and should become the focus of high-density residential development:

- K71 (Main Road) and K73 (west of K71): The K71 and part of the K73 is proposed as the primary public transportation (BRT) route through the Eastern Sub-Region and should therefore be densified in support of the BRT system.
- K56: the K56 is a proposed east-west public transportation linkage, which will ultimately link Cosmo City to Midrand and the Midrand Gautrain Station.

- K52: The K52 is an envisaged longer-term public transportation spine linking Diepsloot and Olievenhoutbosch to Centurion.

Densification Spine
A densification spine refers to a major road accommodating high-density residential development immediately adjacent to it. Typically, densification spines are public transportation routes that connected a number of mixed-use nodes within a region. Transit stations are provided at the mixed-use node and along the spine to provide access to the higher-density residential areas abutting the spine.

Land use intensification along the identified densification spines within the Central Sub-Region should be limited to residential densification only, typically involving the development of flats, walk-ups and cluster housing. A mix of land uses (including for example retail and office uses) should not be encouraged along these densification spines, but should rather be limited to the demarcated mixed use nodes. In other words, 'strip development' should not be encouraged along the densification spines. Strip development has many drawbacks: it is esthetically unpleasing, it encourages chaotic vehicular movement and it does not concentrate development sufficiently to enable the creation of pedestrian environments.

5.2. INFRASTRUCTURE DEVELOPMENT

Infrastructure development often forms of backbone of urban development initiatives. The reason for this is the fact that infrastructure development provides the access, the capacity and the opportunities for urban development.

5.2.1. TRANSPORTATION

Developing the Eastern Sub-Region's transportation infrastructure is dealt with in terms of the road network and public transportation network. Whereas the road network primarily refers to provincial and metropolitan roads, transit facilities refer to public transportation routes and stations (bus and rail) that provide access to public transportation systems. Figure 21 illustrates the transportation infrastructure development proposals made for Eastern Sub-Region.

5.2.1.1. ROAD NETWORK DEVELOPMENT

An extensive freeway and distributor road network is planned for the Eastern Sub-Region (as was set out in the Status Quo section of this report), characterized by strong north-south and east-west linkages. However, compared to the planned network, the existing network is poorly developed. The reason for this is probably because the Eastern Sub-Region was mostly rural in nature until recently. However, this situation is rapidly changing as the area is urbanized. Consequently, urbanization is exerting pressure for the development of the planned road network or at least parts thereof. Planned freeway and distributor roads that are currently prioritized in terms of provincial planning and developer pressure as follows:

a. Freeway construction

The PWV 9 will most probably be the next freeway to be built within Gauteng, primarily because it needs to serve as an alternative route to the N1 freeway between Johannesburg and Tshwane. Whether the entire route from Sandton to Soshanguve will be constructed is in question, because the section of the road north of the N14 freeway involves tunneling through 3 mountain ranges, which is costly. However, the stretch of the PWV9 south of the N14, linking the Sandton to the N14 freeway is feasible and will allow commuter to access Johannesburg via the N14 and the PWV9. In addition to the PWV9, the section of the PWV5 stretching from Cosmo City to Midrand is also considered a priority, as this freeway will relieve pressure on the N1 freeway. Currently, the N1 is carrying all the east-west destined regional traffic within the northern reaches of Johannesburg, but was actually only intended as the bypass for national traffic. Both the PWV9 and the PWV5 are at detailed design level, the planning level before construction.

There is great concern amongst the residents of the Eastern Sub-Region, in particular the residents of the small holdings located along the planned alignment of the of the PWV9 freeway, on the impact that the freeway will have on the rural residential landscape of the Eastern Sub-Region. As a freeway, the purpose of the planned PWV9 is first and foremost mobility. In other words, the freeway aims to transport large volumes of traffic efficiently over large distances. This purpose impacts on the design of the freeway; usually involving grade separation and interchanges located at 3km intervals, which makes the freeway largely inaccessible from neigbouring properties. As a result, a freeway tends to cut or split communities, creating a buffer between communities, hence the concerns of the communities of the Eastern Sub-Region.

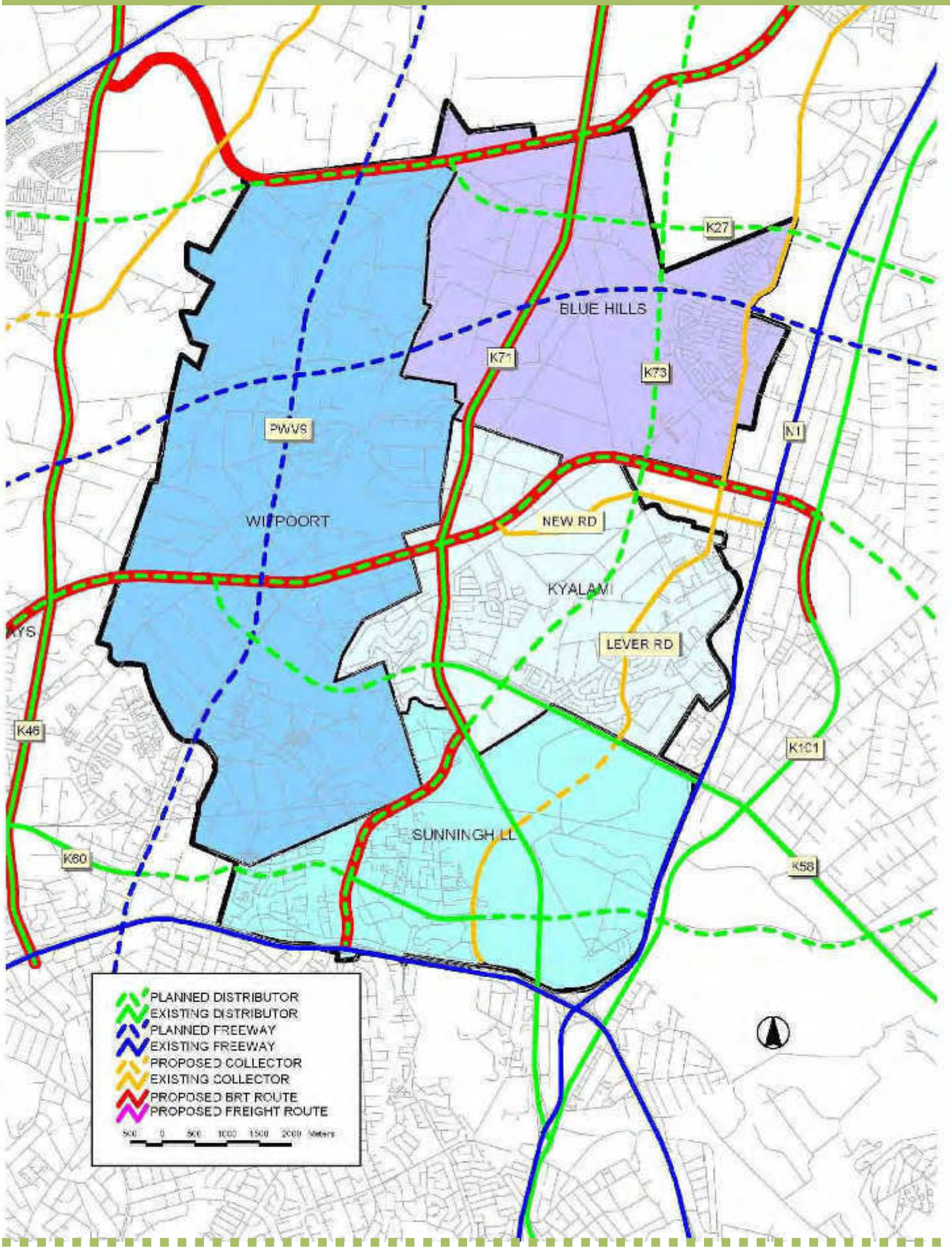


FIGURE 21
PROPOSED ROAD NETWORK

To address the above, it is suggested that the Eastern Sub-Region communities engage with the Provincial Roads Department (Gautrans) to research and considered alternative options for the design and/ or alignment of the PWV9 freeway. Mention was made in the stakeholder meetings that as an alternative, the PWV9 could be replaced by an enlarged K46 (William Nicol Drive) and K71 (Main Road) road design. The proposed BRT routes along these roads can assist in transporting the high commuter volumes. Another alternative would be to maintain the current alignment of the planned PWV9 freeway, but alter its design to negate its impact of the local landscape. For example, it can be developed as a pedestrian-crossable, accessible road, with additional lanes to allow the same traffic volumes and mobility that a typical freeway would be able to accommodate. The additional lanes could the separated to reduce the scale of the road's cross-section in a particular area.

b. Distributor road construction

Two distributor roads in particular are a priority within the Eastern Sub-Region: the K56, the K60 and the K73. The K56 will provide a needed east-west linkage, linking Cosmo City, as well as the northern reaches of Fourways and Kyalami, to Midrand. The development of this road is favoured by private developers as it will open up development within the central parts of the Eastern Sub-Region. The K60 has partially been constructed in the Sunninghill and Fourways regions. The remaining section of this road between Sunninghill and Fourways needs to be completed. This will provide commuters access to alternative interchanges to the N1 freeway, thus better distributing access to the N1 freeway. Also, the section of the K73, linking Rivonia Road to the K71 (Main Road) needs to be constructed. This will enable the construction of a BRT route that will link to the current BRT route on Rivonia Road and stretches up along the K71 to Olievenhoutbosch. This K73 road link is considered a high priority.

c. Collector road construction

Compared to the distributor road network, the collector road network is poorly conceived and developed. This creates a situation whereby the internal road network designed to serve small holdings is used to access employment and shopping areas within the region. To address this, it is proposed that Lever Road be extended southwards to link up with Maxwell Drive in Sunninghill. This will create a north-south collector road serving the strip development abutting the N1 freeway. This linkage will cross Mia's Land and will therefore have to be taken into account in the layout design of Mia's Land.

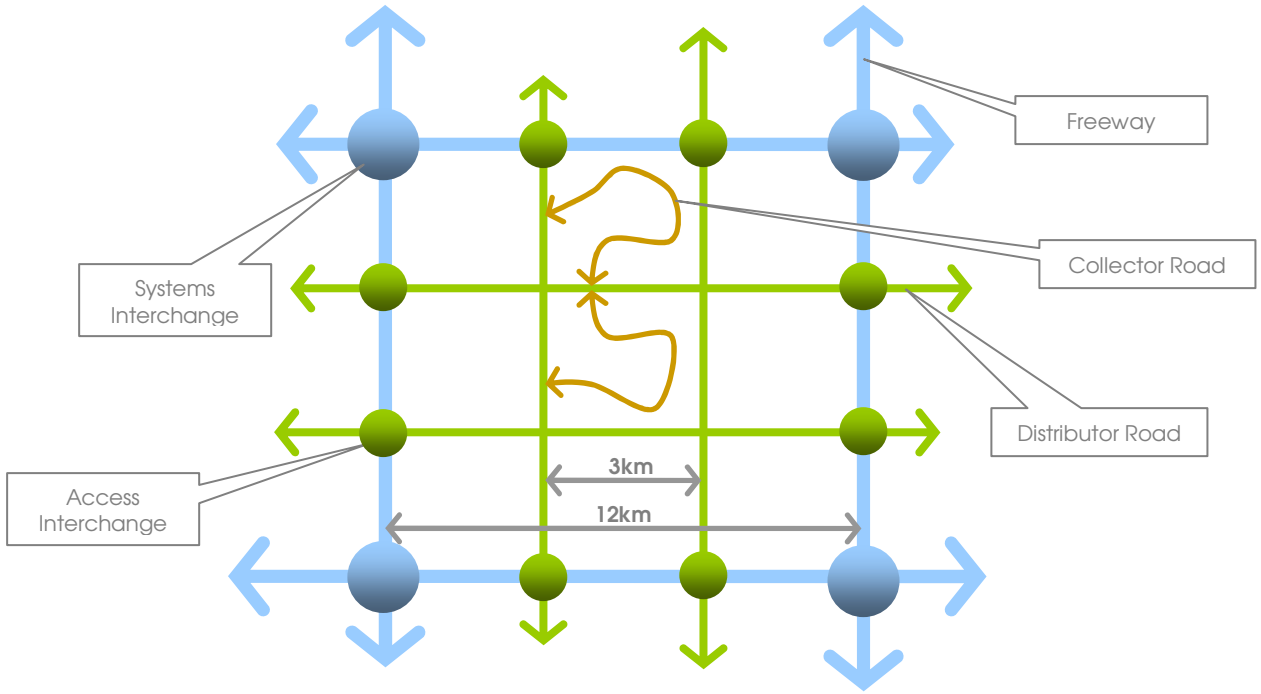


DIAGRAM 29: CONCEPTUAL PWV ROAD GRID NETWORK

Access to the freeway and distributor road network is determined by the PWV road network design parameters. This grid road network was designed with the freeways (PWV roads) spaced 5 to 12km apart and the distributor roads (K-rood) spaces 2 to 3km apart (see Diagram above). This implies that access to a freeway can only be obtain at 2 to 3km intervals, via the distributor road network, making freeways inaccessible from neighbouring land uses, except at its interchanges.

If a strip development is envisaged next to the PWV9 freeway similar to the Midrand Strip, this will have to be deliberately addressed using distributor or collector roads, which are more accessible. For example, the Midrand Strip exists because the Old Pretoria Road (K101), which provides access to land parcels abutting the N1 freeway. To enable this, a ring-road is proposed that will encompass a strip of smallholding on either side of the planned PWV9 freeway. This ring-road will provide access (e.g. to trucks) to these smallholding areas, which will allow the smallholding areas to be developed with uses similar to those found along the N1 freeway. Logically, these areas will not be developed before the PWV9 and proposed ring-road are constructed.

TABLE 12: ROAD HIERARCHY AND DESIGN

Road Type	Road Classification	Purpose	Design	Responsibility
Freeway	National road and PWV routes	Links towns and cities	Dual carriageway and grade separating interchanges	National and Provincial Government
Distributor road	K-routes	Links city regions	Dual carriageway with level intersections Allow reserve with for BRT system where applicable	Provincial Government Consultation with Metropolitan Municipality with regard to BRT design
Collector road		Links suburbs	Single carriageway with level intersections	Metropolitan and Local Municipalities

Source: Maluleke Luthuli and Associates, 2008

Basic design plans have been drafted for the design for the freeways and distributor roads planned for the Central Sub-Region. Consequently, the road reserves have been established and are required to be incorporated in the layout plans of township establishment applications. This requirement is enforced by the Provincial government, who is responsible for the PWV road network (PWV and K-routes) implementation.

In addition, it is proposed that the BRT routes (as proposed in this report) be incorporated in the designs of the distributor roads. Usually, a distributor road (or K-routes) has a fairly wide island separating the road surfaces. Such an island can be converted into dedicated bus lanes for the BRT network. To avoid retrofitting a distributor road designs at a later stage, it is recommended that the Johannesburg Metropolitan Municipality consults the Gauteng Province with regard to this matter, to ensure that the BRT network design is incorporated into the distributor road design at an early stage.

The proposed collector roads will not be the responsibility of the Provincial government, but will be the responsibility of the Johannesburg Metropolitan Municipality (see Table above). As such it is recommended that the Municipality prepares basic design plans for the Lever Road link and that the road reserve of this link be protected in the layout designs of township establishment applications affected by this road alignment. This road link needs to be phased and constructed as require by urban expansion within the Eastern Sub-Region.

5.2.1.2. PUBLIC TRANSPORTATION AND STATION DEVELOPMENT

Bus Rapid Transit (BRT) is a high-quality bus-based transit system that delivers fast, comfortable and cost-effective urban mobility through the provision of segregated right-of-way infrastructure, rapid and frequent operations, and excellence in customer service. BRT is simply the idea of creating a modern rail-like performance using road-based public transport technologies that are affordable to most cities.

The BRT system proposed for Johannesburg is expected to revolutionize public transport in Johannesburg. The Johannesburg BRT system will be modeled on the Curitiba Model (see box below), which has also been successfully implemented in countries like China, France and Ecuador. The Johannesburg BRT system will consists of a network of BRT routes and BRT stations located along these routes. Median lanes will be created exclusively for buses, the number and capacity of buses to deal with the expected demand will be drastically increased and there will be a pre-boarding ticketing system. There will be buses every one to three minutes and every 10 minutes in off peak times.

Curitiba Model

The city of Curitiba provides a model on how to integrate sustainable transport with urban development. This model involves making bus travel fast and convenient, effectively creating demand for bus use in the same way that the infrastructure of traditional cities creates demand for private motor vehicles.

