BIODIVERSITY & WETLAND ASSESSMENT FOR THE FGD PROJECT AT MEDUPI POWER STATION - LEPHALALE, LIMPOPO

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All pictures taken on site

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LIST OF ACRONYMS

ACRONYM	DESCRIPTION
ADF	Ash Disposal Facility
APPA	Atmospheric Pollution Prevention Act
CARA	Conservation of Agricultural Resources Act
CBA	Critical Biodiversity Area
CBG4	Central Bushveld Group 4
CI	Conservation Important
CR	Critically Endangered
CIS	Conservation important species
CITES	Convention on International Trade in Endangered Species
CoPs	Conference of the Parties
DAFF	Department of Agriculture, Forestry and Fisheries
DCA	TWINSPAN Detrended Correspondence Analysis
DEAT	Department of Environmental Affairs and Tourism
DWAF	Department of Water Affairs and Forestry
DWS	Department of Water and Sanitation
ECA	Environmental Conservation Act
EA	Environmental Authorisation
EI	Ecological Importance
ES	Ecological Sensitivity
ESA	Ecological Support Area
EIAs	Environmental Impact Assessments
EIS	Ecological Importance and Sensitivity
EMPRs	Environmental Management Programme Reports
EMPs	Environmental Management Plans
EN	Endangered
EO	Environmental Officer
EWT	Endangered Wildlife Trust
FEPA	Freshwater Ecosystem Priority Area
FGD	Flue Gas Desulphurisation
FRAI	Fish Response Assessment Index
GG	Government Gazette
GPS	Global Positioning System
HGM	Hydro-geomorphic
ICP-OES	Inductively Coupled Plasma – Optical Emission Spectrophotometer
ICP-MS	Inductively Coupled Plasma – Mass Spectrophotometer
JPOI	Johannesburg Plan of Implementation
LC	Least Concern
LEDET	Limpopo Department of Economic Development, Environment and Tourism
LCPlan	Limpopo Conservation Plan
LSB	Limpopo Sweet Bushveld
LO	Likelihood of Occurrence
LT	Least Threatened

ACRONYM	DESCRIPTION
m.a.s.l	Meters above sea level
MBG	Mining & Biodiversity Guidelines
MoP 5	5th Meeting of the Parties
MPS	Medupi Power Station
NT	Near Threatened
NBSAP	National Biodiversity Strategy and Action Plan
NEMA	National Environmental Management Act
NEPAD	New Partnership for Africa's Development
NWA	National Water Act
NSS	Natural Scientific Services
NSBA	National Spatial Biodiversity Assessment
PES	Present Ecological State
PS	Protected species
PT	Protected
Pr.Nat.Sci.	Professional Natural Scientist
QDS	Quarter Degree Square
SABAP	Southern African Bird Atlas Projects
SANBI	South African National Biodiversity Institute
SASS5	South African Scoring System Version 5
SQG	sediment quality guidelines
SEW	Semi-Ephemeral Washes
SMPs	Strategic Management Plans
ToR	Terms of Reference
ToPS	Threatened or Protected Species
UNFCCC	UN Framework Convention on Climate Change
VU	Vulnerable
WDBP	Waterberg District Bioregional Plan
WMA	Water Management Area
WMLA	Waste Management Licence Application
WRG	Water Research Group
WULA	Water Use Licence Application
WQ	Water quality

1. Introduction

In South Africa, the legislation affirms the national commitment to conservation. The National Environmental Management: Biodiversity Act, 2004 (Act 10 of 2004) has the objective to provide for, amongst others the management and conservation of South Africa's biodiversity within the framework of the National Environmental Management Act, 1998; the protection of species and ecosystems that warrant national protection; and the sustainable use of indigenous biological resources.

Biodiversity is defined as "…***the variability among living organisms from all sources including…terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are a part; this includes diversity within species, between species and of ecosystems***" (The Convention of Biological Diversity, 1992). In other words, plants, animals and micro-organisms, their genes, and the ecosystems that living organisms inhabit, are all facets of biodiversity.

Further to this, South Africa has various pieces of legislation governing activities in and around wetlands under International, Regional and National legislation and Guidelines. The National Water Act, 1998, (Act 36 of 1998) (NWA) is the principle legal instrument relating to water resource management in South Africa, with all wetlands protected under the NWA. The National Water Act (Act No. 36 of 1998), (NWA) defines a wetland as: "*land which is transitional between terrestrial and aquatic systems where the water table is usually at or near the surface, or the land is periodically covered with shallow water, and which in normal circumstances supports or would support vegetation typically adapted to life in saturated soils* ."

This report represents an amalgamation of work done by NSS on terrestrial biodiversity and wetlands since 2014 at Medupi Power Station (MPS) as it relates to the Flue Gas Desulphurisation (FGD) Retrofit Project. Medupi is located about 15km west of the town of Lephalale in the Limpopo Province. The project essentially involves the reduction of sulphur dioxide (SO_2) emissions from power station and the consequent disposal of its by-product, gypsum, on the proposed ash disposal facility. Medupi will be the first coal-fired power station in the Eskom fleet to deploy this supercritical abatement technology which will reduce SO_2 emissions by over 90%.

Zitholele Consulting (Pty) Ltd (Zitholele) was appointed in 2014 to undertake the environmental processes including an Environmental Impact Assessment (EIA), Water Use Licence Application (WULA) and Waste Management Licence Application (WMLA) for the MPS Flue Gas Desulphurisation (FGD) Retrofit project. In 2017, the MPS FGD project scope was extended to include the environmental authorisation process for the other FGD associated infrastructures including the railway yard and siding, limestone and gypsum handling facilities, diesel storage facilities, new access roads, a Waste Water Treatment plant, and facilities for temporary storage of salts and sludge (hazardouswaste). Additionally the project is dealing with the Water Use Licence Application (WULA) for the wetlands which

were detected by NSS during 2015 within the study area and a 500m buffer around it. Therefore NSS was requested by Zitholele to provide biodiversity and wetland input into this greater EIA process.

It must be noted that the construction of the MPS is almost complete and the ADF construction already commenced prior to 2012 (**Figure 1-1**). The majority of the site is now cleared and any depressions, washes and other wetlands that were within the footprint have now been removed. NSS therefore focused on areas within the railway yard, MPS and ADF that were not transformed as well as within the 500m buffer of the site.

Ongoing construction of the ADF

Ongoing construction of the MPS

Figure 1-1 Construction of MPS and the ADF facilities

2. Terms of Reference

Based on requests made by ESKOM at the FGD scope consolidation workshop held in December 2017, this report represents an amalgamation of NSS work conducted to date for Medupi Power Station (MPS) as it pertains to the FGD project area as a whole. The various projects for which NSS was previously appointed are summarized in **Table 2-1**.

Table 2-1 Work performed by NSS for the Medupi FGD project

WORK REQUESTED	STATUS
Eco assessment FGD railway yard -September 2014:	Submitted – March 2015
Eco & Wetland assessment (2,12 &13) - October 2014	Stopped, fieldwork completed – December 2015
Eco opinion sites 2,12 & 13	Submitted – January 2016
Screening additional ADF sites – April 2016	Cancelled
Wetland assessment Site 13 - October 2016	Submitted – December 2016 - revised 2017
Wetland offset and rehabilitation plan - May 2017	**Ongoing**
Wetland & eco assessment for FGD area – November 2017	**Ongoing**

More specifically the SoW for this report is as follows:

- Combine relevant sections of reports into one integrated biodiversity and wetland report for the FGD study area which includes the Medupi Power Station, the FGD / railway yard area and the area earmarked for the ADF (referred to as Site 13) and a 500m buffer around these areas.
- Over and above integration, address any new impacts which may be associated with the construction and operation of the FGD system within the Medupi Power Station Footprint as well as that of the railway yard, limestone and gypsum handling facilities between the Medupi Power Station and existing ADF.
- The Report includes:
    - An Introduction and Terms of Reference;
    - List of applicable legislation, guidelines, standards and criteria;
    - A broad description of the biophysical environment wherein Medupi is situated;
    - The terrestrial assessment methods and results including:
        - A description of regional vegetation and local floral (including their structure, dominant plant composition and condition);
        - Recorded alien invasive species;
        - The local diversity of mammals, birds, reptiles, frogs, butterflies, odonata (dragonflies and damselflies), scorpions and megalomorph spiders;
        - Recorded Conservation Important (CI) species of flora and fauna.
    - The wetland assessment methods and results including:
        - The delineation of wetlands (including pans) within 500m of the MPS and ADF footprint based on limited field work.
        - The sediment and water quality analysis of surface water bodies – especially the FEPA to the south-west of the ADF area;
        - An assessment of pan invertebrate diversity through laboratory hatching tests.
        - Wetland ecosystem goods and services;
        - The determination of wetland buffers.

- A qualitative assessment (and mapping) of the relative sensitivity or conservation importance of local floral, faunal and wetland biodiversity.
- A detailed Impact Assessment with recommended impact mitigation measures.
- Concluding remarks.
- References.
- Appendices.

3. Project Team

This assessment was conducted and managed by NSS (**Table 3-1**). The NSS team has extensive experience in project management and fieldwork for numerous ecological and biodiversity studies as well as aquatic and wetland assessments. The team has also been involved in the management of Environmental Impact Assessments (EIAs), Environmental Management Programme Reports (EMPRs), Strategic Management Plans (SMPs) and Environmental Management Plans (EMPs) for the Conservation, Mining, Waste, Commercial and Industrial sectors. The following professional registrations and accreditations apply to NSS:

- The senior team members are registered Professional Natural Scientists in the ecological, environmental, aquatic and zoological fields.
- The aquatics team are accredited with Department of Water and Sanitation (DWS) to perform the SASS5 (South African Scoring System version 5) for aquatic macro-invertebrate monitoring.
- The Wetland Specialists is acknowledged by the DWS as a Competent Wetland Delineator.

Table 3-1 Project team with associated areas of specialisation

ASPECT INVESTIGATED	SPECIALIST	QUALIFICATIONS
Ecology, Wetlands & Project Management	Susan Abell	M.Sc. Resource Conservation Biology (WITS). Pr.Nat.Sci. Registered – Ecology & Environmental Science. (400116/05)
Wetlands & Fauna	Tyron Clark	M.Sc. – Zoology in progress (WITS).
Fauna	Dr Caroline Lötter	Ph.D. – Zoology (UP). Pr.Nat.Sci. registered (400182/09) – Zoology.
Sediment Analysis	Dr Wynand Malherbe	Ph. D – Aquatic Science. Water Research Group (Ecology) NW University Pr.Nat.Sci. Registered – Zoology (400200/13)
Review	Kathy Taggart	M.Sc. Resource Conservation Biology (WITS). Pr.Nat.Sci. Registered – Ecology & Environmental Science. (400225/08)
GIS mapping	Tim Blignaut	M.Sc. – Geography (UJ) – in progress.

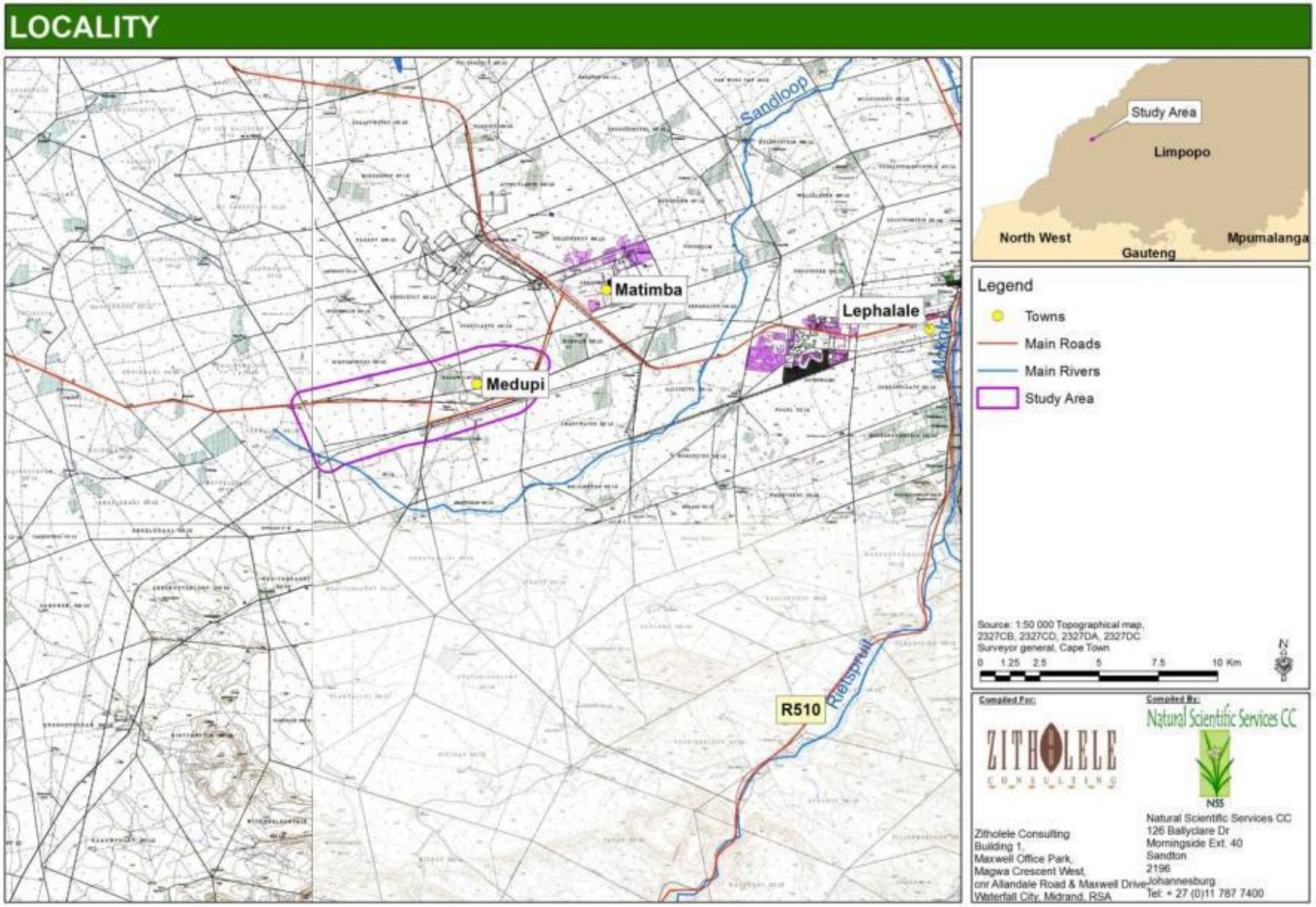
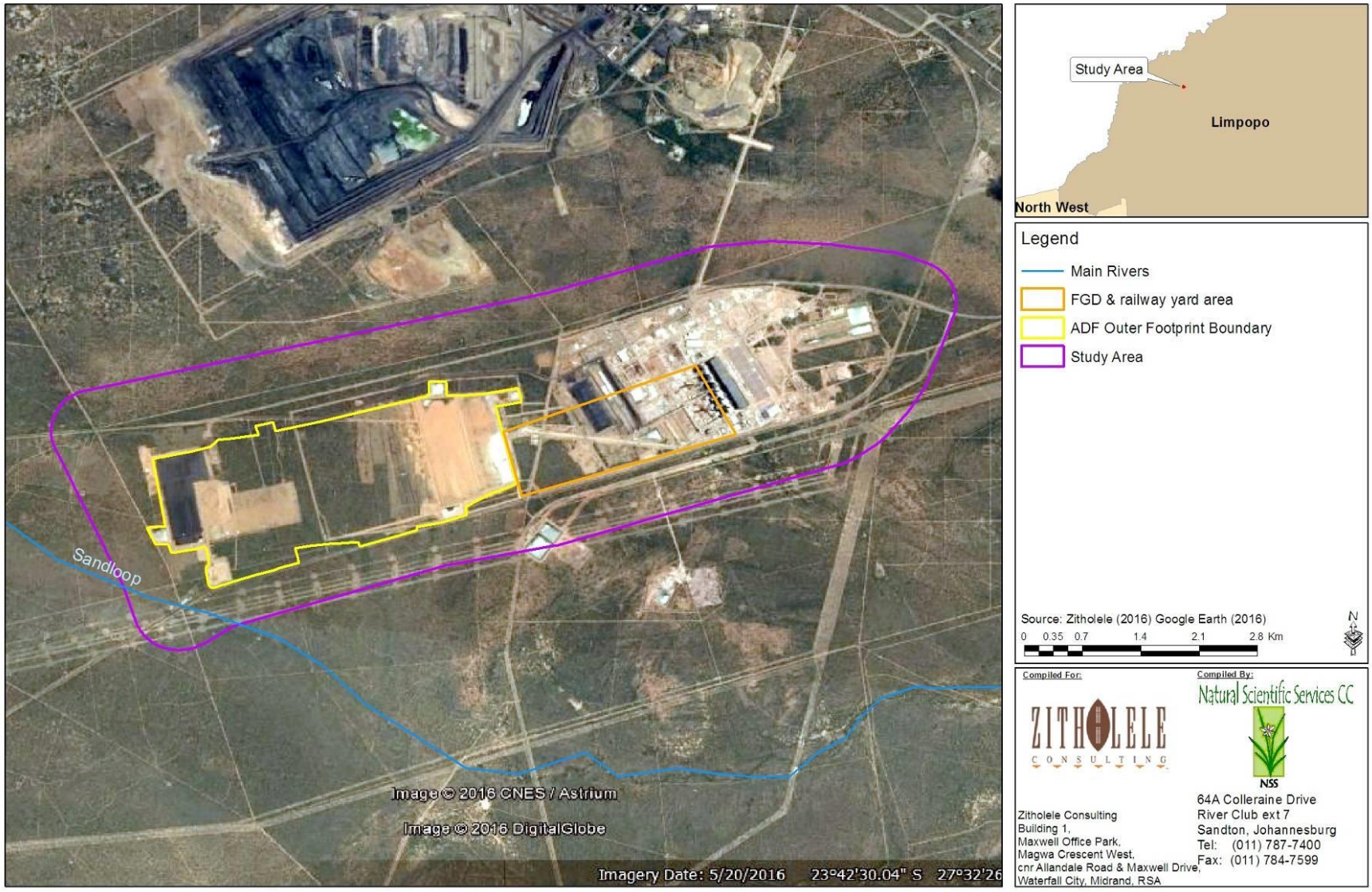


Figure 3-1 Locality map of the study area showing the position of the Sandloop FEPA

