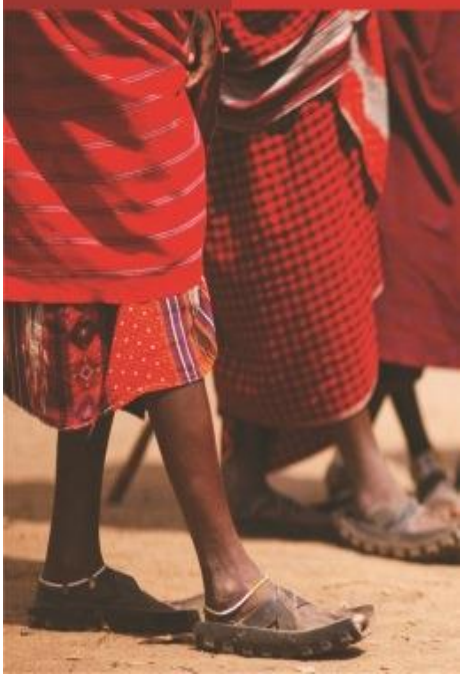

DIGBY WELLS
ENVIRONMENTAL

Sasol Sigma Defunct Colliery Surface Mitigation Project: Proposed River Diversion and Flood Protection Berms

Fauna & Flora Specialist Study

Project Number:

SAS5250

Prepared for:

Sasol Mining (Pty) Ltd

September 2018

Digby Wells and Associates (South Africa) (Pty) Ltd
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This document has been prepared by Digby Wells Environmental.

Report Type:	**Fauna & Flora Specialist Study**
Project Name:	**Sasol Sigma Defunct Colliery Surface Mitigation Project: Proposed River Diversion and Flood Protection Berms**
Project Code:	**SAS5250**

Name	Responsibility	Signature	Date
Lusanda Matee	Report Compiler		August 2018
Rudi Greffrath	Report Reviewer		August 2018
Brett Coutts	Report Reviewer		August 2018

EXECUTIVE SUMMARY

Digby Wells Environmental (Digby Wells) has been appointed by Sasol Mining (Pty) Ltd (Sasol Mining) as the Independent Environmental Assessment Practitioner (EAP) to ensure compliance by undertaking the required environmental regulatory process required for implementing the proposed surface mitigation measures to be implemented in areas of significant risk to pillar failure which can result in subsidence at the Sasol Sigma Defunct Colliery.

The study site is situated in the Grassland Biome (Highveld Grassland) of Southern Africa and is covered by the Soweto Highveld Grassland and Central Free State Grassland, which are both vulnerable as they are Endangered. The majority of the study area has undergone transformation and/or degradation due to current land use practices, such as grazing and agricultural related activities, mining and industry.

Upon the completion of the infield assessment, it was established that the study site can be divided into four main broad vegetation types or rather habitat units: Secondary Grassland, Woodland/Savanna, Alien vegetation, and Riparian/Wetland. Two transformed land units including Infrastructure & Mining and Agricultural fields were also recorded.

The study area was found to be in different states of sensitivity, with the riparian/wetland, areas, and secondary grassland areas designated as Medium Sensitivity while Alien vegetation and transformed areas being assigned low sensitivity. The Woodland/Savannah vegetation on site is in a disturbed ecological condition and was allocated a Medium Sensitivity, due to it falling inside the Soweto Highveld Grassland unit which is designated as Endangered according to Mucina & Rutherford (2012). The Secondary Grassland vegetation occurring on flat lower lying areas was overgrazed or cultivated and was in relatively poor condition. However, within the Sasol Mining the game farm area was assigned a Medium Sensitivity, as a result of ecosystem function that this area is providing.

During the infield assessment, only one plant species of Species of Conservation Concern (SCC) was recorded, this being *Hypoxis hemerocallidea*. PRECIS suggests that six other SSC may potentially occur within the study area. However, during the assessment undertaken by Digby Wells in 2013, none of these species weer recoreded. A *Kniphofia* spp colony was recorded in a wetland area during the infield assessment although it was not possible to identify it down to species level due to the timing of the assessment and the fact that *Kniphofia* species hybridize very easily. There is a possibility that it could be the protected species *Kniphofia typhoides Codd*, thus it is recommended that this is further assessed prior to clearing. Removal of this colony would require an on-site offset, which would require the creation of another suitable habitat for the *Kniphofia* plants and other hygrophytic herbs that occur, to which they would then need to be relocated. Faunal species of conservation concern that were recorded during the infield assessment include Black Wildebeest (*Connochaetes gnou*), Burchell's Zebra (*Equus quagga burchellii*), Secretary Bird (*Sagittarius serpentarius*), Melodious Lark (*Mirafra cheniana*) and African Open bill (*Anastomus lamelligerus*).

A total of 21 Alien Invasive Plants (AIP's) were recorded on site during the 2018 infield assessment. Of these eleven were listed AIP species according to National Environmental Management: Biodiversity 2004 (Act No. 10 of 2004) (NEMBA), while the remaining nine were either weeds or exotic plants. Six mammal species were recorded during the infield assessment and all of these were within the Sasol Mining private game farm. Lists of fauna and flora species that have been recorded for the broader area and could possibly occur within the study area have been included in the appendixes (Appendix B - Appendix F).

The risk assessment for the project indicates that certain activities of the construction phase pose a significantly risk of impacting negatively on the fauna and flora, some of which remain significant following mitigation such as clearance of natural habitat and excavation for canals. Habitat loss due to clearing and excavation for the construction of formalised canals (i.e. Leeuspruit Section 3 and 4) is the principal environmental impact of concern for this proposed project. Vegetation communities and habitats such as Secondary Grassland and more specifically wetland habitat will be impacted. For specific impacts associated to the wetlands, please refer to the Wetlands Assessment (Digby Wells, 2018).

The potential to recover certain secondary grassland landscapes could be achieved by re-vegetation on constructed surfaces, such as the berms and canals that will be implemented. Large sections of natural vegetation will be left relatively intact as clearing activities should be limited to the direct areas of construction. After time it is expected that faunal colonisation will occur within impacted habitats as faunal species move from natural areas back into the impacted sections that have been rehabilitated.

The no-go alternative in this particular instance refers to a situation where the proposed surface mitigations are not implemented. In the event that the proposed surface mitigation measures are not implemented, the potential loss of surface water flow could have larger reaching impacts to fauna and flora than the impacts associated with surface mitigation. The impacts associated with the surface mitigation measures with respect to fauna and flora will be highly localised and overtime through the implementation of rehabilitation measures the impacted areas should recover. The proposed surface mitigation measures will ensure that the system as a whole still functions for the long term.

Detailed methods are provided in this report for prevention, reduction, or remediating of adverse environmental impacts of the proposed surface mitigation measures and their associated activities.

It is important that the site preparation and surface mitigation infrastructure lay down is done with these sensitive areas in mind. The risk assessment for the project indicates that certain activities of the construction phase pose a significantly risk of impacting negatively on the fauna and flora, some of which remain significant following mitigation such as clearance of natural habitat and excavation for canals. Habitat loss due to clearing and excavation for the construction of formalised canals (i.e. Leeuspruit Section 3 and 4) is the principal environmental impact of concern for this proposed project.

It is however expected that the impacts of certain activities such as the construction of flood protection berms will be mostly local and restricted to the proposed mitigation areas and

immediate surrounds as the footprint of the proposed mitigation measures in relation to the surrounding environment is small. In addition to this, the potential to recover certain secondary grassland landscapes will also be presented by re-vegetation on constructed surfaces. As no complete clearing will occur, sections of natural vegetation will be left relatively intact within the site, therefore it is expected that some of the faunal components will return to the site once the construction phase has been completed.

It is the opinion of the specialist that the project may go ahead with the following conditions:

- During construction, all vehicles must make use of existing access routes. Where construction vehicles must traverse the site and make new access routes, these must be kept as narrow as possible and creating of multiple routes should be avoided.
- Vegetation clearing must be kept to a minimum, and this must only occur where it is absolutely necessary.
- Ensure that sufficient secondary grassland and wetland vegetation is retained to maintain ecological processes.
- Newly cleared soils will have to be re-vegetated and stabilised as soon as construction has been completed.
- Care must be taken to provide erosion and sedimentation control protection on the site such that construction runoff is directly away from the proposed infiltration berm location.
- Provision for adequate drainage on the flood protection berm is of paramount importance to ensure movement of water threw the berm. In addition to this, it is the instillation of adequate energy dissipation measures at each spillway outlet to reduce the risk of erosion.
- Rehabilitation of the river corridor must take place after the activities are complete to minimise the risk erosion and indigenous species should be utilised.
- Monitoring activities of structural stability and integrity must take place directly after completion of the construction and then every second month during the first year.
- All mitigation measures prescribed in this document will be adhered to strictly.

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1 Introduction

Digby Wells Environmental (hereafter Digby Wells) has been appointed by Sasol Mining (Pty) Ltd (Sasol Mining) as the independent Environmental Assessment Practitioner (EAP) to ensure compliance by undertaking the required environmental regulatory process required to implement the proposed surface mitigation measures at the Sigma Defunct Colliery (proposed project). This proposed project will require the following authorisations as listed in Table 1-1.

Table 1-1: Relevant Authorisations for Project

Authorisation Process	Relevant Legislation	Competent Authority
Environmental Authorisation – Basic Assessment (BA) Process	National Environmental Management Act, 1998 (Act No. 107 of 1998) (NEMA)	Department of Mineral Resources (DMR)
Water Use Licence (WUL)	National Water Act, 1998 (Act No. 36 of 1998) (NWA)	Department of Water and Sanitation (DWS)
Notification of Intent to Develop (NID)	National Heritage Resources Act, 1999 (Act No. 25 of 1999) (NHRA)	South African Heritage Resources Agency (SAHRA) and Free State Provincial Heritage Resources Authority (FS-PRHA)

The following Listed Activities in terms of NEMA that will be triggered by the proposed project have been listed below:

- Listing Notice 1 Activity 9 - It is proposed that the canals to divert the water will exceed 1000 metres in length and will have a width of 12.5 - 30 metres (Northern and southern diversion);
- Listing Notice 1 Activity 12 - The canals to be constructed to divert the water will exceed 100 square metres (m^2), which are proposed to be located within a watercourse;
- Listing Notice 1 Activity 19 - Movement of soil of more than 10 cubic metres (m^3) within a watercourse;
- Listing Notice 1 Activity 27 – The clearing of vegetation of more than 1 ha but less than 20 ha;
- Listing Notice 1 Activity 24 - Construction of access roads to the river during construction phase and maintenance to be undertaken during operational phase.

Activities identified as water uses in terms of Section 21 of the NWA may not be undertaken without a WUL or General Authorisation. The following Section 21 Water Uses (NWA) are triggered:

- Section 21(c): impeding or diverting the flow of water in a watercourse; and
- Section 21(i): altering the bed, banks, course or characteristics of a watercourse.

Construction of the diversion canals in proximity to wetlands and water resources will require a WUL to be undertaken.

The overall aim of this study was to undertake a fauna and flora assessment of the study areas in relation to where surface mitigation is being adopted. Information generated from this study has been used to assess the potential impacts that the proposed surface mitigations will have on this environment and prescribed suitable mitigation measures.

1.1 Locality

Sasol's Sigma Defunct Colliery is a defunct coal mine situated immediately southwest of the Sasolburg area, south of the Vaal River in the Free State Province, South Africa. It is located within the Fezile Dabi District Municipality, formerly known as Northern Free State District Municipality, which is one of the five districts of Free State Province. (Refer Figure 1-1).

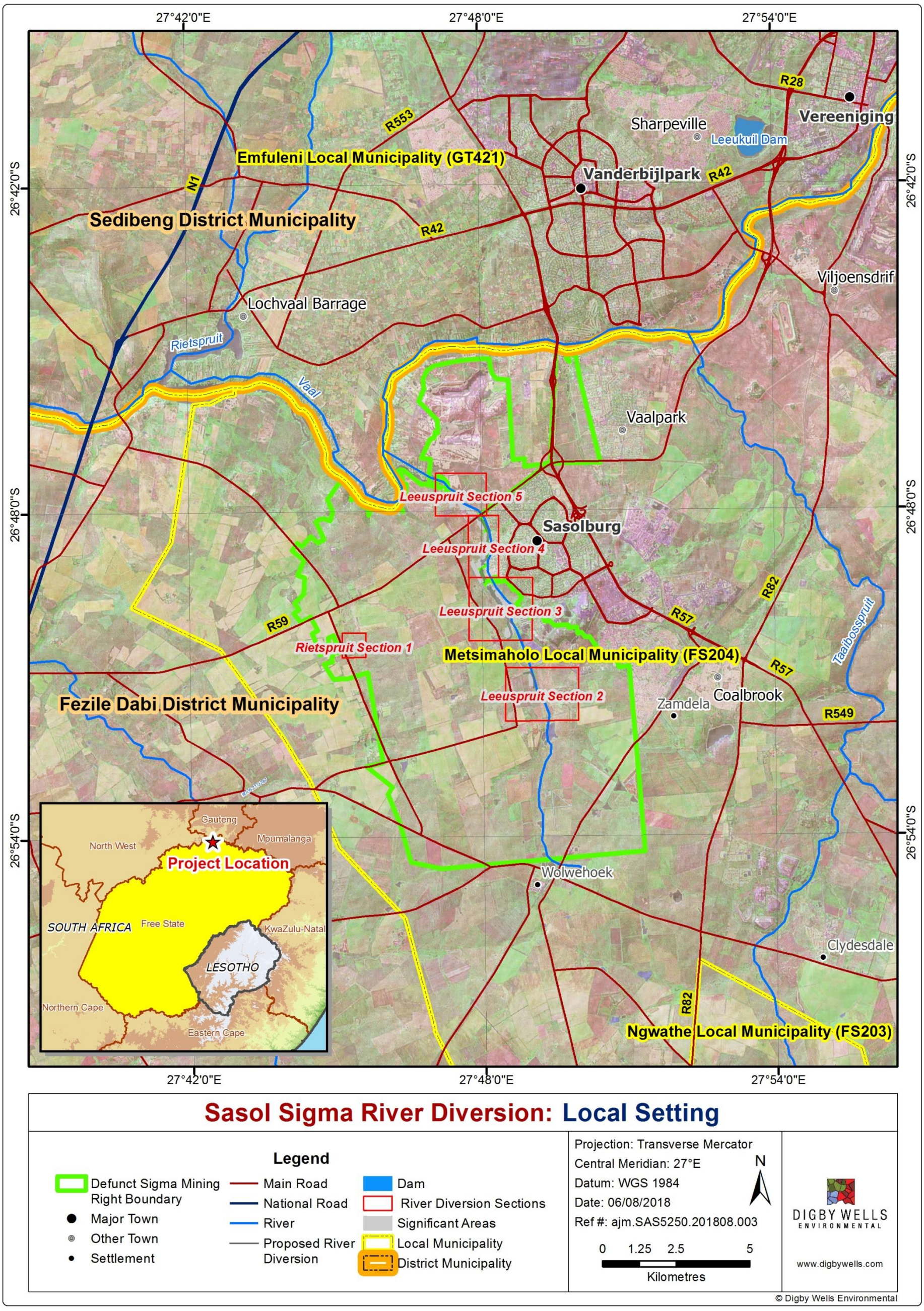

Figure 1-1: Locality Map

1.2 Project Description

Sasol Sigma Defunct Colliery is a defunct coal mine and the first Sasol owned mine. This Defunct Colliery occupies a historical mining area of approximately 11 643 ha. Mining activities at the Sigma Defunct Colliery were conducted under Mining Licences No. 1/2001 and 3/2001, granted by the Department of Mineral Resources (DMR). The first incline shaft for Sigma Colliery was completed on the 31st of August 1953 and operations commenced in 1954. Mining at Sigma Colliery was ceased in 2005 after which the mine was flooded. The Sigma Defunct Colliery consists of three underground mining sections and an opencast mine section. The Sigma Underground Operation is made up of, the defunct Mohlolo Underground Operation (Mohlolo North and Mohlolo South), and the defunct Wonderwater Opencast Mine.

Underground mining method was the primary method of extracting these reserves and included mechanised board-and-pillar, rib pillar extraction and bottom coaling methods. Access to the underground operations was via several shafts, and the coal was then conveyed to a ‘dry’ coal handling plant at 3 Shaft where the coal was screened and fed to silos.

In 1992 the Wonderwater opencast mine was developed to extract coal from the north-eastern side of the reserves which occupied a mining area of approximately 385 ha. The Wonderwater opencast mine was mined utilising truck and shovel methods. The mining ceased in 2005 after which the opencast mine was backfilled and rehabilitated. The final voids were left as part of the water management of the underground workings.

The Mohlolo Operations, situated adjacent to the Wonderwater opencast mine commenced with its activities in 1999 and occupied a mining area or approximately 264 ha. The underground operations were accessed from the Wonderwater opencast mines highwalls in the north and the south and divided the operations into Mohlolo North and Mohlolo South. The underground mining was scaled down and ceased by 2005, the underground mine workings were left to be flooded.

Sigma Defunct Colliery applied for mine closure where a closure application and closure report was submitted to the DMR in 2009. Sigma Defunct Colliery began to implement the proposed mitigation measures as per the requirements of the closure plan and Environmental Management Programme (EMP) to address all the significant risks and rehabilitation measures which were required to obtain the needed closure certificate. Jones and Wagener (J&W) were appointed to assist Sasol Mining in the compilation of a Risk Assessment Report for mine closure process to identify all the significant latent risks which Sigma Defunct Colliery have and rate them in accordance with the Sasol Risk Assessment Methodology. This report further proposed mitigation measures to be implemented to reduce the significant rated risks to an acceptable residue risk level. The report was compiled in 2015 and has now been updated in 2018.

As part of the risk report the mitigation measures have been proposed and grouped together as underground mitigation measures (ash backfilling) and surface mitigation measures (river diversions and berm constructions).

The underground mitigation measure which entails the ash backfilling of certain areas with ash slurry is being dealt with as a separate project and has not been incorporated as part of this project.

The surface mitigation measures that were considered include full stream diversions, partial stream diversion and ash backfilling of mined panels or various combinations thereof. A description of the various diversion types is provided below:

- Full stream diversion:
  - Typically consists of a diversion canal which follows along a completely new alignment from the original stream alignment. The streamflow is diverted along the new route and discharges back into the existing stream downstream of the affected area. A diversion canal mitigates the risk by moving the stream away from the significant risk area.
- Partial stream diversion:
  - A partial stream diversion entails confining the stream flow by means of either channelling the stream or flood protection berms or both in order for it not to cross areas where a significant chance of pillar failure which can result in subsidence could occur. The purpose of flood protection berms is to prevent the existing stream flow from entering significant risk areas. Where possible, flood protection berms are used in isolation, however, if the position of a berm obstructs the natural stream flow (i.e. crossing existing watercourse centreline), flood protection berms are used in combination with channelling the stream. This prevents unnecessary secondary issues, for example, backwater or ponding upstream of the berm, and allows unimpeded flow of the stream past the problem areas.
- Backfilling:
  - Ash backfilling is predominantly used where a full stream diversion or partial stream diversion alone does not mitigate the risk or where a diversion canal cannot avoid crossing over a significant risk area. In the case where a full diversion or partial diversion is not possible, only backfilling is proposed.
  - It must be noted that although mentioned, ash backfilling is being dealt with as a separate project and is not considered to be incorporated as part of this environmental authorisation process.

1.3 Surface Mitigation Measures

As mentioned above the surface mitigation measures have been divided into four sections along the Leeuspruit with only one section in the Rietspruit. A description of each section is provided below:

Table 1-2: Description of mitigation measures proposed for each section

Significant Risk Area	Mitigation Measure Implemented	Description
Leeuspruit: Section 2	■ Flood protection berm to be constructed to avoid one area of significant risk.	■ The flood protection berm will comprise of suitable material, typically clayey sand or sandy clay material obtained from other necessary excavations.
Leeuspruit: Section 3	■ Combination of diversion canals, flood protection berms and ash backfilling.	■ The proposed design comprises of two flood protection berms to direct the flow of water away from significant areas; ■ A formalised canal to divert the stream flow away from the natural stream flow path (Armorflex or a similar approved lining); and ■ Ash backfilling will be utilised were diversions are not possible. Ash Backfilling is considered to be a separate project and under a separate environmental authorisation process.
Leeuspruit: Section 4	■ Two Full stream diversion canals are proposed, namely the Southern diversion canal and Northern diversion canal; ■ Flood protection berms will also be utilised; and ■ Ash Backfilling will also be utilised.	■ This section is located immediately west of the Sasolburg residential area and comprises approximately 2.3km of the Leeuspruit, from the Afrikaans High Sasolburg up to the R59 provincial road; and ■ Ash backfilling will be utilised were diversions are not possible. Ash Backfilling is considered to be a separate project and under a separate environmental

Significant Risk Area	Mitigation Measure Implemented	Description
		authorisation process.
Leeuspruit: Section 5	■ This section's design comprises mainly of backfilling polygons due to surface restrictions on either side of the stream.	■ Located on the south-western side of the area is private infrastructure and northeast is an operational sand mine; and ■ Some of these areas have already been backfilled. Ash Backfilling is considered to be a separate project and under a separate environmental authorisation process.
Rietspruit: Section 1	■ Only one significant risk area has been identified; and ■ A flood protection berm is proposed.	■ Small diameter pipes will also be installed at low points along the berm to allow the slow release of water accumulated behind the berms.

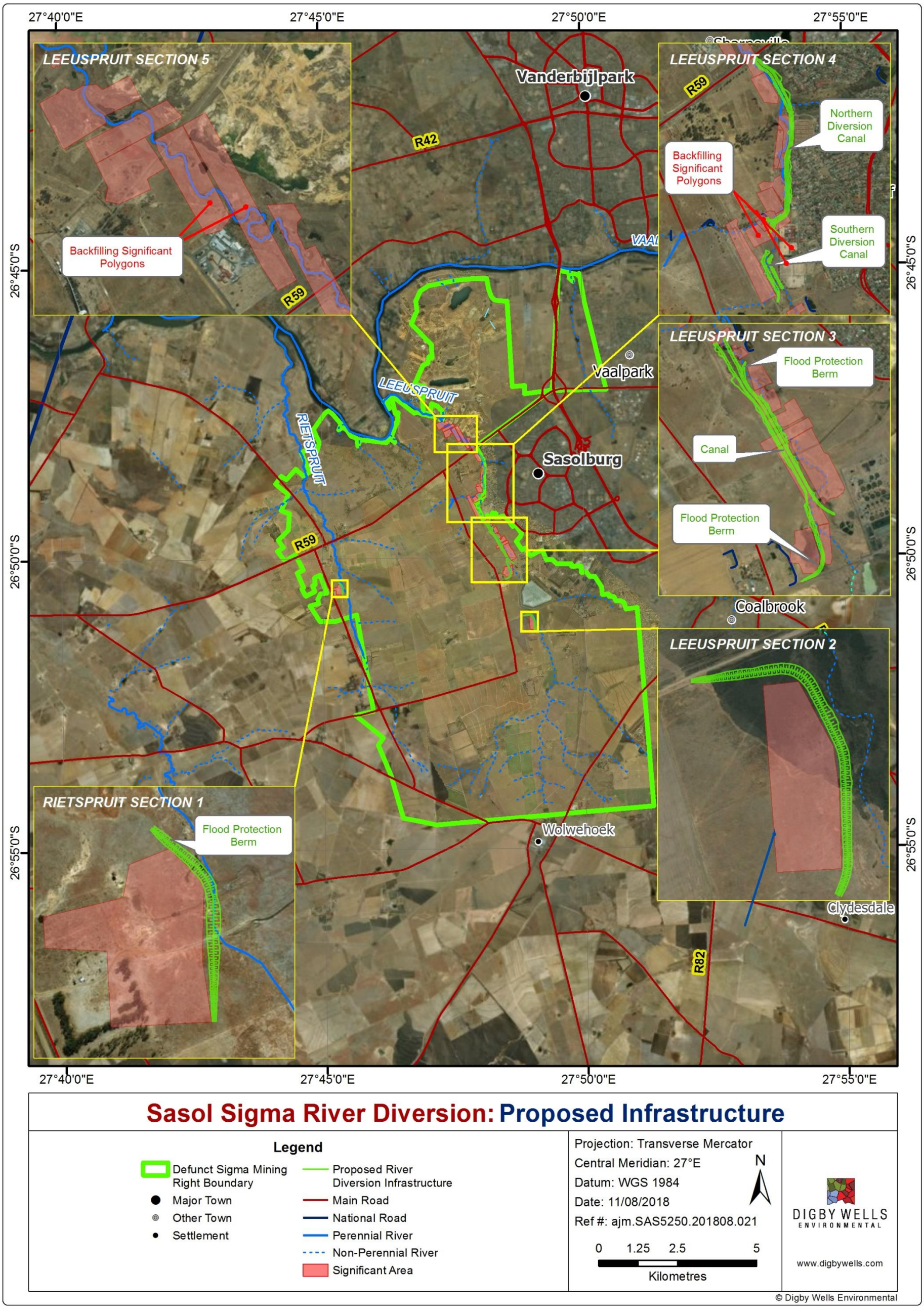

Figure 1-2: Sasol Sigma River Diversion Proposed Infrastructure

1.4 Terms of Reference

Digby Wells was commissioned by Sasol Mining to carry out a Fauna and Flora assessment for the proposed surface mitigations on the Leeuspruit and Rietspruit. This study addresses the following regulations and regulatory requirements:

- Section 21 of the Environment Conservation Act, 1989 (Act No. 73 of 1989);
- Section 24 of the Constitution of the Republic of South Africa, 1996 (Act No.108 of 1996) ;
- National Environmental Management Biodiversity Act, 2004 (Act No. 10 of 2004) (NEMBA); and
- Section 5 of the National Environmental Management Act, 1998 (Act No. 107 of 1998) (NEMA)

1.5 Aims and Objectives

The overall aim of this specialist study was to undertake a Fauna and Flora Assessment of the local fauna and flora communities associated with the study area and to identify and assess the fauna and flora risks and impacts of the proposed surface mitigations. To achieve the overall aim, the following objectives were considered for this specialist study:

- To delineate the various vegetation/habitat types present within the study area and describe their sensitivity;
- To determine if any fauna and flora species or assemblages will be directly impacted upon by the proposed surface mitigation measures, this includes fauna and flora communities present, the ecological state of these communities, identification of possible Red Data Listed species (according to the International Union for the Conservation of Nature (IUCN)) as well as considering National and Provincial criteria; and
- To determine mitigation measures for the identified impacts to reduce the severity of these impacts. In cases where impacts cannot be mitigated, areas may be regarded as ‘no-go’ owing to the presence of Species of Special Concern (SSC) or critical habitat.