Curitiba first outlined its Master Plan in 1965, with the main goal of encouraging growth along two structural north-south transport arteries, radiating from the city center. The plan called for the integration of traffic management, transportation, and land-use planning to achieve its goals. The Master Plan established the guiding principle that mobility and land use can not be disassociated with each other if the city's future design is to succeed. In order to fulfill the goals of the Master Plan, the main transport arteries were modified over time to give public transport the highest priority.

Separating traffic types and establishing exclusive bus lanes on the city's predominant arteries helped to mold the defining characteristics of the city's transport system: a reliable and efficient bus service and densification of development along the bus routes. As a result, Curitiba's petrol use per capita is 30 percent below that of other comparable Brazilian cities. Other results include negligible emissions levels, little congestion, and a pedestrian-oriented living environment.

The phase one proposal encompasses the same flagship corridors already identified in the Strategic Public Transport Network (SPTN). These include a north-to-south route from Sunninghill to Soweto and an east-to-west route from Alexandra to Randburg. The Sunninghill to Soweto route will link a number of Nodes, Including Rivonia, Sandton, Rosebank, Illovo, Killarney and Parktown. This phase one BRT network will also serve as a feeder system to the Gautrain stations located at Sandton and Rosebank. The planning and construction of phase one should be completed by 2009.

It is only logical to extend the BRT system into the northern region of Johannesburg. As opposed to the more established areas of Johannesburg, the new or developing areas pose an opportunity the develop and land use structure that will support the BRT system (higher densities and mixed land use) from the start. It will also provide a much-needed public transportation system within the northern region, which is currently lacks (as was determined in the status quo section of this report). The existing and proposed K-route network traversing the Eastern Sub-Region should be used for the proposed BRT system. A K-route design usually allows for a relatively wide median island, which can be used for the two dedicated BRT lanes. **This approach requires a mind-shift that now considers K-routes also to be public transportation spines, as opposed to only being private vehicle spines.** Apart from allowing the K-route median to be used for BRT lanes, more flexible public transportation oriented design parameters will have to be applied along K-routes, especially where such routes traverse mixed-use nodes. For example, pedestrian crossing and land use access intervals will have to be addressed differently within mixed-use nodes.

TABLE 13: PROPOSED ROUTES, STATION AND INTEGRATION

Proposed BRT Routes	Proposed Station Locations	Integration Principles
Sunninghill to Olievenhoutbosch	o The intersection of the K60 and K73 in Sunninghill o The intersection of the K73 and K71 south of Kyalami o The intersection of the K71 and K56 north of Kyalami o Directly south of the K71 and PWV5 interchange o The intersection of the K71 and K27 south of Olievenhoutbosch	o Develop higher-density, mixed land uses to support transit facility with required commuter numbers o Design and construct pedestrian walkways to facilitate access to BRT stations
Cosmo City to Midrand Gautrain Station	o Directly south of K56 and PWV9 interchange o K71 and K56 intersection northeast of Kyalami	o Integrate BRT station with Gautrain station: preferably a single integrated station o BRT stations to serve major commercial areas

Source: Maluleke Luthuli and Associates, 2008

It is therefore proposed that the phase one BRT route, currently terminating at Rivonia (on Oxford Street) be extended northwards along the K73 (yet to be constructed) and then follow the K71 (at the K71 and K73 intersection) up to Olievenhoutbosch. This route is depicted on Figure 21. In addition to the K71 route, which is a north-south aligned route, two east-west aligned BRT routes are proposed that will traverse the Eastern Sub-Region. The first is a route aligned along the K56, which connect Cosmos City to Midrand. What makes this proposed route of specific importance is its potential linkage to the Midrand Gautrain Station. This will allow the BRT network to function as a feeder system to the Midrand Gautrain station. To ensure optimal modal integration, it would be preferable to design the BRT terminus and Gautrain station as a single integrated station. The second proposed east-west aligned BRT route connects Diepsloot to Olievenhoutbosch along the K52 and has the potential to be extended to Centurion.

The efficient functioning of the public transportation system within the Eastern Sub-Region will not only require a well-developed BRT network, but will also require a well-developed BRT stations that are strategically located along the BRT routes. Well-designed stations are characteristic of BRT system with features such raised platforms for bus-level entry, prepaid ticketing system and the application of modern architecture to design striking facades. With regard to the location of the BRT stations, it is proposed that major stations within the Eastern Sub-Region be located at the intersections set out in the Table above, which correspond with the mix-use nodes identified within the Eastern Sub-Region. Smaller stations can be places at 400-600m intervals along the BRT route.

To ensure the optimal use of each BRT station, it will have to be integrated through competent design with its surround area and the land uses proposed for these areas. This design will involve focusing on pedestrian movement and how pedestrians exchange between the transit facility and the surrounding land uses. Competent building design is also necessary to ensure land use and transportation integration and will have to be applied to the design and layout of existing and planned buildings (clinics, retail centre, walk-ups, etc.) abutting this transit facility.

5.2.2. MUNICIPAL SERVICES

Although this study addresses the primary municipal services (water, electricity and sanitation), it does not assess the capacity of the bulk municipal services network to accommodate urban expansion and densification. Determining capacity involves complex calculations by engineers, thus falling outside the brief of this study. The way this study addresses the issue of bulk municipal services is to (a) ensure areas can connect to the bulk network (specifically the sewer network which is dependant

upon gravitation and therefore topography) and (b) provide an indication of the potential number of dwelling units and supporting land uses that would be development within the Eastern Sub-Region, which would require bulk network capacity.

The issue of access to the bulk network was dealt with as part of the section of this report dealing settlement expansion, because settlement expansion can only occur in areas that have access to bulk infrastructure. **With regard to the potential number of dwelling units and supporting land uses that would require bulk network capacity in future, the Land Use Budget attached as Annexure A provides the estimated numbers up to the year 2050.** Access to bulk municipal services capacity will be required in the following major development areas of the Eastern Sub-Region:

- Mia's Land: Mia's Land west and north of the N1 freeway. This will largely be dealt with under the development framework being prepared by the Mia's Land developers
- Kyalami: North and east of the existing Kyalami cluster and business park developments, to enable infill development between Kyalami and the Midrand strip.
- Blue Hills: In the Blue Hills area, mostly located east of Main Road (K71). Bulk service access will also have to be provided to a strip located on the western side of Main Road. There was mentioned that portions of land abutting the K71 within the Blue Hills area cannot access the Diepsloot sewer network using gravity, requiring the construction of a pump station. if no other solution exists, a pump station should be considered, because the development of the K71 corridor is a spatial priority.
- Olievenhoutbosch South: Bulk services access will be require if Olievenhoutbosch is expanded southwards across the Tshwane boundary. As with Blue Hills, the Olievenhoutbosch South development will form part of the K71 corridor development.

5.3. PUBLIC REALM

Creating a sustainable urban environment involves creating balanced communities in terms of employment opportunities, social amenities and recreation facilities. In other words, it involves supporting residential development with other land use types, such as schools, clinics, retail facilities and parks.

5.3.1. NODAL DEVELOPMENT

The Spatial Development Framework of Johannesburg uses a hierarchy of mixed-use nodes to delineate and contain mixed-use development within the municipal area. The metropolitan mixed-use node occupies the first place in the nodal hierarchy, and is represented by the Sandton and Midrand CBDs. The regional mixed-use node occupies second place in the nodal hierarchy. Sunninghill and Parktown are examples of regional mixed-use nodes. The district mixed-use node occupies third place in the nodal hierarchy and is represented by areas such as Illovo and Killarney.

The mixed-use node hierarchy was applied to the Western Sub-Region. A number of mixed-use nodes were delineated and are illustrated on Figure 22. Each of these nodes are located on land with low development densities (usually farmland or agricultural holdings) allowing the redevelopment of these areas into high-density, mixed-use area. These nodes were also distinguished in terms of existing, proposed and future nodes. Proposed nodes are nodes that are proposed to be developed by the year 2020, thus falling within the timeframe of this study. Future nodes are nodes that are envisaged, but which will most probably only be developed after 2020.

Community, recreation and economic facilities should be clustered within the mixed-use nodes proposed for the Western Sub-Region, rather than dispersed, in order to (a) stimulate the viability of these activities, (b) create strong focal points with which the surrounding communities can identify and (c) create a more ordered spatial structure. The composition of each mixed-use node within the nodal hierarchy must take into account certain key variable, such as its intended function of the node; the size of the population its serves and its geographical location. For example, a higher order mixed-use node will contain higher-order functions, such as a satellite university campus or hospital. Lower-order mixed-use nodes will contain uses that are required on a local level, such as a clinics or library.

5.3.2. ECONOMIC ACTIVITY

It is important that land use strategies are developed that recognize the need to stimulate economic growth and job creation within the Eastern Sub-Region. These land use strategies must focus institutional support and private sector spending to achieve the aforementioned. In turn, this will creates economic potential and provide opportunities for local communities to participate in local economic development.

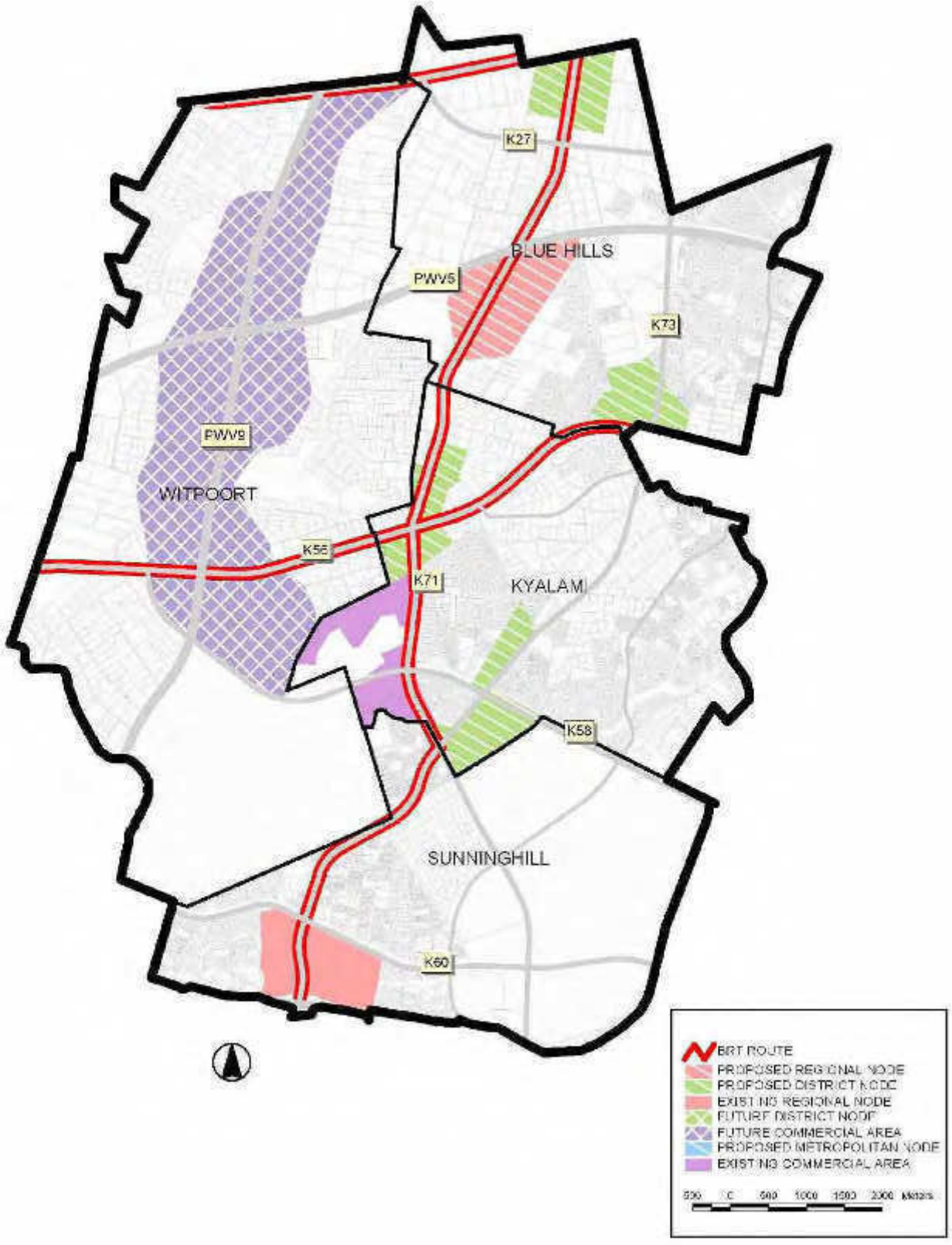


FIGURE 22
PROPOSED NODAL STRUCTURE

5.3.2.1. BUSINESS CENTRE HIERARCHY

Economic activities should be concentrated, rather than dispersed in order to stimulate the viability of these activities. To achieve this, economic activity should be clustered within the mixed-use nodes. The business component linked to each mixed-use node is summarized in the following Table. This Table also provides the proposed business composition suitable for each mixed-use node within the hierarchy. The size of the business component is dependant on the size and spending capacity of the Eastern Sub-Region population. This relation has been established in the Land Use Budget, set out in Annexure A.

a. Metropolitan mixed-use node

A metropolitan mixed-use node is a business node of city-wide significance and can therefore develop a strong retail, entertainment and office component. The retail component can accommodate 2 or more regional shopping centres, similar to Sandton City. The entertainment component should include entertainment venues that cater for national events, such as music concerts and motor shows. This will require venues similar to Gallagher Estates and the Coca-Cola Dome. A metropolitan mixed-use node can accommodate a large office component, comprising for example campus-layout office developments of national and international corporations. Access to an international airport (such as Lanseria Airport) would be a necessity.

b. Regional mixed-use node

A regional mixed-use node can accommodate a regional shopping centre or retail floor area equaling that of a regional shopping centre. In addition, a regional mixed-use node can accommodate entertainment venues of regional significance, such as a cinema complex and casino. The office component can provide office space for businesses operating within the larger Gauteng area.

c. District mixed-use node

A district mixed-use node will require a medium-sized shopping centre or a total retail area similar to that of a medium-sized shopping centre. In addition, a district mixed-use node can accommodate local entertainment venues, such as restaurants and cafes, as well as a cluster of office buildings catering for local businesses, such as medical, law and accounting firms.

TABLE 14: BUSINESS CENTRE SIZE AND COMPOSITION

Node hierarchy	Centre size	Minimum trade area	Minimum access requirements	Composition
Metropolitan mixed-use node	600000-900000m2	8km	Access to freeway, distributor road and major public transport route Linkage to an international airport	Two or more regional shopping centres Large-scale entertainment venues, catering for national events such as concerts and motor shows Cluster of large-scale office buildings catering for national and international corporations
Regional mixed-use node	300000-600000m2	4km	Access to distributor road and major public transport route	A regional shopping centre Entertainment venues of regional significance, such as cinemas, casinos, etc. Cluster of office buildings catering for business operating in Gauteng
District mixed-use node	<300000m2	2km	Access to distributor road	A shopping centre Local entertainment venues, such as restaurants and cafes Cluster of office buildings catering for local enterprises, such as law and accounting firms

Source: Maluleke Luthuli and Associates, 2008

5.3.2.2. BUSINESS CENTRE DEVELOPMENT

To ensure the viability of proposed economic activities within the Eastern Sub-Region, it is important to (a) link the business areas proposed to the Land Use Budget, and (b) develop a retail hierarchy to ensure the orderly and logical development of retail facilities within the Eastern Sub-Region. Two regional business nodes are proposed. The first comprises the existing Sunninghill mixed-use node and the second is proposed within the Blue Hills area, on the intersection of the K71 and the planned PWV5. These nodes can accommodate approximately 300000m2 of business space by the year 2020 and can include a sizable office, retail and entertainment component, providing employment opportunities and services to the entire Eastern Sub-Region population.

Four district mixed-use nodes are proposed for the Eastern Sub-Region. These nodes aim to serve local neighbourhoods and are therefore centrally located within the suburbs they serve. All these nodes have been located on proposed public transport routes (BRT routes) and to link and to increase the accessibility of these nodes. Each district node could accommodate approximately 250000m2 of business space by the year 2020, comprising a sizable office cluster and retail component.

It is imperative that the development of the proposed regional and district mixed-use nodes coincide with residential expansion within the Eastern Sub-Region. In other words, proposed nodes should not be allowed to develop until residential expansion has reached to boundaries of the proposed nodes. Nodes located on the peripheral areas of the Eastern Sub-Region, such as the proposed Olievenhoutbosch South district mixed-use node (located on the intersection of the K52 and K71), should not be allowed to develop before nodes that are located next to existing residential areas, such as the district mixed-use node proposed in Kyalami (located on the intersection of the K73 and K58).

