The Upgrade of the Provincial Routes D620 and D621 from Gravel to Surfaced Roads in the Winterveld Area, Gauteng Province

BIODIVERSITY ASSESSMENT

Ecological Assessment and Wetland Assessment for the Provincial Routes D620 & D621

Compiled by
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1 EXECUTIVE SUMMARY

Background

The Gauteng Roads Agency is in the process of planning the upgrade of the existing Provincial Routes D620 and D621 from gravel to covered surfaces. The roads are in the Winterveld area of the Gauteng Province.

The basic information for the two road sections is as follows:

Road D620

- Length of road: 8.8km + 0.5km existing portion reviewed
- Single / dual carriageway: D620 Dual Carriageway
- Current width of the road: Approximately 7-8m (varies)
- Width of the upgraded road (including lane, shoulder and pavement width if applicable): 38.8m (including medians)
- Current road reserve: Approximately 19m (varies)
- Proposed road reserve: 62m
- New storm water infrastructure to be constructed and existing storm water infrastructure to be replaced/ extended along the route.

Road D621

- Length of road: 4.439km
- Single / dual carriageway: D621 Single Carriageway
- Current width of the road: Approximately 7m
- Width of the upgraded road (including lane, shoulder and pavement width if applicable): 11.7m
- Current road reserve: Approximately 20m (varies)
- Proposed road reserve: 30m
- New storm water infrastructure to be constructed and existing storm water infrastructure to be upgraded and/or cleaned along the route.

Flori Scientific Services cc was appointed as the independent consultancy to conduct a biodiversity assessment, which includes a terrestrial ecological assessment and wetland assessment. The field investigations and assessment report only deal with the existing road, road reserve and an approximate 50m bufferzone along each side of the road.

Field investigations were conducted during March 2017.

Location of the study area

The study site consists of the existing D620 and D621 gravel provincial roads. The D620 and D621 roads are 8,8km and 3,4km long, respectively. The roads are situated in the Winterveld area, within the City of Tswane Metropolitan Municipality, Gauteng Province.

TERRESTRIAL ECOLOGY

Vegetation

The study area is with the Central Bushveld Bioregion of the Savanna Biome. The study area is situated mainly within the veldtype unit of Central Sandy Bushveld, with a small section of the D621 route within Springbokvlakte Thornveld.

Priority species

No red data species were observed during field investigations.

Protected trees in the study area

No protected trees were observed in the study area during field investigations.

AQUATIC ECOLOGY

Watercourses in the study area

There are no large perennial rivers or even large semi-perennial streams in the study area. The closest large rivers in the region are the Tolwane / Sand (to the west); the Kutswane / Soutpanspruit (to the north and east); and the Tswane (to the east). There are no wetlands in the study area, including pans. There are a few stormwater culverts along both routes that simply channel and allow the free movement of stormwater run-off across (under) the road. These are not watercourses, but need to be inserted, as roads can have a significant impeding impact on the free flow of surface stormwater.

Route D620 only crosses over two small seasonal drainage lines and no streams or rivers. Route D621 crosses over two watercourses, the one being a seasonal drainage line and the other one a larger seasonal drainage line or small seasonal stream. The two watercourses along Route D621 are part of the same, larger drainage system.

Drainage areas

South Africa is geographically divided up into a number of naturally occurring Primary Drainage Areas (PDAs) and Quaternary Drainage Areas (QDAs). The different areas are demarcated into Water Management Areas (WMAs) and Catchment Management Agencies (CMAs). Until recently there were 19 WMAs and 9 CMAs. As of September 2016, these were revised and there are now officially only 9 WMAs, which correspond directly in area to the 9 CMAs.

The study area is situated within the Primary Drainage Area (PDA) of A and the Quaternary Drainage Areas (QDAs) of A23J and A23K.

PES of watercourses in the study area

Criteria	Identified Watercourses		
	Stream (D621_2)	Drainage Line (621_1)	Drainage Lines (D620_1 & 2)
Category:	C/D	D	D
Integrity (PES):	Low	Low	Low
PES Description	Largely Modified	Largely Modified	Largely Modified
Recommended EMC	C	C	C

EIS of watercourses in the study area

Determinant	Stream (D621_2)	Drainage line (621_1)	Drainage lines (D620_1 & D620_2)	Confidence
Overall EIS	C	C	C/D	-
Description	Moderate	Moderate	Moderate/Low	-

Sensitivity analyses

The ecological sensitivity of the study area is determined by combining the sensitivity analyses of both the floral and faunal components. The highest calculated sensitivity unit of the two categories is taken to represent the sensitivity of that ecological unit, whether it is floristic or faunal in nature. According to the analyses there are no high sensitivity areas or habitats. However, watercourses by default must be viewed and approached as sensitive.

Ecological community	Floristic sensitivity	Faunal sensitivity	Ecological sensitivity	Development Go-ahead
Thornveld	Medium/Low	Medium/Low	Medium/Low	Go-Slow
Road area	Low	Low	Low	Go
Cultivated lands	Low	Medium/Low	Medium/Low	Go-Slow
Watercourses	Medium	Medium	Medium	Go-But

Fatal flaws

There are no fatal flaws.

Priority areas

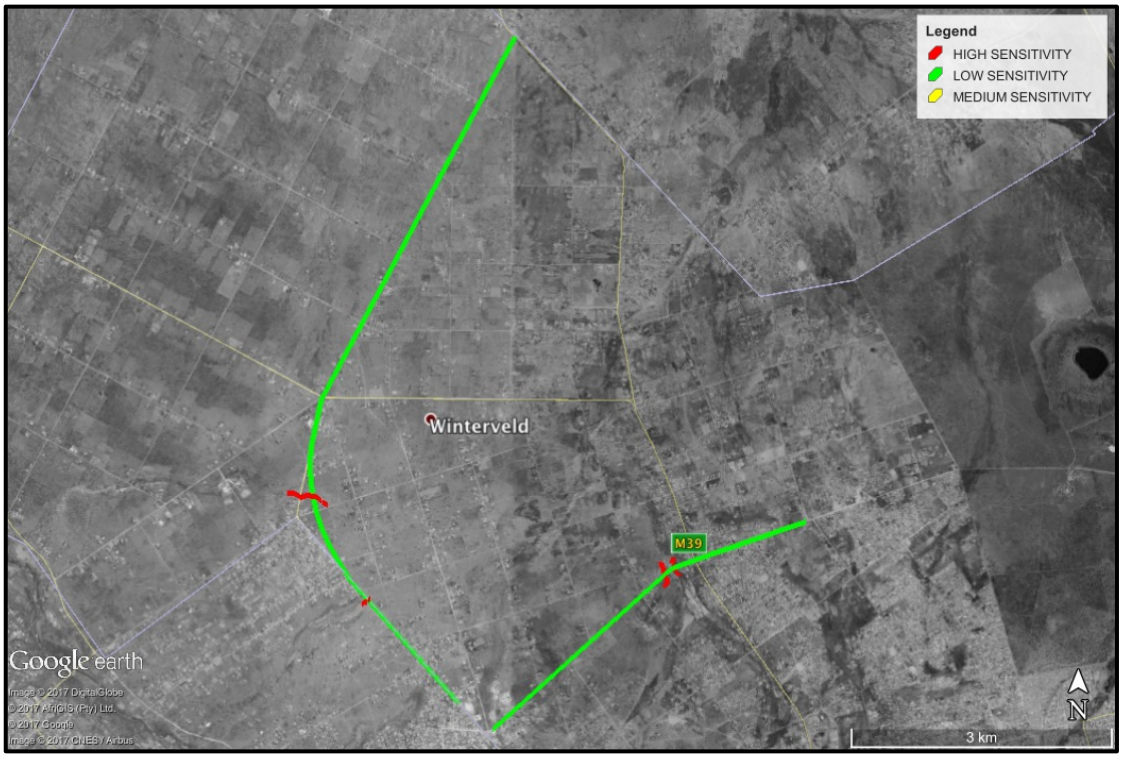
Priority areas include formal and informal protected areas (nature reserves); important bird areas (IBAs); RAMSAR sites; National fresh water ecosystem priority areas (NFEPA) and National protected areas expansion strategy (NPAES) areas. The study area is not situated within, or adjacent to, any priority areas.

Critical Biodiversity Areas and Ecological Support Areas

The study area is not within any Critical Biodiversity Areas (CBAs). Route D621 crosses through an Ecological Support Area (ESA) in the area of the stream crossing, which is approximately 220m west of the M39.

Sensitivity Map

There are no actual areas of High Sensitivity or 'No-Go' zones in the study area. There are a few small watercourse crossings. Although in reality these watercourses are not highly sensitive all watercourses, by default, are viewed as sensitive and must be approached as such.



Conclusions

The conclusions of the study are as follows:

- There are no fatal flaws
- There are no 'No-Go' zones or highly sensitive areas, but mitigating measures are recommended to reduce negative impacts on the natural environment
- There are no major watercourses in the study area, although a few seasonal drainage lines and a small stream are present. Watercourses, by default, are viewed as sensitive
- Most of the study site is the existing gravel roads earmarked for upgrade and therefore most of the study site is within a transformed environment
- The study site is not within any national priority areas
- The study site is not within CBAs
- The study site does cross through an ESA, which is the watercourse on Route D621
- It is the opinion of the specialist and the conclusion of the study that at most a GA process is required for the upgrade of the existing water crossings.

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CBA	Critical Biodiversity Areas
CMA	Catchment Management Agencies
DEA	Department of Environment Affairs
DWA	Department of Water Affairs (Old name for DWS)
DWS	Department Water and Sanitation
EIS	Ecological Importance & Sensitivity
EMC	Environmental Management Class
EWR	Ecological Water Requirements
HGM	Hydrogeomorphic
IBA	Important Bird Area(s)
IUCN	International Union for Conservation of Nature
MAP	Mean Annual Precipitation
NFEPA	National Freshwater Ecosystem Priority Areas
NPAES	National Protected Areas Expansion Strategy
PES	Present Ecological State
PDA	Primary Drainage Area
QDA	Quaternary Drainage Area
REC	Recommended Ecological Category (or Class)
REMC	Recommended Ecological Management Category (or Class)
RVI	Riparian Vegetation Index
SANBI	South African National Biodiversity Institute
SWSA	Strategic Water areas of South Africa
WMA	Water Management Areas
WUL	Water Use Licence
WULA	Water Use Licence Application

3 BACKGROUND

3.1 Project overview

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Flori Scientific Services cc was appointed as the independent consultancy to conduct a biodiversity assessment, which includes a terrestrial ecological assessment and a wetland assessment.

Field investigations were conducted during March 2017.

4 METHODOLOGY

4.1 Desktop assessment

A literature review was conducted regarding the main vegetation types and fauna of the general region and of the specific study area. The primary guidelines used were those of Mucina & Rutherford (eds) (2006), Low & Rebelo (1996) and Acocks (1988). Background data regarding soils, geology, climate and general ecology were also obtained from existing datasets and relevant organisations. These are useful in determining what species of fauna and flora can be expected or possibly present within the different habitats of the study area.

Lists of plant species for the relevant 1:50 000 base map grid references within which the proposed project is situated, were obtained from the database of the South Africa National Biodiversity Institute (SANBI). The lists represent all plant species that have been identified and recorded within the designated grid coordinates. The main aim was to determine if any protected species or Red Data species were know to occur in the study area or in the immediate vicinity of the study area.

Red data and protected species listed by the National Environmental Management: Biodiversity Act (Act No. 10 of 2004), as well as in other authoritative publications were consulted and taken into account. Alien invasive species and their different Categories (1, 2 & 3) as listed by the Conservation of Agricultural Resources Act (Act No. 43 of 1983) and the National Environmental Management: Biodiversity Act (Act No. 10 of 2004) were also consulted.

4.2 Field surveys

During field surveys, cognisance was taken of the following environmental features and attributes:

- Biophysical environment;
- Regional and site specific vegetation;
- Habitats ideal for potential red data fauna species
- Sensitive floral habitats;
- Red data fauna and flora species;
- Fauna and flora species of conservation concern; and
- Water courses and water bodies.

Digital photographs and GPS reference points of importance where recorded.

4.3 Floristic Sensitivity

The methodology used to estimate the floristic sensitivity is aimed at highlighting floristically significant attributes and is based on subjective assessments of floristic attributes. Floristic sensitivity is determined across the spectrum of communities that typify the study area. Phytosociological attributes (species diversity, presence of exotic species, etc.) and physical characteristics (human impacts, size, fragmentation, etc.) are important in assessing the floristic sensitivity of the various communities.

Criteria employed in assessing the floristic sensitivity vary in different areas, depending on location, type of habitat, size, etc. The following factors were considered significant in determining floristic sensitivity:

- Habitat availability, status and suitability for the presence of Red Data species
- Landscape and/or habitat sensitivity
- Current floristic status
- Floristic diversity
- Ecological fragmentation or performance.

Floristic Sensitivity Values are expressed as a percentage of the maximum possible value and placed in a particular class or level, namely:

- High: 80 – 100%
- Medium/high: 60 – 80%
- Medium: 40 – 60%
- Medium/low: 20 – 40%
- Low: 0 – 20%

High Sensitivity Index Values indicate areas that are considered pristine, unaffected by human influences or generally managed in an ecological sustainable manner. Nature reserves and well-managed game farms typify these areas. Low Sensitivity Index Values indicate areas of poor ecological status or importance in terms of floristic attributes, including areas that have been negatively affected by human impacts or poor management.

Each vegetation unit is subjectively rated on a sensitivity scale of 1 to 10, in terms of the influence that the particular Sensitivity Criterion has on the floristic status of the plant community. Separate Values are multiplied with the respective Criteria Weighting, which emphasizes the importance or triviality that the individual Sensitivity Criteria have on the status of each community.

Ranked Values are then added and expressed as a percentage of the maximum possible value (Floristic Sensitivity Value) and placed in a particular class or level, namely:

- High: 80% – 100%
- Medium/high: 60% – 80%
- Medium: 40% – 60%
- Medium/low: 20% – 40%
- Low: 0% – 20%

4.4 GO, NO - GO Criteria

The sensitivity analyses are also expressed in terms of whether the "Go Ahead" has or has not been given for development in a specific area or ecological unit, with regards to the ecological sensitivity along with mitigating measures. The criteria are directly linked to all the other analyses used in the study and can be expressed as follows:

- GO: Areas of low sensitivity

These would typically be areas where the veld as been totally or mostly transformed.

- GO-SLOW: Areas of medium/low sensitivity

These would typically be areas where large portions of the veld has been transformed and/or is highly infested with alien vegetation and lacks any real faunal component. Few mitigating measures are typically needed, but it is still always wise to approach these areas properly and slowly.

- GO-BUT: Areas of medium sensitivity and medium/high sensitivity

These are areas that are sensitive and should generally be avoided if possible. But, with the correct implementation of mitigating and management measures can be entered if need be.

- NO-GO: Areas of high sensitivity

These are areas of high sensitivity and should be avoided at all cost. In these areas mitigating measures are typically futile in limiting impacts.

The Precautionary Principle is applied throughout this investigation.

4.5 Floral Assessment – Species of Conservation Concern

Baseline data for the quarter degree grids in which the study area is situated were obtained from the SANBI database and were compared to the Interim Red Data List of South African Plant Species (Raimondo D. *et.al.*, 2009) to compile a list of Floral Species of Conservation Concern (which includes all Red Data flora species) that could potentially occur within the study area.

A snapshot investigation of an area presents limitations in terms of locating and identifying Red Data floral species. Therefore, particular emphasis is placed on the identification of habitats deemed suitable for the potential presence of Red Data species by associating available habitat to known habitat types of Red Data floral species. The verification of the presence or absence of these species from the study area is not perceived as part of this investigation as a result of project limitations.

4.6 Faunal Sensitivity

Determining the full faunal component of a study area during a short time scale of a few field trips can be highly limiting. Therefore, the different habitats within the study area and nearby surrounding areas were scrutinised for attributes that are deemed to be suitable for high diversity of fauna, as well as for Red Data species. Special consideration was given to habitats of pristine condition and high sensitivity.

Areas of faunal sensitivity were calculated by considering the following parameters:

- Habitat status – the status or ecological condition of the habitat. A high level of habitat degradation will often reduce the likelihood of the presence of Red Data species.
- Habitat linkage – Movement between areas used for breeding and feeding purposes forms an essential part of ecological existence of many species. The connectivity of the study area to surrounding habitats and adequacy of these linkages are evaluated for the ecological functioning of Red Data species within the study area
- Potential presence of Red Data species – Areas that exhibit habitat characteristics suitable for the potential presence of Red Data species are considered sensitive.

The same Index Values, Sensitivity Values and Categories used for the floral sensitivity ratings are used for the faunal sensitivity ratings. The same Go, No-Go criteria and ratings used for the flora component are also used for the faunal component.

4.7 Faunal Assessment – Species of Conservation Concern

Literature was reviewed and relevant experts contacted to determine which faunal species of conservation concern (which include all Red Data species) are present, or likely to be present, in the study area.

A snapshot investigation of an area presents limitations in terms of locating and identifying Red Data fauna species. Particular emphasis was therefore placed on the identification of habitat deemed suitable for the potential presence of Red Data fauna species by associating available habitat to known habitat types of Red Data species. The verification of the presence or absence of these species from the study area is not perceived as part of this investigation as a result of project limitations.

4.8 Biodiversity Impact Assessment

The impact assessment takes into account the nature, scale and duration of the effects on the natural environment and whether such effects are positive (beneficial) or negative (detrimental).

A rating/point system is applied to the potential impact on the affected environment and includes an objective evaluation of the mitigation of the impact. In assessing the significance of each issue the following criteria are used and points awarded as shown:

- Extent: National - 4; Regional – 3; Local – 2; Site – 1.
- Duration: Permanent – 4; Long term – 3; Medium term – 2; Short term – 1.
- Intensity: Very high – 4; High – 3; Moderate – 2; Low – 1.
- Probability of Occurrence: Definite – 4; Highly probable – 3; Possible – 2; Impossible – 1.

4.9 Criteria for the classification of an impact

Nature

A brief description of the environmental aspect being impacted upon by a particular action or activity is presented.

Extent (Scale)

Considering the area over which the impact will be expressed. Typically, the severity and significance of an impact have different scales and as such bracketing ranges are often required. This is often useful during the detailed assessment phase of a project in terms of further defining the determined significance or intensity of an impact.

- Site: Within the construction site
- Local: Within a radius of 2 km of the construction site
- Regional: Provincial (and parts of neighbouring provinces)
- National: The whole of South Africa

Duration

Indicates what the lifetime of the impact will be.

- Short-term: The impact will either disappear with mitigation or will be mitigated through natural process in a span shorter than the construction phase.
- Medium-term: The impact will last for the period of the construction phase, where after it will be entirely negated.
- Long-term: The impact will continue or last for the entire operational life of the development, but will be mitigated by direct human action or by natural processes thereafter.
- Permanent: The only class of impact, which will be non-transitory. Mitigation either by man or natural process will not occur in such a way or in such a time span that the impact can be considered transient.

