

## **IMPACT ASSESSMENT REPORT:**

Ecological study on the impacts of the construction of the Giyani  
WWTW to the south of Giyani within Limpopo Province

Prepared by

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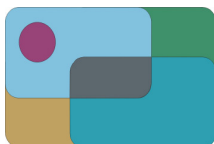
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**David Hoare Consulting cc**  
**Biodiversity Assessments, Vegetation Description /**  
**Mapping, Species Surveys**

## **DECLARATION OF INDEPENDENCE & SUMMARY OF EXPERTISE**

### **Appointment of specialist**

David Hoare of David Hoare Consulting cc was commissioned by Environmental Impact Management Services (Pty) Ltd to provide specialist consulting services for the Impact Assessment for the proposed construction of various components of infrastructure related to the the South Zambezi Projects water services infrastructure upgrade in the Giyani area of Limpopo Province. The services require impact assessments of various components of infrastructure, as well as input into site-specific EMPs.

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### **Summary of expertise**

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- Registered professional member of The South African Council for Natural Scientific Professions (Ecological Science, Botanical Science), registration number 400221/05.
- Founded David Hoare Consulting cc, an independent consultancy, in 2001.
- Ecological consultant since 1995, with working experience in Gauteng, Mpumalanga, Limpopo, North West, Eastern Cape, Western Cape, Northern Cape and Free State Provinces, Tanzania, Kenya, Mozambique and Swaziland.
- Conducted, or co-conducted, over 350 specialist ecological surveys as an ecological consultant. Areas of specialization include general ecology, biodiversity assessments, vegetation description and mapping, plant species surveys and remote sensing of vegetation. Has undertaken work in grassland, thicket, forest, savannah, fynbos, coastal vegetation, wetlands and nama-karoo vegetation, but has a specific specialization in grasslands and wetland vegetation.
- Published six technical scientific reports, 15 scientific conference presentations, seven book chapters and eight refereed scientific papers.
- Attended 15 national and international congresses & 5 expert workshops, lectured vegetation science / ecology at 2 universities and referee for 2 international journals.

## **Independence**

David Hoare Consulting cc and its Directors have no connection with the proponent. David Hoare Consulting cc is not a subsidiary, legally or financially, of the proponent. Remuneration for services by the proponent in relation to this project is not linked to approval by decision-making authorities responsible for authorising this proposed project and the consultancy has no interest in secondary or downstream developments as a result of the authorisation of this project. David Hoare is an independent consultant to the Environmental Assessment Practitioner and has no business, financial, personal or other interest in the activity, application or appeal in respect of which he was appointed other than fair remuneration for work performed in connection with the activity, application or appeal. There are no circumstances that compromise the objectivity of this specialist performing such work.

## **Conditions relating to this report**

The findings, results, observations, conclusions and recommendations given in this report are based on the author's best scientific and professional knowledge as well as available information. David Hoare Consulting cc and its staff reserve the right to modify aspects of the report including the recommendations if and when new information may become available from ongoing research or further work in this field, or pertaining to this investigation.

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## EXECUTIVE SUMMARY

David Hoare Consulting cc was appointed by Environmental Impact Management Services to undertake a general ecology assessment of the proposed infrastructure. This report provides details of the results of the Impact Assessment study, based on fieldwork, a desktop assessment of the study area and mapping from aerial imagery. The study area is located in Limpopo Province on the southern edge of Giyani.

The site is in a completely altered state due to disturbance associated with the existing WWTW.

The vegetation at this location has been designated in the provincial C-Plan as being mostly Critical Biodiversity 1 (CBA 1) with small parts falling within Ecological Support Area 2 (ESA2). There are therefore significant sensitivities at the site in terms of meeting regional conservation targets. There is therefore a conflict at a regional level between the C-Plan expectation of the site and the local patterns found to occur there. Given the transformed status of the vegetation on site, the surrounding vegetation in a natural state should be considered to be of high regional conservation value. The riparian habitat adjacent to the site has been mapped as having HIGH sensitivity and should be treated as a "No Go" area.

There are no listed or protected plant or animal species that are considered to be of concern for the site. The lack of natural habitat on site means there is little likelihood of any of them occurring on site.

A risk assessment was undertaken which identified three potential negative impacts due to construction or operation of the proposed infrastructure. The potential impacts are as follows:

1. Impacts on riparian vegetation during construction;
2. Introduction and/or spread of declared weeds and alien invasive plants in terrestrial habitats.

Potential impacts were assessed using a standardised methodology. The results of the assessment are provided in the table below.

<b>Impact</b>	<b>Pre-mitigation impact rating</b>	<b>Post-mitigation impact rating</b>
Impacts on riparian vegetation	-21.25 (high negative)	-3.50 (low negative)
Establishment and spread of declared alien plants	-11.25 (medium negative)	-3.00 (low negative)

Impacts were all low negative after mitigation. It is important to ensure that impacts on the riparian habitat is avoided. It has important regional significance in terms of maintaining ecological function in the landscape and preserving biodiversity patterns at a regional level.

Mitigation measures proposed include the following:

1. Treat the riparian zone as "No Go".
2. Compile a Surface Runoff and Stormwater Management Plan.
3. Compile a Rehabilitation Plan.
4. Compile an Alien Plant Management Plan.
5. Compile a Monitoring Programme and undertake regular monitoring during the construction and operation phases.

The main recommendations are to treat the riparian zone as a No Go area and to compile an alien management plan to control possible invasion by alien plant species.

The report concludes that the project is unlikely to have highly significant impacts on the ecological receiving environment, except for potential impacts on riparian areas. The main issues related to this project are the potential damage to riparian habitat in adjacent areas. Avoidance of impacts on riparian vegetation is very possible by treating it as a "No Go" area.

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## **INTRODUCTION**

This document presents the results of the Impact Assessment process applied to the ecological receiving environment of the proposed Giyani WWTW to the south of Giyani in Limpopo Province.

Environmental Impact Management Services (Pty) Ltd was appointed by South Zambezi Projects to undertake an application for environmental authorisation through a Basic Assessment (BA) for the proposed construction of the Giyani WWTW. The purpose of the assessment is to identify environmental impacts associated with the project. On 9 November 2015 David Hoare Consulting cc was appointed by Environmental Impact Management Services (Pty) Ltd to undertake a general ecology assessment of the study area.

### **Terms of reference and approach**

The specific Terms of Reference for the Ecology impact assessment were the following:

- Ecological Impact Assessment (including sensitivity mapping, identification of applicable legislative requirements; species lists; identification, assessment (according to EIMS methodology) and mitigation of impacts.
- Specific Note: It is necessary for the specialist to confirm whether the footprints of the proposed project fall within the definition of 'indigenous vegetation' as defined in the NEMA EIA Regulations.
- All specialist reports must comply with the requirements of Appendix 6 of the EIA regulations (GNR 982).
- Management and mitigation measures identified must take cognizance and comply, where applicable, with the requirements of Appendix 4 of the EIA Regulations (GNR 982) (Content of EMPr).
- Services provided must comply with relevant national and provincial guidelines, requirements and policies.

Appendix 4 and 6 of GNR 982 are included as an Appendix to this report (Appendix 6). This report provides details of the results of the Basic assessment. The findings of the study are based on a desktop assessment of the study area, mapping from aerial imagery and other sources and a field assessment of the study area.

## **BACKGROUND INFORMATION USED AND DETAILS OF SITE VISITS UNDERTAKEN**

This section provides an outline of the background information that was used to make the assessment of potential impacts on the ecological receiving environment as well as information on site visits undertaken.

### **Background information**

#### ***Infrastructure layout plan***

An infrastructure layout plan was provided that showed the proposed location of the infrastructure. This could be overlaid on aerial imagery in Google Earth to show the spatial relationship of proposed infrastructure and landscape features. This provided a spatial indication of the location of potential impacts on the biodiversity receiving environment.

#### ***Electronic databases***

There are various electronic databases containing up-to-date on the threatened status and known distribution of plants and animals within the borders of South Africa (for example: <http://redlist.sanbi.org/> (species national threatened status), <http://www.iucnredlist.org> (species global threatened status), <http://posa.sanbi.org> (plant species distribution), <http://sibis.sanbi.org/> (species distribution), <http://vmus.adu.org.za> (species distribution)).

#### ***Published field guides***

There are various published field guides providing habitat, distribution and identification information on various groups of plants and animals (for example: Friedmann & Daly 2004, Mills & Hes 1997, Monadjem et al. 2010 (mammals), Du Preez & Carruthers 2009 (amphibians), Alexander & Marais 2007, Branch 1988, Marais 2004, Tolley & Burger 2007 (reptiles), Chittenden 2007, Barnes 2000 (birds)).

#### ***National and Provincial legislation***

Various National and Provincial legislation provide lists of protected plant and animal species, including the following:

1. GNR 151: Critically Endangered, Endangered, Vulnerable and Protected Species List, published under Section 56(1) of the National Environmental Management: Biodiversity Act (Act No. 10 of 2004).
2. GNR 1187: Amendment of Critically Endangered, Endangered, Vulnerable and Protected Species List, published under Section 56(1) of the National Environmental Management: Biodiversity Act (Act No. 10 of 2004).
3. National Forests Act (Act no 84 of 1998).
4. Government Notice No. 1002 of 2011: National List of Ecosystems that are Threatened and in need of protection, published under Section 52(1)(a) of the National Environmental Management: Biodiversity Act (Act No. 10 of 2004)

### **Site visits undertaken**

A single site visit was undertaken on 24 November 2015. The purpose of the site visit was to gain familiarity with the site selected for proposed infrastructure as well as general familiarity with the broad study area. The location of the proposed infrastructure was visited and traversed on foot. Notes and photographs were taken at this site. Surrounding parts of the study area were traversed by vehicle.

## METHODOLOGY

The assessment was undertaken in a single phase that included field and desktop assessments and an assessment of potential impacts based on the information collected.

### Assessment philosophy

Many parts of South Africa contain high levels of biodiversity at species and ecosystem level. At any single site there may be large numbers of species or high ecological complexity. Sites also vary in their natural character and uniqueness and the level to which they have been previously disturbed. Assessing the potential impacts of a proposed development often requires evaluating the conservation value of a site relative to other natural areas and relative to the national importance of the site in terms of biodiversity conservation. A simple approach to evaluating the relative importance of a site includes assessing the following:

- Is the site unique in terms of natural or biodiversity features?
- Is the protection of biodiversity features on the site of national/provincial importance?
- Would development of the site lead to contravention of any international, national or provincial legislation, policy, convention or regulation?

Thus, the general approach adopted for this type of study is to identify any critical biodiversity issues that may lead to the decision that the proposed project cannot take place, i.e. to specifically focus on red flags and/or potential fatal flaws. Biodiversity issues are assessed by documenting whether any important biodiversity features occur on site, including species, ecosystems or processes that maintain ecosystems and/or species. These can be organised in a hierarchical fashion, as follows:

#### Species

1. threatened plant species
2. protected trees
3. threatened animal species

#### Ecosystems

1. threatened ecosystems
2. protected ecosystems
3. critical biodiversity areas
4. areas of high biodiversity
5. centres of endemism

#### Processes

1. corridors
2. mega-conservancy networks
3. rivers and wetlands
4. important topographical features

It is not the intention to provide comprehensive lists of all species that occur on site, since most of the species on these lists are usually common or widespread species. Rare, threatened, protected and conservation-worthy species and habitats are considered to be the highest priority, the presence of which would most likely to result in significant negative impacts on the ecological environment. The focus on national and provincial priorities and

critical biodiversity issues is in line with National legislation protecting environmental and biodiversity resources, including, but not limited to the following which ensure protection of ecological processes, natural systems and natural beauty as well as the preservation of biotic diversity in the natural environment:

1. Environment Conservation Act (Act 73 of 1989)
2. National Environmental Management Act, 1998 (NEMA) (Act 107 of 1998)
3. National Environmental Management Biodiversity Act, 2004. (Act 10 Of 2004)

### **Species of conservation concern**

There are two types of species of concern for the site under investigation, (i) those listed by conservation authorities as being on a Red List and are therefore considered to be at risk of extinction, and (ii) those listed as protected according to National and/or Provincial legislation.

#### ***Red List plant species***

Determining the conservation status of a species is required in order to identify those species that are at greatest risk of extinction and, therefore, in most need of conservation action. South Africa has adopted the IUCN Red List Categories and Criteria to provide an objective, rigorous, scientifically founded system to identify Red List species. A published list of the Red List species of South African plants (Raimondo et al. 2009) contains a list of all species that are considered to be at risk of extinction. This list is updated regularly to take new information into account, but these are not published in book/paper format. Updated assessments are provided on the SANBI website (<http://redlist.sanbi.org/>). According to the website of the Red List of Southern African Plants (<http://redlist.sanbi.org/>), *the conservation status of plants indicated on the Red List of South African Plants Online represents the status of the species within South Africa's borders. This means that when a species is not endemic to South Africa, only the portion of the species population occurring within South Africa has been assessed. The global conservation status, which is a result of the assessment of the entire global range of a species, can be found on the International Union for the Conservation of Nature (IUCN) Red List of Threatened Species: <http://www.iucnredlist.org>.* The South African assessment is used in this study.

The purpose of listing Red List species is to provide information on the potential occurrence of species at risk of extinction in the study area that may be affected by the proposed infrastructure. Species appearing on these lists can then be assessed in terms of their habitat requirements in order to determine whether any of them have a likelihood of occurring in habitats that may be affected by the proposed infrastructure.

Lists were compiled specifically for any species at risk of extinction (Red List species) previously recorded in the area. Historical occurrences of threatened plant species were obtained from the South African National Biodiversity Institute (<http://posa.sanbi.org>) for the quarter degree square/s within which the study area is situated. Habitat information for each species was obtained from various published sources. The probability of finding any of these species was then assessed by comparing the habitat requirements with those habitats that were found, during the field survey of the site, to occur there.

#### ***Protected trees***

Regulations published for the National Forests Act (Act 84 of 1998) as amended, provide a list of protected tree species for South Africa. The species on this list were assessed in order to determine which protected tree species have a geographical distribution that coincides with the study area and habitat requirements that may be met by available habitat in the study

area. The distribution of species on this list were obtained from published sources (e.g. van Wyk & van Wyk 1997) and from the SANBI Biodiversity Information System website (<http://sibis.sanbi.org/>) for quarter degree grids in which species have been previously recorded. Species that have been recorded anywhere in proximity to the site (within 100 km), or where it is considered possible that they could occur there, were listed and were considered as being at risk of occurring there. The site was searched for these species during the field survey and any individuals or concentrations noted.

### **Other protected species**

National legislation was evaluated in order to provide lists of any plant or animal species that have protected status. The most important legislation is the following:

- *National Environmental Management: Biodiversity Act (Act No 10 of 2004)*

This legislation contains lists of species that are protected. These lists were scanned in order to identify any species that have a geographical range that includes the study area and habitat requirements that are met by those found on site. These species were searched for within suitable habitats on site or, where relevant, it was stated that it was considered possible that they could occur on site.

There is additional legislation that provides lists of protected species, but the legislation to which these are attached deal primarily with harvesting or trade in listed species and do not specifically address transformational threats to habitat or individuals. This includes the following legislation:

- *CITES: Convention on the Trade in Endangered Species of Wild Fauna and Flora.*

### **Red List animal species**

To assess impacts on biodiversity a complete inventory of species occurring on site is usually required. However, it can take long periods of time to determine the presence of faunal species on site using various faunal survey methods, after which it is usually only the most common species that are detected.