ADF FOOTPRINT



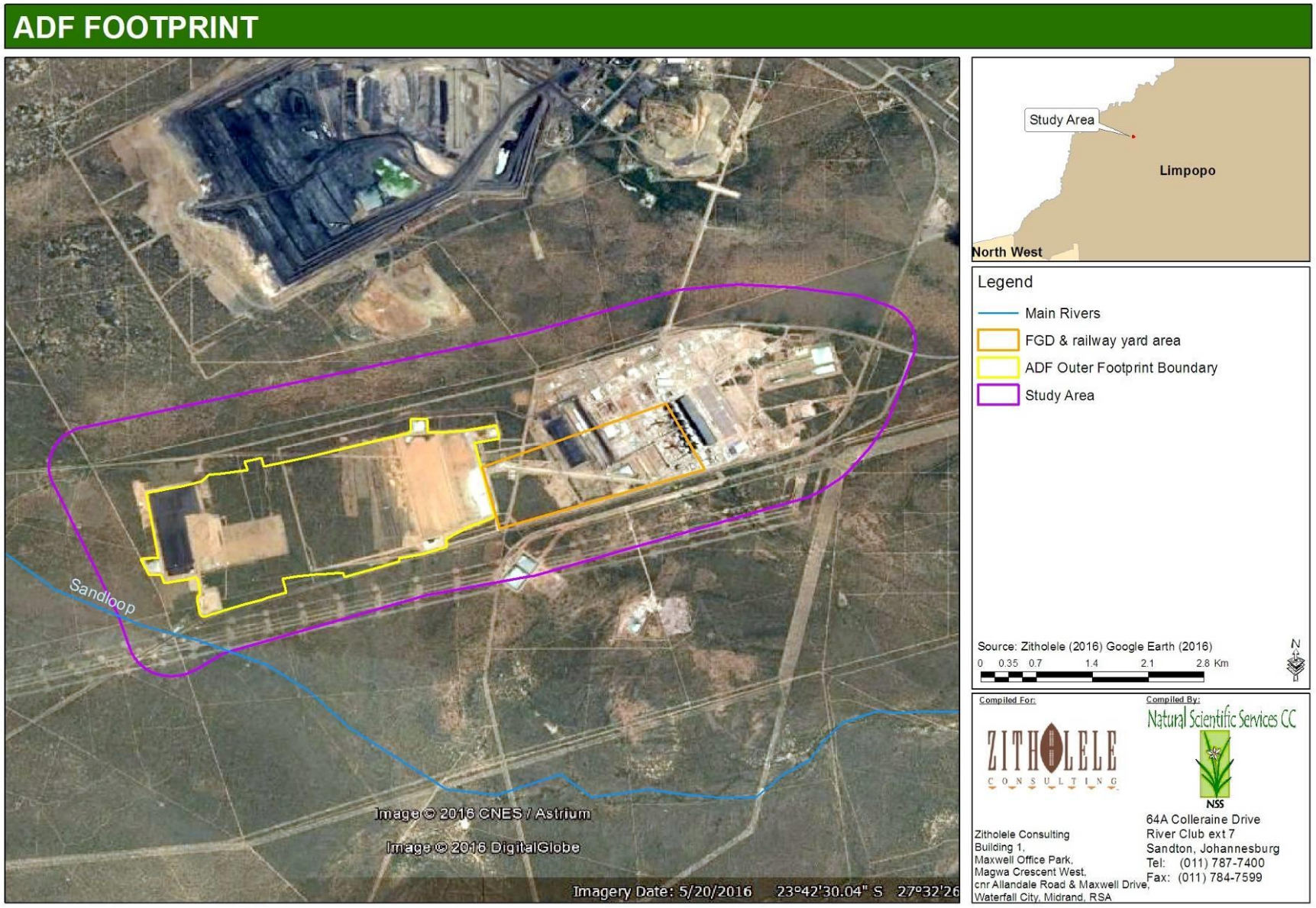


Figure 3-2 Locality map of the study area showing the position of the proposed FGD Footprint area

4. Applicable Legislation

There are several international treaties and considerable national and provincial legislation regarding the sustainable use and conservation of terrestrial and wetland biodiversity including species and ecosystems. As coal fired power stations such as MPS inevitably have the potential to have major negative impacts on biodiversity, all the below-mentioned international, regional, national and provincial legislation, policies and guidelines are applicable to the proposed project. While the list below is extensive, additional legislation, policies and guidelines that have not been mentioned may apply.

4.1. International Agreements

- *World Summit on Sustainable Development*, 2002;
- *Johannesburg Plan of Implementation* (JPoI), Chapter 4, 2002. The JPoI acknowledges that biodiversity is critical for the planet, sustainable development, poverty eradication, human well-being and the cultural integrity people. It also recognizes that biodiversity is currently being lost at unprecedented rates due to human activities, and that this trend can only be reversed if local people benefit directly from the conservation and sustainable use of biological diversity in their countries. South Africa uses the National Biodiversity Strategy and Action Plan (NBSAP) as a means to achieve the JPoI biodiversity targets;
- *UN Framework Convention on Climate Change* (UNFCCC), 1994. UNFCCC is an international agreement to stabilize greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system. This agreement, although non-binding, does provide for updates called "protocols," which set mandatory emission limits.
  - *Kyoto Protocol*, 1997. The principal update is the Kyoto Protocol developed during the 3rd Conference of the Parties (CoP 3) in Kyoto, Japan in 1997, and was entered into force in 2005. Approximately 191 states have signed and ratified the Protocol including South Africa. Under the Protocol, 37 countries ("Annex I countries") committed themselves to reduce their greenhouse gas emissions by 5.2% on average for the period 2008-2012. This reduction was relative to their annual emissions in a base year, generally 1990.
  - *Copenhagen Accord*, 2009. This included the 15th Conference of the Parties (CoP 15) to the UNFCCC and the 5th Meeting of the Parties (MoP 5) to the Kyoto Protocol. A framework for climate change mitigation beyond 2012, the Copenhagen Accord, was drafted during the Summit by the United States, China, India, Brazil and South Africa. It was "taken note of," but not "adopted". The Accord recognizes that climate change is one of the greatest challenges of the present day and that actions should be taken to keep any temperature increases to below 2°C.

- *17th Conference of the Parties* (CoP 17). The 2011 UNFCCC in Durban was held to establish a new treaty to limit carbon emissions. This Convention agreed to a legally binding deal comprising all countries, which will be prepared by 2015 and to take effect in 2020. While the president of the conference, Maite Nkoana-Mashabane, declared it a success, scientists and environmental groups warned that the deal was not sufficient to avoid global warming beyond 2°C as more urgent action is needed.
- *Paris Agreement* to reduce climate change, and the Paris Pledge for Action. This latest agreement on climate change calls for zero net anthropogenic greenhouse gas emissions to be reached during the second half of the 21st century. The agreement is due to enter into force in 2020, and Parties that have signed the Agreement, including South Africa, will need to adopt the Agreement within their own legal systems. By joining the Pledge, businesses, cities, civil society groups, investors, regions, trade unions and other signatories promise to ensure that the Agreement's ambition to limit the global temperature rise to less than 2ºC is met. A number of mining companies, including those operating in South Africa have joined this Pledge.

- *Convention on Biological Diversity* (Rio de Janeiro, 1992). The CBD has three main goals: conservation, and sustainable use of biodiversity, and equitable sharing of benefits arising from genetic resources. South Africa signed this treaty in 1998 showing further commitment to the conservation of biodiversity;
- *Agenda 21* and Rio Declaration, 1992;
- The *Bonn Convention* (on conservation of migratory species of wild animals), 1979. South Africa is a party to this Convention, which affords protection to all migratory animals in the project area including various bird, bat and butterfly species;
- *CITES* (the Convention on International Trade in Endangered Species of Wild Fauna and Flora), 1973. CITES is an international agreement between governments, which aims to ensure that international trade in specimens of wild animals and plants does not threaten their survival. It accords varying degrees of protection to more than 33,000 species of animals and plants;
- The *World Heritage Convention*, 1972. This aims to preserve the world's natural and scenic areas and historic sites for present and future generations of humanity; The Convention recognizes the way in which people interact with nature, and the fundamental need to preserve the balance between the two. Eight World Heritage Sites are currently recognized in South Africa, with the Mapungubwe Cultural Landscape being the closest to the study area.
- The *Ramsar Convention* (on wetlands of international importance especially as waterfowl habitat). This is an intergovernmental treaty that embodies the commitments of its member countries to maintain the ecological character of their Wetlands of International Importance but also to plan for the "wise use", or sustainable use, of all of the wetlands in their territories. In terms of the site, an

ephemeral system is existing the study area to the south west and there are a number of water bodies present just south of the site; and

- *United Nations Convention to Combat Desertification*.

4.2. Regional Agreements

- Action Plan of the Environmental Initiative of NEPAD. This New Partnership for Africa's Development (NEPAD) Action Plan was established during the 2003 African Convention on Conservation of Nature and Natural Resources held in Maputo. As a contracting state, South Africa has undertaken to adopt measures to ensure the conservation, utilization and development of soil, water, flora and faunal resources in accordance with scientific principles and with due regard to the best interests of the people.
- *African Convention on the Conservation of Nature and Natural Resources*, 1969.

4.3. National Legislation, Policies and Guidelines

- *Constitution of the Republic of South Africa* (Act 108 of 1996). According to South Africa's Constitution, South African citizens have the right to have the environment protected for the benefit of present and future generations.
- *Conservation of Agricultural Resources Act* (CARA; Act 43 of 1983). CARA includes the use and protection of land, soil, wetlands and vegetation and the control of weeds and invader plants. In 1984 regulations were passed under CARA, which declared about 50 plant species as "weeds" or "invader plants." On 30 March 2001 the Minister of Agriculture promulgated an amendment to these regulations, which now contain a comprehensive list of declared weed and invader plant species. Further additions to the law have occurred and are discussed under NEMBA below.
- *Water Services Act* (WSA; Act 108 of 1997). This Act provides for, among other things, the effective water resource management and conservation.
- *White Paper on Environmental Management Policy* for South Africa (1998). Through this Policy, Government undertakes to give effect to the many rights in the Constitution that relate to the environment.
- *National Veld and Forest Fire Act* (NVFFA; Act 101 of 1998). The purpose of this Act is to prevent and combat veld fires in the country. The NVFFA was amended by the National Forest and Fire Laws Amendment Act (NFFLAA; Act 12 of 2001).
- *National Water Act* (NWA; Act 36 of 1998). The NWA recognises that water is a scarce and unevenly distributed natural resource that should be equitably utilised in a sustainable manner. The Act ensures that water resources are protected, used, developed, conserved and controlled in ways that take into account a range of needs and obligations, including the need to "Protect aquatic and associated ecosystems and their biological diversity." The NWA specifies that water use must be authorised. It indicates the means for authorisation and includes minimum requirements for evaluation and decision-making by relevant authorities. To protect aquatic

ecosystems and biodiversity, the NWA has a number of requirements, which are controlled by the DWS, including:

- Section 19(2) which states that: responsible persons of pollution of any water resources must take all measures to prevent and remedy effects of pollution.
- Section 21 which states that a license for water use is required if activities such as taking water from a water resource; storing water; impeding or diverting the flow of water in a watercourse or engaging in a stream flow reduction activity amongst others. As per the NWA, a General Authorisation from Section 21 (c) and (i) water use is not an entitlement for the use of water in terms of section 21 *(c)* and *(i)* within a 500 metre radius from the boundary of any wetland and is based on the outcome of a Risk Assessment.
- Section 37(2) states that activities (described in Section 37(1)) require authorization before being undertaken and include: irrigation on any land with waste or water containing waste generated through any industrial activity of by a waterworks; intentional recharging of an aquifer with any waste or water containing waste; and an activity which has been declared by the minister as a "controlled activity."

- *National Forests Act* (NFA; Act 84 of 1998) and Protected Tree Species. An objective of the NFA is to provide special measures for the protection of certain forests and tree species, and to promote the sustainable use of forests for environmental, economic, educational, recreational, cultural, health and spiritual purposes. In terms of Section 15(1) of the NFA forest trees or Protected Tree Species may not be cut, disturbed, damaged, destroyed and their products may not be possessed, collected, removed, transported, exported, donated, purchased or sold – except under license granted by the Department of Agriculture, Forestry and Fisheries (DAFF) or a delegated authority. Government Notice 35648 of 2012 provides the latest List of Protected Tree Species within the borders of South Africa under the NFA.
- *National Environmental Management Act* (NEMA; Act 107 of 1998). NEMA is an umbrella Act covering broad principles of environmental management. NEMA can be regarded as the most important piece of general environmental legislation covering three main areas namely: Land, planning and development; Natural and cultural resources use and conservation; Pollution control and waste management. According to NEMA sustainable development requires the consideration of all relevant factors including:
  - That the disturbance of ecosystems and loss of biological diversity are avoided, or, where they cannot be altogether avoided, are minimised and remedied;
  - That the use and exploitation of non-renewable natural resources is responsible and equitable, and takes into account the consequences of the depletion of the resource; and
  - That the development, use and exploitation of renewable resources and the ecosystems of which they are part do not exceed the level beyond which their integrity is jeopardised.

According to Section 2(r) in NEMA, sensitive, vulnerable, highly dynamic or stressed ecosystems require specific attention in management and planning procedures, especially where they are subject to significant human resource usage and development pressure. Grasslands and wetlands in Mpumalanga are a strong case in point.

- *National Heritage Resources Act* (NHRA; Act 25 of 1999). According to the NHRA heritage sites, sensitive, vulnerable, highly dynamic or stressed ecosystems, such as coastal shores, dolomitic land and ridges, estuaries, wetlands, and similar systems require specific attention in management and planning procedures, especially where they are subject to significant human resource usage and development pressure.
- *National Mineral and Petroleum Resources Development Act* (NMPRD; Act 28 of 2002). The NMPRDA is concerned with equitable access to and sustainable development of the nation's mineral and petroleum resources.
- *National Environmental Management Protected Areas Act* (NEMPAA: Act. 57 of 2003). The NEM:PAA is focussed on the protection and conservation of ecologically viable areas representative of South Africa's biological diversity and its natural landscapes and seascapes, and addresses, inter alia:
    - The protection and conservation of ecologically viable areas representative of South Africa's biological diversity and its natural landscapes and seascapes;
    - The establishment of a national register of all national, provincial and local protected areas;
    - The management of those areas in accordance with national standards;
    - Inter-governmental co-operation and public consultation in matters concerning protected areas.
- *National Environmental Management: Biodiversity Act* (NEMBA; Act 10 of 2004). A main objective of NEMBA is to provide for the management and conservation of South Africa's biodiversity within the framework of NEMA and to ensure the sustainable use of indigenous biological resources. In addition to regulations on Threatened, Protected, Alien and Invasive Species in South Africa, the NBSAP was formulated where under the NSBA was used to identify Terrestrial and Aquatic Priority Areas and Threatened Ecosystems for biodiversity conservation.
    - *Threatened, Protected, Alien and Invasive Species Regulations.* Chapter 4, Part 2 of NEMBA provides for listing of species that are threatened or in need of protection to ensure their survival in the wild while regulating the activities, including trade, which may involve such listed threatened or protected species and activities which may have a potential impact on their long-term survival. According to Section 56(1) of NEMBA, in February 2007 the Minister of Environmental Affairs and Tourism published a list of Critically Endangered (CR), Endangered (EN), Vulnerable (VU) and Protected Species (PS).
    - *Alien and Invasive Species Regulations, 2014* (GG 37885, 1 August 2014). These regulations listed all declared weeds and invasive plant species in South Africa.

- *National Biodiversity Strategy and Action Plan* (NBSAP). The development of the NBSAP is part of South Africa's obligations as a signatory to the CBD, and was compiled by the Department of Environmental Affairs and Tourism (DEAT 2005). Through the NBSAP it is recognized that biodiversity cannot be conserved through protected area networks only. All stakeholders, from private landowners and communities to business and industry must get involved in biodiversity management. The NBSAP highlights, in particular, that South Africa's rivers are poorly protected and that the present status of many of these freshwater ecosystems is disturbing. To ensure further protection and sustainability of South Africa's wetlands, the DWS (DWAF at the time) initiated the National Aquatic Ecosystem Health Monitoring Programme (NAEHMP) and River Health Programme (RHP).
- *National Spatial Biodiversity Assessment* (NSBA). The NSBA, which is part of the NBSAP, was led by the SANBI (Driver *et al.* 2004). Its main focus was on mainstreaming biodiversity priorities and making links between biodiversity and socio–economic development in South Africa. The NSBA represents South Africa's first national assessment of spatial priorities for conservation action, integrating terrestrial, river, estuarine and marine ecosystems, using available spatial data, biodiversity planning software and a series of expert and stakeholder workshops.
- *National Aquatic Ecosystem Health Monitoring Program* (NAEHMP) & *River Health Program* (RHP). The NAEHMP is a national programme managed by DWS's Resource Quality Services with support from the Water Research Commission (WRC), the Council for Scientific and Industrial Research (CSIR) and various regional and provincial authorities. The overall purpose of the NAEHMP is to provide ecological information for South African rivers and the broader aquatic ecosystems required to support the rational management of these systems. The best-known component of the NAEHMP is the RHP.
- *National Freshwater Ecosystem Priority Areas* (NFEPA). The NFEPA project is a multi-partner project between CSIR, South African National Biodiversity Institute (SANBI), Water Research Commission (WRC), Department of Water Affairs (DWA), Department of Environmental Affairs (DEA), Worldwide Fund for Nature (WWF), South African Institute of Aquatic Biodiversity (SAIAB) and South African National Parks (SANParks). The NFEPA project aims to:
  - Identify Freshwater Ecosystem Priority Areas (hereafter referred to as 'FEPAs') to meet national biodiversity goals for freshwater ecosystems (through systematic biodiversity planning); and
  - Develop a basis for enabling effective implementation of measures to protect FEPAs, including free-flowing rivers.

  FEPAs should be regarded as ecologically important and as generally sensitive to changes in water quality and quantity, owing to their role in protecting freshwater ecosystems and supporting sustainable use of water resources (Driver *et al*. 2011).

- *National Environmental Management: Air Quality Act* (NEMAQA; Act 39 of 2004). The Atmospheric Pollution Prevention Act (APPA; Act 45 of 1965), which largely governed point-source emission control and therefore did not take into consideration the cumulative impacts of air pollution, has been repealed by the NEMAQA. Amongst other objectives, this Act provides for the "prevention of air pollution and ecological degradation."
- *National Environmental Management: Waste Act* (Act 59 of 2008). This act serves inter alia to protect health and the environment by providing reasonable measures for the prevention of pollution and ecological degradation and for securing ecologically sustainable development.
- *Mining & Biodiversity Guideline* (MBG). The mining industry plays a vital role in South Africa's growth and development and indirectly is connected to MPS. The MBG (DEA *et al*. 2013) interprets the best available biodiversity knowledge and science in terms of the implications and risks for mining in a practical and user-friendly guideline for integrating relevant biodiversity information into decision making. The development of this guideline was initiated by the Chamber of Mines and the South African Mining and Biodiversity Forum (SAMBF), in partnership with the DEA, the Department of Mineral Resources (DMR), and with technical input and co-ordination by the SANBI Grasslands Programme.
- *National Water Resource Strategy* (NWRS) 2. The NWRS2 (DWA 2013) builds on the first NWRS published in 2004. The purpose of the NWRS2 is to ensure that national water resources are protected, used, developed, conserved, managed and controlled in an efficient and sustainable manner towards achieving South Africa's development priorities in an equitable manner over the next five to 10 years.
- *Draft National Biodiversity Offset Policy.* The recently published draft National Biodiversity Offset Policy (GG 40733, GN 276, 31 March 2017) aims to ensure that significant residual impacts of developments are remedied as required by NEMA, and in line with the Constitutional right to an environment that is not harmful.

4.4. Limpopo Legislation, Policies and Guidelines

In addition to national legislation, some of South Africa's nine provinces have their own provincial biodiversity legislation, as nature conservation is a concurrent function of national and provincial government in terms of the Constitution (Act 108 of 1996).