5.3.3. COMMUNITY FACILITIES

Housing development in particular requires the support of other land use types, such as schools and clinics, in order to create sustainable living environments. As was determined in the status quo section of this report, the Eastern Sub-Region has a poorly developed community infrastructure network, which urgently needs to be addressed. It is imperative that proposed community facilities, as set out in the Land Use Budget, be located in such a way that they are accessible to the communities they serve. This is best achieved using a hierarchy of community nodes.

5.3.3.1. COMMUNITY FACILITY HIERARCHY

The composition of the proposed mixed-use nodes in terms of community facilities have been specifically designed to suite the Eastern Sub-Region and should serve as a guideline for the design and development of these nodes. The proposed composition of each mixed-use node is depicted in the Table below.

a. Metropolitan mixed-use node

A metropolitan mixed-use node, providing higher-order community services, serves a region within the municipal area, comprising of a number of suburbs. With regard to educational facilities, the metropolitan node should accommodate a

region's tertiary educational facilities, as well as a number of primary and secondary schools. With regard to health care, the metropolitan mixed-use node should provide the region's hospital(s), as well as other higher-order and specialized medical facilities. Other community facilities to be provided in this node include a large community hall, police station and emergency service centre. These facilities are all highest-order facilities when compared to similar facilities provided in lower-order nodes.

TABLE 15: COMMUNITY FACILITY COMPOSITION

Nodal Hierarchy	Service Area Radius	Size	Proposed composition
Metropolitan mixed-use node	8km	30ha	1 tertiary education facility 1 secondary schools 2 primary schools 1 hospital 1 large-scale post office 1 large-scale library 1 large-scale community hall 1 large-scale police station 1 emergency service centre
Regional mixed-use node	4km	20ha	2 secondary schools 3 primary schools 1 day hospital 1 medium-scale post office 1 medium-scale library 1 medium-scale community hall 1 small-scale police station
District mixed-use node	1-2km	15ha	1 secondary schools 2 primary schools 1 clinic 1 small-scale post office 1 small-scale library 1 small-scale community hall

Source: Maluleke Luthuli and Associates, 2008

b. Regional mixed-use node

A regional mixed-use node should serve one of two suburbs and should provide medium-order community services to the suburbs they serve. A regional node should at least comprise a secondary school, 2 primary schools, a community centre and a library. It can also accommodate a day hospital and a police station, only on a slightly smaller scale than those provided in a metropolitan mixed-use node.

c. District mixed-use node

District mixed-use nodes should provide low-order community services to localized areas within suburbs. A district node should at least comprise a secondary school and a primary school, but can also contain a clinic and a post office. These types of community facilities need not be restricted to district mixed-use node, but can also be clustered within residential areas.

5.3.3.2. COMMUNITY FACILITY DEVELOPMENT

The Land Use Budget set out in a previous section of this report calculated the number of community facilities required within Eastern Sub-Region to support the existing and envisaged year 2020 population within Eastern Sub-Region. These facilities have been divided into a hierarchy of mixed-use nodes (as set out in a Table above), basically comprising regional and district community facilities.

Regional community facilities should be located at the proposed Blue Hills regional mixed-use node, located on the K71 and planned PWV5 intersection. This node would, for example, be suitable for a day hospital, and police station, and other higher-order community facilities. Regional community facilities can also supplement the existing regional community facilities (such as the Sunning Hospital) within the Sunninghill Regional mixed-use node.

A number of district mixed-use nodes have been proposed for the Eastern Sub-Region, requiring district community facilities. The Kyalami District mixed-use node in particular, located on the intersection of the K71 and the K56 requires a number of schools to support the existing higher-density residential component (cluster housing) within the bordering Sunninghill node. In addition, district community facilities can be clustered within existing and envisaged residential neighbourhoods, in order to be within

walking distance of the residential neighbourhoods they serve. Community facilities that are used and a daily basis, such as a primary school, a post office and a clinic, are suitable for such clusters.

As was mentioned, the Eastern Sub-Region has a poorly developed community infrastructure network, lacking the most basic community facilities such as schools and clinics. The primary reason for this is the fact the most of the Eastern Sub-Region, which comprises small holdings, is being developed into cluster housing developments. Individually, these cluster developments do not reach the threshold for providing any community facilities. However, collectively, these cluster developments are developing large numbers of housing, without any of these cluster developments taking responsibility for providing schools stands.

To address the situation mentioned above, it is proposed in developers of cluster housing be required to provide contributions for the purchasing of stands for community facilities, much in the same way that developers make bulk services contribution. These funds will have to be ring-fenced and used by the municipality to purchase land (small holdings) for the development of community nodes. Because the availability of land for sale is unknown, the exact location of community nodes can only be determined during the purchasing phase.

In order to develop the community infrastructure required within the Eastern Sub-Region, the Johannesburg Metropolitan Municipality will have to work in close relationship with the provincial governmental bodies concerned with the development and management of community facilities, such as the Gauteng Department of Health and Welfare and Department of Education. The responsibility of the Johannesburg Metropolitan Municipality will be to ensure that the necessary stands for community facilities are provided and that these stands are strategically placed. The construction and management of the relevant buildings will be the responsibility of the provincial government departments concerned.

5.3.4. OPEN SPACE & RECREATION

An open space system fulfils a number of functions. These functions include hazard avoidance, resource conservation, ensuring community well-being and educational. These functions are listed in more detail in the Table below. Open space and recreation within the Eastern Sub-Region can be divided into 2 categories: passive and active open space. Passive open space consists of land that is unsuitable or undesirable for urban development due to topographical, ecological constraints or for flood protection. Passive open space also involves landscape spaces within an urban area, such as parks and pedestrian walkways. Active open space involves the recreational component of the open space system. It provides sport facilities throughout an urban area for use by local clubs and schools.

TABLE 16: FUNCTIONS OF AN OPEN SPACE SYSTEM

Hazard avoidance	Resource conservation	Recreational and psychological	Educational
Open spaces must reserve flood prone areas. Open spaces must reserve steep slopes and geologically unstable ground. Open spaces should protect drinking water sources from being contaminated.	Open spaces must protect water sources. Open spaces must protect linked areas of conservable indigenous vegetation.	Developed and maintained open space must be provided for recreational purposes. Open space must be provided for community interaction and as symbols of community identity. Open spaces must be protected for psychological relief from the stresses of urban live.	Open spaces must be protected for environmental education purposes. Well-equipped and designed open spaces must be provided for sport education.

Source: Maluleke Luthuli and Associates, 2008

5.3.4.1. PASSIVE OPEN SPACE

The greening of urban areas is of utmost importance for the psychological and physical well-being of a community. To a large extent, ecological areas provide a strong and significant element of greening within an urban area. Apart from the aforementioned, passive open space protects land that is unsuitable or undesirable for urban development due to a number of reasons, such as geotechnical constraints or flood protection. The conservation of passive open spaces that contain watercourses is of specific importance.

The Jukskei River and the Sand River which flows into the Jukskei River, flows through the southern parts of the Eastern Sub-Region, affecting Mai's Land, the Leeukop Prison site and the western parts of Sunninghill. The Jukskei River in particular, is a significant natural water sources traversing the Eastern Sub-Region, which is important to the metropolitan area as a whole. Two tributaries of the Jukskei River flow through the northern parts of the Eastern Sub-Region, between Kyalami and Blue Hills.

At the very least, the natural drainage channels and banks of the Jukskei River and its tributary must be protected up to the 100-year flood line to protect the Eastern Sub-Region communities from flooding. However, GDACE often requires the protection of river environments wider than the 100-year flood line area, if the 100-year flood line area is narrow due to steep river embankments.

Due to the importance of the Jukskei river system, it is imperative that the ecological integrity of this river system be protected. To date, the upstream parts of this waters source has been exploited and damaged due to informal urban development and dumping. To protect his river system, dumping must be strictly prohibited and the pollution of these water sources by sewerage and other harmful effluents avoided at all costs.

5.3.4.2. ACTIVE OPEN SPACE DEVELOPMENT PRINCIPLES

Formulating principles for the development of active open spaces can help ensure that standards of quality and usefulness are achieved in the planning, design and management of such spaces. The following development principles need to be taken into account when developing active open spaces:

a. Linking a use to open space

Open spaces that do not have a deliberate use connected to them are often not of value to a local community and often become dumping ground as a consequence. It is therefore imperative that a use be linked to an open space to ensure the utilization of these spaces. One of the best ways of utilizing open spaces within urban areas is to use these spaces as recreation areas or sport facilities.

b. Type of Facilities Provided

When planning active open spaces, it is important that appropriate recreation facilities are provided. Often recreational facilities are provided that do not fulfill the needs of the community, usually because they are not the preferred recreational types. To prevent the provision of inappropriate recreational facilities, the recreational preferences of a local community must be established before planning and developing a recreational facility.

c. Maintenance of Active Open Spaces

An important factor in determining the success of active open spaces is the maintenance thereof. Past experience has proved that active open spaces that are not maintained often lose their practical value to local residents. Therefore, it can be argued that larger and fewer active open spaces that are maintained are more useful than smaller more numerous active open spaces that are not.

d. Accessibility of Active Open Spaces

When locating active open spaces, it is important to ensure that it is accessible to the community it serves. This implies locating an active open space within walking distance of most of the people living within a community. Locating an active open space centrally will also ensure the continued presence of people in the vicinity of such a facility, which would protect it from vandalism.

e. Urban Form and Function

In order to enhance the mentioned focal function of active open spaces, it is imperative that attention is given to the design of these active open spaces. For example, the planting of trees along the periphery of an active open space will enhance the identity and attractiveness of this space. If active open spaces are integrated through design with surrounding facilities, it will enhance the usage of these spaces. For example, placing an active open space next to or close to a primary school will allow the space to supplement school sport facilities.

5.3.4.3. ACTIVE OPEN SPACE HIERARCHY

The limited funds available for the construction of an active open space network necessitate a critical appraisal of the generally accepted standards and norms applicable to active open space development. An approach based on practical considerations rather than on accepted norms should be followed. One of the most practical ways of utilizing open spaces is to use these spaces as sport or recreation facilities. This connects a deliberate use to open spaces, ensuring they serve a specific community need.

Taking into account the above, a hierarchy consisting of three types of active open spaces is proposed for the Eastern Sub-Region. The composition of these active open spaces should serve as a guideline for the design and development of the active open spaces, but can differ depending on the recreational preferences of local communities. The proposed active open space hierarchy and its composition are depicted in the Table below.

a. Metropolitan mixed-use node

A metropolitan mixed-use node should provide recreation facilities that are significant on a metropolitan level, usually with a stadium making up the central facility within such a node. In addition to the stadium, such a node should contain other highest-order recreations facilities, such as practice rugby or soccer fields, a cricket oval, tennis courts, a swimming pool and a multi-purpose indoor sports centre. In addition, such a recreational facility must include a parking area and must be accessible to and from a large bus and taxi terminus. A metropolitan recreational facility will be the base of city sports clubs.

TABLE 17: ACTIVE OPEN SPACE COMPOSITION

Nodal Hierarchy	Service Area Radius	Size	Proposed composition
Metropolitan mixed-use node	8km	20ha	1 rugby or soccer and athletic stadium 3 practice rugby or soccer fields 1 cricket oval 6 tennis courts 2 netball courts Swimming pool Multi-purpose indoor sport centre
Regional mixed-use node	4km	15ha	1 rugby or soccer field and athletic track 2 practice rugby or soccer fields 4 tennis courts
District mixed-use node	2km	10ha	1 rugby or soccer field and athletic track 2 tennis courts Children's playground

Source: Maluleke Luthuli and Associates, 2008

b. Regional mixed-use node

A regional mixed-use node should provide regional sport facilities, typically a number of rugby or soccer fields. The rugby or soccer fields can double as a cricket oval. Such a recreational facility can serve as the base for regional sports clubs.

c. District mixed-use node

A district mixed-use node will serve local neighbourhoods and should therefore comprise local recreational facilities, such as a rugby or soccer field and a few tennis courts. As with community facilities, these types of recreational facilities need not be restricted to district mixed-use nodes, but can also be clustered within residential areas. These recreational facilities can supplement the recreation facilities of schools and can therefore be located in close proximity of schools.

5.3.4.4. ACTIVE OPEN SPACE DEVELOPMENT

A regional mixed-use node is proposed within the Blue Hills area. This node must contain regional recreation facilities, as depicted in the active open space hierarchy set out above. As such, this node must cater for the higher-order recreation needs of the entire Eastern Sub-Region. Four district mixed-use nodes are also proposed and are located in accessible location through the Eastern Sub-Region. These nodes should all contain district recreational facilities as set out in the active open space hierarchy above.

Up to date, all recreational facilities within the Eastern Sub-Region have been provided by the private (or semi-private) sector. The Megawatt Park (Eskom) facility is a typical example. Although this is prudent, this should not defer the municipality from providing the necessary recreation facilities required within the Eastern Sub-Region.

One of the reasons why the municipality has not provided the necessary open space within the Eastern Sub-Region to date is due to the lack of stands zoned for recreational purposes. In turn, this lack of stands is due to cluster developments, which usually are not large enough to reach the thresholds required to provide stands for active open space development. **To address this situation, it is proposed that developers of cluster housing be required to provide contributions for the purchasing of stands for active open space, much in the same way that developers make bulk services contributions.** These funds will have to be ring-fenced and used by the municipality to purchase land for the development of recreation nodes. Because the

availability of land for sale is unknown, the exact location of recreation nodes can only be determined during the purchasing phase.

5.4. HOUSING DEVELOPMENT

Affordable housing is a strong form-giving element that can impact substantially of the development of an urban area. For example, housing can be used as an infill land use, which could enable the urban integration of a fragmented urban area. Also, housing can provide the necessary land use densities to support public transport operation and retail centre development.

5.4.1. HOUSING TYPOLOGIES

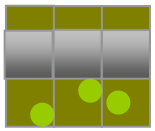
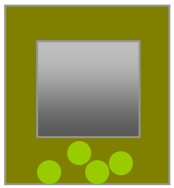
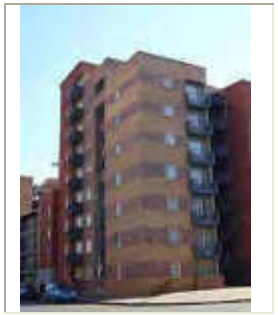
Housing types can be categorised according to level of attachment. Level of attachment refers to the vertical and horizontal attachment of buildings. There is a tendency, when addressing the housing demand, especially for the low-income sectors of the population, to provide freestanding units with little on no level of attachment. There is little exploration on the benefits of other housing typologies, such flats, walk-ups, row housing and semi-detached units.

The following discussion on typologies is not exhaustive, but rather focuses on housing and density types that are appropriate for the Eastern Sub-Region. The Table above provides an easy-reference summary of the attributes of the different housing typologies and how it compares with the attributes of other housing typologies.

a. Detached housing

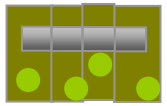
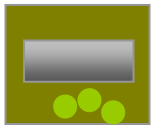
Single, detached units are standalone structures situated on a single, individually registered stand. In addition to cluster housing, this is the most common housing type within the Eastern Sub-Region. This housing type has a private garden and on-site parking. Estate development often uses this housing type, but adds security fencing and communal facilities to achieve some of the advantages that are usually associated for cluster housing developments.

TABLE 18: BONDED HOUSING TYPOLOGIES

Housing Typology	Gross Density	Nett Density	Stand Size	Building Height	Tenure Options	Subsidy Options	Plot layout	Example
Detached housing	5-10 u/ha	10-15 u/ha	800-1000m2	1-2 storey	Full title	n/a		
Cluster housing	10-20 u/ha	20-30 u/ha	300-500m2	1-2 storey	Full title or sectional title	n/a		
Flats	100-200 u/ha	200-400 u/ha	n/a	4-8 storey	Rental or sectional title	Institutional subsidy		

Source: Maluleke Luthuli and Associates, 2008

TABLE 19: AFFORDABLE HOUSING TYPOLOGIES

Housing Typology	Gross Density	Nett Density	Stand Size	Building Height	Tenure Options	Subsidy Options	Plot layout	Example
Detached housing	20 u/ha	40 u/ha	250 m2	1 storey	Full title	Project-linked subsidy		
Semi-detached	40 u/ha	80 u/ha	120 m2	1-2 storey	Full title	Project-linked subsidy		
Row housing	60 u/ha	120 u/ha	70 m2	2 storey	Full title	Project-linked subsidy		
Walk-ups	80 u/ha	160 u/ha	n/a	3 storey	Rental or sectional title	Institutional subsidy		

Source: Maluleke Luthuli and Associates, 2008

The densities of this housing type is the lowest of the various housing typologies and, depending on stand size (generally between 800 and 1000m²), has an average gross density of 5 to 10u/ha. Such densities do not promote the efficient use

of land and do not promote the viable operation of public transportation systems. Consequently, this housing type should not be promoted is close proximity of public transportation routes, but should rather be use in peripheral areas of cities.