Intensity

Describes whether an impact is destructive or benign.

- Low: Impact affects the environment in such a way that natural, cultural and social functions and processes are not affected.
- Medium: Effected environment is altered, but natural, cultural and social functions and processes continue albeit in a modified way.

- High: Natural, cultural and social functions and processes are altered to extent that they temporarily cease.
- Very high: Natural, cultural and social functions and processes are altered to extent that they permanently cease.

Probability

Probability is the description of the likelihood of an impact actually occurring.

- Improbable: Likelihood of the impact materialising is very low.
- Possible: The impact may occur.
- Highly probable: Most likely that the impact will occur.
- Definite: Impact will certainly occur.

Significance

Significance is determined through a synthesis of impact characteristics. It is an indication of the importance of the impact in terms of both the physical extent and the time scale and therefore indicates the level of mitigation required. The total number of points scored for each impact indicates the level of significance of the impact.

Using the scoring from the previous section, the significance of impacts is rated as follows:

- Low impact: 4-7 points. No permanent impact of significance. Mitigating measures are feasible and are readily instituted as part of a standing design, construction or operating procedure.
- Medium impact: 8-10 points. Mitigation is possible with additional design and construction inputs.
- High impact: 11-13 points. The design of the site may be affected. Mitigation and possible remediation are needed during the construction and/or operational phases. The effects of the impact may affect the broader environment.
- Very high impact: 14-16 points. The design of the site may be affected. Intensive remediation as needed during construction and/or operational phases. Any activity, which results in a “very high impact”, is likely to be a fatal flaw.

Status

Status gives an indication of the perceived effect of the impact on the area.

- Positive (+): Beneficial impact.
- Negative (-): Harmful or adverse impact.
- Neutral Impact (0): Neither beneficial nor adverse.

It is important to note that the status of an impact is assigned based on the *status quo.* That is, should the project not proceed. Therefore not all negative impacts are equally significant. The suitability and feasibility of all proposed mitigation measures will be included in the assessment of significant impacts. This will be achieved through the comparison of the significance of the impact before and after the proposed mitigation measure is implemented.

5 RECEIVING ENVIRONMENT

5.1 Study Site Location

The study site consists of the existing D620 and D621 gravel provincial roads. The D620 and D621 roads are 8,8km and 3,4km long, respectively. The roads are situated in the Winterveld area, within the City of Tswane Metropolitan Municipality, Gauteng Province (Figure 1 & Figure 2).

5.2 GPS Coordinates of the Main Landmarks

The GPS coordinates of the main landmarks within the project area are as follows:

- Winterveld: 25°24'52.30"S; 28° 0'26.00"E
- D620 (Start): 25°26'37.19"S; 28° 0'36.33"E.
- D620 (End): 25°22'29.10"S; 28° 0'59.56"E.
- D621 (Start): 25°26'47.16"S; 28° 0'50.54"E.
- D621 (End): 25°25'30.10"S; 28° 2'59.78"E.
- 1:50 000 map grid references: 2527BD; 2528AC.

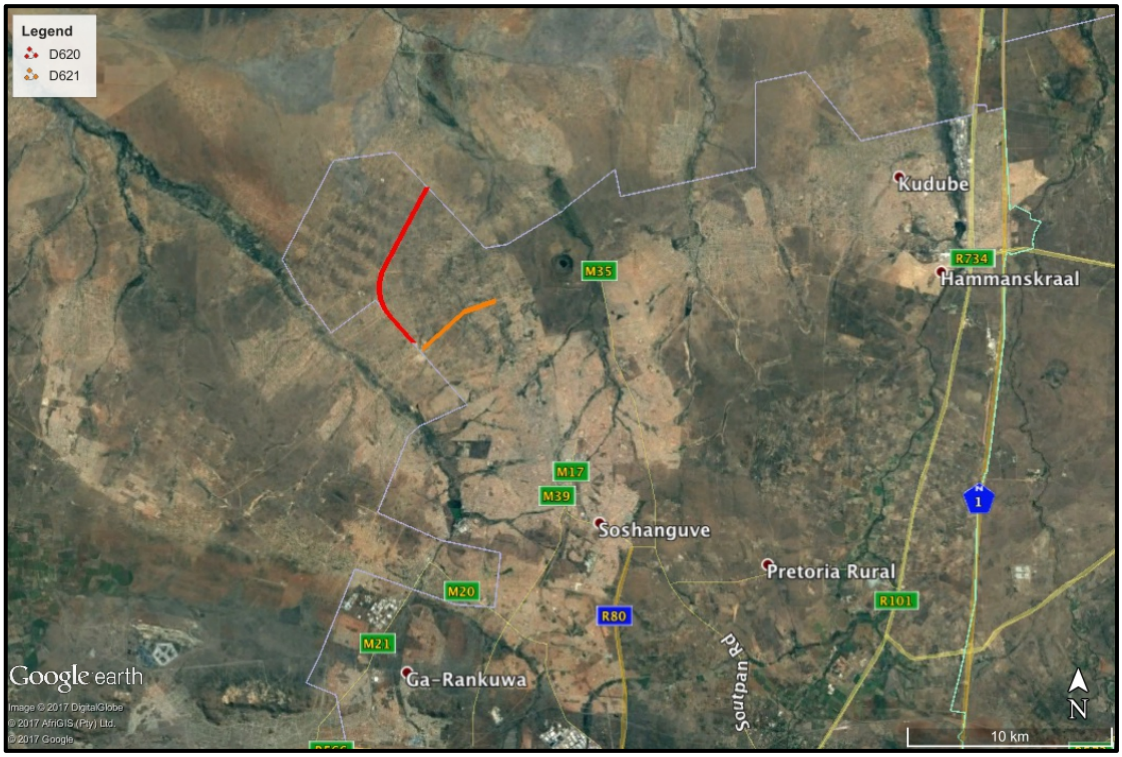

Figure 1: Site location (Google Earth)

Figure 2: Site location (Close up)

5.3 Topography

The topography of the study area is that of flat to slightly undulating plains, with little to no steep gradients. There are no rocky outcrops (koppies), rocky ridges, valleys or steep ravines present. The average elevation of the study site is between 1 100m and 1140m with an overall gradient of less than 2%. Even in the region of the small stream there are no sudden or steep gradients.

5.4 Geology and Soils

The area in which the study site is situated is predominantly underlain by granite of the Lebowa Granite Suite and some granophyre of the Rashoop Granophyre Suite (both Bushveld Complex, Vaalian). Well-drained, deep Hutton or Clovelly soils often with a catenary sequence from Hutton at the top to Clovelly on the lower slopes; shallow, skeletal Glenrosa soils also occur. Land types mainly Bb, Fa, Ba, Bd and Ac. Short descriptions of the land types are given in the table below (Table 1) (www.agis.agric.za).

Table 1: Description of the Land Types found in the Region

Code	Description
Ac	Red-yellow apedal, freely drained soils (Red and yellow, dystrophic and/or mesotrophic). Dominantly (> 40%) red and yellow, freely drained, apedal (= structureless) soils. Normally associated with high rainfall areas, where soils are subjected to moderate (= mesotrophic) to intense (= dystrophic) leaching of nutrients from the soil profile. Soils are thus mostly low in base elements (K, Ca, Mg, Na). A broad range of textures may occur.
Ba & Bb	Plinthic catena: Upland duplex and margalitic soils rare (Dystrophic and/or mesotrophic; red and/or yellow soils). Mainly red (Ba) or yellow (Bb), apedal (= structureless) soils, moderately (mesotrophic) to highly (dystrophic) leached (low to moderate fertility status), with a wide textural range, mostly sandy loam to sandy clay loam. Soils contain a greyish subsoil layer (plinthic) where iron and manganese accumulate in the form of mottles, due to a seasonally fluctuating water table. With time these mottles may harden (or even cement) to form concretions. These plinthic layers will cause restricted water infiltration and root penetration. In drier areas, however, they may help to hold water in the soil that plants can use.
Bd	Plinthic catena: Upland duplex and margalitic soils rare (Eutrophic; red and/or yellow soils). Mainly yellow (Bd), apedal (= structureless) soils, which are eutrophic (= high base status). They have a moderate to high fertility status and a wide textural range, mostly sandy loam to sandy clay loam. Soils contain a greyish subsoil layer (plinthic) where iron and manganese accumulate in the form of mottles, due to a seasonally fluctuating water table. With time these mottles may harden (or even cement) to form concretions. These plinthic layers will cause restricted water infiltration and root penetration. In drier areas, however, they may help to hold water in the soil that plants can use.
Fa	Glenrosa and /or mispah forms (other soils may occur); lime rare or absent in the entire landscape. Generally shallow soils consisting of a topsoil directly underlain by weathered rock (Glenrosa form) or hard rock (Mispah form), sometimes with surface rock and steep slopes. Found in moister areas or areas with acidic parent materials, where little lime exists.

5.5 Climate

The study area is situated just within the moderate rainfall regions of South Africa (401mm – 600mm per annum) as can be seen from the map below (Figure 3). It is also situated within the Temperate Interior Climatic Zone of South Africa (Figure 4).

The Winterveld, in which the study site if found, normally receives on average about 453mm of rain per year, with most rainfall occurring during the summer. The area

receives the lowest rainfall (0mm) in June, the middle of winter and the highest (84mm) in January, during summer. The monthly average for daily maximum temperatures for the Winterveld range from 20.6°C in June, to 29.8°C in January. The region is the coldest during July when the average night temperate is around 2.4°C (www.saexplorer.co.za).

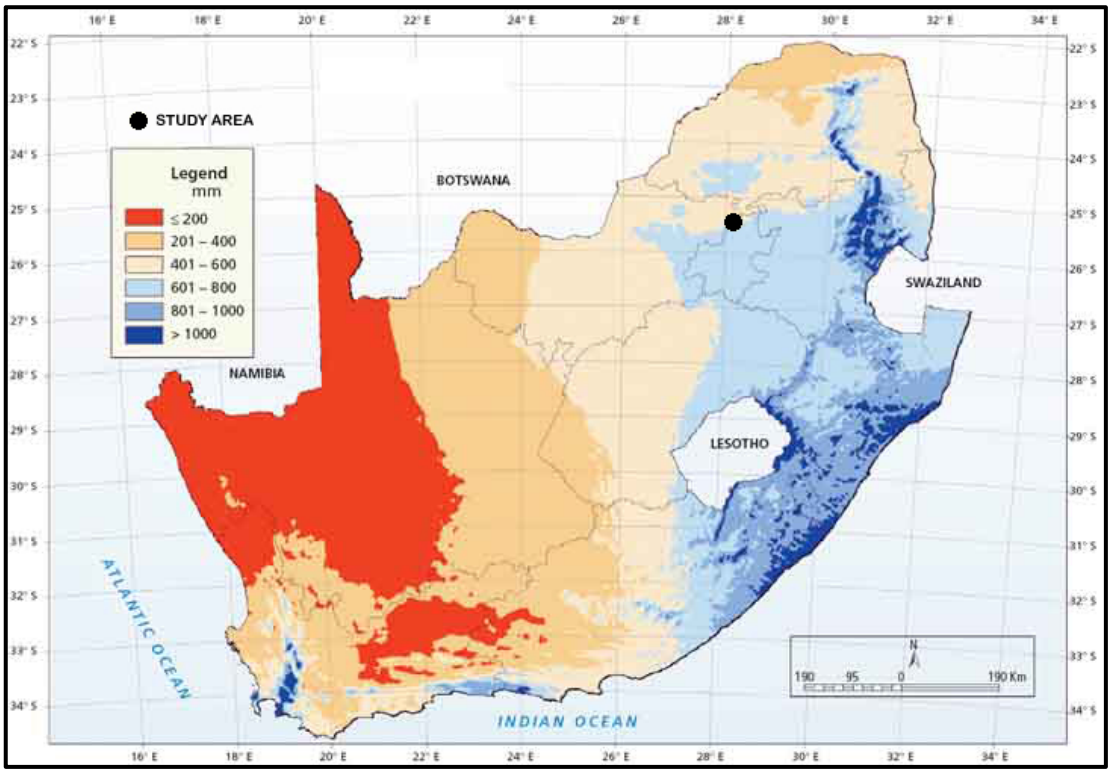

Figure 3: Rainfall averages for South Africa

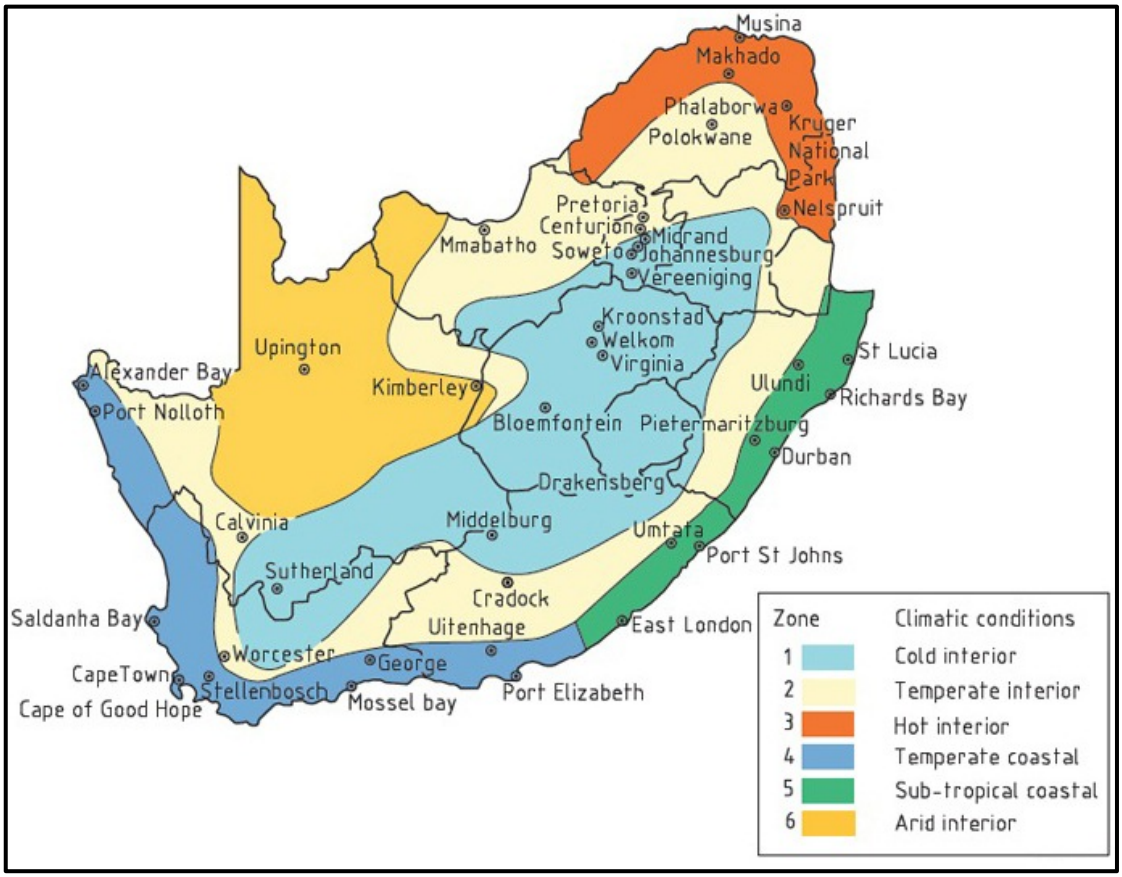

Figure 4: Broad climatic zones of South Africa

5.6 Landcover

The landcover of the study site is predominantly existing gravel (sand) roads and road reserves. This is because the project is the upgrade of these existing roads and not a new road or development as such. The surrounding landcover or landuse is that of high- to medium-density urbanisation, with open areas of thornveld and cultivated lands. There are no areas of pristine veld within the study site, or immediate adjacent areas. The open areas of thornveld are moderately to highly negatively impacted on by free-roaming grazing cattle and other anthropogenic impacts, such as litter.

6 TERRESTRIAL ECOLOGY

6.1 Vegetation

South Africa is divided up into nine Biomes. The study area and the surrounding region fall within the Savanna Biome, which is also known as the Bushveld Biome (Figure 5). Savanna vegetation types tend to have a mix of a lower grassy layer, middle shrub layer and an upper woody layer. The mix and ratio of the three layers varies from veldtype to veldtype within the Savanna Biome.

The Savanna Biome is subdivided into six bioregions, namely, Central Bushveld; Mopane; Lowveld; Sub-Escarpment Savanna; Eastern Kalahari Bushveld; and Kalahari Duneveld (Mucina & Rutherford, 2006). The study area is found within the Central Bushveld Bioregion of the Savanna Biome.

The study area is situated mainly within Central Sandy Bushveld, with a small section of the D621 route within Springbokvlakte Thornveld (Figure 6). The map used in Figure 6 was created using the SANBI website (www.bgis.sanbi.org).