- *Limpopo Environmental Management Act, 2003* (Act No. 7 of 2003). This Act repealed the former Lebowa, Gazankulu, Venda and Northern Province Acts and the Nature Conservation Ordinance (Ordinance 12 of 1983). It provides the lists for Protected and Specially Protected species under Schedule 2, 3 and 12 as well as the stipulation for permit applications to remove these species. In addition it gives protection measures for the terrestrial and aquatic biota and systems. Schedule 9 lists aquatic plant species that are prohibited in the province.
- *Limpopo Conservation Plan version 2,* 2013. This conservation plan is consistent with NEMA principles and the NEMBA. It is designed to support integrated

development planning and sustainable development by identifying an efficient set of CBAs that are required to meet national and provincial biodiversity objectives, in a configuration that is least conflicting with other land uses and activities. Where alternatives are available, the CBAs are designed to avoid conflict with existing IDPs, EMFs and SDFs in the region by favouring the selection of sites that are least conflicting with other land-uses.

- *Municipal Biodiversity Summaries Project,* 2010. This was the most relevant biodiversity conservation plan for Lephalale Municipality, prior to the C-Plan 2 publication.
- *Limpopo State of Environment Report (SoER), 2004*. This report provides a high-level overview of the State of the Environment in Limpopo.
- *Waterberg Environmental Management Plan* (EMP), 2006. The Waterberg EMP provides for the protection of the environment and describes how activities that have, or could have, an adverse impact on the environment, should be mitigated, controlled, and monitored. The Waterberg EMP is a coarse-scale planning tool that outlines strategic objectives. New development in the Waterberg District Municipality should be aligned with these objectives.
- *Waterberg Biosphere Reserve*. The Waterberg Biosphere Reserve, proclaimed in 2001 and recognized by UNESCO, covers a 654, 033ha area in the Waterberg wherein more than 80, 000 people live (DEA 2016). It is managed by the Waterberg Biosphere Reserve Committee and the Limpopo Department of Economic Development, Environment and Tourism (LEDET), which coordinates the provincial Man and the Biosphere Reserves programme. Like most other biosphere reserves, the Waterberg Biosphere Reserve comprises:
  - A (104, 179ha) Core Area for conserving biological diversity, monitoring minimally disturbed ecosystems, and undertaking non-destructive research and other low-impact uses.
  - A (185, 517ha) Buffer Area for cooperative activities compatible with sound ecological practices, including environmental education, recreation, ecotourism and applied basic research.
  - A (364, 336ha) Transitional Area, which contains a variety of agricultural activities, settlements and other uses in which local communities, management agencies, scientists, non-governmental organizations, cultural groups, economic interest and other stakeholders work together to manage and sustainably develop the area's resources.
- *Waterberg Spatial Development Framework, 2009*. The Waterberg Spatial Development Framework delineated areas of ecological sensitivity within the district, based on the occurrence of threatened species; centres of endemism; existing protected areas; occurrence of rivers and streams; vegetation types of conservation importance; and areas with high aesthetic value (Environomics, 2010).

- *Lephalale Spatial Development Framework, 2008*. The Lephalale Municipality compiled a Spatial Development Framework (SDF) with the purpose of guiding the form and location of future physical development within a Municipal area in order to address the imbalances of the past. This SDF identifies environmentally sensitive areas (e.g. mountain ridges, riverine environments) and makes recommendations regarding proposed developments in these areas.
- *Lephalale Integrated Development Plan (2014-2016)*. The role of an IDP is to facilitate local governments' planning and municipal management. Lephalale Municipality has an environmental function to execute and ensure that the fundamental environmental rights of the community as enshrined in the constitution are realized. The Municipality has sensitive and conservation worthy areas within its jurisdiction, such as the wetlands, river systems, cultural sites, rare and endangered species and part of the Waterberg biosphere. There are also many areas that require remedial attention i.e. the eradication of alien vegetation, soil erosion control and aspects that require special management, such as pollution control and land use management. The Municipality has the capacity to perform duties that enhance sound environmental management practices which include EIA related. Within the 2014/2015 Revenue and Expenditure Framework, no revenue/expenditure has been listed for Environmental and Biodiversity Sectors. However, a forecast of funds for environmental campaigns including educating the communities has been set up going forward (2016-2019).
- *Waterberg Bio-regional Plan* - The Waterberg bioregional plan considers the *Limpopo Conservation Plan version 2,* 2013 and *Waterberg EMF* together to develop an Integrated Development Framework.
- *Waterberg EMF, 2010* - The purpose of the Waterberg EMF is to develop a framework that will integrate policies and frameworks, and align different government mandates in a way that will streamline decision-making to improve cooperative governance and guide future development in an environmentally responsible manner.

5. Study Site Description

5.1. Locality and Land Use

The FGD study area includes the site for the ADF, the MPS precinct and a 500m buffer on this area (**Figure 3-1**). This area is 2745 ha in extent (1629 ha excluding buffer). The site is approximately 1.5km from Grootegeluk Mine, 12km from Lephalale and 4.5km from Marapong ('as the crow flies'). The site falls within the 1:50 000 topographical map Quarter Degree Square (QDS) 2327DA.

Within this greater study area NSS was commissioned to focus on two specific areas:

- The site for the ADF.
- The site for the FGD and associated infrastructure including the railway siding, limestone offtake and storage facilities.

Details on the operation design and conceptual layout of the ADF and FGD infrastructure will be detailed in the EIA and WULA application conducted by Zitholele and in the interim the reader is referred to the technical documents and design philosophies produced by Jones and Wagener and Knight & Piesold Consulting. The basic FGD process is outlined in **Figure 5-1**.

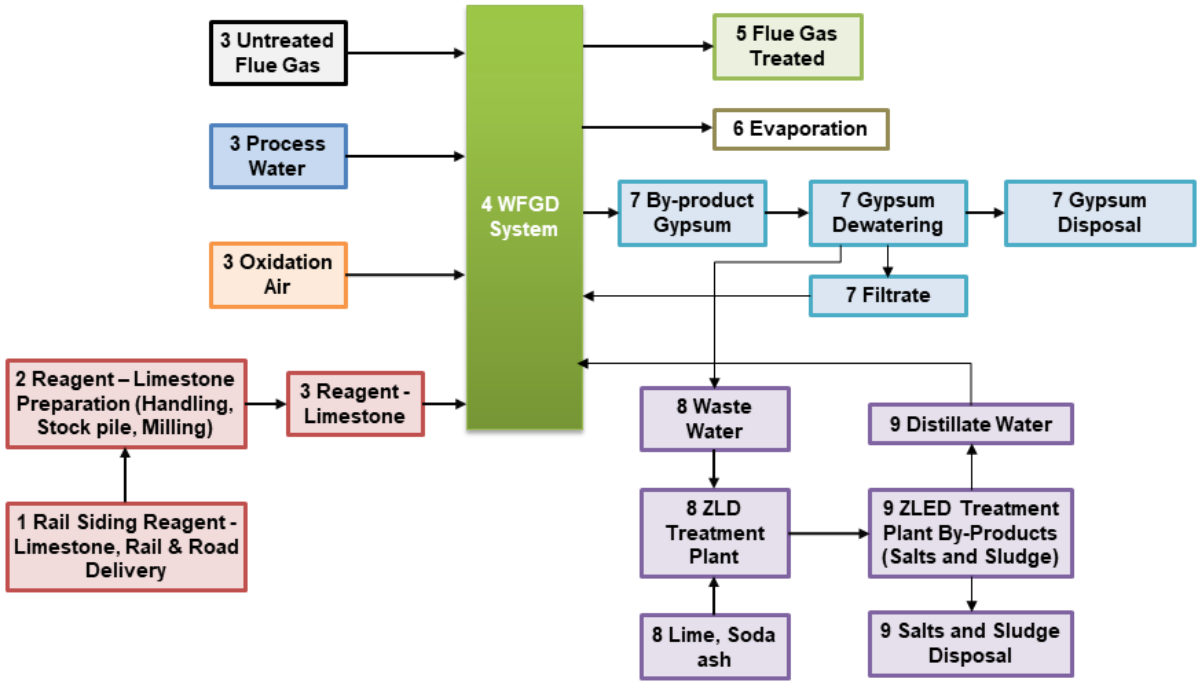


Figure 5-1 Basic process Flow Diagram for the FGD process at Medupi Power Station

Current forms of land use on and surrounding the site are presented in **Figure 5-2**. To the south and west of the study area are game and cattle farms consisting mostly of natural woodland vegetation. To the north of the FGD study area is the Manketti Reserve (the wildlife area of Grootegeluk Mine). To the east of the study area is the Matimba Power Station, game and cattle farms and the towns of Marapong and Lephalale.

5.2. Climate

The study region falls within a summer rainfall region and little to no precipitation is recorded in the months May, August and September whilst the maximum rainfall occurs in November and December. The average annual rainfall is recorded as 410.4mm per year (data from 1993-2009, Station [0674341 8]). The maximum summer temperature is experienced from November to February with an average high of 25°C and maximum temperatures reaching 37°C. The lowest temperatures are experienced between May and August. Monthly rainfall and temperature data measure at Lephalale since September 2014 are shown in **Figure 5-3**.

Game farms

Cattle farms

Mining and industrial related activities

Figure 5-2 Current Land Use for the site and surrounds

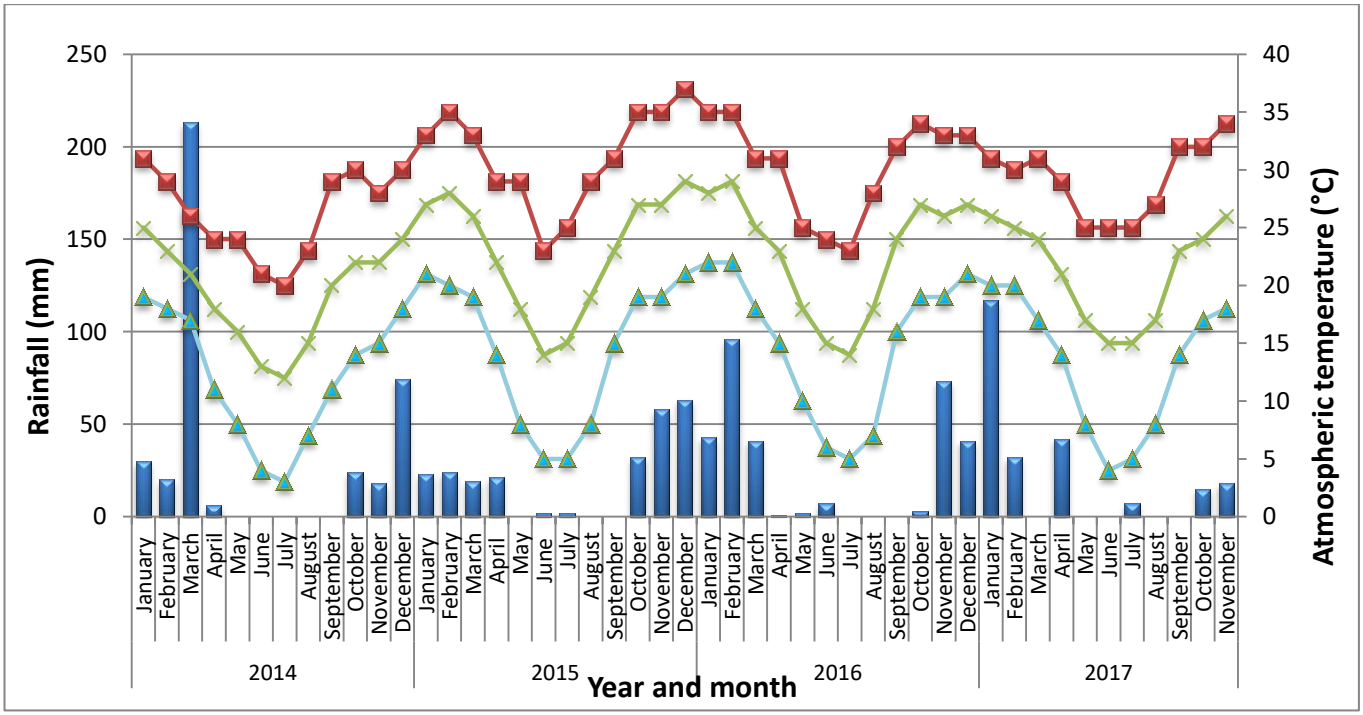


Figure 5-3 Monthly rainfall and temperature data measured at Lephalale

The rainfall data indicate that the study region had received a slightly below-average amount of (329mm) rainfall during the 12-month period preceding the site visit in November 2016. However, the 2016/2017 summer season was not as hot, and more promising in terms of rainfall, than the preceding 2015/2016 and 2014/2015 summer seasons. NSS conducted a number of site visits throughout the seasons and was able to obtain a reasonable understanding of the ephemeral systems within the study area and beyond. This was particularly the case for the December 2015 site visit, where the area received significant rainfall in the weeks preceding the visit. Not as much rain fell prior to the November 2016 visit, which allowed a broader understanding of the dynamics and fluctuation in these systems.

5.3. Geology and Soils

The study area is underlain with a sequence of yellow to purple coloured sandstones and conglomerate rock of the Waterberg Group. The majority of the Waterberg occurs within the Limpopo Province with exposures extending into Botswana. It lies unconformably over the Transvaal Group and is comprised of three subgroups. With regard to economic geology, the Waterberg was mined for lead in the early 20th century and currently is mined for tin in the Rooiberg region. Geohydrological studies indicate that the area is located over aquifers that contain limited amounts of groundwater. Groundwater flowing to the south and east is reported to be contaminated, although to a limited extent, by the ash deposited at the existing Matimba Power Station (Envirolution Consulting, 2009).

Land types represent areas that are uniform with respect to climate, terrain form, geology and soil. According to the Agricultural Geo-referenced Information System (AGIS, 2014), the site is situated in land type Ah86, Bd46 and Ae252 (**Figure 5-5**). This and the surrounding land types are associated with shale, sandstone, mudstone and coal from the Karoo sequence as well as sandstone and conglomerate rock from the Kransberg Subgroup. The study area is situated in a region where erosion rates are considered as moderate to high relative to other parts of the country and soils are generally sandy and rarely more than 3m thick. Clay soils are uncommon in the area.

Across a landscape, usually five terrain units can be identified. Wetlands occur most frequently in valley bottoms (unit 5), but can also occur on crests, mid slopes and foot slopes (units 1, 3 and 4). The catenas within land types Ah86 and Bd46 incorporate all of the four terrain units 1, 3, 4 and 5, whilst land type Ae252 mainly features terrain units 4 and 5 as shown in **Figure 5-4**. Presented in **Table 5-1** is an overview of the soil forms and their extent of coverage, which can be expected within different terrain units in land type Ae252, Ah86 and Bd46.

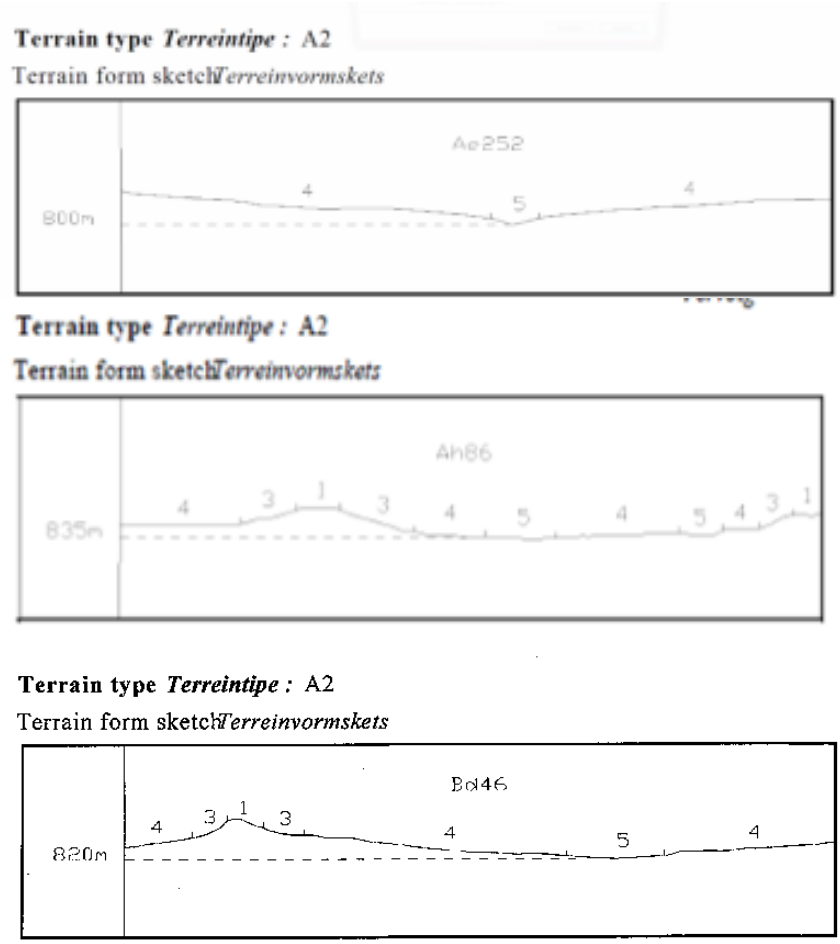


Figure 5-4 Terrain units occurring within land type Ae252, Ah86 and Bd46 (AGIS, 2014)

According to ESS (2015), the most dominant soil units for the study area (**Figure 7-15**) include:

- Shallow (<400mm) sandy to silty loams (salm/silm);
- Moderate to Shallow (400-600mm) sandy loam (salm); and
- Wet based soils with a variety of depths and clay composition.

Specifically important for the wetland assessment are the wet-based soils of varying depths and clay content. According to ESS (2015), the semi-arid climate and negative water balance combined with the horizontal attitude of the sedimentary host lithologies that characterise the Karoo sediments in the area have aided in the development of evaporates within the vadose zone. These include calcrete and in some areas ferricrete or laterite formations. The presence of the ferricrete or hard pan calcretes and plinthic horizons is considered of importance in the soil moisture regime and in many cases the reason for wet features within the soil profile. These soils classify as highly sensitive where they occur in the top 500mm of the profile.

Table 5-1 Soil forms, their wetland potential, coverage, and erodibility classes within the terrain units of land type Ae253, Ah86 and Bd46

SOIL FORM	% COVER PER TERRAIN UNIT			
	1	3	4	5
Ae253				
SLOPE (%)			**0-1%**	**1-2%**
Shigalo Hu46			79	
Mispah Ms10, Muden Ms20			11	10
Portsmouth Hu35			8	
Levubu Oa34, Jozini Oa36,				
Limpopo Oa46				70
Shorrocks Hu36			2	20
Ah86				
SLOPE (%)	**1-2%**	**0-2%**	**0-1%**	**1-3%**
Bontberg Hu25, Portsmouth Hu35	60	55	43	
Gutu Cv25, Denhere Cv35	40	45	38	
Shorrocks Hu36			4	25
Tweefontein Cv20, Ofazi Cv23, Annandale Cv33, Maputa Fw10			5	
Chester Hu22, Moriah Hu32			5	
Vaalsand Lo31			2	20
Windmeul Av35, Newcastle Av25, Soetmelk Av36, Uitkot Gc35			2	5
Lindley Va41, Limpopo Oa46, Mutale Oa47, Killarney Ka20				30
Blinkklip Cv36			1	5
Pans				15
Bd46				
SLOPE (%)	**1-3%**	**2-8%**	**0-1%**	**1-3%**
Denhere Cv35, Sandveld Fw12, Constantia Ct12	20	15	27	
Windmeule Av35, Soetmelk Av36, Leslie Gc36			28	
Paddock We31, Davel We32			14	4
Venda Oa35, Jozini Oa36, Limpopo Oa46, Valsrivier Va40			10	60
Portsmouth Hu35, Shorrocks Hu36	30	25	10	
Valssand Lo31			11	6
Mispah Ms10	50	60		
Slangkop Kd15				15
Stream beds/Stroombeddings				15

5.4. Hydrology

The Study Area falls within the Limpopo Water Management Area (WMA) 1 and is situated in the Mokolo River Catchment area (8387 km^2), where the Mokolo River (also known as the Mogol or Mogolo River) system varies from good to fair health (RHP, 2006). The Mokolo River rises in the western part of the Waterberg (between 1200 and 1600 metres above mean sea level). It originates in a flattish, open area with numerous koppies and flows through a steep gorge emerging above the town of Vaalwater. Here the river flows through a relatively flat area until it enters the Mokolo Dam. From there, it flows through another gorge before entering the Limpopo Plain, near the junction with the Rietspruit. From this point, the Mokolo River flows through flat sandy areas until it reaches the Limpopo River. The main

tributaries joining the Mokolo River downstream of the Mokolo Dam are the Rietspruit, Poer se Loop, and Tamboti River (DWA, 2012a; 2012b, RHP, 2006). The Mokolo River is a major tributary of the Limpopo River and commands a total catchment area of over 8 387 km^2 (Savannah Environmental, 2013) with a total natural mean annual runoff (MAR) of almost 300 Mm^3/a. The towns of Lephalale and Vaalwater are situated in the Mokolo Catchment. Agriculture (irrigation) is the major water user in the catchment (RHP, 2006).