In terms of infrastructure costs, this housing typology is the most expensive housing option. The low densities and large stand sizes of this housing type result in large street frontages, which result in long infrastructure runs. In terms of the structure, this housing type is the least complicated to construct, resulting in relatively low construction costs, when compared to other housing typologies.

b. Cluster Housing

Cluster housing developments are characterized by housing units located within a housing complex, which shares communal facilities and a perimeter security wall. These housing units can either be detached or attached to one another, thus sharing at least one wall of the unit. This housing type does not exclude a second and third storey. Ground access, a private garden and on-site parking is possible with the housing typology. These housing types can either be

Custer houses are usually located on stands of smaller size than those used for detached housing. These smaller stand sizes are often achieved through the use of shared walls. Stand sizes typically range from 300-500m² and yield a gross density of approximately 10-20u/ha. The smaller stand sizes translate to substantial infrastructure cost savings, making cluster housing more cost-effective than detached housing units. Shared walls also reduce the construction costs of the buildings, compared to detached housing units.

The smaller stands and higher densities achieved by this housing typology, compared to that of detached housing units, make it more suitable as a public transport related development. Although it does not create the desired densities that would significantly boost public transport patronage, it is a better option than detached units. In a sense, this housing typology creates a balance between creating detached or semi-detached housing units and achieving higher densities that are more transport related. This housing typology is preferably located along public transport routes, but not is next to public transportation termini, which would require higher-density housing options.

c. Walk-ups

Walk-ups provide a low-rise, higher-density housing option. It is only at this level of density that it really becomes beneficial for public transportation and the cost-effective operation of public transport. With densities of approximately

80u/ha, this housing typology places enough commuters within walking distance of public transportation stations to ensure the viable operation of a public transportation system. Also, residents living in walk-up apartments are usually of a household income bracket that uses public transport as their means of transport, which implies a mutually beneficial relationship between walk-up housing and public transport.

This housing type involves individual housing units stacked on top of each other up to 3 storeys high and is located on a single stand. Consequently, full title ownership is not possible. Such units are either sold off as sectional title units or applied as rental units. What distinguishes walk-up from flats is the fact that walk-up units are accessed via a staircase. The gardens surrounding the building are in communal ownership and use. On-site parking is possible in the form of a parking lot and garages.

Although walk-up units cost substantially more than conventional affordable housing typologies, they do provide a means of accommodating government subsidized housing within a mixed-use, primarily bonded residential environment (as is found in the Eastern Sub-Region). This housing typology does is cheaper to built than flats, because it does not require costly lifts or and costly construction methods to construct high buildings. In addition, the higher densities obtained through walk-ups compared to detached and semi-detached housing units, makes substantial savings in infrastructure costs possible. This cost saving not only applies to municipal infrastructure (water, sanitation and electricity), but also to the provision of roads.

d. Flats

Flats are the highest density housing typology. As with walk-ups, this housing typology comprises housing units stacked on top of each other. The difference between flats and walk-ups is the height of the buildings, with flats exceeding 3-storeys and walk-ups not. Consequently, flats have to be served by a lift, whereas walk-up only need be served by a staircase. The configuration of a block of flats excludes full title ownership as a tenure option, leaving sectional title and rental as the only tenure options. The gardens of the building are communal and on-site parking is provided using parking lots and garages.

An advantage of flats is the infrastructure cost savings that is made possible by its high occupation densities. These cost savings are partly negated by the costs involved in the construction of this more structurally complicated building, as was discussed under 'walk-ups' above. This complicates providing and subsidizing affordable housing units within such buildings.

The primary advantage of flats relates to the use and operation of public transportation systems. Because flats place high numbers of people within close proximity of public transportation stations, it can significant increase the number of commuters living within walking distance of a public transport system, thus boosting patronage of the transportation system. Taking into account that the household that use public transportation are also the household that typically occupy flats, creates an efficient relationship between this housing typology and public transport.

5.4.2. HIGHER-DENSITY HOUSING DEVELOPMENT

One of the critical factors in developing our cities into sustainable urban environments is the development of new residential areas at higher densities than in the past. In this regards, the higher densities are important for several reasons:

- Higher densities lead to a significant saving in land cost per unit, as less land is needed and land is used more efficiently.
- One of the main arguments for encouraging higher densities is the efficient provision of infrastructure. Low density means long infrastructure runs and therefore higher cost per consumer both for installation and for operation.
- Efficient public transport requires medium to high densities to be able to provide frequent and efficient services. Low densities with long walking distances for the poor cannot support good public transport.
- Community facilities, such as schools and health clinics, are difficult to reach for many people at low densities.
- Density is significant for the economic performance of a city. High population density means a high level of access to employment opportunities and to markets.

5.4.2.1. UNDERSTANDING DENSITY

Density is a controversial topic and is often misunderstood, as it is linked to misplaced values. Perception of density is also linked to cultural background. There are some misconceptions on densities that influence the perception of what appropriate densities are because there is a vast difference between perceived and measured densities. The misconceptions regarding densities are:

- Firstly, it is often taken that low densities create high quality environments and high densities create low quality environments. However, high quality environments can be created at both low and high densities and depend more on design considerations than density. Instead, poor living conditions are more a cause of other factors, such as bad

architectural design, a lack of infrastructure and public services, scarcity of open space, poor environmental conditions and poverty.

- Secondly, there is a misconception that only one housing type can be created at a certain density. In fact, a wide variety of housing types can be provided at most densities, except at the lowest end of the scale. For example, similar densities can be achieved by four storey buildings as can be achieved by high rise tower blocks. Thus, a high-density environment does not necessarily mean a high rise environment.
- Thirdly, the misconception exists that high densities are appropriate for low-income groups and low densities are only appropriate for high-income groups, because of the cost implications. This is not true, since all densities can be suitable for all income groups.

5.4.2.2. DENSITIES APPLIED

Given the facts that gross densities in South Africa are generally seen as low and unsustainable on the one hand and that South Africans are not accustomed to living at high densities on the other hand, a range of gross densities between 20 to 100 dwelling units per hectare are seen as suitable for South African circumstances: Low density can be seen as 20-40 units per hectare, medium density as between 40 and 80 units per hectare, and high density as between 80-100 units per hectare. In addition, applying appropriate densities depend on a variety of factors:

- Land availability and costs: If land is scarce and expensive, it would necessitate higher densities. This is typically at points of high accessibility and visibility.
- Location and transport: Localities with high levels of access, specifically access to public transport, should accommodate higher densities to reinforce the use of public transport.
- Social context and household size: Lifestyles and household size can have a marked impact on acceptable densities.
- Environmental considerations: Environmentally sensitive land should be evaluated to determine its carrying capacity and might necessitate lower gross densities and higher net densities.
- Cultural acceptance: Although there may be a preference for low densities and detached housing, a variety of housing types should be explored.

Choosing an appropriate density usually also involves decisions that require a compromise in one form or another. For example, higher densities will either involve having smaller than average stand sizes (250m2) and having full title or going multi-storey which will involve accepting sectional title or rental as an alternative to full title ownership. In short, density should be the result

of a process of design through which the planner must deal dynamically with standards, stand and dwelling sizes, housing typology and spatial planning principles.

It is imperative that at least part of the future residential need within the Eastern Sub-Region be addressed using higher density housing typologies. Not only this, these higher density housing developments need to be linked to existing or planned public transportation infrastructure and promote urban infill and consolidation. In addition, higher-density housing concepts must promote the creation of sustainable communities by incorporating the development of the necessary community facilities and open space to support these higher-density housing developments. This is an integrated approach to development; whereby community facilities and transportation are develop as part and parcel of housing development.

5.4.3. AFFORDABLE HOUSING DEVELOPMENT

5.4.3.1. DEVELOPMENT APPROACH

In the past, the Provincial Department of Housing considered that the best way to address the housing backlog was to adopt a strategy that was based on chasing numbers: a mass housing approach. Through this approach, houses were built where land could be acquired cheaply and this usually perpetuated urban sprawl, undermining economic, environmental and community sustainability. In recent years, realities in the provision of housing have brought about a shift in the housing strategy. Now the challenge is to go beyond the simple provision of houses and build communities and create conditions that promote sustainability. In terms of planning (as depicted by the Diagram below), this new approach is expressed as follows:

a. New town development

Although new town development involves a mass housing approach, the way it is structure today significantly differs from how is was structures a decade ago. Today the emphasis is on providing a mix of housing typologies and tenure types. Also, achieving transportation integration and linking these housing developments with employment, shopping and community nodes is considered a priority.

b. Nodal (TOD) development

Nodal development involves the use of housing (in this case affordable housing) to breathe new life into decaying inner cities and suburban CBDs. Affordable housing can also be included in the mix of new mixed-use nodes in the form of inclusionary housing, ensuring that the pitfalls of the older CBDs (which as associated with a lack of a residential component) are avoided. At the same time, it places affordable housing in close proximity to employment opportunities and social amenities, which are found within these mixed-use nodes.

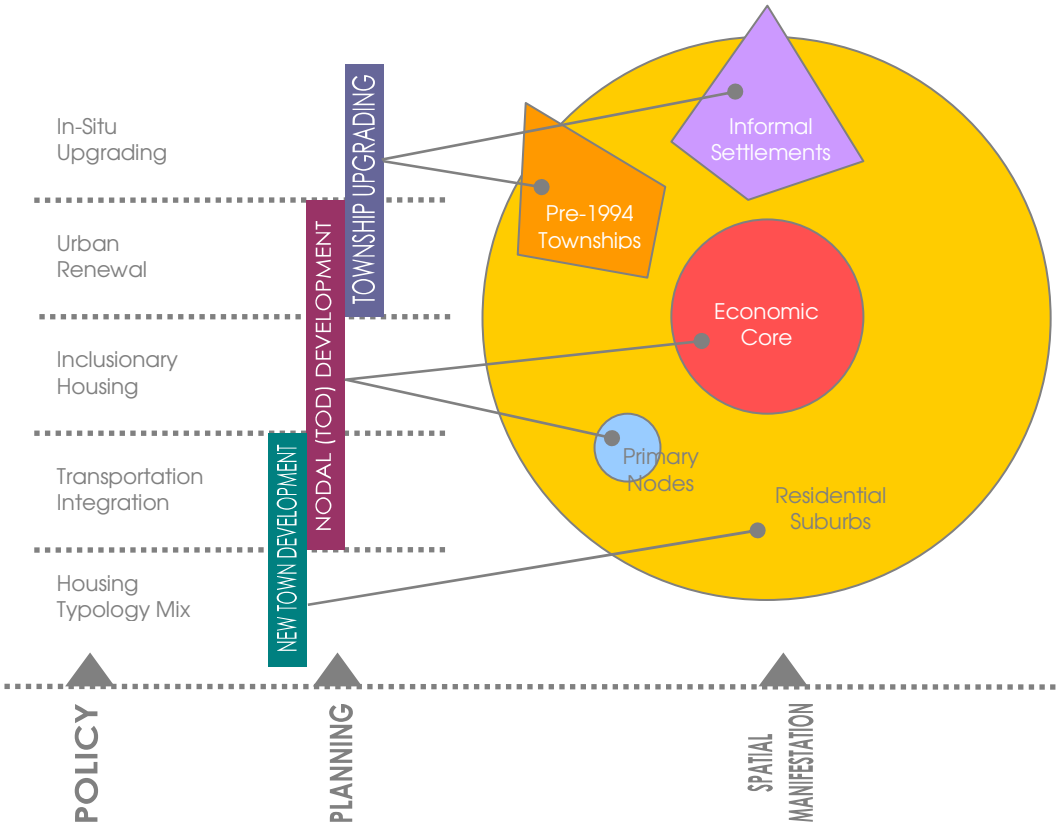


DIAGRAM 30: AFFORDABLE HOUSING DEVELOPMENT APPROACH

c. Township upgrading

With the launching of the Top 20 Priority Township Programme by the Gauteng Department of Housing, recognition was given to upgrade the existing, older townships within Gauteng. This included the upgrading of road and municipal infrastructure within these townships, the use of vacant land within the townships for housing and other purposes, and the in-situ upgrading on informal settlements associated with the townships.

The important point is that no single approach (as set out above) would full address the affordable housing backlog within Gauteng. All three the planning approaches are necessary. For example, the new town approach is necessary because it is the only approach that can address the huge housing backlog within Gauteng, which requires thousands of hectares of land. So too, it is necessary to create more sustainable inner cities and suburban activity nodes, by adding a residential component to these nodes. Affordable housing in the form of inclusionary housing can play an important role in achieving this. This approach can be applied within the Eastern Sub-Region in terms of housing typology mix and geographical distribution, as set out in the Table below.

TABLE 20: HOUSING DEVELOPMENT APPROACH

Development	Tenure	Typologies	Typical Examples	Possible Development Areas
New town	Bonded housing	Detached housing Cluster housing	Dainfern	Dainfern north Fourways Blue Hills Kyalami Sunninghill
New town	Subsidized and bonded housing mix	Detached housing Semi-detached Row housing Walk-ups	Cosmo City	Olievenhoutbosch south Diepsloot East Diepsloot South Cosmo City northeast
Nodal	Subsidized and bonded housing mix	Walk-ups Flats	Melrose Arch	Proposed metropolitan, regional and district mixed-use nodes

Source: Maluleke Luthuli and Associates, 2008

5.4.3.2. INCLUSIONARY HOUSING

Traditionally, affordable housing was seen as a government responsibility and not an area that is suitable for the private sector. The Breaking New Ground policy of the Gauteng Department of Housing floats the idea of requiring private-sector housing developers to invest a percentage in their housing projects at the lower end of the housing market. This housing market typically lies between the housing subsidy market and the bonded housing market, a housing provision band that is currently not covered by either the government or private sector housing initiatives. This approach is known as `inclusionary housing'.

Internationally (e.g. United Kingdom and the United States of America), a number of municipalities are adopting an inclusionary housing policy with the intent of increasing the supply of affordable housing within their areas of jurisdiction. These municipalities recognize that, in some residential markets, affordable housing would not be produced without government intervention. These inclusionary housing policies aim to:

- Implement the affordable housing goals and objectives contained in the local government's housing plan
- Ensure that critical governmental service workers (e.g., teachers, firefighters, and police officers) can afford to live in communities where they work
- Provide affordable housing for employees that work within up-market areas
- Maintain a balanced community that provides housing for people of all income levels

Currently, ideas on inclusionary housing in South Africa basically involve a mandatory approach, whereby developers are forced to provide affordable housing as part of their up-market housing developments. This approach is contentious for obvious reasons, although larger developers are increasingly committing themselves to the provision of affordable housing in order to obtain approval of their township establishment applications.

Whereas the provision of inclusionary housing in South Africa will most probably be mandatory, the provision of inclusionary housing abroad is mostly incentive based. The incentive based approach encourages the development of inclusionary housing in up-market developments by providing a range of incentives in exchange. These incentives include tax reduction, density bonuses and direct subsidies to entice private sector involvement in affordable housing development. Densities bonuses are one of the more common incentives used, especially in the United States of America. The densities bonus programme allows private developers to be allocated additional floor area above the permitted zoning if they provide affordable housing (either for sale or rental accommodation) as part of their development. Logic maintains that the additional cash flow from the bonus floor area offsets the reduced revenue from the affordable housing units.

5.4.3.3. LOCATION CRITERIA AND PROPOSED DEVELOPMENTS

It should be evident from the above that the challenge is to go beyond the simple provision of houses and build communities and create conditions that promote sustainability. Central to sustainability is the issue of location, which involves building houses on well-located land that is close to job opportunities and the necessary social amenities. Consequently, housing projects must adhere to very specific location criteria. This will often necessitate housing developments to be located on well-located and expensive land, rather than on cheap land on the outskirts of cities. The following basic criteria for the location of affordable housing projects should be adhered to:

a. Availability of Bulk Services

Affordable housing projects are reliant on access to bulk municipal services. These include water, sewer and electricity bulk infrastructure, of which access to sewer infrastructure is the most important. As a rule, bulk municipal services are available in or next to existing urban areas. This favours infill development as the primary option for affordable housing development and opposes urban sprawl as a form of urban development.

b. Ownership of Land

The ownership of land determines the timeframe and cost of affordable housing projects. Land already in ownership of the municipality avoids the tedious and expensive purchase and transfer of private owned land for affordable housing development. However, to create sustainable communities, land ownership should be viewed in context of the other criteria set out in this section.

c. Access to Social Amenities and Economic Opportunities

Affordable housing projects should be located in a manner that will ensure that these settlements will have reasonable access to social amenities and economic opportunities. This will imply that affordable housing projects should be located close to existing or planned community and economic nodes.

d. Access to Public Transportation

Households that live in affordable housing units are typically dependant on public transport and walking as their mode of transport. It is therefore imperative that affordable housing projects are located next to existing and planned public transport routes (rail, bus and taxi). This is necessary to obtain access to the social amenities and economic opportunities, as was mentioned in the previous paragraph.

e. Integration of Urban Structure

When locating new housing developments, the chosen areas should always be measured against the extent in which they contribute to the establishment of integrated, economically viable and sustainable communities. Practically, this involves promoting infill development, instead of allowing urban sprawl to continue unabated.

f. Land parcel sizes

The size of a land parcel affects the cost of the land. For example, small holdings are more expensive per hectare than farmland. Consequently, affordable housing can be developed more cost-effectively on larger land parcels than on smaller land parcels.