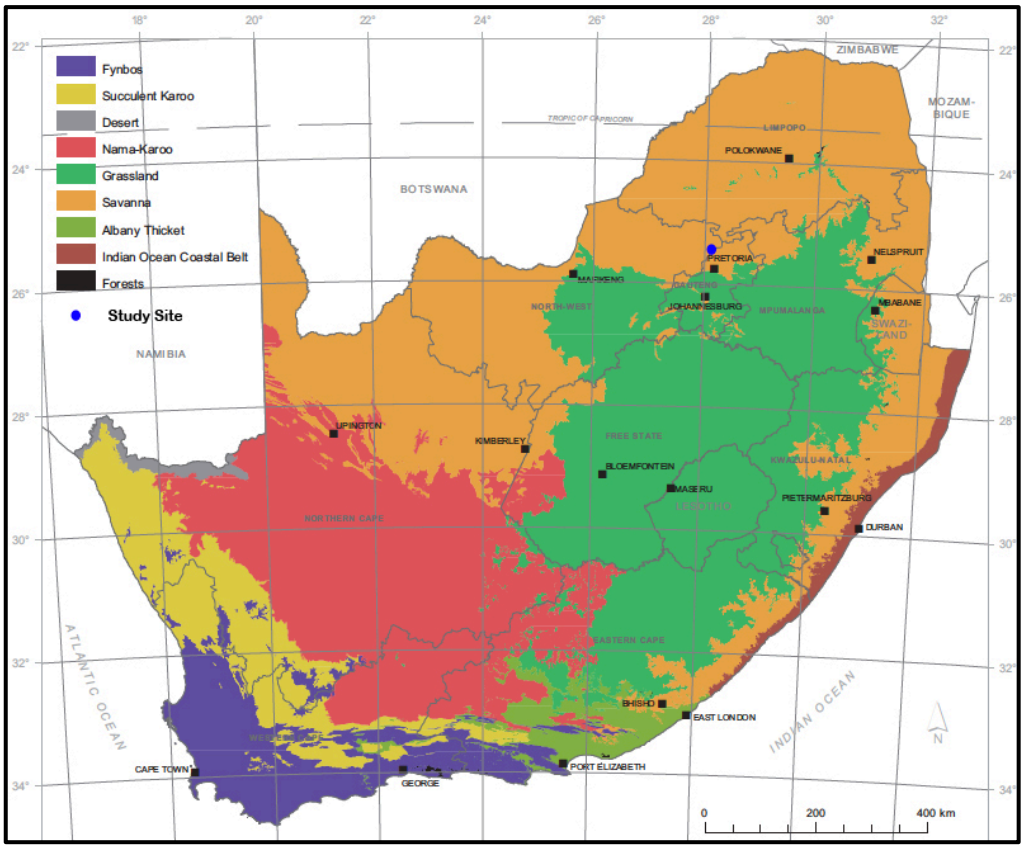

Figure 5: Biomes of South Africa

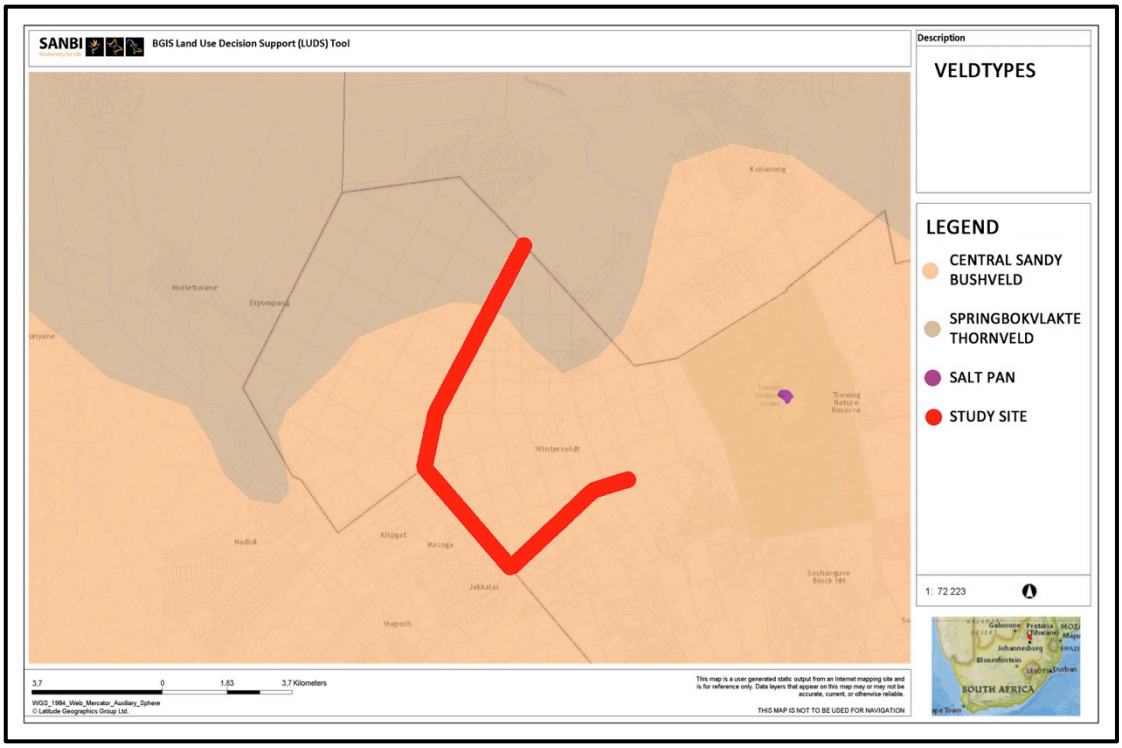

Figure 6: Veld types

Table 2 shows the hierarchy of the vegetation, while Table 3 gives other classification names commonly used for the same veldtypes.

Table 2: Vegetation classification of the study site

Category Description	Classification
Biome	Savanna (Bushveld)
Bioregion	Central Bushveld
Vegetation Types	Central Sandy Bushveld, Springbokvlakte Thornveld

Table 3: Comparison of veldtype names

Mucina & Rutherford (2006)	Low & Rebelo (1996)	Acocks (1953)
Central Sandy Bushveld	Mixed Bushveld	Mixed Bushveld
Springbokvlakte Thornveld	Clay Thorn Bushveld	Springbok Flats Turf Thornveld

6.1.1 Vegetation of the study area

The vegetation of the study area is mostly transformed, as most of the study area is existing gravel roads earmarked for upgrade. The vegetation found in the road reserves and adjacent areas varies from transformed to highly modified to

moderately modified. Actual open veld areas are more characteristic of dense to open thornveld than of mixed bushveld. The vegetation is characteristic of Central Sandy Bushveld in areas and Springbokvlakte Thornveld in other areas. The study area is that of flat to low undulating plains, supporting deciduous *Terminalia sericea* and *Burkea africana* woodland on deep sandy soils (with the former often dominant on the lower slopes of sandy catenas) and low, broad- leaved *Combretum* woodland on shallow rocky or gravelly soils. Species of *Acacia*, *Ziziphus* and *Euclea* are found on flats and lower slopes on eutrophic sands and some less sandy soils (Mucina & Rutherford, 2006). The open bushveld areas are dominated by Acacia thorn trees.

6.1.2 Priority Floral Species

No Red Data species (endangered, threatened or vulnerable) were observed during field investigations. According to the SANBI database (www.posa.sanbi.org) no Red Data species have been recorded in the area of the QDS quadrants in which the study site is situated (Table 4), with the exception of *Brachystelma discoideum* in QDS 2528AC (Table 4). It is fairly unlikely that any Red Data species occur in the study area, but it is not impossible. The summaries of priority floral species per grid reference are tabled below (Table 4). Figure 7 below shows the extent of the roads (study area) within the relevant Quaternary Degree Square (QDS).

Accroding to the Red List of South African Plants (Raimondo, *et. al*., 2009) *Brachystelma discoideum* is a Critically Endangered (CR) (Possibly extinct) succulent that prefers gravelly, sandy soils in a bushveld ecosystem.

Table 4: Priority Floral Species per 1:50 000 Grid Reference

QDS & Priority Category	No. of species	Name of species
2527BD		
Critically endangered (CR)	0	-
Endangered (EN)	0	-
Vulnerable (VU)	0	-
Near threatened (NT)	0	-
2528AC		
Critically endangered (CR)	0	-
Endangered (EN)	1	*Brachystelma discoideum*
Vulnerable (VU)	0	-
Near threatened (NT)	0	-

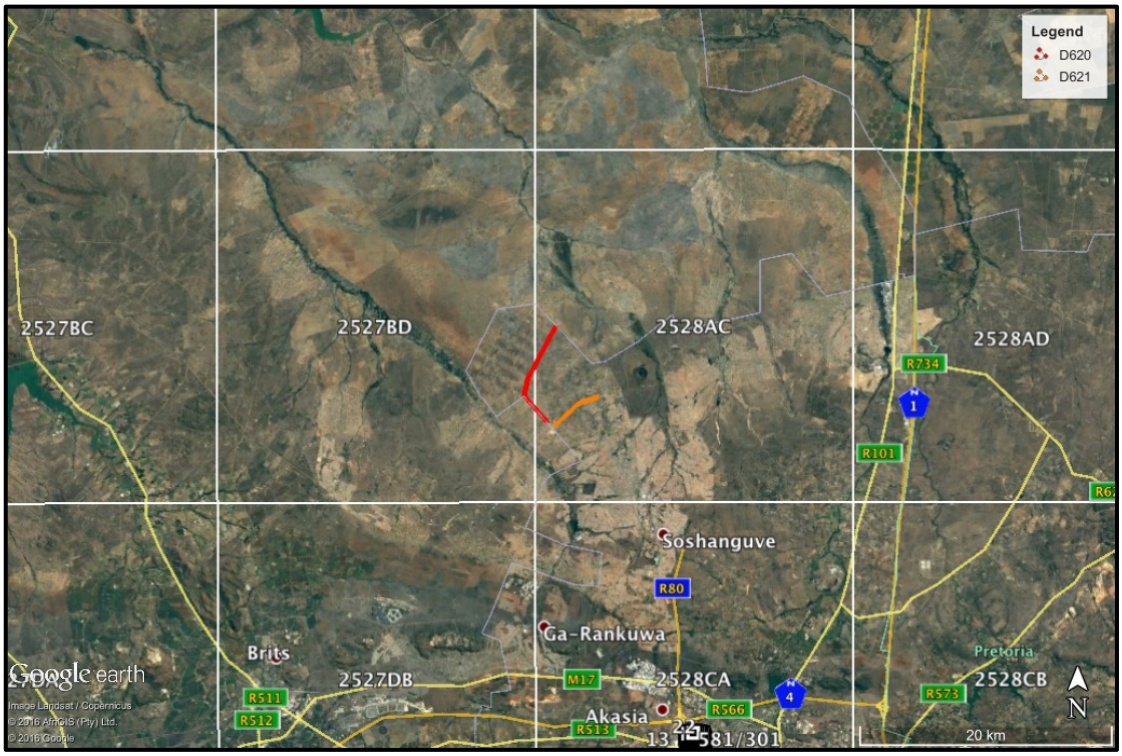

Figure 7: QDS for the study area

6.2 Conservation status

The study site is predominantly within Central Sandy Bushveld, with only a small section of the D620 in the north found in Springbokvlakte Thornveld. According to Mucina & Rutherford (2006, 2010) both veldtypes are Vulnerable (VU), which are threatened ecosystems (Table 5). However, according to the latest information from SANBI (www.bgis.sanbi.org) and the Gauteng C-Plan (v.3.3), Central Sandy Bushveld is not a threatened veldtype.

Table 5: Veldtype status

Veldtype	Status	Info
Central Sandy Bushveld	Vulnerable (VU)	Vulnerable. Target 19%. Less than 3% statutorily conserved spread thinly across many nature reserves including the Doorndraai Dam and Skuinsdraai Nature Reserves. An additional 2% conserved in other reserves including the Wallmansthal SANDF Property and a grouping of private reserves, which include most of the Nylsvlei freshwater wetlands. About 24% transformed, including about 19% cultivated and

		4% urban and built-up areas. Much of the unit in the broad arc south of the Springbokvlakte is heavily populated by rural communities. Several alien plant species occur, but often at low densities; these include *Cereus jamacaru*, *Eucalyptus* species, *Lantana camara*, *Melia azedarach*, *Opuntia ficus-indica* and *Sesbania punicea*. Erosion very low to high, especially in some places north- east of Groblersdal.
Springbokvlakte Thornveld	Vulnerable (VU)	Endangered. Only 1% statutorily conserved, mainly in the Mkombo Nature Reserve. Roughly three times this area is conserved in a number of other reserves. At least 49% transformed, including about 45% cultivated and 3% urban and built-up. Dense rural populations in parts of the southern and eastern side of the unit. Very scattered alien plants over wide areas include *Cereus jamacaru*, *Eucalyptus* species, *Lantana camara*, *Melia azedarach*, *Opuntia ficus-indica* and *Sesbania punicea*. Erosion is very low to moderate.

Table 6 below gives a basic description of each of the status categories, while Figure 8 shows the categories in a hierarchical format (IUCN Redlist, 2010).

A general overview map of the threatened ecosystems of South Africa is shown below in Figure 9. From the map in Figure 9 it can be seen that the study area is situated mostly between two threatened ecosystems (veldtypes) but mostly outside of these. The two threatened veldtypes are Springbokvlakte Thornveld to the north and Marikana Thornveld to the south. The map showing the threatened ecosystems of South Africa, in relation to the study site in Figure 9, is taken from SANBI's website (www.bgis.sanbi.org).

The Biodiversity Act (Act 10 of 2004) provides for listing of threatened or protected ecosystems, in one of four categories: Critically Endangered (CR), Endangered (EN), Vulnerable (VU) or protected. The main purpose for the listing of threatened ecosystems is an attempt to reduce the rate of ecosystem and species destruction

and habitat loss, leading to extinction. This includes preventing further degradation and loss of structure, function and composition of threatened ecosystems (SANBI).

Table 6: Ecosystem Status: Simplified explanation of categories used

STATUS	% Transformed	Effect on Ecosystem
Least Threatened (LT)	0-20% (<20% loss)	No significant disruption of ecosystem functions
Vulnerable (VU)	20-40% (>20% loss)	Can result in some ecosystem functions being altered
Endangered (EN)	40-60% (>40% loss)	Partial loss of ecosystem functions
Critically Endangered (CR)	>60% or BT Index for that specific veldtype	Species loss. Remaining habitat is less than is required to represent 75% of species diversity

Source: South African National Spatial Biodiversity Assessment Technical Report. Volume 1: Terrestrial Component. 2004. SANBI. Mucina & Rutherford (eds) (2010).

BT stands for the Biodiversity Threshold and is an index value that differs for each veldtype. In other words, because the composition, recovery rate, etc. differs for each veldtype there will be a different threshold (in this case percentage transformed) at which species become extinct and ecosystems breakdown. That is, at which point the veldtype is critically endangered. For the grassland vegetation units discussed the index value (BT) is broadly given as 60% and greater.

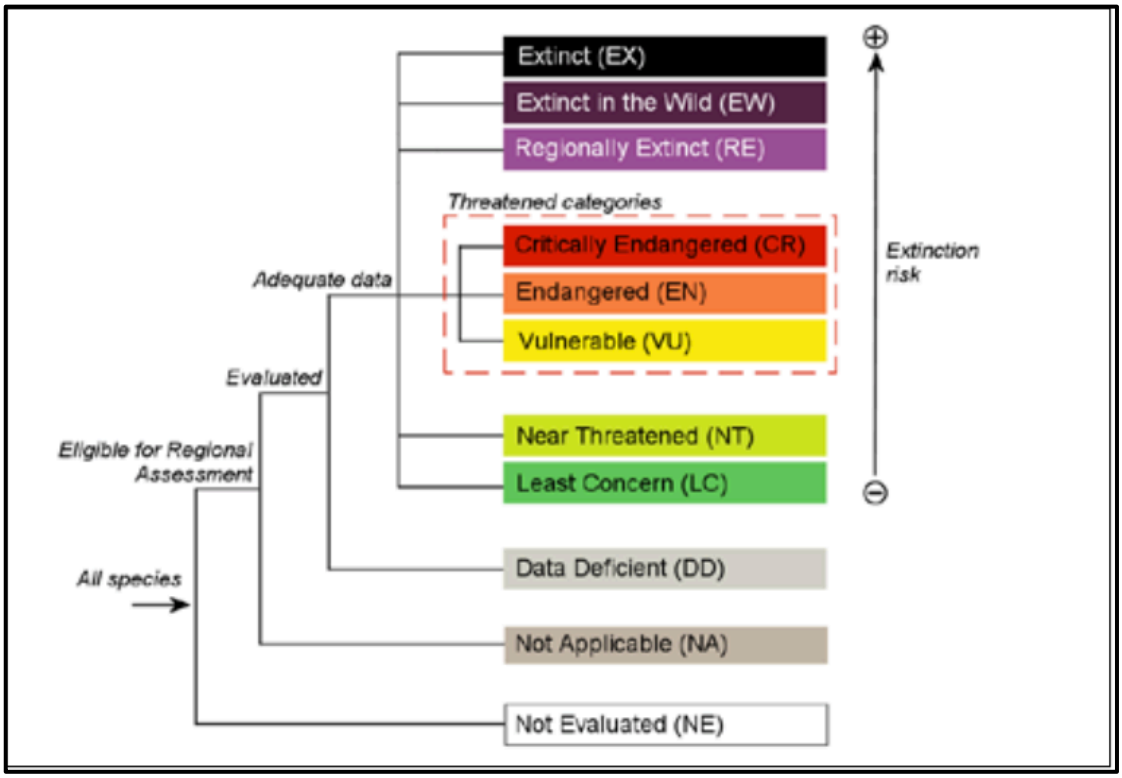

Figure 8: Structure of categories used at the regional level

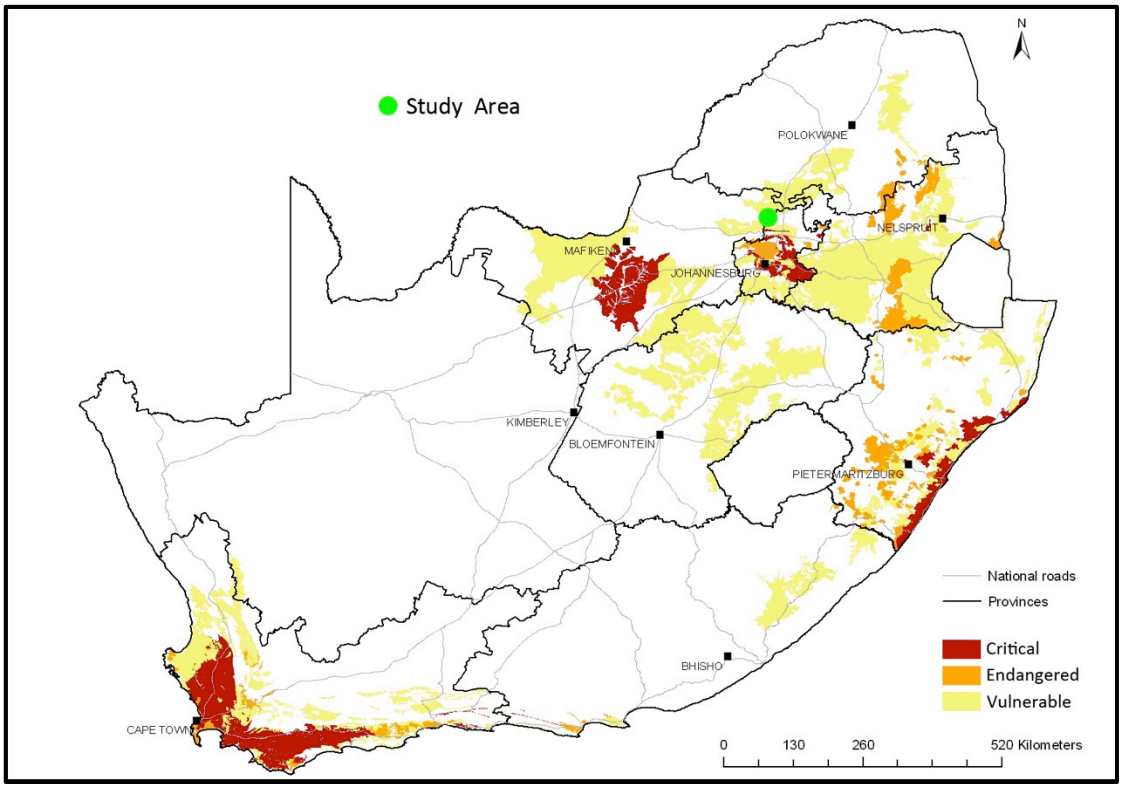

Figure 9: Threatened ecosystems of South Africa

6.3 Plants identified during field investigations

The dominant plant species identified during field investigations are listed in the appendices. Field investigations were limited to a few days only and plant lists can therefore not be considered comprehensive.