To achieve these objectives, the following components were included as part of this specialist assessment:

- Results of the desktop study, including descriptions of general vegetation types/veld types/habitat associated with the faunal component present;
- List with all Red Data and protected fauna and flora species (Globally, National) and their red data/protected status;
- Species list of the floral component for each plant community;

- Dominant floral species for each plant community;
- Exotic species for each plant community;
- Distribution maps of Red Data and protected species recorded;
- Rare or endangered species, as well as all protected plants (if present) for each plant community, including a distribution map of listed red data and protected species, recorded;
- Species list (flora and fauna) for the entire area were compiled for each of the above mentioned;
- A list of endemic species (if present); and
- Mapping of Biodiversity Hotspots and sensitive areas.

2 Assumptions, Limitations, and Gaps in Knowledge

- It is assumed that third-party information obtained and discussed in this report is the most recent and accurate at the time of the compilation of this report.
- One dry season targeted survey was completed within the areas identified as significant risk (Leeuspruit and Rietspruit sections), thus it is possible that although every effort is made to cover as much of the site as possible, representative sampling is done and it is possible that some plant and animal species that are present on site were not recorded during the field investigations, due to seasonality. However, enough previous assessments have been done to give an indication of what species may be present.

3 Details of the Specialist

This Specialist Report has been compiled by the following specialists:

Table 3-1: Details of the Specialist(s) who prepared this Report

Responsibility	Report Writer
Full Name of Specialist	Lusanda Matee
Highest Qualification	MSc Biological Sciences
Years of experience in the specialist field	0.5
Registration(s):	South African Council for Natural Scientific Professionals: Professional Natural Scientist (Reg. No: 119257)

Responsibility	Technical Review
Full Name of Specialist	Rudi Greffrath
Highest Qualification	B-Tech Conservation Management
Years of experience in the specialist field	11
Registration(s):	South African Council for Natural Scientific Professionals: Professional Natural Scientist (Reg. No: 400018/17)

3.1 Declaration of the Specialists

I, Rudi Grefratth, as the appointed review environmental assessment practitioner (“REAP”), hereby declare/affirm the correctness of the information provided or to be provided as part of the application, and that I:

- in terms of the general requirement to be independent:
- other than fair remuneration for work performed/to be performed in terms of this application, have no business, financial, personal or other interest in the activity or application and that there are no circumstances that may compromise my objectivity; or
- am independent, and other than fair remuneration for work performed in terms of this application, have no business, financial, personal or other interest in the activity or application and that there are no circumstances that may compromise my objectivity;
- am fully aware of and meet all the requirements of Regulation 13, and that failure to comply with any the requirements may result in disqualification;
- • have reviewed/will review all the work undertaken by the EAP;
- have disclosed/will disclose, to the applicant, the EAP, the specialist (if any), the Department and interested and affected parties, all material information that have or

may have the potential to influence the decision of the Department or the objectivity of any report, plan or document prepared or to be prepared as part of the application; and

- am aware that a false declaration is an offence in terms of regulation 48 of the 2014 NEMA EIA Regulations

Signature of the specialist

Rudi Greffrath

Full Name and Surname of the specialist

Digby Wells Environmental

Name of company

11-09-2018

Date

I, Lusanda Matee, as the appointed specialist, hereby declare/affirm the correctness of the information provided or to be provided as part of the application, and that I:

- in terms of the general requirement to be independent:
- other than fair remuneration for work performed/to be performed in terms of this application, have no business, financial, personal or other interest in the activity or application and that there are no circumstances that may compromise my objectivity; or
- am not independent, but another specialist that meets the general requirements set out in Regulation 13 has been appointed to review my work (Note: a declaration by the review specialist must be submitted);
- in terms of the remainder of the general requirements for a specialist, am fully aware of and meet all the requirements and that failure to comply with any of the requirements may result in disqualification;
- have disclosed/will disclose, to the applicant, the Department and interested and affected parties, all material information that has or may have the potential to influence the decision of the Department or the objectivity of any report, plan or document prepared or to be prepared as part of the application;
- have ensured/will ensure that information containing all relevant facts in respect of the application was/will be distributed or was/will be made available to interested and affected parties and the public and that participation by interested and affected parties was/will be facilitated in such a manner that all interested and affected parties were/will be provided with a reasonable opportunity to participate and to provide comments.

Signature of the specialist

Lusanda Patrick Herbert Matee

Full Name and Surname of the specialist

Digby Wells Environmental

Name of company

11-09-2018

Date

4 Methodology and Scope of Work

4.1 Site visit

A single season targeted field assessment was conducted by a suitably qualified Digby Wells Fauna and Flora specialist between the 23rd - 24th July 2018 to assess the status of biodiversity within the proposed mine closure and river diversion study area. For this purpose, the Leeuspruit was divided into four sections whereas the Rietspruit only had one section (Figure 1-2). This was done as these are the areas where surface mitigation will be adopted and the potential impacts/ risks are discussed per aspect, per River Section and per each phase of the project. Vegetation and fauna surveys were completed in each of the Leeuspruit sections as well as the Rietspruit section to assess the impact of the proposed surface mitigation measures as outlined in Section 1.3.

4.2 Vegetation Analysis

4.2.1 Sample Plots

Representative samples of the vegetation were assessed as extensive baseline data was available for the site, thus detailed in depth studies were not required. The vegetation was classified according to available aerial imagery as well as through available baseline data from the Fauna and Flora Report for the Sasol Sigma Ash Backfill Project originally undertaken by Digby Wells in 2013.

The number of sample sites visited was determined by the time available for the study as well as the accessibility of each of the sample sites. Areas of each vegetation type that were classified before going to the site were sampled randomly.

This methodology allows for more efficient sampling than overall random sampling. Plants that could not be identified in the field through the use of field guides were collected and photographed. These were identified later through the suitable reference documentation, including field guides.

The Braun Blanquet method was used for the listing of species. The Braun Blanquet method is the standard for phytosociological studies (plant description and mapping) in South Africa and is an internationally recognised method of surveying for plants.

4.2.2 Vegetation Mapping

Using the vegetation types as defined by the above noted analyses as well as the aerial imagery and past vegetation delineations, the vegetation of the site was mapped.

4.2.3 Flora

4.2.3.1 Species List

A desktop study was undertaken, aiming to produce a checklist of all species identified on site. The following literature was consulted for this purpose:

- PRECIS (National Herbarium, Pretoria (PRE) Computerised Information System);
- SIBIS: SABIF – South African Biodiversity Information Facility;
- Mucina and Rutherford, 2012. The vegetation of South Africa, Lesotho and Swaziland; and
- Greffrath, R., 2013. Fauna and Flora Report for the Sasol Sigma Ash Backfill Project, Sasolburg: Unpublished report by Digby Wells Environmental.

4.2.3.2 Species of Special Concern

From the overall species list, a list of Species of Special Concern (SSC) can be drawn up. To be fully comprehensive, this list includes plants from the following lists:

- The SANBI Red List of South African Plants version 2017.1;
- National Environmental Management: Biodiversity Act, (Act No. 10 of 2004) (NEMBA): Threatened and Protected Species;
- National Forests Act, 1998 (Act No. 84 of 1998) (NFA) Protected Trees; and
- Free State Nature Conservation Ordinance 8 of 1969.

A list of SCC expected to be found in the study area was compiled at a desktop level, which ascribed these species as Possible Species of Special Concern (PSSC). If any of these species was confirmed or rather recorded on site, they were then ascribed the status Confirmed Species of Special Concern (CSSC).

The South African Red Data list uses the same criteria as that defined by the IUCN. According to the IUCN, all species are classified in nine groups, set through criteria such as rate of decline, population size, the area of geographic distribution, and degree of population and distribution fragmentation (IUCN, 2017). The categories are described in Table 4-1 below.

Table 4-1: Red Data Categories (IUCN, 2017)

Category		Description
Extinct	(EX)	No known individuals remaining.
Extinct in the Wild	(EW)	Known only to survive in captivity.
Critically Endangered	(CR)	Extremely high risk of extinction in the wild.
Endangered	(EN)	High risk of extinction in the wild

Vulnerable	(VU)	High risk of endangerment in the wild.
Near Threatened	(NT)	Likely to become endangered in the near future.
Least Concern	(LC)	Lowest risk. Does not qualify for a more at risk category. Widespread and abundant taxa are included in this category.
Data Deficient	(DD)	Not enough data to make an assessment of its risk of extinction.
Not Evaluated	(NE)	Has not yet been evaluated against the criteria.

The online IUCN database was referenced in order to identify Red Data species and their various threat status categorisations.

4.2.3.3 Alien Invasive Species

Alien invasive plant species (AIP) are a problem of global significance as they replace indigenous plant species if not controlled. Other significant associated impacts of these plant species include reduced surface water runoff and groundwater reserves, increased biomass, fire intensity and significantly reduced biodiversity. Chapter 5 of NEMBA deals specifically with species and organisms posing potential threats to biodiversity.

According to this Act and the regulations, any species designated under section 70 cannot be propagated, grown, bought, or sold without a permit. AIPS are listed and classified into one of the following categories:

- Category 1a: Invasive species requiring compulsory control. Any specimens of Category 1a listed species need, by law, to be eradicated from the environment. No permits will be issued.
- Category 1b: Invasive species requiring compulsory control as part of an invasive species control programme. Remove and destroy. These plants are deemed to have such a high invasive potential that infestations can qualify to be placed under a government-sponsored invasive species management programme. No permits will be issued.
- Category 2: Invasive species regulated by area. A demarcation permit is required to import, possess, grow, breed, move, sell, buy, or accept as a gift any plants listed as Category 2 plants. No permits will be issued for Cat 2 plants to exist in riparian zones.
- Category 3: Invasive species regulated by activity. An individual plant permit is required to undertake any of the following restricted activities (import, possess, grow, breed, move, sell, buy or accept as a gift) involving a Category 3 species. No permits will be issued for Cat 3 plants to exist in riparian zones.

During the site assessment, alien invasive species for the site were noted and recorded.

4.2.4 Fauna

4.2.4.1 Faunal Survey

One seasonal study of faunal species was conducted concurrently with vegetation surveys. All fauna species encountered on site were identified and recorded. The following methods described below were used during the survey. All methods were applied in each of the river sections listed in Section 1.3

4.2.4.1.1 Mammals

Small mammals were sampled through opportunistic sightings, tracks, dung and refuge examination. Large mammals were recorded using scats, tracks, and nesting or breeding sites such as burrows and dens. Scats and tracks found during active searches were photographed alongside a scale and identified. For identification purposes, the field guides used include Smither's Mammals of Southern Africa (Apps, 2012), The Mammals of the Southern African Sub-region (Skinner & Chimimba, 2005), and the Red Data Book of the Mammals of South Africa (Friedman & Daly 2004).

4.2.4.1.2 Avifauna

Transect surveys and random point surveys were the principal ornithological field survey techniques used. Transect surveys were planned based on representative sites of different avifauna habitat, such as pans, dams, wetlands, agricultural fields, woodlands and open grassland by simply following available roads and paths that transect over these habitat types. Transect procedures involve slow attentive walks along transects during which any bird seen or heard is identified and recorded; this was completed during diurnal surveys only.

The following was recorded:

- All birds encountered or noted during the survey;
- All birds observed by people residing in the study area; and
- A list of rare and endangered species encountered.

Visual identification of birds was used to confirm bird calls where possible. Bird species were confirmed using Sasol Birds of Southern Africa, fourth edition (Sinclair, 2012)

4.2.4.1.3 Herpetofauna (Reptiles and Amphibians)

Herpetofauna includes reptile and amphibian species. Direct/opportunistic observations were conducted along trails or paths within the study area. Any herpetofauna species seen or heard along such paths or trails within the study area were identified and recorded. Another method used was refuge examinations using visual scanning of terrains to record smaller herpetofauna species that often conceal themselves under rocks, in fallen logs, rotten tree stumps, in leaf litter, rodent burrows, ponds, old termite mounds.

4.2.4.1.4 Macro-invertebrates

Direct/opportunistic observations were conducted along trails or paths within the study area. Identification of any recorded macro-invertebrates was completed to the lowest taxonomic levels using current macroinvertebrate identification keys based on the methods of Picker *et al.* (2002), with slight modifications.

4.2.4.1.5 Red Data Faunal Assessment

Using baseline data available for the site as well as data from the Animal Demographic Unit (ADU) Virtual Museum database (http://vmus.adu.org.za) at a desktop level, a list of red data faunal species that could potentially occur on site was compiled. This was then used to aid identification and confirm the presence of these species during the infield assessment. The IUCN Red Data categories (2017) were used for the status identification of mammals, birds, reptiles, and amphibians globally.

4.3 Sensitive Areas

A previous Fauna and Flora assessment completed by Digby Well in 2013, as part of the Ash backfill project identified and delineated sensitive ecosystems as listed by NEMBA, and described by provincial and national legislation. A brief assessment was done to confirm the presence of these areas and to determine whether there were any changes from the baseline.

4.3.1 Legislation

Red Data Books or RDBs are lists of threatened plants and animals specific to a certain region. These are vital sources of information in guiding conservation decisions. South Africa has produced 5 RDBs dealing with each of the following: birds, land mammals, fish (freshwater and estuarine only), reptiles and amphibians, and butterflies.

The conservation status of a plant or animal species is described by the following terms:

- **Extinct:** species of which there is no reasonable doubt that the last individual has died. Species are classified as Extinct only once exhaustive surveys throughout the species' known range have failed to record an individual.
- **Critically Endangered (CR)**: species for which best available evidence indicates that it meets at least one of the five IUCN criteria for Critically Endangered, indicating that the species is facing an extremely high risk of extinction.
- **Endangered:** species for which there is available evidence indicating that it meets at least one of the five IUCN criteria for Endangered, indicating that the species is facing a very high risk of extinction.
- **Vulnerable:** species for which best available evidence indicates that it meets at least one of the five IUCN criteria for Vulnerable, indicating that the species is facing a high risk of extinction i.e. facing an extremely high risk of extinction in the wild in the medium-term future, although they are not an endangered species

- **Rare:** species that meets at least one of four South African criteria for rarity, but is not exposed to any direct or plausible potential threat and does not qualify for a category of threat according to one of the five IUCN criteria i.e. a species with small populations, which are not yet vulnerable or endangered, but which are at risk.
- **Critically Rare**: species are known to occur at a single site, but is not exposed to any direct or plausible potential threat and does not otherwise qualify for a category of threat according to one of the five IUCN criteria
- **Threatened**: commonly used as a collective description for species which are critically endangered, endangered or vulnerable.
- **Near Threatened**: a species is considered as Near Threatened when it has been evaluated but does not qualify for endangered or vulnerable but it is likely to fall within the threatened category in future
- **Least Concern**: a species is Least Concern if it is widespread and abundant and thus considered at low risk of extinction
- **Endemic**: species that are restricted to one region and occur nowhere else. A threatened endemic is a conservation priority.

4.3.1.1 IUCN

The IUCN Red List of Threatened Species provides taxonomic, conservation status and distribution information on plants and animals that have been globally evaluated using the IUCN Red List Categories and Criteria. This system is designed to determine the relative risk of extinction, and the main purpose of the IUCN Red List is to catalogue and highlight those plants and animals that are facing a higher risk of global extinction (i.e. those listed as Critically Endangered, Endangered, and Vulnerable). The IUCN Red List also includes information on plants and animals that are categorised as Extinct or Extinct in the Wild; on taxa that cannot be evaluated because of insufficient information (i.e., are Data Deficient); and on plants and animals that are either close to meeting the threatened thresholds or that would be threatened were it not for an ongoing taxon-specific conservation programme (i.e., are Near Threatened).

Plants and animals that were evaluated to have a low risk of extinction are classified as Least Concern (IUCN.org) (Figure 4-1).

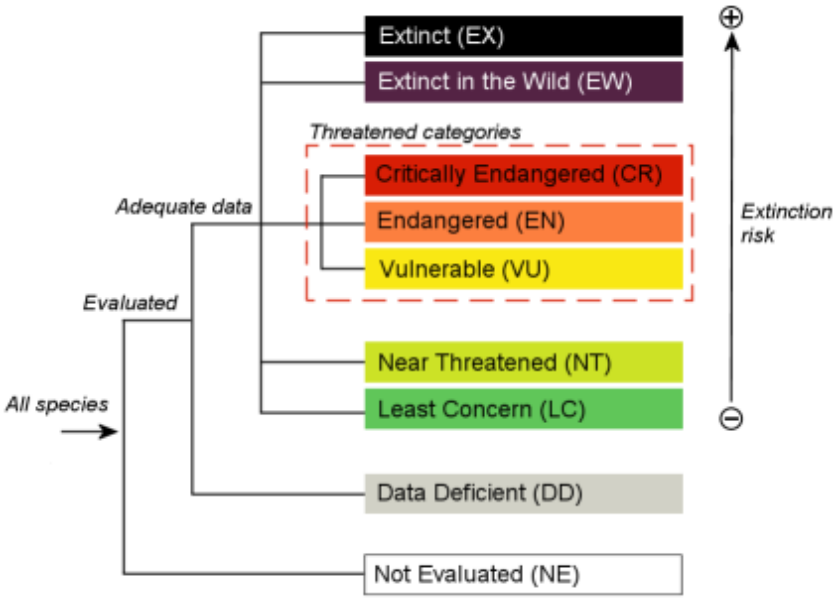

Figure 4-1: IUCN Categories

Abbreviations: EW =Extinct in the Wild; CR =Critically Endangered; EN =Endangered; VU= Vulnerable; NT= Near Threatened; Declining= LC species declining; Rare= LC species considered critically Rare or Rare; LC =Least Concern; DDD= Data Deficient–Insufficient Information; DDT =Data Deficient–Taxonomically Uncertain; NE= Not Evaluated

4.3.1.2 CITES

The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) is an international agreement between governments. Its aim is to ensure that international trade in specimens of wild animals and plants does not threaten their survival (CITES.org).

CITES works by subjecting international trade in specimens of selected species to certain controls. All import, export, re-export, and introduction from species covered by the CITES must be authorised through a licensing system. Each Party to the Convention must designate one or more Management Authorities in charge of administering that licensing system and one or more Scientific Authorities to advise them on the effects of trade on the status of the species (CITES.org).

Specimens are divided into Appendices I, II and III according to the restriction on trade:

- Appendix I: Species threatened with extinction. Trade in specimens of these species is permitted only in exceptional circumstances;
- Appendix II: Species not necessarily threatened with extinction, but in which trade must be controlled in order to avoid utilization incompatible with their survival; and
- Appendix III: Species that are protected in at least one country, which has asked other, CITES Parties for assistance in controlling the trade.

Changes to Appendix III follows a distinct procedure from changes to Appendices I and II, as each Party is entitled to make unilateral amendments to it.

4.4 Impact Assessment Methodology

Impacts and risks have been identified based on a description of the activities to be undertaken. Once impacts have been identified, a numerical environmental significance rating process will be undertaken that utilises the probability of an event occurring and the severity of the impact as factors to determine the significance of a particular environmental impact.

The severity of an impact is determined by taking the spatial extent, the duration, and the severity of the impacts into consideration. The probability of an impact is then determined by the frequency at which the activity takes place or is likely to take place and by how often the type of impact in question has taken place in similar circumstances.

Following the identification and significance ratings of potential impacts, mitigation and management measures will be incorporated into the EMP.

Details of the impact assessment methodology used to determine the significance of physical, biophysical, and socio-economic impacts are provided below.

The significance rating process follows the established impact/risk assessment formula:

Significance = CONSEQUENCE X PROBABILITY X NATURE

Where

Consequence = intensity + extent + duration

And

Probability = likelihood of an impact occurring

And

Nature = positive (+1) or negative (-1) impact

The matrix calculates the rating out of 147, whereby intensity, extent, duration, and probability are each rated out of seven as indicated in Table 4-3. The weight assigned to the various parameters is then multiplied by +1 for positive and -1 for negative impacts.

Impacts are rated prior to mitigation and again after consideration of the mitigation has been applied; post-mitigation is referred to as the residual impact. The significance of an impact is

determined and categorised into one of seven categories (The descriptions of the significance ratings are presented in Table 4-4).

It is important to note that the pre-mitigation rating takes into consideration the activity as proposed, (i.e., there may already be some mitigation included in the engineering design). If the specialist determines the potential impact is still too high, additional mitigation measures are proposed.

Table 4-2: Impact Assessment Parameter Ratings

Rating	Intensity/ Irreplaceability		Extent	Duration/Reversibility	Probability
	Negative Impacts (Nature = -1)	**Positive Impacts (Nature = +1)**			
7	Irreplaceable loss or damage to biological or physical resources or **highly** sensitive environments. Irreplaceable damage to **highly sensitive** cultural/social resources.	Noticeable, on-going natural and/or social benefits which have improved the overall conditions of the baseline.	International The effect will occur across international borders.	Permanent: The impact is irreversible, even with management, and will remain after the life of the project.	Definite: There are sound scientific reasons to expect that the impact will definitely occur. >80% probability.
6	Irreplaceable loss or damage to biological or physical resources or **moderate to highly** sensitive environments. Irreplaceable damage to cultural/social resources of **moderate to highly** sensitivity.	Great improvement to the overall conditions of a large percentage of the baseline.	National Will affect the entire country.	Beyond project life: The impact will remain for some time after the life of the project and is potentially irreversible even with management.	Almost certain / Highly probable: It is most likely that the impact will occur.>65 but <80% probability.

Rating	Intensity/ Irreplaceability		Extent	Duration/Reversibility	Probability
	Negative Impacts (Nature = -1)	**Positive Impacts (Nature = +1)**			
5	Serious loss and/or damage to physical or biological resources or **highly** sensitive environments, limiting ecosystem function. Very serious widespread social impacts. Irreparable damage to highly valued items.	On-going and widespread benefits to local communities and natural features of the landscape.	Province/ Region Will affect the entire province or region	Project Life (>15 years): The impact will cease after the operational lifespan of the project and can be reversed with sufficient management.	Likely: The impact may occur. <65% probability.
4	Serious loss and/or damage to physical or biological resources or **moderately** sensitive environments, limiting ecosystem function. On-going serious social issues. Significant damage to structures/items of cultural significance.	Average to intense natural and/or social benefits to some elements of the baseline.	Municipal Area Will affect the whole municipal area.	Long term: 6-15 years and impact can be reversed with management.	Probable: Has occurred here or elsewhere and could therefore occur. <50% probability.

Rating	Intensity/ Irreplaceability		Extent	Duration/Reversibility	Probability
	Negative Impacts (Nature = -1)	**Positive Impacts (Nature = +1)**			
3	Moderate loss and/or damage to biological or physical resources of **low to moderately** sensitive environments and, limiting ecosystem function. On-going social issues. Damage to items of cultural significance.	Average, on-going positive benefits, not widespread but felt by some elements of the baseline.	Local Local including the site and its immediate surrounding area.	Medium term: 1-5 years and impact can be reversed with minimal management.	Unlikely: Has not happened yet but could happen once in the lifetime of the project, therefore there is a possibility that the impact will occur. <25% probability.
2	**Minor loss and/or effects** to biological or physical resources or low sensitive environments, not affecting ecosystem functioning. Minor medium-term social impacts on the local population. Mostly repairable. Cultural functions and processes not affected.	Low positive impacts experienced by a small percentage of the baseline.	Limited Limited extending only as far as the development site area.	Short term: Less than 1 year and is reversible.	Rare/improbable: Conceivable, but only in extreme circumstances. The possibility of the impact materialising is low as a result of design, historical experience, or implementation of adequate mitigation measures. <10% probability.