It might seem self-evident that a more or less complete species list is vital for the assessment of impacts of a proposed development, as surely the species to be impacted need to be known. However, through the use of species accumulation curves, Thompson et al. (2007) have shown that massive levels of trapping are required to record >80% of the predicted vertebrate faunal assemblage. To a large extent the species to be impacted can be predicted from a literature and habitat review, and as long as errors of inclusion rather than exclusion are made, the species to be impacted will be known. A consequence of conducting an inventory survey is that a great deal of effort is put into work such as establishing and checking traplines that catch mostly common species, whose presence can be readily predicted. This effort can prevent the assessor from doing other, arguably more useful, work. For example, the zoologists' time might be better spent focussing on species of particular conservation significance, investigating rare habitats or developing an understanding of ecological processes. Due to the limitations of field-based inventory surveys, it has been recommended that the following approach be taken:

- Desktop review to identify issues that might arise with respect to a proposal (significant species, rare habitats and processes).
- Site inspection to familiarise the consultant with the site, the scale of the proposal and to determine the appropriate field programme.
- An impact assessment field programme that might involve targeted sampling for significant species, sampling of species sensitive to ecological processes, sampling in rare or significant habitats and sampling to investigate patterns of biodiversity.

- If necessary, undertake a monitoring programme that targets selected significant species (or those that might be considered suitable as bio-indicators).

Lists of threatened animal species that have a geographical range that includes the study area were obtained from literature sources (for example, Alexander & Marais 2007, Branch 1988, 2001, du Preez & Carruthers 2009, Friedmann & Daly 2004, Mills & Hes 1997, Monadjem et al. 2010). The likelihood of any of them occurring was evaluated on the basis of habitat preference and habitats available at each of the proposed sites. The three parameters used to assess the probability of occurrence for each species were as follows:

- *Habitat requirements*: most Red Data animals have very specific habitat requirements and the presence of these habitat characteristics within the study area were assessed;
- *Habitat status*: in the event that available habitat is considered suitable for these species, the status or ecological condition was assessed. Often, a high level of degradation of a specific habitat type will negate the potential presence of Red Data species (especially wetland-related habitats where water-quality plays a major role); and
- *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 these surrounding habitats and adequacy of these linkages are assessed for the ecological functioning Red Data species within the study area.

### **Species probability of occurrence**

Some species of plants may be cryptic, difficult to find, rare, ephemeral or generally not easy to spot while undertaking a survey of a large area. An assessment of the possibility of these species occurring there was therefore provided. For all threatened or protected flora that occur in the general geographical area of the site, a rating of the likelihood of it occurring on site is given as follows:

- LOW: no suitable habitats occur on site / habitats on site do not match habitat description for species;
- MEDIUM: habitats on site match general habitat description for species (e.g. karoo shrubland), but detailed microhabitat requirements (e.g. mountain shrubland on shallow soils overlying sandstone) are absent on the site or are unknown from the descriptions given in the literature or from the authorities;
- HIGH: habitats found on site match very strongly the general and microhabitat description for the species (e.g. mountain shrubland on shallow soils overlying sandstone);
- DEFINITE: species found in habitats on site.

### **Habitat sensitivity**

The purpose of producing a habitat sensitivity map is to provide information on the location of potentially sensitive features in the study area. This was compiled by taking the following into consideration:

1. The general status of the vegetation of the study area was derived by compiling a landcover data layer for the study area (*sensu* Fairbanks et al. 2000) using available satellite imagery and aerial photography. From this it can be seen which areas are transformed versus those that are still in a natural status.
2. Various provincial, regional or national level conservation planning studies have been undertaken in the area, e.g. the National Spatial Biodiversity Assessment (NSBA). The

mapped results from these were taken into consideration in compiling the habitat sensitivity map.

3. Habitats in which various species of plants or animals occur that may be protected or are considered to have high conservation status are considered to be sensitive.

An explanation of the different sensitivity classes is given in Table 1. Areas containing untransformed natural vegetation of conservation concern, high diversity or habitat complexity, Red List organisms or systems vital to sustaining ecological functions are considered potentially sensitive. In contrast, any transformed area that has no importance for the functioning of ecosystems is considered to potentially have low sensitivity.

**Table 1: Explanation of sensitivity ratings.**

Sensitivity	Factors contributing to sensitivity	Example of qualifying features
VERY HIGH	<p>Indigenous natural areas that are highly positive for <u>any</u> of the following:</p> <ul style="list-style-type: none"> <li>• presence of threatened species (Critically Endangered, Endangered, Vulnerable) and/or habitat critical for the survival of populations of threatened species.</li> <li>• <u>High</u> conservation status (low proportion remaining intact, highly fragmented, habitat for species that are at risk).</li> <li>• <u>Protected</u> habitats (areas protected according to national / provincial legislation, e.g. National Forests Act, Draft Ecosystem List of NEM:BA, Integrated Coastal Zone Management Act, Mountain Catchment Areas Act, Lake Areas Development Act)</li> </ul> <p>And may also be positive for the following:</p> <ul style="list-style-type: none"> <li>• <u>High</u> intrinsic biodiversity value (<u>high</u> species richness and/or turnover, unique ecosystems)</li> <li>• <u>High</u> value ecological goods &amp; services (e.g. water supply, erosion control, soil formation, carbon storage, pollination, refugia, food production, raw materials, genetic resources, cultural value)</li> <li>• <u>Low</u> ability to respond to disturbance (low resilience, dominant species very old).</li> </ul>	<ul style="list-style-type: none"> <li>• CBA 1 areas.</li> <li>• Remaining areas of vegetation type listed in Draft Ecosystem List of NEM:BA as Critically Endangered, Endangered or Vulnerable.</li> <li>• Protected forest patches.</li> <li>• Confirmed presence of populations of threatened species.</li> </ul>
HIGH	<p>Indigenous natural areas that are positive for any of the following:</p> <ul style="list-style-type: none"> <li>• <u>High</u> intrinsic biodiversity value (<u>moderate/high</u> species richness and/or turnover).</li> <li>• presence of habitat highly suitable for threatened species (Critically Endangered, Endangered, Vulnerable species).</li> <li>• <u>Moderate</u> ability to respond to disturbance (<u>moderate</u> resilience, dominant species of intermediate age).</li> <li>• <u>Moderate</u> conservation status (moderate proportion remaining intact, moderately fragmented, habitat for species that are at risk).</li> </ul>	<ul style="list-style-type: none"> <li>• CBA 2 "critical biodiversity areas".</li> <li>• Habitat where a threatened species could potentially occur (habitat is suitable, but no confirmed records).</li> <li>• Confirmed habitat for species of lower threat status (near threatened, rare).</li> <li>• Habitat containing individuals of extreme age.</li> </ul>

Sensitivity	Factors contributing to sensitivity	Example of qualifying features
	<ul style="list-style-type: none"> <li>• <u>Moderate to high</u> value ecological goods &amp; services (e.g. water supply, erosion control, soil formation, carbon storage, pollination, refugia, food production, raw materials, genetic resources, cultural value).</li> </ul> <p>And may also be positive for the following:</p> <ul style="list-style-type: none"> <li>• <u>Protected</u> habitats (areas protected according to national / provincial legislation, e.g. National Forests Act, Draft Ecosystem List of NEM:BA, Integrated Coastal Zone Management Act, Mountain Catchment Areas Act, Lake Areas Development Act)</li> </ul>	<ul style="list-style-type: none"> <li>• Habitat with low ability to recover from disturbance.</li> <li>• Habitat with exceptionally high diversity (richness or turnover).</li> <li>• Habitat with unique species composition and narrow distribution.</li> <li>• Ecosystem providing high value ecosystem goods and services.</li> </ul>
MEDIUM-HIGH	Indigenous natural areas that are positive for <u>one</u> or <u>two</u> of the factors listed above, but not a combination of factors.	<ul style="list-style-type: none"> <li>• CBA 2 "corridor areas".</li> <li>• Habitat with high diversity (richness or turnover).</li> <li>• Habitat where a species of lower threat status (e.g. (near threatened, rare) could potentially occur (habitat is suitable, but no confirmed records).</li> </ul>
MEDIUM	Other indigenous natural areas in which factors listed above are of no particular concern. May also include natural buffers around ecologically sensitive areas and natural links or corridors in which natural habitat is still ecologically functional.	
MEDIUM-LOW	Degraded or disturbed indigenous natural vegetation.	
LOW	No natural habitat remaining.	

Any natural vegetation within which there are features of conservation concern will be classified into one of the high sensitivity classes (MEDIUM-HIGH, HIGH or VERY HIGH. The difference between these three high classes is based on a combination of factors and can be summarised as follows:

1. Areas classified into the VERY HIGH class are vital for the survival of species or ecosystems. They are either known sites for threatened species or are ecosystems that have been identified as being remaining areas of vegetation of critical conservation importance. CBA1 areas would qualify for inclusion into this class.
2. Areas classified into the HIGH class are of high biodiversity value, but do not necessarily contain features that would put them into the VERY HIGH class. For example, a site that is known to contain a population of a threatened species would be in the VERY HIGH class, but a site where a threatened species could potentially occur (habitat is suitable), but it is not known whether it does occur there or not, is classified into the HIGH sensitivity class. The class also includes any areas that are not



specifically identified as having high conservation status, but have high local species richness, unique species composition, low resilience or provide very important ecosystem goods and services. CBA2 “irreplaceable biodiversity areas” would qualify for inclusion into this class, if there were no other factors that would put them into the highest class.

3. Areas classified into the MEDIUM-HIGH sensitivity class are natural vegetation in which there are one or two features that make them of biodiversity value, but not to the extent that they would be classified into one of the other two higher categories. CBA2 “corridor areas” would qualify for inclusion into this class.

### Assessment of impacts

The impact assessment methodology is guided by the requirements of the NEMA EIA Regulations (2010). The broad approach to the significance rating methodology is to determine the environmental risk (ER) by considering the consequence (C) of each impact (comprising Nature, Extent, Duration, Magnitude, and Reversibility) and relate this to the probability/likelihood (P) of the impact occurring. This determines the environmental risk. In addition other factors, including cumulative impacts, public concern, and potential for irreplaceable loss of resources, are used to determine a prioritisation factor (PF) which is applied to the ER to determine the overall significance (S).

#### **Determination of Environmental Risk:**

The significance (S) of an impact is determined by applying a prioritisation factor (PF) to the environmental risk (ER).

The environmental risk is dependent on the consequence (C) of the particular impact and the probability (P) of the impact occurring. Consequence is determined through the consideration of the Nature (N), Extent (E), Duration (D), Magnitude (M), and reversibility (R) applicable to the specific impact.

For the purpose of this methodology the consequence of the impact is represented by:

$$C = \frac{(E+D+M+R)}{4} \times N$$

Each individual aspect in the determination of the consequence is represented by a rating scale as defined in Table 2.

**Table 2: Criteria for Determining Impact Consequence**

Aspect	Score	Definition
Nature	-1	Likely to result in a negative / detrimental impact
	+1	Likely to result in a positive / beneficial impact
Extent	1	Activity (i.e. limited to the area applicable to the specific activity)
	2	Site (i.e. within the development property boundary)
	3	Local (i.e. the area within 5 km of the site)
	4	Regional (i.e. extends between 5 and 50 km from the site)
	5	Provincial / National (i.e. extends beyond 50 km from the site)
Duration	1	Immediate (<1 year)
	2	Short term (1-5 years),
	3	Medium term (6-15 years),
	4	Long term (the impact will cease after the operational life span of the project),
	5	Permanent (no mitigation measure of natural process will reduce the impact after construction).
Magnitude / intensity	1	Minor (where the impact affects the environment in such a way that natural, cultural and social functions and processes are not affected),

	2	Low (where the impact affects the environment in such a way that natural, cultural and social functions and processes are slightly affected),
	3	Moderate (where the affected environment is altered but natural, cultural and social functions and processes continue albeit in a modified way),
	4	High (where natural, cultural or social functions or processes are altered to the extent that it will temporarily cease), or
	5	Very high / don't know (where natural, cultural or social functions or processes are altered to the extent that it will permanently cease).
Reversibility	1	Impact is reversible without any time and cost.
	2	Impact is reversible without incurring significant time and cost.
	3	Impact is reversible only by incurring significant time and cost.
	4	Impact is reversible only by incurring prohibitively high time and cost.
	5	Irreversible Impact

Once the C has been determined the ER is determined in accordance with the standard risk assessment relationship by multiplying the C and the P. Probability is rated/scored as per Table 3.

**Table 3: Probability scoring**

<b>Probability</b>	1	Improbable (the possibility of the impact materialising is very low as a result of design, historic experience, or implementation of adequate corrective actions; <25%),
	2	Low probability (there is a possibility that the impact will occur; >25% and <50%),
	3	Medium probability (the impact may occur; >50% and <75%),
	4	High probability (it is most likely that the impact will occur- > 75% probability), or
	5	Definite (the impact will occur),

The result is a qualitative representation of relative ER associated with the impact. ER is therefore calculated as follows:

$$ER = C \times P$$

**Table 4: Determination of Environmental Risk**

<b>Consequence</b>	5	5	10	15	20	25
	4	4	8	12	16	20
	3	3	6	9	12	15
	2	2	4	6	8	10
	1	1	2	3	4	5
		1	2	3	4	5
<b>Probability</b>						

The outcome of the environmental risk assessment will result in a range of scores, ranging from 1 through to 25. These ER scores are then grouped into respective classes as described in Table 5.

**Table 5: Significance classes.**

<b>Environmental Risk Score</b>	
<b>Value</b>	<b>Description</b>

<9	Low (i.e. where this impact is unlikely to be a significant environmental risk),
≥9-<17	Medium (i.e. where the impact could have a significant environmental risk),
≥17	High (i.e. where the impact will have a significant environmental risk).

The impact ER will be determined for each impact without relevant management and mitigation measures (pre-mitigation), as well as post implementation of relevant management and mitigation measures (post-mitigation). This allows for a prediction in the degree to which the impact can be managed/mitigated.

### Impact prioritization

In accordance with the requirements of Regulation 31 (2)(l) of the EIA Regulations (GNR 543), and further to the assessment criteria presented in the Section above it is necessary to assess each potentially significant impact in terms of:

- Cumulative impacts; and
- The degree to which the impact may cause irreplaceable loss of resources.

In addition, it is important that the public opinion and sentiment regarding a prospective development and consequent potential impacts is considered in the decision making process.

In an effort to ensure that these factors are considered, an impact prioritisation factor (PF) will be applied to each impact ER (post-mitigation). This prioritisation factor does not aim to detract from the risk ratings but rather to focus the attention of the decision-making authority on the higher priority/significance issues and impacts. The PF will be applied to the ER score based on the assumption that relevant suggested management/mitigation impacts are implemented.

**Table 6: Criteria for determining prioritization.**

Public response (PR)	Low (1)	Issue not raised in public response
	Medium (2)	Issue has received a meaningful and justifiable public response
	High (3)	Issue has received an intense meaningful and justifiable public response
Cumulative Impact (CI)	Low (1)	Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is unlikely that the impact will result in spatial and temporal cumulative change.
	Medium (2)	Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is probable that the impact will result in spatial and temporal cumulative change.
	High (3)	Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is highly probable/definite that the impact will result in spatial and temporal cumulative change.
Irreplaceable loss of resources (LR)	Low (1)	Where the impact is unlikely to result in irreplaceable loss of resources.
	Medium (2)	Where the impact may result in the irreplaceable loss (cannot be replaced or substituted) of resources but the value (services and/or functions) of these resources is limited.
	High (3)	Where the impact may result in the irreplaceable loss of resources of high value (services and/or functions).

The value for the final impact priority is represented as a single consolidated priority, determined as the sum of each individual criterion represented in Table 5. The impact priority is therefore determined as follows:

$$\text{Priority} = \text{PR} + \text{CI} + \text{LR}$$

The result is a priority score which ranges from 3 to 9 and a consequent PF ranging from 1 to 2 (Refer to Table 7).

**Table 7: Determination of Prioritization Factor.**

Priority	Ranking	Prioritization Factor (PF)
3	Low	1.00
4	Medium	1.17
5	Medium	1.33
6	Medium	1.50
7	Medium	1.67
8	Medium	1.83
9	High	2.00

In order to determine the final impact significance, the PF is multiplied by the ER of the post mitigation scoring. The ultimate aim of the PF is to be able to increase the post mitigation environmental risk rating by a full ranking class, if all the priority attributes are high (i.e. if an impact comes out with a medium environmental risk after the conventional impact rating, but there is significant cumulative impact potential, significant public response, and significant potential for irreplaceable loss of resources, then the net result would be to upscale the impact to a high significance).