No Red Data species were observed during field investigations. No Orange Data species were found within the study area corridor. However, it is possible that in the wetter, grassy areas and watercourse areas *Boophone disticha* might be present and species such as *Haemanthus humilis*, *Hypoxis hemerocallidea* and *Hypoxis rigidula* present in the drier areas. If any bulb species such as mentioned above are found during the construction phase they can easily be lifted and replanted in a similar habitat nearby, as these bulbs are very easy to lift and transplant well.

6.3.1 Alien plants identified in the Study Area

There are a number of alien plants in the study area. The herbaceous plants are especially prevalent in disturbed areas and rehabilitated mining areas. Tree species present tend to be mainly blackwattle (*Acacia mearnsii*) and gum trees (*Eucalyptus* spp.), with indigenous trees been rare to absent. Alien plant species, some of which are invasive, occur scattered throughout the area, especially in disturbed areas, rehabilitated mine areas and along road curbs. The alien plant species encountered in the study area are recorded, along with their category rating, in Table 7. The categories are as set out in the Conservation Act of Agricultural Resources Act, 1983 (CARA) (Act 43 of 1983).

Table 7: Alien plants identified in the study area

Botanical Name	Common Name	Category
Acacia mearnsii	Blackwattle	2
Argemone ochroleuca	White-flowered Mexican poppy	1
Bidens pilosa	Blackjacks	-
Conyza canadensis	Horseweed fleabane	-
Datura ferox	Large thorn-apple	1
Eucalyptus spp & cultivars	Gum trees; Eucalyptus	2
Lantana camara	Lantana	1
Melia azedarach	Syringa	3
Malva verticillata	Mallow	-
Oxalis corniculata	Sorrel	-

Solanum elaeagnifolium	Silverleaf bitter apple	1
Tagetes minuta	Khakibos, kahki weed	-
Verbena bonariensis	Vervain	-

6.4 Protected tree species identified in the study area

No protected trees were observed in the study area. Marula trees are however present in the area and a final walk down prior to the commencement of the construction phase is recommended. Other trees of interest, which also occur in the area, although not protected trees, include *Burkea africana*.

Fauna

Field observations were limited to a few days, which always limits the observation and identification of fauna in the field. Due to the transformed nature of the study area the species richness will be low. Ideal habitats for most large or priority faunal species are rare. However, there are large, open thornveld and farming areas in the region so it is highly likely that numerous mobile species will venture through the study area. Roads are known to create dangerous intersections for animals traveling along familiar routes, especially at night when fast moving vehicles with bright lights cause problems for them.

6.4.1 Mammals

No large- or medium-sized mammals were observed during field investigations. Due to the amount of urbanisation taking place in the region this is not surprising. It is however, more than likely that medium-sized mammals do move through the area from time to time. It is important to instruct contractors not to interact deliberately with any wild animals.

6.4.2 Avifuana

The study area is not situated within or adjacent to any Important Bird Areas (IBAs). However, IBAs such as the Magaliesberg and the Waterberg are situated 20km south and 60km north of the study site, respectively. It is therefore reasonable to believe that priority species will visit the area, especially during the rainy, summer season when migratory birds have also returned. Below is a list of priority birds and raptors that have previously been observed in the general area of the study site,

according to the records of the Southern African Bird Atlas Project 2 (www.sabap2.adu.org.za) (Table 8).

Table 8: Priority birds recorded in the study area

Common Name	Scientific Name
Jackal buzzard	*Buteo rufofuscus*
Steppe buzzard	*Buteo vulpinus*
Lizard buzzard	*Kaupifalco monogrammicus*
Martial eagle	*Polemaetus bellicosus*
Tawny eagle	*Aquila rapax*
Black eagle (Verreaux's)	*Aquila verreauxii*
Wahlberg's eagle	*Aquila wahlbergi*
Spotted eagle-owl	*Bubo africanus*
Verreaux's eage-owl	*Bubo lacteus*
Cape vulture	*Gyps coprotheres*
Lappet-faced vulture	*Torgos tracheliotus*
White-backed vulture	*Gyps africanus*

6.4.3 Reptiles

No reptiles were observed during field investigations. The maps below show the hotspots for priority snake and lizard species for South Africa (Figure 10 & Figure 11). The study area is not within a snake hotspot, although it is possible that rock python (*Python natalensis*) could occur although rarely. From Figure 11 it would appear that the study area is within a lizard hotspot. However, in reality, this hotspot is more to the north of the study area. Lizards tend to prefer rocky habitats and there are no rocky outcrops (koppies), rocky ridges or areas of large rock sheets within the study area. The likelihood is rare that any priority lizard species will be present in the study area.

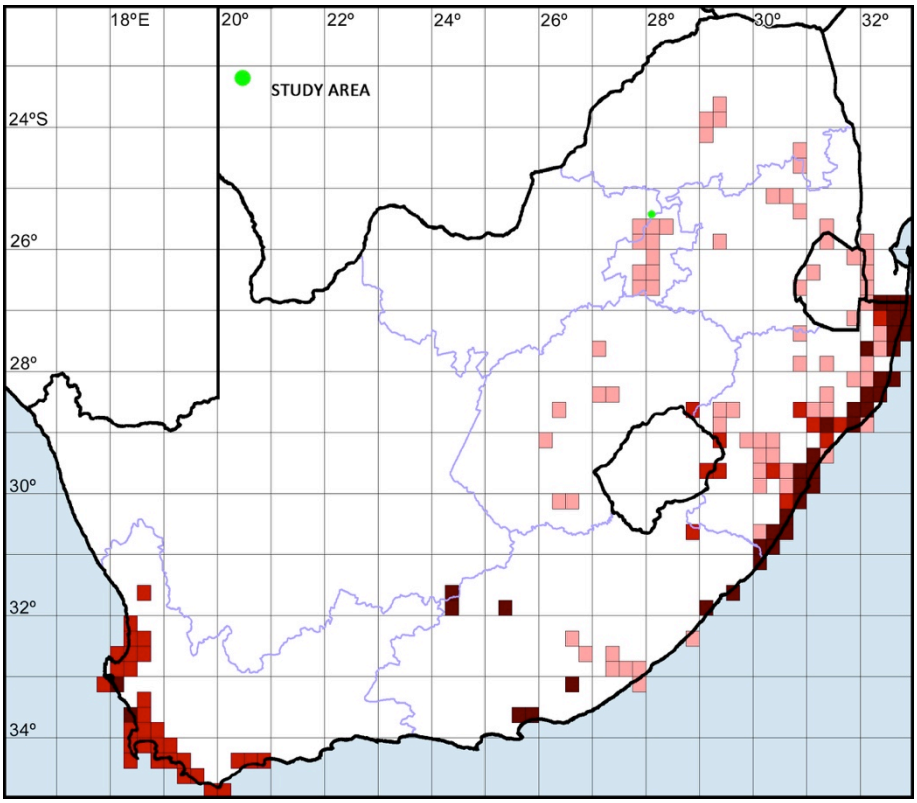

Figure 10: Snake hotspots

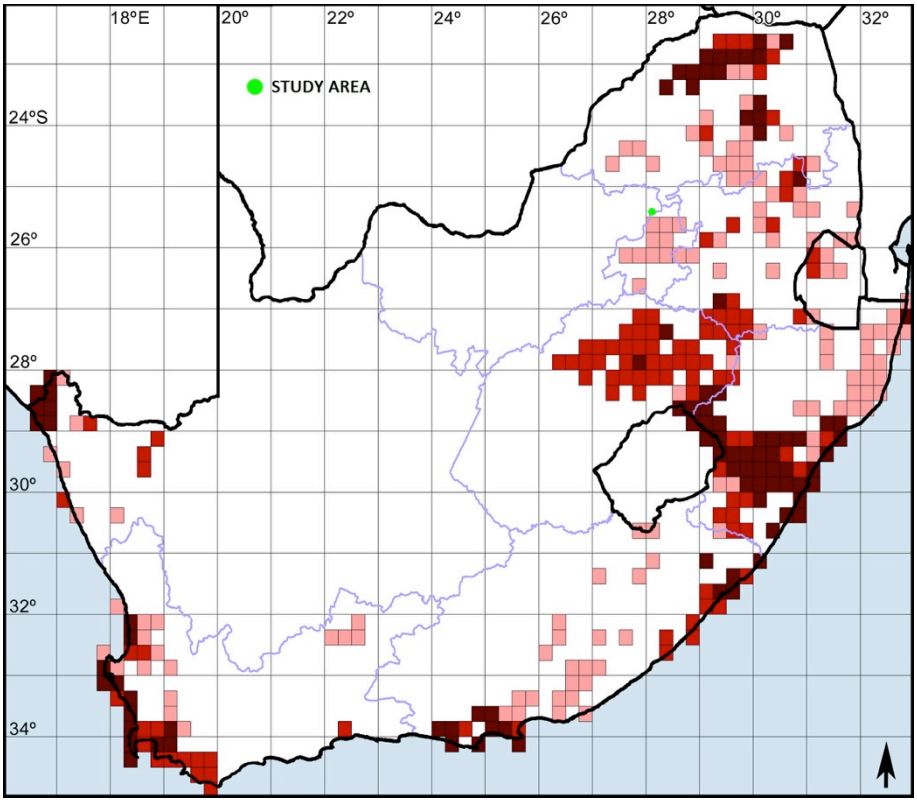

Figure 11: Lizard hotspots

6.4.4 Invertebrates

Invertebrates such as spiders, scorpions and butterflies are important faunal groups, but are difficult to fully assess in a short time period. During field investigations specific attention was given to priority species such as Mygalomorphae arachnids (Trapdoor and Baboon spiders) and red data butterflies. Fortunately, the nature and scope of the project is such that it will have very little negative impact, if any, on these species. No priority species were observed.

The map below shows the hotspots for priority butterflies and species-rich areas for South Africa (Figure 12). The study area is not within any of these known hotspots. The most likely red data butterfly to potentially occur in the region is the Marsh sylph (*Metisella meninx*), which is vulnerable (VU). The Marsh Sylph is endemic to the wet vleis of highland grasslands in northern KwaZulu-Natal, Mpumalanga, Gauteng and the northern part of the Orange Free State.

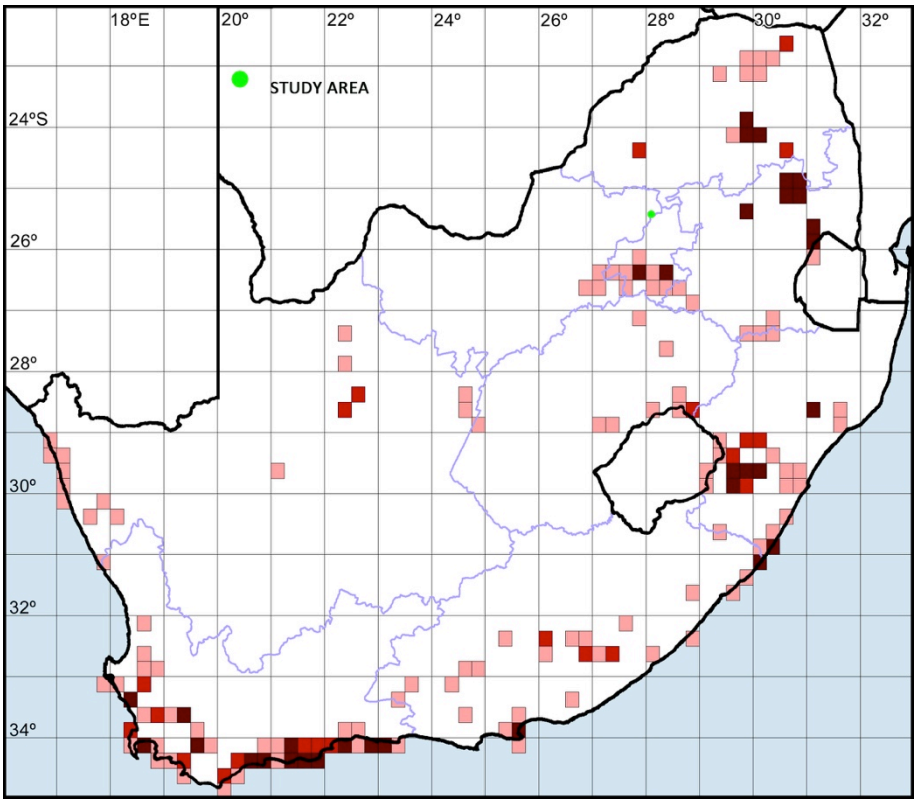

Figure 12: Butterfly hotspots

6.4.5 Faunal species of conservation concern

The general habitats present in the study area are not ideal for most potentially occurring Red Data faunal species. However, it is possible that from time to time

species from the surrounding region can and will wander in and through the Provincial Route R510 corridor. Care should still be taken to avoid impacting on any animals encountered.

The table below highlights the faunal species of conservation concern (which includes Red Data species) that potentially might occur in the study area and surrounding areas from time to time (Table 9).

Table 9: Red Data Faunal Species likely to occur in the area

Species	Common Name	Red Data Status	Preferred Habitat	Habitat Restrictions	Present in Study area
Frogs					
Pyxicephalus adspersus	Giant bullfrog	Threatened / removed from list	Grassland; savanna	Temporary floodplains, pans	Possible
Mammals					
Atelerix frontalis	SA hedgehog	Near threatened	Most, broad	Broad	Occasionally
Manis temmincki	Pangolin (Scaly anteater)	Vulnerable	Grassland, savanna	Woody savanna, ants, termites	Not likely
Mellivora capensis	Honey badger (Ratel)	Near threatened	Most, broad	Broad	Possibly
Cloeotis percivali	Short-eared trident bat	Critically endangered	Savanna	Caves and subterranean habitat	Not likely
Pipistrellus rusticus	Rusty bat	Near threatened	Most, broad	Woody savanna, large trees	Not likely
Snakes					
Python natalensis	Southern African python	Vulnerable	Ridges, wetlands	Rocky areas; open water	Possible, but only near watercourses

7 AQUATIC ECOLOGY

The aquatic ecology focuses on the open waterbodies within the study area. These watercourses include wetlands, rivers, streams, pans, lakes and manmade dams. In reality a pan is actually a type of wetland and must be approached as such. The focus is to delineate watercourses and limit any impact the project might have on these watercourses.

7.1 Wetlands

'Wetland' is a broad term and for the purposes of this study it is defined according the parameters as set out by the Department of Water & Sanitation (DWS) in their guideline (A practical field procedure for identification and delineation of wetlands and riparian areas, 2005). The classification of wetlands (which is a type of watercourse) is summarised below (Figure 13).

According to the DWS document and the National Water Act (NWA) a wetland is defined as, "*land which is transitional between terrestrial and aquatic systems where the water table is usually at or near surface, or the land is periodically covered with shallow water, and which land in normal circumstances supports or would support vegetation typically adapted to life in saturated soil*."

Furthermore, the guidelines stipulate that wetlands must have one or more of the following defining attributes:

- Wetland (hydromorphic) soils that display characteristics resulting from prolonged saturation;
- The presence, at least occasionally, of water loving plants (hydrophytes); and
- A high water table that results in saturation at or near surface, leading to anaerobic conditions developing in the top 50cm of the soil.

During the site investigations the following indicators were used to determine whether an area needed to be defined as a wetland or not, namely:

- Terrain unit indicator;
- Soil form indicator;
- Soil wetness indicator; and
- Vegetation indicator.

Hydrogeomorphic types		Description	Source of water maintaining the wetland[1]	
			Surface	Sub-surface
Floodplain		Valley bottom areas with a well defined stream channel, gently sloped and characterized by floodplain features such as oxbow depressions and natural levees and the alluvial (by water) transport and deposition of sediment, usually leading to a net accumulation of sediment. Water inputs from main channel (when channel banks overspill) and from adjacent slopes.	***	*
Valley bottom with a channel		Valley bottom areas with a well defined stream channel but lacking characteristic floodplain features. May be gently sloped and characterized by the net accumulation of alluvial deposits or may have steeper slopes and be characterized by the net loss of sediment. Water inputs from main channel (when channel banks overspill) and from adjacent slopes.	***	*/ ***
Valley bottom without a channel		Valley bottom areas with no clearly defined stream channel, usually gently sloped and characterized by alluvial sediment deposition, generally leading to a net accumulation of sediment. Water inputs mainly from channel entering the wetland and also from adjacent slopes.	***	*/ ***
Hillslope seepage linked to a stream channel		Slopes on hillsides, which are characterized by the colluvial (transported by gravity) movement of materials. Water inputs are mainly from sub-surface flow and outflow is usually via a well defined stream channel connecting the area directly to a stream channel.	*	***
Isolated Hillslope seepage		Slopes on hillsides, which are characterized by the colluvial (transported by gravity) movement of materials. Water inputs mainly from sub-surface flow and outflow either very limited or through diffuse sub-surface and/or surface flow but with no direct surface water connection to a stream channel.	*	***
Depression (includes Pans)		A basin shaped area with a closed elevation contour that allows for the accumulation of surface water (i.e. it is inward draining). It may also receive sub-surface water. An outlet is usually absent, and therefore this type is usually isolated from the stream channel network.	*/ ***	*/ ***

[1] Precipitation is an important water source and evapotranspiration an important output in all of the above settings

Water source: * Contribution usually small

*** Contribution usually large

*/ *** Contribution may be small or important depending on the local circumstances

*/ *** Contribution may be small or important depending on the local circumstances.

 Wetland

Figure 13: Classification of wetlands

7.2 Riparian zones

Riparian vegetation is typically zonal vegetation closely associated with the course of a river or stream and found in the alluvial soils of the floodplain. According to the National Water Act (NWA) riparian habitat is defined 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 land areas."

It is important to note that the NWA states that the riparian zone has a floral composition distinct from those of adjacent areas. The NWA also defines riparian zones as areas that "c*ommonly reflect the high-energy conditions associated with the water flowing in a water channel, whereas wetlands display more diffuse flow and are lower energy environments*."

7.3 Watercourses in the study area

There are no large perennial rivers or even large semi-perennial streams in the study area. The closest large rivers in the region are the Tolwane / Sand (to the west); the Kutswane / Soutpanspruit (to the north and east); and the Tswane (to the east) (Figure 14). There are no wetlands in the study area, including pans. There are a few stormwater culverts along both routes that simply channel and allow the free movement of stormwater run-off across (under) the road. These are not watercourses, but need to be inserted, as roads can have a significant impeding impact on the free flow of surface stormwater.