Rating	Intensity/ Irreplaceability		Extent	Duration/Reversibility	Probability
	Negative Impacts (Nature = -1)	**Positive Impacts (Nature = +1)**			
1	**Minimal to no loss** and/or effect to biological or physical resources, not affecting ecosystem functioning. Minimal social impacts, low-level repairable damage to commonplace structures.	Some low-level natural and/or social benefits felt by a very small percentage of the baseline.	Very limited/Isolated Limited to specific isolated parts of th site.	Immediate: Less than 1 month and is completely reversible without management.	Highly unlikely / None: Expected never to happen. <1% probability.

Table 4-3: Probability/Consequence Matrix

Significance																																						
-147	-140	-133	-126	-119	-112	-105	-98	-91	-84	-77	-70	-63	-56	-49	-42	-35	-28	-21	21	28	35	42	49	56	63	70	77	84	91	98	105	112	119	126	133	140	147
-126	-120	-114	-108	-102	-96	-90	-84	-78	-72	-66	-60	-54	-48	-42	-36	-30	-24	-18	18	24	30	36	42	48	54	60	66	72	78	84	90	96	102	108	114	120	126
-105	-100	-95	-90	-85	-80	-75	-70	-65	-60	-55	-50	-45	-40	-35	-30	-25	-20	-15	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100	105
-84	-80	-76	-72	-68	-64	-60	-56	-52	-48	-44	-40	-36	-32	-28	-24	-20	-16	-12	12	16	20	24	28	32	36	40	44	48	52	56	60	64	68	72	76	80	84
-63	-60	-57	-54	-51	-48	-45	-42	-39	-36	-33	-30	-27	-24	-21	-18	-15	-12	-9	9	12	15	18	21	24	27	30	33	36	39	42	45	48	51	54	57	60	63
-42	-40	-38	-36	-34	-32	-30	-28	-26	-24	-22	-20	-18	-16	-14	-12	-10	-8	-6	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40	42
-21	-20	-19	-18	-17	-16	-15	-14	-13	-12	-11	-10	-9	-8	-7	-6	-5	-4	-3	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
-21	-20	-19	-18	-17	-16	-15	-14	-13	-12	-11	-10	-9	-8	-7	-6	-5	-4	-3	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
Consequence																																						

Table 4-4: Significance Rating Description

Score	Description	Rating
109 to 147	A very beneficial impact that may be sufficient by itself to justify implementation of the project. The impact may result in a permanent positive change	Major (positive) (+)
73 to 108	A beneficial impact which may help to justify the implementation of the project. These impacts would be considered by society as constituting a major and usually a long-term positive change to the (natural and/or social) environment	Moderate (positive) (+)
36 to 72	A positive impact. These impacts will usually result in a positive medium to long-term effect on the natural and/or social environment	Minor (positive) (+)
3 to 35	A small positive impact. The impact will result in medium to short-term effects on the natural and/or social environment	Negligible (positive) (+)
-3 to -35	An acceptable negative impact for which mitigation is desirable. The impact by itself is insufficient even in combination with other low impacts to prevent the development being approved. These impacts will result in a negative medium to short-term effects on the natural and/or social environment	Negligible (negative) (-)
-36 to -72	A minor negative impact requires mitigation. The impact is insufficient by itself to prevent the implementation of the project but which in conjunction with other impacts may prevent its implementation. These impacts will usually result in a negative medium to the long-term effect on the natural and/or social environment	Minor (negative) (-)
-73 to -108	A moderate negative impact may prevent the implementation of the project. These impacts would be considered as constituting a major and usually a long-term change to the (natural and/or social) environment and result in severe changes.	Moderate (negative) (-)
-109 to -147	A major negative impact may be sufficient by itself to prevent implementation of the project. The impact may result in permanent change. Very often these impacts are immitigable and usually result in very severe effects. The impacts are likely to be irreversible and/or irreplaceable.	Major (negative) (-)

5 Baseline Environment

5.1 Regional Vegetation

The study area is situated within the Grassland Biome of South Africa. It lies within the Highveld Grasslands which is characterised by flat grasslands and rolling rocky zones on top of the escarpment. The Quarter Degree Square (QDS) that the study area occupies is 2627 DD. According to the Vegetation Map of South Africa, Lesotho, and Swaziland (Mucina & Rutherford, 2012), two vegetation units were identified namely the Soweto Highveld Grassland and the Central Free State Grassland. Both these vegetation types are Endangered nationally with none conserved and some altered, primarily by cultivation. (Refer to Figure 5-1)

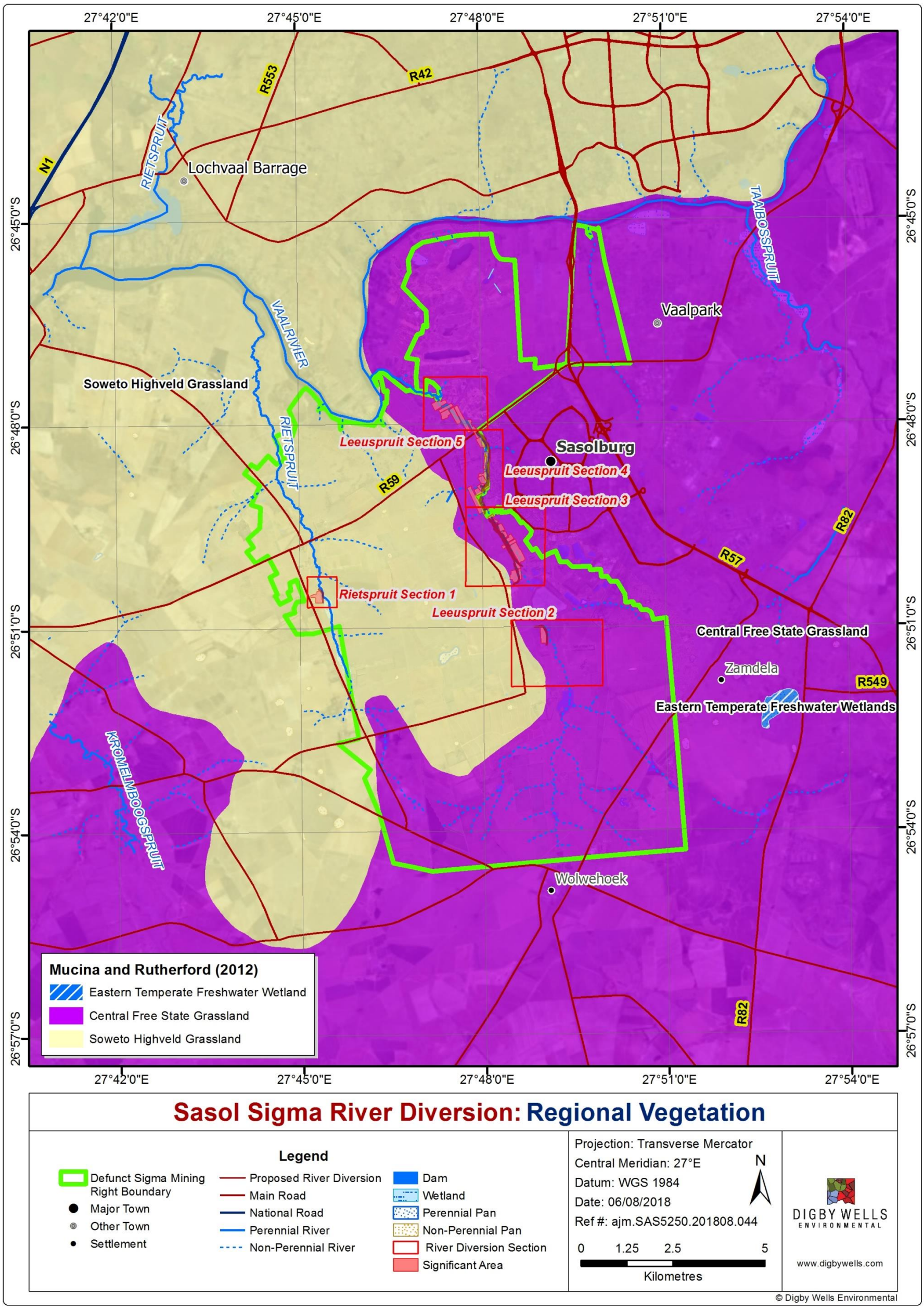

Figure 5-1: Regional Vegetation Types

5.1.1 Soweto Highveld Grassland (Gm8) Vegetation Unit

The Soweto Highveld Grassland unit is characterized by a gently to moderately undulating landscape that supports short to medium-high, dense, tufted grassland dominated almost entirely by *Themeda triandra* (Red Grass) and accompanied by a variety of other grasses such as *Elionurus muticus* (Wire Grass), *Eragrostis racemosa* (Narrow Heart Love Grass), *Heteropogon contortus* (Spear Grass) and *Tristachya leucothrix* (Hairy Trident Grass) (Mucina & Rutherford, 2012) (Refer to Table 5-1). The Soweto Highveld Grassland vegetation type is an endangered vegetation type of which only isolated remnants remain due to large-scale transformation through mining, cultivation, and urban sprawl. Furthermore, in terms of in terms of Section 52 of the NEMBA Government Gazette, 2011), Soweto Highveld Grassland is also listed as a Vulnerable ecosystem. The conservation target is 24%. Only a handful of patches statutorily conserved (Waldrift, Krugersdorp, Leeuwkuil, Suikerbosrand, and Rolfe's Pan Nature Reserves) or privately conserved (Johanna Jacobs, Tweefontein, Gert Jacobs, Nikolaas, and Avalon Nature Reserves, Heidelberg Natural Heritage Site).

5.1.2 Central Free State Grassland

Certain parts of the study area fall within the Central Free State Grassland (Gh6) this is a component of the Grassland Biome. This vegetation unit mostly occurs in the Free State Province and marginally into Gauteng Province in a broad zone from around Sasolburg in the north to Dewetsdorp in the south, also including towns such as Kroonstad, Ventersburg, and Steynsrus. Lindley, Winburg, and Edenvale.

The landscape is characterised by undulating plains supporting short grassland. Under natural conditions, it is dominated by *Themeda triandra* (Red Grass), whereas in disturbed area it is dominated by *Eragrostis curvula* (African Love Grass) and *E. chloromelas* (Blue Love Grass) (Refer to Table 5-1). Dwarf Karoo-shrubs establish in severely degraded clayey bottomlands and overgrazed and trampled low-lying areas are prone to *Vachellia karroo* (Sweet Thorn) encroachment. This vegetation type is classified as Vulnerable and the nationally set conservation target is 24%, only a small extent (<1%) is currently protected and 23% is considered to be transformed (Mucina & Rutherford, 2012).

Small portions of this vegetation type are statutorily conserved (Willem Pretorius, Rustfontein, and Koppies Dam Nature Reserves) as well as some protection in private nature reserves. Almost a quarter of the area has been transformed either for cultivation or by the building of dams (Allemanskraal, Erfenis, Groothoek, Koppies, Kroonstad, Lace Mine, Rustfontein, and Weltevrede). This vegetation type is not listed in the National List of Ecosystems that are threatened and in need of protection. No serious infestation by AIPs has been observed, however encroachment of dwarf Karoo shrubs becomes a problem in the degraded southern parts of this vegetation unit (severely degraded clayey bottom lands)

Table 5-1: Common and Characteristic Plant Species for the Central Free State and Soweto Grasslands

Plant form	Central Free State Grassland	Soweto Highveld Grassland
Graminoids	*Aristida adescensiois* (Annual Three-Awn), *A. congesta (*,Tassel Three-Awn) *Cynodon dactylon* (Bermuda Grass)*, Eragrostis chloromelas* (Curly Leaf)*, E. curvula* (African Love Grass)*, E. plana* (Weeping Love Grass)*, Panicum coloratum* (Small Buffalo Grass), *Setaria sphacelata* (African Bristle Grass), *Themeda triandra* (Red Grass), *Tragus koelerioides* (Carrot Grass)*, Agrostis lachnantha* (Bent Grass), *Andropogon appendiculatus*,(Blue Grass) *Aristida bipartite* (Rolling Three-awned Grass), *A. canescens, (*Pale Three-Awn) *Cymbopogon pospischilii* (Bitter Turpentine Grass) *Cynodon transvaalensis* (African Bermuda Grass), *Digitaria argyrograpta, Elionurus* muticus (,Wire Lemon Grass) *Eragrostis lehmanniana* (,Lehmann's Love Grass) *E. micrantha* (,Finesse Grass) *E. obtusa, E. racemosa* (Narrow Heard Love Grass)*, E. trichophora* (Atherstone's Grass), *Heteropogon contortus* (Spear Gass), *Microchloa caffra* (Pincushion Grass)*, Setaria incrassate* (Vlei Bristle Grass) and *Sporobolus discosporus* (Dropseed).	*Andropogon appendiculatus* (Vlei Bluestem), *Brachiaria serrata* (Velvet Signal Grass), *Cymbopogon pospischilii* (Bitter Turpentine Grass), *Cynodon dactylon* (Bermuda Grass), *Elionurus muticus* (Wire Grass), *Eragrostis capensis* (Heart-seed Love Grass)*, Eragrostis chloromelas* (Curvy Leaf), *Eragrostis curvula* (Weeping Love Grass)*, Eragrostis plana* (Tough Love Grass)*, Eragrostis planiculmis* (Broom Love Grass), *Eragrostis racemosa* (Narrow Heart Love Grass) *Heteropogon contortus* (Spear Grass), *Hyparrhenia hirta* (Common Thatching Grass)*, Setaria nigrirostris* (Black-seed Bristle Grass), *Setaria sphacelata*,(Common Bristle Grass) *Themeda triandra* (Red Grass), *Tristachya leucothrix* (Hairy Trident Grass)

Plant form	Central Free State Grassland	Soweto Highveld Grassland
Herbs	*Berkheya onopordifolia var. onopordifolia, Chamaesyce inaequilatera* (Smooth Creeping Milkweed) *Conyza pinnata, Crabbea acaulis, Geigeria aspera var. aspera (*Misbeksiektebos*), Hermannia depressa* (Rooi-opslag), *Hibiscus pusillus* (Bladder Weed), *Pseudognaphalium luteo-album* (Jersey Cudweed), *Salvia stenophylla* (Blue Mountain sage), *Selago densiflora and Sonchus dregeanus* (Sow Thistle)	*Hermannia depressa*, (Rooi-opslag), *Acalypha angustata* (,Brooms-an-brushes), *Berkheya setifera* (Buffalo-tongue Thistle) *, Dicoma anomala* (Fever Bush), *Euryops gilfillanii,Geigeria aspera var. aspera* (Misbeksiektebos), *Graderia subintegra* (Wild penstemon), *Haplocarpha scaposa* (False Gerbera), *Helichrysum micronifolium ,Helichrysum nudifolium var. nudifolium* (Hairy Everlasting), *Helichrysum rugulosum* (Marot ole), *Hibiscus pusillus* (Bladder Weed), *Justicia anagalloides ,Lippia scaberrima* (Beukesbossie), *Rhynchosia effuse, Schistostephium crataegifolium* (Round-leaf Flat-Flower), *Selago densiflora, Senecio coronatus* (Woolly Grassland Senecio), *Hillardia oligocephala , Wahlenbergia undulata* (African Bluebell)
Geophytic Herbs	*Oxalis depressa* (Wood Sorrel) and *Raphionacme dyeri*	*Haemanthus humilis subsp. Hirsutus* (Rabbit's Ears), *Haemanthus montanus*
Succulent Herb	*Tripteris aghillana var. intergrifolia.*	
Low Shrubs	*Felicia muricata* (Wild Aster), *Anthospermum rigidum subsp. pumilum, Helichrysum dregeanum, Melolobium candicans and Pentzia globosa.*	*Anthospermum hispidulum, Anthospermum rigidum subsp. Pumilum, Berkheya annectens, Felicia muricata* (Wild Aster), *Ziziphus zeyheriana* (Dwarf Buffalo Thorn)

(Source: Mucina & Rutherford, 2012)

5.2 Species of Conservation Concern (SSC)

The Sigma Defunct Colliery falls within 2627DD QDS in terms of the 1:50 000 grid of South Africa. SANBI uses this grid system as a point of reference to determine any Red Data plant species or any species of conservation importance occurring in South Africa. The Pretoria Computerised Information System (PRECIS) list of Red Data plants recorded in the 2627DD quarter degree grid square was consulted to verify the record of the occurrence of the plant species seen near the study area. Although PRECIS suggests that seven SSC (Table 5-2) may potentially occur within the study area, only one plant species of SCC was recorded, this being *Hypoxis hemerocallidea*. This species was categorised as declining by Raimondo *et al*., (2009) based on the modified IUCN Red List Categories and Criteria version 13 of threatened species (IUCN, 2017) and on observations that suggest that the species must be considered for conservation protection. A *Kniphofia* spp colony was recorded in a wetland area during the infield assessment although it was not possible to identify it down to species level due to the timing of the assessment and the fact that *Kniphofia* species hybridise very easily. There is a possibility that it could be the protected species *Kniphofia typhoides Codd*, thus it is recommended that this is further assessed prior to clearing. Removal of this colony would require an on-site offset, which would require the creation of another suitable habitat for the *Kniphofia* plants and other hygrophytic herbs that occur, to which they would then need to be relocated.

Table 5-2: Red Data Plant species recorded in grid cell 2627DD which could potentially occur in the study area

Family	Scientific Name	Common Name	Threat status	Growth forms
Amaryllidaceae	*Crinum bulbispermum (Burm.f.) Milne-Redh. & Schweick.*	Vaal River lily	Declining	Geophyte
Apiaceae	*Alepidea attenuata Weim.*	-	NT	Herb
Apocynaceae	*Brachystelma incanum R.A.Dyer.*	-	VU	Geophyte
Apocynaceae	*Stenostelma umbelluliferum (Schltr.) S.P.Bester & Nicholas.*	-	NT	Geophyte
Asphodelaceae	*Kniphofia typhoides Codd.*	-	NT	Herb
Fabaceae	*Indigofera hybrida N.E.BR.*	-	VU	Herb
Hypoxidaceae	*Hypoxis hemerocallidea Fisch., C.A.MEY. & Avé-lall.*	Star-flower	Declining	Geophyte

***** Raimondo et al., (2009) categorised C. bulbispermum and Hypoxis hemerocallidea Fisch as declining in South Africa based on the modified IUCN Red List Categories and Criteria version 3.1 of threatened species(IUCN,2001). According to Victor and Keith (2004) and Von Staden et al. (2009), a species listed as Least Concern (LC) under the IUCN Red List Categories and Criteria version 3.1 (IUCN, 2001) can additionally be categorised either as rare, critically rare or declining based on observations that suggest that the species must be considered for conservation protection over and above those that are threatened according to the IUCN. This equally applicable to the most recent version of the IUCN Red List Categories, version 13 (2017).

5.3 Vegetation Types

Four broad vegetation communities (Figure 5-5) were identified during the infield assessment these include:

- Secondary Grassland;
- Woodland/Savanna;
- Alien vegetation; and
- Riparian/Wetland.

5.3.1 Secondary Grassland

This was the primary vegetation unit found in the study area. Grasslands are vegetation types that are mainly characterised by open vegetation cover, made up of predominantly a continuous grassy layer. The grassland type in the study area was degraded grassland characterised by the presence of indigenous flora species such as *Hypoxis hemerocallidea* (Star-flower) and a range of dominant species.

The herbaceous layer is generally dominated by grasses such as *Themeda triandra* (Red Grass) and *Eragrostis curvula*. Several secondary succession grassland species were also present which are known to occur within disturbed habitats. Grass species identified in this vegetation unit include *Themeda triandra, Cynodon* dactylon, *Panicum coloratum*, *Heteropogon contortus*, *Seriphium plumosum*, *Phragmites australis,* and *Sporobolus sp*. This herb/forb layer recorded in this vegetation unit during the most recent infield assessment was dominated by invasive or exotic species such as *Tagetes minuta* (Tall Khakhi Weed), *Verbena bonariensis* (Tall Verbena), *Schkuhria pinnata* (Dwarf Mexican Marigold), *Cirsium vulgare* (Scotch thistle), *Berkheya rigida* (African thistle), and *Seriphium plumosum* (Bankrupt Bush). Trees and shrubs are almost absent within this main vegetation type and only scattered individual trees or shrubs occur. Individual trees and /or shrubs recorded within this main vegetation type consists of tall exotic tree species such as *Eucalyptus cameldulensis* (Red River Gum), *Salix babylonica* (Weeping Willow), *Gleditsia triacanthos* (Honeyshuck) and *Populus x Canescens* (Grey Poplar). (Refer to Figure 5-2)

Figure 5-2: Secondary Grassland vegetation type

The figure above shows the secondary grassland vegetation and the associated plant species that were identified in this vegetation type. Species shown above include Spear grass (*Heteropogon contortus*), Red grass (*Themeda triandra*), and the herbaceous species Star flower (*Hypoxis hemerocallidea*) amongst others. A full list plant species recorded in this vegetation type is included above (section 5.3.1).

5.3.2 Alien Vegetation

Pockets of alien and exotic trees were recorded throughout the study area and were mostly dominated by *Eucalyptus camaldulensis*. Along with the riparian areas, these pockets also contained species such as *Populus x canescens*, Salix *babylonica,* and *Eucalyptus camaldulensis* (Refer to Figure 5-3). A majority of these woody invasions occurred and

persisted due to human interventions. These species generally out-compete indigenous vegetation for space, nutrients, water, and other environmental requirements required for growth. The result of these infestations often includes the transformation of the native ecosystem in such a manner that compromises the ecological integrity of the ecosystem that could lead to its eventual collapse if not addressed.

Figure 5-3: Alien vegetation

The figure above displays the alien vegetation unit. The woody species displayed above include Red river gum (*Eucalyptus camaldulensis*), Grey poplar (*Populus x Canescens*), and Weeping willow (*Salix babylonica*). The bottom left picture also shows non-woody species that were recorded in this unit including Tall Khakiweed (*Tagetes minuta*) and Tall Verbena (*Verbena bonariensis*)

5.3.3 Woodland/Savanna

The Woodland/Savanna unit was encountered within the general grassland, in rocky relatively sheltered areas. The presence of the Woodland/Savanna unit within outcrops in the grassland unit can be attributed to the ruggedness of the outcrops which increased the soil moisture and excluded fires thus enabling trees to establish on and in the vicinity of these outcrops. This vegetation type was largely dominated by *Vachellia karroo– Asparagus laricinus* Woodland (Refer to Figure 5-4).

Figure 5-4: Woodland/Savanna vegetation

The figure above displays the *Vachellia karroo– Asparagus laricinus* Woodland that dominated the Woodland/Savanna vegetation unit.

5.3.4 Riparian/Wetland

The riparian/wetland unit was identified to be within areas where drainage lines are present. This vegetation unit is mainly associated with the moderately deep, poorly drained, dark, moderately structured clay soils, with signs of permanent wetness in the subsoil or in other words drainage lines. A total of 413.9 ha of wetlands were identified within the study area. In Leeuspruit section one a floodplain wetland was identified, whereas 44.2 ha of floodplain in were identified in section three of the Leeuspruit and floodplain of 35.2 ha as well as associated hillslopes of 8.2 in section four of the Leeuspruit. In the Rietspruit section of the study area, a floodplain wetland was identified as well as a channelled valley bottom wetland which is fed by two unchannelled valley bottom wetlands. An artificial wetland was also identified in this section. For further details on wetlands, the wetlands report for this project should be consulted.