**Table 8: Final Environmental Significance**

Environmental Significance Rating	
Value	Description
< 10	Low (i.e. where this impact would not have a direct influence on the decision to develop in the area),
≥ 10 < 20	Medium (i.e. where the impact could influence the decision to develop in the area),
≥ 20	High (i.e. where the impact must have an influence on the decision process to develop in the area).

## PROPOSED INFRASTRUCTURE

### Project location

The study area is within Limpopo Province directly south of Giyani at the site of the existing WWTW. This is in the north-eastern part of Limpopo Province close to the boundary with the Kruger National Park. The site is on the flats close to the river south of Giyani (Figure 1). There is existing infrastructure at the site and the proposal is to upgrade this existing infrastructure.

### Project layout alternatives

No alternative locations for the infrastructure have been proposed. The proposed upgrade will happen at the site of the existing infrastructure and will incorporate components of the existing system (Figure 2).



**Figure 1: Location of proposed infrastructure.**



**Figure 2: Location for the proposed infrastructure.**

## DESCRIPTION OF STUDY AREA

The field survey was undertaken during the height of the growing season, which is ideal for assessing the general characteristics and condition of the study area. However, the season has been particularly dry this year and the vegetation had already been impacted by this factor. This was not, however, considered to be a serious limitation. The assessment was also undertaken during a single season, which means that no seasonal variation in species composition was included. This means that observational checklists are unlikely to be comprehensive. This is also not a serious limitation, since species lists from the desktop assessment fill in the gaps and habitat observations provide an assessment of what habitat is available and therefore which additional species are likely to occur on site.

### Site conditions

The study site is situated in a flat area adjacent to the river at the location of the existing WWTW. The elevation on site varies from 450 to 455 m above sea level. This is a 5 m change in elevation over a distance of over 400 m.

Landtype data was used to provide a general description of soils in the study area (landtypes are areas with largely uniform soils, topography and climate). The landtypes described below provide a generalized description of soils on site that may differ in detail from site-specific



**Figure 3: Typical view of vegetation on site.**

patterns, but not in overall trends. There is one land type in the study area that is affected by the proposed infrastructure. This is the Ae landtype (Land Type Survey Staff, 1987).

The A-group of land types refers to red-yellow, freely drained soils (MacVicar et al. 1974). The Ae landtype consists of land types with red, high base status, greater than 300 mm deep, with no dunes (MacVicar et al. 1974).

The general climate in the study area is hot, moist summers and moderate to cool, dry winters. Rainfall occurs primarily from December to March. Mean annual rainfall is 720 mm per year. All areas with less than 400 mm rainfall are considered to be arid and areas with more than 600 mm as moist. The study area can therefore be considered to be moist. Winter frost is rare. Summers have high temperatures.

### **Landuse and landcover of the study area**

The site is in a completely altered state due to disturbance associated with the existing WWTW (see Figure 4). The construction of the existing WWTW has resulted in the complete loss of natural vegetation within the footprint of the proposed upgrades. Currently the site consists of WWTW infrastructure, in addition to roads, buildings and gardens associated with the site. There are some areas of secondary lawn, weed patches and exotic trees, but no natural vegetation remaining.

### **Broad vegetation patterns**



**Figure 4: Existing infrastructure on site.**



The vegetation of the study area indicates that there is one regional vegetation type historically occurring in the study area. This is Granite Lowveld. No other vegetation types occur anywhere near to the site. This vegetation type is briefly described below. Note that the description below applies to the vegetation type over its entire range, not just within the study area.

**Granite Lowveld**

This vegetation type occurs in the Limpopo and Mpumalanga Provinces and Swaziland and marginally into KwaZulu-Natal. It is a tall shrubland with few trees to moderately dense low woodland on the deep sandy uplands with *Terminalia sericea*, *Combretum zeyheri* and *Combretum apiculatum* and ground layer including *Pogonarthria squarrosa*, *Tricholaena monachme* and *Eragrostis rigidior*. Dense thicket to open savanna in the bottomlands with *Acacia nigrescens*, *Dichrostachys cinerea*, *Grewia bicolor* in the woody layer. The dense herbaceous layer contains the dominant *Digitaria erianthe*, *Panicum maximum* and *Aristida congesta* on fine-textured soils, while brackish bottomlands support *Sporobolus nitens*, *Urochloa mosambicensis* and *Chloris virgata*.

**Conservation status of broad vegetation types**

On the basis of a scientific approach used at national level by SANBI (Driver *et al.* 2005), vegetation types can be categorised according to their conservation status which is, in turn, assessed according to the degree of transformation relative to the expected extent of each vegetation type. The status of a habitat or vegetation type is based on how much of its original area still remains intact relative to various thresholds. The original extent of a vegetation type is as presented in the most recent national vegetation map (Mucina, Rutherford & Powrie 2005) and is the extent of the vegetation type in the absence of any historical human impact. On a national scale the thresholds are as depicted in Table 6, as determined by best available scientific approaches (Driver *et al.* 2005). The level at which an ecosystem becomes Critically Endangered differs from one ecosystem to another and varies from 16% to 36% (Driver *et al.* 2005).

**Table 6: Determining ecosystem status (Driver *et al.* 2005).** \*BT = biodiversity target (the minimum conservation requirement).

Habitat remainin g (%)	80-100	least threatened	LT
	60-80	vulnerable	VU
	*BT-60	endangered	EN
	0-*BT	critically endangered	CR

**Table 7: Conservation status of different vegetation types occurring in the study area, according to Driver *et al.* 2005 and Mucina *et al.* 2005.**

Vegetation Type	Target (%)	Conserved (%)	Transformed (%)	Conservation status	
				Driver <i>et al.</i> 2005; Mucina <i>et al.</i> , 2006	National Ecosystem List (NEM:BA)
Granite Lowveld	19	35	21	Vulnerable	Not listed

According to scientific literature (Driver *et al.* 2005; Mucina *et al.*, 2006), as shown in Table 7,

the vegetation type is listed as Vulnerable.

The National List of Ecosystems that are Threatened and need of protection (GN1002 of 2011), published under the National Environmental Management: Biodiversity Act (Act No. 10, 2004), lists national vegetation types that are afforded protection on the basis of rates of transformation. The thresholds for listing in this legislation are higher than in the scientific literature, which means there are fewer ecosystems listed in the National Ecosystem List versus in the scientific literature.

The vegetation type is not listed in the National List of Ecosystems that are Threatened and need of protection (GN1002 of 2011).

The Limpopo Conservation Plan version 2 (Desmet et al. 2013) provides a map of Critical Biodiversity Areas for the Province and associated land-use guidelines. The CBA categories are as follows:

- Protected Area (PA);
- Critical Biodiversity Area 1 (CBA1);
- Critical Biodiversity Area 2 (CBA2);
- Ecological Support Area 1 (ESA1);
- Ecological Support Area 2 (ESA2);
- Other Natural (ON);
- No Natural Remaining.

The C-Plan shows that most of the site is designated as a CBA 1 area with small parts falling within ESA2. This indicates that, despite transformation of natural habitat on site, most of the



**Figure 5: Limpopo Conservation Plan version 2 units in and near the site.**

site is within the second-highest Provincial conservation category and is therefore considered to have high conservation value.

### **Protected areas**

According to the Provincial C-Plan, none of the site falls within a protected area.

### **Red List plant species of the study area**

Lists of plant species previously recorded in the quarter degree grids in which the study area is situated were obtained from the South African National Biodiversity Institute. These are listed in Appendix 1. Additional species that could occur in similar habitats, as determined from database searches and literature sources, but have not been recorded in these grids are also listed.

The species on this list were evaluated to determine the likelihood of any of them occurring on site on the basis of habitat suitability. Of the species that are considered to occur within the geographical area under consideration, there are two Declining plant species that could occur in habitats that are available in the study area (see Appendix 1). These species are *Ansellia africana* and *Crinum bulbispermum*.

*Crinum bulbispermum* is a geophyte that occurs near rivers and streams, in seasonal pans and in damp depressions. Although the habitat is suitable for the species, no individuals of this species were found on site. It is therefore considered unlikely that it occurs there.

*Ansellia africana* is an epiphytic orchid that grows on *Hyphaene*, *Adansonia*, *Colophospermum*, *Ficus*, *Brachystegia*, *Parinari*, *Terminalia*, *Uapaca* and *Albizia* spp., also sometimes on rocks in shade, rarely in forest. It is found in hot dry mixed deciduous woodlands at medium to low altitudes, in riverine vegetation and miombo woodlands near rivers. The site is marginally suitable for the species, although none of these genera occur on site. The species is cryptic to some degree, but no individuals of this species were found on site during the field survey. It is therefore considered unlikely that it occurs there.

In conclusion, it is considered that there is a low probability of any plant species of conservation concern occurring on site. There is therefore a very low likelihood of any such plants being affected by the proposed project.

### **Protected plants (National Environmental Management: Biodiversity Act)**

Plant species protected under the National Environmental Management: Biodiversity Act, 2004 (Act 10 of 2004) are listed in Appendix 4. Three plant species that appear on this list that could potentially occur in the general region are *Warburgia salutaris*, *Merwillia plumbea* and *Encephalartos transvenosus*.

*Warburgia salutaris* (pepper-bark tree) is found in forest and savanna in variable habitats, including coastal, riverine, dune and montane forest as well as open woodland and thickets. It also occurs on dry rocky hillsides and in dry thickets. The habitats on site fall within this range of suitable habitats. Historical distribution data indicates that the species has not been previously recorded in the grid in which the site is located or any adjacent grid and the overall distribution appears to be slightly to the west and south of the current site. No individuals

were found on site, but it is unknown whether the species occurs in adjacent areas. Based on distribution data, it is considered unlikely for it to occur there.

*Merwillia plumbea* (blue squill) is a relatively large and long-lived geophytic bulb that is found in the montane mistbelt and Ngongoni grassland of the eastern half of South Africa. It is found on rocky areas on steep, well-drained slopes. This habitat description does not match that found at the current site and it is considered unlikely that this species would occur there. The overall known distribution of this species is just off to the west of the current site and it has not been previously recorded in the grid in which the site is located.

*Encephalartos transvenosus* (Modjadje Cycad) is a cycad species that is found in grassland and savanna. It's favoured habitat is tall grassveld and mixed bushveld, mainly on steep rocky slopes facing southeast in the mistbelt zone. A large population of this species occurs at Modjadji (over 15 000 individuals). The overall distribution of this species is to the west of the current site and it has not been previously recorded in the grid in which the site is located. The habitat requirements are also not met by those found on site and it is not considered likely that this species would be found on site.

In conclusion, there are no species protected under national legislation that are likely to occur or site or that were found on site.

### **Protected trees**

Tree species protected under the National Forest Act are listed in Appendix 2. There are a large number species that are known to have a geographical distribution that includes the grids in which the proposed infrastructure is to be located, namely *Adansonia digitata*, *Azelia quanzensis*, *Balanites maughamii*, *Boscia albitrunca*, *Breonadia salicina*, *Catha edulis*, *Combretum imberbe*, *Curtisia dentata*, *Elaedendron (Cassine) transvaalensis*, *Ocotea bullata*, *Philenoptera violacea (Lonchocarpus capassa)*, *Pittosporum viridiflorum*, *Podocarpus falcatus*, *Podocarpus latifolius*, *Prunus africana*, *Pterocarpus angolensis*, *Sclerocarya birrea* subsp. *caffra* and *Warburgia salutaris*.

*Adansonia digitata* (baobab) is found in low dry bushveld, often on alluvial soil along rivers and on flood plains. There are no individuals on site.

*Azelia quanzensis* (pod mahogany) is found in bushveld and woodland on sandy soils. There is no suitable habitat on site and no individuals were observed to occur within the area of interest.

*Balanites maughamii* is found in bushveld, sand forest and sandstone outcrops, often in small colonies. Suitable habitat does not occur within the area of interest and there were no individuals on site.

*Boscia albitrunca* occurs in semi-desert areas and bushveld, often on termitaria, but is common on sandy to loamy soils and calcrete soils. Suitable habitat does not occur within the area of interest.

*Breonadia salicina* is a typical constituent of low-altitude riverine forest in the eastern lowveld. Suitable habitat occurs within the area of interest, but no individuals were observed to occur there.

*Catha edulis* is found in submontane forest, on rocky hillsides and in riverine forest. Suitable habitat occurs within the area of interest, but no individuals were observed to occur there.

*Combretum imberbe* occurs in bushveld, often on alluvial soils along rivers or dry watercourses. Suitable habitat occurs within the area of interest, but no individuals were observed to occur there.

*Curtisia dentata* is found in Afromontane forest, usually within the mist-belt. No such habitat is found on site. No individuals were found on site or nearby.

*Elaeodendron transvaalensis* is found in bushveld and on wooded hillsides, often on termite mounds. Suitable habitat does not occur within the area of interest and no individuals were observed to occur there.

*Ocotea bullata* is found sporadically in mistbelt Afromontane forests along the escarpment. No such habitat is found on site. No individuals were found on site or nearby.

*Philenoptera violacea* (*Lonchocarpus capassa*) is found in bushveld at low to medium altitudes, usually on alluvial soils close to rivers. Suitable habitat does occur within the area of interest but no individuals were observed to occur on site.

*Pittosporum viridiflorum* is found in open bushveld, rocky outcrops, thickets, forest margins and forests. Suitable habitat occurs within the area of interest. No individuals were found on site or nearby.

*Afrocarpus* (*Podocarpus*) *falcatus* is found in Afromontane forest along the escarpment. No such habitat is found on site. The species does not occur there.

*Podocarpus latifolius* is found in Afromontane forest and bush clumps on rocky outcrops, always in the mist-belt zone. These habitat conditions do not occur on site. The species does not occur on site.

*Prunus africana* (African almond) is found in Afromontane forest. The site is not within such a zone. No individuals of this species occur on site.

*Pterocarpus angolensis* is found on well-drained soils in grassland and open bushveld. Suitable habitat does not occur within the area of interest. No individuals were found on site or nearby.

*Sclerocarya birrea* subsp. *caffra* is found in bushveld. Suitable habitat occurs within the area of interest. No individuals were found on site or nearby.

*Warburgia salutaris* is found on dry rocky hillsides and dry thickets, although it may also occur in wet forests elsewhere in its range. Suitable habitat does not occur within the area of interest and no individuals were found on site or nearby.

In summary, no protected tree species were found on site or are expected to occur there. Clearing of the site for construction of the reservoir will not lead to the loss of any individuals of any of these species.

### **Animal species of the study area**

A list of animal species with a geographical distribution that includes the study area is given in Appendix 3. All threatened (Critically Endangered, Endangered or Vulnerable) or near threatened vertebrate animals (mammals, reptiles, amphibians and birds) that could occur in

the study area are listed in Appendix 4. Those vertebrate species of conservation concern with a geographical distribution that includes the study area, and habitat preference that includes habitats available in the study area are discussed further.

### ***Mammals***

There is a high diversity of mammal species that have a geographical distribution that includes the study area (Appendix 3). This includes 24 antelope and related species, four of which are threatened or near threatened (Black Rhinoceros, Roan Antelope, Sable Antelope and Sharpe's Grysbok), 2 hyrax species, neither of which are listed, 28 carnivores, of which 8 (the Cheetah, Spotted Hyaena, Brown Hyaena, Serval, Spotted-necked Otter, African Wild Dog, Honey Badger and Lion) are listed, 38 bat species, of which 17 are listed in a threat category, 7 insectivores, none of which are listed, 3 lagomorphs, none of which are listed, 4 primates, none of which are listed, 27 rodents, one of which is listed (Water Rat), 3 elephant shrews, none of which are listed, Temminck's Ground Pangolin (listed as Vulnerable) and the aardvark, which is not listed.

Three of the four antelope and related species that are listed (Black Rhinoceros, Roan Antelope, Sable Antelope) only occur in protected areas. Sharpe's Grysbok occurs more widely, but is not known to occur in the nearby Man'ombe Nature Reserve (Limpopo DEDET 2013). None of these four species are therefore expected to occur on site.