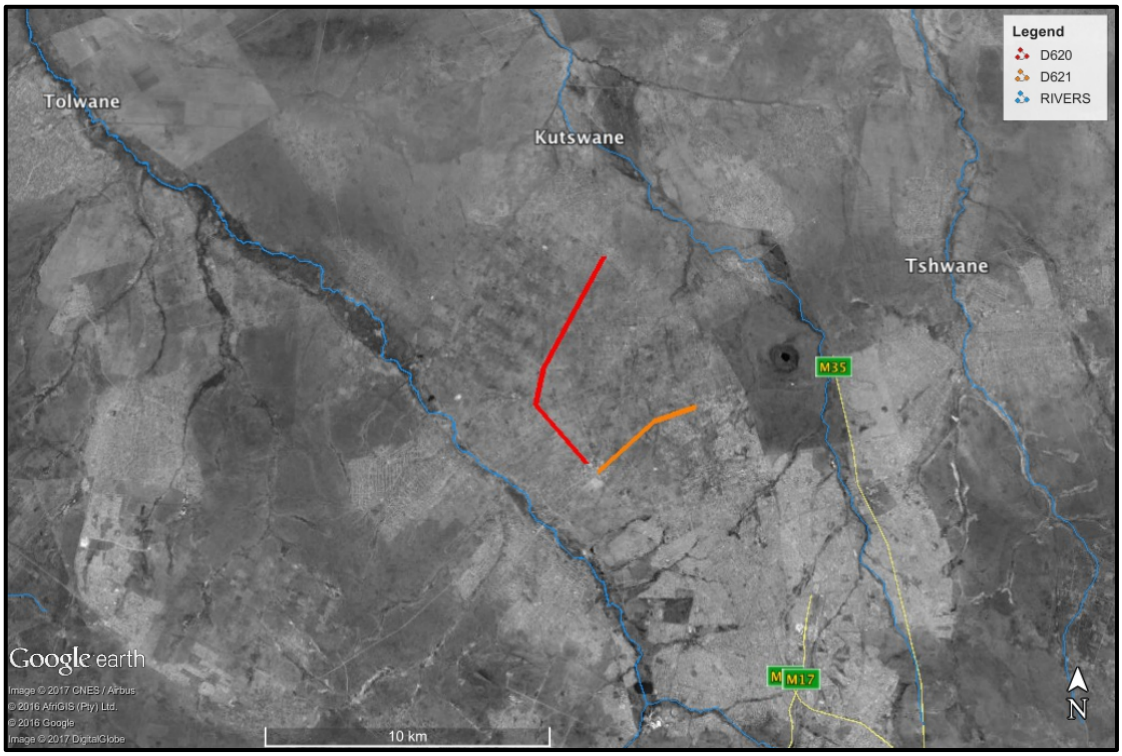

Figure 14: Main rivers in the region

Route D620 only crosses over two small seasonal drainage lines and no streams or rivers (Figure 15). Route D621 crosses over two watercourses, the one being a seasonal drainage line and the other one a larger seasonal drainage line or small seasonal stream (Figure 16). The two watercourses along Route D621 are part of the same, larger drainage system, as is evident from the satellite Google Earth image below (Figure 16). The watercourses in the study area are moderately to highly impacted on by years of urbanisation, cultivation, general movement of people through the area and the over utilisation of resources. The watercourses present are small, highly seasonal and insignificant, with little to no significant riparian zones or vegetation. Many of the channels have been altered over the years, which makes it difficult to accurately delineate.

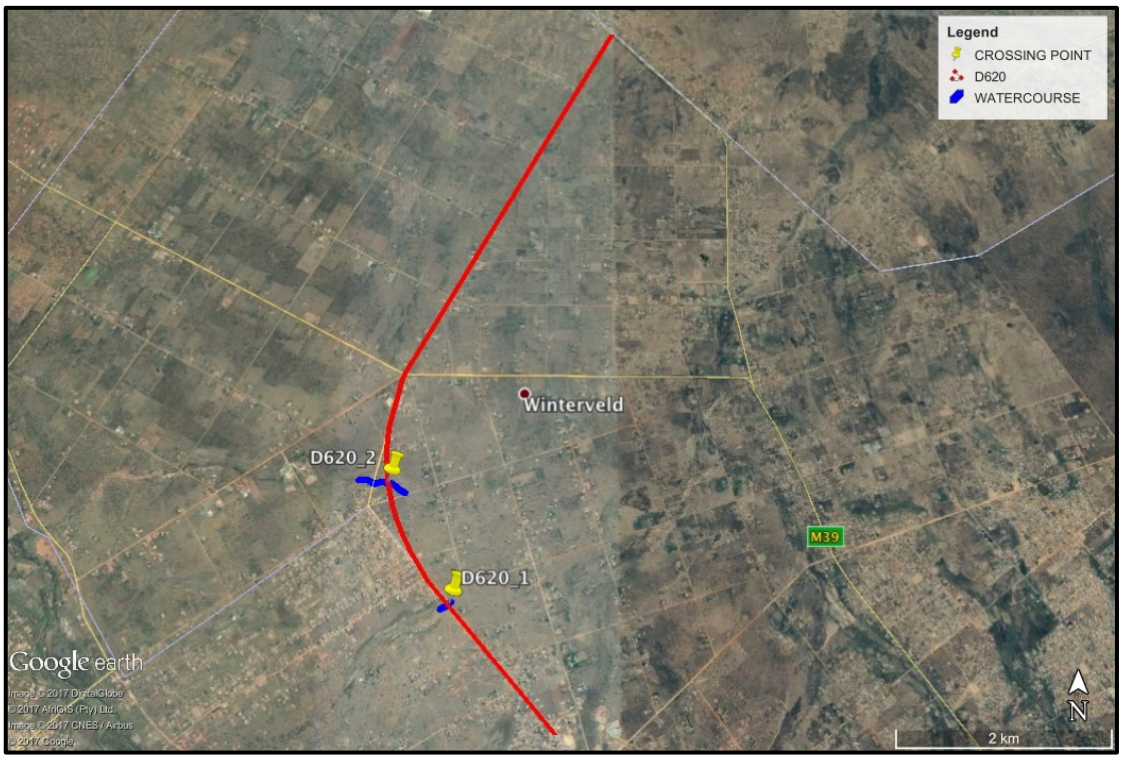

Figure 15: Watercourse crossings along Route D620

Figure 16: Watercourse crossings along Route D621

The approximate positions of the watercourse crossings are given in the table below (Table 10). A map showing the ID of the watercourses and positions of crossings is shown in Figure 17below.

Table 10: Positions of watercourse crossings

Watercourses	Coordinates at Route Crossing
D620_1	25°25'59.03"S; 27°59'59.46"E
D620_2	25°25'20.72"S; 27°59'36.19"E
D621_1	25°25'49.82"S; 28°02'1.45"E
D621_2	25°25'47.06"S; 28°02'5.67"E

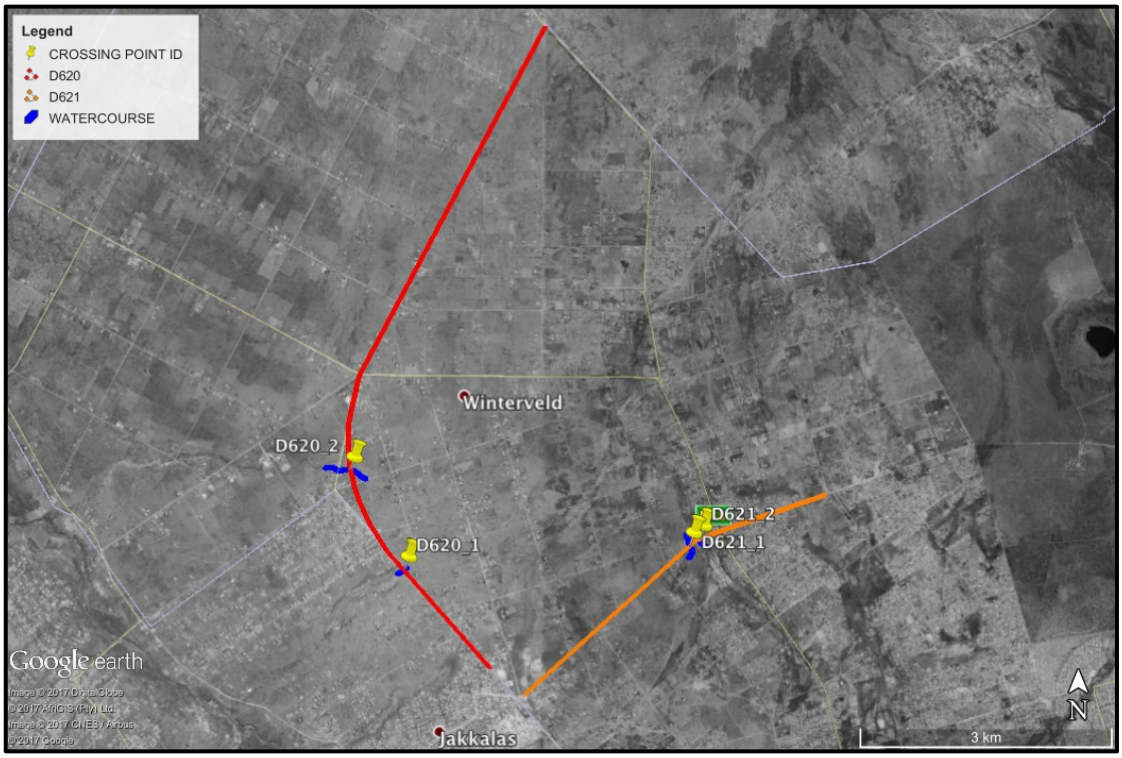

Figure 17: Position and ID of water crossings along Routes D620 & D621

7.4 Classification of watercourses in the study area

The watercourses of the study area were classified along different hydrogeomorphic (HGM) types or units, up to Level 4, in terms of various levels as refined for South Africa by Kleynhans, *et. al*. (2005) and used in the Classification System for Wetlands user manual – SANBI Series 22 (Ollis *et. al.* 2013). See tables below (Table 11 & Table 12). The classification system shown above in Figure 13 is more applicable to wetlands and was therefore not used in this assessment as there are no wetlands present.

Table 11: Classification levels 1 - 4

LEVEL 1 System	LEVEL 2 Regional setting (Ecoregion)	LEVEL 3 Landscape Unit	LEVEL 4 HGM Unit	
			HGM Type	Landform
Inland	SA Ecoregions according to DWS and/or NFEPA	• Valley floor • Slope • Plain	River	• Mountain headwater stream • Mountain stream • Transitional stream

		• Bench		• Upper foothill • Lower foothill • Lowland • Rejuvenated foothill • Upland floodplain
			Channeled valley bottom wetland	
			Unchannelled valley bottom wetland	
			Floodplain Wetland	
			Depression	• Exorheic • Endorheic • Dammed
			Seep	• With channel outflow (connected) • Without channel outflow (disconnected)
			Wetland flat	

Table 12: HGM Level 4: Watercourses in study area

Delineated Watercourse	Level 1 System	Level 2 Regional Setting (Ecoregion)	Level 3 Landscape Unit	Level 4 HGM Unit	
				Type	Landform
Seasonal Stream (D621_1)	Inland	Central Bushveld Group 2	Plain	River	Lowland
Seasonal Drainage line (D621_2)	Inland	Central Bushveld Group 2	Plain	River	Lowland
Seasonal Drainage Lines (D620_1 &	Inland	Central Bushveld Group 2	Plain	River	Lowland

D620_2)					

7.5 Delineated Watercourses

All the watercourse crossings were delineated during field investigations. As already mentioned there are no significant rivers or streams in the study area. The few drainage lines that are present are highly seasonal and erratic with little to no distinctive riparian zones and main channels. The most significant watercourse in the study area is the seasonal drainage line / stream along Route D621, which is approximately 232m east of the M39 junction. The watercourses in this area have been highly modified an impacted on by cultivating, ploughing and planting directly within the main channel and floodplain area. This along with other impacts such as urbanisation, movement of cattle and people, etc.

The maps below (Figure 18 & Figure 19) show the delineations of the watercourses along Route D620. The watercourses are seasonal, highly erratic drainage lines that have been modified over the years. There are no distinct riparian zones or seasonal floodplains associated with these two watercourses. For this reason 32m buffer zones have been delineated around the main channels. These areas are to be viewed as sensitive.

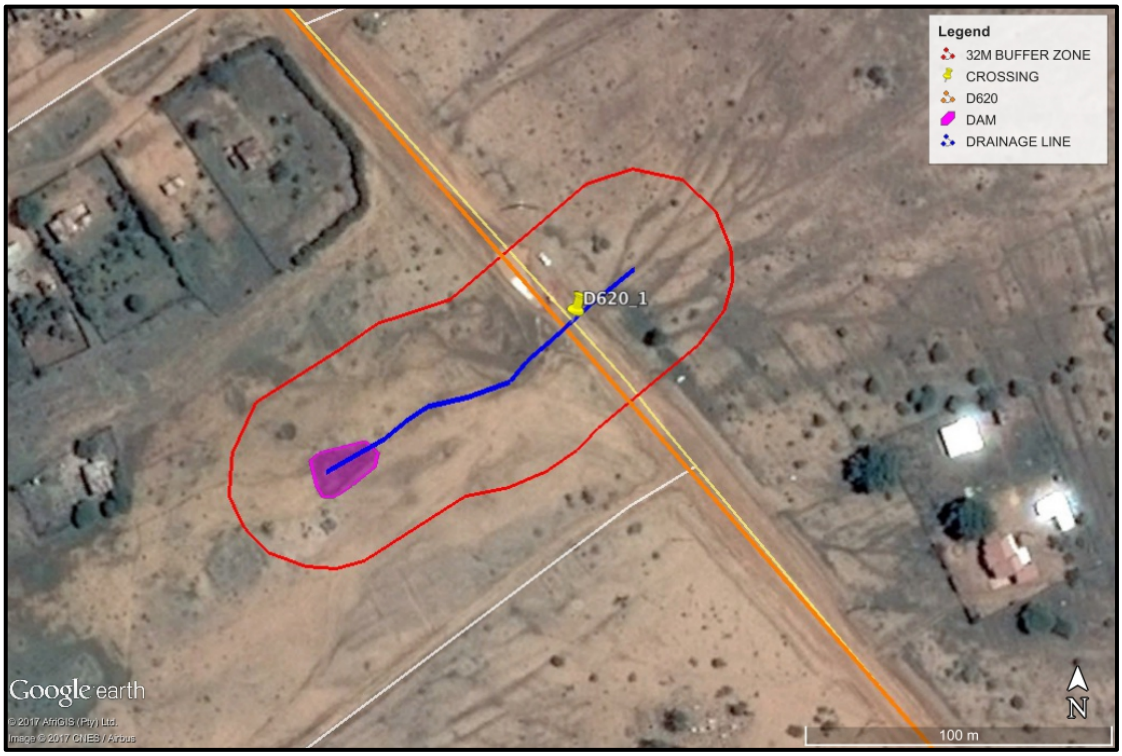

Figure 18: Delineated watercourse at D620_1

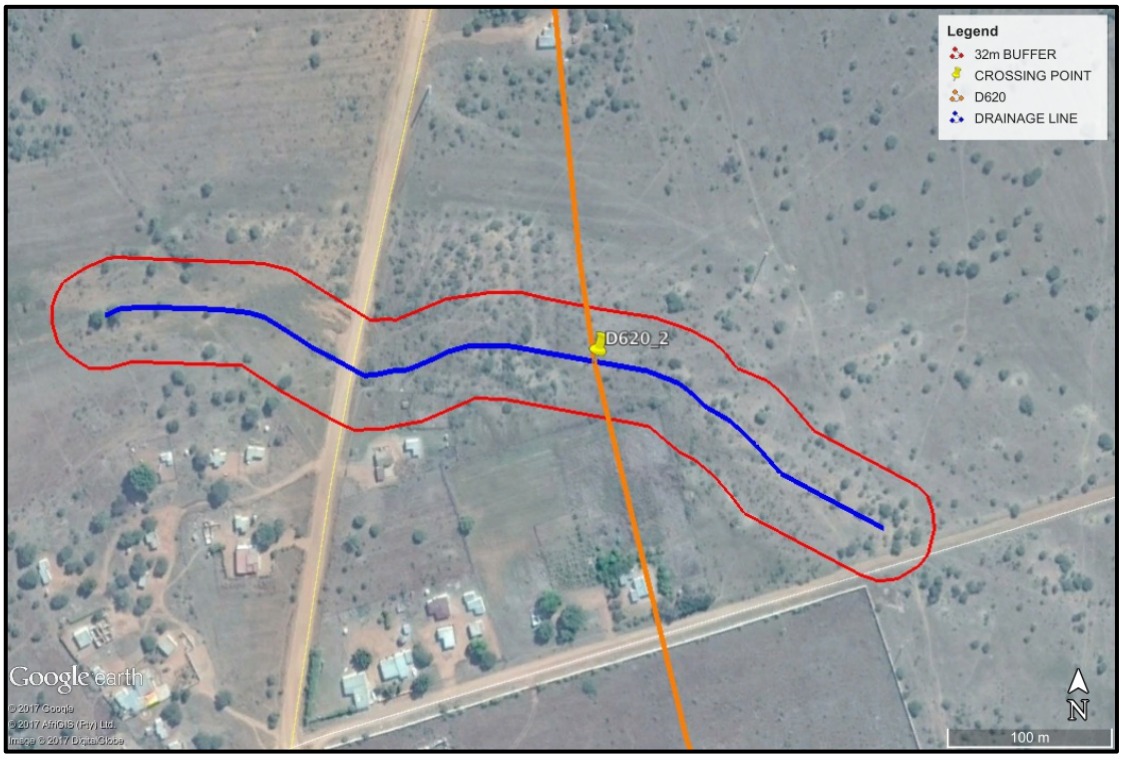

Figure 19: Delineated watercourse at D620_2

The map below (Figure 20) shows the delineation of the watercourses along Route D621. D621_1 is highly modified and no clear main channel is present. There is also no distinctive floodplain area or riparian zone. For this reason a 32m bufferzone has been delineated around the basic main channel in the area of the road, which can be determined as sensitive. No 1:100 year floodlines were determined as part of this study.