According to the RHP (2006), the river channel of the Mokolo River is dominated by sandy runs and pools, but is heavily infested with reed beds (*Phragmites mauritianus*). The lower part of the Mokolo river is afforded some protection by game farms and other private farms while the wide floodplain and reed beds also limit access. The river flow highly regulated from the Mokolo Dam with sporadic flows being released for the farming community. There are five major road bridges in this area. A number of farm dams are located in the Mokolo River close to the Limpopo confluence and sand mining is widespread. The lower Mokolo River is dominated by hardy, pool dwelling species of fish. It is possible that some species may have been lost due to fragmentation of the river from the Limpopo River. No fish species requiring permanent flow were recorded, but several species that require flowing water for breeding purposes still remain, such as the Large Scale Yellowfish (*Labeobarbus marequensis*) and other *Labeo* species. However, no alien fish species were recorded. The poor habitat diversity caused the invertebrate assemblage to be dominated by hardy families associated with marginal vegetation and sand. The moderately scoring SASS assessments are likely to be as a result of the irregular flow regime. The main vegetation impact is considered to be reed encroachment and there are clear indications that the regulated flow regime is contributing to this problem. Alien vegetation was very sparse and only a few Syringa (*Melia azedarach)* was recorded. Downstream from Lephalale, disturbance to the riparian zone was limited to bridges, sand mining, and agricultural practices (mostly water abstraction pumps and the cutting of vegetation to the river's edge) (RHP, 2006).

The Sandloop is a tributary of the Mokolo River. A summary of the Present Ecological State (PES), Ecological Importance (EI), Ecological Sensitivity (ES) and current impacts on the Sandloop is presented in **Table 5-2** (DWS, 2014). The Desktop PES of the Sandloop is moderately modified (C category) where the loss and change of natural habitats and biota have occurred but the basic ecosystem functions are still predominately unchanged. According to the DWS (2014), this river is seriously influenced by cattle grazing and land-use. The instream and riparian habitats are moderately influenced by agricultural fields, low water crossings, erosion, overgrazing and trampling. The WQ is also moderately impacted on by run-off from mining. These habitats are also affected by bed and channel disturbances, small farm dams, inundation, road crossings, urbanisation and vegetation removal but only to a lesser degree. The moderate EI of the Sandloop is due to the one wetland and two riparian habitat types, 12 different types of vegetation cover and three endemic species in this sub-quaternary catchment with a taxon richness of at least 25 species (wetland, riparian and aquatic vegetation). The size of stream, morphology and geomorphic habitat units determine

the ES. The Sandloop has a low sensitivity to modified flow conditions and water level changes because this is an ephemeral system and has a natural lack of surface water (DWS, 2014). The Sandloop is a Lower Foothill and a Least Threatened (LT) system but poorly protected (Nel & Driver, 2012; Driver *et al*. 2011).

Table 5-2 Summary of the Sandloop and Mokolo River's Ecostatus and impacts (DWS, 2014)

Quaternary Catchment	Water Resource	Present Ecological State (PES)	Ecological Importance (EI)	Ecological Sensitivity (ES)	Current Impacts
A42J	Sandloop	**C Moderately Modified**	**Moderate**	**Low**	LARGELY: Cattle grazing (land-use) MODERATE: Agricultural fields, low water crossings, erosion, overgrazing and trampling, run-off from mining SMALL: Bed and channel disturbance, small (farm) dams, inundation, roads, urbanisation and vegetation removal.
A42	Mokolo River (after confluence with Sandloop)	**D Largely Modified**	**High**	**High**	SERIOUS: Water abstraction LARGE: Algal growth, inundation and irrigation MODERATE: Agricultural fields, bed and channel disturbance, small (farm) dams, Runoff and effluent from irrigation, grazing (land-use) and vegetation removal, SMALL: Alien vegetation, overgrazing/trampling and sedimentation.

5.5. Regional Vegetation

Mucina and Rutherford (2006) provide an extensive account of the vegetation of South Africa (in addition to Lesotho and Swaziland) via the employment of appropriate tools for vegetation mapping and description. The Study Area falls within the ***Limpopo Sweet Bushveld (code SVcb 19)*** vegetation type (**Figure 5-5**) as described by Mucina and Rutherford (2006). This area was formerly classified as Arid Sweet Bushveld by Acocks (1953), which was the original vegetation map of South Africa, and forms part of the Savanna Biome in South Africa. The Savanna biome covers the northern and eastern parts of South Africa where a continuously shifting balance occurs between the woody and herbaceous vegetation. The typical vegetation consists of short open woodland. In disturbed areas thickets of *Acacia erubescens*, *Acacia mellifera* and *Dichrostachys cinerea* are almost impenetrable. Important plant species for the Limpopo Sweet Bushveld are presented in **Table 5-3**.

The conservation status of the Limpopo Sweet Bushveld is classified as Least Threatened. In 2006, about 5% of the vegetation type had been transformed, mainly by cultivation and the area is suitable for game and cattle farming due to the high grazing capacity of sweet veld. Subsequent to 2006, the area has been facing increasing pressure from numerous coal mining projects within the vicinity with a much greater percentage of land transformed.

Table 5-3 Important plant species in the Limpopo Sweet Bushveld

SPECIES GROUP	IMPORTANT TAXA
Tall trees	***Acacia robusta*** (d), *Acacia burkei*
Small trees	***Acacia erubescens*** (d), *A. fleckii* (d), ***A. nilotica*** (d), *A. senegal* var *rostrata* (d), *Albizia anthelmintica (d),* ***Boscia albitrunca*** (d), ***Combretum apiculatum*** (d), ***Terminalia sericea***
Tall shrubs	*Catophractes alexandri* (d), ***Dichrostachys cinerea*** (d), *Phaeoptilum spinosum* (d), *Rhigozum obovatum* (d), *Cadaba aphylla, Combretum hereroense, Commiphora pyracanthoides,* ***Ehretia rigida*** **subsp.** ***rigida****,* ***Euclea undulata****,* ***Grewia flava****, Gymnosporia senegalensis*
Low shrubs	*Acacia tenuispina* (d), *Commiphora africana, Felicia muricata, Gossypium herbaceum* subsp. *africanum, Leucospaera bainesii.*
Graminoids	***Digitaria eriantha*** **subsp.** ***eriantha*** (d), *Enneapogon cenchroides* (d), *Eragrostis lehmanniana* (d), *Panicum coloratum* (d), ***Schmidtia pappophoroides*** (d), ***Aristida congesta,*** *Cymbopogon nardus, Eragrostis pallens, E. rigidior, E. trichophora, Ischaemum afrum,* ***Panicum maximum****, Setaria verticillata, Stipagrostis uniplumis,* ***Urochloa mosambicensis****.*
Herbs	*Acanthosicyos naudinianus,* ***Commelina benghalensis****, Harpagophytum procumbens* subsp. *transvaalense, Hemizygia elliotii, Hermbstaedtia odorata, Indigofera daleoides.*
Succulent herbs	*Kleinia fulgens, Plectranthus neochilus*

Source: Mucina & Rutherford (2006)

Key: (d) = dominant species; Species in **Bold** indicate those identified in the study area

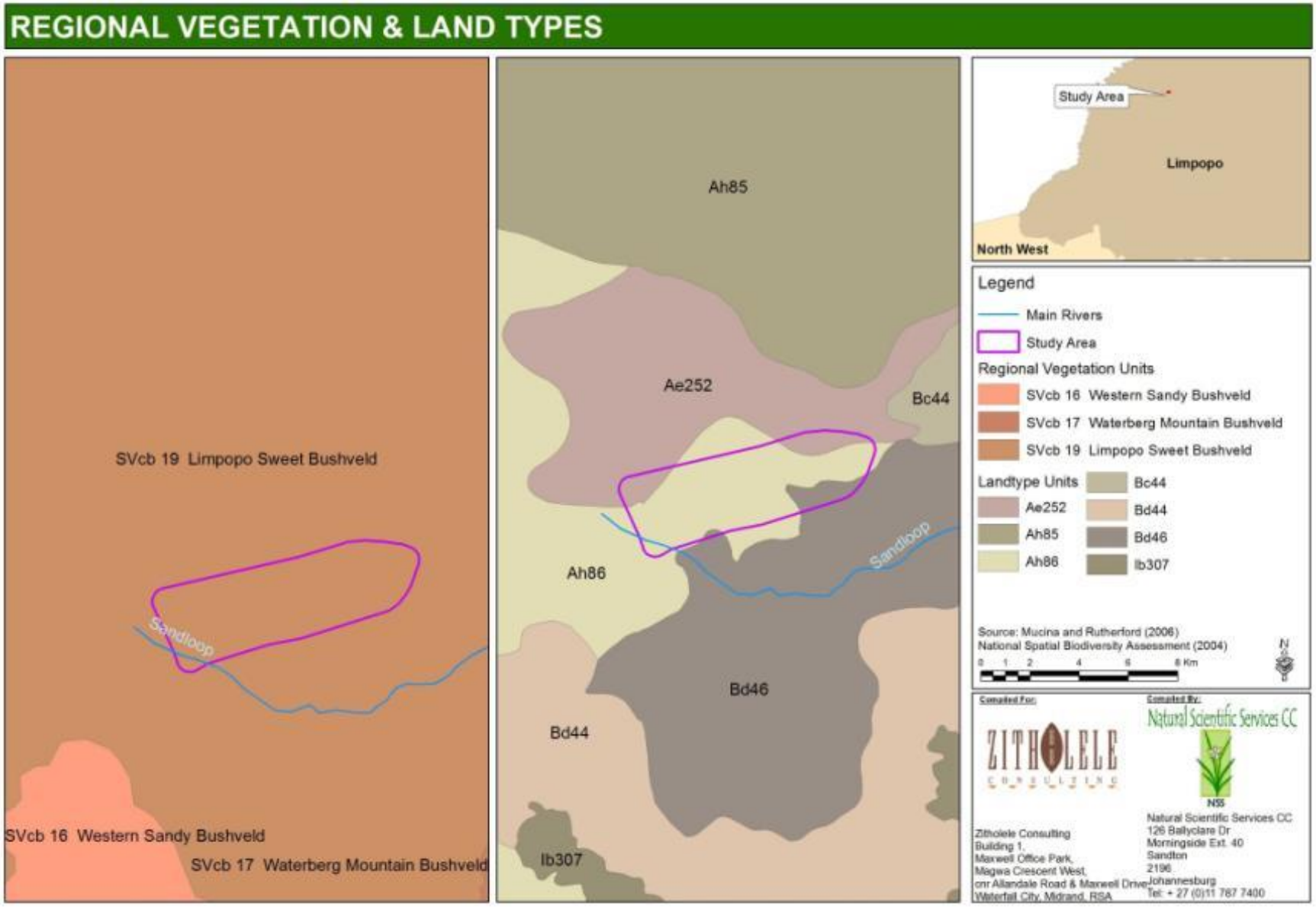


Figure 5-5 Regional Vegetation and Land Types

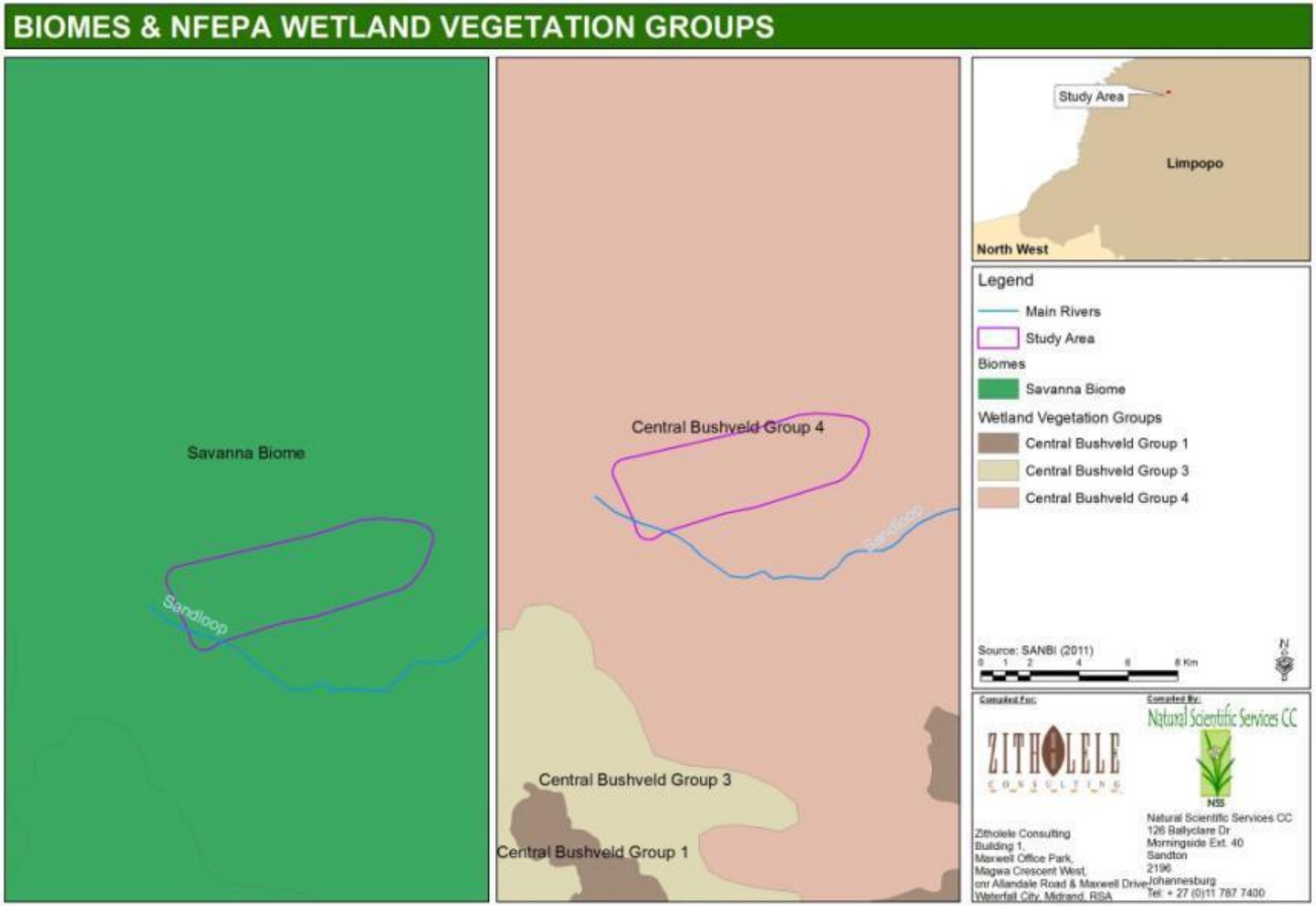


Figure 5-6 Biomes and Wetland Vegetation in the Study Area

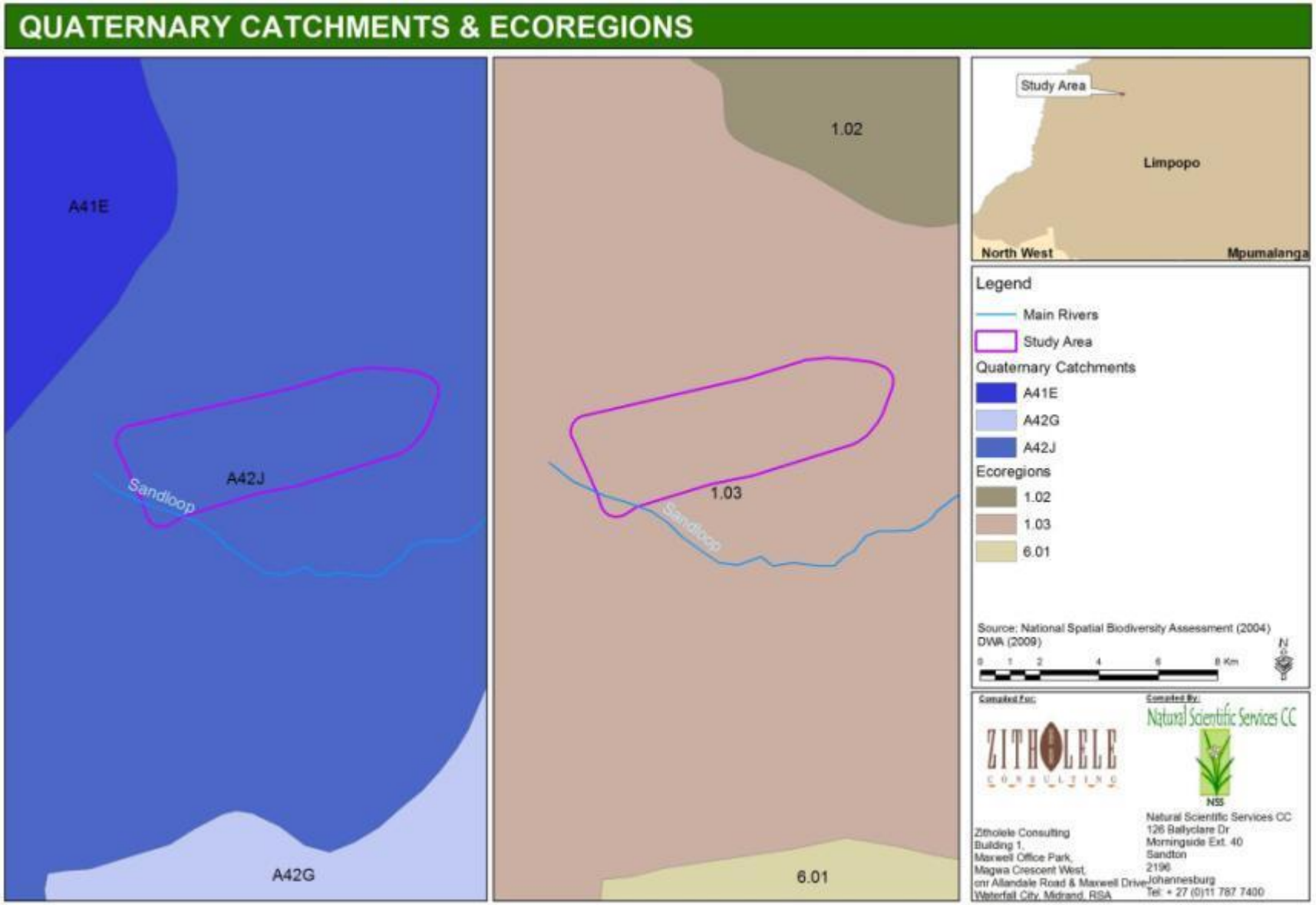


Figure 5-7 Quaternary Catchments and Ecoregion in the Study Area

6. Methodology

6.1. Vegetation & Floral Communities

6.1.1 *Desktop Research*

A desktop investigation of regional vegetation, including Conservation Important (CI) and alien, invasive floral species, was performed by consulting the following information sources:

- Google Earth (recent and historical imagery) and Bing satellite imagery. Historical imagery was incorporated into the assessment due to the continuous earth moving activities and developments occurring within the Medupi ADF, coal stockpile area and FGD portion of the Power Station.
- Mucina & Rutherford's (2006) vegetation map of southern Africa.
- The South African National Biodiversity Institute's (SANBI's) online PRECIS (PREtoria Computerised Information System), which provides taxonomic information for plant species occurring in southern Africa (in the format of Germishuizen & Meyer, 2003). For this study, plant species data were obtained for the quarter degree square (QDS) 2327DA.
- CI plant species records in the study region, supplied by Limpopo Conservation.
- The current Limpopo C-Plan (Version 2, 2013).
- The list of declared weeds and invader species as promulgated under the amended regulations (Regulation 15) of the Conservation of Agricultural Resources Act (CARA; Act 43 of 1983), and the Alien and Invasive Species Regulations (August, 2014) under Section 70 of the National Environmental Management: Biodiversity Act (NEMBA; Act 10 of 2004).