The only proposed large-scale affordable housing development located within the Eastern Sub-Region is Olievenhoutbosch South, located on the northern boundary of the Eastern Sub-Region. The location of this township is included in the development framework, which is depicted on Figure 19, and will essentially involve the southward expansion of Olievenhoutbosch. Two aspects, as defined in the Diagram above, needs to be form the basis of the design and the development of the Olievenhoutbosch South. The first involves creating a housing mix that will cater for a wide range of households and income groups, applying different tenure and housing typologies. The second aspect involves linking the Olievenhoutbosch South development to public transportation. A BRT route is proposed along Main Road (K71) and it is proposed that the design of the Olievenhoutbosch South development supports this proposed BRT system. This implies creating higher-density, mixed-use developments at the proposed BRT stations serving the Olievenhoutbosch South township.

Affordable housing can also be developed as inclusionary housing within the Eastern Sub-Region. Inclusionary housing can effectively be implemented within the mixed-use nodes proposed for the Eastern Sub-Region, such as the regional mixed-use node proposed within the Blue Hills area (on the intersection of the K71 and the planned PWV5 freeway). This will allow

affordable housing to become part of the land use mix of such node, thus allowing the residents of such housing units to live within close proximity of their places of employment.

Annexure M

PUBLIC PARTICIPATION

Annexure M(i)

PROOF OF ADVERTISEMENT IN FOURWAYS REVIEW

NOTICE OF ENVIRONMENTAL IMPACT ASSESSMENT PROCESS

Notice is given of an application for an Environmental Impact Assessment Process that was submitted to the Gauteng Department of Agriculture and Rural Development in terms of Regulation No. R543 published in the Government Notice No. 33306 of 18 June 2010 of the National Environment Management Act, 1998 (Act No. 107 of 1998) governing Environmental Impact Assessment Procedures (Notice 1, 2 and 3 – Governing Notice R544, R545 & R546) for the following activity:

Reference No. Gaut. 002 / 11-12 / E0255

Project Name: The design and construction of Erling Road between the K46 and the K56 and the K46 between the K56 and Main Road (R 1) including all required access roads and infrastructure.

Property Description: The Remainder, and Portions 156, 145, 11, 202 and 8 of the Farm Zeventontein 407-JR; Erf 91, 76, 75, 40, 42, 56, 74, 80, 81, 82, 83, 72, and 73 of Kyalami Agricultural Holdings; Erf 118, 116, 115, 114, 113, 110, 100 and 99 Portion 1 of Glen Erness Agricultural Holdings; Erf 15, 17, 19, 20, 21, 22, 25 and 27 Glenlow, and the road reserves or servitudes of Ash Road, Lynx Street, Chattan Road, Macgregor Road, Zinnia Road, Marinnes Road, Macgillivray Road, Salvia Road, Pine Road, Campoloni Road, Macintyre Road, Erling Road, William Nicol Drive(R511), Dunmaglass Road, Maple Road, Main Road(M71)

Extend of Development: The proposed K56 Road is approximately 5.5km in extent.

Listing Notices Applied for: GNR 544(Listing Notice 1) 18 June 2010,Activity 11,18,24,39,47,(Listing Notice 2),18 June 2010,Activity 18,(Listing Notice 3),18 June 2010,Activity 4,13,19.

Proponent Name: Department of Roads and Transport
Date of Notice: 22 February 2012
Date of first Public Meeting: 7 March 2012, 18:00, at Grace Point Church located at 125 Duncan Road, Glenferness.
Queries regarding this matter should be referred to:

Bokamoso Landscape Architects and Environmental Consultants
Juanita de Beer Tel: (012) 346 3810
P.O. Box 11375 Fax: (086) 570 5659
Maroelana 0161 E-mail: lizelleg@mweb.co.za
www.bokamoso.net

Annexure M(ii)

SITE NOTICE

NOTICE OF EVIRONMENTAL IMPACT ASSESSMENT PROCESS

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Extend of Development: The proposed K56 is approximately 5.5km in extent.

Listing Activities Applied for:

GNR 544 (Listing Notice 1), 18 June 2010	Activity 11
GNR 544 (Listing Notice 1), 18 June 2010	Activity 18
GNR 544 (Listing Notice 1), 18 June 2010	Activity 24
GNR 544 (Listing Notice 1), 18 June 2010	Activity 39
GNR 544 (Listing Notice 1), 18 June 2010	Activity 47
GNR 545 (Listing Notice 2), 18 June 2010	Activity 18
GNR 546 (Listing Notice 3), 18 June 2010	Activity 4
GNR 546 (Listing Notice 3), 18 June 2010	Activity 13
GNR 546 (Listing Notice 3), 18 June 2010	Activity 19

Proponent Name: Gauteng Department of Roads and Transport

Date of Notice: 10 April - 2 June 2014 (excluding Public Holidays)

Queries regarding this matter should be referred to:

Bokamoso Landscape Architects and Environmental Consultants CC
Public Participation registration and inquiries: **Juanita De Beer**
Project inquiries: **Mientjie Coetzee**
P.O. Box 11375
Maroelana 0161
www.bokamoso.biz
Tel: (012) 346 3810
Fax: (086) 570 5659
E-mail: lizelleg@mweb.co.za

In order to ensure that you are identified as an Interested and/or Affected Party (I&AP) please submit your name, contact information and interest in the matter, in writing, to the contact person given above **within 40 days of this Notice.**

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Extend of Development: The proposed K56 Road is approximately 5, 5km in extent.

Listing Notices Applied For:

GNR 544 (Listing Notice 1), 18 June 2010	Activity 11
GNR 544 (Listing Notice 1), 18 June 2010	Activity 18
GNR 544 (Listing Notice 1), 18 June 2010	Activity 24
GNR 544 (Listing Notice 1), 18 June 2010	Activity 39
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GNR 545 (Listing Notice 2), 18 June 2010	Activity 18
GNR 546 (Listing Notice 3), 18 June 2010	Activity 4
GNR 546 (Listing Notice 3), 18 June 2010	Activity 13
GNR 546 (Listing Notice 3), 18 June 2010	Activity 19

Proponent Name: Department of Roads and Transport

Date of Notice: 22 February 2012

Date of first Public Meeting: 7 March 2012, 18:00, at Grace Point Church located at 125 Duncan Road, Glen Ferness.

Queries regarding this matter should be referred to:

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Juanita de Beer
P.O. Box 11375
Maroelana 0161
www.bokamoso.net

Tel: (012) 346 3810
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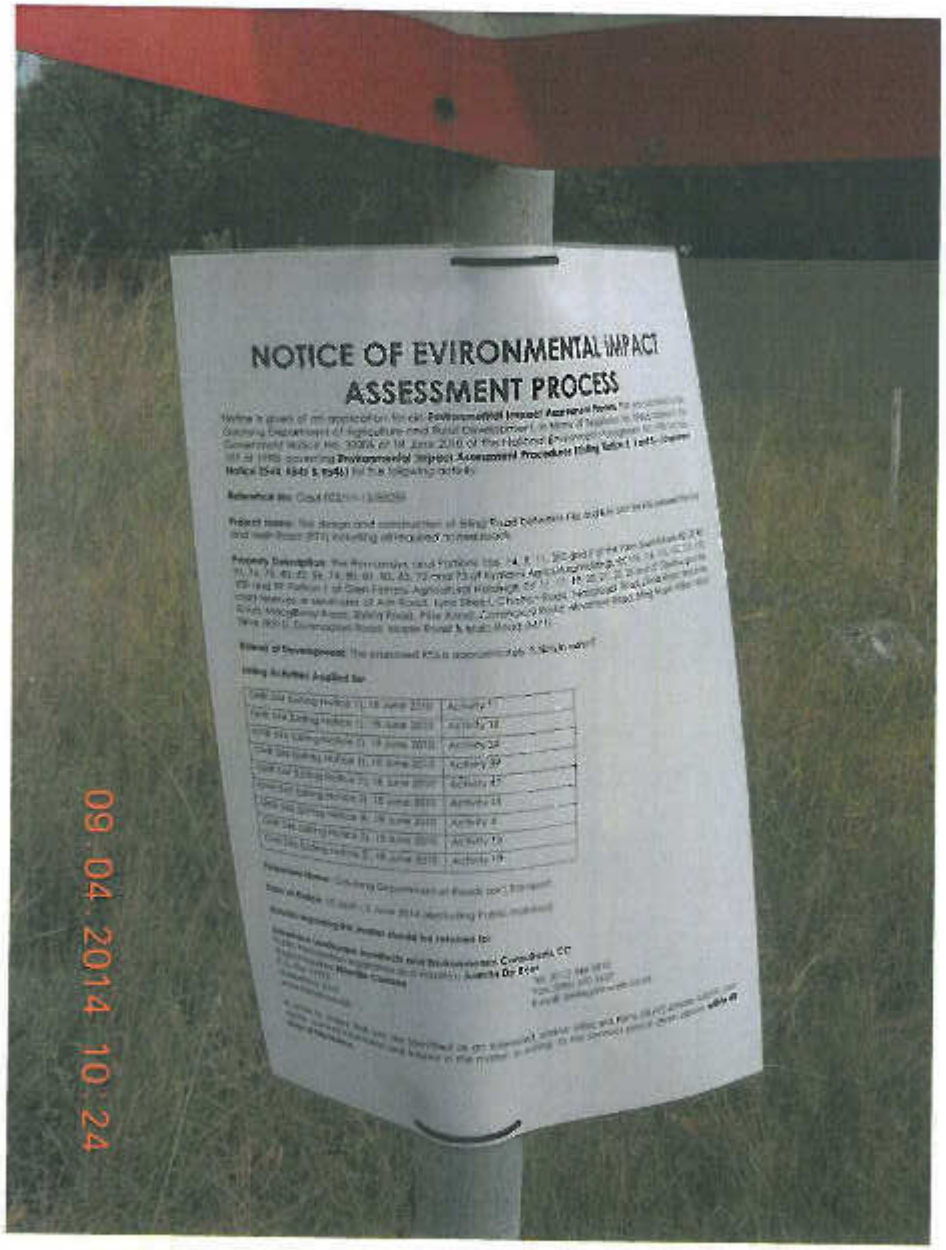
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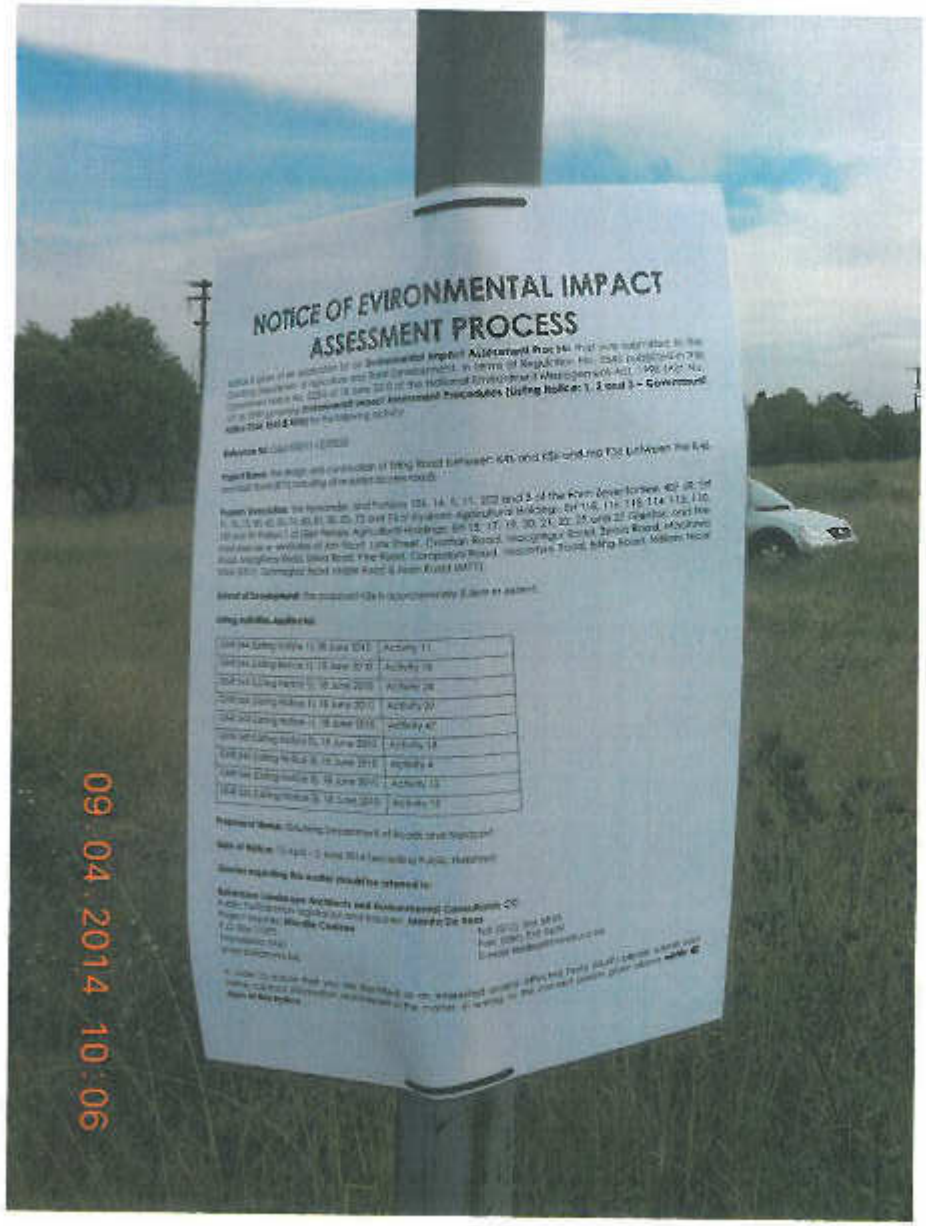
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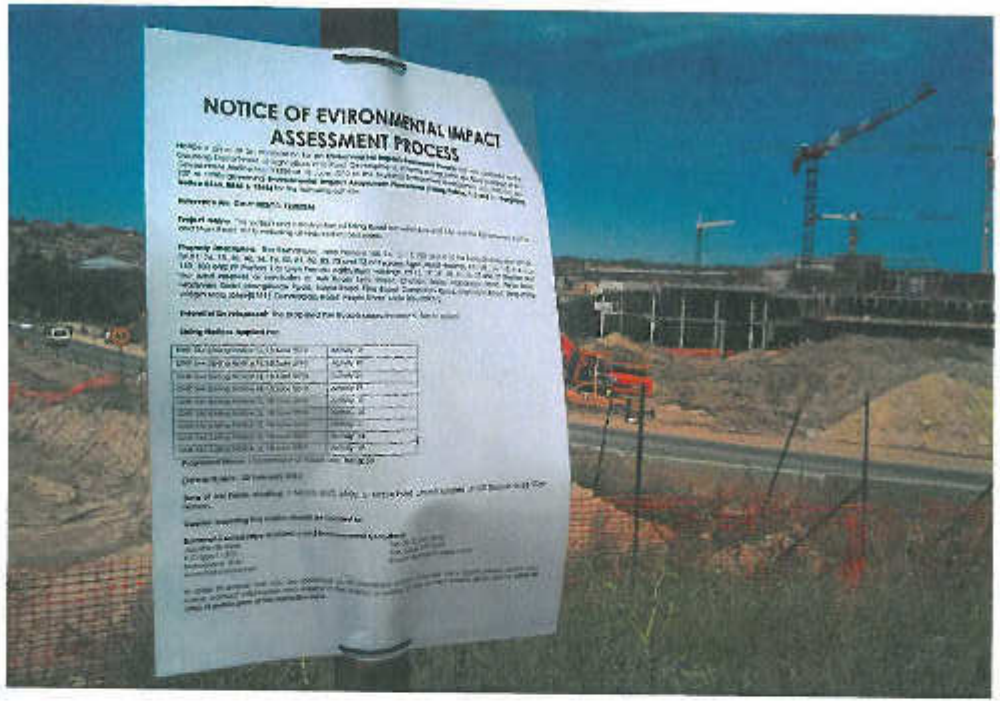