Of the 8 listed carnivore species, only the Brown Hyaena, Serval and Honey Badger have any probability of occurring on site. These three are all highly mobile species that range across wide areas and would not be restricted to a single small site. No evidence of any of these three was found on site and it is therefore considered unlikely that they are resident on site and unlikely that they would be affected by upgrading of the WWTW at the site.

There are a number of bat species of potential conservation concern that have a geographical distribution that includes the study area. There are 17 species listed in the Red Data Book of the Mammals of South Africa (Friedmann & Daly 2004). Of these species, 11 are listed as Near Threatened in South Africa, but are now considered Least Concern (Monadjem et al. 2010 and IUCN Red List of Threatened Species). The remaining 6 species were originally listed in a higher conservation category nationally, but all are considered to be currently globally Least Concern. Currently, three species are listed as Near Threatened nationally (Wood's Slit-faced Bat, Peak-saddle Horseshoe Bat and Swinny's Horseshoe Bat) and one is listed as Vulnerable nationally (Percival's Short-eared Trident Bat). For all these species, the roosting requirements are not found on site, so the species could potentially forage across the site, but would not be resident.

The Water Rat is the only listed rodent species that has a geographical distribution that includes the site. It is restricted to wetland habitats, which do not occur in an unaltered state on site.

The Ground Pangolin has a geographical distribution that includes the site, but the site does not have habitats that are potentially suitable for the species. It is associated with ants or termites, of which no significant concentrations were seen on site, and it requires suitable burrows or above-ground debris within which to shelter, which was also not seen on site. It is therefore considered unlikely that the site is important for this species. Being a solitary species, it is also not likely that, if it did occur there, that there would be any more than a single individual.

In conclusion, there are no mammals that are listed in a threat category that are considered to have a moderate to high probability of potentially being resident on site or that would be significantly negatively affected by construction of a reservoir on site.

### **Reptiles**

There are 58 snake species with a geographical distribution that includes the study area, one of which is protected, but no longer listed (Southern African Python), 3 agamas, 1 chameleon species, 2 monitor lizards, 24 lizards, 8 gecko species, 1 crocodilian, listed as Vulnerable (Nile Crocodile) and 4 tortoise/terrapin species, none of which are listed in any threat category.

The Nile Crocodile has a geographical distribution that includes the site, but is only found in significant water bodies and will not occur on site. The nearby river is suitable habitat for the species.

The Southern African Python was previously listed in a threat category, but has been de-listed. It is, however, still protected according to national legislation. Habitat on site is marginally suitable for this species and it could potentially occur there, although favoured habitat components are missing. The small size of the site means that it is unlikely to be an important location for this species. Also, the species tends to avoid places where humans occur.

There are therefore no reptiles that are listed in a threat category that are considered to have a probability of potentially occurring on site.

### **Amphibians**

The potential amphibian diversity of the study area is moderate with 31 species that have a geographical distribution that includes the study area. There are no listed amphibian species that have a geographical distribution that includes the study area. There are therefore no amphibians that are listed in a threat category that are considered to have a probability of potentially occurring on site.

### **Birds**

Based on a desktop assessment, there are 417 bird species with a geographical distribution that includes the study area. A total of 43 of these bird species are listed in a threatened or near threatened category, of which 21 occur in riparian, wetland, pan, open water or marsh habitats or in rank grassland that does not occur on site. There are 9 species of vulture and eagles that, on the basis of foraging and roosting behaviour, may forage over the site, but would not nest or roost there. Finally, there are 3 species that are non-breeding migrants that would, therefore, not be dependent on the site for breeding, but may forage there only. The remaining species that could potentially be found on site are the following:

1. Bat Hawk,
2. Black-bellied Bustard,
3. Black-rumped Buttonquail,
4. Kori Bustard,
5. Lanner Falcon,
6. Red-billed Oxpecker,
7. Secretarybird
8. Southern Ground Hornbill,
9. Yellow-billed Oxpecker.

In all cases, the site does not constitute important habitat for any of these species and, due to the disturbed nature of the site and the close proximity of the town, it is considered unlikely that they would occur there. Development of the WWTW and associated infrastructure is unlikely to cause any significant loss of habitat for any of these species.

### **Protected animals**

There are a number of animal species protected according to the National Environmental Management: Biodiversity Act (Act No. 10 of 2004). According to this Act, *"a person may not carry out a restricted activity involving a specimen of a listed threatened or protected species without a permit issued in terms of Chapter 7"*. Such activities include any that are *"of a nature that may negatively impact on the survival of a listed threatened or protected species"*. This implies that any negative impacts on habitats in which populations of protected species occur or are dependent upon would be restricted according to this Act.

Those species protected according to the National Environmental Management: Biodiversity Act (Act No. 10 of 2004) that have a geographical distribution that includes the site are listed in Appendix 6, marked with the letter "N". As discussed in the previous section, many of these species are unlikely to be found on site due to an absence of suitable habitat or due to the close proximity of the site to a town. Those that have a possibility of occurring on site are the following species:

- Brown Hyaena,
- Serval,
- Honey Badger.

All of these species are mobile animals that are likely to move away in the event of any activities on site disturbing them. They are therefore unlikely to be affected by the proposed development of the WWTW and associated infrastructure.

### **Important Bird Areas**

The study area is not within an Important Bird Area, but there is an Important Bird Areas 20 km to the east of the site (the Kruger National Park IBA). This reserve is important for a wide variety of species and houses almost 500 species of birds. The reserve has a high diversity of habitats and therefore has a wide cross-section of different types of birds, including high numbers of species that probably only survive in South Africa because of the conservation of that area.



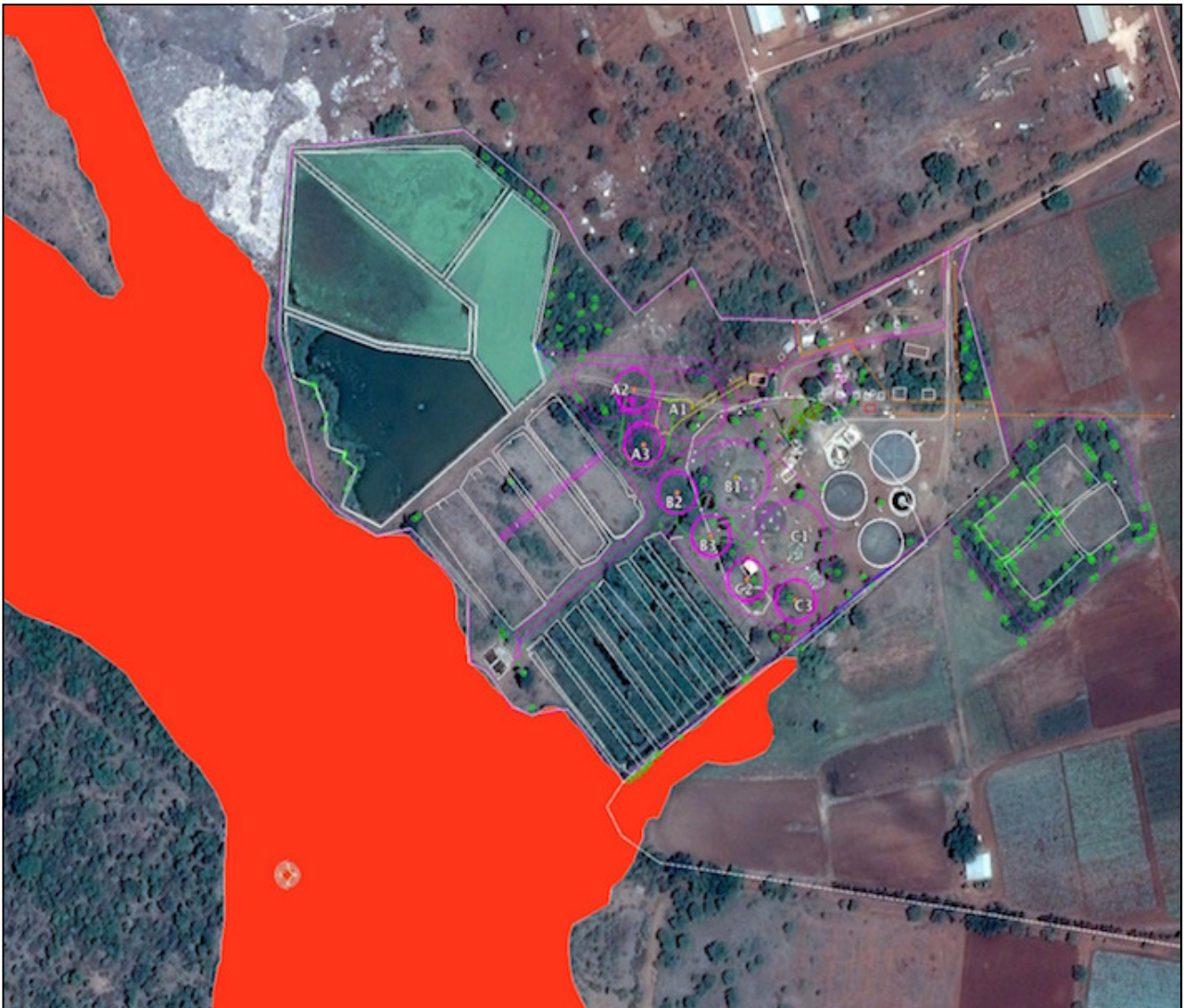
## SITE SENSITIVITIES

### Habitat sensitivity on site

Important habitats to be treated as sensitive include the following:

- Riparian habitat adjacent to the site. They are mapped as CBA1 in the C-Plan for the Province. These are mapped as having HIGH sensitivity.

Sensitive features have been mapped for the site. The results are shown in Figure 6 below and are available as GIS files.



**Figure 6: Habitat sensitivity of the study area.**

## **SITE CONSTRAINTS**

There is one main constraint to further development of the site:

1. The presence of the river in adjacent areas along with riparian habitat associated with the river. It is important that this riparian zone is not disturbed by activities associated with upgrading of infrastructure on site.

## **RELEVANT LEGISLATIVE AND PERMIT REQUIREMENTS**

Relevant legislation is provided in this section to provide a description of the key legal considerations of importance to the proposed project. The applicable legislation is listed below.

### **Legislation**

#### ***National Environmental Management Act, Act No. 107 of 1998 (NEMA)***

NEMA requires, inter alia, that:

- "development must be socially, environmentally, and economically sustainable",
- "disturbance of ecosystems and loss of biological diversity are avoided, or, where they cannot be altogether avoided, are minimised and remedied." ,
- "a risk-averse and cautious approach is applied, which takes into account the limits of current knowledge about the consequences of decisions and actions",

NEMA states that "the environment is held in public trust for the people, the beneficial use of environmental resources must serve the public interest and the environment must be protected as the people's common heritage."

#### ***Environment Conservation Act No 73 of 1989 Amendment Notice No R1183 of 1997***

The ECA states that:

Development must be environmentally, socially and economically sustainable. Sustainable development requires the consideration of inter alia the following factors:

- that pollution and degradation of the environment is avoided, or, where they cannot be altogether avoided, are minimised and remedied;
- that the use and exploitation of non-renewable natural resources is responsible and equitable, and takes into account the consequences of the depletion of the resource;
- that the development, use and exploitation of renewable resources and the ecosystems of which they are part do not exceed the level beyond which their integrity is jeopardised; and
- that negative impacts on the environment and on peoples' environmental rights be anticipated and prevented, and where they cannot be altogether prevented are minimised and remedied.

The developer is required to undertake Environmental Impact Assessments (EIA) for all projects listed as a Schedule 1 activity in the EIA regulations in order to control activities which might have a detrimental effect on the environment. Such activities will only be permitted with written authorisation from a competent authority.

#### ***National Environmental Management: Biodiversity Act (Act No 10 of 2004)***

In terms of the Biodiversity Act, the developer has a responsibility for:

- The conservation of endangered ecosystems and restriction of activities according to the categorisation of the area (not just by listed activity as specified in the EIA regulations).
- Promote the application of appropriate environmental management tools in order to ensure integrated environmental management of activities thereby ensuring that all development within the area are in line with ecological sustainable development and protection of biodiversity.
- Limit further loss of biodiversity and conserve endangered ecosystems.

Chapter 4 of the Act relates to threatened or protected ecosystems or species. According to Section 57 of the Act, "Restricted activities involving listed threatened or protected species":

- (1) A person may not carry out a restricted activity involving a specimen of a listed threatened or protected species without a permit issued in terms of Chapter 7.

Such activities include any that are “of a nature that may negatively impact on the survival of a listed threatened or protected species”.

Chapter 5 of the Act relates to species and organisms posing a potential threat to biodiversity. According to Section 75 of the Act, "Control and eradication of listed invasive species":

- (1) Control and eradication of a listed invasive species must be carried out by means of methods that are appropriate for the species concerned and the environment in which it occurs.
- (2) Any action taken to control and eradicate a listed invasive species must be executed with caution and in a manner that may cause the least possible harm to biodiversity and damage to the environment.
- (3) The methods employed to control and eradicate a listed invasive species must also be directed at the offspring, propagating material and re-growth of such invasive species in order to prevent such species from producing offspring, forming seed, regenerating or re-establishing itself in any manner.

***GNR 151: Critically Endangered, Endangered, Vulnerable and Protected Species List***

Published under Section 56(1) of the National Environmental Management: Biodiversity Act (Act No. 10 of 2004).

***GNR 1187: Amendment of Critically Endangered, Endangered, Vulnerable and Protected Species List***

Published under Section 56(1) of the National Environmental Management: Biodiversity Act (Act No. 10 of 2004).

***National Veld and Forest Fire Act (Act No. 101 of 1998)***

Provides requirements for veldfire prevention through firebreaks and required measures for fire-fighting. Chapter 4 of the Act places a duty on landowners to prepare and maintain firebreaks. Chapter 5 of the Act places a duty on all landowners to acquire equipment and have available personnel to fight fires.

## **IDENTIFICATION OF RISKS AND DESCRIPTION OF POTENTIAL IMPACTS**

Potential issues relevant to potential impacts on the ecology of the study area include the following:

- Impacts on biodiversity: this includes any impacts on populations of individual species of concern, including protected species, on overall species richness and on habitats of species of concern. This includes impacts on genetic variability, population dynamics, overall species existence or health and on habitats important for species of concern.
- Secondary and cumulative impacts on ecology: this includes an assessment of the impacts of the proposed project taken in combination with the impacts of other known projects for the area or secondary impacts that may arise from changes in the social, economic or ecological environment.

A number of direct risks to ecosystems that would result from **construction** of the proposed infrastructure are as follows:

- Clearing of land for construction.
- Construction of access roads.
- Chemical contamination of the soil by construction vehicles and machinery.
- Operation of construction camps.
- Storage of materials required for construction.

There are also risks associated with **operation** of the proposed infrastructure, as follows:

- Maintenance of surrounding vegetation as part of management of the infrastructure.
- Invasion by alien plants in disturbed areas surrounding the infrastructure.

### **Description of potential impacts**

Due to the nature of the sensitivities associated with the proposed infrastructure, only three potential impacts have been identified that are likely to be of significant concern for the site. These are described below.

#### ***Impact 1: Impacts on riparian vegetation***

Riparian habitat forms part of the river system that flows past the site. These areas are protected under the National Water Act. The riparian vegetation is outside the footprint of the existing site and the area to be upgraded, but there is a possibility that activities on site could cause damage to this system.

#### ***Impact 2: Establishment and spread of declared weeds and alien invader plants***

Major factors contributing to invasion by alien invader plants includes *inter alia* high disturbance (such as clearing for construction activities) and negative grazing practices (Zachariades *et al.* 2005). Exotic species are often more prominent near infrastructural disturbances than further away (Gelbard & Belnap 2003, Watkins *et al.* 2003). Consequences of this may include:

1. loss of indigenous vegetation;
2. change in vegetation structure leading to change in various habitat characteristics;
3. change in plant species composition;
4. change in soil chemical properties;
5. loss of sensitive habitats;

6. loss or disturbance to individuals of rare, endangered, endemic and/or protected species;
7. fragmentation of sensitive habitats;
8. change in flammability of vegetation, depending on alien species;
9. hydrological impacts due to increased transpiration and runoff; and
10. impairment of wetland function.