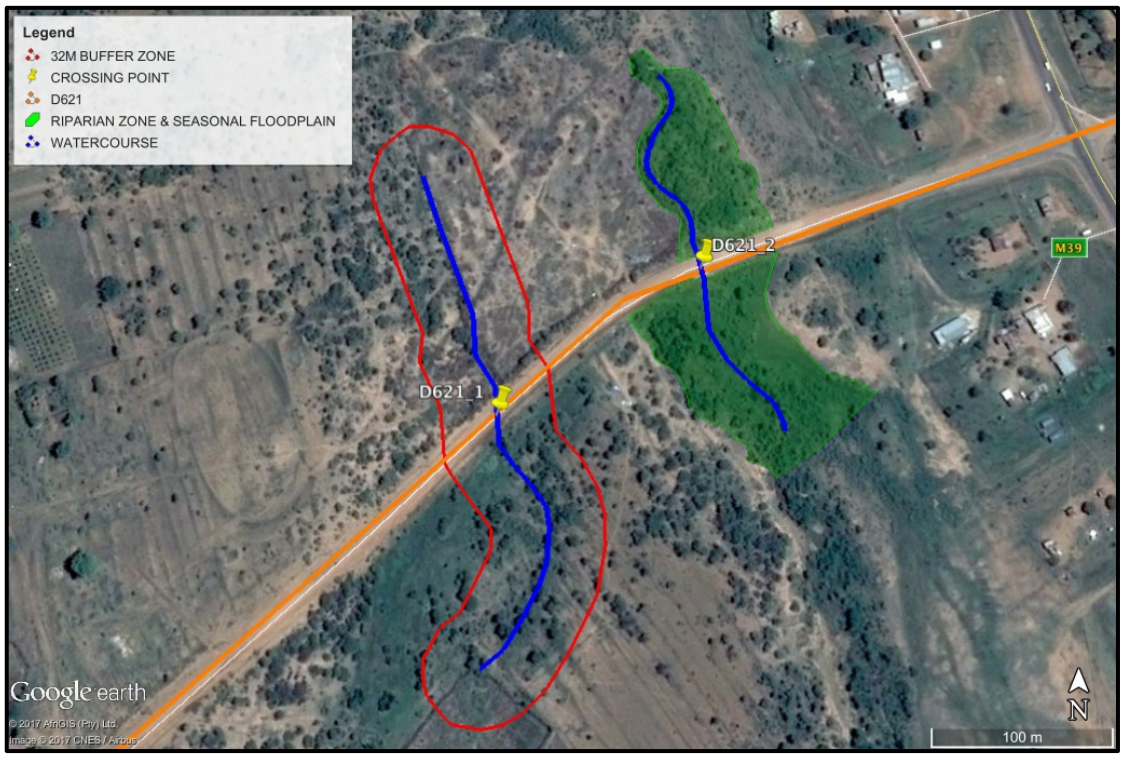

Figure 20: Delineated watercourses for Route D621

7.6 Drainage areas

South Africa is geographically divided up into a number of naturally occurring Primary Drainage Areas (PDAs) and Quaternary Drainage Areas (QDAs) (Figure 21). The different areas are demarcated into Water Management Areas (WMAs) and Catchment Management Agencies (CMAs). Until recently there were 19 WMAs and 9 CMAs (Figure 22). As of September 2016, these were revised and there are now officially only 9 WMAs, which correspond directly in area to the 9 CMAs (Figure 23 & Figure 24) (Government Gazette, 16 September 2016. No.1056, pg. 169-172).

The study area is situated within the Primary Drainage Area (PDA) of A and the Quaternary Drainage Areas (QDAs) of A23J and A23K (Figure 25).

The study area is within the Limpopo Water Management Area (WMA 1) (previously under the old Crocodile (West) & Marico WMA) and under the jurisdiction of the Limpopo Catchment Management Agency (CMA 1).

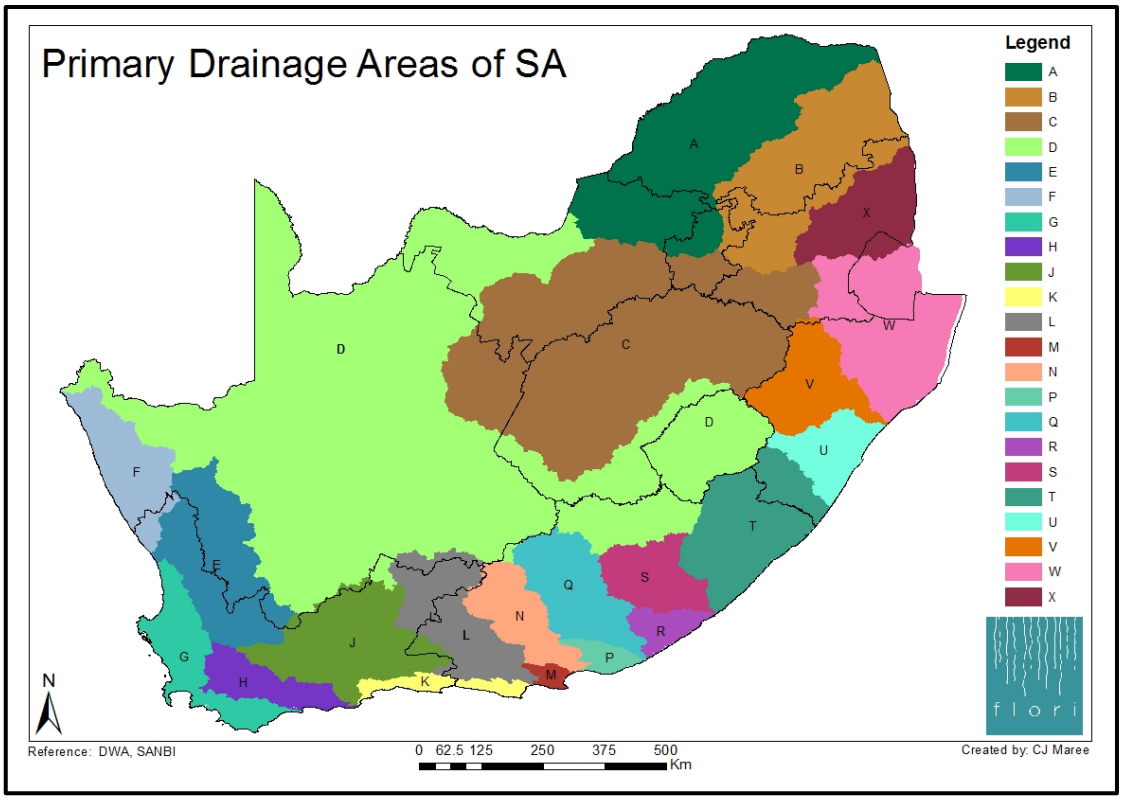

Figure 21: Primary drainage areas of South Africa

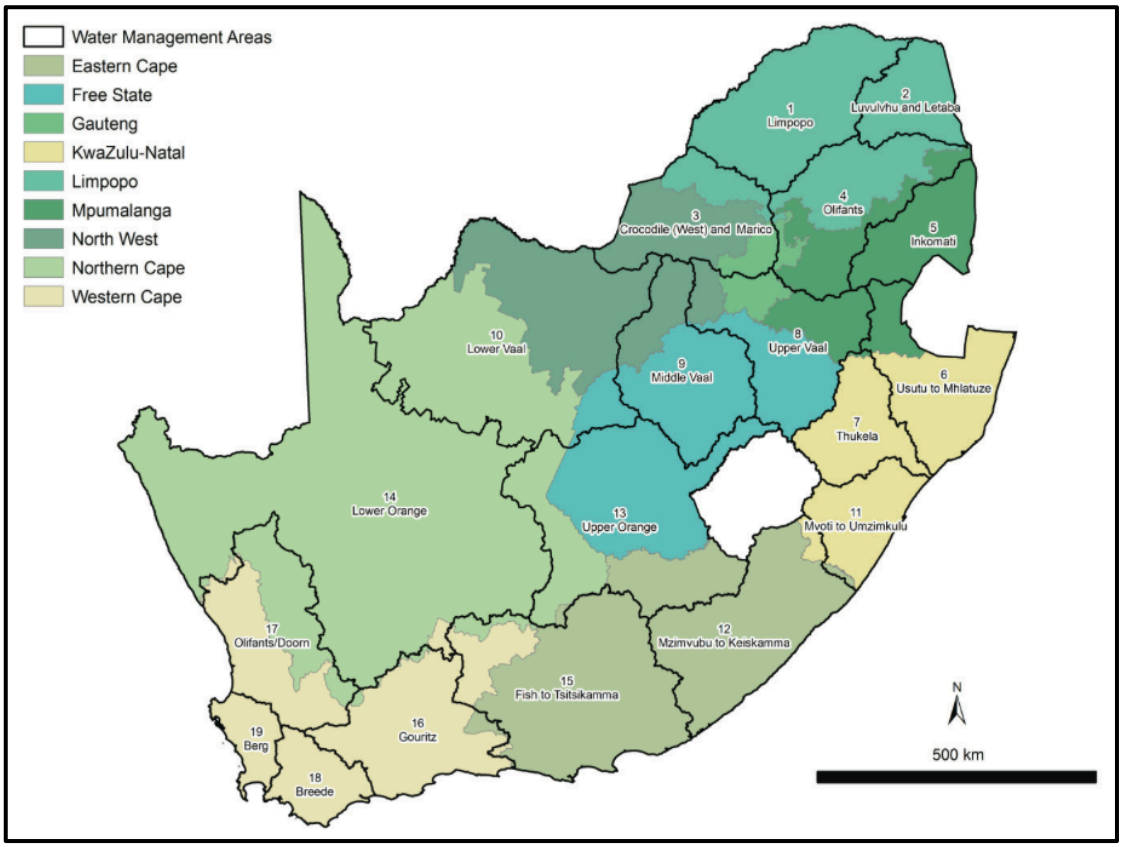

Figure 22: Previous Water management areas (WMAs) of South Africa

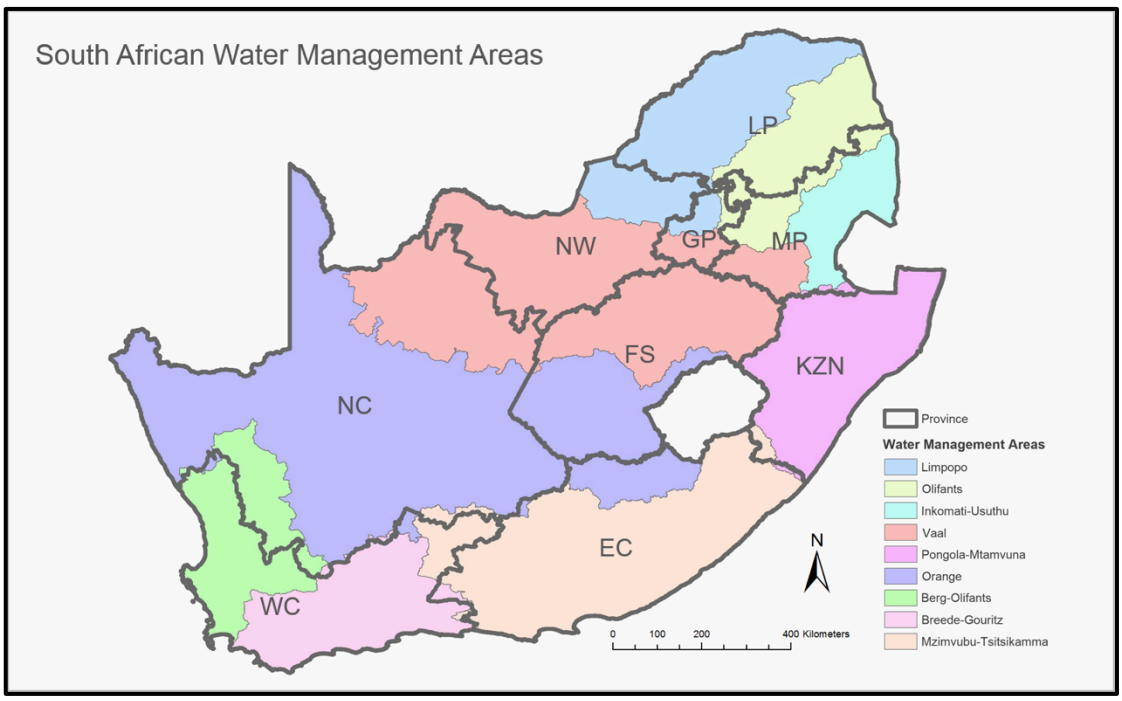

Figure 23: New WMAs of South Africa

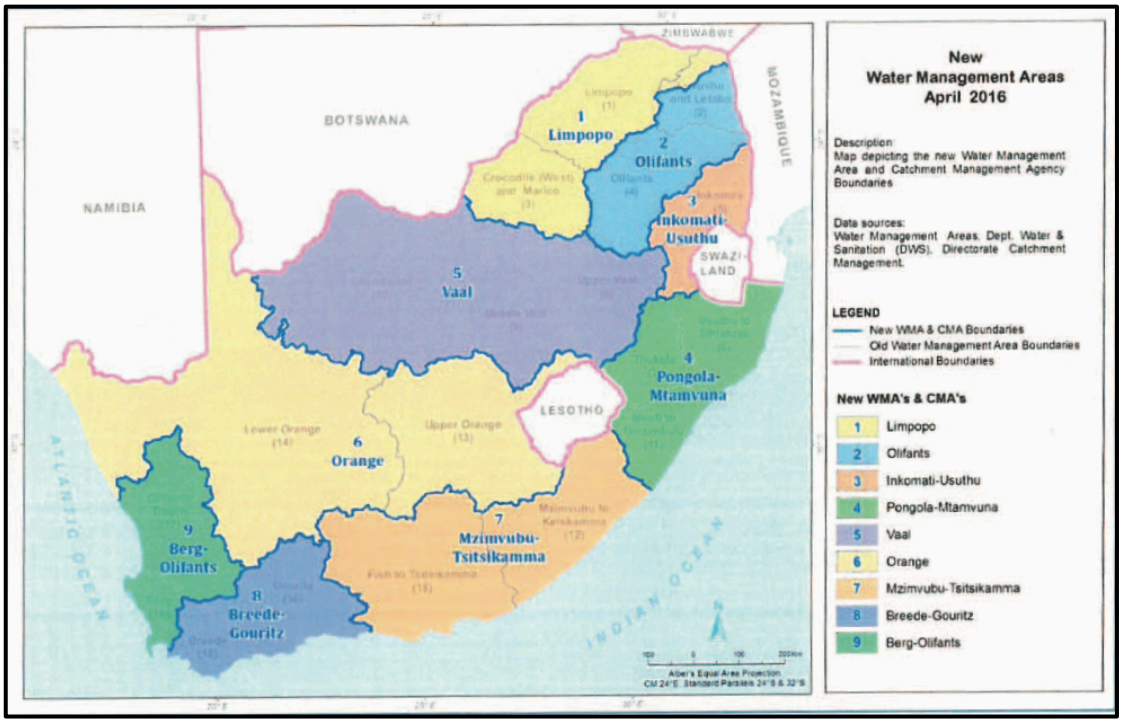

Figure 24: New WMA & CMA of South Africa

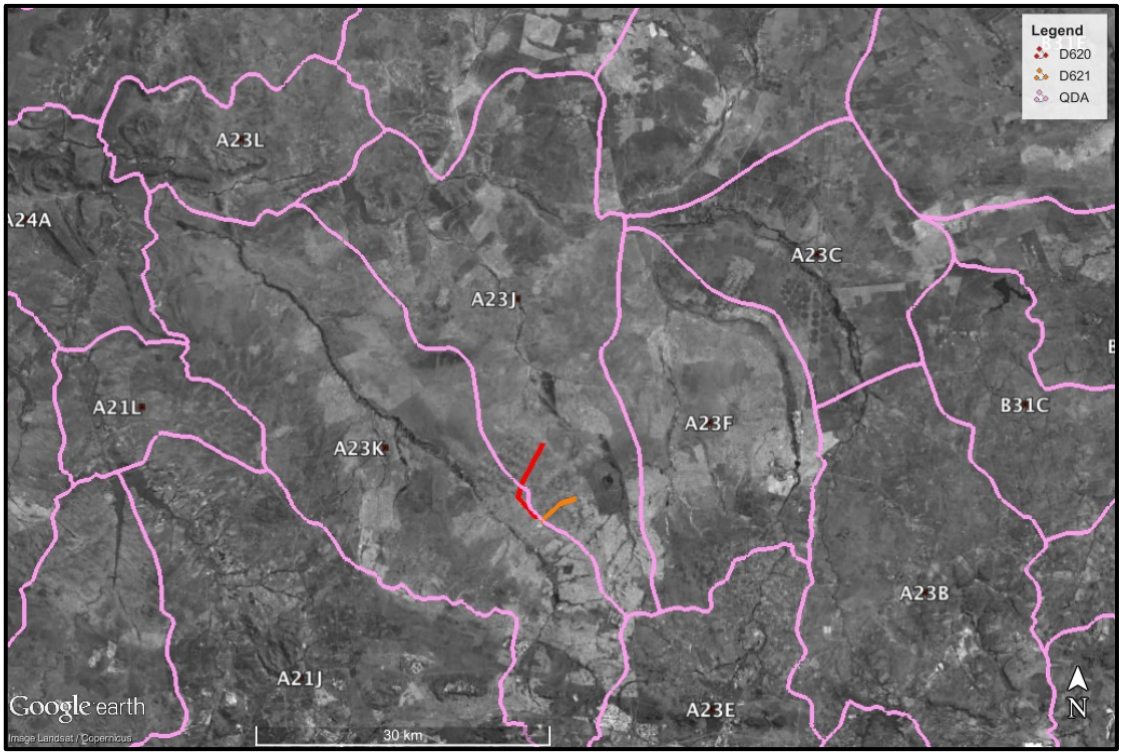

Figure 25: Quaternary drainage areas (QDAs)

7.7 Strategic water source areas (SWSA) of South Africa

The Strategic Water Source Areas of South Africa (SWSA) are those areas that supply a disproportionate amount of mean annual runoff compared to the actual size of the geographical area. These areas are important because they have the potential to contribute significantly to the overall water quality and supply of the country, supporting growth and development needs that are often a far distance away. These areas make up 8% of the land area across South Africa, Lesotho and Swaziland but provide 50% of the water in these countries.

At a national level, Strategic Water Source Areas form the foundational ecological infrastructure on which a great deal of built infrastructure for water services depends. Investing in Strategic Water Source Areas is also an important mechanism for long-term adaptation to the effects on climate change on water provision growth and development (SANBI). The study area is not situated within any Strategic Water Source Areas of South Africa (SWSA) (Figure 26).

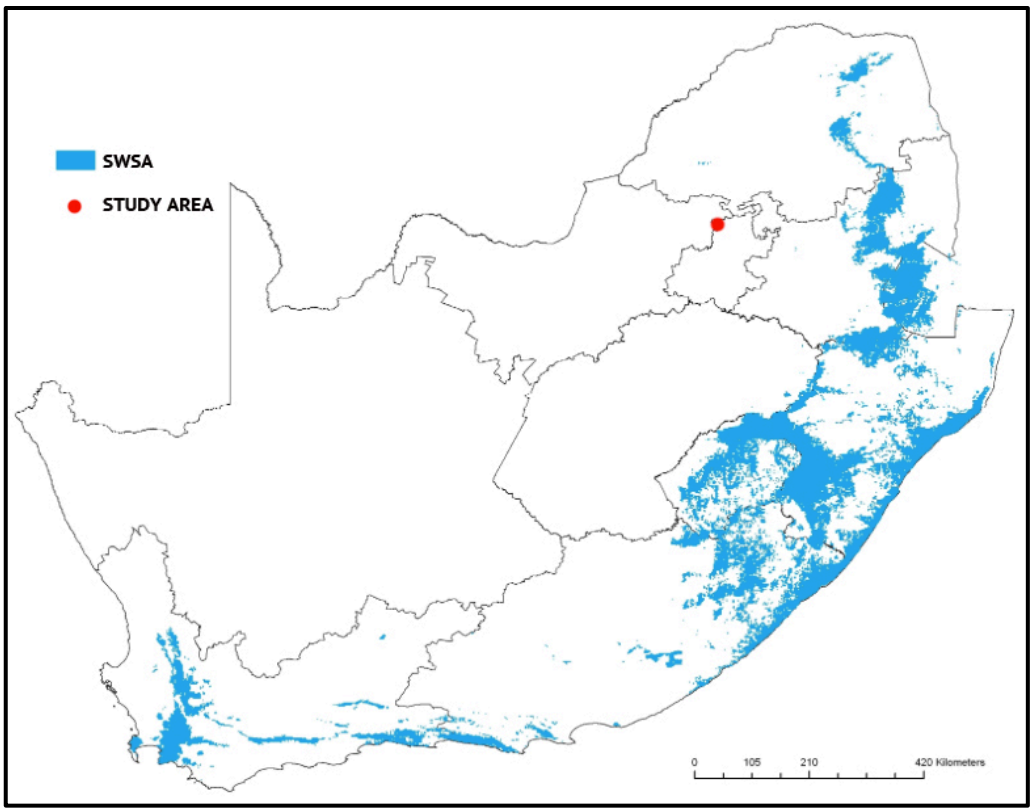

Figure 26: SWSA of South Africa

7.8 Methodology (PES)

The Present Ecological State (PES) is the current (present) ecological condition (state) in which the watercourse is found, prior to any further developments or impacts from the proposed project. The PES ratings of watercourses found in the study area are just as important to determine, as are the potential impacts of the proposed development. The PES of a watercourse is assessed relative to the deviation from the Reference State (also known as the Reference Condition).