NOTICE OF EVIRONMENTAL IMPACT
ASSESSMENT PROCESS


ERLING RD

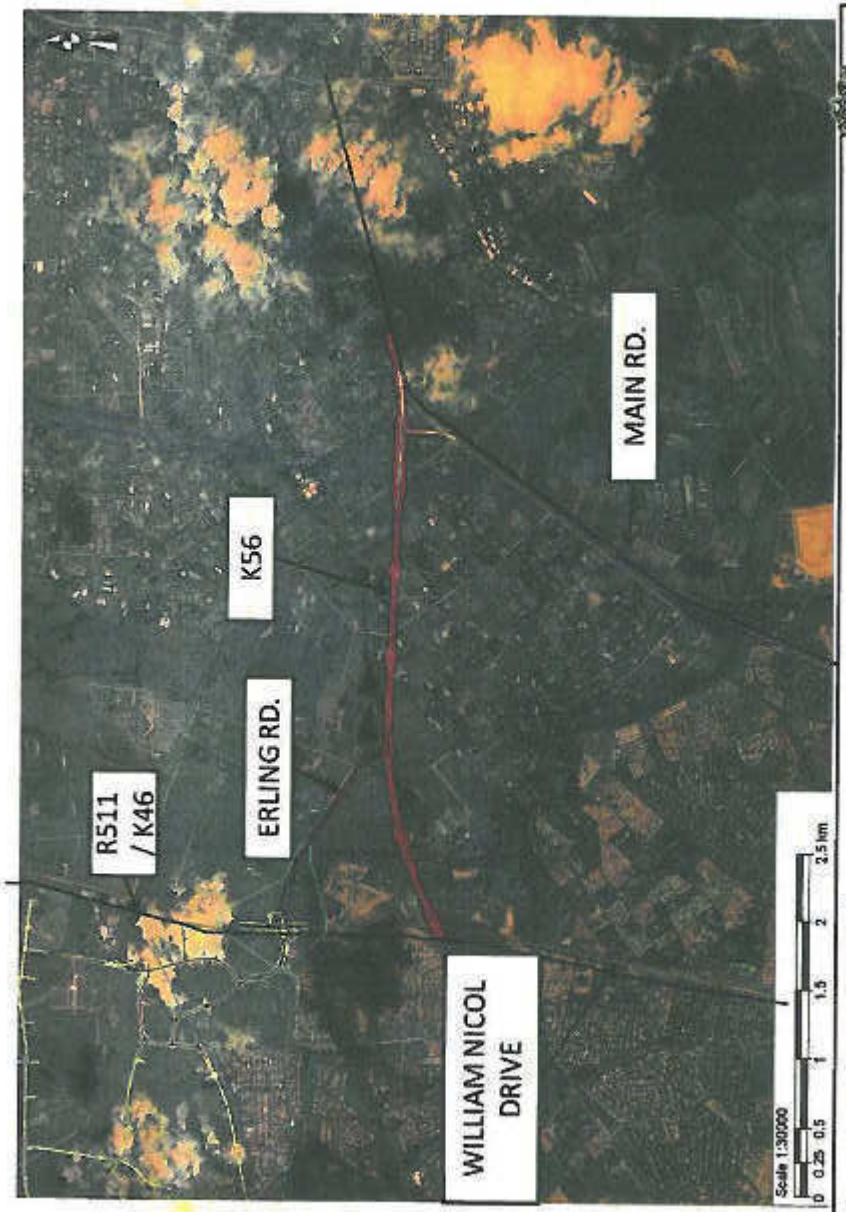

NOTICE OF EVIRONMENTAL IMPACT
ASSESSMENT PROCESS


NOTICE OF EVIRONMENTAL IMPACT
ASSESSMENT PROCESS

Annexure M(iii)

NOTICE/FLYERS DISTRIBUTED
TO I&AP'S

K56



Erling road between K46 and K56 and the K56 between K46 and Main Road

Fig 2: Aerial Map

Locality Map

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Extend of Development: The proposed K56 is approximately 5.5km in extent.

Proponent Name: Gauteng Department of Roads and Transport

Listing Activities Applied: GNR 544 (Listing Notice 1), 18 June 2010 – Activity 11, 18, 24, 39 & 47 and GNR 545 (Listing Notice 2), 18 June 2010 – Activity 18 and GNR 546 (Listing Notice 3), 18 June 2010 – Activity 4, 13 & 19

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Queries regarding this matter should be referred to:

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Public Participation registration and inquiries: **Juanita De Beer**
Project inquiries: **Mientjie Coetzee**
P.O. Box 11375
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Tel: (012) 346 3810
Fax: (086) 570 5659
E-mail: lizelleg@mweb.co.za

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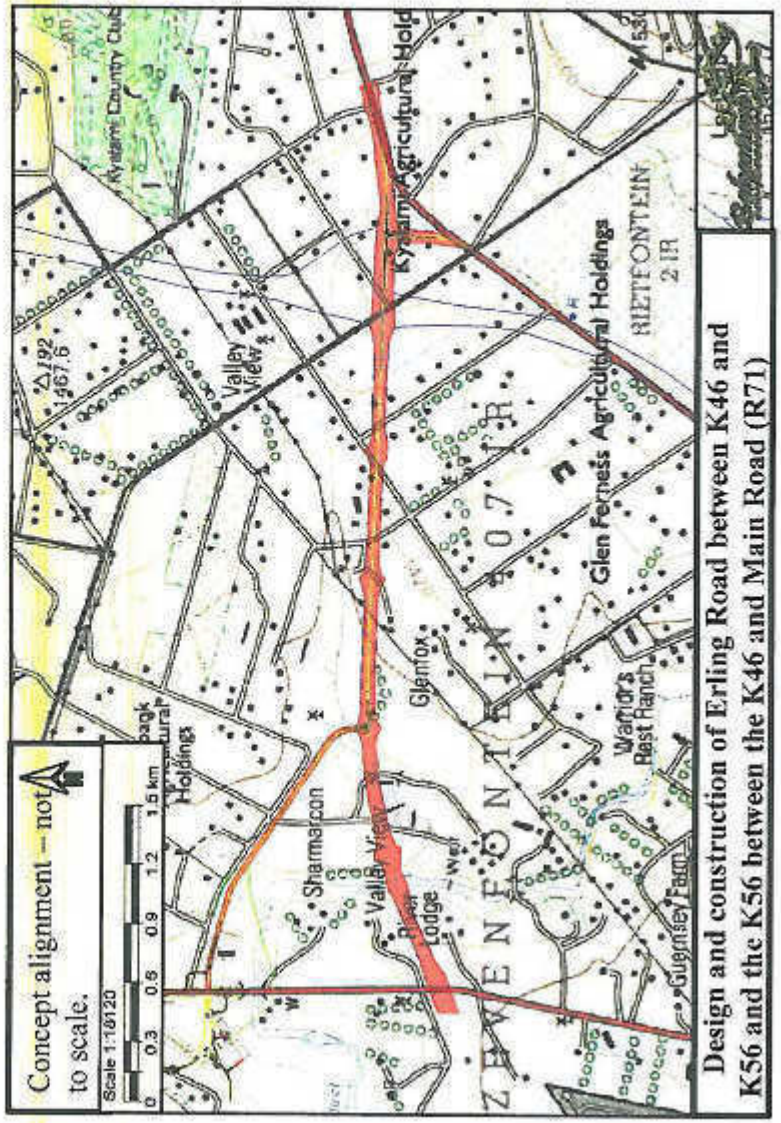

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LEBOMBO GARDEN BUILDING
36 LEBOMBO ROAD
ASHLEA GARDENS
0081

P.O. BOX 11375
MAROELANA
0161

Tel: (012) 346 3810
Fax: 086 570 5659
E-mail: [redacted]
Website: www.Bokamoso.net

Bokamoso ENVIRONMENTAL

31 January 2012

Dear Landowner

RE: DESIGN AND CONSTRUCTION OF ERLING ROAD BETWEEN K46 AND K56 AND THE K56 BETWEEN K46 AND MAIN ROAD (R71), INCLUDING ALL REQUIRED ACCESS ROADS

First of all we would like to apologize for the faulty notification letter that was delivered/mailed to you during December 2011. There was a misunderstanding in our office regarding the documents to supply to the landowners and the interested and affected parties and we therefore request that you ignore all correspondence supplied prior to this notification letter. Please regard this letter as the first step in the EIA process and this first step is only the land-owner's notification. This notification does not form part of the public participation process that must be followed in terms of Section 54 of the 2010 Amended NEMA EIA Regulations National Environmental Management Act. 1998 (Act No. 107 of 1998). A separate public participation process will commence shortly and you will also be notified of such process. Note that and all parties (including landowners) will be able to register as interested and affected parties during this process. All registered I & AP's to this date will be placed on the register, without them having to register again.

Bokamoso Landscape CC. T/A Bokamoso Landscape Architects and Environmental Consultants has been appointed by WSP SA Civil and Structural Engineers to conduct the Environmental Impact Assessment (EIA) process (in terms of the 2010 Amended NEMA EIA Regulations) for the project titled – **Design and construction of Erling Road between K46 and K56 and the K56 between K46 and Main Road (R71), including all required access roads.**

In terms of Section 17, the Environmental Assessment Practitioner (EAP) must notify all affected landowners of the EIA application that will affect the owner's land and proof of such notification must be attached as part of the EIA application to be submitted to the Gauteng Department of Agriculture and Rural Development (GDARD). This notice represents the landowner's notification letter.

According to the available GIS information, the study area incorporates some environmentally sensitive features and it will therefore be necessary to appoint specialist consultants (i.e. wetland specialists, fauna and flora specialists, heritage specialists etc.) to conduct the necessary specialist studies. Due to season limitations, the fauna and flora studies must be completed before the middle of March 2012. The specialists as well as employees of Bokamoso will present the WSP appointment letter ***(Please Refer to appointment letter attached as part of this notification bundle)*** when visiting the study area (for specialist surveys and public participation) and this will act as proof of the

person's involvement in the project. Please refrain from allowing any parties to the study area without such a letter, because it will only cause security risks.

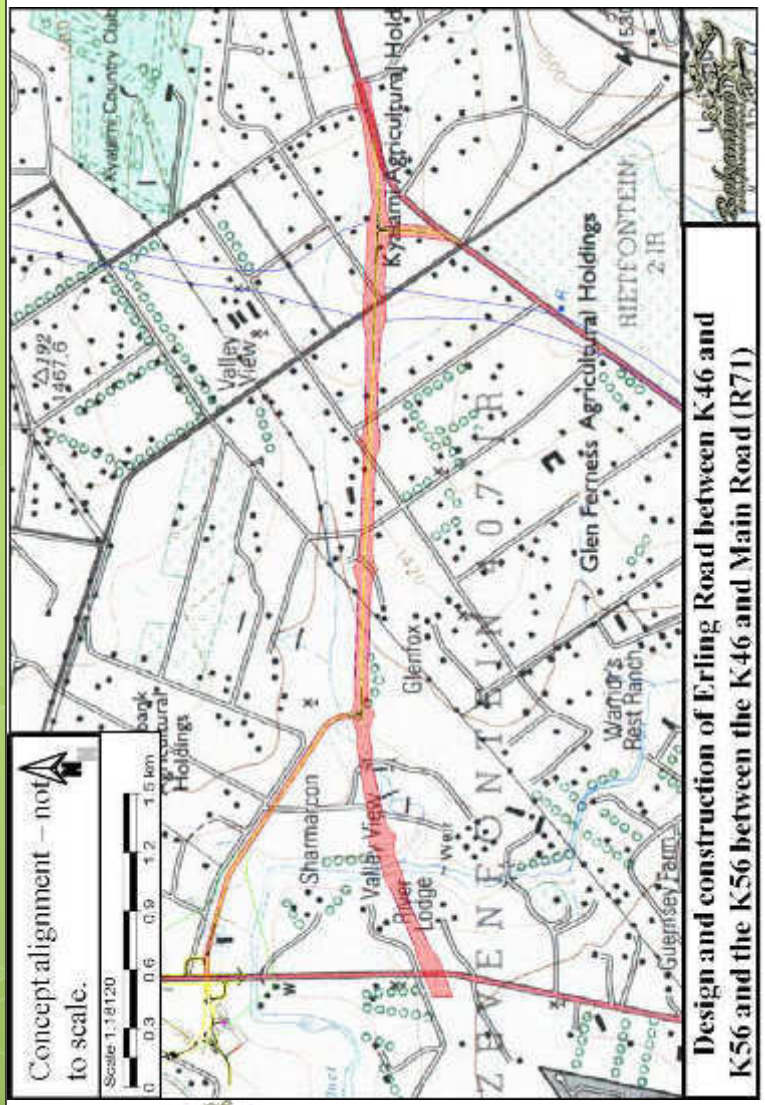
Please do not hesitate to contact Juanita, Genevieve or Lizelle at Bokamoso if you have any queries regarding the EIA application.

Kind Regards

Juanita De Beer

Tel: 012 346 3810
Fax: 086 570 5659
Email: lizelleg@mweb.co.za

K56 Draft EIA Report for Review

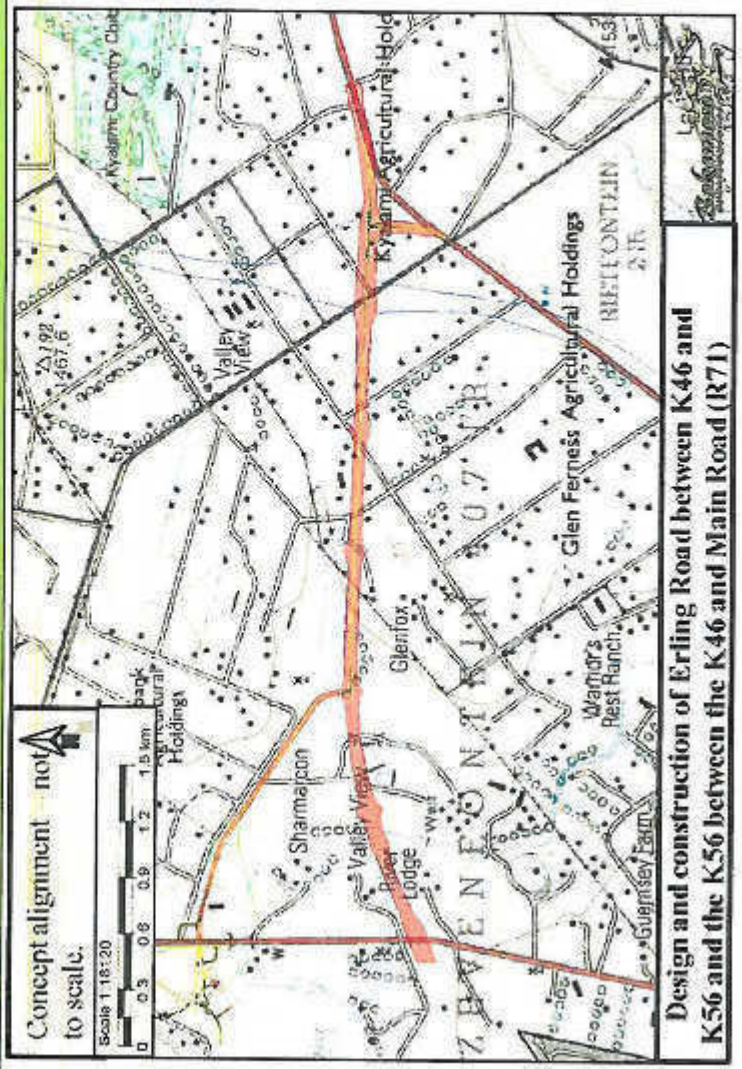


All interested and affected parties are invited to review the development information and to register any issues and concerns to be included and addressed in the Final EIA Report.