6.1.2 *Fieldwork*

Fieldwork was performed during January 2015, November 2015, December 2015 and December 2016 and involved:

- Sampling vegetation plots to determine the spatial extent, structure, condition and dominant species composition of different local floral communities (**Figure 6-1**) Sampling plot size was standardised at 100m^2. Whilst a plot was sampled, a list of plant taxa was compiled and each taxon was assigned a cover-abundance estimate using the Braun-Blanquet approach (Mueller-Dombois & Ellenberg 1974). The cover-abundance categories that were used for this purpose are listed in **Table 6-1**. It must be noted that the habitat in which the site fell was mostly homeogenous in nature, fragmented and disturbed, therefore the use of the Braun-Blanquet approach was limited.
- Walking random transects to detect localised and CI plant species (i.e. Red Data, endemic, protected and cultural species).
- Recording any observed alien and invasive plant species on site.

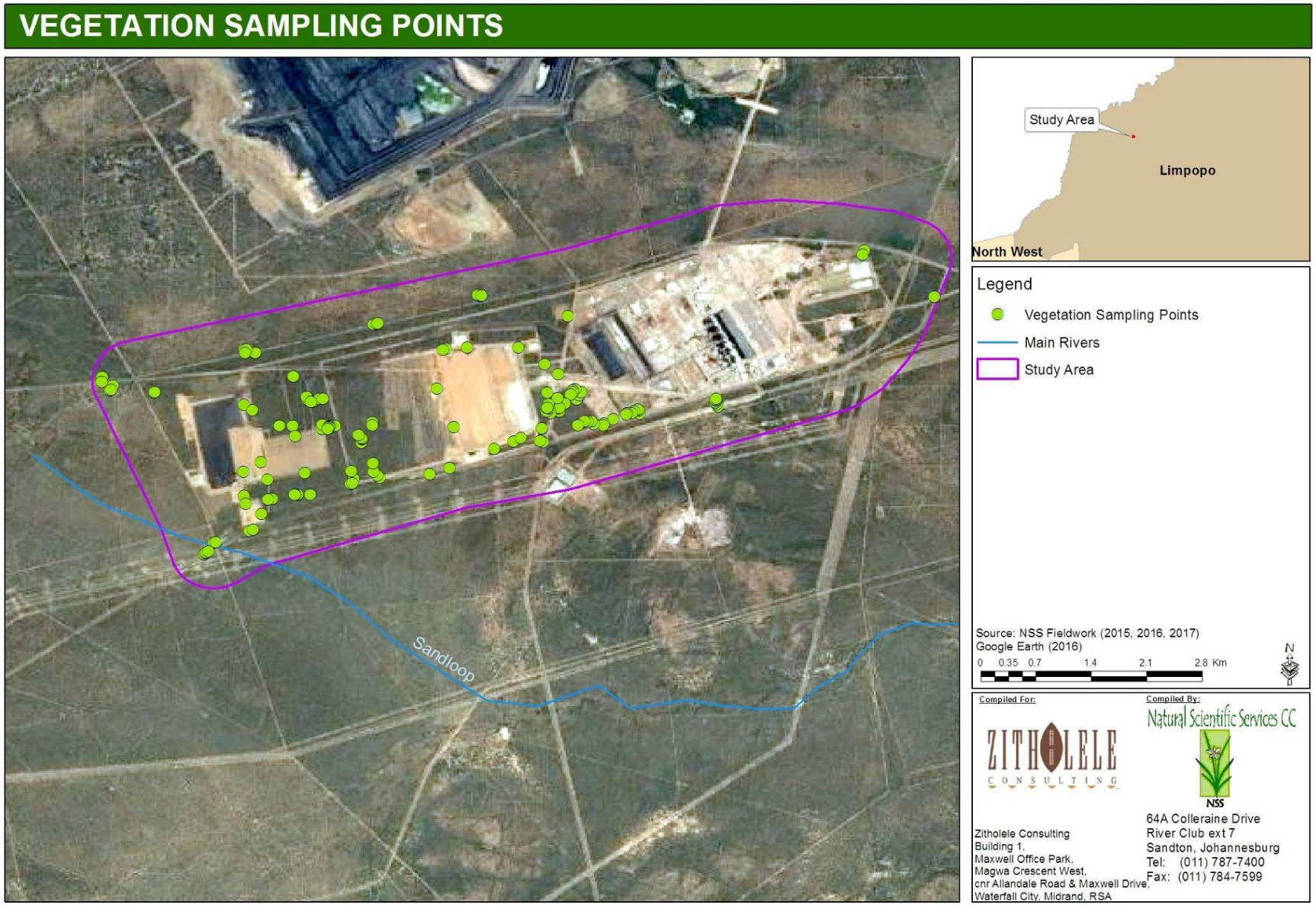


Figure 6-1 Main vegetation sampling points

6.1.3 *Data Analysis*

- The Juice (version 7.0.99) software program for management, analysis and classification of ecological data was used to conduct a TWINSPAN Detrended Correspondence Analysis (DCA) (Tichy & Holt, 2006) on the limited sampling points. The R-program was included as an add-on programme to Juice to conduct the DCA ordination.
- A TWINSPAN analysis (Hill 1979) of the Braun-Blanquet data, which represented the cover-abundance of species in each sample plot, was used to classify vegetation assemblages. TWINSPAN is used to investigate associations between samples with the purpose of objectively distinguishing groups or assemblages. Samples that cluster together are believed to have similar compositions. The data were left untransformed to allow for only common or dominant species to participate in the analysis.
- For CI floral species, Likelihood of Occurrence (LO) rating is assigned to each species based on the availability of suitable habitat using the following scale:
  - Present
  - Highly likely
  - Possible
  - Unlikely
  - No Habitat

Table 6-1 Braun-Blanquet cover classes (Mueller-Dombois & Ellenberg 1974)

CLASS	RANGE OF COVER (%)	MEAN
5	75-100	87.5
4	50-75	62.5
3	25-50	37.5
2	5-25	15.0
1	1-5	2.5
+	<1	0.1
r	<<1	0.01

6.1.4 *Limitations*

It is important to note that the absence of species on site does not conclude that the species is not present at the site. Reasons for not finding certain species during the different visits (all conducted in mid-summer) may be due to:

- The fragmented nature of the remaining natural vegetation within the boundary of the Medupi Power Station FGD Project area.
- The duration of fieldwork and the period at which rainfall events took place. I.e. while the December 2015 fieldwork took place during a heavy rainfall period – this was beneficial for faunal species. Floral species require some growth time after such events.
- Some plant species, which are small, have short flowering times, rare or otherwise difficult to detect may not have been detected even though they were potentially present on site.

- As an alternative to other vegetation cover methods (such as the Domin method), the Braun-Blanquet cover-abundance scale was used to analyse vegetation. It is reported that the Braun-Blanquet method requires only one third to one fifth the field time required to other similar methods (Wikum & Shanholtzer, 1978). Furthermore, cover-abundance ratings are better suited than density values to elucidate graphically species-environment relationships. For extensive surveys this method provides sufficiently accurate baseline data to allow environmental impact assessment as required by regulatory agencies. However, there are a couple of problems that have been detected with such sampling methods (Hurford & Schneider, 2007). These are as follows:
    - It can be seen as subjective and dependent upon the experience and knowledge of the vegetation type by the surveyor. The cover estimate may vary from observer to observer.
    - There also may be a problem when the cover estimate is very close to two different classes (on the border so to speak) and then it is for the observer to decide which class it should be allocated to. In Hurford & Schneider's (2007) experience, in marginal situations, where the cover of a species is close to a boundary between two classes, the chance of two observers allocating the species to the same cover class is no better than 50:50. However, when comparing to other sampling methods such as Domin, Braun-Blanquet scale is better adapted for monitoring (less cover classes and fewer boundaries).

6.2. Faunal Communities

6.2.1 *Desktop Research*

Lists of potentially occurring faunal species (**Appendices 2-7**) were based on distribution data sourced for:

- Mammals, using the published species distribution maps in Friedmann & Daly (2004), as well as the online species distribution data provided by the ADU's MammalMap (2018) for the regional QDSs 2327CB, 2327DA, 2327CD and 2327DC.
- Birds, using the online species distribution data from the first and second Southern African Bird Atlas Projects (SABAP 1 & 2, 2018) for QDSs 2327CB, 2327DA and respective pentads 2340_2725 and 2340_2730.
- Reptiles, using the published species distribution maps in Bates *et al.* (2014) and the online species distribution data from ReptileMap (2018) for all four regional QDSs.
- Frogs, using the published species distribution maps in Minter *et al.* (2004) and the online species distribution data from FrogMap (2018) for all four QDSs.
- Butterflies, using the online species distribution data from Mecenero *et al.* (2015) and LepiMap (2018) for all four QDSs.
- Dragonflies and damselflies (odonata), using distribution maps and habitat information provided in Samways (2008).

- Scorpions, using distribution maps and habitat information provided in Leeming (2003).
- Baboon Spiders, using distribution maps provided in Dippenaar-Schoeman (2002).

A Likelihood of Occurrence (LO) rating was then assigned to each species based on distribution and the availability of suitable habitat using the following scale:

1 Present
2 High
3 Moderate
4 Unlikely
5 The species would only occur in the area as a managed population.

Species lists were then supplemented with records obtained by BEC (2006) as part of the Medupi EMPR, as well as combined records from NSS studies in the Vicinity at Grootegeluk and Limpopo West Mines, Mafutha Project and Matimba Power Station.

6.2.2 *Fieldwork*

NSS visited the greater FGD study area three times i.e. during 12-13 January 2015, 9-11 November 2015 and 7-11 December 2015. During the first two visits a brief scan was performed, which involved active searching, deployment of motion cameras, and night time bat and frog acoustic surveys. The final five day survey followed a similar approach but with the addition of live-trapping.

Visual observations, grab-sampling and netting

Faunal observations were made during active point searches both by day and night on foot and incidentally while driving in and around the study area. Herpetofauna were searched for by turning rocks, logs and mats deployed during the November visit. Holes were investigated using a burrow scope. Tadpoles were sampled by dipnetting, and identified based on morphology and labial tooth row formula. Sweepnetting was used to sample butterflies. Scorpions were searched for under bark and rocks. Mammals were detected from observations of dead or live animals and their spoor, droppings, burrows and any other evidence of their presence. Birds were identified based on direct observation or from their calls and flight behaviour. Spotlighting during slow night drives was used to detect additional nocturnal fauna.

Live-trapping

In total, four live-trapping sites were installed in and around the FGD study area. Each trap site consisted of one array trap and a set of rodent traps. The trap sites operated over five days and four nights, and were checked daily. The location of each trap site is mapped in **Figure 6-5**.

Trap sites and techniques are shown in **Figure 6-2** and **Figure 6-4**, respectively. Additionally three sets of five large Astroturf mats were deployed during the November visit targeting reptiles, frogs and fossorial fauna. The mats were recollected during the December visit.

Trap Site 1 Trap Site 2 Trap Site 3 Trap Site 4

Figure 6-2 Live trapping sites

A schematic layout of an array trap site is presented in **Figure 6-3**. The array traps (Campbell & Christman, 1982) were used to sample herpetofauna (reptiles and frogs) and terrestrial macro-invertebrates. Each array consisted of three arms of plastic drift fencing (30cm high and 8m long). Pitfall traps (5 litre buckets sunken to ground level) were placed at the centre of the array and at the end of each drift fence. Each pitfall trap was provisioned with a stone, wet cotton wool and a raised, wooden cover board to provide shelter, moisture and shade for trapped animals. A plastic, mesh funnel trap was placed on either side of each drift fence and covered with a wooden board for shade.

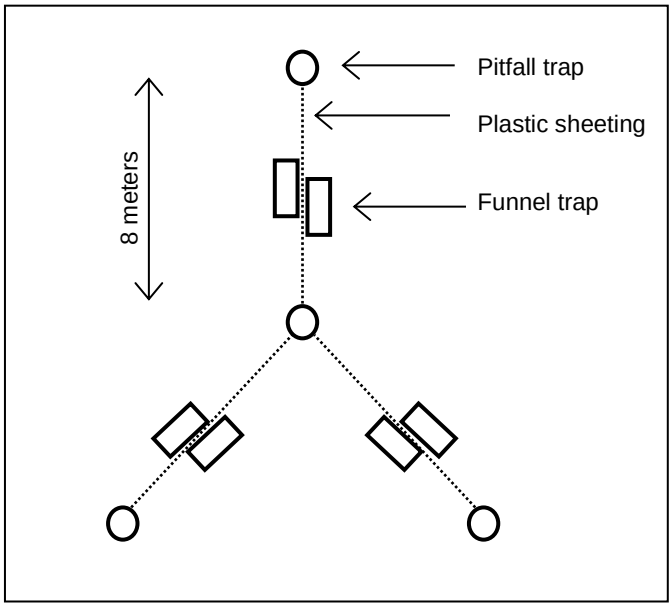


Figure 6-3 Schematic layout of an array trap including drift fences, pitfall and funnel traps

A live rodent trapping transect typically included a series of metal rodent traps spaced at 5-10m intervals. Each series included one pair of multi-entry traps, and 16 Sherman traps. Each trap was baited with a mixture of peanut butter, rolled oats, raisins, sunflower oil and seeds, and supplied with cotton wool and a wooden cover board to provide warmth and shade for trapped animals. The traps were checked daily and re-baited when necessary.

Funnel and pitfall traps along drift fence

Sherman rodent trap

Motion camera

Mat Trap

Figure 6-4 Examples of sampling techniques employed

Acoustic survey for bats and frogs

Bat calls were recorded during a short driven transect in the study area (**Figure 6-5**) using an ultra-sonic Echo Meter 3 (EM3) detector (Wildlife Acoustics, Inc., USA). Wildlife Acoustics Compressed (.wac) files of bat calls recorded by the EM3 detector were converted to zero crossing (.zc) and wave (.wav) files using the WAC2WAV and Kaleidoscope programmes (Wildlife Acoustics Inc., USA). The converted data were subsequently processed using the BatSound Pro (Pettersson Elektronik, Sweden) programme to identify bat taxa from detailed examination of the peak frequency, duration and band width of calls.

Camera-trapping

Motion-sensitive cameras, set to record both infrared and flash images, were installed in and around the FGD study area where vertebrate activity was deemed likely, such as near water holes, game feeding stations or along paths (**Figure 6-5** and **Figure 6-4**). Some cameras were baited to attract secretive, nocturnal, carnivorous mammals.

Designation of Conservation Status

In the appended faunal species lists the global, national and provincial conservation status of applicable species is provided. Global and National Red Lists are based on the IUCN Red List criteria and categories, shown in **Figure 6-6,** which were developed to provide a simple and effective system for rating the conservation status of species, mainly at global and regional levels. The global status of species was sourced from the IUCN (2017.3) Red List. The latest national Red List status of species was sourced for mammals, birds, reptiles, frogs and butterflies from the atlases and Red Data books by SANBI & EWT (unpubl.), Taylor *et al.* (2015), Bates *et al.* (2014), Minter *et al.* (2004) and Mecenero *et al.* (2013), respectively. A legally-binding national list of Threatened or Protected Species (ToPS, 2015) is provided under the 2004 National Environmental Management: Biodiversity Act (NEMBA). As there is often spatio-temporal variation in human disturbances, the conservation status of some species differs between the IUCN global/regional, national and provincial Red Listings.

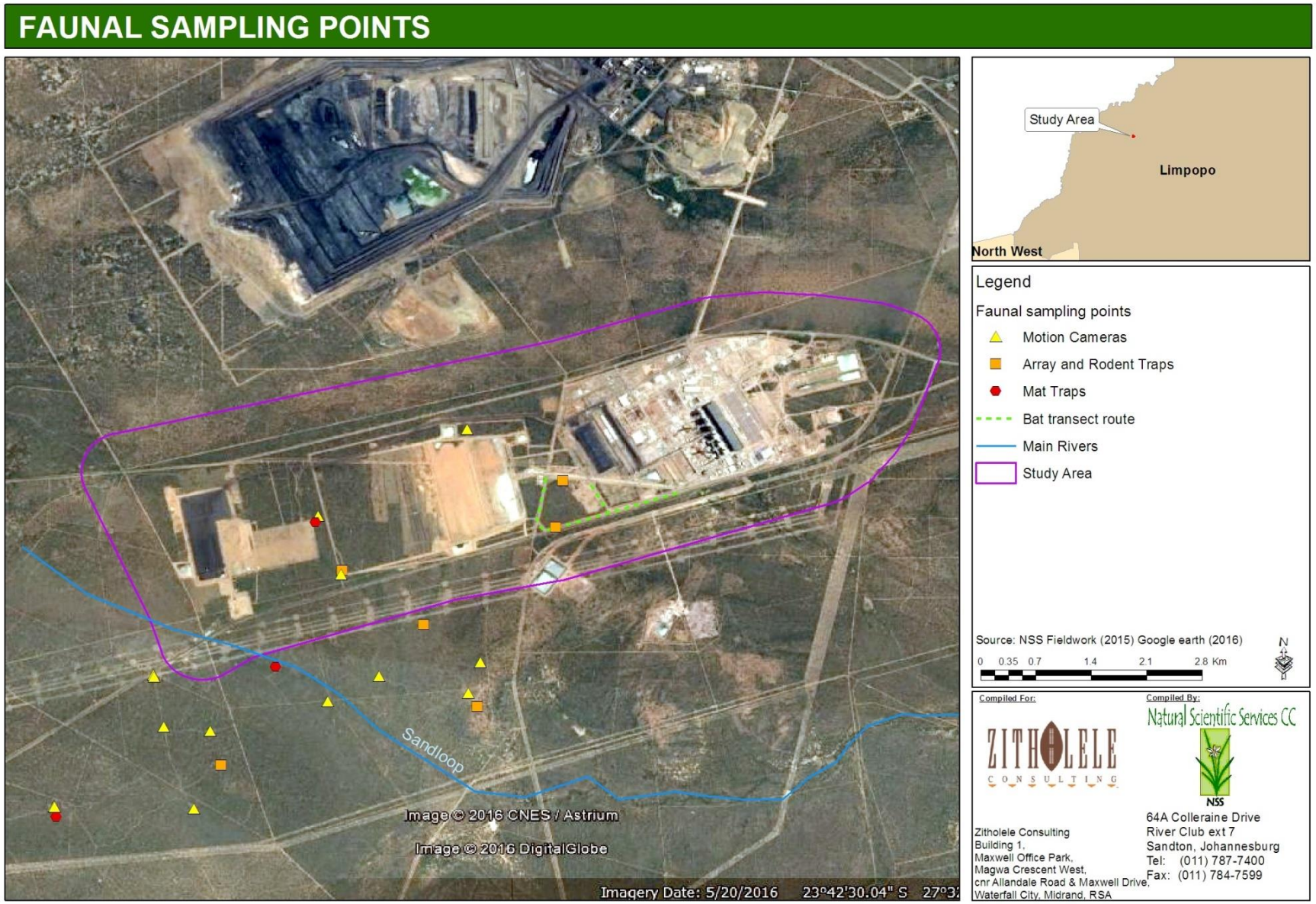


Figure 6-5 Layout of faunal sampling points showing the bat acoustic transect and position of the motion cameras.