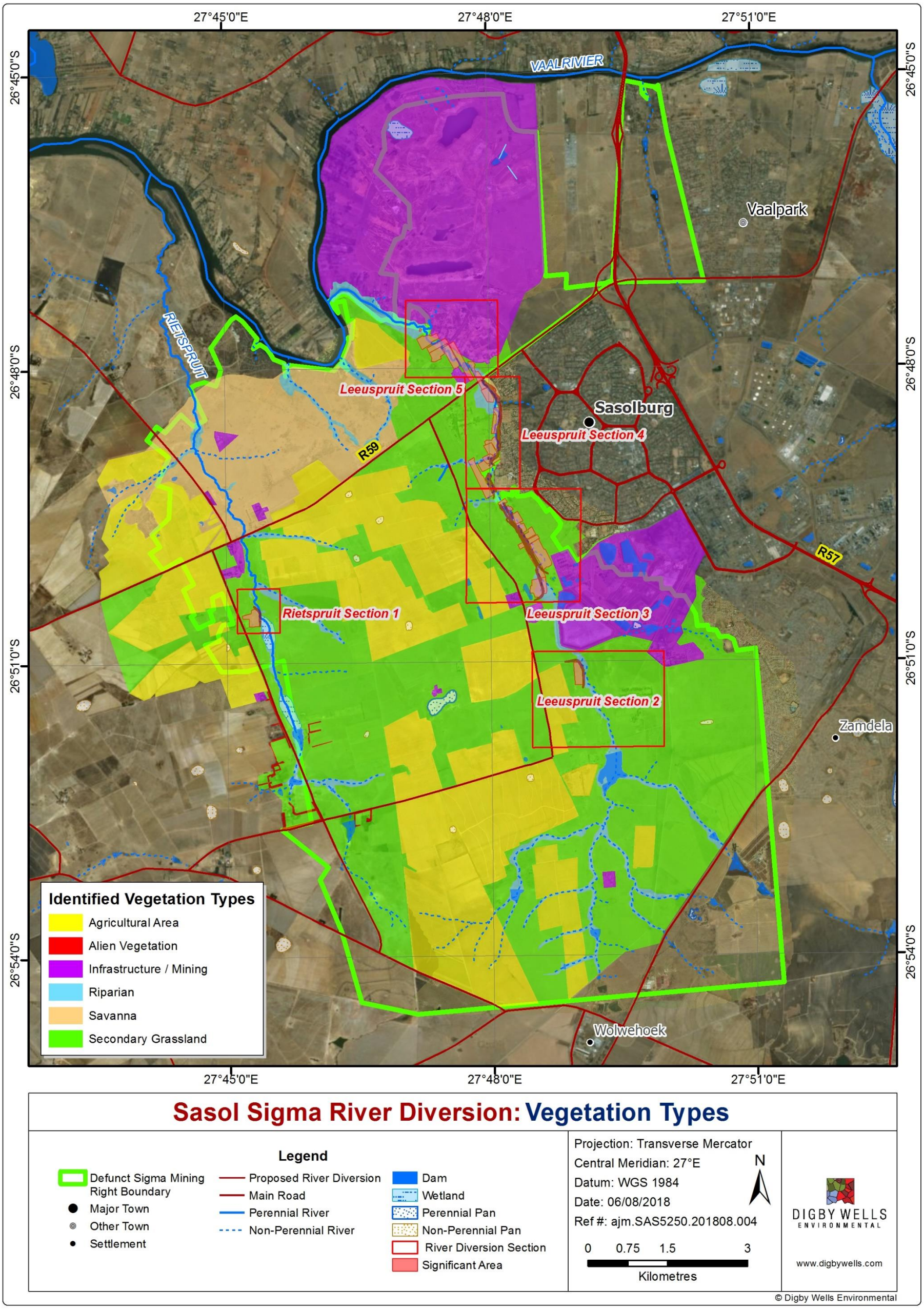

Figure 5-5: Identified Vegetation communities

5.4 Transformed Land Units

Two transformed land units were recorded on site these include:

- Agricultural Fields; and
- Infrastructure and Mining.

5.4.1 Agricultural Fields

This transformed land unit mainly consists of old fields, cultivated areas and grazing areas which are collectively referred to as agricultural areas. A major factor contributing to the grassland habitat destruction in this area is the transformation of natural lands into agricultural fields. This vegetation unit is found throughout the area.

Figure 5-6: Agricultural fields

The above figure shows the areas collectively known as agricultural fields. The figure on the top right show grazing areas, whereas the bottom pictures are areas that are cultivated

5.4.2 Infrastructure and Mining

This unit was made up of residential areas, Sasol owned infrastructure, a commercial feedlot, a tannery, farmhouses, a sand mining operation, and property let to privately owned businesses. This has resulted in habitat destruction and fragmentation.

5.5 Flora

Results from the 2018 field assessment along with those of a previous assessment done by Digby Wells (2013) indicate that a total of 63 plant species have been recorded (From 16 different families). The *Poaceae* (the grass family) is the best represented with 27 different species. A total of 12 tree species represented the woody layer, whereas the herbaceous layer is represented by 31 different herbs and 27 graminoid species. Common species identified during the most recent infield assessment include *Themeda triandra, Cynodon dactylon, Panicum coloratum* and *Heteropogon contortus.*

Seriphium plumosum (Bankrupt bush) encroachment was common in a number of areas in the Secondary Grassland unit. Bankrupt bush is an indigenous woody dwarf shrub that is noted for not being favoured by grazing livestock and their presence in overgrazed areas.

5.5.1 Alien Invasive Plant Species

AIP's are considered a serious threat to native fauna and flora globally including South Africa. McNeely (2001) defined alien invasive species as "species introduced into a habitat and whose establishment and spread threatens the ecosystem, habitat, or species with economic or environmental harm. AIP species tend to cause major damage to ecosystems leading to loss of biodiversity, soil erosion, and water loss.

Alien plant species in South Africa have been classified according to Alien and Invasive Species Lists (GN R599 in GG 37886 of 1 August 2014) of the NEMBA (Act 10 of 2004). Each of the categories listed in this act has different legal obligations and conditions as indicated below:

- Category 1a: Species requiring compulsory control
- Category 1b: Invasive species controlled by an Alien Invasive Species Management Programme;
- Category 2: Invasive species controlled by area; and
- Category 3: Invasive species controlled by activity.

A total of 21 AIP's were recorded on site during the 2018 infield assessment. Eleven of these have been assigned alien invader plant categories according to NEMBA (Table 5-3).

Table 5-3: AIP's Recorded on Site

Scientific name	Common name (English)	Common name (Afrikaans)	Invasive Category* NEMBA
Agave americana L	American Agave	Kaalgaarboom	N/A (weed)
Argemone ochroleuca subsp. ochroleuca	White-Flowered Mexican Poppy	Witblombloudissels	NEMBA Category 2.
Amaranthus hybridus L.	Smooth Pigweed	Sprinkaanbossie	N/A (weed)
Asparagus laricinus	Bushveld Asparagus	Langbeenkatdoring	N/A (weed)
Berkheya rigida	African Thistle	Disseldoring	N/A (weed)
Bidens pilosa-	Blackjack	Gewone knapsekerel	N/A (weed)
Cirsium vulgare	Scottish Thistle	Speerdissel	NEMBA Category 1b.
Conyza canadensis (L.)	Cronq- Canadian Fleabane	Kanadese skraalhans	N/A (weed)
Datura ferox	Large Thorn-Apple	Grootstinkblaar	NEMBA Category 1b.
Eucalyptus camaldulensis	Red River Gum	Rooibloekom	NEMBA Category 2.
Flaveria bidentis	Smelter's Bush	Smeltersbossie	NEMBA Category 1b.
Gleditsia triacanthos	Honey Locust	Springkaanboom	NEMBA Category 1b.
Pinus patula	Patula Pine	Treurden	NEMBA Category 2.
Populus x canescens	Grey Poplar	Vaalpopulie	NEMBA Category 2.
Prosopis glandulosa	Honey Mesquite	Heuningprosopis	NEMBA Category 1b.
Pseudognaphalium luteo-album (L.)	Jersey Cudweed	Roerkruid	N/A (weed)
Salix babylonica	Weeping Willow	Treurwilger	NEMBA Category 2.
Solanum incanum	Bitter Apple	Bitter apple	N/A (weed)
Tagetes minuta	Tall Khakiweed	Kakiebos	N/A (weed)
Verbena bonariensis	Tall Verbena	Blouwaterbossie	NEMBA Category 1b.
Xanthium spinosum	Spiny Cocklebur X	Boetebossie, Pinotiebossie	NEMBA Category 1b.

5.6 Fauna

5.6.1 Mammals

The study area has a relatively low faunal diversity due to the disturbed nature of the site (Table 5-4). Six mammal species were recorded during the infield assessment and all of these were within the Sasol Mining private game farm. A more rigorous search outside of the game farm might indicate additional species. A list of species that have been recorded for the broader area and could possibly occur within the study area are listed in Table 5-4 below and Appendix F.

Table 5-4: Mammal Species Recorded in the study area

Scientific Name	Common Name	TOPS listing (NEMB) (2007)	CITES Listing	IUCN 2017	Habitat found in
Damaliscus pygargus phillipsi	Blesbok	None	None	Least Concern	Grassland
Xerus inauris	Cape Ground Squirrel	None	None	Least Concern	Grassland and open calcareous ground on
Oryx gazella	Gemsbok	None	None	Least Concern	Grassland
Lepus saxatilis	Scrub Hare	None	None	Least concern	Grassland
Antidorcas marsupialis	Springbok	None	None	Least Concern	Grassland
Connochaetes gnou	Black Wildebeest	Protected	None	Least Concern	Grassland
Equus quagga burchellii	Burchell's zebra	Endangered	Appendix 1	Near Threatened	Grassland
Cynictis penicillata	Yellow Mongoose	None	None	Least Concern	Grassland

5.6.2 Avifauna

The diversity of avifauna is one of the most important ecological indicators to evaluate the quality of habitats. Several bird species respond to small changes in habitat structure and composition, therefore they are good proxies to measure the diversity and integrity of

ecosystems as they tend to be near the top of the food chain, have large ranges, and the ability to move elsewhere when their environment becomes unsuitable (Sekercioglu, 2006). Forty-seven bird species were recorded during the infield assessment and these have been listed in Table 5-5 below.

Table 5-5: Avifauna Species Recorded in the study area

Common Names	Scientific Names	IUCN Status	Grass-land	Alien bush clumps	Transformed land	Riparian/ Wetland
African Openbill	*Anastomus lamelligerus*	NT	#			#
African Quailfinch	*Ortygospiza atricollis*	LC				#
Black Heron	*Egretta ardesiaca*	LC				#
Black-collared Barbet	*Lybius torquatus*	LC				
Black-headed Heron	*Ardea melanocephala*	LC				#
Black-mustered Kite	*Elanus caeruleus*	LC	#		#	
Blacksmith Lapwing	*Vanellus armatus*	LC	#		#	#
Blue Korhaan	*Eupodotis caerulescens*	NT	#			
Brown-backed Honeybird	*Prodotiscus regulus*	LC	#			
Burchell's Coucal	*Centropus burchellii*	LC	#	#		
Cape Robin-Chat	*Cossypha caffra*	LC	#	#	#	
Cape Sparrow	*Passer melanurus*	LC	#			
Cape Turtle-Dove	*Streptopelia capicola*	LC	#			
Cattle Egret	*Bubulcus ibis*	LC	#		#	
Common Fiscal	*Lanius collaris*	LC	#	#	#	
Common House-Martin	*Delichon urbicum*	LC	#			

Common Names	Scientific Names	IUCN Status	Grass-land	Alien bush clumps	Transformed land	Riparian/ Wetland
Common Moorhen	*Gallinula chloropus*	LC				
Corncrake	*Crex crex*	LC	#			
Crested Barbet	*Trachyphonus vaillantii*	LC				
Crowned Lapwing	*Vanellus coronatus*	LC	#		#	
Dark-capped Bulbul	*Pycnonotus tricolor*	NA	#	#	#	#
Egyptian Goose	*Alopochen aegyptiaca*	LC				#
European Bee-eater	*Merops apiaster*	LC	#			
Fork-tailed Drongo	*Dicrurus adsimilis*	LC			#	
Fulvous Whistling-duck	*Dendrocygna bicolor*					#
Hadeda Ibis	*Bostrychia hagedash*	LC	#			
Helmeted Guineafowl	*Numida meleagris*	LC	#		#	
House Sparrow	*Passer domesticus*	LC		#	#	
Laughing Dove	*Streptopelia senegalensis*	LC	#			
Marsh Owl	*Asio capensis*	LC	#		#	
Melodious Lark	*Mirafra cheniana*	NT	#			#
Namaqua Dove	*Oena capensis*	LC	#			
Ostrich	*Struthio camelus*	LC	#			
Pied Avocet	*Recurvirostra avosetta*	LC				#
Red-knobbed Coot	*Fulica cristata*	LC				#

Common Names	Scientific Names	IUCN Status	Grass-land	Alien bush clumps	Transformed land	Riparian/ Wetland
Rock Dove	*Columba livia*	LC	#			
Secretary Bird	*Sagittarius serpentarius*	VU	#			
South African Shelduck	*Tadorna cana*	LC				#
Southern Masked Weaver	*Ploceus velatus*	LC	#			#
Southern Pochard	*Netta erythrophthalma*	LC				#
Southern Red Bishop,	*Euplectes orix*	LC				#
Speckled Pigeon	*Columba guinea*	LC	#			
Spur-winged Goose	*Plectropterus gambensis*	LC				#
White-faced Duck	*Dendrocygna viduata*	LC				#
Yellow-billed Duck	*Anas undulata*	LC				#

5.6.3 Herpetofauna

No reptiles were encountered during the 2018 dry season infield survey as well as the previous assessment done by Digby Wells (2013). Expected species are depicted in Appendix E.

5.6.4 Invertebrates

No invertebrate species were opportunistically sighted during the infield assessment. This is primarily due to sampling methods employed. The abundant presence of species such as the Yellow mongoose and several avifauna species which feed predominantly on insects and other invertebrates suggests that invertebrate numbers are significantly high on site It is worth noting that snouted harvester termite mounds were recorded throughout, the secondary grassland areas, these are now being used by burrowing animals. According to records from the According to the ADU (Animal Demographic Unit Virtual Museum), no butterfly species of conservation importance are known to occur in and around the project area. Butterfly species recorded by Mecenero *et al*. (2015) in the region indicates 57 species which are listed as least Concern.

5.7 Sensitivity of the Site and No-Go Areas

In terms of ecological sensitivity, the following features are assessed to determine how sensitive the habitat identified within the site is:

- Presence or absence of Red Data Listed or protected plant and animal species;
- Presence or absence of exceptional species diversity;
- Extent of intact habitat in good ecological condition in the absence of disturbance; and
- Presence or absence of important ecosystems such as Important Bird and Biodiversity Areas (IBAs), Protected Areas, and areas demarcated for future protected area status (National Protected Areas Expansion Strategy) (NPAES) and wetlands.

There are several assessments for South Africa as a whole, as well as on provincial levels, that allow for detailed conservation planning as well as meeting biodiversity targets for the country's variety of ecosystems. These guides are essential to consult for development projects and will form an important part of the sensitivity analysis.

Areas earmarked for conservation in the future or that are essential to meet biodiversity and conservation targets must not be developed, and have a high sensitivity as they are necessary for overall ecological functioning. Further to this, details of the field investigation are used to determine the site-specific sensitivity.

5.7.1 Protected Areas

The National Protected Areas Expansion Strategies (NPAES) are areas designated for future incorporation into existing protected areas (both National and Informal protected areas). These areas are large, mostly intact areas required to meet biodiversity targets, and suitable for protection. They may not necessarily be proclaimed as protected areas in the future and are a broad scale planning tool allowing for better development and conservation planning.

NPAES have been developed to coordinate the expansion of protected areas in order to ensure that a representative sample of all ecosystems as well as key ecological processes are included in the protected area network. Figure 5-7 indicates the proximity of the river diversion project to existing expansion focus areas, approximately 60 km from the Vaal Grasslands, 45 km from Free State Highveld Grassland and approximately 60 km from NW/Gauteng Bushveld.

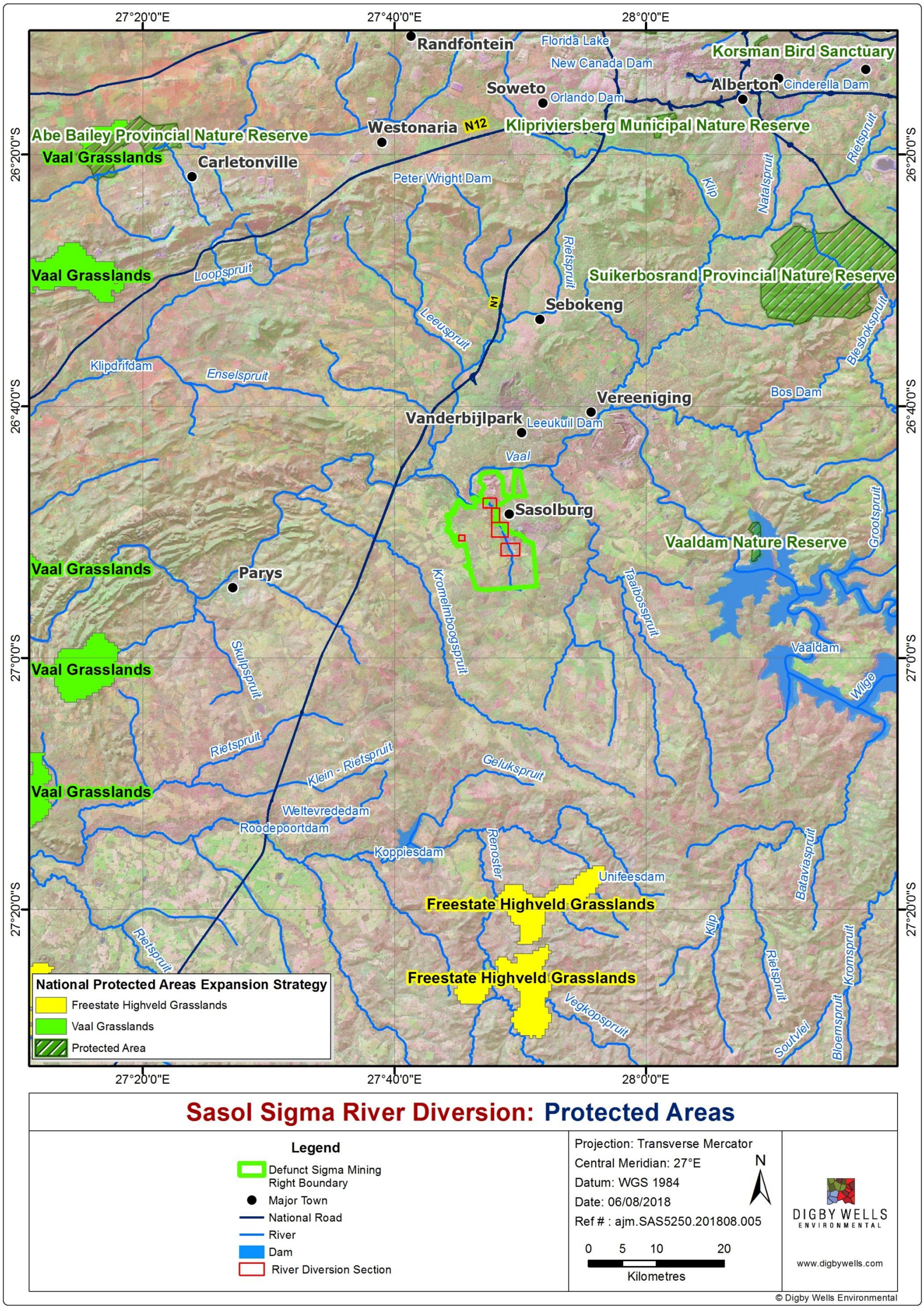

Figure 5-7: National Protected Area Expansion Strategy focus areas proximity to the Sigma study area

5.7.2 Free State Biodiversity Plan (2015) (http://bgis.sanbi.org)

The Free State Province has not given any specific guidelines in terms of habitat sensitivity mapping. The 2015 Free State Biodiversity Plan (http://bgis.sanbi.org) does, however, provide a map of Critical Biodiversity Areas (CBA's) and Ecological Support Areas (ESA's), which has conservation guidelines of different Land-Use areas in the province in mind. Management criteria and recommendations for CBA's and ESA's are still under development and expected to be published sometime in 2018. These are however expected to be similar to that of other provinces where agriculture is an important land use. The FSBP Critical Biodiversity Areas map mostly accounts for terrestrial only. According to the SANBI's Biodiversity GIS website the CBA map for aquatic systems is still incomplete and consideration of the aquatic component is only limited to the Freshwater Ecosystem Priority Areas (FEPA) catchments (included in the cost layer and for the identification of Ecological Support Areas (ESAs)) and wetland clusters (included in the ESAs only). CBAs are areas that are important for conserving biodiversity while ESAs are areas that are important to ensure the long-term persistence of species or the functioning of other important ecosystems. The degradation of CBAs or ESAs could potentially result in the loss of important biodiversity features and/or their supporting ecosystems (More detailed technical definitions are provided in Table 5-6):

There are five main categories that t appear on a CBA Map:

- Protected Areas;
- Critical Biodiversity Areas (CBAs);
- Ecological Support Areas (ESAs);
- Other Natural Areas (ONAs); and
- Areas with No Natural Habitat Remaining (NNR)/Degraded.

Although the proposed surface mitigation measures don't traverse any CBA's, there are small pockets within Leeuspruit Section 4 which are classified as 'ESA 2'. Leeuspruit Section 5 has large areas classified as 'ESA 2' as well as 'ESA 1. Rietspruit Section 1 is closely bordered by 'CBA 2'.

Table 5-6: Summary of the Different Categories occurring within the Free State Terrestrial CBA Map

Map Category	Description	Sub-Category	Description
Protected Areas	Areas that are formally protected by law and recognised in terms of the Protected Areas Act, including contract protected areas declared through the biodiversity stewardship program.	National Parks & Nature Reserves	Includes formally proclaimed National Parks, Nature Reserves, Special Nature Reserves, and Forest Nature Reserves.
		Protected Environments: Natural	Includes Protected Environments, declared in terms of Protected Areas Act (Act 57 of 2003, as amended).
		Protected Environments: Modified	Heavily modified areas in formally proclaimed Protected Environments.
Critical Biodiversity Areas (CBAs)	All areas required to meet biodiversity pattern and process targets; Critically Endangered ecosystems, critically linkages (corridor pinch-points) to maintain connectivity; CBAs are areas of high biodiversity value that must be maintained in a natural state.	CBA 1: Irreplaceable	This category includes (1) Areas required to meet targets and with irreplaceable values of more than 80%; (2) Critical linkages or pinch- points in the landscape that must remain natural; (3) Critically Endangered Ecosystems.
		CBA 2: Optimal	The CBA Optimal Areas (previously called 'important and necessary') are the areas optimally located to meet both the various biodiversity targets and other criteria defined in the analysis. Although these areas are not 'irreplaceable' they are the most efficient land configuration to meet all biodiversity targets and design criteria.
Ecological Support Areas (ESA)	Areas that are not essential for meeting targets but play important role in supporting the functioning of CBAs and that deliver services. Important ecological services	ESA 1	Intact natural areas supporting CBAs
		ESA 2	Areas with no natural habitat that is important for supporting ecological processes

Map Category	Description	Sub-Category	Description
Other Natural Areas (ONA) Areas that have not been identified as a priority in the current systematic biodiversity plant but retain most of their natural character and perform a range of biodiversity and ecological infrastructural functions.			
Degraded	Areas in which significant or complete loss of natural habitat and ecological function have taken place due to activities such as ploughing, hardening of surfaces, open-cast mining, and cultivation and so on.	Heavily Modified	All areas currently modified to such an extent that any valuable biodiversity and ecological functions have been lost.
		Moderately Modified: lands Old	All areas currently modified to such an extent that any valuable biodiversity and ecological functions have been lost.