Venue: Grace Point Church
Tel: 011 702 4600
Date: From 23 June 2015 – 3 August 2015
Times available at Church: 7.30 AM – 17:00 PM
Also available on our Website:
www.bokamoso.biz

Please do not hesitate to contact us if there are any questions in connection with the abovementioned development.
Contact person: **Juanita De Beer**
Tel: 012 346 3810 Fax: 086 570 5659
E-mail: lizelleg@mweb.co.za

K56 Final Scoping Report for Review

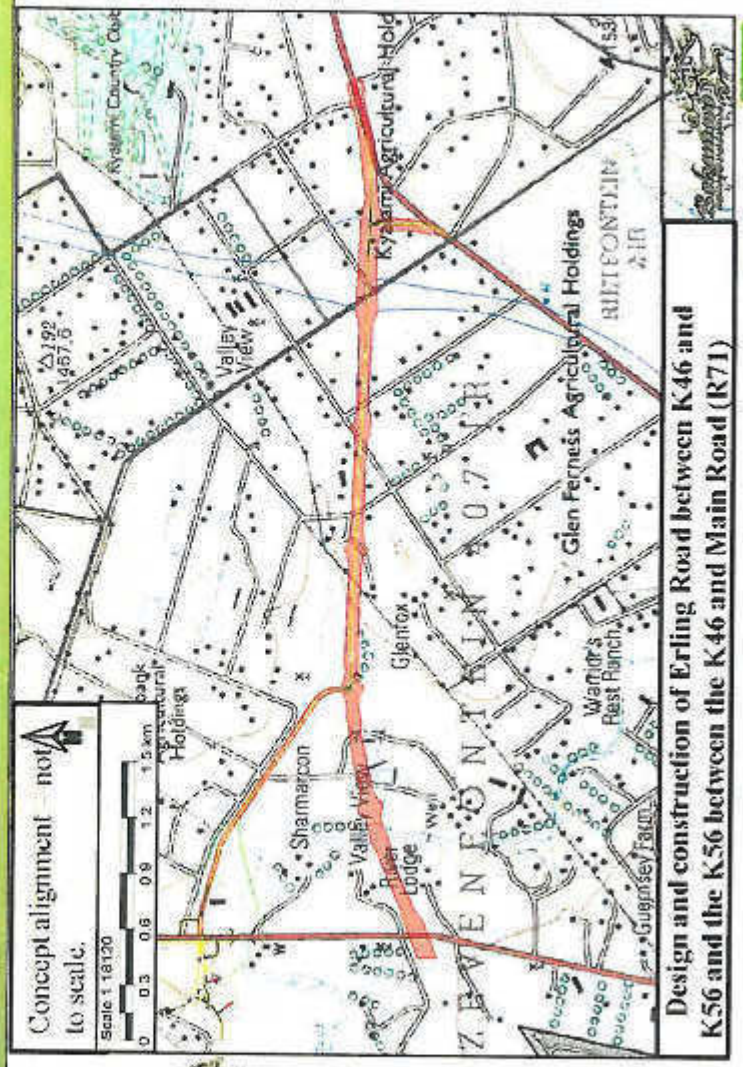


All interested and affected parties are invited to review the development information. Please submit your comments on the Final Scoping Report within 21 days (excluding school holidays & 15 Dec – 2 Jan)to the Gauteng Department of Agriculture and Rural Development (GDARD) – Attention: Justine Chan (email: Justine.Chan@gauteng.gov.za or fax: 011 355 1000). Please cc your comments to Bokamoso (email: lizelleg@mweb.co.za or fax: 086 570 5659)

Venue: Grace Point Church
Tel: 011 702 4600
Date: 25 November 2013 – 30 January 2014
(Excluding School Holiday days & 15 Dec – 2 Jan)
Times available at Church: 7.30 AM – 17:00 PM

Website: **www.bokamoso.biz**
Please do not hesitate to contact us if there are any questions in connection with the abovementioned development.
Contact person: **Juanita De Beer**
Tel: 012 346 3810 Fax: 086 570
E-mail: lizelleg@mweb.co.za

K56 Draft Scoping Report Review



All interested and affected parties are invited to review the development information and to register any issues and concerns to be included and addressed in the Final Scoping Report.

Venue: Grace Point Church
Tel: 011 702 4600
Date: 27 June 2013 – 23 August 2013
(Excluding School Holiday days)
Times available at Church: 7.30 AM – 17:00 PM
Website: **www.bokamoso.biz**
Please do not hesitate to contact us if there are any questions in connection with the abovementioned development.
Contact person: **Juanita De Beer**
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Bokamoso

Annexure M(iv)

FOCUS GROUP MEETING

Focus Group Workshop Meeting

Date: 9 May 2012
Place: Bokamoso Office
Time: 10h00

Contact Details of the Environmental Consultants:
Bokamoso Environmental Consultants
Tel: 012 346 3810
E-pos: lizelleg@mweb.co.za
Contact Person: Juanita De Beer
Address: Lebombo Gardens Building,
36 Lebombo Road, Ashley Gardens

MINUTES OF THE FOCUS GROUP WORKSHOP MEETING – K56 – 9 MAY 2012

OPENING AND WELCOMING

Lizelle Gregory from Bokamoso Environmental Consultants welcomed all the people at the meeting.

ATTENDANCE

Howard Betts	193 Maple RD
Shiree Darley	193 Maple RD
Annette Deppe	Ward Councillor 93
Chris De Villiers	Great Kyalami Res Council Glenferness
John Mendelsohn	Ward Councillor 94
Juanita De Beer	Bokamoso Consultant
Lizelle Gregory	Bokamoso Consultant
Francois van Rensburg	WSP Group
Michael Drenman	Metrum Project Manager
Kristin Kallesen	GECKO

Francois van Rensburg: If there is any road designed etc. We can sort out the alignment question first and then the environmental issues secondly. Lizelle take over on that.

Lizelle Gregory: Thank you very much for attending this meeting. The main purpose of today's meeting is to focus on the group of people around the table that we can look at alternatives and what you thinking of and that we can hear what your major concern is. My aim is to prepare a drawing for the next Scoping Phase Public Meeting and where we going to table some alternatives to the people, which we going to discuss and we just want to get feedback from you, some of you have been involved in this alignment and know a lot about the alignment for many years. If we can get some

feedback from you as community and there have were apparently some frameworks done in the areas and some planning in the area. Any information that can be of any assistance and the idea is to more like an inform meeting and give us some inputs and tell us what you will suggest, then we can take it from there forward.

We have already tried for the next Public Meeting for the MEC to attend, they said that there won't attend a MEC but the Representative will be attending. Unfortunately Chris Buitendach that was the Engineer of the Project died, so I'm managed to get the person that is now in his place and we have invite him to the meeting

Annette Deppe: Who is it?

Lizelle Gregory: We not sure yet.

Kristin Kallesen: Is he from Gautrans?

Lizelle Gregory: Yes he is from Gautrans.

Juanita De Beer: The MEC in Chris Buitendach's place is Ismail Vali.

Annette Deppe: Yes, he is the MEC.

Francois van Rensburg: The guy who takes over from Chris Buitendach is Cumon Pillay, I spoke to Andre Killian, and unfortunately he can't be here today. Andre is also sitting on the steering commitment of the entire infrastructure from the area. If you want to speak to them, it will be the best

Lizelle Gregory: Yes, we have to invite him to the next meeting.

Francois van Rensburg: You can't ask them, you have to go there for the meeting.

Lizelle Gregory: If we have the next Public Meeting do you think it is possible to ask him to attend?

Francois van Rensburg: I don't know, I can't say. I have been in the business for almost 20 years and I have never succeeded in getting any of them to attend a meeting.

Annette Deppe: That is why I request the MEC presence there for the Public Meeting like Ismail Vali. If you request him in writing and respond that he will send a Representative, its fine and we happy with that. I have also a name for you a guy called Eddy Sikala, his position is also counting of the roads of transport, if you want his name to invite him as well; he is working a lot with me on roads.

Lizelle Gregory: Can you please give his contact details?

Annette Deppe: 083 634 6188 – He is in Johannesburg.

Francois van Rensburg: Lizelle you said to get some ideas, so that is the good question from the Public Meeting, if you want to interrupt please do so. There was a big question come from now, maybe just a feed background. Where we come from is we are WSP Consultants has been appointed initially from Steyn City Properties to do a Consultation Investigation for the development of the Steyn City development. Everybody knows about that everything it is not an issue on the table we not going to discuss that, I don't think it is necessary, we going to have a separate meeting on that. We have also been appointed by Century Properties to look at their development in the Eastern side of the K46. Just for introduction, Michael Drenman is the Project Manager from Metrum, he is the Project Manager for Steyn City Properties. We have done the transportation modelling for the area; we had distinctive discussion of the modelling that was been required. We did a whole transportation investigation basically from Fourways North including up to the N14, including the Lanseria Development that has been proved already and we extended the investigation up to just the East of Main Road and also the future K53 on the other side. So we've looked at the holistic picture of this area. It is public knowledge it is part of the submission of the Steyn City, so you can get a copy.

The investigation has been done and as part of the larger picture the certain road network has been identified, not accommodate only the Steyn City and Century Development is also to accommodate the ready approved more than 5 developments as I said the Lanseria Development, the extension of Diepsloot Development and also the other things that has been approved by the city in terms of the Spatial Development framework for the area. There are quite extensive roads been required obviously to accommodate all these developments. Obviously how you do the transportation investigation, first of all look at your existing road network and can it accommodate it? Secondly, you need to look at what the plan road network is and then what you need to do additional to that.

We are in the fortunate position there is not really anything you need to do additional over and above the planned road network. The planned road network needs to be implemented of part of all this, is basically PWV5, PWV9, K56 between Main road, the current alignment that goes down here, the further extension that align up to K53 west and the a portion of K53 as well and then also there is a new link that has been planned as part of the Sanral planning goes for a year, we called it currently just the East West link through the Steyn City, it's just North fron Steyn City Development, if all that has been identified and then the city will approve the development. Steyn City didn't request anything, that is what we must realise; a developer will never request to spend any money. The developer wants to spend more than they have to spend. Steyn City have done the traffic report has based on the requirements of the authorities, and the authorities said you can develop provided the x

and y Road that the development be done and one of those are K56, K56 that is a requirement is basically from the section here up to Erling and then from the extension Erling and up to the interchange that is currently being built, the K46. There is also others as well, including K46 upgrading and Cederal road upgrading construction from the East etc.

Chris de Villiers: That is what we saying, why don't they do that first? We can't understand that.

Francois van Rensburg: I think just on that score, what you also must realise there is a process that is followed and you should have been part of that process if you want to influence those requirements. It is my opinion that Steyn City has been approved by the authorities, based on certain requirements and if you want to influence the requirements based on what Steyn City's been approved, and then you should have taken that process.

Now we dealing with a Roads design, I would rather sit here completely not even looking at Steyn City. Everybody is making an issue out of Steyn City, Steyn City is not the issue, the issue is the construction of a provincial Road.

John Mendelsohn: Exactly!

Francois van Rensburg: Province is funding the Road. They are providing 17% of the funds of the Road and they are the owners of the Road, they will also take over the Road after the construction. There is an agreement between the developer and Province, and the only reason why we running on behalf of Steyn City with the process, is because Gautrans doesn't have the capacity to do this thing. You made the comment earlier about the people just passing away and everything, I mean there is nobody inside the Province that has actually the capacity that is why they appointing the Consultants to run through the process on their behalf, in this terms they the one that contributing the Steyn City Property to the other contributing Party, so it makes sense that they just use one of the partners to facilitate the process. They appointed ourselves as the Engineers, for the design and planning, basically the design because the planning has been done and we appointed Bokamoso for that. So in the end mostly we get paid by the Province of this project.

The drawing that you see on here is basically the planning that has been done originally for K56. I got all the Reports with me, it's unfortunately split into two separate Reports, the section from the Road there has been done in one Report, with the whole section down to PWV3 which is the next freeway and this section has been done in the separate Report as well, it is a bit challenging reading the Reports together and they also in very good 1978 in Afrikaans, so that Reports are available. Unfortunately I'm not going to copy for everybody of those Reports, we made scans of the drawing, and we can give that electronically. The Reports is quite thick so if you want a copy of it,

you are welcome to borrow it from us and then make your own copy. It cost almost R400 to make copies from us.

Chris de Villiers: Are u paid by Steyn City?

Kristin Kallesen: 70% Province and then 30% Steyn City.

Francois van Rensburg: We part of the Project cost and that's been discounted.

Chris De Villiers: Can I ask you a tricky question? How do we maintain the independence of the contract of the interest?

Francois van Rensburg: I'm a professional engineer and our company is also registered with proceed.

Chris de Villiers: You are ensuring us of your independence. We don't have proof of anything.

Francois van Rensburg: Well, you welcome to bring your own engineers on board as well, and they can maybe argue your case for you. As I say, we are a professional Company and we act professionally. I am an engineer, in terms of my kind of conduct it is what I need to do.

Chris de Villiers: Is there no contract between you or Stein City or you and Bokamoso?

Lizelle Gregory: As Bokamoso, I can also say yes.

Chris de Villiers: No conflict at all.

Lizelle Gregory and Francois van Rensburg: No.

Michael Drenman: Also Francois's design is to determine what is required to service the area not just Steyn City.

Francois van Rensburg: Chris can I just ask a favour? That you just can keep it a little bit back the arrogance and also the sarcastic little comments that you add, because I can also like all kinds of arrogance and sarcastic little comments, but that will also show that I'm not in partial.

Kristin Kallesen: Sorry can I also ask just a question to understand, in the traffic impact study that has been done; does it work on current traffic volume? What goes into the traffic because I have never looked at one?

Francois van Rensburg: The traffic study has taken account of existing traffic but it is also taken account of future grant of the area, and then it is also taken account on physical basis of the development that can happen in the areas as well, so all of that then added together and you do a transportation model for the area and then it looks at the impact of the road network.

John Mendelsohn: Please, don't jump in place to place, subject to subject. I did ask before we actually got into this meeting, let's have an agreed agenda and go through that agenda and appoint etc. Lizelle, you called the meeting.

Lizelle Gregory: Yes.

John Mendelsohn: It is not clear to me that why you called the meeting or what the purposes are. You must kick off and say what you think that must be on the agenda.

Lizelle Gregory: The reason why I called the meeting was because we have a Report discussion on the Public Meeting at the Church. The Ward Councillor and some of the other people said that you have some information of working on the frameworks in the area. I would like that information. You also said that you would like to discuss the possible alternatives that the people in the area have looked at and you would like us to consider us the alternatives. That was actually the purpose of the meeting; I arranged it because of the request of the people in the area.

John Mendelsohn: Okay, the first thing we looking at is Framework, whatever that Framework might be and the second thing we going to discuss are alternatives.

Lizelle Gregory: There is apparently a Framework done. There is another Town planner currently busy in the area with a Framework plan.

Kristin Kallesen: But it's getting started.

Anette Deppe: So just 2 frameworks, the first one done by Seeff and it is a cross boarder Framework between Tshwane and Johannesburg, and the other Framework was approved by the Province, that was an Environmental Framework. The other Framework was the Eskom Framework, also Environmental. So there is no transportation Framework on the cards that I know of from anyone except this one that you presenting to us now.

So I'm pleased in a way that Province is undertaken this because we've got huge changes in this area as we all know, the Cities priority is North of this conservancy and North-East of this conservancy, there is a huge priority for the City of Johannesburg West. The focus is not in Midrand, the focus is on the Diepsloot Lanseria side, so I can imagine the reason why they asked a Private Consultant to be involved of this whole exercise, so I'm actually pleased for it, so we must wait for the Reports, when you finish with them and get some copies of them that is approved by the Province and the City of Johannesburg. So we must get copies of that so that we can peruse them.

I think from the Environmental side can we leave that until Francois is finished with the Transport side.

Francois van Rensburg: I just want to give background where the Project comes from, because I know it was quite a debate at the Public Meeting.

Anette Deppe: We just want to know that this Steyn City just to elaborate on Steyn City. That application comes through the Ward Councillor from that area which is unfortunately an ANC Councillor, so it would not be in his interested to be distributed the application to any of the people in the surrounding areas, so there was no Public Participation from the conservancy or other areas around Steyn City, if you can put that to Red. That Process came and gone, and nobody gave input to it.

Chris de Villiers: There was no wider distribution of the information about the applications, with the road development in the area.

Anette Deppe: Politically there's by law they don't have to distribute it. All they have to do is to give it to the Local Councillor. The immediate Neighbours as well.

John Mendelsohn: Please wait, I want this clearly on record. I am the Ward Councillor of Ward 94. There was until this thing was well at vast, I personally have no knowledge of its implications. Yes, there is stuff in the past of Rietvlei Development; I had a perusal input there done for this current Development. Nothing came to me and nothing came to my community, and I want to paste on record that this meeting, I want the alternatives which could have been proposed, had I have been aware of them at the appropriate time to take into account. Thank You.

Francois van Rensburg: Alternatives in terms of? Just for my knowledge.

John Mendelsohn: The alternative routing of the traffic.

Kristin Kallesen: Can I just add because the Helderfontein Property does fall into our area, and we did take part in that Process with the Development and on the basis it used the K56 as the main access point, and that they shouldn't be using it to get approval of the Development if the Road not yet had been approved.

Anette Deppe: I think the request here would be, because I was the Ward Councillor for the Helderfontein side in the last 5 year term, the request would be from Bokamoso that you include the EIA study that was done by Helderfontein in your Process of your submissions to the Province, so that they can see the comments that have been made in that Development. It is very relevant to this Road.