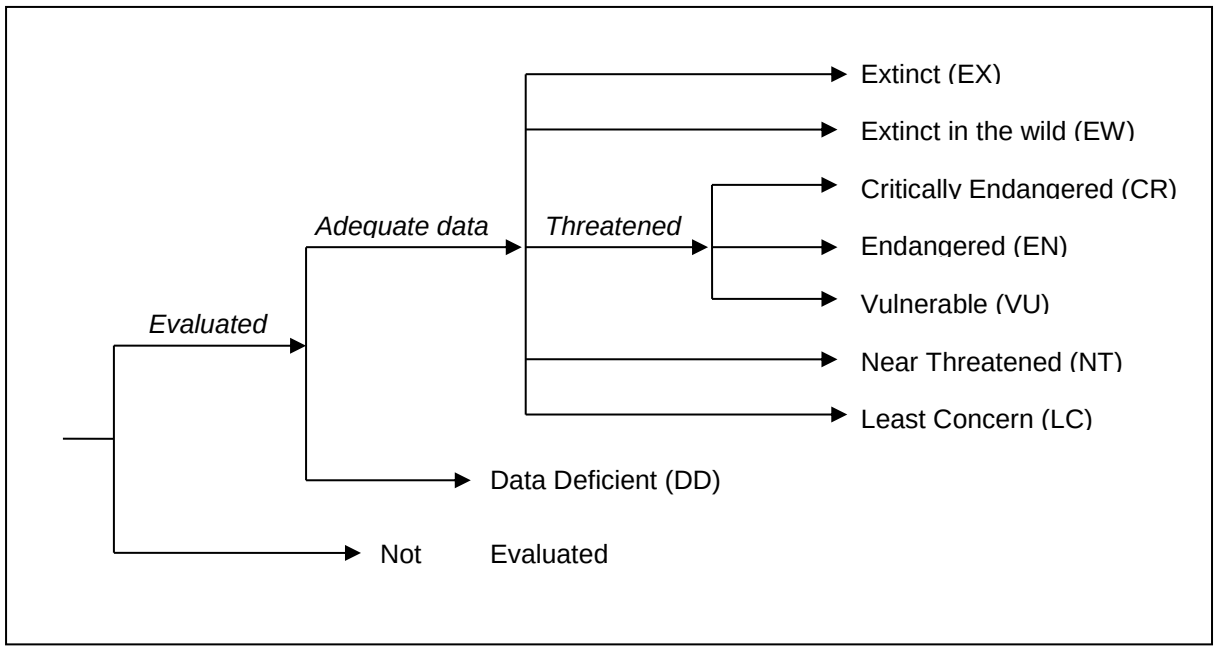


Figure 6-6 IUCN Red List categories

6.2.3 *Limitations*

Several inherent and unavoidable limitations need to be considered when interpreting survey results. Reasons for the lack of detection of some species include:

- Inductions and security protocol which significantly decreased the amount of time spent in the study area.
- The small, fragmented nature of the study area, and disturbances from Medupi Power Station.
- The short duration of each field survey, and the lack of significant rainfall preceding the January survey.
- The cryptic nature of certain species or simply lack of species presence. Some animal species, which are uncommon, small, migratory, secretive or otherwise difficult to find may not have been detected even though they were potentially present in the study area.

6.3. Watercourses, Wetlands and Ephemeral Systems

As part of this study it is important to define what systems are being investigated. As mentioned in **Section 5,** the study area lies within a drier region of the country where evapotranspiration exceeds rainfall. Rainfall in this region is approximately 400mm per annum. Systems, therefore within this region are largely ephemeral and are seen as drainage systems that potentially flow intermittently. These fall under the definition of a Watercourse.

A watercourse defined by the National Water Act (Act 36 of 1998) means –

(a) a river or spring;

(b) a natural channel or depression in which water flows regularly or intermittently;

(c) a wetland, lake or dam into which, or from which, water flows; and

(d) any collection of water which the Minister may, by notice in the Gazette, declare to be a watercourse as defined in the National Water Act, 1998 (Act No. 36 of 1998) and reference to a watercourse includes, where relevant, its bed and banks;

When discussing a wetland, the definition used within this study is that defined by the Ramsar Convention[1] and those used within publications such as the "Classification System for Wetlands and other Aquatic Ecosystems in South Africa" (Ollis *et al*. 2013) which incorporates both the definition of Aquatic Ecosystems[2] and Wetlands[3] as defined by the National Water Act (Act 36 of 1998).

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

Due to the extent of the areas to be investigated, the ToR for NSS was to identify and delineate watercourses and wetland systems at a desktop level within a 500m buffer of the MPS and ADF and to then undertake limited ground truthing (mainly within December 2015 and November 2016) within the areas identified. Prior to any field investigations being undertaken, the area was therefore surveyed at a desktop level using 1:50 000 topographical maps, Google Earth™ Imagery, and available contour data (a relatively flat region, so contour data limiting in this assessment) to determine the layout of potential watercourses and wetlands within the study site and immediate surrounds.

6.3.1 *Classification of the Watercourses and Wetlands*

Where wetlands were found, they were defined using the classification system discussed above by Ollis *et al*. (2013), hereafter referred to as "the Classification System". The Classification System recognizes three broad inland systems: rivers, wetlands and open water bodies. Like Kotze ***et al's.*** (2008) classification of wetlands based on hydro-geomorphic (HGM) units, the Ollis *et al*. (2013) Classification System asserts that the

[1] "*Wetlands – areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six meters*" Ramsar Convention Secretariat, 2011.

[2] Aquatic Ecosystem: *an ecosystem that is permanently or periodically inundated by flowing or standing water, or which has soils that are permanently or periodically saturated within 0.5m of the soil surface.*

[3] [3] NWA defines a wetland as *"land which is transitional between terrestrial and aquatic systems where the water table is usually at or near the surface, or the land is periodically covered with shallow water, and which land in normal circumstances supports or would support vegetation typically adapted to life in saturated soil."*

functioning of an inland aquatic ecosystem is determined fundamentally by hydrology and geomorphology.

The Classification System has a six-tiered structure where under the determination of a system's HGM unit (Level 4) is the most fundamental:

Level 1 – Type of Systems (Marine, estuarine or Inland)
Level 2 – Regional Setting (Level 1 Ecoregions; NFEPA WetVeg units etc)
Level 3 – Landscape Unit (Valley Floor, Slope, Plain, Bench)
Level 4 – Hydrogeomorphic (HGM) Unit
Level 5 – Hydrological Regime
Level 6 – Descriptors (e.g. Natural vs Artificial; Salinity; pH etc)

6.3.1.1 Ephemeral Systems (Watercourses)

Within the study area there are a number of drainage features referred to hereafter as Semi-Ephemeral Washes (SEWs). These are situated in the upper reaches of their catchment and characterised by a very gradual slope (<1%) and cross sectional profile. Although a very slight change in vegetation structure (not composition) is sometimes apparent, no clearly defined channel is obvious and it is often difficult to locate these systems on the ground without the aid of aerial imagery.

6.3.2 *Wetlands and Riparian Extent*

Where required, the wetland delineation methods used in the field were the same as those outlined in the DWS field procedure for identification and delineation of wetlands and riparian areas (DWAF, 2005). The following three indicators described by DWAF (2005) were used:

- *Terrain Unit Indicator*: The topography of the area was used to determine where in the landscape wetlands were likely to occur. During the December 2015 field visit the site experienced 38mm of rainfall in one week. This assisted NSS in determining the flow paths of a number of the ephemeral systems on site. In addition, aerial imagery and contour data were used to identify potential flow paths in the landscape.
- *Soil Wetness Indicator*: The soil wetness and duration of wetness are indicated by the colour of the soil. A grey soil matrix such as a G-horizon is an indication of wetness for prolonged periods of time and mottles indicate a fluctuating water table. In terms of the DWS guidelines (DWAF, 2005), signs of soil wetness must be found within the top 50 cm of the soil surface to classify as a wetland. Temporary wetlands in arid environments however do not usually exhibit mottling, because often the soils have naturally low levels of iron, and the soils are by definition not exposed to the specific conditions under which such indicators are formed so the absence of mottles does not necessarily indicate the absence of a wetland in these systems (Day *et al*, 2010). Where possible, soils data supplied by ESS (2016) for the study area were used to identify wet-based and alluvial soils; and
- *Vegetation Indicator*: Vegetation is a key component of the wetland definition in the National Water Act, 1998 (Act No 36 of 1998), and vegetation can be used as an indicator of wetland conditions. The presence / absence of hydrophytes usually

provide a useful additional criterion in determining the boundaries of wetlands. Within arid environments and the temporary wetlands identified on site it was more the change in vegetation structure and facultative wetland plants (helophytes) that were used as wetland indicators, as opposed to only hydrophytes. (Day *et al*. 2010). The delineation of riparian vegetation was conducted using the three simple steps outlined by Mackenzie & Rountree (2007), for sites that support predominantly indigenous and naturally occurring vegetation, as such:

- Starting at the sides of the channel, identify the edge of the zone of obligate riparian plants using the regional riparian vegetation indicator list.
- Check if there are hydric indicators in the soil, such as G-horizons or soil mottling, or evidence of unconsolidated recent alluvial sediment. Find the outer edges of these indicators.
- Examine the geomorphology (shape) of the channel and river banks. The locations selected based on riparian indicator species or soil features described above, should be at or close to the edge of the "macro-channel bank" (in the case of erosive rivers) or at the edge of an active floodplain / flood zone (in the case of alluvial depositional rivers). At this point, or nearby, should be an inflection point (change of slope) between the riparian area and the upland (terrestrial) slopes. This site can be considered as the edge of the riparian zone.

The study site was traversed, on foot, with select areas chosen from the desktop mapping for limited ground truthing. Soil samples, within the top 50cm and deeper where necessary, of the soil profile, were taken using a hand auger along transects across the property and within areas where wetland vegetation indicators were present. The areas were assessed for the above wetland indicators. Each auger point sampled was marked with a handheld Global Positioning System (GPS) device (Geographic projection, WGS 84 Datum).

6.3.3 *Present Ecological State*

6.3.3.1 Semi-Ephemeral Washes

Although this is not an HGM unit defined specifically in Ollis *et al* (2013), an attempt was made to obtain a PES score using the Level 1 WET-HEALTH tool of Macfarlane *et al.* (2008). In spite of this limitation it is our opinion that the scores attained for the wetlands are representative and therefore afforded a high confidence. The WET-HEALTH tool is designed to assess the health or integrity of a wetland. To assess wetland health, the tool uses indicators based on the main wetland drivers: geomorphology, hydrology and vegetation.

Macfarlane *et al.* (2008) explain that the application and methodology of WET-HEALTH uses:

- An impact-based approach, for those activities that do not produce clearly visible responses in wetland structure and function. The impact of irrigation or afforestation

in the catchment, for example, produces invisible impacts on water inputs. This is the main approach used in the hydrological assessment.

- An indicator-based approach, for activities that produce clearly visible responses in wetland structure and function, e.g. erosion or alien plants. This approach is mainly used in the assessment of geomorphology and vegetation health.

With WET-HEALTH a wetland is first classified into HGM units (Level 4 – Ollis *et al.* 2013), and each HGM unit is separately assessed in terms of the extent, intensity and magnitude of impacts on the hydrology, geomorphology and vegetation of the unit, which is translated into a health score as follows:

- The *extent* of impact is measured as the proportion (percentage) of a wetland and/or its catchment that is affected by an activity.
- The *intensity* of impact is estimated by evaluating the degree of alteration that results from a given activity.
- The *magnitude* of impact for individual activities is the product of extent and intensity.
- The magnitudes of all activities in each HGM unit are then combined in a structured and transparent way to calculate the overall impact of all activities that affect a unit's hydrology, geomorphology and vegetation, and wetland PES is expressed on a scale of A-F (**Table 6-2**).

Table 6-2 Impact scores and Present Ecological State categories

ECOLOGICAL CATEGORY	DESCRIPTION	COMBINED IMPACT SCORE
A	**Unmodified, natural**	0-0.9
B	**Largely natural with few modifications**. A slight change in ecosystem processes is discernible and a small loss of natural habitats and biota may have taken place.	1-1.9
C	**Moderately modified**. A moderate change in ecosystem processes and loss of natural habitat has taken place but the natural habitat remains predominantly intact.	2-3.9
D	**Largely modified**. A large change in ecosystem processes and loss of natural habitat and biota has occurred.	4-5.9
E	**Seriously modified**. The change in ecosystem processes and loss of natural habitat and biota is great but some remaining natural habitat features are still recognizable.	6-7.9
F	**Critically modified**. Modifications have reached a critical level and the ecosystem processes have been modified completely with an almost complete loss of natural habitat and biota.	8-10

Source: Modified from Macfarlane *et al.* (2008)

In addition, the threat and/or vulnerability of a wetland must be assessed to determine its likely "trajectory of change" (**Table 6-3**). Overall wetland health is then jointly represented by the wetland's PES and trajectory of change. This approach not only provides an indication of

hydrological, geomorphological and vegetation health, but also highlights the key causes of wetland degradation.

Table 6-3 Trajectory of change classes, scores and symbols

TRAJECTORY CLASS	DESCRIPTION	CHANGE SCORE	CLASS RANGE	SYMBOL
Improve markedly	Condition is likely to improve substantially over the next five years	2	1.1 to 2	↑↑
Improve	Condition is likely to improve over the next five years	1	.3 to 1	↑
Remains stable	Condition is likely to remain stable over the next five years	0	-0.2 to +0.2	→
Deterioration slight	Condition is likely to deteriorate slightly over the next five years	-1	-0.3 to -1	↓
Deterioration substantial	Condition is likely to deteriorate substantially over the next five years	-2	-1.1 to 2	↓↓
Source:	Modified from Macfarlane *et al.* (2008)			

6.3.3.2 Pan Systems

Historically there has been little research done in South Africa on pans, especially when compared to palustrine[4] wetlands (Ferreira, 2012). In terms of assessing the functioning and ecosystem services supplied by ephemeral pans, the standard methods used in South Africa are not applicable as these focus on palustrine systems.

Ferreira (2012) undertook his PhD on developing a methodology for determining the ecological integrity of *perennial* endorheic pans within South Africa. Unfortunately this methodology is not applicable to the ephemeral pan system identified within the study area, and no method is available in South Africa to assess the habitat integrity of such systems. In spite of this limitation it is our opinion that the scores attained for the wetlands are representative and therefore afforded a high confidence. The main impacts for the various pan systems have therefore been discussed, based on expert opinion, under **Section 7.6**.

6.3.4 *Predicted Ecological State*

In order to assess the anticipated gains/losses to wetland health, specifically the semi-ephemeral washes associated with upper tributaries of the Sandloop as a result of the proposed development, a hectare equivalent approach was adopted using scoring guidelines and equations as presented in the WRC document WET – RehabEvaluate (Cowden & Kotze, 2008). First an overall ecological health score for the wetland with and without mitigation for all three alternatives was calculated by taking a weighted average of the three wetland drivers namely hydrology, geomorphology and vegetation using a 3:2:2 weighting ratio

[4] Palustrine: All non-tidal wetlands dominated by persistent emergent plants, emergent mosses or lichens, or shrubs or trees (Kotze *et al*, 2008)

respectively. Secondly this score was then used in to calculate hectare equivalents which represent the extent of functional wetland in relation to the total wetland extent. This was done using the following formula:

((Overall Health Score – 10) / 10) x Wetland Area = Hectare Equivalent

6.3.5 *Ecosystem Services*

The WET – EcoServices tool is a technique for rapidly assessing ecosystem services supplied by wetlands (Kotze *et. al.,* 2008). This tool has been designed for inland palustrine wetlands, i.e. marshes, floodplains, vleis and seeps and has been developed to help assess the goods and services that individual wetlands provide to support planning and decision-making. No palustrine wetlands were identified on site, but rather semi-ephemeral drainage features (Washes). This proposed methodology was only utilised in this assessment as a guide to the services offered by the different systems. In spite of this limitation it is our opinion that the scores attained for the wetlands are representative and therefore afforded a high confidence.

6.3.6 *Ecological Importance and Sensitivity*

The assessment of wetland Ecological Importance and Sensitivity (EIS) was based on the EIS Tool developed by Rountree and Kotze (2012). The purpose of assessing the EIS of water resources is to identify those systems that provide higher than average ecosystem services and/or biodiversity support functions, and/or are especially sensitive to impacts.

The Tool collectively considers:

- Ecological Importance and Sensitivity, incorporating the traditionally examined criteria used in EIS assessments of other water resources by DWS and thus enabling consistent assessment approaches across water resource types;
- Hydro-functional importance, which considers water quality, flood attenuation and sediment trapping ecosystem services that the wetland may provide; and
- Importance in terms of basic human benefits - this suite of criteria consider the subsistence uses and cultural benefits of the wetland system.

It is recommended that the highest scoring of these three criteria be used to determine the overall Importance and Sensitivity category (**Table 6-4**) of the wetland system.

Table 6-4 Ecological importance and sensitivity categories – Interpretation of median scores for biotic and habitat determinants

Range of Median	Ecological Importance & Sensitivity (EIS)	Recommended EMC
>3 and <=4	**Very high** Wetlands that are considered ecologically important and sensitive on a national / international level. The biodiversity of these systems is usually very sensitive to flow and habitat modifications. They play a major role in moderating the quantity and quality of water of major rivers.	**A**
>2 and <=3	**High** Wetlands that are considered to be ecologically important and sensitive. The biodiversity of these systems may be sensitive to flow and habitat modifications. They play a role in moderating the quantity and quality of water of major rivers.	**B**
>1 and <=2	**Moderate** Wetlands that are considered to be ecologically important and sensitive on a provincial or local scale. The biodiversity of these systems is not usually sensitive to flow and habitat modifications. They play a small role in moderating the quantity and quality of water of major rivers.	**C**
>0 and <=1	**Low/Marginal** Wetlands which are not ecologically important and sensitive at any scale. The biodiversity of these systems is ubiquitous and not sensitive to flow and habitat modifications. They play an insignificant role in moderating the quantity and quality of water of major rivers.	**D**

6.3.7 *Sediment*

Sediment samples were collected to determine the metal concentrations of the samples. These sediment samples were collected at six of the sampling sites during the high flow season (December 2015) and two additional samples within the November 2016 visit. The sediment samples were collected in PET jars, frozen to prevent any organic decomposition and sent to the Water Research Group (WRG) at the Potchefstroom Campus of North-West University for the metal analysis.