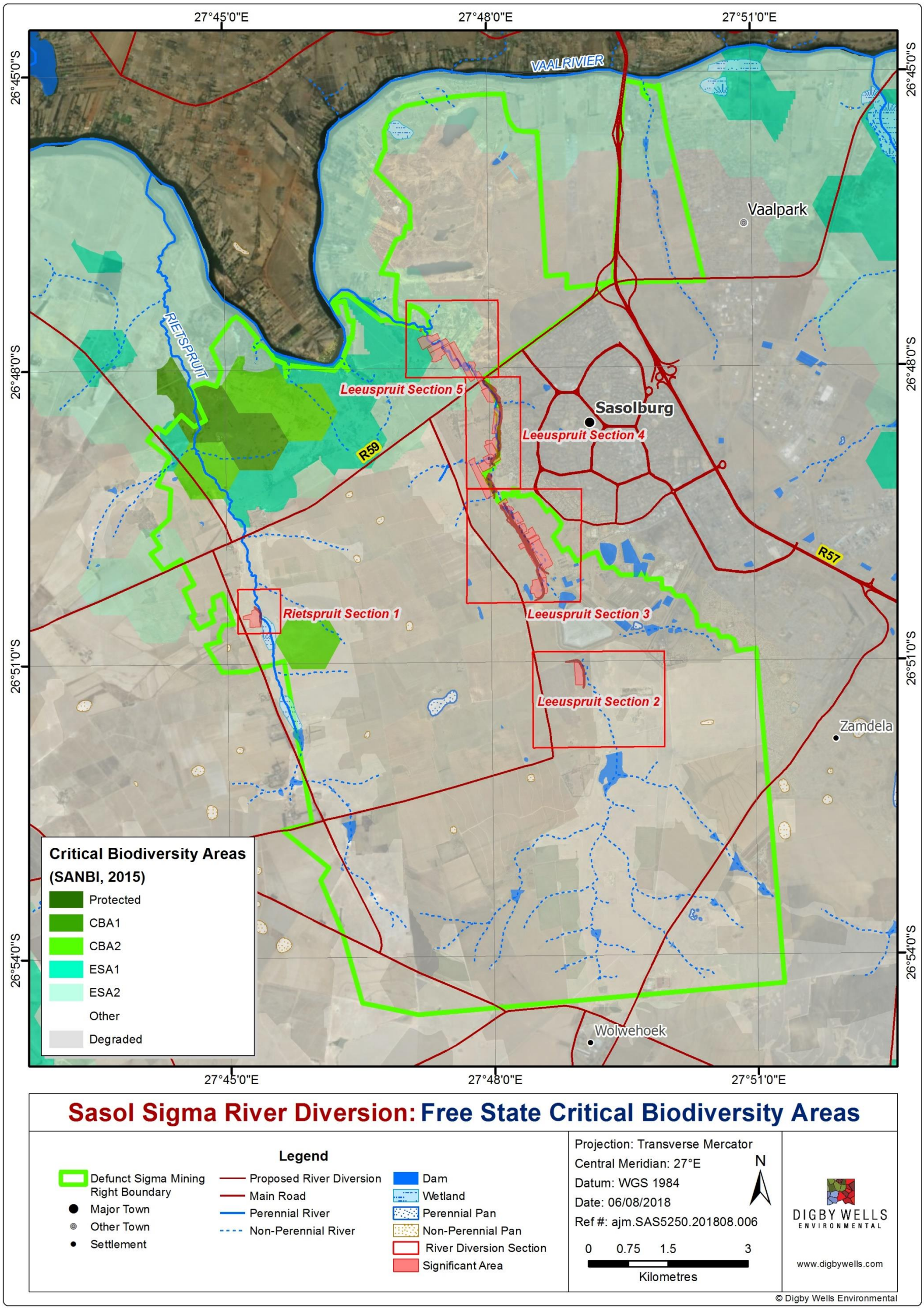

Figure 5-8: Critical Biodiversity Areas (Free State Biodiversity Plan)

5.7.3 Important Bird Area

An Important Bird and Biodiversity Area (IBA) is an area designated as globally important habitat for the conservation of bird populations. The programme was developed by BirdLife International and the stewardship of IBA's in each country is designated by a national conservation organisation, in our case Birdlife South Africa. More than 12,000 IBA's have been identified globally. At present, South Africa has 124 IBA's (101 of global-, and 21 of regional importance), covering over 14 million hectares of habitat for our threatened, endemic and congregatory birds. The Biodiversity GIS (BGIS) Interactive maps and other conservation and planning tools were consulted for the relevance of this project to determine if any IBA categories as listed in Table 5-7 and it was found that no IBA falls within the planned river diversion sections.

Table 5-7: IBA Criteria according to Birdlife International

Criterion			Notes
A1.	**Globally threatened species**	The site is known or thought regularly to hold significant numbers of a globally threatened species or other species of global conservation concern.	The site qualifies if it is known, estimated, or thought to hold a population of a species categorised by the IUCN Red List as Critically Endangered, Endangered or Vulnerable. In general, the regular presence of a Critical or Endangered species, irrespective of population size, at a site may be sufficient for a site to qualify as an IBA. For Vulnerable species, the presence of more than threshold numbers at a site is necessary to trigger selection. Thresholds are set regionally, often on a species by species basis. The site may also qualify if holds more than threshold numbers of other species of global conservation concern in the Near Threatened, Data Deficient and, formerly, in the no-longer recognised Conservation Dependent categories. Again, thresholds are set regionally.

Criterion			Notes
A2.	**Restricted-range species**	The site is known or thought to hold a significant component of a group of species whose breeding distributions define an Endemic Bird Area (EBA) or Secondary Area (SA).	**Notes:** This category is for species of Endemic Bird Areas (EBAs). EBAs are defined as places where two or more species of restricted range, i.e. with world distributions of less than 50,000 km2, occur together. More than 70% of such species are also globally threatened. Also included here are species of Secondary Areas. A Secondary Area (SA) supports one or more restricted-range species but does not qualify as an EBA because less than two species are entirely confined to it. Typical SAs include single restricted-range species which do not overlap in distribution with any other such species and places where there are widely disjunct records of one or more restricted-range species, which are clearly geographically separate from any of the EBAs.
A3.	**Biome-restricted species**	The site is known or thought to hold a significant component of the group of species whose distributions are largely or wholly confined to one biome.	This category applies to groups of species with largely shared distributions of greater than 50,000 km2, which occur mostly or wholly within all or part of a particular biome and are, therefore, of global importance. As with EBAs, it is necessary that a network of sites be chosen to protect adequately all species confined to each biome and, as necessary, in each range state in which the biome occurs. The 'significant component' term in the Criterion is intended to avoid selecting sites solely on the presence of one or more biome-restricted species that are common and adaptable within the EBA and, therefore, occur at other chosen sites. Additional sites may, however, be chosen for the presence of one or a few species which would, e.g. for reasons of particular habitat requirements, be otherwise under-represented.

Criterion			Notes
A4.	**Congregations**	A site may qualify on any one or more of the four criteria listed below). The site is known or thought to hold, on a regular basis, ≥ 1% of a biogeographic population of a congregatory waterbird species. ii). The site is known or thought to hold, on a regular basis, ≥ 1% of the global population of a congregatory seabird or terrestrial species. iii). The site is known or thought to hold, on a regular basis, ≥ 20,000 water birds or ≥ 10,000 pairs of seabirds of one or more species. iv). The site is known or thought to exceed thresholds set for migratory species at bottleneck sites.	This applies to 'water bird' species as defined by Delaney and Scott (2006) Waterbird Population Estimates, Fourth Edition, Wetlands International, Wageningen, The Netherlands, and is modelled on Criterion 6 of the Ramsar Convention for identifying wetlands of international importance. Depending upon how species are distributed, the 1% thresholds for the biogeographic populations may be taken directly from Delaney & Scott, they may be generated by combining flyway populations within a biogeographic region or, for those for which no quantitative thresholds are given, they are determined regionally or inter-regionally, as appropriate, using the best available information. ii. This includes those seabird species not covered by Delaney and Scott (2002). Quantitative data are taken from a variety of published and unpublished sources. iii. This is modelled on Criterion 5 of the Ramsar Convention for identifying wetlands of international importance. iv. Thresholds are set regionally or inter-regionally, as appropriate.

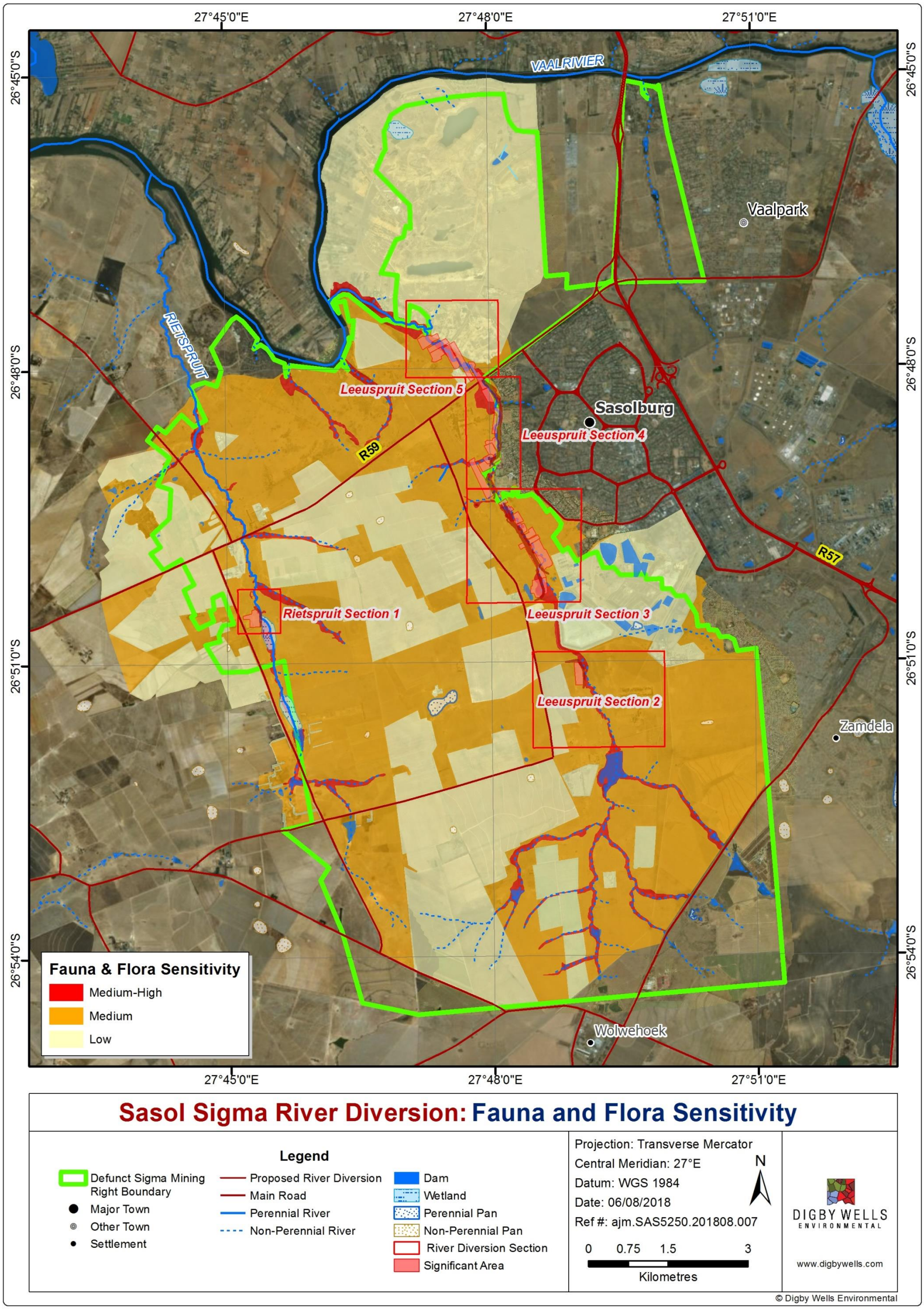

Figure 5-9: Vegetation Sensitivity of the Sasol Sigma study area

6 Project Activities

The potential impacts/ risks identified in this section are a result of both the environment in which the project activities take place, as well as the actual activities. The potential impacts/ risks are discussed per aspect, per River Section and per each phase of the project i.e. the Construction Phase. It is also noted that although the impacts for the construction phase of the various sections may be different the operational phase is predicted to be relatively similar for each section therefore only one operational phase for each aspect has been assessed. No decommissioning phase will be undertaken for this project as once the surface mitigation measures have been implemented these changes are proposed to be permanent. The following activities for the proposed river diversion project that will be assessed are listed in Table 6-1 below.

Table 6-1: Project Activities

Significant Risk Area	Phase	Project Activity
Leeuspruit Section 2- 5 and Rietspruit Section 1	General Construction Activities	▪ Contractor Camp / Laydown Area Establishment; ▪ Site clearing, including the removal of topsoil and vegetation; ▪ Excavation of soils from a watercourse ▪ Stockpiling of soil once excavated ▪ Water Management (Ensure flow of river is not significantly impacted) ▪ Construction activities within a watercourses and wetlands (Heavy vehicles and excavators); ▪ Temporary storage of hazardous products, including fuel; and ▪ Storage of waste. ▪ Utilise existing roads to access the various river sections
Leeuspruit Section 2	Construction Phase	▪ Construction of flood protection berm ▪ Vegetation of flood protection berm
Leeuspruit Section 3	Construction Phase	▪ Construction of flood protection berm ▪ Vegetation of flood protection berm ▪ Construction of formalised canal
Leeuspruit Section 4	Construction Phase	▪ Construction of flood protection berm ▪ Vegetation of flood protection berm ▪ Construction of formalised canal
Leeuspruit Section 5	Construction Phase	▪ Ash backfilling has been assessed as a separate environmental authorisation project. Mitigation measures proposed from this project will be implemented in this section
Rietspruit: Section 1	Construction Phase	▪ Construction of flood protection berm ▪ Vegetation of flood protection berm

Significant Risk Area	Phase	Project Activity
Leeuspruit Section 2- 5 and Rietspruit Section 1	Operational Phase	▪ Revegetate area to ensure erosion does not occur ▪ Maintenance and monitoring activities ▪ Removal of all machinery and equipment utilised during the construction phase ▪ Rehabilitate areas affected by laydown area and machinery ▪ Removal of waste

6.1 Construction Phase Impact

The potential impacts associated with the proposed surface mitigation measure on the study area during the construction phase have been divided into two broad categories: The generalised construction phase impacts which are applicable to all sections of the Leeuspruit and the Rietspruit; and the river section specific impacts. Mitigation measures are provided to prevent, reduce, or remediate adverse environmental impacts.

6.1.1 Generalised Expected Construction Phase Impacts

This section looks at the general impacts that can be expected during the construction phase for all the different sections, these impacts include the following:

6.1.1.1 Activity Site Establishment

6.1.1.1.1 Impact Description - Vegetation Destruction and Loss of Biodiversity

Site setup as well as immediate vegetation clearing and earthworks that precede construction activities may lead to impacts related to loss of plant species and habitats. This may result in not only the immediate destruction of individual plants and loss of faunal habitats but may lead to a loss of biodiversity. Activities during this phase will include vegetation clearance, soil disturbance (topsoil stripping, trench excavation for pipes and canals; topsoil stockpiling, storage and dumping of building materials). All the different surface mitigation sections are considered in this impact assessment. All the proposed sections traverse impacted habitat and vegetation types. Potential impacts associated with this include the potential for pollution of important watercourses, wetlands or other waterbodies which may negatively impact on the fauna and flora on site. Other potential impacts include soil contamination due to fuel and chemical spills and, which may lead to vegetation disturbance and vegetation loss. During the construction phase, disturbance of native fauna due to noise or light pollution may also be expected. Other possible impacts during this phase of the project include fragmentation of habitats, road kills and contamination of adjoining habitats by dust.

From a fauna and flora perspective, the impact of site clearance will have a minimal impact on these areas, if mitigation measures are followed. Although the proposed surface mitigation measures don't traverse any CBA's, there are small pockets within Leeuspruit Section 4 which are classified as 'ESA 2'. Leeuspruit Section 5 has large areas classified as

'ESA 2' as well as 'ESA 1. Rietspruit Section 1 is closely bordered by 'CBA 2'. Leeuspruit Section 4 is also located within the Sasol privately owned game farm (Leeuspruit Nature Reserve), however, it is also anticipated that the impact of site establishment will have a minimal impact to this area if mitigation measures are followed.

Vegetation clearing could lead to loss of vegetation communities and habitats, which may lead to a change in the ability of these vegetation types and associated features to fulfil their ecological function. This impact is however regarded to be low, it is expected that the impacts will be mostly local and restricted to the proposed mitigation areas and immediate surrounds.

The related impacts on fauna populations on the site relate to the above-mentioned loss of habitats during the construction phase of the project. However, the footprint of the project is relatively small and natural vegetation will be left intact within the site and it is expected that some of the faunal components will return to the site once the construction phase has been completed.

6.1.1.1.2 Disturbance to Fauna due to Noise and increased Vehicular Movement on Site

The remaining fauna on site may be scared away due to increased activity associated with construction activities. In addition, breeding species within proximity of the activities may be disturbed. The surrounding environment contains the same vegetation types and same habitat, it is thus expected that mobile fauna species will disperse into these surrounding areas during construction and return upon the completion of construction.

6.1.1.1.3 Alien Plant Species Invasion

As detailed in Section 4.2.3.3, alien plant species degrade the natural state of a habitat. Species that may establish are listed in Table 5-3. Small areas of invader tree species were encountered throughout the study area. The secondary grassland unit was invaded by a number of woody and nonwoody species, whereas the riparian vegetation was mostly invaded by woody species, where the dominant tree species found were *Eucalyptus* spp., *Populus* spp., *Acacia* spp., and *Pinus* spp. The clearing of vegetation and Indirect loss of downstream habitat and spp through perturbation in river flows and flood regime, altered physical and chemical characteristics of water will increase the risk of alien invasions in the study area. It is thus critical that newly cleared soils, especially in Section 3 and 4 of the Leeuspruit, will have to be re-vegetated and stabilised as soon as construction has been completed and there must be an on-going monitoring program to control and/or eradicate newly emerging invasive plant species.

6.1.1.1.4 Management Objectives

Management objectives will need to be implemented to prevent the loss of important/protected landscapes, species of plants and animals (such as those with Red Data Status, National, and Provincial) and to reduce the impact on faunal species particularly

breeding individuals. This is achieved by avoiding destruction of areas where these species are located. In the case of plants, if it is not possible to avoid the destruction of these areas then relocation permits are required. These permits can be obtained from the competent authorities such as the Department of Economic Development, Tourism, and Environmental Affairs of the Free State Province and any other relevant competent authority. The sensitive landscapes on site include all wetland and riparian areas.

The ecosystem present must be preserved as far as possible; this includes areas not directly affected by project activities and can be achieved by limiting project activities to areas where they are essential. Of importance for this are the wetland and riparian areas and the secondary grassland as the proposed surface mitigation will only directly impact on these areas. The wetland and grassland areas form important habitat for species such as the marsh owl and form process areas that are vital to the functioning of the ecosystem

Rehabilitation measures must be initiated during construction to minimise disturbed areas, through continuous rehabilitation and revegetation. This entails revegetation of disturbed areas with indigenous grass species. Further details on this are contained in the Rehabilitation Plan. Habitat/vegetation degradation must be prevented through the implementation of an Alien Invasive Plant Management Strategy.

The objective of managing noise and general disturbance on site is to reduce the impact on faunal communities, particularly breeding individuals.

6.1.1.1.5 Management Targets and Actions

Care must be taken to avoid indiscriminate destruction of habitat; and where possible the rehabilitation of transformed areas and restoration of degraded secondary riparian vegetation units and grassland must take place in order to improve the ecological health of the floristic component on the affected habitat types. Furthermore during construction workers must limit the impact to the footprint and immediate support areas, especially within the areas located downstream of the river diversion study area. Do not store building materials and excess stockpiled soils within riparian zones or within areas where natural vegetation will remain the following completion of the construction phase of the development.

An Alien Plant Management Strategy must be implemented whereby a qualified vegetation ecologist will monitor the disturbed areas annually for three years for alien plants. Monitoring must preferably take place between November and March. All alien plant species must be identified, demarcated, and removed. Such a strategy will entail the identification of areas where such infestation occurs and what the extent of it is. Thereafter, specific eradication measures can be prescribed for species present. The strategy must reduce the number of these plant species that occur in the study area. This can be measured against the number of plants that were identified in this and previous studies. Current mapped alien invasive plant infestations must, therefore, be removed with the aim of complete eradication thereof.

Designated construction areas must be clearly demarcated and contractors must make use of existing access routes. Where construction vehicles must traverse the site, they must

remain on demarcated roads. If vehicles must leave the road for construction purposes, they must utilise a single track and must not take multiple paths. Animals residing within the designated area shall not be unnecessarily disturbed. During site preparation, special care must be taken during the clearing of the works area to minimise damage or disturbance of roosting and nesting sites. Any excavated trenches and diversion canals will be inspected regularly for fauna that may have fallen into them and become trapped. All fauna found in these canals must be rescued.

6.1.1.1.6 Impact Rating

This section presents the impact ratings for the general impacts expected during the construction phase for all the different sections. This impact is rated in Table 6-2 to Table 6-3 and mitigation measures are provided to prevent (first priority), reduce, or remediate adverse environmental impacts.

Table 6-2: Potential Impacts due to site establishment and establishment of access and service roads

Dimension	Rating	Motivation	Significance
Activity and Interaction: Site establishment and establishment of access and service roads			
Impact Description: Direct loss of floral species/vegetation types, displacement of fauna and loss biodiversity			
Prior to mitigation/ management			
Duration	Permanent mitigated (6)	Total loss of fauna and flora species will occur.	Minor (negative) (-65)
Extent	Local (3)	Establishment of site (camps, laydown/storage areas, and access roads) could occur without proper planning thereby affecting the fauna and flora in the development site area.	
Intensity x type of impact	Serious mid-term (-4)	The proposed river diversion area covers natural areas such wetland and Endangered grassland areas which form important habitat for species. Due to the disturbed nature of the site, the impact could have serious mid-term effects	
Probability	Likely (5)	It is likely that vegetation will be destructed and faunal species displaced during site establishment and access	
Nature	Negative		
Mitigation/ Management actions			

Dimension	Rating	Motivation	Significance
▪ Construction activities must be restricted to the project footprint ▪ Designated construction areas must be clearly demarcated and contractors must make use of existing access route. ▪ If construction vehicles must leave the road for construction purposes, they must utilise a single track and must not make multiple paths. ▪ Best practices noise control management measures must be applied to minimise noise during construction. ▪ Dust suppression and dust control measures must be implemented to prevent and/or minimise surface and air transport of dust during construction. ▪ Proper waste management must be implemented and all waste generated during construction activities must be stored in temporary demarcated areas prior to disposal in licenced disposal sites. ▪ During site preparation, special care must be taken during the clearing of the works area to minimise damage or disturbance of roosting and nesting sites. ▪ Any excavated trenches and diversion canals will be inspected regularly for fauna that may have fallen into them and become trapped. All fauna found in these canals must be rescued.			
Post-mitigation			
Duration	Medium term (3)	Medium mitigation measures prescribed will ensure this.	Negligible (negative) (–35)
Extent	Limited (2)	If contractors adhere to mitigation such as to limit the footprint of disturbance to only essential areas and remaining on demarcated roads and demarcating construction laydown and/or storage area	
Intensity x type of impact	Minor (-2)	Dependent on the sensitivity of the specific site.	
Probability	Probable (4)	This impact may occur	
Nature	Negative		

Table 6-3: Encroachment of alien invasive plant

Dimension	Rating	Motivation	Significance
Activity and Interaction: Site establishment for camp laydown and construction requires vegetation clearance			
Impact Description: Alien vegetation establishment			
Prior to mitigation/ management			
Duration	Beyond Project Life (6)	Alien vegetation will colonise any area that is available (open areas), with no mitigation this problem will persist and spread.	Minor (negative) (–70)
Extent	Municipal area (4)	Such an infestation can easily spread to the entire municipal area and infest water sources.	
Intensity x type of impact	Serious Loss (-4)	Serious loss of sensitive habitats and species due to alien vegetation colonisation.	
Probability	Likely (5)	It is unlikely that without mitigation measures, alien vegetation will establish	
Nature	Negative		
Mitigation/ Management actions			
▪ Phased vegetation clearing must be implemented to minimise the extent of bare areas. ▪ An Alien Invasive Management Strategy needs to be implemented during construction and post-construction to manage nationally restricted alien invasive plant species ▪ If alien vegetation is encountered, remove these plants, in the correct way and timeously. Alien plants should be removed as seedlings before they reach seed-bearing age. Alien plants can establish on a site after removal for up to two to three years, therefore appropriate monitoring must take place. ▪ Indigenous vegetation must be utilised during the revegetation of disturbed areas			
Post management			
Duration	Medium term (3)	Alien vegetation colonisation will be eradicated through the Management Plan.	Negligible (negative) (–28)
Extent	Limited (2)	An infestation will not be allowed to spread.	
Intensity x type of impact	Minor (-2)	Only limited areas will experience this for a short duration.	

Dimension	Rating	Motivation	Significance
Probability	Probable (4)	It probable that alien vegetation will establish due to the nature of the project and the alteration of the river bank that will occur however infestations can be controlled if mitigation is adhered to.	
Nature	Negative		

6.1.2 Leeuspruit – Surface Mitigation Section 2

6.1.2.1 Activity: Site clearing and Construction of Flood Protection Berm

6.1.2.1.1 Impact description - Loss of Vegetation Units

Construction of the flood protection berm will lead to loss of grassland vegetation and narrowing of wetlands and therefore reduce the physical and functional attributes of the wetland system. These impacts are however regarded to be low. It is expected that the impacts will be mostly local and restricted to the proposed mitigation areas and immediate surrounds as the footprint of the proposed mitigation measures in relation to the surrounding environment is small. Revegetation of areas upon completion of vegetation clearing will present the potential for establishment of grassland vegetation, if mitigation measures are strictly adhered to.

The flood protection berm will typically comprise of suitable material (clayey sand, sandy clay) compacted in layers to the design level and reseeded (i.e. planting process using slurry of seed and mulch) to provide protection against erosion on the side-slopes of 1V:5H. The flood protection berm will extend up to the 1:100-year flood line on the upstream side to channel the 1:100-year flood away from the potential significant areas of pillar failure.

6.1.2.1.2 Management Objectives

Management objectives are to avoid indiscriminate loss of vegetation units during clearing and subsequent construction of flood protection berms in this section of the river diversion.