No alien plants were seen on site, but it is a common problem that disturbed areas are vulnerable to invasion by alien species. The risk for this particular site is to the surrounding vegetation, which forms part of a riparian system and therefore has elevated conservation value. There is a moderate possibility that alien plants could be introduced to areas within the footprint of the proposed infrastructure from surrounding areas in the absence of control measures. The potential consequences may be of moderate to high seriousness for surrounding natural habitats due to the intact nature of these areas. Control measures could prevent the impact from occurring.

## ASSESSMENT OF POTENTIAL IMPACTS

The following section provides a detailed assessment of the potential impacts identified in the sections above. Impacts are assessed according to Construction, Operations and Decommissioning phases of the project. Mitigation measures are proposed for reducing impacts and an assessment is provided for each impact following application of mitigation measures.

### Construction Phase

#### ***Loss/fragmentation of riparian vegetation***

The entire site is in a transformed state, but this adjoins an area of natural vegetation that forms part of a riparian system.

A. Loss/fragmentation of riparian vegetation - Alternative 1					
Impact Name	Loss/fragmentation of riparian vegetation				
Alternative	Alternative 1				
Phase	Construction				
Environmental Risk					
Attribute	Pre-mitigation	Post-mitigation	Attribute	Pre-mitigation	Post-mitigation
Nature of Impact	-1	-1	Magnitude of Impact	5	2
Extent of Impact	2	1	Reversibility of Impact	5	2
Duration of Impact	5	2	Probability	5	2
Environmental Risk (Pre-mitigation)					-21,25
Mitigation Measures					
<i>Keep impacts within footprint of the proposed WWTW site.                      Treat the riparian area as "No Go".                      Clear only necessary footprint.                      Rehabilitate disturbed areas as soon as possible.                      Use existing access road.</i>					
Environmental Risk (Post-mitigation)					-3,50
Degree of confidence in impact prediction:					Low
Impact Prioritisation					
Public Response					1
<i>Low: Issue not raised in public responses</i>					
Cumulative Impacts					2
<i>Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is probable that the impact will result in spatial and temporal cumulative change.</i>					
Degree of potential irreplaceable loss of resources					2
<i>The impact may result in the irreplaceable loss (cannot be replaced or substituted) of resources but the value (services and/or functions) of these resources is limited.</i>					
Prioritisation Factor					1,33
<b>Final Significance</b>					<b>-4,67</b>

### Operational Phase

**Establishment and spread of declared weeds and alien invader plants**

The existence of infrastructure represents a disturbance in the landscape that could advance conditions in which declared weeds and alien invader plants could potentially be favoured.

B. Establishment and spread of declared weeds and alien invader plants - Alternative 1					
Impact Name	Establishment and spread of declared weeds and alien invader plants				
Alternative	Alternative 1				
Phase	Operation				
Environmental Risk					
Attribute	Pre-mitigation	Post-mitigation	Attribute	Pre-mitigation	Post-mitigation
Nature of Impact	-1	-1	Magnitude of Impact	4	1
Extent of Impact	3	2	Reversibility of Impact	4	2
Duration of Impact	4	1	Probability	3	2
Environmental Risk (Pre-mitigation)					-11,25
Mitigation Measures					
<i>Existing concentrations of alien plants within the zone of control on site should be eradicated. Areas disturbed due to construction activities should be rehabilitated as quickly as possible. Soil stockpiles should not be translocated from areas with alien plants into the site and within the site alien plants on stockpiles must be controlled so as to avoid the development of a soil seed bank of alien plants within the stock-piled soil. Any alien plants must be immediately controlled to avoid establishment of a soil seed bank. An ongoing monitoring programme should be implemented to detect and quantify any aliens that may become established and provide information for the management of aliens. This should form part of an alien management programme.</i>					
Environmental Risk (Post-mitigation)					-3,00
Degree of confidence in impact prediction:					Low
Impact Prioritisation					
Public Response					1
<i>Low: Issue not raised in public responses</i>					
Cumulative Impacts					2
<i>Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is probable that the impact will result in spatial and temporal cumulative change.</i>					
Degree of potential irreplaceable loss of resources					2
<i>The impact may result in the irreplaceable loss (cannot be replaced or substituted) of resources but the value (services and/or functions) of these resources is limited.</i>					
Prioritisation Factor					1,33
<b>Final Significance</b>					<b>-4,00</b>



## MITIGATION MEASURES

This section of the report provides a description of mitigation measures that could be applied to minimize identified impacts.

### The mitigation hierarchy approach

The mitigation hierarchy consists of a number of sequential steps (avoid, mitigate, restore or rehabilitate and offset). This approach enables an infrastructure development project to work towards "no net loss" of biodiversity, and ideally, a net gain. The mitigation hierarchy is defined as:

- **Avoidance:** measures taken to avoid creating impacts from the outset, such as careful spatial or temporal placement of elements of infrastructure, in order to completely avoid impacts on certain components of biodiversity.
- **Minimisation:** measures taken to reduce the duration, intensity and / or extent of impacts (including direct, indirect and cumulative impacts, as appropriate) that cannot be completely avoided, as far as is practically feasible.
- **Rehabilitation/restoration:** measures taken to rehabilitate degraded ecosystems or restore cleared ecosystems following exposure to impacts that cannot be completely avoided and/ or minimised.
- **Offset:** measures taken to compensate for any residual significant, adverse impacts that cannot be avoided, minimised and / or rehabilitated or restored, in order to achieve no net loss or a net gain of biodiversity. Offsets can take the form of positive management interventions such as restoration of degraded habitat, arrested degradation or averted risk, protecting areas where there is imminent or projected loss of biodiversity.

### Mitigation measures

#### ***Treat the riparian zone as "No Go"***

The riparian zone adjacent to the site is considered to be sensitive and of high ecological value. It is in an intact state and should not be disturbed. It is entirely possible to avoid direct impacts on this area by treating it as a "No Go" area. The boundary of the site should be properly fenced and no personnel should be allowed into the riparian area.

#### ***Surface Runoff and Stormwater Management Plan***

The purpose of a Surface Runoff and Stormwater Management Plan is to prevent damage to areas downslope / downstream of the project area. This is an impact avoidance measure. This plan must indicate how all surface runoff generated as a result of the project and associated activities (during both the construction and operational phases) will be managed (e.g. artificial wetlands/stormwater and flood retention ponds) prior to entering any natural drainage system or wetland and how surface water runoff will be retained outside of any demarcated buffer/flood zones and subsequently released to simulate natural hydrological conditions.

#### ***Rehabilitation Programme***

The purpose of a Rehabilitation Plan is to provide a framework for rehabilitating areas outside of the infrastructure footprint that will be disturbed during the construction of the proposed project. Rehabilitation Programme should be established before operation. The programme must address the rehabilitation of the existing habitats as well as rehabilitation after closure. This Rehabilitation Programme must be approved by the relevant government departments. Rehabilitation can also be undertaken in habitats adjacent to sensitive areas that will not be developed, but that are currently disturbed by existing impacts on site. This will constitute a

form of offset. Rehabilitation must include aspects such as undertaking rehabilitation as quickly as possible after disturbance, soil management measures and using native plants during rehabilitation.

***Alien plant management plan***

It is recommended that a monitoring programme be implemented to enforce continual eradication of alien and invasive species, especially within the riparian habitat. An Alien Invasive Programme is an essential component to the successful conservation of habitats and species. Alien species, especially invasive species are a major threat to the ecological functioning of natural systems and to the productive use of land. In terms of the amendments of the regulations under the Conservation of Agricultural Resources Act, 1983 (Act No. 43 of 1983), landowners are legally responsible for the control of alien species on their properties. The protection of our natural systems from invasive species is further strengthened within Sections 70-77 of the National Environmental Management: Biodiversity Act, 2004 (Act No. 10 of 2004). This programme should include monitoring procedures.

***Worker education***

Educate workers (permanent staff and contractors) regarding the occurrence of important ecological features and resources in the area and the importance of their protection. This applies to the adjacent riparian habitat.

***Dust control***

Use abatement measures to minimise fugitive dust that could have a negative effect on vegetation and habitats, especially adjacent to sensitive areas.

***Undertake regular monitoring***

Monitoring should be undertaken to evaluate the success of mitigation measures. Monitoring methods must be in accordance with features that need to be monitored and can form part of a monitoring programme to be compiled.

## **RECOMMENDATIONS**

The following is recommended:

- The area of riparian vegetation adjacent to the site should be treated as a "No Go" area.
- Control measures for some potential impacts are relatively well-known and easy to implement and it is recommended that these be applied as mitigation measures for some potential impacts. These mitigation measures are described in a section above.

## DISCUSSION AND CONCLUSIONS

The study area consists mostly of altered habitat, but immediately adjacent to the site is an area of intact riparian habitat associated with the river flowing by. The vegetation on site is altered and no longer natural, but the adjacent habitat is natural and has high biodiversity value.

There are no listed or protected species that are likely to be affected by the proposed project. It was established that no listed animal or plant species are likely to be affected by the proposed project.

The project is located within areas defined in the Provincial Conservation Plan as CBA1 (Critical Biodiversity Area) and ESA2 (Ecological Support Area). The Conservation Plan has identified the CBA1 areas as being required to meet conservation targets at a regional level. However, the habitat on site is completely altered and does not constitute natural habitat.

A risk assessment was undertaken which identified two potential negative impacts due to construction or operation of the proposed infrastructure. The potential impacts are as follows:

1. Loss/fragmentation of riparian vegetation in adjacent areas during construction;
2. Introduction and/or spread of declared weeds and alien invasive plants in terrestrial habitats.

Potential impacts were assessed using a standardised methodology. The results of the assessment are provided in the table below.

<b>Impact</b>	<b>Pre-mitigation impact rating</b>	<b>Post-mitigation impact rating</b>
Impacts on riparian vegetation	-21.25 (high negative)	-3.50 (low negative)
Establishment and spread of declared alien plants	-11.25 (medium negative)	-3.00 (low negative)

Impacts were all low negative after mitigation. It is important to ensure that impacts on the riparian habitat is avoided. It has important regional significance in terms of maintaining ecological function in the landscape and preserving biodiversity patterns at a regional level.

Proposed mitigation measures follow a mitigation hierarchy approach, with the first objective to avoid impacts, where possible, followed by minimisation and rehabilitation. The avoidance of impacts is feasible for this project due to the already altered state of the site. However, adjacent areas are in a natural state and impacts on these areas must be avoided to prevent significant impacts from occurring in relation to this project.

### Conclusion

The main issue related to this project is the potential damage to riparian habitat in adjacent areas. These natural habitats are within areas designated as having high conservation value in the Provincial Conservation Plan. Avoidance of impacts on riparian vegetation is very possible by treating it as a "No Go" area.

To conclude, the project will not have highly significant impacts on the ecological receiving environment, except for potential impacts on riparian areas. This potential impact can be easily controlled and reduced to low significance.

## **ASSUMPTIONS, LIMITATIONS AND GAPS**

- Red List species are, by their nature, usually very rare and difficult to locate. Compiling the list of species that could potentially occur in an area is limited by the paucity of collection records that make it difficult to predict whether a species may occur in an area or not. The methodology used in this assessment is designed to reduce the risks of omitting any species, but it is always possible that a species that does not occur on a list may be unexpectedly located in an area.
- The study area was in the grip of a drought and temperatures were very high at the time of the field survey. This means that there are probably many plant and animal species that could occur on site that were not able to be seen at the time of the survey, either because they had not yet emerged (plants) or were not active at the time of the survey (animals).
- This study excludes invertebrates.
- Animal species are mostly highly mobile and often migrate seasonally. Any field assessment of relatively short duration is therefore unlikely to record anything more than the most common species that happen to be on site at the time of the survey. This is possibly a poor reflection of the overall diversity of species that could potentially occur on site.

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**APPENDICES:****Appendix 1: Plant species of conservation importance (Threatened, Near Threatened and Declining) that have historically been recorded in the study area.**

Sources: South African National Biodiversity Institute in Pretoria.

Family	Taxon	Status	Habitat	Likelihood of occurrence in study area
AMARYLLIDACEAE	Boophone disticha	Declining	Throughout South Africa and up to Uganda. Dry grassland and rocky areas.	LOW
AMARYLLIDACEAE	Crinum bulbispermum	Declining	Near rivers and streams, in seasonal pans and in damp depressions.	HIGH
CELASTRACEAE	Elaeodendron transvaalense	Near Threatened	Savanna or bushveld, from open woodland to thickets, often on termite mounds.	LOW
HYACINTHACEAE	Drimea sanguinea	Near threatened	Open veld and scrubby woodland in a variety of soil types.	LOW
ORCHIDACEAE	Ansellia africana	Declining	In hot dry mixed deciduous woodlands at medium to low altitudes, in riverine vegetation and miombo woodlands near rivers, on Hyphaene, Adansonia, Colophospermum, Ficus, Brachystegia, Parinari, Terminalia, Uapaca and Albizia spp., also sometimes on rocks in shade, rarely in forest 0-2200 m.	MEDIUM

\* Conservation Status Category assessment according to IUCN Ver. 3.1 (IUCN, 2001), as evaluated by the Threatened Species Programme of the South African National Biodiversity Institute in Pretoria. \*IUCN (3.1) Categories: VU = Vulnerable, EN = Endangered, CR = Critically Endangered, NT = Near Threatened.

**Appendix 2: Checklist of plant species recorded during previous botanical surveys in the grids in which the study area is located.**

(Species from quarter degree grid in which the site is located as well as surrounding grids in which similar vegetation is found)

Abutilon austro-africanum Hochr.  
Acacia permixta Burttt Davy  
Agelanthus crassifolius (Wiens) Polhill & Wiens  
Amaranthus spinosus L.  
Ammannia prieuriana Guill. & Perr.  
Aponogeton junceus Lehm.  
Aristida adscensionis L.  
Aristida canescens Henrard subsp. canescens  
Aristida congesta Roem. & Schult. subsp. barbicollis (Trin. & Rupr.) De Winter  
Asparagus aspergillus Jessop  
Asparagus bechuanicus Baker  
Berchemia discolor (Klotzsch) Hemsl.  
Bothriochloa insculpta (Hochst. ex A.Rich.) A.Camus  
Bothriochloa radicans (Lehm.) A.Camus  
Brachiaria deflexa (Schumach.) C.E.Hubb. ex Robyns  
Brachiaria nigropedata (Ficalho & Hiern) Stapf  
Breonadia salicina (Vahl) Hepper & J.R.I.Wood  
Buchnera reducta Hiern  
Cadaba termitaria N.E.Br.  
Cenchrus ciliaris L.  
Ceropegia crassifolia Schltr. var. crassifolia  
Ceropegia nilotica Kotschy var. nilotica  
Chloris roxburghiana Schult.  
Chlorophytum galpinii (Baker) Kativu var. galpinii  
Citrullus lanatus (Thunb.) Matsum. & Nakai  
Cleome monophylla L.  
Coccinia rehmannii Cogn.  
Combretum apiculatum Sond. subsp. apiculatum  
Combretum erythrophyllum (Burch.) Sond.  
Combretum imberbe Wawra  
Commelina africana L. var. barberae (C.B.Clarke) C.B.Clarke  
Corchorus asplenifolius Burch.  
Corchorus tridens L.  
Cucumis anguria L. var. longaculeatus J.H.Kirkbr.  
Cucumis melo L. subsp. melo  
Cucumis myriocarpus Naudin subsp. myriocarpus  
Cynodon dactylon (L.) Pers.  
Cyphostemma humile (N.E.Br.) Desc. ex Wild & R.B.Drumm. subsp. humile  
Dalbergia melanoxylon Guill. & Perr.  
Decorsea galpinii (Burttt Davy) Verdc.  
Denekia capensis Thunb.  
Digitaria eriantha Steud.  
Dombeya rotundifolia (Hochst.) Planch. var. rotundifolia  
Drimia sanguinea (Schinz) Jessop  
Drimiopsis burkei Baker subsp. burkei  
Ehretia amoena Klotzsch  
Eleocharis acutangula (Roxb.) Schult.  
Enneapogon cenchroides (Licht. ex Roem. & Schult.) C.E.Hubb.  
Eragrostis rigidior Pilg.  
Eragrostis superba Peyr.  
Eriocaulon abyssinicum Hochst.  
Evolvulus alsinoides (L.) L.