The reference state is the original, natural or pre-impacted condition of the system. The reference state is not a static condition, but refers to the natural dynamics (range and rates of change or flux) prior to development. The PES Method (DWA, 2005) was used to establish the present state (integrity) of the unnamed drainage line in the study area. The methodology is based on the modified Habitat Integrity approach of Kleynhans (1996, 1999).

Table 13 shows the criteria used for assessing the habitat integrity (PES) of wetlands and other watercourses, along with Table 14 describing the allocation of scores to the various attributes. These criteria were selected based on the assumption that anthropogenic modification of the criteria and attributes listed under each selected criterion can generally be regarded as the primary causes of the ecological integrity of a wetland.

Table 13: Habitat assessment criteria

Rating Criteria	Relevance
Hydrology	
Flow modification	Consequence of abstraction, regulation by impoundments or increased runoff from human settlements or agricultural lands. Changes in flow regime (timing, duration, frequency), volumes, and velocity, which affect inundation of wetland habitats resulting in floristic changes or incorrect cues to biota. Abstraction of groundwater flows to the wetland.
Permanent inundation	Consequence of impoundment resulting in destruction of natural wetland habitat and cues for wetland biota.
Water quality	
Water Quality Modification	From point or diffuse sources. Measured directly

	by laboratory analysis or assessed indirectly from upstream agricultural activities, human settlements and industrial activities. Aggravated by volumetric decrease in flow delivered to the wetland.
Sediment Load Modification	Consequence of reduction due to entrapment by impoundments or increase due to land use practices such as overgrazing. Cause of unnatural rates of erosion, accretion or infilling of wetlands and change in habitats.
Geomorphology & Hydraulics	
Canalisation	Results in desiccation or changes to inundation patterns of wetland and thus changes in habitats. River diversions or drainage.
Topographic Alteration	Consequence of infilling, ploughing, dykes, trampling, bridges, roads, railway lines and other substrate disruptive activities, which reduce or changes wetland habitat directly in inundation patterns.
Biota	
Terrestrial Encroachment	Consequence of desiccation of wetland and encroachment of terrestrial plant species due to changes in hydrology or geomorphology. Change from wetland to terrestrial habitat and loss of wetland functions.
Indigenous Vegetation Removal	Direct destruction of habitat through farming activities, grazing or firewood collection affecting wildlife habitat and flow attenuation functions, organic matter inputs and increases potential for erosion.
Invasive Plant Encroachment	Affects habitat characteristics through changes in community structure and water quality changes (oxygen reduction and shading).
Alien Fauna	Presence of alien fauna affecting faunal community structure.
Over utilisation of Biota	Overgrazing, over fishing, over harvesting of plant material, etc.

Table 14: Scoring guidelines for habitat assessment

Scoring guidelines per criteria	
Natural / unmodified	5
Mostly natural	4
Moderately modified	3
Largely modified	2
Seriously modified	1
Critically modified (totally transformed)	0

Table 15 provides guidelines for the determination of the Present Ecological Status Category (PESC), based on the mean score determined for the assessments. This approach is based on the assumption that extensive degradation of any of the wetland attributes may determine the PESC (DWA, 2005).

Table 15: Wetland integrity categories

Category	Mean Score	Description
A	>4	Unmodified, natural condition.
B	>3 to 4	Largely natural with few modifications, but with some loss of natural habitats.
C	>2,5 to 3	Moderately modified, but with some loss of natural habitats.
D	2 to 2,5	Largely modified. A large loss of natural habitats and basic ecosystem functions has occurred.
E	>0	Seriously modified. The losses of natural habitats and basic ecosystem functions are extensive.
F	0	Critically modified. Modifications have reached a critical level and the system has been modified completely with an almost complete loss of natural habitat.

The integrity of watercourses with a category rating of F,E & D were deemed to be Low. Category rating of C was deemed to be Medium, while Category ratings of B & A were deemed to be High.

7.9 PES of watercourses in the study area

All of the watercourses identified during field investigations in the study area were assessed (Table 16). The seasonal stream and drainage lines are in reality and functionality the same. The assessment criteria and structure is based on the modified Habitat Integrity approach of Kleynhans (1996, 1999). The PES is

calculated by looking at the hydrology, geomorphology, water quality and biota of each watercourse. Of importance is the overall PES of the system.

Table 16: PES of watercourses in the study area

Criteria	Identified Watercourses		
	Stream (D621_2)	Drainage Line (621_1)	Drainage Lines (D620_1 & 2)
HYDROLOGY			
Flow modification	2	2	2
Permanent inundation	2	2	1
WATER QUALITY			
Water Quality Modification	2	2	2
Sediment Load Modification	2	2	2
GEOMORPHOLOGY			
Canalisation	2	2	2
Topographic Alteration	3	2	2
BIOTA			
Terrestrial Encroachment	2	2	2
Indigenous Vegetation Removal	3	2	2
Invasive Plant Encroachment	3	3	3
Alien Fauna	3	3	3
Over utilisation of Biota	2	1	1
Total:	26	23	22
Average:	2,4	2,1	2,0
Category:	**C/D**	**D**	**D**
Integrity (PES):	**Low**	**Low**	**Low**
PES Description	**Largely Modified**	**Largely Modified**	**Largely Modified**
Recommended EMC	**C**	**C**	**C**

All of the streams and drainage lines in the study area are similar in terms of their PES ratings. The watercourses and not large, perennial stream with constant flow. The drainage lines are in reality highly seasonal with erratic flow occurring mainly after good downpours and then only for short periods. These drainage lines do not have distinctive riparian zones or main channels with established aquatic plants and habitats. Ideally, one would want the watercourses in the area to be managed and improved to a PES of at least Category C.

7.10 Methodology (EIS)

Ecological importance and sensitivity (EIS) looks at the importance of the wetland, watercourse or water ecosystem in terms of biodiversity and maintenance. The determination is not just based on the identified watercourse in isolation, but also its' importance in terms of supplying and maintaining services to the larger catchment and water systems up and downstream.

The ecological sensitivity (ES) part of the EIS looks at how sensitive the system is to changes in services and environmental conditions. The Recommended Environmental Management Class (REMC) is the recommended state to which the watercourse should be returned to or maintained at. The EIS categories and descriptions are outlined in the table below (Table 17).

A high REMC relates to ensuring a high degree of sustainability and a low risk of ecosystem failure occurring. A low REMC would ensure marginal sustainability, but with a higher risk of ecosystem failure. The REMC is based on the results obtained from assessing the ecosystem or watercourse in terms of EIS, PES and function. The ideal would be that with realistic recommendations and mitigating actions, to return the system to a certain level of functionality and original state. The determination of the Environmental Importance and Sensitivity (EIS) of the identified watercourses in the study area are shown below (Table 18).

Table 17: EIS Categories and Descriptions

EIS Categories	Median Range	Category
Wetlands that are considered ecologically important and sensitive on a **national or international** level. The biodiversity of these wetlands is usually very sensitive to flow & habitat modifications. They play a major role in moderating the quantity and quality of water of major rivers.	Very high 3 - 4	A
Wetlands that are considered to be ecologically important and sensitive. The biodiversity of these wetlands may be sensitive to flow and habitat modifications. They play a role in moderating the quantity and quality of water of major rivers.	High 2 - 3	B
Wetland that are considered to be ecologically important and sensitive on a **provincial or local** scale. The biodiversity of these wetlands is not usually sensitive to flow and habitat modifications. They play a small role in moderating the quantity and quality of water of major rivers.	Moderate 1 - 2	C
Wetlands that are not ecologically important and sensitive on any scale. The biodiversity of these wetlands is ubiquitous and not sensitive to flow and habitat modifications. They play an insignificant role in moderating the quantity and quality of water of major rivers.	Low 0 - 1	D

7.11 EIS of watercourses in the study area

The EIS values of the watercourses were determined using the above methodology. The calculations and categories are shown in the table below (Table 18). The drainage lines are small, very seasonal, lack species-richness, lack habitat diversity and are not important in terms of aquatic biota and migratory routes for birds. Their EIS rating is therefore borderline between being Low and Moderate.

Table 18: EIS and EMC values of watercourses

Determinant	Stream (D621_2)	Drainage line (621_1)	Drainage lines (D620_1 & D620_2)	Confidence
PRIMARY DETERMINANTS				
1. Rare & Endangered Species	2	2	1	4
2. Populations of Unique Species	2	2	1	4
3. Species/taxon Richness	2	2	1	4
4. Diversity of Habitat Types or Features	1	1	1	4
5 Migration route/breeding and feeding site for wetland species	2	2	0	3
6. Sensitivity to Changes in the Natural Hydrological Regime	3	3	1	3
7. Sensitivity to Water Quality Changes	3	3	2	3
8. Flood Storage, Energy Dissipation & Particulate/Element Removal	2	2	2	3
MODIFYING DETERMINANTS				
9. Protected Status	1	1	1	4
10. Ecological Integrity	2	2	1	4
TOTAL	20	20	11	-

AVERAGE	2,0	2,0	1,1	-
Overall EIS	**C**	**C**	**C/D**	**-**
Description	**Moderate**	**Moderate**	**Moderate/Low**	**-**

7.12 Drivers of ecological change on the watercourses

The main drivers of ecological change on the watercourses and water ecosystems in the study area are:

- Cultivation (Agriculture);
- Impoundment by means of in-channel farm dams;
- Urbanisation; and
- Over-utilisation of natural resources.

Although roads do have an impact on watercourses, especially in terms of impeding water flow (if not probably designed), their impact in the study area is not a major driver of ecological change.

8 SENSITIVITY ASSESSMENT

The sensitivity assessment identifies those areas and habitats within the study site that have a high conservation value and that may be sensitive to disturbance. All watercourses, including seasonal streams and drainage lines are always deemed to be sensitive, even if they are badly degraded. Areas or habitats have a higher conservation value (or sensitivity) based on their threatened ecosystem status, ideal habitat for priority species (including Red Data species), species-richness, distinctive habitats, etc.

The natural environment within the study area is relatively uniform and consists of only two natural habitats, namely thornveld and watercourses. The watercourses are similar to one another in nature. No pristine thornveld areas are present in the study area. The study area is almost totally transformed as it consists mostly of the existing hard-surface road and the bare, gravel shoulder (road area). The floral and faunal sensitivity analyses are shown in the tables below (Table 19 & Table 20).

8.1 Floristic Sensitivity Analysis

Table 19: Floristic sensitivity analysis

Criteria	Distinctive habitats in the study area			
	Thornveld	Road area	Cultivated lands	Watercourses
Red Data Species	2	0	1	5
Habitat Sensitivity	2	0	1	6
Floristic Status	3	0	1	6
Floristic Diversity	3	0	1	5
Ecological Fragmentation	5	0	1	6
Sensitivity Index	30%	0%	10%	56%
Sensitivity Level	Medium/Low	Low	Low	Medium
Development Go Ahead	Go-Slow	Go	Go	Go-But

There are no floristic areas that have a High Sensitivity rating. The watercourses are in reality only Medium Sensitivity, but by default all watercourses are rated as High Sensitivity.

8.2 Faunal Sensitivity Analysis

Table 20: Faunal sensitivity analysis

Criteria	Distinctive habitats in the study area			
	Thornveld	Road area	Cultivated lands	Watercourses
Red Data Species	3	1	5	5
Habitat Sensitivity	3	1	2	6
Faunal Status	4	1	3	6
Faunal Diversity	5	1	1	5
Ecological Fragmentation	5	1	1	6
Sensitivity Index	40%	10%	24%	56%
Sensitivity Level	Medium/Low	Low	Medium/Low	Medium
Development Go Ahead	Go-Slow	Go	Go-Slow	Go-But

8.3 Ecological Sensitivity Analysis

The ecological sensitivity of the study area is determined by combining the sensitivity analyses of both the floral and faunal components. The highest calculated sensitivity unit of the two categories is taken to represent the sensitivity of that ecological unit, whether it is floristic or faunal in nature (Table 21).

Table 21: Ecological sensitivity analysis

Ecological community	Floristic sensitivity	Faunal sensitivity	Ecological sensitivity	Development Go-ahead
Thornveld	Medium/Low	Medium/Low	Medium/Low	Go-Slow
Road area	Low	Low	Low	Go
Cultivated lands	Low	Medium/Low	Medium/Low	Go-Slow
Watercourses	Medium	Medium	Medium	Go-But

According to the analyses there are no high sensitivity areas or habitats. However, the watercourses must be viewed and approached as sensitive.

8.4 Priority areas

Priority areas include formal and informal protected areas (nature reserves); important bird areas (IBAs); RAMSAR sites; National fresh water ecosystem priority areas (NFEPA) and National protected areas expansion strategy (NPAES) areas. The study site is not situated within any priority areas. The closest priority area is the

Tswaing Meteorite Crater Reserve, which is approximately 1,8km east of the outer boundary of the study site (Figure 27).

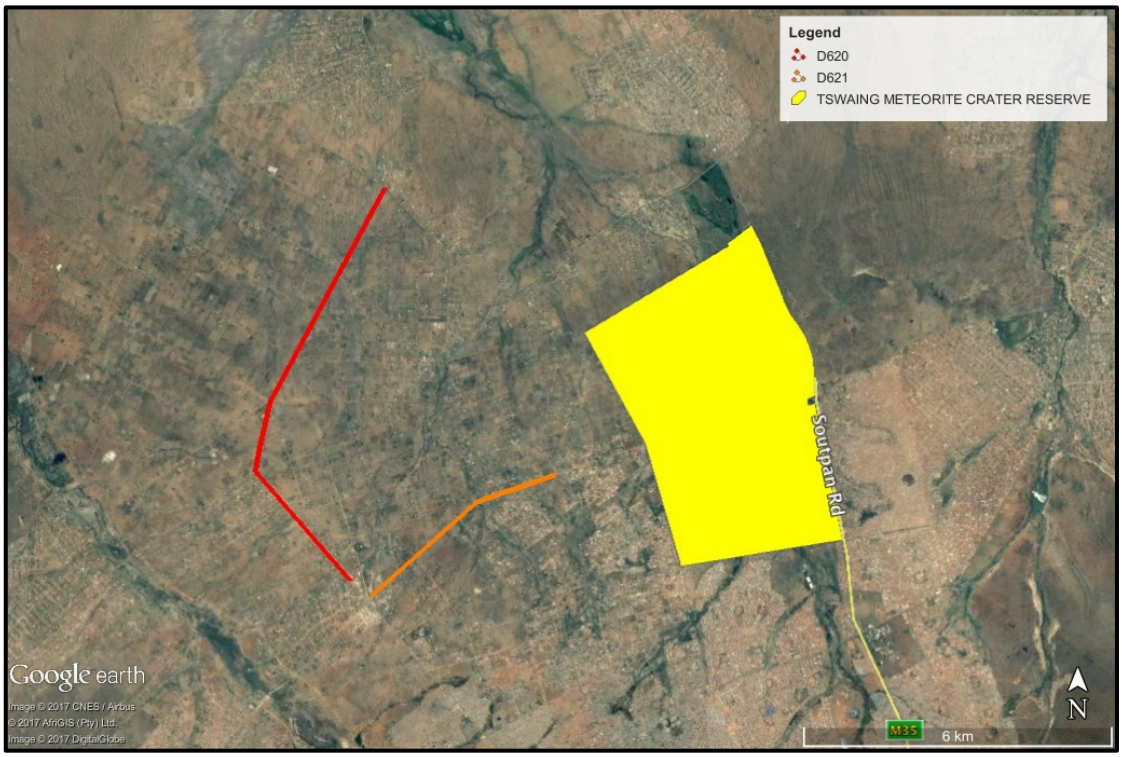

Figure 27: Priority areas

8.5 Gauteng Conservation Plan

According to GDARD's Gauteng Conservation Plan (v.3.3), the study site is not situated within any critical biodiversity areas (CBAs). The eastern section of Route D621 crosses through an ecological support area (ESA) in the area of the small stream crossing (D621_1 and D621_2) (Figure 28). The map shown in Figure 28 was created using the GDARD C-Plan v3.3 data overlay as obtained from the SANBI website (www.bgis.sanbi.org).

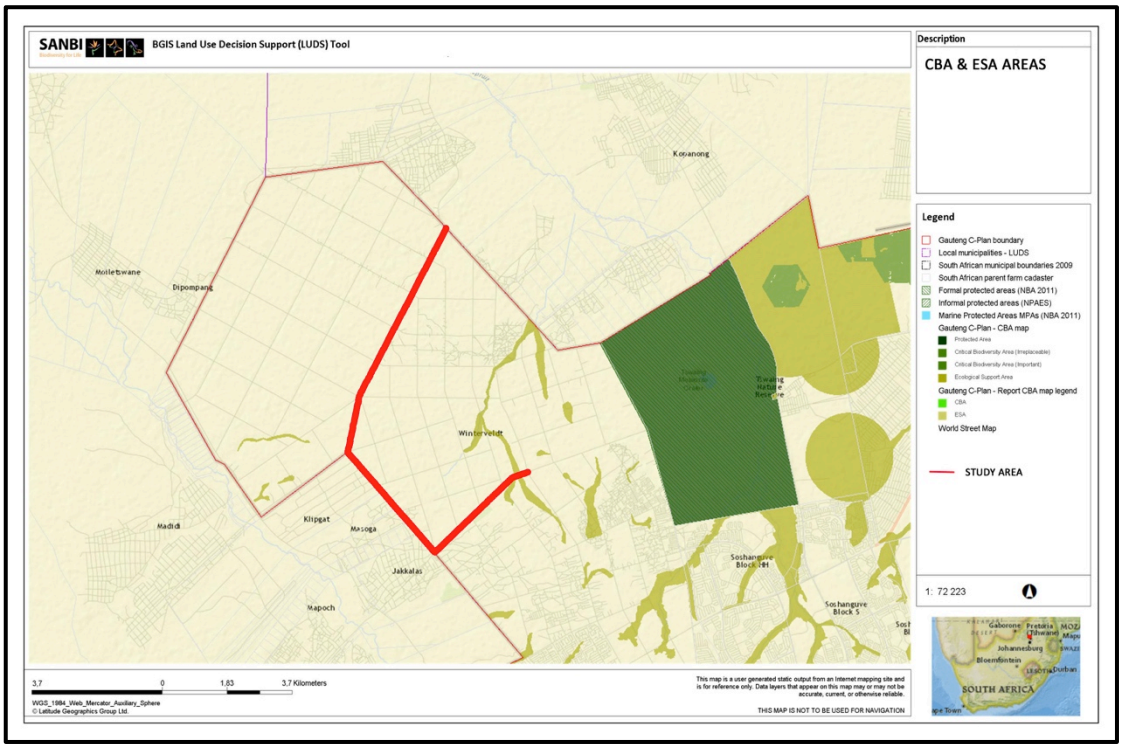

Figure 28: CBAs & ESAs (C-Plan v3.3)

8.6 Sensitive areas identified during field investigations

There are no High sensitivity areas identified during field investigations within the study site. Most of the site consists of totally transformed existing road areas (gravel or sand roads). The roads are to be upgraded with little to no further impacts along the routes. The areas of road to be widened are situated mostly within the existing road reserve most of which is disturbed. The watercourse crossings are not highly sensitive in reality, but like all watercourses (even degraded ones) they are by default, viewed as sensitive and need to be approached as such.