6.1.2.1.3 Management Targets and Actions

Phased clearing must be implemented to minimise the extent of bare areas. During clearing, natural vegetation must be retained, as far as possible and all berms must be immediately vegetated to prevent wind and water erosion. It is also important to ensure that indiscriminate vegetation clearing is avoided in order to maintain vegetation associated with grasslands and natural wetlands that ought to be protected.

Care must be taken to provide erosion and sedimentation control protection on the site such that construction runoff is directed away from the proposed berm location. Provision for adequate drainage is of paramount importance to facilitate seepage underneath berms.

Provision of adequate energy dissipation at spillway outlets is important in order to minimise erosion and the destruction of vegetation.

6.1.2.1.4 Impact Rating

The impacts associated with the construction of flood protection berms and the associated mitigation measures are detailed in below in Table 6-4.

Table 6-4: Loss of Vegetation Units

Dimension	Rating	Motivation	Significance
Activity and Interaction: Construction of flood protection berms require vegetation clearing			
Impact Description: Direct loss of floral species/vegetation			
Prior to mitigation/ management			
Duration	Medium term (3)	Loss of floral species/vegetation unit	Minor (negative) (-45)
Extent	Local (3)	Removal of vegetation could occur without planning, thereby affecting the development site area.	
Intensity x type of impact	Moderate(-3)	The proposed flood protection berm will be constructed on secondary grassland which is degraded and is regarded as Endangered nationally and wetland habitats	
Probability	Likely (5)	It is likely that destruction of vegetation types will occur.	
Nature	Negative		
Mitigation/ Management actions			
▪ Limit clearing to areas that have been designated for the construction of the flood protection berms. ▪ Implement phased clearing and ensure that indiscriminate vegetation clearing is avoided. ▪ During clearing, natural vegetation must be retained, as far as possible and all berms must be immediately vegetated to prevent wind and water erosion. This will also aid in water infiltration and flood attenuation. ▪ Ensure that topsoil and sub-soils are protected from contamination by stripping separately and storing separately from spoil material for use in revegetation of berms upon completion of construction. ▪ Provide adequate energy dissipation at each spillway outlet to minimise erosion and the subsequent destruction of vegetation that would result from it.			
Post-mitigation			
Duration	Short term (2)	Short term, mitigation measures prescribed will ensure this.	Negligible (negative) (– 24)

Dimension	Rating	Motivation	Significance
Extent	Limited (2)	If contractors adhere to mitigation such as to limit the footprint of disturbance to only essential areas.	
Intensity x type of impact	Minor (-2)	Impacted vegetation units have been allocated a medium sensitivity.	
Probability	Probable (4)	This impact will occur	
Nature	Negative		

6.1.3 Leeuspruit – Surface Mitigation Section 3 and 4

Habitat loss is the principal environmental impact of concern for this project. Secondary grassland habitat and wetland/riparian vegetation will be subject to vegetation clearing and earthworks during the construction of canals and berms causing direct habitat loss and fragmentation.

6.1.3.1 Activity: Canal excavation

6.1.3.1.1 Impact description - Loss of Vegetation Units

The activities that have been rated as having the most significant impacts are the excavation of diversion canals in the secondary grassland areas and riparian areas. Secondary grassland vegetation habitat and more specifically wetland habitat will be impacted on and permanently lost due to construction activities related to the clearance of natural habitat and excavation for canals. The most significant impacts constitute the excavation of the wetlands to construct the canals; this will result in a loss of a wetland areas as well as large impacts downstream such as erosion, sedimentation, and altered water quality due to large-scale construction within the wetland. Although significant, the impact on secondary grassland is however regarded to be lower in comparison to the impact on riparian/wetland vegetation unit, it is expected that the impacts will be mostly local and restricted to the proposed mitigation areas and immediate surrounds as the footprint of the proposed mitigation measures in relation to the surrounding environment is small

6.1.3.1.2 Management Objectives

The impact on the wetland in this river section will remain significant even after the implementation of mitigation measures. Sections of wetlands will have impacted upon due to construction on this wetland. Additionally, limited sections of secondary grassland will be impacted on due to the excavation of canals. It must be noted that if the proposed surface mitigation measures are not implemented there is a significant potential for pillar failure which can result in subsidence, which could lead to loss of secondary grassland vegetation, wetland habitat and loss of connectivity between habitats on a much larger scale as surface water flow would be lost which overtime could have a significant impact to overall ecology. Management objectives will be to limit habitat destruction to the areas that are designated

for the surface mitigation measures and minimise indiscriminate destruction of vegetation outside of these areas.

6.1.3.1.3 Management Targets and Actions

As mentioned above the impact on the riverine/wetland vegetation will remain significant even after the implementation of mitigation measures. Care must; however, be taken to keep vegetation clearance and excavations to a minimum extent.

In addition, runoff and erosion must be controlled to minimise sedimentation. To mitigate the impact on secondary grassland management must ensure that clearing is reasonably minimised and, sufficient vegetation is retained to maintain ecological processes.

Phased clearing is suggested to minimise bare areas as the proliferation of alien and invasive species is expected within the disturbed areas. Should alien vegetation be encountered, it must be cleared and controlled to prevent further spread.

6.1.3.2 Activity: Construction of Flood Protection Berms

6.1.3.2.1 Impact description - Loss of Vegetation Units

Construction of the flood protection berm will lead to loss of grassland vegetation and narrowing of wetlands and therefore reduce the physical and functional attributes of the wetland system. The proposed flood protection berms in these sections of the proposed area however more extensive than those proposed in Section two, thus the impact is expected to be higher and also influenced by the excavation of formalised canals that has been proposed in these sections.

6.1.3.2.2 Management Objectives

Management objectives will be to ensure that indiscriminate vegetation clearing is avoided and sufficient vegetation is retained to maintain ecological processes. Due to the larger spatial dimensions of the proposed flood protection berms, extra care must be taken to ensure that will vegetation clearing is limited to the areas required for construction.

6.1.3.2.3 Management Targets and Actions

Similar management targets and actions as proposed in Section 6.1.2.1.2 must also be applied in this proposed river diversion. Extra care must be taken to adhere strictly to these actions due to the larger spatial extent of the proposed flood protection berms.

6.1.3.2.4 Impact Rating

The impacts associated with the construction of the flood protection berm and associated mitigation measures are detailed in below in Table 6-5.

Table 6-5: Loss of Vegetation Units

Dimension	Rating	Motivation	Significance
Activity and Interaction: Construction of flood protection berms require vegetation clearing			
Impact Description: Direct loss of floral species/vegetation of the Secondary Grassland Unit			
Prior to mitigation/ management			
Duration	Medium term (3)	Loss of floral species/vegetation unit	Minor (negative) (-50)
Extent	Local (3)	Removal of vegetation could occur without planning, thereby affecting the development site area.	
Intensity x type of impact	Serious mid-term (4)	The proposed flood protection berm will be constructed on secondary grassland which is degraded and is regarded as Endangered nationally	
Probability	Likely (5)	It is likely that destruction of vegetation types will occur.	
Nature	Negative		
Mitigation/ Management actions			
▪ Limit clearing to areas that have been designated for the construction of the flood protection berms. ▪ Implement phased clearing and ensure that indiscriminate vegetation clearing is avoided ▪ During clearing, natural vegetation must be retained, as far as possible and all berms must be immediately vegetated to prevent wind and water erosion. This will also aid in water infiltration and flood attenuation. ▪ Ensure that topsoil and sub-soils are protected from contamination by stripping separately and storing separately from spoil material for use in revegetation of berms upon completion of construction. ▪ Provide adequate energy dissipation at each spillway outlet to minimise erosion and the subsequent destruction of vegetation that would result from this.			
Post-mitigation			
Duration	Permanent (2)	Short-term, mitigation measures prescribed will ensure this.	Minor (negative) (-40)
Extent	Local (3)	If contractors adhere to mitigation such as to limit the footprint of disturbance to only essential areas.	
Intensity x type of impact	Moderate (3)	Impacted vegetation units have been allocated a medium sensitivity.	
Probability	Probable (4)	This impact will occur	

Dimension	Rating	Motivation	Significance
Activity and Interaction: Construction of flood protection berms require vegetation clearing			
Nature	Negative		

6.1.3.2.5 Impact Rating

The impacts associated with the excavation, construction of formalised canals and the associated mitigation measures are detailed in below in Table 6-6 and Table 6-7.

Table 6-6: Loss of riparian/wetland vegetation due to excavation

Dimension	Rating	Motivation	Significance
Activity and Interaction: Clearing and excavation for the construction of formalised canals			
Impact Description: Direct and indirect loss of floral wetlands			
Prior to mitigation/ management			
Duration	Permanent (7)	Total loss of wetlands and loss of connectivity between wetlands will occur	Major (negative) (-119)
Extent	Municipal area (4)	Loss of natural habitat will affect the whole channel and connectivity between wetlands	
Intensity x type of impact	Very serious long-term (5)	Excavation will traverse wetlands leading to total loss of a wetland and construction of berms will also reduce the physical and functional attributes of wetlands	
Probability	Definite (7)	This impact will occur	
Nature	Negative		
Mitigation/ Management actions			
▪ No mitigation			
Post-mitigation			
Duration	Permanent (7)	Total loss of wetlands and loss of connectivity between wetlands will occur	Major (negative) (-119)
Extent	Municipal area (4)	Loss of natural habitat will affect the whole channel and connectivity between wetlands	
Intensity x type of impact	Very serious long-term (5)	Excavation will traverse wetlands leading to total loss of a wetland and construction of berms will also reduce the physical and functional attributes of wetlands	
Probability	Definite (7)	This impact will occur	

Dimension	Rating	Motivation	Significance
Nature	Negative		

Table 6-7: Loss of Secondary Grassland

Dimension	Rating	Motivation	Significance
Activity and Interaction: Clearing and excavation for the construction of formalised canals			
Impact Description: Direct and indirect loss of secondary grassland			
Prior to mitigation/ management			
Duration	Permanent (6)	Loss of floral species/vegetation in sections of the secondary grassland will occur.	Moderate (negative) (-84)
Extent	Local (3)	Removal of vegetation could occur without planning, thereby affecting the development site area.	
Intensity x type of impact	Moderate (3)	Excavation will occur on secondary grassland which is degraded and is regarded as Endangered nationally	
Probability	Definite (7)	Destruction of vegetation type will occur.	
Nature	Negative		
Mitigation/ Management actions			
▪ Clearing and excavation must be kept to a minimum, and this must only occur where it is absolutely necessary. ▪ Implement phased clearing and ensure that indiscriminate vegetation clearing is avoided. ▪ Ensure that clearing is reasonably minimised and, sufficient vegetation is retained to maintain ecological processes.			
Post-mitigation			
Duration	Permanent (6)	Short-term, mitigation measures prescribed will ensure this.	Moderate (negative) (-77)
Extent	Limited (2)	If contractors adhere to mitigation such as to limit the footprint of disturbance to only essential areas.	
Intensity x type of impact	Moderate (3)	Excavation will occur on secondary grassland which is degraded and is regarded as Endangered nationally	
Probability	Definite (7)	Destruction of vegetation type will occur.	
Nature	Negative		

6.1.3.3 Rietspruit– Surface Mitigation Section 1

Similarly, Leeuspruit Section 2 impacts on the wetland/riparian vegetation and secondary grassland can be expected in this river section as the proposed activities are the same (clearing as well as the construction of the flood protection berm) and the same vegetation units are found in both sections. These impacts are however regarded to be very low, as it is expected that the impacts will be mostly local and restricted to the proposed mitigation areas and immediate surrounds.

6.1.3.3.1 Activity: Construction of Flood Protection Berm

Most of activities that have an impact will only be limited to the areas required for construction of the earth flood protection berm. Construction of the flood protection berm will lead to loss of grassland vegetation and narrowing of wetland and therefore reduce the physical and as well as the functional attributes of the wetland system. These impacts are however regarded to be low, it is expected that the impacts will be mostly local and restricted to the proposed mitigation areas and immediate surrounds as the footprint of the proposed mitigation measures in relation to the surrounding environment is small.

6.1.3.3.2 Impact Description - Loss of Vegetation Units

Construction of the flood protection berm will lead to loss of grassland vegetation and narrowing of wetlands and therefore reduce the physical and functional attributes of the wetland system. These impacts are however regarded to be low. It is expected that the impacts will be mostly local and restricted to the proposed mitigation areas and immediate surrounds as the footprint of the proposed mitigation measures in relation to the surrounding environment is small. Revegetation of areas upon completion of vegetation clearing will present the potential for establishment of grassland vegetation if mitigation measures are strictly adhered to.

6.1.3.3.3 Management Objectives

Management objectives are to avoid indiscriminate loss of vegetation units during clearing and subsequent construction of flood protection berms in this section of the river diversion.

6.1.3.3.4 Management Targets and Actions

Phased clearing must be implemented to minimise the extent of bare areas. During clearing, natural vegetation must be retained, as far as possible and all berms must be immediately vegetated to prevent wind and water erosion. It is also important to ensure that indiscriminate vegetation clearing is avoided to maintain vegetation associated with grasslands and natural wetlands that ought to be protected.

Care must be taken to provide erosion and sedimentation control protection on the site such that construction runoff is directed away from the proposed berm location. Provision for adequate drainage is of paramount importance to facilitate seepage underneath berms.

Provision of adequate energy dissipation at spillway outlets is important in order to minimise erosion and the destruction of vegetation

6.1.3.4 Impact Rating

The impacts and related mitigation measures for the proposed activities in this river section are outlined in Table 6-8 below.

Table 6-8: Loss of Vegetation Units

Dimension	Rating	Motivation	Significance
Activity and Interaction: Construction of flood protection berms require vegetation clearing			
Impact Description: Direct loss of floral species/vegetation			
Prior to mitigation/ management			
Duration	Medium term (3)	Loss of floral species/vegetation unit	Minor (negative) (-45)
Extent	Local (3)	Removal of vegetation could occur without planning, thereby affecting the development site area.	
Intensity x type of impact	Moderate (-3)	The proposed flood protection berm will be constructed on secondary grassland which is degraded and is regarded as Endangered nationally and wetland habitat	
Probability	Likely (5)	It is likely that destruction of vegetation types will occur.	
Nature	Negative		
Mitigation/ Management actions			
▪ Limit clearing to areas that have been designated for the construction of the flood protection berms. ▪ Implement phased clearing and ensure that indiscriminate vegetation clearing is avoided. ▪ During clearing, natural vegetation must be retained, as far as possible and all berms must be immediately vegetated to prevent wind and water erosion. This will also aid in water infiltration and flood attenuation. ▪ Ensure that topsoil and sub-soils are protected from contamination by stripping separately and storing separately from spoil material for use in revegetation of berms upon completion of construction. ▪ Provide adequate energy dissipation at each spillway outlet to minimise erosion and the subsequent destruction of vegetation that would result from this.			
Post-mitigation			
Duration	Short term (2)	Short-term, mitigation measures prescribed will ensure this.	Negligible (negative) (–24)

Dimension	Rating	Motivation	Significance
Extent	Limited (2)	If contractors adhere to mitigation such as to limit the footprint of disturbance to only essential areas.	
Intensity x type of impact	Minor (-2)	Impacted vegetation units have been allocated a medium sensitivity.	
Probability	Probable (4)	This impact will occur	
Nature	Negative		

6.2 Operational Phase

The stream diversion system is designed as a gravity flow system with no operational inputs required. Thus, the stream diversion system during the operational phase will not lead to direct impacts to fauna. The operational phase of the project would have limited impact on the surrounding vegetation once the plants are allowed to re-establish themselves in any remaining areas; however, the potential of alien vegetation encroachment would definitely be present. Thus, an Alien Plant Management Strategy must be implemented during the operational phase whereby a qualified vegetation ecologist will monitor the disturbed areas annually for three years for alien plants. Monitoring must preferably take place between November and March.

All alien plant species must be identified, demarcated, and removed. The ultimate purpose of implementing proposed risk mitigations is for Sasol Mining to obtain a closure certificate. This means that, after mine closure, the ultimate responsibility for ensuring the infrastructure remains functional such as routine maintenance inspections of project infrastructure as well as repair and maintenance works of project infrastructure will ultimately be transferred to the State. It is however recommended that Sasol Mining must carry out regular inspections of all mitigated sections until a closure certificate is obtained i.e. grass cutting, removal of debris, erosion repair. It is recommended that monitoring of vegetation be undertaken for a three year period until sustainability is achieve with respect to succession and basal cover establishment.

Table 6-9: Destruction and disturbance through site access associated with routine maintenance

Dimension	Rating	Motivation	Significance
Activity and Interactions: Destruction and disturbance through site access associated with routine maintenance			
Prior to Mitigation/Management			
Duration	Project life (5)	The impact will cease after the operational lifespan of the project.	Minor (negative) (-55)

Dimension	Rating	Motivation	Significance
Extent	Local (3)	This impact will extend as far as the development site area	
Intensity x type of impact	Moderate, short-term effects (3)	Moderate, short-term effects but not affecting ecosystem function	
Probability	Likely (5)	This impact will likely occur	
Nature	Negative		
Mitigation/ Management actions			
▪ When possible make use of existing roads rather than creating new access routes. ▪ Encroachment of alien vegetation should be monitored regularly. ▪ The area must be kept clear of all invader plants as per the National Environmental Management: Biodiversity 2004 (Act No. 10 OF 2004) (NEMBA). ▪ Rehabilitation measures must be employed until such a time as indigenous species is established. ▪ Suitable erosion control measures should be implemented.			
Post-Mitigation			
Duration	Project life (5)	The impact will cease after the operational lifespan of the project.	Negligible (negative)(32)
Extent	Very Limited (1)	Limited to specific isolated parts of the site.	
Intensity x type of impact	Minor (2)	This impact will have minor effects on fauna and flora	
Probability	Probable (4)	This impact could happen	
Nature	Negative		

7 Cumulative Impacts

It is vital to consider the impacts that the development will have from a broad area perspective, by considering land-use and transformation of natural habitat in areas surrounding the site. Cumulative impacts are assessed by considering past, present and anticipated changes to biodiversity. The only construction and subsequent removal of vegetation that will occur is within the footprint of the River Diversion (after mitigation). Impacts occurring from site clearing, soil disturbance and subsequent removal of vegetation pose the most noteworthy cumulative impacts to the general area. This also includes the consequential risk of alien plant invasions that could possibly occur because of these activities.

8 No-Go Alternative

The no-go alternative in this particular instance refers to a situation where the proposed surface mitigations are not implemented. In the event that the proposed surface mitigation measures are not implemented, the potential loss of surface water flow could have larger reaching impacts to fauna and flora than the impacts associated with surface mitigation. The impacts associated with the surface mitigation measures with respect to fauna and flora will be highly localised and overtime through the implementation of rehabilitation measures the impacted areas should recover. The proposed surface mitigation measures will ensure that the system as a whole still functions for the long term.

All these impacts can lead to alteration of surviving habitats and change in the ecological function of communities. Species that depend on these terrestrial, aquatic, and semi-aquatic habitats can be particularly susceptible to these impacts.

The deformation of ground surfaces and the subsequent loss of habitat and connectivity of habitats that will occur in the event that this project is not granted approval can be considered a very detrimental impact on the fauna and flora in the study area as the study area is covered by the Soweto Highveld Grassland and Central Free State Grassland, which are both vulnerable as they are considered to be Endangered at a National level.

Table 8-1: Impact Rating for the No-Go Alternative

Dimension	Rating	Motivation	Significance
Activity and Interactions: Loss of vegetation units and habitat functionality as a result of loss of surface water flow to the system			
Prior to Mitigation/Management			
Duration	Permanent (7)	The impact is irreversible and will remain after the life of the project. Freshwater resource habitat and function will be destroyed.	Major (negative)(-114)

Dimension	Rating	Motivation	Significance
Extent	Province/Region (5)	The no-go option may have a regional impact as the water will be prevented from reaching the Vaal.	
Intensity x type of impact	Very significant impact on the environment. Irreparable damage to species, habitats and ecosystems (7)	Loss of ground surfaces, alterations of flow regimes and water quality in both ground and surface water, loss of habitats and loss of connectivity between habitats.	
Probability	Almost certain to occur (6)	If the proposed surface mitigation measures are not implemented these impacts are almost certain to occur	
Nature	Negative		
Post-Mitigation			
Duration	Permanent (6)	The impact is irreversible and will remain after the life of the project. Vegetation units, habitats and faunal species will be permanently lost and alien invasions will spread and persist	Moderate (negative) (-90)
Extent	Municipal area (4)	Habitat loss within the canals will affect entire ecosystems	
Intensity x type of impact	Very serious, long-term environmental impairment of ecosystem function that may take several years to rehabilitate (5)	The effectiveness of the rehabilitation will determine the intensity; however, some vegetation units will be permanently lost. Serious loss of sensitive habitats and species due to alien vegetation colonisation may also occur	
Probability	Almost certain (6)	Should the proposed project proceed, impacts on the terrestrial ecology of the study area will remain	
Nature	Negative		

9 Unplanned Events and Low Risks

Low risks can be monitored to gauge if the baseline changes and mitigation are required. Unplanned events may happen on any project. Table 9-1 shows possible unplanned events and management/mitigation measures.

Table 9-1: Unplanned events, low risks and their management measures

Unplanned event	Potential impact	Mitigation/ Management/ Monitoring
Hydrocarbon spillage	Soil contamination	▪ Appropriate measures must be implemented in order to prevent potential soil pollution through fuel and oil leaks and spills and compliance monitored by an appropriate person. Soil pollution through fuel and oil leaks may harm fauna and flora due to their chemical constituents which are poisonous. ▪ Make sure construction vehicles are maintained and serviced to prevent oil and fuel leaks. ▪ Emergency on-site maintenance must be done over appropriate drip trays and all oil or fuel must be disposed of according to waste regulations. Drip-trays must be placed under vehicles and equipment when not in use. ▪ Implement suitable erosion control measures.
Accidents and structural failure	Habitat degradation	▪ Equipment and infrastructure must be designed to withstand natural phenomena as best possible. ▪ Regular inspections and maintenance must be carried out in all sections for a minimum period of 3 years ▪ Impacts of natural hazards, such as flooding, must not be exacerbated;

10 Mitigation and Management Measures

Below in Table 10-1, a description of the mitigation and management options for the environmental impacts anticipated during the construction and the operational phases are provided.

Table 10-1: Impacts and Mitigation

Activities	Phase	Mitigation Measures	Compliance with standards	Time period for implementation
Surface Mitigation flood protection berms and diversion canals				
Site clearance and construction of flood protection berms and formalised canals	Pre-construction and construction	▪ Red Data Status plants located in areas of development must be marked prior to construction and the necessary permits for relocations of protected species must be obtained from the relevant government department. The relocation strategy must be approved by relevant authorities prior to relocation to a safe place to avoid destruction. ▪ Training to be provided to onsite staff with respect to the identification of sensitive species and the process that may be required for relocation of such species. ▪ Vegetation clearing must be kept to a minimum, and this must only occur where it is necessary. ▪ Ensure that sufficient secondary grassland and wetland vegetation is retained to maintain ecological processes. ▪ Newly cleared soils will have to be re-vegetated and stabilised as soon as construction has been completed. ▪ Care must be taken to provide erosion and sedimentation control protection on the site such that construction runoff is directly away from the proposed infiltration berm location. ▪ During construction, all vehicles must make use of existing access routes. Where construction vehicles must traverse the site to make new access routes, these must be kept as narrow as possible and creating of multiple routes should be avoided. ▪ During construction, areas must be clearly demarcated and no equipment or personnel will be allowed outside of the demarcated construction servitude unless unavoidable and essential for the construction phase. ▪ Proper waste management must be implemented and all waste generated during construction activities must be stored in temporary demarcated areas prior to disposal in licenced disposal sites. ▪ Illegal waste dumping must be prohibited. ▪ An Alien Plant Management Strategy must be implemented during the construction and post-construction, whereby a qualified vegetation ecologist will monitor the disturbed areas annually for three years for alien plants.	South African National Biodiversity Institute (SANBI) Red List of South African plants version 2012.1 National Environmental Management Biodiversity Act, 2004 (Act No. 10 of 2004) (NEMBA) listed species; and National Forests Act, 1998 (Act No. 84 of 1998) Protected Trees.	Continually, specifically construction
Revegetation/Rehabilitation of cleared areas	Post construction	▪ All areas to be affected by the proposed project will be rehabilitated after construction and all waste generated must be removed and disposed at a licensed registered	National Environmental Management Biodiversity Act, 2004 (Act No. 10 of 2004) (NEMBA) listed	Continually, specifically during the operational phase

Activities	Phase	Mitigation Measures	Compliance with standards	Time period for implementation
		landfill site. ▪ Re-vegetation with indigenous fast-growing grass species as soon as possible. ▪ Indigenous species used for revegetation should be less palatable. ▪ Cattle and other grazers should be excluded during using a fence, during the first year of vegetation establishment on the berms and canals. ▪ Avoid steep slopes during contouring. ▪ Make use of the and implement the AIP Management Plan.	species	

11 Monitoring Requirements

Upon completion of the construction phase, a vegetation rehabilitation programme for disturbed and degraded areas on the site must be instituted and monitored accordingly. In addition to this, alien invasive plants must be monitored regularly and controlled through the use of an Alien Invasive Management Strategy as per NEMBA the plan must include mitigation measures to reduce the invasion of alien species and ensure that the continuous monitoring and removal of alien species is undertaken.