*Ficus capreifolia* Delile  
*Flacourtia indica* (Burm.f.) Merr.  
*Fuirena ciliaris* (L.) Roxb.  
*Gossypium herbaceum* L. subsp. *africanum* (Watt) Vollesen  
*Grewia flavescens* Juss.  
*Grewia monticola* Sond.  
*Hermannia boraginiflora* Hook.  
*Heteropogon contortus* (L.) Roem. & Schult.  
*Hexalobus monopetalus* (A.Rich.) Engl. & Diels var. *monopetalus*  
*Hibiscus micranthus* L.f. var. *micranthus*  
*Hybanthus enneaspermus* (L.) F.Muell. var. *enneaspermus*  
*Ipomoea dichroa* Choisy  
*Jamesbrittenia huillana* (Diels) Hilliard  
*Jasminum stenolobum* Rolfe  
*Kalanchoe lanceolata* (Forssk.) Pers.  
*Lagarosiphon verticillifolius* Oberm.  
*Lanea schweinfurthii* (Engl.) Engl. var. *stuhlmannii* (Engl.) Kokwaro  
*Leersia hexandra* Sw.  
*Limnophila indica* (L.) Druce  
*Lipocarpha rehmannii* (Ridl.) Goetgh.  
*Ludwigia adscendens* (L.) Hara subsp. *diffusa* (Forssk.) P.H.Raven  
*Melinis repens* (Willd.) Zizka subsp. *repens*  
*Nuxia oppositifolia* (Hochst.) Benth.  
*Ocimum americanum* L. var. *americanum*  
*Ormocarpum trichocarpum* (Taub.) Engl.  
*Ottelia ulvifolia* (Planch.) Walp.  
*Ozoroa paniculosa* (Sond.) R.& A.Fern. var. *paniculosa*  
*Panicum coloratum* L. var. *coloratum*  
*Panicum maximum* Jacq.  
*Peltophorum africanum* Sond.  
*Persicaria hystricula* (J.Schust.) Soj-k  
*Physalis angulata* L.  
*Plicosepalus kalachariensis* (Schinz) Danser  
*Pogonarthria squarrosa* (Roem. & Schult.) Pilg.  
*Polygala sphenoptera* Fresen. var. *sphenoptera*  
*Pycreus pumilus* (L.) Nees  
*Pyrenacantha grandiflora* Baill.  
*Rhoicissus digitata* (L.f.) Gilg & M.Brandt  
*Riccia cavernosa* Hoffm. emend. Raddi  
*Rotala filiformis* (Bellardi) Hiern  
*Sacciolepis spiciformis* (A.Rich.) Stapf  
*Schoenoplectus corymbosus* (Roth ex Roem. & Schult.) J.Raynal  
*Schoenoplectus senegalensis* (Hochst. ex Steud.) Palla  
*Seddera suffruticosa* (Schinz) Hallier f.  
*Selaginella kraussiana* (Kunze) A.Braun  
*Senecio inaequidens* DC.  
*Setaria nigrirostris* (Nees) T.Durand & Schinz  
*Sida acuta* Burm.f. subsp. *acuta*  
*Sorghum versicolor* Andersson  
*Syncolostemon elliottii* (Baker) D.F.Otieno  
*Themeda triandra* Forssk.  
*Trachyandra saltii* (Baker) Oberm. var. *saltii*  
*Tragus berteronianus* Schult.  
*Tricalysia junodii* (Schinz) Brenan var. *kirkii* (Hook.f.) Robbr.  
*Trichilia emetica* Vahl subsp. *emetica*  
*Urochloa mosambicensis* (Hack.) Dandy  
*Utricularia reflexa* Oliv.

Vangueria infausta Burch. subsp. infausta  
Viscum combreticola Engl.  
Xanthocercis zambesiaca (Baker) Dumaz-le-Grand

### Appendix 3: List of protected tree species (National Forests Act).

<i>Vachellia (Acacia) erioloba</i>	<i>Vachellia (Acacia) haematoxylon</i>
<b><i>Adansonia digitata</i></b>	<b><i>Azelia quanzensis</i></b>
<b><i>Balanites subsp. maughamii</i></b>	<i>Barringtonia racemosa</i>
<b><i>Boscia albitrunca</i></b>	<i>Brachystegia spiciformis</i>
<b><i>Breonadia salicina</i></b>	<i>Bruguiera gymnorhiza</i>
<i>Cassipourea swaziensis</i>	<b><i>Catha edulis</i></b>
<i>Ceriops tagal</i>	<i>Cleistanthus schlechteri</i> var. <i>schlechteri</i>
<i>Colubrina nicholsonii</i>	<b><i>Combretum imberbe</i></b>
<b><i>Curtisia dentata</i></b>	<b><i>Elaeodendron (Cassine) transvaalensis</i></b>
<i>Erythrophysa transvaalensis</i>	<i>Euclea pseudebenus</i>
<i>Ficus trichopoda</i>	<i>Leucadendron argenteum</i>
<i>Lumnitzera racemosa</i> var. <i>racemosa</i>	<i>Lydenburgia abottii</i>
<i>Lydenburgia cassinoides</i>	<i>Mimusops caffra</i>
<i>Newtonia hildebrandtii</i> var. <i>hildebrandtii</i>	<b><i>Ocotea bullata</i></b>
<i>Ozoroa namaensis</i>	<b><i>Philenoptera violacea (Lonchocarpus capassa)</i></b>
<b><i>Pittosporum viridiflorum</i></b>	<i>Podocarpus elongatus</i>
<b><i>Podocarpus falcatus</i></b>	<i>Podocarpus henkelii</i>
<b><i>Podocarpus latifolius</i></b>	<i>Protea comptonii</i>
<i>Protea curvata</i>	<b><i>Prunus africana</i></b>
<b><i>Pterocarpus angolensis</i></b>	<i>Rhizophora mucronata</i>
<b><i>Sclerocarya birrea subsp. caffra</i></b>	<i>Securidaca longependunculata</i>
<i>Sideroxylon inerme</i> subsp. <i>inerme</i>	<i>Tephrosia pondoensis</i>
<b><i>Warburgia salutaris</i></b>	<i>Widdringtonia cedarbergensis</i>
<i>Widdringtonia schwarzii</i>	

***Adansonia digitata*, *Azelia quanzensis*, *Balanites maughamii*, *Boscia albitrunca*, *Breonadia salicina*, *Catha edulis*, *Combretum imberbe*, *Curtisia dentata*, *Elaeodendron (Cassine) transvaalensis*, *Ocotea bullata*, *Philenoptera violacea (Lonchocarpus capassa)*, *Pittosporum viridiflorum*, *Podocarpus falcatus*, *Podocarpus latifolius*, *Prunus africana*, *Pterocarpus angolensis*, *Sclerocarya birrea subsp. caffra* and *Warburgia salutaris*** have a geographical distribution that coincides with the study area.

## Appendix 4: Animal species with a geographical distribution that includes the study area.

Notes:

1. Species of conservation concern are in red lettering.
2. Species protected according to the National Environmental Management: Biodiversity Act of 2004 (Act 10 of 2000) marked with "N"

### Mammals:

#### Antelope:

Impala  
<sup>N</sup>White rhinoceros  
Blue wildebeest  
Tsessebe  
<sup>N</sup>Black rhinoceros VU  
Plains zebra  
Giraffe  
Hippopotamus  
<sup>N</sup>Roan antelope VU  
<sup>N</sup>Sable antelope VU  
Waterbuck  
<sup>N</sup>African elephant  
Klipspringer  
Warthog  
Bushpig  
Steenbok  
<sup>N</sup>Sharp's grysbok NT  
<sup>N</sup>Reedbuck  
Mountain reedbuck  
Common duiker  
Cape buffalo  
Eland  
Nyala  
Bushbuck  
Kudu  
Hyraxes:  
Yellow-spotted rock hyrax  
Rock hyrax  
Carnivores:  
<sup>N</sup>Cheetah VU  
<sup>N</sup>Cape clawless otter  
Water mongoose  
Side-striped jackal  
Black-backed jackal  
Caracal  
African civet  
<sup>N</sup>Spotted hyaena NT  
African wild cat  
Slender mongoose  
Small-spotted genet  
Large-spotted genet  
Dwarf mongoose  
<sup>N</sup>Brown hyaena NT  
White-tailed mongoose  
Striped polecat  
<sup>N</sup>Serval NT

<sup>N</sup>Spotted-necked otter NT

<sup>N</sup>African wild dog EN

<sup>N</sup>Honey badger NT

Banded mongoose

Bat eared fox

<sup>N</sup>Lion VU

<sup>N</sup>Leopard

Selous' mongoose

African weasel

Aardwolf

Meller's mongoose

#### Bats:

Ansorge's free-tailed bat

Little free-tailed bat

<sup>N</sup>Percival's short-eared trident bat CR/VU

Gambian epauletted fruit bat

Wahlberg's epauletted fruit bat

Long-tailed serotine bat

<sup>N</sup>Variiegated butterfly bat NT/LC

Sundevall's leaf-nosed bat

<sup>N</sup>Damara woolly bat EN/LC

<sup>N</sup>Lesser woolly bat NT/LC

<sup>N</sup>Botswana long-eared bat VU/LC

<sup>N</sup>Natal long-fingered bat NT/LC

Angolan free-tailed bat

Midas free-tailed bat

Rufous hairy bat

<sup>N</sup>Temminck's hairy bat NT/LC

<sup>N</sup>Welwitsch's hairy bat NT/LC

Cape serotine bat

Banana bat

Aloe bat

Egyptian slit-faced bat

<sup>N</sup>Wood's slit-faced bat NT/NT

Schlieffen's bat

African pipistrelle

<sup>N</sup>Rusty bat NT/LC

<sup>N</sup>Peak-saddle horseshoe bat VU/NT

<sup>N</sup>Geoffroy's horseshoe bat NT/LC

<sup>N</sup>Darling's horseshoe bat NT/LC

<sup>N</sup>Ruppell's horseshoe bat NT/LC

<sup>N</sup>Hildebrandt's horseshoe bat NT/LC

<sup>N</sup>Lander's horseshoe bat NT/LC

Bushveld horseshoe bat

<sup>N</sup>Swinny's horseshoe bat EN/NT

Egyptian fruit bat

Yellow house bat

Lesser yellow house bat

Egyptian free-tailed bat  
 Mauritian tomb bat  
*Insectivores:*  
 Reddish-grey musk shrew  
 Tiny musk shrew  
 Lesser red musk shrew  
 Swamp musk shrew  
 Lesser grey-brown musk shrew  
 Least dwarf shrew  
 Greater dwarf shrew  
*Lagomorphs:*  
 Cape hare  
 Scrub hare  
 Jameson's red rock rabbit  
*Primates:*  
 Vervet monkey  
 Senegal bushbaby  
 Brown greater galago / thick-tailed bushbaby  
 Chacma baboon  
*Rodents:*  
 Spiny mouse  
 Red veld rat  
 Tete veld rat  
 Namaqua rock mouse  
 Common mole-rat  
**Water rat NT**  
 Grey climbing mouse  
 Brant's climbing mouse  
 Chestnut climbing mouse  
 Mozambique woodland mouse  
 Woodland mouse  
 Woodland dormouse  
 Porcupine  
 Single-striped mouse  
 Multimammate mouse  
 Natal multimammate mouse  
 Pygmy mouse  
 Angoni vlei rat  
 Vlei rat  
 Tree squirrel  
 Springhare  
 Striped mouse  
 Pouched mouse  
 Fat mouse  
 Bushveld gerbil  
 Tree rat  
 Greater cane rat  
*Shrews:*  
 Short-snouted elephant shrew  
 (Bushveld elephant shrew)  
 Rock elephant shrew  
*Other:*  
**<sup>N</sup>Temminck's ground pangolin VU**  
 Aardvark

**Reptiles:**  
 Puff adder  
 Rhombic night adder  
 Snouted night adder  
 Black mamba  
 Snouted cobra  
 Mozambique spitting cobra  
 Rinkhals  
 Shield-nose snake  
 Zambezi garter snake  
 Long-tailed garter snake  
 Spotted harlequin snake  
 Boomslang  
 Vine snake  
 Southern stiletto snake  
 Rufous beaked snake  
 Olive whip snake  
 Short-snouted whip snake  
 Kalahari sand snake  
 Western stripe-bellied sand snake  
 Crossed whip snake  
 Dwarf whip snake  
 Spotted skaapsteker  
 Striped skaapsteker  
 Eastern bark snake  
 Common tiger snake  
 Marbled tree snake  
 Herald snake  
 Black-headed centipede-eater  
 Common purple-glossed snake  
 Striped quill-snouted snake  
<sup>N</sup>Southern African python  
 Brown house snake  
 Olive house snake  
 Aurora house snake  
 Spotted rock snake  
 Swazi rock snake  
 Common brown water snake  
 Mole snake  
 Two-striped shovel-snout  
 East African shovel-snout  
 Lined shovel-snout  
 Spotted bush snake  
 Green water snake  
 Western Natal green snake  
 Common slug-eater  
 Common wolf snake  
 Variegated wolf snake  
 Southern file snake  
 Black file snake  
 Common egg-eater  
 Southern brown egg eater  
 Delalande's beaked blind snake  
 Shlegel's beaked blind snake  
 Bibron's blind snake  
 Long-tailed worm snake  
 Peter's worm snake

Incognito worm snake  
 Distant's worm snake  
 Southern tree agama  
 Distant's ground agama  
 Peter's ground agama  
 Common flap-necked chameleon  
 Rock monitor  
 Water monitor  
 Bushveld lizard  
 Common rough-scaled lizard  
 Holub's sandveld lizard  
 Spotted sandveld lizard  
 Ornate sandveld lizard  
 Giant legless skink  
 Spotted-neck snake-eyed skink  
 Wahlberg's snake-eyed skink  
 Sundevall's writhing skink  
 Lowveld dwarf burrowing skink  
 Limpopo dwarf burrowing skink  
 Rainbow skink  
 Striped skink  
 Variable skink  
 De Coster's worm lizard  
 Dusky worm lizard  
 Slender worm lizard  
 Jone's girdled lizard  
 Common flat lizard  
 Zimbabwe flat lizard  
 Yellow-throated plated lizard  
 Rough-scaled plated lizard  
 Black-lined plated lizard  
 Common giant plated lizard  
 Common tropical house gecko  
 Wahlberg's velvet gecko  
 Common dwarf gecko  
 Stevenson's dwarf gecko  
 Turner's gecko  
 Transvaal gecko  
 Tiger gecko  
 Van son's gecko  
<sup>N</sup>Nile crocodile VU  
 Marsh terrapin  
 (Black-bellied hinged terrapin)  
 Speke's hinged tortoise  
 Leopard tortoise

### **Amphibians**

Brown-backed tree frog  
 Bushveld rain frog  
 Eastern olive toad  
 Guttural toad  
 Flat-backed toad  
 (Raucous toad)  
 Northern pygmy toad  
 Red toad  
 Mottled shovel-nosed frog

Painted reed frog  
 Water lily frog  
 Bubbling kassina  
 Banded rubber frog  
 Dwarf puddle frog  
 Snoring puddle frog  
 Ornate frog  
 Plain grass frog  
 Broad-banded grass frog  
 Sharp-nosed grass frog  
 Common platanna  
 Muller's platanna  
 Boettger's caco  
 Common river frog  
 Cape river frog  
 African bullfrog  
 Striped stream frog  
 Tremolo sand frog  
 Knocking sand frog  
 Russet-backed sand frog  
 Natal sand frog  
 Southern foam nest frog