The only sensitive areas in the study area are therefore the watercourse crossings. The sensitivity map is shown below (Figure 29).

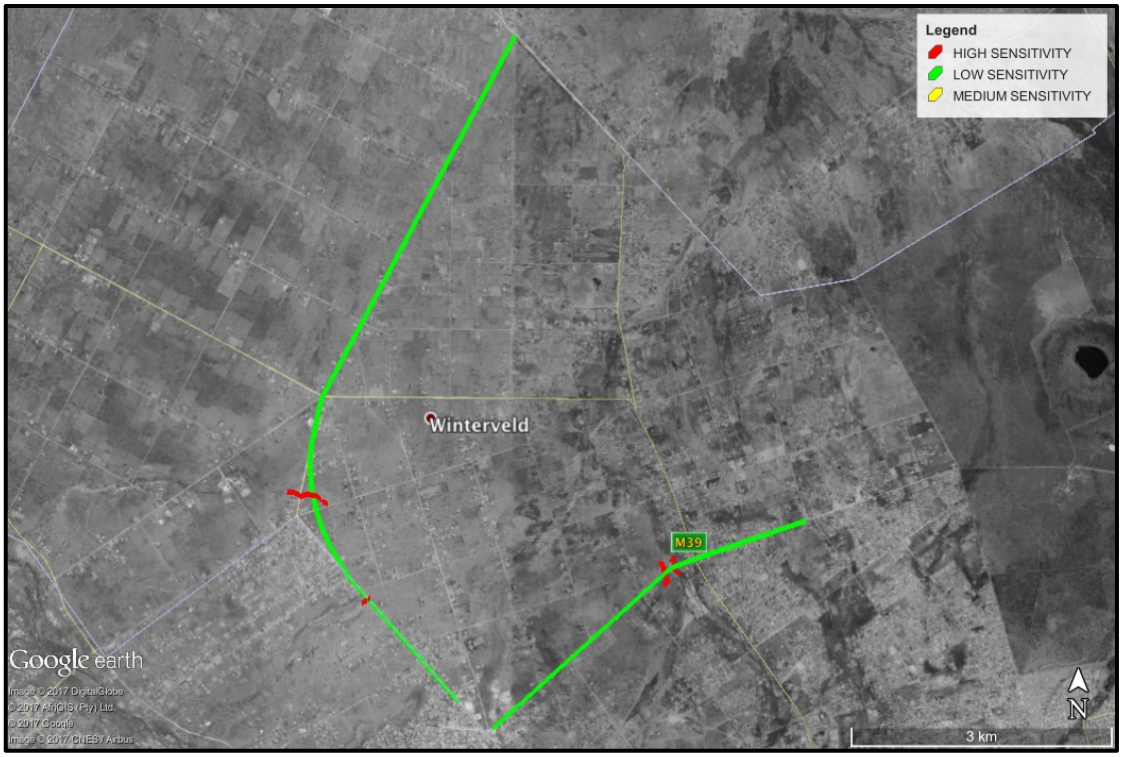

Figure 29: Sensitivity map

9 THE GO, NO-GO OPTION

9.1 Classification criteria

The term ‘fatal flaw’ is used in the pre-application planning and screening phases of a project to evaluate whether or not an impact would have a ‘no-go’ implication for the project. In the scoping and impact assessment stages, this term is not used. Rather impacts are described in terms of their potential significance.

A potential fatal flaw (or flaws) from a biodiversity perspective is seen as an impact that could have a "no-go" implication for the project. A ‘no-go’ situation could arise if residual negative impacts (i.e. those impacts that still remain after implementation of all practical mitigatory procedures/actions) associated with the proposed project were to:

a) Conflict with international conventions, treaties or protocols (e.g. irreversible impact on a World Heritage Site or Ramsar Site);

b) Conflict with relevant laws (e.g. clearly inconsistent with NEMA principles, or regulations in terms of the Biodiversity Act, etc.);

c) Make it impossible to meet national or regional biodiversity conservation objectives or targets in terms of the National Biodiversity Strategy and Action Plan (BSAP) or other relevant plans and strategies (e.g. transformation of a ‘critically endangered’ ecosystem);

d) Lead to loss of areas protected for biodiversity conservation;

e) Lead to the loss of fixed, or the sole option for flexible, national or regional corridors for persistence of ecological or evolutionary processes;

f) Result in loss of ecosystem services that would have a significant negative effect on lives (e.g. loss of a wetland on which local communities rely for water);

g) Exceed legislated standards (e.g. water quality), resulting in the necessary licences/approvals not being issued by the authorities (eg. WULA);

h) Be considered by the majority of key stakeholders to be unacceptable in terms of biodiversity value or cultural ecosystem services.

9.2 Potential Fatal Flaws for the Project

There are no fatal flaws and the project may go ahead. There are no ‘No-Go’ areas within the study site. However, mitigating measures need to be implemented and care must be taken specifically in the areas of watercourse crossings.

10 IMPACT ASSESSMENT

The impacts of the activities related to the proposed project were rated. There are existing and potential impacts and mitigating measures are recommended to help reduce the sum of any potentially new (additional) impacts that might arise from the project. The rated impacts of the proposed project before and after the implementation of mitigating measures are shown in the table below ().

Table 22: Impact Assessment

R510 PROVINCIAL ROUTE (SECTIONS 1 & 2)		
THORNVELD		
Impact Rating	**Mitigating Measures**	**Sensitivity**
Before Mitigation: **Low** Total = 7 Extent: (Site) 1 Duration: (Short-term) 1 Intensity: (Moderate) 2 Probability: (Highly probable) 3 With Mitigation: **Low** Total = 6 Extent: (Site) 1 Duration: (Short-term) 1 Intensity: (Moderate) 2 Probability: (Possible) 2	**Construction Phase** All temporary facilities (i.e. storage, accommodation, portable toilets, etc.) to be setup in existing built-up areas or disturbed areas only. No temporary facilities to be setup within 100m of any watercourses. Ensure small footprint during construction phase. Use existing roads and road reserve for haul vehicles, contract vehicles, etc. If possible no new access roads to be constructed. Erosion to be continually monitored and rectified during construction phase, not only after construction. All excess materials brought onto site for construction to be removed after construction. No open trenches or mounds of soils to be left. Rehabilitation plan for disturbed areas to be compiled and implemented. Re-seeding of bare areas with local indigenous grasses to be part of the rehabilitation plan. No exotic species to be used for rehabilitation. No open fires allowed at all during the construction phase by contractors. Proper control and management of litter is important. **Operation Phase & Maintenance Phase** Erosion plan to be compiled and implemented. Stormwater management plan to be compiled and implemented.	Sensitivity rating with mitigating measures **LOW**
WATERCOURSES		
Impact Rating	**Mitigating Measures**	**Sensitivity**

Before Mitigation: Medium Extent: Local: 2 Duration: Long-term: 3 Intensity: Moderate: 2 Probability: Highly probable: 2 Total: 9 After Mitigation: Low Extent: Site: 1 Duration: Long-term: 1 Intensity: Moderate: 2 Probability: Possible: 2 Total: 6	**Construction Phase** All temporary facilities (i.e. storage, accommodation, portable toilets, etc.) to be setup in existing built-up areas or disturbed areas only. No temporary facilities to be setup within 100m of any watercourses, including wetlands. Ensure small footprint during construction phase. Erosion around bridges and stormwater culverts to be monitored during the construction phase and rectified on and on-going basis (if occurring directly as a result of the construction activities). Erosion control not to be left until after construction only. Avoid and minimise the unnecessary removal of any indigenous vegetation, especially trees. Full rehabilitation plans for water crossings, including stream banks, to be compiled and implemented. **Operation Phase & Maintenance Phase** Erosion plan to be compiled and implemented. Stormwater management plan to be compiled and implemented.	Sensitivity rating with mitigating measures **MEDIUM**
CULTIVATED LANDS AND ROAD RESERVES		
Impact Rating	**Mitigating Measures**	**Sensitivity**
Before Mitigation: Medium Extent: Local: 2 Duration: Medium-term: 2 Intensity: Moderate: 2 Probability: Highly probable: 3 Total: 9 After Mitigation: Low Extent: Site: 1 Duration: Medium-term: 2 Intensity: Low: 1 Probability: Possible: 2 Total: 6	**Construction Phase** No movement of heavy vehicles through farmlands directly after rains to limit damage to lands and farm roads (although this should not be necessary). Any farm roads or gravel roads used by contractors during construction to be rehabilitated. Erosion along gravel roads and access roads to be continually monitored and repaired. Ensure small footprint during construction phase. Dust suppression along gravel roads to be implemented. Erosion plan to be implemented and monitored. Any farm roads / private roads / gravel roads used during construction to be rehabilitated after construction. **Operation Phase & Maintenance Phase** Erosion plan to be compiled and implemented. Stormwater management plan to be compiled and implemented.	Sensitivity rating with mitigating measures **LOW**

Besides the direct impacts of the project, a number of other general impacts can occur during the construction phase that needs to be taken into account. The significances of these are highlighted in the table below (Table 23).

Table 23: General impacts of the project in the study area

Issue	Significance rating before and after mitigation	
	Before	After
Farming Related & Other Issues		
Access to properties	Medium	Low
Access roads (damage, blocking)	Medium	Low
Loss of agricultural potential	Low	Low
Loss of cultivation potential	Low	Low
Loss of grazing potential	Low	Low
Impact on airstrips	Low	Low
Impacts on seasonal activities	Low	Low
Natural Environment		
Erosion	Low	Low
Impact on flora	Low	Low
Impact on fauna	Low	Low
Impact on wetlands	Low	Low
Impact on watercourses	Medium	Low
Importation of alien vegetation	Low	Low
Impact of herbicides	Low	Low
Impact on conservation areas	Low	Low

11 MITIGATION OF IMPACTS

The following general mitigating measures are recommended to help reduce the potential negative impacts of the project on the natural environment. The mitigating measures as laid out in the Impact Assessment (Chapter 10) also need to be implemented and many are similar or the same as those highlighted below. The implementation of all recommended mitigating measures are necessary if the conclusions and assessments of the report are to remain pertinent.

11.1 Construction & Operation Phase

- No temporary accommodation or temporary storage facilities may be setup within 100m of the any river, stream, drainage line, wetland or farm dam.
- No temporary facilities (including portable toilets) to be positioned within a 50m bufferzone of the edge of any watercourses.
- Only existing roads to be used by vehicles during construction as far as possible. Especially in terms of crossing over watercourses.
- No vehicles may drive through wetland areas and no new service road may be made through wetland areas.
- Upgrade activities close to watercourses to be carefully monitored in terms of erosion and possible resulting siltation of watercourses. Weekly inspection of work areas around watercourses to be conducted. Any signs of new erosion and siltation to be rectified immediately.
- Disturbed surface areas in the construction phase to be rehabilitated. No open trenches to be left. No mounds of soils created during construction to be left.
- All construction material, equipment and any foreign objects brought into the area by contractors to be removed immediately after completion of the construction phase.
- Proper rubbish/waste bins to be provided. These to be emptied weekly and the waste to be removed to an official waste disposal site.

11.2 Maintenance phase (to be implemented in defect liability period for 1 year)

- Mechanical control of alien plants around disturbed areas caused by construction need to be implemented within three months of completion of construction. Thereafter every six months. Mechanical control to be of such a nature as to allow local, indigenous grasses and other pioneers to colonise the previously disturbed areas, thereby assisting in keeping out invasive weed species.
- No chemical control (herbicides) of alien plants to be used within 100m of any watercourses.
- Areas around foundations, culverts, gabions, etc. need to be check before and after the summer rainy season for signs of soil erosion due to stormwater run-off. Such sites need to be modified and rehabilitated to prevent ongoing erosion. These sites need to be monitored more closely than other sites which show no or minimal signs of erosion.
- Inspection of road shoulders in areas of steep topography to be inspected after the summer rainy season for signs of erosion and rehabilitated and rectified as required.

12 CONCLUSIONS

The conclusions of the study are as follows:

- There are no fatal flaws
- There are no 'No-Go' zones or highly sensitive areas, but mitigating measures are recommended to reduce negative impacts on the natural environment
- There are no major watercourses in the study area, although a few seasonal drainage lines and a small stream are present. Watercourses, by default, are viewed as sensitive
- Most of the study site is the existing gravel roads earmarked for upgrade and therefore most of the study site is within a transformed environment
- The study site is not within any national priority areas
- The study site is not within CBAs
- The study site does cross through an ESA, which is the watercourse on Route D621
- It is the opinion of the specialist and the conclusion of the study that at most a GA process is required for the upgrade of the existing water crossings.

13 APPENDICES

13.1 List of floral species identified on site

Trees

Acacia caffra, Acacia erubescens, Acacia hebeclada, Acacia karroo, Acacia nilotica, Acacia tortillis, Acacia fleckii, Acacia mellifera, Combretum imberbe, Eucalyptus spp., Erythrina lysistemon, Searsia (=Rhus) lancea, Vepris lanceolata, Ziziphus mucronata.*

* = Alien species.

Shrubs & Herbaceous plants

Ammocharis coranica, Combretum hereroense, *Diospyros lycioides* subsp. *lycioides*, *Euclea undulata*, *Grewia flava*, *Tarchonanthus camphoratus*. *Acacia tenuispina*, *Abutilon austro-africanum*, *Aptosimum elongatum*, *Hirpicium bechuanense*, *Pavonia burchellii*, *Rhynchosia minima, Solanum delagoense*.

Grasses

Aristida bipartita, Bothriochloa insculpta, Digitaria eriantha, Ischaemum afrum, Panicum maximum, Cymbopogon pospischilii, Eragrostis chloromelas, Eragrostis curvula, Monocymbium ceresiiforme, Sehima galpinii, Setaria incrassate, Themeda triandra

Aquatic species

Cyperus congestus, Cyperus cyperoides.

Red Data species

None.

Priority Species

Aloe zebrine (*Aloe transvaalensis*).

13.2 Protected trees

None. However, it is possible that a few marula trees (*Sclerocarya birrea* subsp. *caffra*) might be present in the area.

13.3 Photographs

13.3.1 Route D620

Photo 1: Route D620 in area of M39 looking south

Photo 2: Open thornveld along gravel road in northern section of D620

Photo 3: Gravel road (D620) at about 7km looking north

Photo 4: Stormwater drain along D620 route

Photo 5: Homesteads along Study route

Photo 6: Sparse housing in areas of study site

13.3.2 Route D621

Photo 7: Study site (D621) at start looking east along route

Photo 8: Cemetery along side route

Photo 9: Houses along study route of D621

Photo 10: End of route in east of study site

Photo 11: Culverts / stormwater drains over stream at 3,3km. This is the largest watercourse crossing in the study area

Photo 12: Small stormwater drain in area of 3,3km near east end of route

14 REFERENCES

- Acocks, J.P.H. 1988. 3rd ed. Veld types of South Africa. Memoirs of the Botanical Survey of South Africa 57: 1-146.
- Branch, B. 1998. Field Guide to Snakes and other Reptiles of Southern Africa. 3d ed. Struik, Cape Town.
- Bromilow, C. 2010. Problem plants and alien weeds of South Africa. Briza, Pretoria.
- Carruthers, V. 2001. Frogs and Frogging in Southern Africa. Struik, Cape Town.
- Gerber, A., Cilliers, CJ., van Ginkel, C. & Glen, R. 2004. Easy identification of Aquatic plants. Dept. of Water Affairs, Pretoria.
- Low, A.B. & G. Rebelo (eds). 1998. Vegetation of South Africa, Lesotho and Swaziland. Dept. Environmental Affairs and Tourism, Pretoria.
- Manning, J. 2009. Field Guide to Wild Flowers of South Africa. Struik, Cape Town.
- Mpumalanga Biodiversity. Sector Plan Handbook (MBSP). 2014. Compiled by Lötter M.c., cadman, M.J. and Lechmere-Oertel R.G. Mpumalanga Tourism & Parks Agency, Mbombela (nelspruit).
- Mucina, L. & M.C. Rutherford (eds). 2006. The vegetation of South Africa, Lesotho and Swaziland. SANBI, Pretoria.
- Palgrave, K.C. 1983. Trees of Southern Africa. 2ed. Struik, Cape Town.
- Picker, M., Griffiths, C. & Weaving, A. 2004. Field guide to Insects of South Africa. Struik Nature, Cape Town.
- Raimondo D., L. von Staden, W. Fonden, JE Victor, NA. Helme, RC. Turner, DA. Kamundi, PA. Manyama (eds). 2009. Red List of South African Plants. Strelitzia 25. SANBI. Pretoria.
- SANBI. South African National Biodiversity website. www.sanbi.org.
- Schmidt, E., M. Lötter & W. McCleland. 2002. Trees and shrubs of Mpumalanga and Kruger National Park. Jacana, Johannesburg.
- South African National Biodiversity Institute (SANBI). Threatened ecosystems of South African Biomes. Draft 2009. www.sanbi.org or www.bgis.sanbi.org.
- Stuart, C. & T. Stuart. 2001. Field Guide to Mammals of Southern Africa. Struik, Cape Town.
- The Plants of Southern Africa (POSA) database. SANBI website. http://posa.sanbi.org or www.sanbi.org

- van Wyk, A-E. & S. Malan. 1988. Field guide to the wild flowers of the Witwatersrand and Pretoria region. Struik, Cape Town.
- van Wyk, E. & F. van Oudtshoorn. 2009. Guide to Grasses of Southern Africa. 2nd ed. Briza, Pretoria.
- Woodhall, S. 2005. Field Guide to Butterflies of South Africa. Struik, Cape Town.