Lizelle Gregory: I can really not include it, as part of my EIA, but I can refer to it and I can get the people that object against the Road in terms of that Process, but it will be difficult for me because that is the Process that have been completed.

Shiree Darley: Can I just say, so this is basically all been approved, is that what you saying?

Anette Deppe: Yes, prefer to it in your document.

Kristin Kallesen: I can send you our appeal?

Anette Deppe: Further into that, because this Road is not just that little piece of the Road, it's a Road that goes from Midrand to wherever it ends up, I'm not sure. As the Ward Councillor for 93, which includes the whole of the Road coming from Midrand, my comments will be send to you with regarding the whole Road that has set not just that piece.

Lizelle Gregory: Yes, you actually want to know what the purpose of the section of the Road is for the whole Road.

Anette Deppe: I think that what is important for you, Francois van Rensburg, is that you did the study for this area, the study for the other area was done by Arap and my question is can you refer to the Arab study, as well as their study in your document to the Province, Because I want this Road to be looked at holistic that is what I ask for. The 2 Transport Studies have to be put together and have to look at it holistically, that is what I'm asking for.

John Mendelsohn: Mr van Renburg, you made a comment that the appropriate time to have suggested transport alternatives. There was a time Steyn City Development was for comments and objection, and I have already given the reason for the Councillor Deppe, why this did not happen, but we are now at a point where Bokamoso is doing a Scoping Report which will be all in bracing I'm sure there is nothing they can exclude from it, if it is valid to the Process.

For the purpose of the Bokamoso Process we the community present and I myself have suggested alternatives and the next item in the Agenda is the alternatives and Mr. van Rensburg aspect that it cannot object.

Francois van Rensburg: I think what I try to say is if you want to influence the requirements for the approval of Steyn City, that something separate from this Process. What I also try to say to you, is that we might have sat here without considering Steyn City or Helderfontein or anything else. This has been a planned Road since the 1970's, and we must look at it in that sense. Forget about Steyn City, forget about all those things. We must look at the Road in its own sense, that is what I trying to say and that is why I agree with the Councillor to some extended, you must look at the transportation modelling for the area holistically and that's it.

This Road has been on the planning, all the traffic engineers in this City have always taken that into consideration with everything that they do in terms for planning areas. The Province is taking comments from it and to look at the general master planning as well and taking comments from it. So yes, I agree

with you looking at the alternatives but what I was trying to say is look at alternatives related to this road in terms of the planning of this Road, and not in terms of alternatives how to accommodate Steyn City, that's what I'm trying to say.

Chris de Villiers: We not necessary in our alternatives proposed for the Developers as much, I must be honest with you. What we are saying is, in fact if you exclude them from the picture, you will have a better idea how the alternatives work. If you improve Main Road and if you improve the R55 up to 4lane highways, you already got an East-West-North-South improved flow of traffic. Just of this one small element of the proposal, just do that first and then come back with the Traffic Studies.

You said these roads has always been planned, just to follow up, but what has never been facted into this is the social consequences of these guys planning in the 70's and doing things in a very focused way, for example not putting things on title deeds, they planned the Roads and they put them in place, everybody's been consulted except the owners of the properties. They got quotations on their Title Deeds, with some hidden document, but not on the Title Deed. So they stand to lose their properties, no compensation and extremely happy about this Process. You see Lizelle, now I'm digressing that it must be facted in a holistic situation regarding this Road.

Francois van Rensburg: I have done a bit of investigation and we are waiting for the final documentation from Gautrans but there are basically 5 to 7 persons that have not been compensated yet. The rest of the people that being affected by this road that is inconsideration has been compensated fully or has been boarding to the bureau already and just to give you an indication, this section of the Road is not being affected by anybody in support of it. This section up to the point Dunmaglass, up to there has been expropriated and been compensated for, it is only that section there, that people hasn't been expropriated.

Chris de Villiers: Now I'm asking a personal question, that property there has not been expropriated!!!

Francois van Rensburg: According to the information that I have now.

Anette Deppe: Can we get a list of those 7 properties?

Francois van Rensburg: That is what I'm waiting for, yes.

Chris de Villiers: Is the people on the other side that don't know about it in Glenferness? In fact this is going to be like a huge shock to them because they bought properties, since their expropriation placed and nothing was on the Title Deeds, so they bought properties.

Francois van Rensburg: I understand, I had the discussions with Gautrans and they are busy looking for that on their files and we have our own people as well, so they are assisting for going through files.

Chris de Villiers: You said the Road has been planned, were planned is not really a good word, because it's not really properly planned.

Howard Betts: This whole area John, you know yourself, this whole area probably the most out fluent?

John Medelsohn: Yes.

Howard Betts: It is sliced into four in the big picture. I mean us alone, we employed 7 staff and I know that this Greater Kyalami area, I heard like 5 or 10 years ago was contributing over a billion into the economy. It goes right through horse feed to big labour thing and you got to chase them away from here. They can't stay; in fact they already made the road. It's a big screw up and replacing half of the R55. I wait for 15 cars to go out of my driveway to the midway.

Chris de Villiers: You must excuse us Francois for being angry but you see why we being angry about this, is because those two Roads is remain under development and we can see it every day, and here we want a new Road.

Francois van Rensburg: Look. Let me just put my impartiality on the table, I don't care less what alternative we building from an engineer point of view, I can say to you from an Engineer point of view just for the moment of a traffic Engineer hands on, you need a link from here to over East and you don't need only that link, you need that link, you need that link and you need that link. You need actually further links through here.

Howard Betts: Why through there?

Francois van Rensburg: The reason is you've got a 5years scale, 5km's stretch here, that's about 7.5km that you have there. You cannot have just every 10km's crossroads East-West link through an area that the Government has identified us a priority area for the Developer. The reason why I come from that point of view is that certain planning places you need to design for, so you need these links.

Howard Betts: The tax payers live here.

Anette Deppe: So the question then remains is in your professional opinion looking at the studies you have done and you proposed to this community. If you think that there is an alternative that could be on the table from your point of view. Just that stretch.

Francois van Rensburg: Considering impact on the communities and changes of the designs and planning of proposals that have been made in

the past. I would say no, you can maybe look at tweaking something here and tweaking something there, the reason being is like I said, I doubt this thing is over 20years now and the fact is that this thing has been in the cards. Yes, I understand they've got sympathy, I always say that in the beginning, sympathy with people because the ignorant guy out there don't go and study the planning in the area, we just had a chat before the meeting. If you go by a house where you just concern somebody of the Environment and say to them what's going on and how to access. You don't think of the planning of the Municipality, because I mean really, I find my way for 4years here, People don't do that for investigation so then you get the guy that does that. Now, as soon as I start moving this thing around, then I affect that guy that will he say immediately. I have never been affected by any Road, these guys should of known that they going to be affected, you guys are expropriated that portion. You have expropriated most of this Road already, I think it's expropriated up to PWV5 if I may mistake. So this has been al expropriated, as soon as we start one thing to relocate this Road, you need to look at phasing between the interchange, all of us know about the bugger up in Menlyn for example, the closed phasing of the interchanges there. We know of all the accidents happen there, as soon as you move this thing up then you influence this design. If I move it down then influence all the accesses that has been approved around here as well.

Chris de Villiers: I just want to make sure, we are not saying move the Road. I was saying it must either go completely and the alternatives that we are proposing are upgrading all the roads in the area that exist, from 2 lines to 4line highways.

Francois van Rensburg: I think what I saying to you is, let's give you the opportunity to study the Reports for us; I don't know if you got the copy of the Arab Report, I know the guys from Arab. I can get you a copy as well, study the Reports, the Reports show you that you don't need either or, you need all of them. That is basically the reality.

If you don't want Roads to build, if you don't want development then stop having kids. People, the population grow. I mean it's a South African thing and as the gentleman said, we want all our little pieces of grass and everything, I mean if you want to travel to Europe, everybody pay the same there for the apartments, yes, we want this open spaces and everything and I know unfortunately this things have an impact in terms of infrastructure provision as well.

Chris de Villiers: You see, where we come from, I hear what you say, on one level there is like 2 things on my mind, I know what you saying of population development. We are concern because we don't have the resources to rebuff your Reports, that's why I ask you about your conflicts and the rest, I apologise for that. You must understand from a very weak provision and I think you know that, and we don't always trust all the stuff that gets thrown to us in many cases and a lot of stuff that comes our way. It is not always correct

and for example a question about Public Transportation is always thrown away, we always ask why we have not taken to account the holistic approach of Road upgrade plus affected public transport plus taken to account the Cities of overseas, where the roads going into disrepair, this use because the car is no longer of importance, has that taken into account, I don't know?

Anette Deppe: That middle section where that piece of Road comes through, it forms part of the RSDF of City of Johannesburg is a declared no further development area and it is very clear that the northern Development frame work of the City that was done for last year that that section that the conservancies that falls in, it should be getting very limited development in infrastructure development, which means that that piece of Road that is in the frame work, so if they built the Road that it will be conflict of that framework.

Kristin Kallesen: Sorry, that is exactly what I want to say is we mentioned that the Government is embarked this area for development.

Anette Deppe: Not Government, the City of Johannesburg.

Kristin Kallesen: Okay, you get different, this is the problem getting many departments to talk to each other, we've got plans to show that this conservational area, the PWV9 goes through a number of wetlands, there have been submissions on the Environmental Management Framework where they suggest the Roads do not go there, and you got different levels that don't talk to the other one. What you given to us is the traffic perspective and the City of Johannesburg planning of the area, that's where the precinct plan is under discussion is to identify and clarify and bring these different plans together. That's why we, the conservancy feel's that there should be no Roads going through this area, this is a green lung for this City of Johannesburg, further Roads done support the current GDS2040 which has just come out, because it says we must stop urban sprawl. We hear that, we hear from certain people from PWV9 is now being upgraded as the part of the R511. We heard so many different stories on these Roads it's not even funny. Can you give me the Broad overview of the roads as well in this area and what the prospective futures is for them in 10-15years, where will the funding come from etc.

Francois van Rensburg: A year ago I would have given you a different story then what I giving you now. No, it is quite easy, maybe Chris just before I answer on your question, you're question about Public Transport is one comment I want to make, you must always be very careful to say to the Cities you got to implement public transport – Public Transport is being planned, the challenge of the public transport is how to make it feasible, unfortunately again what I said earlier, we want a piece of lawn in front of our houses and we want to walk out on our own little swimming pool etc. We don't want to stay in high rise high density development, if you don't know

how high rise high density development public transport is not going to be feasible.

John Mendelsohn: Correct.

Francois van Rensburg: Right over the world, if you take Europe, I have travelled a couple of countries in Europe, as soon as you go out the City there is no Public Transport. I have travelled to Rome, just outside of Rome and outside of London; you can't get to the City if you go by the car. So that system is not going to work if we team up with all the low densities in the area. First we must put Public Transport in to consideration as far as those users are concern being the domestics etc. Just in terms of the planning of these Roads, it's been done in 2006, don't correct me for the number now, I can give you the Report, the dates are in there. Gautrans did the review of the strategic road network which is basically all the blue and yellow lines on this, the PWV5, PWV9 and the K56, which direct what I prefer now, was directly affecting you guys, have again identified high priority Roads.

If Sanral be able to continue with the E-toll system, then PWV6 and PWV5 and PWV9 was high priority on phase 2, it was actually phase 2A for construction and tolling.

Kristin Kallesen: So it would funded by the Tolling and then become toll roads as well?

Francois van Rensburg: Well, that was the thinking a year or 2years or 3years ago. Gautrans's planning doesn't refer to anything about tolling, all that it says that it is high priorities PWV9 is priority 2 or 3, after other small sections of PWV3 further down South to be built and PWV9 is priority 3 if I'm not mistaken, PWV5 I cannot say, K56 in terms of the K-Routes is priority 11 in the whole of Gauteng. It competes like routes K54 in Tshwane and K99 in Tshwane and those kinds of things. So I can give you a copy of that Report, it's quite a fast process information.

Kristin Kallesen: I think I have seen the Report, that's what I want to mention from that Report. In other areas in the city, I did notice that the routes were rewind to existing roads in some places where they felt it was feasible; it has been done in other areas.

Francois van Rensburg: Correct.

Anette Deppe: So just to confirm what you saying, I send an email to Eddy Sikala to ask him about the Road, PWV5 and PWV9, and he responded this way: "The discussions for these roads are still at very early stages, they were initially supported to be done as Phase 2 of the Gauteng Freeway improvement scheme, but now because of the tolling issue going on, the Project has slow down should I get clear details, I will be able to update you soon. The Department may be able to share more light on us. He has

responded exactly in that matter, just to come back to the realignment of the road.

The nodes have been declared in the City of Johannesburg, RSDF for future development, the No's is Blue Hills, which is the top of there, Francois, and then the intersection by Crow Thorn, where Retail Africa is the Shopping Centre. Then there is a declared Node by Diepsloot, their by Steyn City, that type of road and the other declared node, there is not another declared node here, so there is no declared node by the RSDF or the City of Johannesburg. So what I requesting is, all I'm asking, can the consideration not be that road comes through from K71/1 and carry going on through to the clay oven, instead of going through the section here.

Francois van Rensburg: If you look at this, this is already developed houses.

Anette Deppe: No. It is an existing road.

Kristin Kallesen: So basically you need to turn it, and carry on to the existing Main Road.

Francois van Rensburg: What I'm saying to you is, this provides North South Capacity to you basically. That is the issue in the Northern areas of Johannesburg; there is No East West leakages. We had a big challenge with Steyn City as well, because the City actually wanted the additional East West link through the however crooked their idea was for the East West. The unfortunate thing is Dayne Firn has been developed, so we in the end with the blessing convinced Steyn City, that we provide an East West link. The Northern side through the development, they had to split a certain section of the development, and then extend further up the link in here.

Anette Deppe: The looks of things, Kristin, there is really 2 options, even we stick with the K56 or we stick with the PWV5 and PWV9, because they need problems of the East West corridor, so either way they going to build the roads.

Shirlee Darley: It's more than having our own piece of lawn and our own swimming pool. We require these sizes lands, we require this infrastructure that we've got in this area to facilitate and support that. If these roads come in, you wipe it out, we got to go. Without question, we cannot survive here and we cannot maintain here, we have to move. So you are taking all of this economy, so it's gone and finished. This whole province is going to lose and I don't know where we going, we might pack up our horses and just head off to Germany.

Kristin Kallesen: The conservancy regard where you take it.

Shirlee Darley: The wildlife in this area, sitting on our patio on a Sunday afternoon and we could hear the Jackals, there is so much support for them and we have taken out so badly or of Maple Road, the reason of Maple

Road is the way it is, is because the other roads in such a bad way, people can't move on them and there is no flow, that's the way people are penetrating, there is nothing here to accommodate them. The fact that the existing roads don't actually facilitate accommodates that needs to happen. They wiping out an entire industry.

Francois van Rensburg: I just want to show you some figures and then you tell me where to put this lanes in, there is an easier way to explain to people are, Steyn City is for example a very low density development, the average span sizes of thousands one hundred square meters, I mean all of us know that is large for a single residential property.

Shirlee Darley: The offices are 5000 people.

Francois van Rensburg: But still, it is a small office building.

Shirlee Darley: It is not a small office building. It is a massive office building, and it is the first of the Office development there.

Francois van Rensburg: Of the Northern side.

Shirlee Darley: Yes. So there is a huge capacity they trying to facilitate.

Francois van Rensburg: The offices and everything is not the bigger traffic generator, the end it is the residential side and the people are moving around that creates the biggest challenges. Just to indicate, we considered both all 3 basically, the East-West link, like explained to you and in the end somehow I can give you that plan separately that linked back to Main road, there is Main road. Then we have also PWV5 into consideration and then we have also K56 into consideration, K56 will carry the volumes 2500 vehicles per direction, that is equal Avant of a free lane per direction.

Anette Deppe: On Maple Road we had a traffic impact study done by City of Johannesburg, with a counter, the counter at the moment is taking 1700 vehicles per hour coming up to Maple road.

Francois van Rensburg: PWV5, just to continue is in a one direction 4500 vehicles and I'm rounding it up and in the other direction I read it correctly 5300 vehicles, so you talking about 5 lane freeways. Then on K56 it's 2200 vehicles in the peak direction. Now in general you can accommodate 2200 or 2500 vehicles on a free flowing lane, as soon as you put the news traffic signals on the road which is the idea of K56, then you talking about less capacity about 20%. Just counting all this together, you need about 10 lanes of roads to provide East-West capacity. We are talking about high order roads, we are not talking about residential streets and those kind of things, that is what we trying to get, is the regional traffic, get that out of the residential areas by developing the major road network. If you now take those 3 roads into consideration, it basically lays in this area. Where do we