### **Birds**

Abdim's Stork  
 Acacia Pied Barbet  
 African Barred Owllet  
 African Black Duck  
 African Black Swift  
 African Crake  
 African Crowned Eagle NT  
 African Cuckoo Hawk  
 African Cuckoo  
 African Darter  
 African Dusky Flycatcher  
 African Emerald Cuckoo  
 African Finfoot VU  
 African Firefinch  
 African Fish-Eagle  
 African Golden Oriole  
 African Goshawk  
 African Green-Pigeon  
 African Grey Hornbill  
 African Harrier-Hawk  
 African Hawk-Eagle  
 African Hoopoe  
 African Jacana  
<sup>N</sup>African Marsh-Harrier VU  
 African Mourning Dove  
 African Olive-Pigeon  
 African Openbill NT  
 African Palm-Swift  
 African Paradise-Flycatcher  
 African Pied Wagtail  
 African Pipit  
 African Purple Swamphen

**African Pygmy-Goose NT**

African Pygmy-Kingfisher  
African Quailfinch  
African Reed-Warbler  
African Sacred Ibis  
African Scops-Owl  
African Snipe  
African Spoonbill  
African Stonechat  
African Wattled Lapwing  
African Wood-Owl  
Allen's Gallinule  
Alpine Swift  
Amethyst Sunbird  
Amur Falcon  
Arnott's Chat  
Arrow-marked Babbler  
Ashy Flycatcher  
**Ayres's Hawk-Eagle NT**  
Baillon's Crake  
Bar-throated Apalis  
Barn Owl  
Barn Swallow  
**Bat Hawk NT**  
<sup>N</sup>**Bateleur VU**  
Bearded Scrub-Robin  
Bearded Woodpecker  
Bennett's Woodpecker  
**Black Coucal NT**  
Black Crake  
Black Cuckoo  
Black Cuckooshrike  
Black Heron  
Black Kite  
Black Sparrowhawk  
<sup>N</sup>**Black Stork NT**  
Black-backed Puffback  
**Black-bellied Bustard NT**  
Black-chested Snake-Eagle  
Black-collared Barbet  
Black-crowned Night-Heron  
Black-crowned Tchagra  
Black-headed Heron  
Black-headed Oriole  
**Black-rumped Buttonquail EN**  
Black-shouldered Kite  
Black-winged Stilt  
Blacksmith Lapwing  
Blue Waxbill  
Blue-cheeked Bee-eater  
Blue-mantled Crested Flycatcher  
Bohm's Spinetail  
Booted Eagle  
Broad-billed Roller  
Bronze Mannikin  
Bronze-winged Courser  
Brown Snake-Eagle

Brown-backed Honeybird  
Brown-crowned Tchagra  
Brown-headed Parrot  
Brown-hooded Kingfisher  
Brown-throated Martin  
Brubru  
Buffy Pipit  
Burchell's Coucal  
Burchell's Starling  
Burnt-necked Eremomela  
Bushveld Pipit  
Cape Glossy Starling  
Cape Turtle-Dove  
<sup>N</sup>**Cape Vulture VU**  
Cape Wagtail  
Cape White-eye  
Capped Wheatear  
Cardinal Woodpecker  
Caspian Plover  
Cattle Egret  
Chestnut-backed Sparrowlark  
Chinspot Batis  
Cinnamon-breasted Bunting  
Collared Sunbird  
Comb Duck  
Common Cuckoo  
Common Fiscal  
Common Greenshank  
Common House-Martin  
Common Moorhen  
Common Ostrich  
Common Quail  
Common Ringed Plover  
Common Sandpiper  
Common Scimitarbill  
Common Swift  
Common Waxbill  
Common Whimbrel  
Coqui Francolin  
**Corn Crake VU**  
Crested Barbet  
Crested Francolin  
Crested Guineafowl  
Croaking Cisticola  
Crowned Hornbill  
Crowned Lapwing  
Cuckoo Finch  
Curlew Sandpiper  
Cut-throat Finch  
Dark Chanting Goshawk  
Dark-capped Bulbul  
Desert Cisticola  
Dickinson's Kestrel  
Diderick Cuckoo  
Double-banded Sandgrouse  
Dusky Indigobird  
Dusky Lark

Dwarf Bittern  
 Eastern Nicator  
 Egyptian Goose  
 Emerald-spotted Wood-Dove  
 Eurasian Golden Oriole  
 Eurasian Hobby  
 European Bee-eater  
 European Honey-Buzzard  
 European Nightjar  
 European Roller  
 Familiar Chat  
 Fiery-necked Nightjar  
 Fiscal Flycatcher  
 Flappet Lark  
 Fork-tailed Drongo  
 Freckled Nightjar  
 Fulvous Duck  
 Gabar Goshawk  
 Garden Warbler  
 Giant Kingfisher  
 Glossy Ibis  
 Golden Weaver  
 Golden-breasted Bunting  
 Golden-tailed Woodpecker  
 Goliath Heron  
 Gorgeous Bush-Shrike  
 Great Egret  
 Great Reed-Warbler  
 Great Spotted Cuckoo  
 Great White Pelican NT  
 Greater Blue-eared Starling  
 Greater Flamingo NT  
 Greater Honeyguide  
 Greater Painted-snipe NT  
 Green Sandpiper  
 Green Wood-Hoopoe  
 Green-backed Camaroptera  
 Green-backed Heron  
 Green-capped Eremomela  
 Green-winged Pytilia  
 Grey Go-away-bird  
 Grey Heron  
 Grey Penduline-Tit  
 Grey Tit-Flycatcher  
 Grey-backed Camaroptera  
 Grey-headed Bush-Shrike  
 Grey-headed Gull  
 Grey-headed Kingfisher  
 Grey-headed Parrot  
 Grey-rumped Swallow  
 Groundscraper Thrush  
 Hadedda Ibis  
 Half-collared Kingfisher NT  
 Hamerkop  
 Harlequin Quail  
 Helmeted Guineafowl  
 Hooded Vulture VU

Horus Swift  
 Hottentot Teal  
 House Sparrow  
 Icterine Warbler  
 Jackal Buzzard  
 Jacobin Cuckoo  
 Jameson's Firefinch  
 Kittlitz's Plover  
 Klaas's Cuckoo  
 Kori Bustard VU  
 Kurrichane Thrush  
 Lanner Falcon NT  
 Lappet-faced Vulture VU  
 Laughing Dove  
 Lesser Flamingo NT  
 Lesser Grey Shrike  
 Lesser Honeyguide  
 Lesser Kestrel VU  
 Lesser Masked-Weaver  
 Lesser Moorhen  
 Lesser Spotted Eagle  
 Lesser Striped Swallow  
 Lesser Swamp-Warbler  
 Levillant's Cuckoo  
 Lilac-breasted Roller  
 Little Bee-eater  
 Little Bittern  
 Little Egret  
 Little Grebe  
 Little Rush-Warbler  
 Little Sparrowhawk  
 Little Stint  
 Little Swift  
 Lizard Buzzard  
 Long-billed Crombec  
 Long-crested Eagle  
 Long-tailed Paradise-Whydah  
 Magpie Shrike  
 Malachite Kingfisher  
 Marabou Stork  
 Marico Sunbird  
 Marsh Owl  
 Marsh Sandpiper  
 Marsh Warbler  
 Martial Eagle VU  
 Mocking Cliff-Chat  
 Monotonous Lark  
 Montagu's Harrier  
 Mosque Swallow  
 Mottled Spinetail  
 Namaqua Dove  
 Narina Trogon  
 Natal Francolin  
 Neddicky  
 Olive-tree Warbler  
 Orange-breasted Bush-Shrike  
 Orange-breasted Waxbill



Orange-winged Pytilia  
Osprey  
Ovambo Sparrowhawk  
Pale Flycatcher  
**Pallid Harrier NT**  
Pearl-breasted Swallow  
Pearl-spotted Owllet  
<sup>N</sup>**Pel's Fishing-Owl VU**  
Pennant-winged Nightjar  
<sup>N</sup>**Peregrine Falcon NT**  
Pied Avocet  
Pied Crow  
Pied Kingfisher  
Pin-tailed Whydah  
<sup>N</sup>**Pink-backed Pelican VU**  
Plain-backed Pipit  
Purple Heron  
Purple Indigobird  
Purple Roller  
Purple-crested Turaco  
Rattling Cisticola  
Red-backed Mannikin  
Red-backed Shrike  
Red-billed Buffalo-Weaver  
Red-billed Firefinch  
Red-billed Hornbill  
**Red-billed Oxpecker NT**  
Red-billed Quelea  
Red-billed Teal  
Red-breasted Swallow  
Red-capped Lark  
Red-capped Robin-Chat  
Red-chested Cuckoo  
Red-chested Flufftail  
Red-collared Widowbird  
Red-crested Korhaan  
Red-eyed Dove  
Red-faced Cisticola  
Red-faced Mousebird  
Red-footed Falcon  
Red-headed Weaver  
Red-knobbed Coot  
Red-winged Starling  
Reed Cormorant  
Retz's Helmet-Shrike  
Rock Dove  
Rock Kestrel  
Rock Martin  
Ruff  
Rufous-cheeked Nightjar  
Rufous-chested Sparrowhawk  
Rufous-naped Lark  
Sabota Lark  
**Saddle-billed Stork EN**  
Sand Martin  
Sanderling  
Scarlet-chested Sunbird

**Secretarybird NT**  
Sedge Warbler  
Shaft-tailed Whydah  
Shelley's Francolin  
Shikra  
Small Buttonquail  
Sombre Greenbul  
Southern Black Flycatcher  
Southern Black Tit  
Southern Boubou  
Southern Carmine Bee-eater  
Southern Grey-headed Sparrow  
<sup>N</sup>**Southern Ground-Hornbill VU**  
Southern Masked-Weaver  
Southern Pochard  
Southern Red Bishop  
Southern White-crowned Shrike  
Southern White-faced Scops-Owl  
Southern Yellow-billed Hornbill  
Speckled Mousebird  
Speckled Pigeon  
Spectacled Weaver  
Spotted Crake  
Spotted Eagle-Owl  
Spotted Flycatcher  
Spotted Thick-knee  
Spur-winged Goose  
Squacco Heron  
Square-tailed Nightjar  
Steppe Buzzard  
Steppe Eagle  
Stierling's Wren-Warbler  
Streaky-headed Seedeater  
**Striped Flufftail**  
Striped Kingfisher  
Striped Pipit  
Swainson's Spurfowl  
Tambourine Dove  
<sup>N</sup>**Tawny Eagle VU**  
Tawny-flanked Prinia  
Temminck's Courser  
Terrestrial Brownbul  
Thick-billed Cuckoo  
Thick-billed Weaver  
Three-banded Plover  
Thrush Nightingale  
Tree Pipit  
Trumpeter Hornbill  
Verreaux's Eagle-Owl  
Verreaux's Eagle  
Village Indigobird  
Village Weaver  
Violet-backed Starling  
Violet-eared Waxbill  
Wahlberg's Eagle  
Water Thick-knee  
Wattled Starling

Western Marsh-Harrier  
Whiskered Tern  
White Stork  
White-backed Duck  
White-backed Night-Heron VU  
White-backed Vulture VU  
White-bellied Sunbird  
White-breasted Cormorant  
White-breasted Cuckooshrike  
White-browed Robin-Chat  
White-browed Scrub-Robin  
White-crested Helmet-Shrike  
White-crowned Lapwing NT  
White-faced Duck  
White-fronted Bee-eater  
White-fronted Plover  
White-headed Vulture VU  
White-rumped Swift  
White-throated Robin-Chat  
White-throated Swallow  
White-winged Tern  
White-winged Widowbird  
Willow Warbler  
Wing-snapping Cisticola  
Wire-tailed Swallow  
Wood Sandpiper  
Woodland Kingfisher  
Woolly-necked Stork NT  
Yellow Wagtail  
Yellow-bellied Eremomela  
Yellow-bellied Greenbul  
Yellow-billed Duck  
Yellow-billed Egret  
Yellow-billed Kite  
Yellow-billed Oxpecker VU  
Yellow-billed Stork NT  
Yellow-breasted Apalis  
Yellow-crowned Bishop  
Yellow-fronted Canary  
Yellow-fronted Tinkerbird  
Yellow-throated Longclaw  
Yellow-throated Petronia  
Zitting Cisticola

**Appendix 5: Vertebrate species of conservation concern with a geographical distribution that includes the study area.**

**MAMMALS (excluding bats)**

Common name	Taxon	Habitat <sup>1</sup>	National status <sup>1</sup>	Global status <sup>2</sup>	Likelihood of occurrence
Black rhinoceros	<i>Diceros bicornis minor</i>	Browser occurring in bushveld habitats of Limpopo, Mpumalanga and KZN. Only found in formal conservation areas and, in some cases, on private game farms.	VU <sup>1</sup> Protected (NEMBA)	CR	<b>LOW</b> , does not occur outside formal conservation areas - not found in Man'ombe NR
Roan antelope	<i>Hippotragus equinus</i>	Open savannah woodlands, requires medium-tall grasses and permanent water.	VU <sup>1</sup> Protected (NEMBA)	LC	<b>LOW</b> , does not occur in Man'ombe NR
Sable antelope	<i>Hippotragus niger niger</i>	Water-dependent grazer within woody savanna. Occurs primarily in protected areas and private game farms.	VU <sup>1</sup> Protected (NEMBA)	LC	<b>LOW</b> , does not occur in Man'ombe NR
Sharpe's grysbok	<i>Raphicerus sharpei</i>	Found in shrublands and savanna woodlands. Mixed feeders on low growing shrubs and grasses, avoids tall grasses.	NT <sup>1</sup> Protected (NEMBA)	LC	<b>LOW</b> , does not occur in Man'ombe NR
Cheetah	<i>Acinonyx jubatus</i>	Savanna and grassland species, preying on small to large-sized mammals and birds. Only found in formal conservation areas.	VU <sup>1</sup> Protected (NEMBA)	VU	<b>LOW</b> , does not occur in Man'ombe NR
Spotted hyaena	<i>Crocuta crocuta</i>	Predator/scavenger found in a wide range of habitats. In South Africa, usually only found in formal conservation areas and persecuted outside these areas.	NT <sup>1</sup> Protected (NEMBA)	LC	<b>LOW</b> , does not occur in Man'ombe NR
Brown hyaena	<i>Hyaena brunnea</i>	All vegetation types, including urban areas. Scavenger.	NT	NT	<b>MEDIUM</b> , within known distribution range & suitable habitat
Serval	<i>Leptailurus serval</i>	Moist savanna, tall grass, eating small mammals, birds, reptiles, fruits, invertebrates, amphibia and fish.	NT	LC	<b>MEDIUM</b> , within known distribution range & suitable habitat
Spotted-necked otter	<i>Lutra maculicollis</i>	Permanent, unsilted and unpolluted rivers, streams and freshwater lakes, where sufficient numbers of its prey are present. Adequate riparian vegetation is essential to provide cover during periods of inactivity.	NT	LC	<b>LOW</b> , within known distribution range but no suitable habitat
African wild dog	<i>Lycaon pictus</i>	Only found in formal conservation areas and, in some cases, on private game farms.	EN <sup>1</sup> Protected (NEMBA)	EN <sup>2</sup>	<b>LOW</b> , does not occur in Man'ombe NR
Honey Badger	<i>Mellivora capensis</i>	Savanna, shrubland, grassland, desert. Generalist predator, commensural with humans.	NT <sup>1</sup> Protected (NEMBA)	LC <sup>2</sup>	<b>MEDIUM</b> , suitable habitat.
Lion	<i>Panthera leo</i>	Only found in formal conservation	VU <sup>1</sup>	VU <sup>2</sup>	<b>LOW</b> , does not occur