The analysis for metals involved a total digestion of sediments and was based on the methodology of Hassan *et al.* (2007). Each sediment sample was oven-dried for 2–4 days at 70°C. A known amount of each sample (approximately 0.5 g) was digested with Suprapur nitric acid (HNO_3) in a MARS 5 Microwave Digester for 20 minutes. The samples were then diluted and filtered with 0.45 µm cellulose nitrate under vacuum pressure. The filtered extract was analysed by Inductively Coupled Plasma – Optical Emission Spectrophotometer (ICP-OES) and an Inductively Coupled Plasma – Mass Spectrophotometer (ICP-MS). The results are expressed as mg/kg. Currently no sediment quality guidelines (SQGs) exist for freshwaters in South Africa. Therefore, the concentrations for each of the metals are compared to international standards and other local studies.

6.3.7.1 Invertebrate Hatching

The aim of the invertebrate hatching was to determine if any invertebrate resting eggs were present in the sediment from selected pans in the study area. Certain invertebrates, especially Branchiopoda, form resting eggs of ephippia to overcome the harsh conditions experienced in ephemeral wetlands. These resting eggs within the sediment are thus called the egg bank. The resting eggs remain in the sediment until the correct environmental triggers and conditions are present. The hatchlings are the first inhabitants of these ephemeral pans before other insect taxa colonise the system. When these ephemeral systems are dry it is impossible to determine what the biological community will comprise of when it is inundated. However, determining what the initial community will be comprised of can go a long way to provide an indication of the potential community.

Sediment samples from site MD7 and site MD8 were dried, at room temperature, upon receiving the samples from the field investigations, for a minimum of 48 hours. The hatching experiments were completed at a room temperature of approximately 22 °C. Each sample was hatched in triplicate. A known amount of sediment, 25g, was placed into 2L plastic containers for the hatching experiment. The experiment was initiated when 1L of distilled water was added to each hatching container. Due to time constraints the hatching experiment was allowed to run for 10 days but it would have been ideal to continue for up to 28 days. The hatching containers were examined every three to four days for any sign of invertebrate hatchlings. A small amount of oxygen was also added to each container when they were examined for invertebrate hatchlings. Both sites, MD7 and MD8, indicated that hatching of invertebrates occurred more or less after three days.

6.3.7.2 Comparative analysis with Water Quality Results

NSS collected water quality samples for Golder & Associates Surface Water Quality Assessment at the same time and position as the Sediment Samples. Water quality (WQ) is used to describe the aesthetic, biological, chemical and physical properties of water that determine its condition for a variety of uses and for the protection of the health and integrity of aquatic ecosystems. These dissolved or suspended constituents, in the water, could influence or control the WQ properties. For example, in some cases anthropogenic activities can cause the physio-chemical constituents that occur naturally in the water to become toxic under certain conditions. Each aquatic ecosystem possesses natural limits or thresholds to the extent and frequency of change it can tolerate without being permanently modified (DWAF, 1996). If an aquatic ecosystem crosses these thresholds, it will be difficult to recover or regain its functional capacity without mitigation. It must also be taken into consideration that determining the effects of changes in WQ on aquatic ecosystems is considered complex, as these systems can fluctuate spatially and temporally. For this project the results from the WQ analysis were used to compare those found within the sediment analysis.

6.3.8 *Limitations*

Even though all attempts were made to take samples under optimal conditions certain limitations were encountered. The limitations to this study included:

- Wetland assessment techniques are inherently subjective.
- The PES and EcoServices were also not designed for systems such as Ephemeral Washes
- The boundary determined by infield wetland delineation can often occur within a certain tolerance because of the potential for the change in gradient of the wetness zones within wetlands.
- The modification of the soil profile related to agricultural activities and the clearing of the site and the modification of the hydrological conditions within disturbed sites limits the accuracy of the resulting boundary as the sampling methodology relies heavily on interpretation of undisturbed soil morphology and characteristic.
- The use of vegetation indicators (seasonal and temporary zones) was limited to non-existent due to the ephemeral nature of the systems. Riparian vegetation was even not evident. Only vegetation structure in comparison to surrounding areas was conducted.
- Water was limited to sandy pools within the drainage features in the study area.
- None of the biomonitoring indices (**Box 1**) could be used due to the ephemeral nature of these systems (Not within this Scope). Instead Invertebrate hatching at two pans in the ADF site was conducted. Due to time constraints the hatching experiment was allowed to run for 10 days but it would have been ideal to continue for up to 28 days.

Box 1

* The assessment of macro-invertebrate communities in a river system is a recognised means of determining river "health". Macro-invertebrates are good indicators because they are visible, easy to identify and have rapid life cycles (Dickens & Graham, 2002). According to Dickens & Graham (2002), the SASS5 (South African Scoring System, version 5) method is designed for low/moderate flow hydrology and is not applicable in wetlands, impoundments, estuaries and other lentic habitats. In addition, it has not been tested in ephemeral rivers and so should be used with caution.

* No fish sampling was performed during the current study as the sampling sites were shallow pools with limited water levels. The Fish Response Assessment Index (FRAI) developed by Kleynhans (2008) cannot not be used in these ephemeral systems.

7. Results

7.1. Vegetation Communities

SANBI frequently collect/collate floral data within Southern Africa and update their PRECIS database system (National Herbarium Pretoria (PRE) Computerised Information System) which is captured according to QDS. For this study, the site falls with 2327DA. Species within the POSA database for this QDS do not exceed 311 species (Date extracted February 2015) and represent 68 Families. The dominant families being FABACEAE, POACEAE and MALVACEAE (**Table 7-1**), with the herbs representing 30.87%, dwarf shrubs 14.47%, shrubs to small trees 15.76% and graminoids representing 11.25% of the total species listed for the area. This is a typical representation of vegetation structure for savanna communities.

Table 7-1 Top Ten Dominant Families and Most Dominant Growth Forms obtained from the POSA website for the QDS 2327DA

IMPORTANT FAMILIES	No. OF SPP	GROWTH FORMS	% TOTAL SPP
FABACEAE	38	Herb	30.87
POACEAE	35	Dwarf shrub	14.47
MALVACEAE	35	Graminoid	11.25
ACANTHACEAE	17	Shrub	9.65
ASTERACEAE	16	Shrub to small tree	6.11
CONVOLVULACEAE	11	Climbers	5.14
APOCYNACEAE	11	Geophyte	4.5
EUPHORBIACEAE	10	Succulent	3.86
HYACINTHACEAE	9	Tree	3.54
RUBIACEAE	8	Bryophyte	2.57

7.1.1 *Vegetation Communities*

For a more detailed sampling of the project area, sample points were investigated in various natural and semi natural habitats of the study area and analysed using TWINSPAN. The study area was very homogenous in nature, fragmented and largely disturbed through clearing etc. This made it difficult to use a sampling method that would yield different communities. The main plant communities were identified based on understory coverage and disturbances (**Table 7-2** and **Figure 7-2**). These communities were mainly *Acacia* dominated Woodlands with associated Wetlands and included: *Acacia nigrescens* - *Grewia* Open Veld; *Acacia nigrescens –Combretum apiculatum* dominated woodland, *Acacia erubescens* - *Grewia* Thornveld, Disturbed *A nigrescens-Dicrostachys-Grewia* fragmented Thornveld and Disturbed *Acacia* mixed woodland. Associated wetland and hydromorphic areas included the *Acacia* dominated Wetland Flats, Depressions and Artificial Waterbodies.

Acacia nigrescens –Combretum apiculatum dominated woodland

Acacia nigrescens - Grewia Open Veld

A nigrescens-Dicrostachys-Grewia fragmented Thornveld

Depressions within the *Acacia* Woodlands

Depressions within the *Acacia* Woodlands

Acacia erubescens - Grewia Thornveld

Acacia erubescens - Grewia Thornveld

Waterbodies

Waterbodies

Acacia mixed woodland

Acacia dominated Wetland Flat

Figure 7-1 Photographic representation of the different vegetation found within the study area

Table 7-2 Vegetation Communities

UNIT	HABITAT & VEGETATION COMMUNITIES	% COVERAGE
A	**Main Vegetation Communities – Acacia Woodlands**	
	Acacia nigrescens - Grewia Open Veld	9.19
	Acacia nigrescens –Combretum apiculatum dominated woodland	22.87
	Acacia erubescens - Grewia Thornveld	2.26

UNIT	HABITAT & VEGETATION COMMUNITIES	% COVERAGE
B	**Disturbed Woodlands**	
	A nigrescens-Dicrostachys-Grewia fragmented Thornveld	8.27
	Acacia mixed woodland	6.59
C	**Transformed**	
	Disturbed (previously scraped)	11.47
	Cleared areas and stockpiles	14.61
	Roads and Storm Water	4.32
	Infrastructure	16.21
D	**Wetland Areas / Hydromorphic Grasslands**	
	Acacia dominated Wetland Flat	3.56
	Depressions	0.37
	Artificial water points / Waterbodies	0.15

A description and photographic evidence for each main natural vegetation unit is provided in the Tables below (**Table 7-3** to **Table 7-7**). This excludes depressions (lack of vegetation, with only occasional hydromorphic species present), waterbodies and transformed areas such as the alien bushclumps and any agricultural areas. The *Acacia* dominated Wetland Flats were situated within the *Acacia* Woodland Communities and showed limited variation from the surrounding vegetation other than a denser leaf coverage and height change. Wetlands constituted over 4% of the study area.

Table 7-3 ***Acacia nigrescens - Grewia*** **Open Veld Vegetation Description**

Acacia nigrescens - Grewia Open Veld	
Photographic representation	 
National Zones:	C-Plan Ecological Support Area; Waterberg CBA-Optimal, LC Vegetation Type ; Sweet Limpopo Bushveld
Sub-Community	*A nigrescens-Dicrostachys-Grewia fragmented Thornveld*
% Site Coverage	9.19 % - mainly in the northern region; Fragmented Habitat – 8.27%
Condition:	▪ Limited to no alien encroachment ▪ Quicker establishing grass species – dominated by Increaser 2 and sub-climax species
CI Species:	▪ *Sclerocarya birrea (A.Rich.)* (PT) ▪ *Spirostachys africana Sond.* (PT)
Common	▪ *Abutilon cf austro-africanum* ▪ *Digitaria eriantha Steud.*

Acacia nigrescens - Grewia Open Veld		
species:	*Hochr.* ▪ *Acacia karroo Hayne* ▪ *Acacia nigrescens Oliv.* ▪ *Acacia tortilis (Forssk.) Hayne subsp. heteracantha (Burch.) Brenan* ▪ *Agathisanthemum bojeri Klotzsch subsp. bojeri* ▪ *Alistilus bechuanicus N.E.Br.* ▪ *Aristida congesta Roem. & Schult. subsp. barbicollis (Trin. & Rupr.) De Winter* ▪ *Aristida stipitata Hack.* ▪ *Asparagus cf cooperi Baker* ▪ *Boscia albitrunca (Burch.) Gilg & Gilg-Ben.* ▪ *Chlorophytum recurvifolium (Baker) C.Archer & Kativu* ▪ *Clerodendrum ternatum Schinz* ▪ *Combretum apiculatum Sond. subsp. apiculatum* ▪ *Commelina africana L. var. africana* ▪ *Commelina benghalensis L.* ▪ *Cyperus margaritaceus Vahl var. margaritaceus*	▪ *Dipcadi viride (L.) Moench* ▪ *Eragrostis superba Peyr.* ▪ *Evolvulus alsinoides (L.) L.* ▪ *Gomphocarpus tomentosus Burch. subsp. tomentosus* ▪ *Grewia flavescens Juss.* ▪ *Grewia monticola Sond.* ▪ *Heliotropium ciliatum Kaplan* ▪ *Hermannia spp* ▪ *Ipomoea bolusiana* ▪ *Kyllinga alba Nees* ▪ *Oxygonum dregeanum Meisn. subsp. canescens (Sond.) Germish. var. canescens* ▪ *Panicum maximum Jacq.* ▪ *Pavonia burchellii* ▪ *Polygala amatymbica Eckl. & Zeyh.* ▪ *Polygala sphenoptera var. sphenoptera* ▪ *Schmidtia pappophoroides Steud.* ▪ *Solanum panduriforme Dr œge er Dunal* ▪ *Stipagrostis uniplumis (Licht.) De Winter var. uniplumis* ▪ *Terminalia sericea Burch. er DC.*
Species Examples:		
	Agathisanthemum bojeri	*Pavonia burchellii*
Current Conservation Status	**Medium**	
Current Conservation Status - *A nigrescens-Dicrostachys-Grewia fragmented Thornveld*	**Medium-Low**	

* Alien Species; *[1] Category 1 Alien Invasive; PT: Protected –DAFF;

Table 7-4 *Acacia nigrescens –Combretum apiculatum* Woodland Vegetation Description

***Acacia nigrescens –Combretum apiculatum* dominated woodland**	
Photographic representation	 
National Zones:	C-Plan Critical Biodiverse Area;Ecological Support Area; Waterberg CBA, LC Vegetation Type; Sweet Limpopo Bushveld
% Site Coverage	22.87 % - central region
Condition:	▪ Limited to no alien encroachment ▪ Similar species contribution to *Acacia nigrescens - Grewia* Open Veld ▪ Pioneer to sub-climax species; Increaser 2 species the most common
CI Species:	▪ *Sclerocarya birrea (A.Rich.)* (PT)
Common species:	▪ *Abutilon cf austro-africanum Hochr.* ▪ *Acacia erubescens Welw. er Oliv.* ▪ *Acacia nigrescens Oliv.* ▪ *Acacia tortilis (Forssk.) Hayne subsp. heteracantha (Burch.) Brenan* ▪ *Agathisanthemum bojeri Klotzsch subsp. bojeri* ▪ *Aristida congesta Roem. & Schult. subsp. barbicollis (Trin. & Rupr.) De Winter* ▪ *Aristida congesta Roem. & Schult. subsp. congesta* ▪ *Aristida stipitata Hack.* ▪ *Asparagus cf cooperi Baker* ▪ *Boscia albitrunca (Burch.) Gilg & Gilg-Ben.* ▪ *Cenchrus ciliaris L.* ▪ *Combretum apiculatum Sond. subsp. apiculatum* ▪ *Cyperus margaritaceus Vahl var. margaritaceus* ▪ *Eragrostis superba Peyr.* ▪ *Evolvulus alsinoides (L.) L.* ▪ *Gomphocarpus tomentosus Burch. subsp. tomentosus* ▪ *Grewia flavescens Juss.* ▪ *Grewia monticola Sond.* ▪ *Kyllinga alba Nees* ▪ *Oxygonum dregeanum Meisn. subsp. canescens (Sond.) Germish. var. canescens* ▪ *Panicum maximum Jacq.* ▪ *Polygala sphenoptera var. sphenoptera* ▪ *Schmidtia pappophoroides Steud.* ▪ *Sida ovata Forssk.* ▪ *Solanum panduriforme Droge er Dunal* ▪ *Stipagrostis uniplumis (Licht.) De Winter var. uniplumis*

Acacia nigrescens –Combretum apiculatum dominated woodland		
	▪ *Commelina africana var. africana*	
Species Examples:		
	Polygala sphenoptera var. sphenoptera	*Gomphocarpus tomentosus*
Current Conservation Status	**Medium**	

Table 7-5 *Acacia erubescens - Grewia Thornveld* Vegetation Description

Acacia erubescens - Grewia Thornveld		
Photographic representation		
National Zones:	Sandloop FEPA, C-Plan Critical Biodiverse Area; Waterberg CBA; LC Vegetation Type ; Sweet Limpopo Bushveld	
% Site Coverage	2.26 % - western section	
Condition:	▪ Limited to no alien encroachment ▪ Limited herbacous and grass cover present (even during the mid-summer sampling months)	
CI Species:	▪ *Ammocharis coranica (P)*	
Common species:	▪ *Acacia erubescens* ▪ *Acacia karroo Hayne* ▪ *Acacia nigrescens Oliv.* ▪ *Acacia tortilis (Forssk.) Hayne subsp. heteracantha (Burch.) Brenan* ▪ *Aristida congesta Roem. & Schult. subsp. barbicollis (Trin. & Rupr.) De Winter* ▪ *Aristida stipitata Hack.* ▪ *Asparagus spp*	▪ *Evolvulus alsinoides (L.)* ▪ *Eragrostis spp* ▪ *Grewia flava.* ▪ *Heliotropium ciliatum Kaplan* ▪ *Hermannia spp* ▪ *Ipomoea bolusiana* ▪ *Kyllinga alba Nees* ▪ *Oxygonum dregeanum Meisn.* ▪ *Panicum maximum Jacq.* ▪ *Pavonia burchellii* ▪ *Polygala amatymbica Eckl. &*

Acacia erubescens - Grewia Thornveld		
	▪ *Chlorophytum recurvifolium (Baker) C.Archer & Kativu* ▪ *Clerodendrum ternatum Schinz* ▪ *Commelina africana L. var. africana* ▪ *Digitaria eriantha Steud.* ▪ *Eragrostis superba Peyr.*	*Zeyh.* ▪ *Schmidtia pappophoroides Steud.* ▪ *Solanum panduriforme Dr ge er Dunal* ▪ *Stipagrostis uniplumis (Licht.) De Winter var. uniplumis* ▪ *Terminalia sericea Burch. er DC.*
Species Examples:		
	Ammocharis coránica flowers	*Ammocharis coránica* leaves
Current Conservation Status	**Medium**	

* Alien Species; *[1] Category 1 Alien Invasive; P: Protected under the ordinance;

Table 7-6 *Acacia* Mixed Woodland Vegetation Description

Acacia* mixed *woodland	
Photographic representation	 
National Zones:	C-Plan Ecological Support Area; LC Vegetation Type; Sweet Limpopo Bushveld
% Site Coverage	6.59% - eastern and southern region
Condition:	▪ Alien encroachment evident, specifically weedy species such as *Gomphrena* present ▪ Very fragmented habitat ▪ Quicker establishing grass species – dominated by Increaser 2 and sub-climax species
CI Species:	▪ *Sclerocarya birrea (A.Rich.)* (PT)
Common species:	▪ *Acacia erubescens Welw. er Oliv.* ▪ *Acacia karroo Hayne* ▪ *Evolvulus alsinoides (L.) L.* ▪ *Gomphocarpus tomentosus Burch.*