Monitoring will include sites in undisturbed vegetation areas which will act as control plots. Plots within the disturbed infrastructure areas will have baseline data and then be monitored during the rehabilitation phase. The same plots will be monitored with each survey so as to ensure collected data is comparable and trends are identified.

Aspects that will be monitored in the annual surveys will include species richness, vegetation composition i.e. proportion grasses, forbs and woody species, canopy height, cover percentage, the presence of Red Data or protected species, and presence of alien invasive species.

11.1 Vegetation Cover Monitoring

The vegetation cover established on the disturbed areas needs to be monitored annually for the first two years after construction phase has been completed to ensure that the rehabilitation work has been successful in terms of stabilising the newly formed surfaces (preventing air and water erosion from affecting those surfaces), and that the newly established vegetation cover is trending towards convergence with the original vegetation cover found on the areas prior to disturbance (and on adjacent undisturbed areas) (Dawson, 2007).

Monitoring activities of structural stability and integrity of the berms must take place directly after completion of the construction phase and then every second month during the first six months and thereafter on an annual basis during the wet season for a period of two years. All berms must be immediately vegetated to prevent wind and water erosion.

Vegetation cover of rehabilitated areas must be assessed a month after the rain has fallen so that there has been an opportunity for fresh plant development to have occurred. Environmental indicators that need to be kept in mind to assess whether rehabilitation has been successful or not include the following:

- Increasing similarity between rehabilitated and undisturbed areas in terms of species composition and vegetation structure;
- Increasing species diversity of desired (local) species in rehabilitation cover over time;
- Reduction in presence of weed species over time;

- Increase in woody plant growth, and achievement of reproductive status and production of reproductive propagules (seed);
- Ability of the rehabilitation species populations to reproduce, indicated by the presence of seedlings of the rehabilitation species once the original generation has reached sexual maturity ("population recruitment");
- Increase in vegetation basal cover and biomass; and
- Increase in soil organic matter.

If the vegetation cover remains static, or deteriorates; additional seeding, with locally harvested species, and possibly fertilisation, would be required as a mitigation measure.

11.2 Alien Vegetation Monitoring

During vegetation monitoring, the presence of alien species must also be detected. An active program of weed management, to control the presence and spread of invasive weeds, will need to be instituted so that any weeds encroaching because of the disturbed conditions are controlled by means appropriate to the species.

Species likely to be problematic include those identified during the field assessment; namely *Acacia mearnsii, Cosmos bipinnatus Cortaderia selloana*, *Salix babylonica Persicaria lapathifolia*, *Solanum incanum*, *Solanum mauritianum* and *Targetes minuta* amongst others

The environmental indicator assessed in this instance is the reduction in presence of weed species over time, to the point where no invasive weed species are present and no further population recruitment occurs.

Table 11-1: Monitoring Requirements

Activity	Impact requiring monitoring	Phase	Monitoring details	Indicator	Roles and Responsibility	Time frame
Overall	Establishment and spread of alien plant species	Ongoing	Alien invasive vegetation monitoring and control through Alien Invasive Alien Invasive Management Plan, NEM:BA and Best Practice Guidelines.	▪ Reduction in presence of weed species over time; ▪ No further population recruitment	Environmental control officer	Monitor on a bi-monthly basis during construction and post construction, bi-annually thereafter for a minimum of three years
Overall	Vegetation establishment and erosion	Operational phase	Vegetation monitoring through rehabilitation plan	▪ Ability of the rehabilitation species populations to reproduce, indicated by the presence of seedlings of the rehabilitation species once the original generation has reached sexual maturity (“population recruitment”); ▪ Increase in soil organic matter. ▪ Decrease in bare vulnerable areas ▪ Increasing similarity between rehabilitated and undisturbed areas in terms of species composition and vegetation structure; ▪ Increasing species diversity of desired (local) species in rehabilitation cover over time;	Environmental control officer	Bi-monthly for the first 6 months post construction and bi-annually thereafter for a minimum of three years
Overall	Biological diversity (Fauna)	Ongoing	Monitoring of changes in faunal diversity	▪ Changes in species diversity in response to management actions	Environmental control officer	Bi-monthly for the first 6 months post construction and bi-annually thereafter for a minimum of three years
Berms		Ongoing	Regular inspections and maintenance must be carried out in all sections to ensure structural integrity	▪ Structures withstand natural processes ▪ No erosion and weathering	Environmental control officer	Bi-monthly the first year upon completion of construction and thereafter on an annual basis
Canal		Construction	Monitoring of structural integrity	▪ Ensure canal dug deep enough ▪ Ensure that that no permeable layers are likely to	Environmental control officer	Daily basis until completion of construction

12 Conclusion and Recommendations

The infield assessment indicates that the study area consists of different levels of sensitivity from a biodiversity standpoint these areas have been delineated and described.

It is important that the site preparation and surface mitigation infrastructure lay down is done with these sensitive areas in mind. The risk assessment for the project indicates that certain activities of the construction phase pose a significantly risk of impacting negatively on the fauna and flora, some of which remain significant following mitigation such as clearance of natural habitat and excavation for canals. Habitat loss due to clearing and excavation for the construction of formalised canals (i.e. Leeuspruit Section 3 and 4) is the principal environmental impact of concern for this proposed project.

It is however expected that the impacts of certain activities such as the construction of flood protection berms will be mostly local and restricted to the proposed mitigation areas and immediate surrounds as the footprint of the proposed mitigation measures in relation to the surrounding environment is small. In addition to this, the potential to recover certain secondary grassland landscapes will also be presented by re-vegetation on constructed surfaces. As no complete clearing will occur, sections of natural vegetation will be left relatively intact within the site, therefore it is expected that some of the faunal components will return to the site once the construction phase has been completed.

It is the opinion of the specialist that the project may go ahead with the following conditions:

- During construction, all vehicles must make use of existing access routes. Where construction vehicles must traverse the site and make new access routes, these must be kept as narrow as possible and creating of multiple routes should be avoided.
- Vegetation clearing must be kept to a minimum, and this must only occur where it is necessary.
- Ensure that sufficient secondary grassland and wetland vegetation is retained to maintain ecological processes.
- Newly cleared soils will have to be re-vegetated and stabilised as soon as construction has been completed.
- Care must be taken to provide erosion and sedimentation control protection on the site such that construction runoff is directly away from the proposed infiltration berm location.
- Provision for adequate drainage on the flood protection berm is of paramount importance to ensure movement of water threw the berm. In addition to this, it is the instillation of adequate energy dissipation measures at each spillway outlet to reduce the risk of erosion.
- Rehabilitation of the river corridor must take place after the activities are complete to minimise the risk erosion and indigenous species should be utilised.

- Monitoring activities of structural stability and integrity must take place directly after completion of the construction and then every second month during the first year.
- All mitigation measures prescribed in this document will be adhered to strictly.

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Appendix A: Specialist CV

CURRICULUM VITAE

Mr. Rudolph Greffrath

Manager: Biodiversity & Senior Terrestrial Ecology Specialist

Biophysical Department

Digby Wells Environmental

Tertiary Education

- 2005-2006: B-tech Degree in Nature Conservation, Nelson Mandela Metropolitan University (NMMU).
- 2001- 2004: National Diploma in Nature Conservation, Nelson Mandela Metropolitan University (NMMU).

Professional Registration

- South African Council for Natural Scientific Professions, *Professional Natural Scientist* in the field of practice *Conservation Science,* registration number is *400018/17*;
- IAIA, International Association for Impact Assessments;
- Botanical Society of South Africa;
- The Land Rehabilitation Society of Southern Africa, LARSA (Membership No. 0085);
- Birdlife International;
- Endangered Wildlife Trust (EWT);
- Grassland Society of Southern Africa.

Employment

2006 – Present: Digby Wells Environmental, Johannesburg, South Africa.

2002 - 2003: Shamwari Game Reserve, Eastern Cape, South Africa.

2001: Kop-Kop Geotechnical instrumentation specialists, Johannesburg, South Africa.

Experience

Rudolph's current role is that of a terrestrial ecologist, with specific reference to Fauna and flora. In this capacity, he is responsible for the planning and completion of terrestrial ecological studies, in the context of standalone reports, EIA reports and ESIA reports used for environmental authorisations or are focused specialist studies which meet local and international standards.

Rudolph has extensive experience in the application and adherence to the International Finance Corporation Performance standards, specifically performance standard 6. In this field, he has worked with mining companies across Africa to ensure their compliance with IFC PS6. In this regard, he has gained experience in applying the No Net Loss and Net Positive Impact approaches for Biodiversity in a mining business context. He has experience in applying the Equator Principles and World Bank criteria, specifically Criteria 7.

In support of this, Rudolph is responsible for offset design after a mitigation hierarchy is applied; in this regard he compiles Biodiversity Land Management Programs where various specialist studies are collated into a working document for clients in order to aid in pre or post-mining management and achieving the No Net Loss and Net Positive Impacts.

Further to this he is also involved in rehabilitation design studies which entail the planning, implementation and monitoring of vegetative rehabilitation in designated areas on mines. He is responsible for the planning of post mine land use and the various methods utilised to achieve this.

Rudolph also fulfils the role of project manager here he manages national and international projects across Africa, specifically west, central and southern Africa, managing a multi-disciplinary team of specialists.

Rudolph is also involved in the acquisition of regulatory permits for clients; this includes the planning of relocation strategies for protected and endangered plant species in areas where mines are to be established. This involves the planning and execution of data gathering surveys, thereafter he manages the process involving relevant provincial and National authorities in order to obtain the specific permit that allows for a development to continue.

Information pertaining to the technical expertise of Rudi includes the following:

- Environmental Impact Assessments (EIAs), Basic Assessments and Environmental Management Plans (EMPs) for environmental authorisations in terms of the South African National Environmental Management Act (NEMA), 1998 (Act 107 of 1998);
- Environmental pre-feasibility studies for gold tailings reclamation and iron ore mining projects:
  - International Finance Corporation (IFC) related projects across central and west Africa, applying performance standards and Equator Principles on the Environmental Health and Safety Guidelines set down by the IFC;
  - Environmental and Social Impact Assessments (ESIA) for Environmental Authorisation;
  - Environmental off-Set studies, determining off-set liability, applying the Mitigation hierarchy and best practice in the form of IFCPS6 and BBOP.
  - Large Mammal Monitoring Projects;
  - Biodiversity Assessments including Mammalia, Avifauna, Herpetofauna and Arthropoda;

- Environmental Impact Assessments (EIA) based Impacts to the terrestrial Ecological environment;
- Biodiversity Action Plan, design and Implementation;
- Biodiversity and Land Management Programs;
- Protected plant species management strategies planning and implementation;
- Monitoring of rehabilitation success by means of vegetation establishment;
- Rehabilitation planning;
- Environmental auditing of rehabilitated areas;
- Project management of ecological specialist studies;
- Planning and design of Rehabilitation off-set strategies.

Training

- Measurements of Biodiversity at the University of the Free State, led by Prof. M. T. Seaman. September 2008.
- IFC performance standards implementation training, Lee-Ann Joubert, January 2013.
- Bird Identification course led by Ettiene Marais November 2009.
- Introduction to VEGRAI and Eco-classification led by Dr. James Mackenzie December 2009 and January 2018.
- Dangerous snake handling and snake bite treatment with Mike Perry 2011, 2015.
- Rehabilitation of Mine impacted areas, with Fritz van Oudshoorn, Dr Wayne Truter and Gustav le Roux 2011.
- First aid Level 2, School of Emergency and Critical care, Netcare, 2013
- First aid Level 2, National First Aid Academy, 2017.

Projects

The following project list is indicative of Rudolph's experience, providing insight into the various projects, roles and locations he has worked in.

Project	Location	Client	Main project features	Positions held	Activities performed
Tongon Off-set project	Ivory Coast	Randgold Resources Limited	Applying IFC, BBOP and other best practice guidelines in designing an Off-set project for the residual Impact of the Tongon Gold Mine	Project Lead Technical Specialist	
Annual Large Mammal Monitoring in the Niokola Koba National Park.	Senegal	DPN Direction des Parcs Nationaux du Sénégal	Applying Aerial, Ground and vehicle, monitoring techniques in the National Park.	Aerial game counter, project specialist.	Training of field staff, recording of data in the vehicle and aerial surveys, Report reviews
Mmamabula Energy Project (MEP).	Botswana	CIC energy	Construction of a railway, opencast mine, wellfield, conveyors, addits, housing.	Technical Specialist Ecologist	IFC level specialist studies, Fauna and flora surveys for the project features, including impact assessments, management plans. Alien eradication plans.
Orlight Solar PV Power Project	South Africa	Orlight SA	Environmental Impact Assessment (EIA) process for five proposed Solar Photovoltaic (PV) Power Plants	Technical Specialist Ecologist	EIA Terrestrial Biodiversity studies, IFC level specialist studies

Project	Location	Client	Main project features	Positions held	Activities performed
Twenty Nine Capitol	South Africa	CSIR	Photovoltaic Power stations	Technical Specialist Ecologist	EIA Terrestrial Biodiversity studies, in support of the EIA report, IFC level specialist studies
Tongan Biodiversity Land Management Plan	Ivory Coast	Randgold Resources Limited	Design, compilation and implementation of the BLMP	Technical Specialist Ecologist, Project Manager	Fauna and flora surveys for the BLMP, compilation of BLMP. Alien eradication plans. IFC level specialist studies
Kibali Gold mine	DRC Congo	Randgold Resources Limited	Gold mine infrastructure	Technical Specialist Ecologist	Technical specialist, Fauna and flora , for the Kibali ESIA. IFC level specialist studies
Kibali Gold mine	DRC Congo	Randgold Resources Limited	ESIA Update	Technical Specialist Ecologist	Technical specialist, Fauna and flora , for the Kibali ESIA. IFC level specialist studies
Nzoro Hydroelectric station	DRC Congo	Randgold Resources Limited	Hydroelectric plant	Technical Specialist Ecologist	Technical specialist, Fauna and flora , for the Nzoro ESIA. IFC level specialist studies.
Loulo Biodiversity Land Management Plan	Mali	Randgold Resources Limited	Design, compilation and implementation of the BLMP	Technical Specialist Ecologist, Project Manager	Fauna and flora surveys for the project features, compilation of BLMP.

Project	Location	Client	Main project features	Positions held	Activities performed
Koidu Diamond Mine	Sierra Leone	Koidu Resources	Construction of new open pit	Technical Specialist Ecologist	Technical specialist, Fauna and flora , for the Koidu ESIA. IFC level specialist studies, terrestrial ecology management plans
Resource Generation	South Africa	Temo Coal	Coal mine/Railway Line	Technical Specialist Ecologist	Fauna and flora surveys, Protected plant species management plans, Permitting and Rehabilitation design.
Impunzi Rehabilitation monitoring	South Africa	Glencore	Monitoring of rehabilitation success and suggested management measures	Technical Specialist Flora specialist, Project manager	Vegetation surveys, rehabilitation monitoring. Alien eradication plan.

Publications

- Biodiversity Action Plans for faunal habitat maintenance and expansion in mining. Poster presented at the 48th Annual Grassland Society of Southern Africa (GSSA) conference.
- Limpopo Province South Africa – the Biodiversity perspective Paper presentation, presented at the Limpopo Minerals Conference and Tradeshow, hosted by the fossil fuel foundation and LEDET, 2015/11/11.

CURRICULUM VITAE

Mr. Lusanda Patrick Matee

Assistant Ecologist (Consultant): Fauna and flora

Biophysical Department

Digby Wells Environmental

Education

- 2012 :BSc. Biological Sciences

  University of KwaZulu-Natal

  Research Project: “Mapping the distribution of selected Southern African bat species”

- 2013 : BSc. (Honours) Biological Sciences (Zoology)

  University of KwaZulu-Natal

  Research Project: “Sleeping patterns in selected South African avian species: Ring-necked Parakeets (*Psittacula krameri*), and Red-winged Starling (*Onychognathus morio*)”

- 2016: MSc by Research Biological Sciences

  University of KwaZulu-Natal

  Research Project: “Lichen photobiology in relation to climate change: Protection in Peltigeralean lichens against excess ultraviolet (UV) radiation using induced melanins and the effects of UV on melanin synthesizing enzymes”

  Master of Science (Masters by Research in Biological Sciences (Botany) SANCOOP Project, collaboration with Norwegian University of Life Sciences Department of Ecology and Natural Resource Management

Language Skills

- English: 1st Language
- isiXhosa: Home language
- isiNdebele: Conversational and written command
- isiZulu : Conversational and written command

Employment

- November 2017-Present: Assistant Ecologist (Consultant)
- June 2017- November 2017: Digby Wells Environmental Biophysical Intern (Ecology intern: Fauna and flora)

- 2011-2016 : Laboratory demonstrator & Teaching Assistant University of KwaZulu-Natal
- 2012-2013: DNA Bar-coding Research Intern at the South African National Biodiversity institute (SANBI)

Experience

Lusanda Matee is Assistant Ecologist (Consultant) in the Biophysical department. He has Working knowledge of environmental planning processes, policies, regulatory frameworks, and legislation. He is also competent in Compilation of environmental reports in accordance with relevant environmental legislative requirements. His role in the company is assisting with projects related to Fauna and flora.

Project Experience

Year	Client	Project	Responsibility	Location
2017	Sibanye Gold	Long Term Rehabilitation and Closure Strategy for the Cooke Operations	Update of Rehab and Closure Plan	South Africa
2017	Mutsho Power Company (Pty) Ltd	Proposed Mutsho Power Project Wetland Baseline Scoping Report	Wetland Scoping Report Compilation	South Africa
2017	Randgold Resources	Kibali BLMP Audit	Assisting with Report Compilation	DRC
2017	Randgold Resources	Environmental and Social Impact Assessment for the Massawa and Sofia Gold Project, Senegal	Assisting with the Baseline Report Compilation	Senegal
2017	Exxaro	BAR : Environmental Authorisation in Support of the Rehabilitation and Closure of Tshikondeni Coal Mine	Assisting with BAR Compilation and Submission	South Africa
2017	Exxaro	Exxaro Grootegeluk Coal Mine Exploration Drilling Sites Protected Tree Assessment	Protected Tree Infield Assessment	South Africa
2017	Exxaro	Exxaro Matla Biomonitoring	River biomonitoring	South Africa
2018	Rustenburg Platinum Mines Limited	Closure Environmental Management Plan for Prospecting Right on Farm Cyferkruil	Baseline Compilation	South Africa

Year	Client	Project	Responsibility	Location
2018	Rustenburg Platinum Mines Limited	Closure Environmental Management Plan for Prospecting Right on the Farm Waagfontein 89 JQ	Baseline Compilation	South Africa
2018	Rustenburg Platinum Mines Limited	Closure Environmental Management Plan for Prospecting Right on the Farm Zandspruit 168 JP	Baseline Compilation	South Africa
2018	Exxaro	Alien Invasive Vegetation Assessment and Management Plan for the Matla Colliery	Alien Invasive Vegetation Infield Assessment and Compilation of Management Plan	South Africa
2018	Sasol Mining	Alien Invasive Vegetation Assessment and Management Plan for the Sigma: Mooikraal Colliery	Alien Invasive Vegetation Infield Assessment and Compilation of Management Plan	South Africa
2018	Anker Coal and Mineral Holdings SA (Pty) Ltd.	Alien Invasive Vegetation Assessment and Management Plan for the Elandsfontein Colliery	Alien Invasive Vegetation Infield Assessment and Compilation of Management Plan	South Africa

Professional Bodies and Memberships

- South African Council for Natural Scientific Professions, Candidate Natural Scientist in the field of practice Biological Science, registration number is 119257
- Golden Key International Honour Society
- Zoological Society of Southern Africa

Publications

- Matee, L. P., Beckett, R. P., Solhaug, K. A., & Minibayeva, F. V. (2016). Characterization and role of tyrosinases in the lichen *Lobaria pulmonaria* (L.) Hoffm. The Lichenologist, 48(4), 311-322.

Appendix B: Species List for the Study Area

Family	Scientific Name	Common Name	Ecological Status	Form
EUPHORBIACEAE	*Acalypha angustata*	Brooms and Brushes	Medicinal	Herb
EUPHORBIACEAE	*Acalypha sp.*	-	-	Herb
ASTERACEAE	*Acanthospermum glabratum*	Creeping Starbur	-	Herb
AGAVACEAE	*Agave americana L*	American agave	Exotic	Herb
ASPARAGACEAE	*Albuca shawii*	Lantern Flower	-	Herb
AMARANTHACEAE	*Amaranthus hybridus*	Pigweed	Alien Invasive	Herb
POACEAE	*Andropogon appendiculatus*	Vlei Bluestem	Decreaser - Climax	Grass
POACEAE	*Andropogon eucomus*	Snowflake grass	Increaser 2 - Subclimax	Grass
AGAVACEAE	*Anthericum cooperii*	Coopers Anthericum	-	Herb
PAPAVERACEAE	*Argemone ochroleuca subsp. ochroleuca*	White-flowered Mexican poppy	Alien Invasive	Herb
POACEAE	*Aristida adscensionis*	Annual three awn	Pioneer Increase 2	Grass
POACEAE	*Aristida congesta barbicolis*	Spreading three awn	Pioneer Increase 2	Grass
POACEAE	*Aristida congesta*	Tassel Tree-awn	Increaser 2 - Pioneer	Grass
POACEAE	*Aristida diffusa*	Iron Grass	Increaser 3 - Subclimax to climax	Grass
POACEAE	*Aristida junciformis*	Ngongoni Three-awn	Invasive	Grass
POACEAE	*Aristida stipatata*	Long awned grass	Pioneer Subclimax Increaser 2	Grass
ASPARAGACEAE	*Asparagus aethiopicus*	-	-	Herb
ASPARAGACEAE	*Asparagus africanus*	Bush asparagus	Medicinal	Herb
ASPARAGACEAE	*Asparagus laricinus*	Bushveld Asparagus	Alien Invasive	Herb

Family	Scientific Name	Common Name	Ecological Status	Form
IRIDACEAE	*Babiana hypogea*	-	-	Herb
ASTERACEAE	*Berkheya rigida*	African thistle (Engl)	Exotic	Herb
ASTERACEAE	*Bidens bipinnata*	-	Alien Invasive	Herb
ASTERACEAE	*Bidens formosa*	Cosmos	Alien Invasive	Herb
ASTERACEAE	*Bidens pilosa*	Common Black-jack	Alien Invasive	Herb
ACANTHACEAE	*Blepharis integrifolia var. integrifolia*		Medicinal	Herb
FABACEAE	*Chamaecrista comosa*	Trailing dwarf cassia	-	Herb
POACEAE	*Chloris virgata*	Feather top chloris	Pioneer increaser 2	Grass
ASPARAGACEAE	*Chlorophytum fasciculatum*	-	-	Herb
ASTERACEAE	*Cirsium vulgare*	Scotch Thistle	Alien Invasive*	Herb
ASTERACEAE	*Conyza canadensis (L.)*	Cronq- Canadian fleabane	Exotic	Herb
POACEAE	*Cynodon dactylon*	Couch Grass	Increaser 2 - Pioneer	Grass
SOLANACEAE	*Datura ferox*	Large thorn-apple	Alien Invasive	Herb
POACEAE	*Digitaria eriantha*	Common Finger Grass	Decreaser - Climax	Grass
POACEAE	*Eragrostis chloromelas*	(Narrow) Curly Leaf	Increaser 2 - Subclimax to climax	Grass
POACEAE	*Eragrostis cilianensis*	Stink love grass	Pioneer increaser 2	Grass
POACEAE	*Eragrostis curvula*	Weeping Love Grass	Increaser 2 - Subclimax to climax	Grass
POACEAE	*Eragrostis gummiflua*	Gum Grass	Increaser 2 - Subclimax	Grass
MYRTACEAE	*Eucalyptus camaldulensis*	Red river gum	Alien Invasive	Tree