		areas and, in some cases, on private game farms.	Protected (NEMBA)		in Man'ombe NR
Percival's short-eared trident bat	<i>Cloeotis percivali</i>	Appear to be associated with woodland, where they roost in small numbers (20-200 individuals) in caves and small crevices.	CR/VU <sup>3</sup>	LC <sup>2</sup>	<b>MEDIUM</b> , habitat suitable; roosting sites possibly occur in nearby areas.
Damara woolly bat	<i>Kerivoula argentata</i>	Associated with various types of woodland. Roosts in foilage, under the eaves of buildings and in birds nests.	EN/LC <sup>3</sup>	LC <sup>2</sup>	<b>MEDIUM</b> , habitat suitable; roosting sites occur on site and in nearby areas.
Botswana long-eared bat	<i>Laephotis botswanae</i>	Poorly known species. Appears to be associated with open woodland and savanna, where it has only been caught near water	VU/LC <sup>3</sup>	LC <sup>2</sup>	<b>MEDIUM</b> , habitat suitable; roosting sites unknown.
Wood's slit-faced bat	<i>Nycteris woodi</i>	In South Africa, restricted to the Limpopo River valley. Roosts in family groups in baobab trees, small sandstone caves, mine adits and possibly buildings. Found in semi-arid and moist savanna.	NT/NT <sup>3</sup>	LC <sup>2</sup>	<b>LOW</b> , habitat suitable; roosting sites possibly occur in nearby areas, but geographic distribution may not include this site.
Peak-saddle horseshoe bat	<i>Rhinolophus blasii</i>	Roosts in caves and mine adits in small groups of up to 4 individuals. In southern Africa, associated with savanna woodlands.	VU/NT <sup>3</sup>	LC <sup>2</sup>	<b>MEDIUM</b> , habitat suitable; roosting sites possibly occur in nearby areas.
Swinny's horseshoe bat	<i>Rhinolophus swinnyi</i>	Roosts singly or in small groups of up to 5 individuals in caves and old mines. Associated with Afromontane forests and savanna woodlands.	EN/NT <sup>3</sup>	LC <sup>2</sup>	<b>MEDIUM</b> , habitat suitable; roosting sites possibly occur in nearby areas.
Water Rat	<i>Dasymys incomtus</i>	Marshes, swamps, fens, peatlands. A terrestrial, nocturnal, semi-aquatic species. It is found in wetlands habitats of moist savanna, temperate, subtropical or tropical grassland and in seasonally wet or flooded lowland grassland and swamps.	NT <sup>1</sup>	LC <sup>2</sup>	<b>LOW</b> , substrate and habitat properties on site not considered to be suitable for this species
Temminck's Ground Pangolin	<i>Smutsia temminckii</i>	Found in grassland, shrubland and savanna, where it is associated with ants/termites. Also requires holes in the ground or above-ground debris within which to shelter. Solitary.	VU <sup>1</sup> Protected (NEMBA)	VU	<b>LOW</b> , within geographical range and suitable habitat occurs on site, but no suitable burrows or prey seen on site.

<sup>1</sup>Distribution and national status according to Friedmann & Daly 2004.

<sup>2</sup>Global status according to IUCN Red List of Threatened Species. Version 2015.4. ([www.iucnredlist.org](http://www.iucnredlist.org)). Downloaded on 17 December 2015.

Bats: <sup>3</sup>National/global status according to Monadjem et al. 2010.

## REPTILES

Common name	Species	Habitat	Status	Likelihood of occurrence
Southern African Python	<i>Python natalensis</i>	Bushveld, savanna and forest. May be found in trees, rocky areas and water. Prefers rocky outcrops and is fond of water, where it may dive into deep pools and remain submerged for long periods.	LC <sup>1</sup> Protected (NEMBA)	<b>MEDIUM</b> , habitat suitable
Nile crocodile	<i>Crocodylus niloticus</i>	Inhabit rivers, lakes, swamps, estuaries and mangroves. Restricted largely to game and nature reserves.	VU <sup>1</sup> Protected (NEMBA)	<b>LOW</b> , no suitable habitat.

<sup>1</sup>National status according to Bates et al. 2014.

## AMPHIBIANS

Common name	Species	Habitat	Status	Likelihood of occurrence
None				

<sup>1</sup>Status according to Minter et al. 2004.

## BIRDS (resident, non-wetland species shown, large raptors excluded - see text)

Common name	Species	Habitat	Status	Importance of site for species
Bat Hawk	<i>Macheiramphus alcinus</i>	Dense woodland and riverine forest. Favours habitat with nearby riverine woodland. Builds large platform nest on lateral branch of tall tree.	NT <sup>1</sup> LC <sup>2</sup>	LOW, breeding, LOW, foraging
Black-bellied Bustard	<i>Eupodotis melanogaster</i>	Bushveld, savanna, grassland, vleis, cultivated lands. Prefers tall grassland and open woodland with long grass. Common resident in study area. Eggs laid on bare ground, often near base of tree. Largely sedentary.	NT <sup>1</sup> LC <sup>2</sup>	LOW, breeding, LOW, foraging
Black-rumped Buttonquail	<i>Turnix nanus</i>	High rainfall, damp, short fairly grassland, usually on clay soils, either in open or lightly wooded country. Nest a grass-lined scrape.	EN <sup>1</sup> LC <sup>2</sup>	LOW, breeding, LOW, foraging
Kori Bustard	<i>Ardeotis kori</i>	Open plains of karoo, highveld grassland, Kalahari sandveld, arid scrub, Namib Desert, lightly wooded savanna, bushveld. Prefers dry open savanna woodland, shrublands and occasionally grassland. Eggs laid on bare ground in shallow scrape.	VU <sup>1</sup> NT <sup>2</sup> Protected (NEMBA)	LOW, breeding, LOW, foraging
Lanner Falcon	<i>Falco biarmicus</i>	Most frequent in open grassland, open or cleared woodland, and agricultural areas. Breeding pairs generally favour habitats where cliffs available as nest and roost sites, but will use alternative sites (eg trees, electricity pylons, buildings) if cliffs absent. Widespread species, occurring in Afrotropics, Middle East and western Palearctic. Occurs in mountains or open country from semidesert to woodland and agricultural land; also cities (Durban, Harare).	NT <sup>1</sup> LC <sup>2</sup>	LOW, breeding, LOW, foraging
Red-billed Oxpecker	<i>Buphagus erythrorhynchus</i>	Savanna and bushveld. Prefers open woodland where ungulate hosts are present.	NT <sup>1</sup> LC <sup>2</sup>	LOW, breeding, LOW, foraging

Common name	Species	Habitat	Status	Importance of site for species
Secretarybird	<i>Sagittarius serpentarius</i>	Semi-desert, grassland, savanna, open woodland, farmland, mountain slopes. Favours open grassland with scattered trees or shrubs. Nest a stick platform usually placed at the top of a flat thorn tree.	NT <sup>1</sup> VU <sup>2</sup>	LOW, breeding, LOW, foraging
Southern Ground Hornbill	<i>Bucorvus leadbeateri</i>	Any woodland, savanna, open grassland, agricultural lands. Favours open woodland and grassland with a few scattered trees. Nests usually in natural tree cavity, sometimes in crevice on rock face or on old stick nest.	VU <sup>1</sup> VU <sup>2</sup> Protected (NEMBA)	LOW, breeding, LOW, foraging
Yellow-billed oxpecker	<i>Buphagus africanus</i>	Savanna and open woodland, mainly along watercourses and on floodplains in the Caprivi Strip.	VU <sup>1</sup> LC <sup>2</sup>	LOW, breeding, LOW, foraging

<sup>1</sup>Status according to Barnes 2000.

<sup>2</sup>Status according to IUCN 2010. IUCN Red List of Threatened Species. Version 2010.3. ([www.iucnredlist.org](http://www.iucnredlist.org)).  
Downloaded on 8 September 2014.

**Appendix 6: Flora and vertebrate animal species protected under the National Environmental Management: Biodiversity Act, 2004 (Act 10 of 2004)**

(as updated in R. 1187, 14 December 2007)

**CRITICALLY ENDANGERED SPECIES**

**Flora**

Adenium swazicum  
Aloe pillansii  
Diaphanthe millarii  
Dioscorea ebutsniorum  
Encephalartos aemulans  
Encephalartos brevifoliolatus  
Encephalartos cerinus  
Encephalartos dolomiticus  
Encephalartos heenanii  
Encephalartos hirsutus  
Encephalartos inopinus  
Encephalartos latifrons  
Encephalartos middelburgensis  
Encephalartos nubimontanus  
Encephalartos woodii

**Reptilia**

Loggerhead sea turtle  
Leatherback sea turtle  
Hawksbill sea turtle

**Aves**

Wattled crane  
Blue swallow  
Egyptian vulture  
Cape parrot

**Mammalia**

Riverine rabbit  
Rough-haired golden mole

**ENDANGERED SPECIES**

**Flora**

Angraecum africae  
Encephalartos arenarius  
Encephalartos cupidus  
Encephalartos horridus  
Encephalartos laevifolius  
Encephalartos lebomboensis  
Encephalartos msinganus  
Jubaeopsis caffra  
Siphonochilus aethiopicus  
Warburgia salutaris  
Newtonia hilderbrandi

**Reptilia**

Green turtle  
Giant girdled lizard  
Olive ridley turtle  
Geometric tortoise

**Aves**

Blue crane  
Grey crowned crane  
Saddle-billed stork  
Bearded vulture  
White-backed vulture  
Cape vulture  
Hooded vulture  
Pink-backed pelican  
Pel's fishing owl  
Lappet-faced vulture

**Mammalia**

Robust golden mole  
Tsessebe  
Black rhinoceros  
Mountain zebra  
African wild dog  
Gunning's golden mole  
Oribi  
Red squirrel  
Four-toed elephant-shrew

**VULNERABLE SPECIES**

**Flora**

Aloe albida  
Encephalartos cycadifolius  
Encephalartos Eugene-maraisii  
Encephalartos ngovanus  
Merwillia plumbea  
Zantedeschia jucunda

**Aves**

White-headed vulture  
Tawny eagle  
Kori bustard  
Black stork  
Southern banded snake eagle  
Blue korhaan  
Taita falcon  
Lesser kestrel  
Peregrine falcon  
Bald ibis

Ludwig's bustard  
Martial eagle  
Bataleur  
Grass owl

### **Mammalia**

Cheetah  
Samango monkey  
Giant golden mole  
Giant rat  
Bontebok  
Tree hyrax  
Roan antelope  
Pangolin  
Juliana's golden mole  
Suni  
Large-eared free-tailed bat  
Lion  
Leopard  
Blue duiker

### **PROTECTED SPECIES**

#### **Flora**

Adenia wilmsii  
Aloe simii  
Clivia mirabilis  
Disa macrostachya  
Disa nubigena  
Disa physodes  
Disa procera  
Disa sabulosa  
Encephelartos altensteinii  
Encephelartos caffer  
Encephelartos dyerianus  
Encephelartos frederici-guilielmi  
Encephelartos ghellinckii  
Encephelartos humilis  
Encephelartos lanatus  
Encephelartos lehmannii  
Encephelartos longifolius  
Encephelartos natalensis  
Encephelartos paucidentatus  
Encephelartos princeps  
Encephelartos senticosus  
Encephelartos transvenosus  
Encephelartos trispinosus  
Encephelartos umbeluziensis  
Encephelartos villosus  
Euphorbia clivicola  
Euphorbia meloformis  
Euphorbia obesa  
Harpagophytum procumbens

Harpagophytum zeyherii  
Hoodia gordonii  
Hoodia currorii  
Protea odorata  
Stangeria eriopus

### **Amphibia**

Giant bullfrog  
African bullfrog

### **Reptilia**

Gaboon adder  
Namaqua dwarf adder  
Smith's dwarf chameleon  
Armadillo girdled lizard  
Nile crocodile  
African rock python

### **Aves**

Southern ground hornbill  
African marsh harrier  
Denham's bustard  
Jackass penguin

### **Mammalia**

Cape clawless otter  
South African hedgehog  
White rhinoceros  
Black wildebeest  
Spotted hyaena  
Black-footed cat  
Brown hyaena  
Serval  
African elephant  
Spotted-necked otter  
Honey badger  
Sharpe's grysbok  
Reedbuck  
Cape fox



**Appendix 6: GNR 982: Environmental Impact Assessment Regulations, 2014 of the National Environmental Management Act, 1998 (Act No. 107 of 1998).**

***GNR 982 Appendix 4: Content of environmental management programme (EMPr)***

1. (1) An EMPr must comply with section 24N of the Act and include-

(a) details of-

(i) the EAP who prepared the EMPr; and

(ii) the expertise of that EAP to prepare an EMPr, including a curriculum vitae;

(b) a detailed description of the aspects of the activity that are covered by the EMPr as identified by the project description;

(c) a map at an appropriate scale which superimposes the proposed activity, its associated structures, and infrastructure on the environmental sensitivities of the preferred site, indicating any areas that should be avoided, including buffers;

(d) a description of the impact management objectives, including management statements, identifying the impacts and risks that need to be avoided, managed and mitigated as identified through the environmental impact assessment process for all phases of the development including-

(i) planning and design;

(ii) pre-construction activities;

(iii) construction activities;

(iv) rehabilitation of the environment after construction and where applicable post closure; and

(v) where relevant, operation activities;

(e) a description and identification of impact management outcomes required for the aspects contemplated in paragraph (d);

(f) a description of proposed impact management actions, identifying the manner in which the impact management objectives and outcomes contemplated in paragraphs (d) and (e) will be achieved, and must, where applicable, include actions to -

(i) avoid, modify, remedy, control or stop any action, activity or process which causes pollution or environmental degradation;

(ii) comply with any prescribed environmental management standards or practices;

(iii) comply with any applicable provisions of the Act regarding closure, where applicable; and

(iv) comply with any provisions of the Act regarding financial provisions for rehabilitation, where applicable;

- (g) the method of monitoring the implementation of the impact management actions contemplated in paragraph (f);
- (h) the frequency of monitoring the implementation of the impact management actions contemplated in paragraph (f);
- (i) an indication of the persons who will be responsible for the implementation of the impact management actions;
- (j) the time periods within which the impact management actions contemplated in paragraph (f) must be implemented;
- (k) the mechanism for monitoring compliance with the impact management actions contemplated in paragraph (f);
- (l) a program for reporting on compliance, taking into account the requirements as prescribed by the Regulations;
- (m) an environmental awareness plan describing the manner in which-
  - (i) the applicant intends to inform his or her employees of any environmental risk which may result from their work; and
  - (ii) risks must be dealt with in order to avoid pollution or the degradation of the environment; and
- (n) any specific information that may be required by the competent authority.

***GNR 982 Appendix 6: Specialist reports***

1. (1) A specialist report prepared in terms of these Regulations must contain- (a) details of-
  - (i) the specialist who prepared the report; and
  - (ii) the expertise of that specialist to compile a specialist report including a curriculum vitae;
- (b) a declaration that the specialist is independent in a form as may be specified by the competent authority;
- (c) an indication of the scope of, and the purpose for which, the report was prepared;
- (d) the date and season of the site investigation and the relevance of the season to the outcome of the assessment;
- (e) a description of the methodology adopted in preparing the report or carrying out the specialised process;
- (f) the specific identified sensitivity of the site related to the activity and its associated structures and infrastructure;
- (g) an identification of any areas to be avoided, including buffers;
- (h) a map superimposing the activity including the associated structures and infrastructure on the environmental sensitivities of the site including areas to be avoided, including buffers;

- (i) a description of any assumptions made and any uncertainties or gaps in knowledge;
- (j) a description of the findings and potential implications of such findings on the impact of the proposed activity, including identified alternatives on the environment;
- (k) any mitigation measures for inclusion in the EMPr;
- (l) any conditions for inclusion in the environmental authorisation;
- (m) any monitoring requirements for inclusion in the EMPr or environmental authorisation; (n) a reasoned opinion-
  - (i) as to whether the proposed activity or portions thereof should be authorised; and
  - (ii) if the opinion is that the proposed activity or portions thereof should be authorised, any avoidance, management and mitigation measures that should be included in the EMPr, and where applicable, the closure plan;
- (o) a description of any consultation process that was undertaken during the course of preparing the specialist report;
- (p) a summary and copies of any comments received during any consultation process and where applicable all responses thereto; and
- (q) any other information requested by the competent authority.