Family	Scientific Name	Common Name	Ecological Status	Form
ASTERACEAE	*Flaveria bidentis*	Smelter's bush	Alien Invasive	Herb
FABACEAE	*Gleditsia triacanthos*	Honey locust	Alien Invasive	Tree
POACEAE	*Heteropogon contortus*	Spear grass	Increaser 2 - Pioneer to subclimax	Grass
POACEAE	*Hyparrhenia hirta*	Common Thatching Grass	Increaser 1 - Subclimax to climax	Grass
POACEAE	*Imperata cylindrica*	Cottonwool grass	Increaser 1 - Subclimax to climax	Grass
POACEAE	*Melinis repens*	Natal Red Top	Increaser 2 - Pioneer to subclimax	Grass
POACEAE	*Panicum coloratum*	Small panicum	Decreaser	Grass
POACEAE	*Pennisetum clandestinum*	Kikuyu Grass	Exotic	Grass
POACEAE	*Perotis patens*	Cat's Tail	Increaser 2 - Pioneer to subclimax	Grass
POACEAE	*Phragmites australis*	Common Reed	Decreaser	Grass
PINACEAE	*Pinus patula*	Patula pine	Alien Invasive	Herb
SALICACEAE	*Populus x canescens*	Grey poplar	Alien Invasive	Tree
FABACEAE	*Prosopis glandulosa*	Honey mesquite	Alien Invasive	Tree
ASTERACEAE	*Pseudognaphalium luteo-album (L.)*	Jersey Cudweed	Exotic	Herb
SALICACEAE	*Salix babylonica*	Weeping willow	Alien Invasive	Tree
ASTERACEAE	*Seriphium plumosum*	Bankrupt Bush	Exotic	Herb
POACEAE	*Setaria nigrirostris*	Black-seed bristle grass	Decreaser	Grass
POACEAE	*Setaria sphacelata var torta*	Small Creeping Foxtail	Decreaser	Grass
SOLANACEAE	*Solanum incanum*	Bitter apple	Alien Invasive	Herb

Family	Scientific Name	Common Name	Ecological Status	Form
POACEAE	*Sporobolus africanus*	Rat's tail dropseed	Increaser 3 - Subclimax to climax	Grass
ASTERACEAE	*Tagetes minuta*	Tall khakiweed	Alien Invasive	Herb
POACEAE	*Themeda trianda*	Red grass	Decreaser	Grass
TYPHACEAE	*Typha capensis*	Bulrush	-	Herb
VERBENACEAE	*Verbena bonariensis*	Tall verbena	Alien Invasive	Herb
ASTERACEAE	*Xanthium spinosum*	Spiny cocklebur	Alien Invasive	Herb

Appendix C: PRECIS Data for the 2627DD

Family	Species	IUCN
ACANTHACEAE	*Chaetacanthus setiger (Pers.) Lindl.*	LC
ACANTHACEAE	*Crabbea acaulis N.E.Br.*	LC
ACANTHACEAE	*Crabbea hirsuta Harv.*	LC
ALISMATACEAE	*Alisma plantago-aquatica L.*	Not Evaluated
ALLIACEAE	*Tulbaghia leucantha Baker*	LC
AMARANTHACEAE	*Achyranthes aspera L. var. aspera*	Not Evaluated
AMARANTHACEAE	*Achyranthes aspera L. var. sicula L.*	Not Evaluated
AMARANTHACEAE	*Gomphrena celosioides Mart.*	Not Evaluated
AMARANTHACEAE	*Guilleminea densa (Willd. ex Roem. & Schult.) Moq.*	Not Evaluated
AMARANTHACEAE	*Hermbstaedtia odorata (Burch.) T.Cooke var. aurantiaca (Suess.) C.C.Towns.*	LC
AMARANTHACEAE	*Hermbstaedtia odorata (Burch.) T.Cooke var. odorata*	LC
AMARYLLIDACEAE	*Ammocharis coranica (Ker Gawl.) Herb.*	LC
AMARYLLIDACEAE	*Crinum bulbispermum (Burm.f.) Milne-Redh. & Schweick.*	Declining
AMARYLLIDACEAE	*Cyrtanthus breviflorus Harv.*	LC
AMARYLLIDACEAE	*Haemanthus montanus Baker*	LC
ANACARDIACEAE	*Searsia lancea (L.f.) F.A.Barkley*	LC
ANACARDIACEAE	*Searsia pyroides (Burch.) Moffett var. gracilis (Engl.) Moffett*	LC
ANACARDIACEAE	*Searsia pyroides (Burch.) Moffett var. pyroides*	LC
ANTHERICACEAE	*Chlorophytum cooperi (Baker) Nordal*	LC
ANTHERICACEAE	*Chlorophytum fasciculatum (Baker) Kativu*	LC
APIACEAE	*Afrosciadium magalismontanum (Sond.) P.J.D.Winter*	LC
APIACEAE	*Alepidea attenuata Weim.*	NT
APIACEAE	*Berula thunbergii (DC.) H.Wolff*	LC
APIACEAE	*Centella asiatica (L.) Urb.*	LC
APIACEAE	*Cyclospermum leptophyllum (Pers.) Sprague ex Britton & P.Wilson*	Not Evaluated
APIACEAE	*Deverra burchellii (DC.) Eckl. & Zeyh.*	LC

Family	Species	IUCN
APOCYNACEAE	*Araujia sericifera Brot.*	Not Evaluated
APOCYNACEAE	*Asclepias gibba (E.Mey.) Schltr. var. gibba*	LC
APOCYNACEAE	*Asclepias gibba (E.Mey.) Schltr. var. media N.E.Br.*	LC
APOCYNACEAE	*Asclepias meyeriana (Schltr.) Schltr.*	LC
APOCYNACEAE	*Aspidoglossum interruptum (E.Mey.) Bullock*	LC
APOCYNACEAE	*Brachystelma incanum R.A.Dyer*	VU
APOCYNACEAE	*Cordylogyne globosa E.Mey.*	LC
APOCYNACEAE	*Gomphocarpus fruticosus (L.) Aiton f. subsp. fruticosus*	LC
APOCYNACEAE	*Pachycarpus schinzianus (Schltr.) N.E.Br.*	LC
APOCYNACEAE	*Pentarrhinum insipidum E.Mey.*	LC
APOCYNACEAE	*Raphionacme hirsuta (E.Mey.) R.A.Dyer*	LC
APOCYNACEAE	*Raphionacme velutina Schltr.*	LC
APOCYNACEAE	*Riocreuxia polyantha Schltr.*	LC
APOCYNACEAE	*Schizoglossum nitidum Schltr.*	LC
APOCYNACEAE	*Stenostelma capense Schltr.*	LC
APOCYNACEAE	*Stenostelma umbelluliferum (Schltr.) S.P.Bester & Nicholas*	NT
APONOGETONACEAE	*Aponogeton junceus Lehm.*	LC
ASPARAGACEAE	*Asparagus cooperi Baker*	LC
ASPARAGACEAE	*Asparagus laricinus Burch.*	LC
ASPHODELACEAE	*Bulbine abyssinica A.Rich.*	LC
ASPHODELACEAE	*Bulbine favosa (Thunb.) Schult. & Schult.f*	LC
ASPHODELACEAE	*Bulbine narcissifolia Salm-Dyck*	LC
ASPHODELACEAE	*Chortolirion angolense (Baker) A.Berger*	LC
ASPHODELACEAE	*Kniphofia porphyrantha Baker*	LC
ASPHODELACEAE	*Kniphofia typhoides Codd*	NT
ASPHODELACEAE	*Trachyandra asperata Kunth var. asperata*	LC
ASPHODELACEAE	*Trachyandra asperata Kunth var. macowanii (Baker) Oberm.*	LC
ASPHODELACEAE	*Trachyandra asperata Kunth var. nataglencoensis (Kuntze) Oberm.*	LC
ASPHODELACEAE	*Trachyandra laxa (N.E.Br.) Oberm. var. laxa*	LC

Family	Species	IUCN
ASPHODELACEAE	*Trachyandra saltii (Baker) Oberm. var. saltii*	LC
ASTERACEAE	*Arctotis arctotoides (L.f.) O.Hoffm.*	LC
ASTERACEAE	*Arctotis microcephala (DC.) Beauverd*	LC
ASTERACEAE	*Arctotis venusta Norl.*	LC
ASTERACEAE	*Berkheya pinnatifida (Thunb.) Thell. subsp. ingrata (Bolus) Roessler*	LC
ASTERACEAE	*Berkheya radula (Harv.) De Wild.*	LC
ASTERACEAE	*Chrysocoma obtusata (Thunb.) Ehr.Bayer*	LC
ASTERACEAE	*Cirsium vulgare (Savi) Ten.*	Not Evaluated
ASTERACEAE	*Cnicus benedictus L.*	Not Evaluated
ASTERACEAE	*Conyza bonariensis (L.) Cronquist*	Not Evaluated
ASTERACEAE	*Conyza canadensis (L.) Cronquist*	Not Evaluated
ASTERACEAE	*Conyza chilensis Spreng.*	Not Evaluated
ASTERACEAE	*Conyza podocephala DC.*	LC
ASTERACEAE	*Cotula anthemoides L.*	LC
ASTERACEAE	*Cotula microglossa (DC.) O.Hoffm. & Kuntze ex Kuntze*	LC
ASTERACEAE	*Denekia capensis Thunb.*	LC
ASTERACEAE	*Dicoma anomala Sond. subsp. anomala*	LC
ASTERACEAE	*Felicia fascicularis DC.*	LC
ASTERACEAE	*Felicia muricata (Thunb.) Nees subsp. muricata*	LC
ASTERACEAE	*Flaveria bidentis (L.) Kuntze*	Not Evaluated
ASTERACEAE	*Gamochaeta subfalcata (Cabrera) Cabrera*	Not Evaluated
ASTERACEAE	*Gazania krebsiana Less. subsp. arctotoides (Less.) Roessler*	LC
ASTERACEAE	*Gazania krebsiana Less. subsp. krebsiana*	LC
ASTERACEAE	*Gazania krebsiana Less. subsp. serrulata (DC.) Roessler*	LC
ASTERACEAE	*Geigeria aspera Harv. var. aspera*	LC

Family	Species	IUCN
ASTERACEAE	*Gerbera ambigua (Cass.) Sch.Bip.*	LC
ASTERACEAE	*Gnaphalium confine Harv.*	LC
ASTERACEAE	*Haplocarpha scaposa Harv.*	LC
ASTERACEAE	*Helichrysum argyrosphaerum DC.*	LC
ASTERACEAE	*Helichrysum caespititium (DC.) Harv.*	LC
ASTERACEAE	*Helichrysum callicomum Harv.*	LC
ASTERACEAE	*Helichrysum lineare DC.*	LC
ASTERACEAE	*Helichrysum nudifolium (L.) Less. var. nudifolium*	LC
ASTERACEAE	*Helichrysum paronychioides DC.*	LC
ASTERACEAE	*Helichrysum rugulosum Less.*	LC
ASTERACEAE	*Helichrysum subglomeratum Less.*	LC
ASTERACEAE	*Hypochaeris brasiliensis (Less.) Griseb.*	Not Evaluated
ASTERACEAE	*Hypochaeris microcephala (Sch.Bip.) Cabrera var. albiflora (Kuntze) Cabrera*	Not Evaluated
ASTERACEAE	*Hypochaeris radicata L.*	Not Evaluated
ASTERACEAE	*Litogyne gariepina (DC.) Anderb.*	LC
ASTERACEAE	*Nolletia ciliaris (DC.) Steetz*	LC
ASTERACEAE	*Osteospermum muricatum E.Mey. ex DC. subsp. muricatum*	LC
ASTERACEAE	*Pentzia globosa Less.*	LC
ASTERACEAE	*Platycarphella parvifolia (S.Moore) V.A.Funk & H.Rob.*	LC
ASTERACEAE	*Pseudognaphalium luteo-album (L.) Hilliard & B.L.Burtt*	
ASTERACEAE	*Pseudognaphalium oligandrum (DC.) Hilliard & B.L.Burtt*	LC
ASTERACEAE	*Schkuhria pinnata (Lam.) Kuntze ex Thell.*	Not Evaluated
ASTERACEAE	*Senecio consanguineus DC.*	LC
ASTERACEAE	*Senecio coronatus (Thunb.) Harv.*	LC
ASTERACEAE	*Senecio erubescens Aiton var. erubescens*	LC
ASTERACEAE	*Senecio gregatus Hilliard*	LC
ASTERACEAE	*Senecio harveianus MacOwan*	LC
ASTERACEAE	*Senecio inaequidens DC.*	LC

Family	Species	IUCN
ASTERACEAE	*Senecio inornatus DC.*	LC
ASTERACEAE	*Senecio laevigatus Thunb. var. laevigatus*	LC
ASTERACEAE	*Senecio polyodon DC. var. polyodon*	LC
ASTERACEAE	*Sonchus integrifolius Harv. var. integrifolius*	LC
ASTERACEAE	*Tolpis capensis (L.) Sch.Bip.*	LC
ASTERACEAE	*Tripteris aghillana DC. var. aghillana*	LC
ASTERACEAE	*Ursinia nana DC. subsp. leptophylla Prassler*	LC
ASTERACEAE	*Xanthium spinosum L.*	Not Evaluated
ASTERACEAE	*Xanthium strumarium L.*	Not Evaluated
AZOLLACEAE	*Azolla filiculoides Lam.*	Not Evaluated
BRASSICACEAE	*Coronopus integrifolius (DC.) Spreng.*	Not Evaluated
BRASSICACEAE	*Diplotaxis muralis (L.) DC.*	Not Evaluated
BRASSICACEAE	*Lepidium bonariense L.*	Not Evaluated
BRASSICACEAE	*Nasturtium officinale R.Br.*	Not Evaluated
BRASSICACEAE	*Raphanus raphanistrum L.*	Not Evaluated
BRASSICACEAE	*Rorippa fluviatilis (E.Mey. ex Sond.) Thell. var. caledonica (Sond.) Marais*	LC
BRYACEAE	*Bryum apiculatum Schwägr.*	
CAMPANULACEAE	*Wahlenbergia androsacea A.DC.*	LC
CAMPANULACEAE	*Wahlenbergia denticulata (Burch.) A.DC. var. transvaalensis (Adamson) W.G.Welman*	LC
CAMPANULACEAE	*Wahlenbergia undulata (L.f.) A.DC.*	LC
CAPPARACEAE	*Cleome maculata (Sond.) Szyszyl.*	LC
CAPPARACEAE	*Cleome monophylla L.*	LC
CAPPARACEAE	*Cleome rubella Burch.*	LC
CARYOPHYLLACEAE	*Cerastium arabidis E.Mey. ex Fenzl*	LC

Family	Species	IUCN
CARYOPHYLLACEAE	*Corrigiola litoralis L. subsp. litoralis var. litoralis*	LC
CARYOPHYLLACEAE	*Dianthus basuticus Burtt Davy subsp. basuticus var. basuticus*	LC
CARYOPHYLLACEAE	*Pollichia campestris Aiton*	LC
CARYOPHYLLACEAE	*Silene burchellii Otth var. angustifolia Sond.*	Not Evaluated
CELASTRACEAE	*Gymnosporia buxifolia (L.) Szyszyl.*	LC
CELTIDACEAE	*Celtis africana Burm.f.*	LC
CHENOPODIACEAE	*Chenopodium album L.*	Not Evaluated
CHENOPODIACEAE	*Chenopodium carinatum R.Br.*	Not Evaluated
CHENOPODIACEAE	*Chenopodium giganteum D.Don*	Not Evaluated
COMMELINACEAE	*Commelina africana L. var. krebsiana (Kunth) C.B.Clarke*	LC
COMMELINACEAE	*Commelina benghalensis L.*	LC
COMMELINACEAE	*Commelina livingstonii C.B.Clarke*	LC
COMMELINACEAE	*Cyanotis speciosa (L.f.) Hassk.*	LC
CONVOLVULACEAE	*Convolvulus sagittatus Thunb.*	LC
CONVOLVULACEAE	*Convolvulus thunbergii Roem. & Schult.*	LC
CONVOLVULACEAE	*Falkia oblonga Bernh. ex C.Krauss*	LC
CONVOLVULACEAE	*Ipomoea bathycolpos Hallier f.*	LC
CONVOLVULACEAE	*Ipomoea oenotheroides (L.f.) Raf. ex Hallier f.*	LC
CONVOLVULACEAE	*Ipomoea ommanneyi Rendle*	LC
CONVOLVULACEAE	*Merremia verecunda Rendle*	LC
CONVOLVULACEAE	*Seddera capensis (E.Mey. ex Choisy) Hallier f.*	LC
CRASSULACEAE	*Crassula campestris (Eckl. & Zeyh.) Endl. ex Walp.*	LC
CRASSULACEAE	*Crassula lanceolata (Eckl. & Zeyh.) Endl. ex Walp. subsp. lanceolata*	LC
CRASSULACEAE	*Crassula natans Thunb. var. natans*	LC
CRASSULACEAE	*Crassula vaillantii (Willd.) Roth*	Not Evaluated
CUCURBITACEAE	*Citrullus lanatus (Thunb.) Matsum. & Nakai*	LC
CYPERACEAE	*Ascolepis capensis (Kunth) Ridl.*	LC

Family	Species	IUCN
CYPERACEAE	*Bulbostylis burchellii (Ficalho & Hiern) C.B.Clarke*	LC
CYPERACEAE	*Bulbostylis contexta (Nees) M.Bodard*	LC
CYPERACEAE	*Bulbostylis hispidula (Vahl) R.W.Haines subsp. pyriformis (Lye) R.W.Haines*	LC
CYPERACEAE	*Bulbostylis humilis (Kunth) C.B.Clarke*	LC
CYPERACEAE	*Carex glomerabilis V.I.Krecz.*	LC
CYPERACEAE	*Cyperus congestus Vahl*	LC
CYPERACEAE	*Cyperus difformis L.*	LC
CYPERACEAE	*Cyperus eragrostis Lam.*	Not Evaluated
CYPERACEAE	*Cyperus esculentus L. var. esculentus*	LC
CYPERACEAE	*Cyperus longus L. var. tenuiflorus (Rottb.) Boeck.*	LC
CYPERACEAE	*Cyperus margaritaceus Vahl var. margaritaceus*	LC
CYPERACEAE	*Cyperus marginatus Thunb.*	LC
CYPERACEAE	*Cyperus tenax Boeckeler*	LC
CYPERACEAE	*Cyperus usitatus Burch.*	LC
CYPERACEAE	*Eleocharis dregeana Steud.*	LC
CYPERACEAE	*Eleocharis limosa (Schrad.) Schult.*	LC
CYPERACEAE	*Ficinia gracilis Schrad.*	LC
CYPERACEAE	*Fuirena pubescens (Poir.) Kunth var. pubescens*	LC
CYPERACEAE	*Fuirena stricta Steud. var. stricta*	LC
CYPERACEAE	*Isolepis costata Hochst. ex A. Rich.*	LC
CYPERACEAE	*Kyllinga alba Nees*	LC
CYPERACEAE	*Kyllinga erecta Schumach. var. erecta*	LC
CYPERACEAE	*Pycreus chrysanthus (Boeckeler) C.B.Clarke*	LC
CYPERACEAE	*Pycreus macranthus (Boeckeler) C.B.Clarke*	LC
CYPERACEAE	*Pycreus mundii Nees*	LC
CYPERACEAE	*Pycreus nitidus (Lam.) J.Raynal*	LC
CYPERACEAE	*Schoenoplectus decipiens (Nees) J.Raynal*	LC
CYPERACEAE	*Schoenoplectus muricinux (C.B.Clarke) J.Raynal*	LC
CYPERACEAE	*Schoenoplectus muriculatus (Kük.) Browning*	LC

Family	Species	IUCN
CYPERACEAE	*Schoenoplectus pulchellus (Kunth) J.Raynal*	LC
CYPERACEAE	*Scirpoides burkei (C.B.Clarke) Goetgh., Muasya & D.A.Simpson*	LC
DIPSACACEAE	*Cephalaria pungens Szabó*	LC
DIPSACACEAE	*Scabiosa columbaria L.*	LC
EBENACEAE	*Diospyros austro-africana De Winter var. microphylla (Burch.) De Winter*	LC
EBENACEAE	*Diospyros lycioides Desf. subsp. lycioides*	LC
ELATINACEAE	*Bergia pentheriana Keissl.*	LC
EQUISETACEAE	*Equisetum ramosissimum Desf. subsp. ramosissimum*	LC
ERIOCAULACEAE	*Eriocaulon dregei Hochst.*	LC
ERIOSPERMACEAE	*Eriospermum flagelliforme (Baker) J.C.Manning*	LC
EUPHORBIACEAE	*Acalypha angustata Sond.*	LC
EUPHORBIACEAE	*Clutia pulchella L. var. pulchella*	LC

Appendix D: Threatened Bird Species occurring with QDS 2627DD (SABAP, 2012)

Rank	Common Name	Scientific Name	Global threat status
130	Lesser Kestrel	*Falco naumanni*	VU
150	Greater Flamingo	*Phoenicopterus ruber*	NT
208	Secretary bird	*Sagittarius serpentarius*	NT
209	Caspian Tern	*Sterna caspia*	NT
215	Lanner Falcon	*Falco biarmicus*	NT
219	African Marsh-Harrier	*Circus ranivorus*	VU
227	Yellow-billed Stork	*Mycteria ibis*	NT
228	Black-winged Pratincole	*Glareola nordmanni*	NT
236	Melodious Lark	*Mirafra cheniana*	NT
237	African Openbill	*Anastomus lamelligerus*	NT
239	Blue Korhaan	*Eupodotis caerulescens*	NT
245	Peregrine Falcon	*Falco peregrinus*	NT
249	Lesser Flamingo	*Phoenicopterus minor*	NT
252	Blue Crane	*Anthropoides paradiseus*	VU
253	Greater Painted-snipe	*Rostratula benghalensis*	NT
265	White-backed Night-Heron	*Gorsachius leuconotus*	VU

Appendix E: Mammals Recorded in QDS 2627DD (Animal Demography Unit, 2012)

Family	Genus	Species	Subspecies	Common name	Red list category
Bathyergidae	*Cryptomys*	*hottentotus*		Southern African Mole-rat	Least Concern
Bovidae	*Alcelaphus*	*buselaphus*		Hartebeest	Not listed
Bovidae	*Antidorcas*	*marsupialis*		Springbok	Least Concern
Bovidae	*Connochaetes*	*gnou*		Black Wildebeest	Least Concern
Bovidae	*Connochaetes*	*taurinus*	*taurinus*	Blue (Common) wildebeest	Least Concern
Bovidae	*Damaliscus*	*pygargus*	*phillipsi*	Blesbok	Least Concern
Bovidae	*Hippotragus*	*equinus*		Roan Antelope	Vulnerable
Bovidae	*Hippotragus*	*niger*	*niger*	Sable antelope	Vulnerable
Bovidae	*Kobus*	*ellipsiprymnus*	*ellipsiprymnus*	Waterbuck	Least Concern
Bovidae	*Kobus*	*leche*		Lechwe	Not listed
Bovidae	*Oryx*	*gazella*		Gemsbok	Least Concern
Bovidae	*Raphicerus*	*campestris*		Steenbok	Least Concern
Bovidae	*Sylvicapra*	*grimmia*		Bush Duiker	Least Concern
Bovidae	*Syncerus*	*caffer*		African Buffalo	Least Concern
Bovidae	*Tragelaphus*	*angasii*		Nyala	Least Concern
Bovidae	*Tragelaphus*	*oryx*		Common Eland	Least Concern
Canidae	*Otocyon*	*megalotis*		Bat-eared Fox	Least Concern
Cervidae	*Dama*	*dama*		Fallow Deer	Introduced

Family	Genus	Species	Subspecies	Common name	Red list category
Emballonuridae	*Taphozous*	*mauritianus*		Mauritian Tomb Bat	Least Concern
Herpestidae	*Cynictis*	*penicillata*		Yellow Mongoose	Least Concern

Appendix F: Reptile Recorded in QDS 2627DD (Animal Demography Unit, 2012)

Family	Genus	Species	Subspecies	Common name
Agamidae	*Agama*	*aculeata*	distanti	Distant's Ground Agama
Atractaspididae	*Aparallactus*	*capensis*		Black-headed Centipede- eater
Colubridae	*Boaedon*	*capensis*		Brown House Snake
Colubridae	*Crotaphopeltis*	*hotamboeia*		Red-lipped Snake
Colubridae	*Dasypeltis*	*scabra*		Rhombic Egg-eater
Colubridae	*Lamprophis*	*aurora*		Aurora House Snake
Colubridae	*Lycodonomorphus*	*rufulus*		Brown Water Snake
Colubridae	*Psammophylax*	*rhombeatus*	rhombeatus	Spotted Grass Snake
Elapidae	*Hemachatus*	*haemachatus*		Rinkhals
Gekkonidae	*Lygodactylus*	*capensis*	capensis	Common Dwarf Gecko
Gekkonidae	*Pachydactylus*	*capensis*		Cape Gecko
Lacertidae	*Nucras*	*holubi*		Holub's Sandveld Lizard
Pelomedusidae	*Pelomedusa*	*subrufa*		Marsh Terrapin
Scincidae	*Acontias*	*gracilicauda*		Thin-tailed Legless Skink
Scincidae	*Acontias*	*gracilicauda*		Thin-tailed Legless Skink
Scincidae	*Trachylepis*	*capensis*		Cape Skink
Scincidae	*Trachylepis*	*punctatissima*		Speckled Rock Skink
Typhlopidae	*Afrotyphlops*	*bibronii*		Bibron's Blind Snake