Acacia* mixed *woodland		
	▪ *Acacia mellifera (Vahl) Benth. subsp. detinens (Burch.) Brenan* ▪ *Acacia nigrescens Oliv.* ▪ *Acacia tortilis (Forssk.) Hayne subsp. heteracantha (Burch.) Brenan* ▪ *Aristida congesta Roem. & Schult. subsp. congesta* ▪ *Aristida stipitata Hack.* ▪ *Cenchrus ciliaris L.* ▪ *Chenopodium album L.** ▪ *Combretum apiculatum Sond. subsp. apiculatum* ▪ *Commelina africana L. var. africana* ▪ *Commelina benghalensis L.* ▪ *Conyza bonariensis (L.)Cronquist** ▪ *Dichrostachys cinerea (L.) Wight & Arn. subsp. africana Brenan & Brummitt var. africana* ▪ *Eragrostis superba Peyr.*	*subsp. tomentosus* ▪ *Gomphrena celosioides Mart.** ▪ *Grewia flavescens Juss.* ▪ *Grewia monticola Sond.* ▪ *Ipomoea bolusiana* ▪ *Kyllinga alba Nees* ▪ *Melinis repens (Willd.) Zizka subsp. grandiflora (Hochst.) Zizka* ▪ *Monsonia glauca R.Knuth* ▪ *Panicum maximum Jacq.* ▪ *Pavonia burchellii* ▪ *Peltophorum africanum Sond.* ▪ *Schmidtia pappophoroides Steud.* ▪ *Sclerocarya birrea (A.Rich.) Hochst. subsp. caffra (Sond.) Kokwaro* ▪ *Sida ovata Forssk.* ▪ *Solanum panduriforme Droge er Dunal* ▪ *Stipagrostis uniplumis (Licht.) De Winter var. uniplumis* ▪ *Terminalia sericea Burch. er DC.*
Species Examples:		
	Terminalia sericea	*Justica flava*
Current Conservation Status	**Medium-Low**	

Table 7-7 Transformed Areas

Transformed Areas	
Photographic representation	 
National Zones:	C-Plan Ecological Support Area; LC Vegetation Type; Sweet Limpopo Bushveld
% Site Coverage	46.61% but constantly increasing due to the construction of the ADF and coal stockyard
Condition:	▪ Alien species scattered throughout these areas ▪ Very fragmented habitat ▪ Dominated by Pioneer, Increaser 2 and sub-climax species
CI Species:	▪ *Sclerocarya birrea (A.Rich.)* (PT)
Common species:	▪ *Acacia karroo Hayne* ▪ *Achyranthes aspera* ▪ *Aristida congesta Roem. & Schult. subsp. congesta* ▪ *Cenchrus ciliaris L.* ▪ *Chenopodium album L.* ▪ *Commelina benghalensis L.* ▪ *Conyza bonariensis (L.) Cronquist* ▪ *Dichrostachys cinerea (L.) Wight & Arn. subsp. africana Brenan & Brummitt var. africana* ▪ *Gomphocarpus tomentosus Burch. subsp. tomentosus* ▪ *Gomphrena celosioides Mart.* ▪ *Melinis repens (Willd.) Zizka subsp. grandiflora (Hochst.) Zizka* ▪ *Monsonia glauca R.Knuth* ▪ *Nicotiana glauca* ▪ *Nidorella resedifolia DC. subsp. resedifolia* ▪ *Sida ovata Forssk.* ▪ *Solanum panduriforme Dr*ge er Dunal* ▪ *Urochloa brachyura (Hack.) Stapf* ▪ *Verbesina encelioides* ▪ *Xanthium strumarium L.*
Species Examples:	 *Dactyloctenium aegyptium*  *Monsonia cf angustifolia*
Current Conservation Status	**Low**

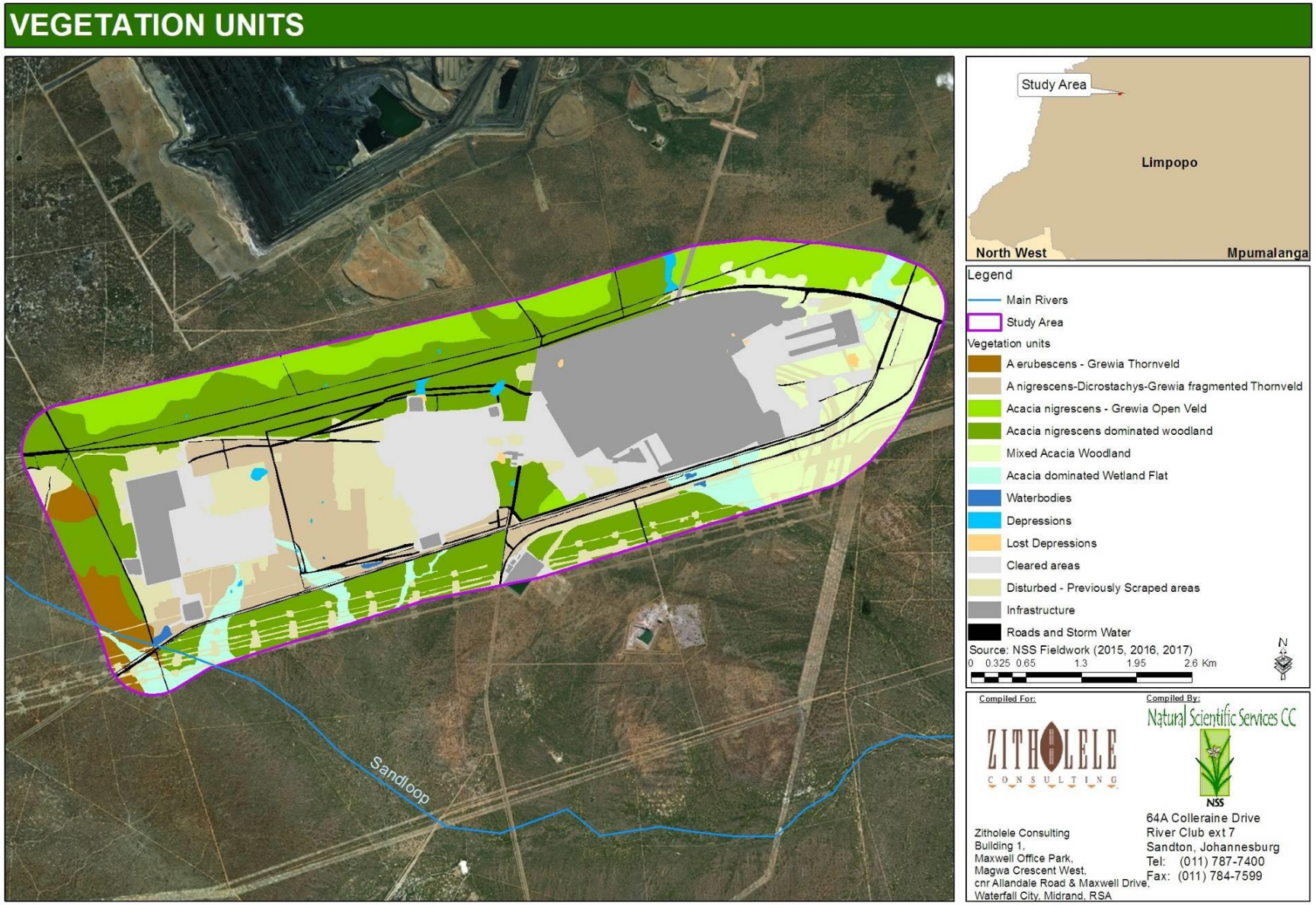


Figure 7-2 Vegetation Units for the study area

7.1.2 *Conservation Important (CI) species*

It is well documented that heterogeneous landscapes, diverse geology and a range of environmental conditions, provide a diverse number of habitats for plant species (Pickett, *et.al*. 1997; O'Farrell, 2006; KNNCS, 1999). These areas are normally associated with high levels of species endemism and richness. For example, at least 74% of the 23 threatened Highveld plant taxa occur on the crests and slopes of ridges and hills (Pfab & Victor 2002). However, homogenous landscapes, either natural or that have been transformed through historical farming practices and infrastructural development contain minimal diversity and endemism. The FDG Study Area is situated in an area that is both natural and modified through soil stockpiling, fragmentation and clearing for construction of the ADF and MPS associated infrastructure. The remaining fragmented natural areas largely consist of *Acacia* woodland habitat that is homogenous in nature.

The Threatened Plant Species Programme (TSP) is an ongoing assessment that revises all threatened plant species assessments made by Craig Hilton-Taylor (1996), using IUCN Red Listing Criteria modified from Davis *et al.* (1986). According to the TSP Red Data list of South African plant taxa (POSA, March 2015), there are 212 Red Data listed species (**Table 7-8**) within Limpopo Province (including Data Deficient species) of which 14 species are Critically Endangered (CR), 17 Endangered (EN) and 40 are Vulnerable (VU).

Table 7-8 Numbers of conservation important plant species per Red Data category within South Africa and Limpopo

Threat Status	South Africa	Limpopo	2327DA
EX (Extinct)	28	0	0
EW (Extinct in the wild)	7	2	0
CR PE (Critically Endangered, Possibly Extinct)	57	2	0
CR (Critically Endangered)	332	14	0
EN (Endangered)	716	17	0
VU (Vulnerable)	1 217	40	0
NT (Near Threatened)	402	21	1
Critically Rare (known to occur only at a single site)	153	5	0
Rare (Limited population but not exposed to any direct or potential threat)	1 212	45	1
Declining (not threatened but processes are causing a continuing decline in the population)	47	19	0
LC (Least Concern)	13 856	3598	287
DDD (Data Deficient - Insufficient Information)	348	13	0
DDT (Data Deficient - Taxonomically Problematic)	904	34	1
Total spp. (including those not evaluated)	**23 399**	**4799**	**311**

**POSA last updated in 2012 – data may be out of date

From the POSA website (QDS 2327DA) and the data supplied by Limpopo for the surrounding farms, 3 CI species have been recorded in the region. The most threatened species recorded within the QDS is the *Eulalia aurea,* which is listed as **Near Threatened**. However, habitat availability for

this species is unlikely. *Corchorus psammophilus* could occur on site based on its habitat requirements. The conservation status of these species and others, their habitat preferences and the possibility of occurring on site has been provided in **Table 8.2** below. Although no Red Listed species were recorded, *Ammocharis coranica* and *Crinum buphanoides* were considered a Protected species under the Nature Conservation Ordinance, 12 of 1983, before Limpopo Province released more recent legislation [which repeals the Ordinance] - Limpopo Environmental Management Act NO. 7 OF 2003, the Protected Status of these species were revised and are no longer on the list.

Government Notice 39433 of 2015 provides the latest List of Protected Tree Species within the borders of South Africa under the NFA. A number of CI Protected Tree species were located during this study. Those found are represented in **Figure 7-3 and Table 7-9.**

- *Boscia albitrunca* (Burch.) Gilg & Gilg-Ben.
- *Sclerocarya birrea* (A.Rich.) Hochst. subsp. caffra (Sond.) Kokwaro
- *Spirostachys africana* Sond.

Boscia albitrunca (Burch.) Gilg & Gilg-Ben and *Sclerocarya birrea* are both Keystone species. Further information on these species and their importance is provided in **Section 9.1.5** below. In terms of Section 15(1) of the *National Forests Act* (NFA; Act 84 of 1998) forest trees or Protected Tree Species may not be cut, disturbed, damaged, destroyed and their products may not be possessed, collected, removed, transported, exported, donated, purchased or sold – except under license granted by the Department of Agriculture, Forestry and Fisheries (DAFF) or a delegated authority.

Table 7-9 Species recorded in the surrounding farms QDG (PRECIS Data)

Family	Species	Threat status	Habitat	LoO
EUPHORBIACEAE	*Acalypha caperonioides Baill. var. caperonioides*	DDT	In grassland, *Brachystegia* woodland and at margins of vleis, typically after grass fires.	Unlikely
POACEAE	*Eulalia aurea (Bory) Kunth*	NT	In water, along rivers and in occasionally inundated soils.	Unlikely
EUPHORBIACEAE	*Euphorbia waterbergensis R.A.Dyer*	Rare	Quartzite ridges and outcrops, mixed bushveld, 900-1100 m.	Unlikely
MALVACEAE	*Corchorus psammophilus Codd*	Threatened	Sandy flats in open *Terminalia sericea* veld.	Possible

NT = Near Threatened; DDT= Data Deficient Taxonomically; P = Protected Limpopo

Spirostachys africana bark

Spirostachys africana leaves

Boscia creating habitat and shade for numerous faunal species

Sclerocarya birrea- Fruit

Figure 7-3 Examples of the CI species located within the study area

7.1.3 *Local Disturbances*

Alien species, especially invasive species, are a major threat to the ecological functioning of natural systems and to the productive use of land. These plants can have the following negative impacts on our natural systems:

- A loss of biodiversity and ecosystem resilience as alien species out-compete indigenous flora and in doing so reduce complex ecosystems to mono-cultures therefore destroying habitats for both plant and animals;
- Through increased evaporative transpiration rates 'alien thickets', reduce the amount of groundwater thus reducing the volume of water entering our river systems;
- Alien invasive species dry out wetlands and riparian areas thereby increasing the potential for erosion in these areas;
- The loss of potentially productive land, and the loss of grazing potential and livestock production;
- Poisoning of humans and livestock;
- An increase in the cost of fire protection and damage in wildfires due to alien invasive stands being denser than natural vegetation and the wood more resinous, creating hotter fires;
- An increased level of erosion, following fires in heavily invaded areas, as well as the siltation of dams.

Two main pieces of legislation are applicable to this section:

- Conservation of Agriculture Resources Act, 1983 (Act No. 43 of 1983) (CARA)
- National Environmental Management: Biodiversity Act, 2004 (Act 10 of 2004) (NEM:BA)
    - NEM:BA Regulations August 2014 -Government Gazette Vol 526, No. 32090

In terms of the amendments to the regulations under CARA, landowners are legally responsible for the control of alien species on their properties. Declared weeds and invasive species had been divided into three categories in accordance with the Act.

These categories are as follows:

Category 1: Declared weeds that are prohibited on any land or water surface in South Africa. These species must be controlled, or eradicated where possible.

Category 2: Declared invader species that are only allowed in demarcated areas under controlled conditions and prohibited within 30m of the 1:50 year flood line of any watercourse or wetland.

Category 3: Declared invader species that may remain, but must be prevented from spreading. No further planting of these species are allowed.

The protection of our natural systems from invasive species is further strengthened within Sections 70-77 of NEMBA. Chapter 5 of this Act specifically deals with Species and

Organisms Posing Potential Threats to Biodiversity. To summarise, the purpose of Chapter 5 is to:

- Prevent the unauthorised introduction and spread of alien species and invasive species to ecosystems and habitats where they do not naturally occur.
- To manage and control alien species and invasive species to prevent or minimise harm to the environment and to biodiversity in particular.
- To eradicate alien species and invasive species from ecosystems and habitats where they may harm such ecosystems or habitats.

Furthermore Section 73 (2) states that a person who is the owner of land on which a listed invasive species occurs must:

- Notify any relevant competent authority, in writing, of the listed invasive species occurring on that land;
- Take steps to control and eradicate the listed invasive species and to prevent it from spreading; and
- Take all the required steps to prevent or minimise negative impacts to biodiversity.

The regulations for this Act were issued for public comment on 3 April 2009 (Government Gazette Vol. 526, No. 32090) and promulgated in August 2014 (Government Gazette Vol. 590, No. 37885). The regulations list the categories for alien and listed invasive species. These are:

- Exempted species.
- **Category 1a** Listed Invasive Species -Species requiring compulsory control.
- **Category 1b** Listed Invasive Species - Invasive species controlled by an invasive species management programme.
- **Category 2** Listed Invasive Species- Invasive species controlled by area (2).
- **Category 3** Listed Invasive Species - Invasive species controlled by activity (3).

An updated set of Invasive Species Lists (as per the NEMBA Regulations) were published on 29 July 2016. This legislation became law on 1 October 2016 and replaced any earlier lists. Note: A species may be listed in different categories for different parts of the country.

According to POSA, over 55 species of Aliens have been recorded within the QDS. Of these 8 species are considered Category 1b species under NEMBA and must be controlled from any property on which they are found (i.e. an invasive species management programme needs to be in place). Patches of natural areas remain within the study area, specifically within the western section and therefore alien species did not completely dominate the landscape. Category 1 species that were identified on site occurred within the soil stockpile areas and included species such as *Nicotiana glauca* and *Xanthium strumarium*. (**Figure 7-4** and **Table 7-10**). These species will need to be controlled by the EO and team as part of MPS's management plan. A list of the main species recorded is supplied in **Table 7-10**.

Table 7-10 Main Alien Invasive Species found within the Study Area

FAMILY	SPECIES	GROWTH FORMS	CARA	NEMBA
AMARANTHACEAE	*Gomphrena celosioides Mart.*	Herb	Weed	Weed
ASTERACEAE	*Conyza cf. bonariensis (L.) Cronquist*	Herb	Weed	Weed
AMARANTHACEAE	*Achyranthes aspera*	Herb	1	
ASTERACEAE	*Xanthium strumarium L.*	Herb	1	1b
ASTERACEAE	*Verbesina encelioides*	Herb/shrub	Weed	Weed
CHENOPODIACEAE	*Chenopodium album L.*	Herb	Weed	Weed
SOLANACEAE	*Nicotiana glauca*	Shrub, tree	1	1b
VERBENACEAE	*Verbena cf bonariensis*	Herb		1b

* Highlights in green represent Category 1 species through either CARA or NEMBA

One species that was prolific in the soil stockpile areas close to the MPS was Golden crownbeard, (*Verbesina encelioides*). This species is part of the Asteraceae family from North America to the tropics and is an annual flowering shrub. As an invasive weed, it grows aggressively in stands within sandy soils, shading out indigenous vegetation, competing for nutrients and water as well as producing chemicals that are toxic to indigenous plants. Flowers produce up to 350 wind dispersed seeds by both cross- and self-pollination and stands self-seed annually. The seeds exhibit highest rate of germination in open, disturbed areas with sandy soils.

Conyza bonariensis

Achyranthes aspera

Nicotiana glauca

Nicotiana glauca in transformed area

Gomphrena celosioides

Verbesina encelioides

Figure 7-4 Evidence of Alien species found within the study area

7.2. Faunal Communities

NSS surveys in and around the FGD study area yielded 43 mammal, 158 birds, 20 reptile, 16 frog, nine butterfly, two dragonfly and one scorpion species, greatly contributing to the overall Medupi inventory. Context for these figures is provided in **Table 7-11** which gives a comparison of the observed species richness, with that expected at both local and regional scales**.** From **Table 7-11** it is evident that remaining natural and semi-natural areas in and around Medupi support a considerable proportion of the region's faunal diversity. Lists of potentially occurring faunal species are provided in **Appendices 2-9,** and the bat call data are presented in **Appendix 9**. Examples of some of the observed species are shown in **Figure 7-6** to **Figure 7-11**.

Table 7-11 Summary of faunal species richness in the study area as compared to a regional scale

FAUNAL GROUP	SPECIES RICHNESS						
	POTENTIAL			OBSERVED			
	REGION[1]	QDS[2]	MEDUPI[3]	BEC (2006)	FGD	MEDUPI	VICINITY[4]
Mammals	124	41	89	18	43	47	54
Birds	345	314	304	67	158	183	211
Reptiles	96	83	47	7	20	20	46
Frogs	27	22	20	8	16	19	14
Butterflies	176	149	88	3	9	26	15
Dragonflies & Damselflies	66	66	48	0	2	3	1
Scorpions	11	11	11	0	1	1	2
Megalomorph Spiders	4	4	2	0	0	0	1

KEY

[1]Species recorded during atlas projects within the four regional QDSs 2327CB, 2327DA, 2327CD & 2327DC

[2]Species that have been recorded during atlas projects within the QDS 2327DA wherein Medupi is situated

[3]Species that are likely to occur (LoO of 2 or 3) in Medupi

[4]Species recorded during NSS studies in the vicinity: Grootegeluk and Limpopo West Mines, Mafutha Project and Matimba Power Station

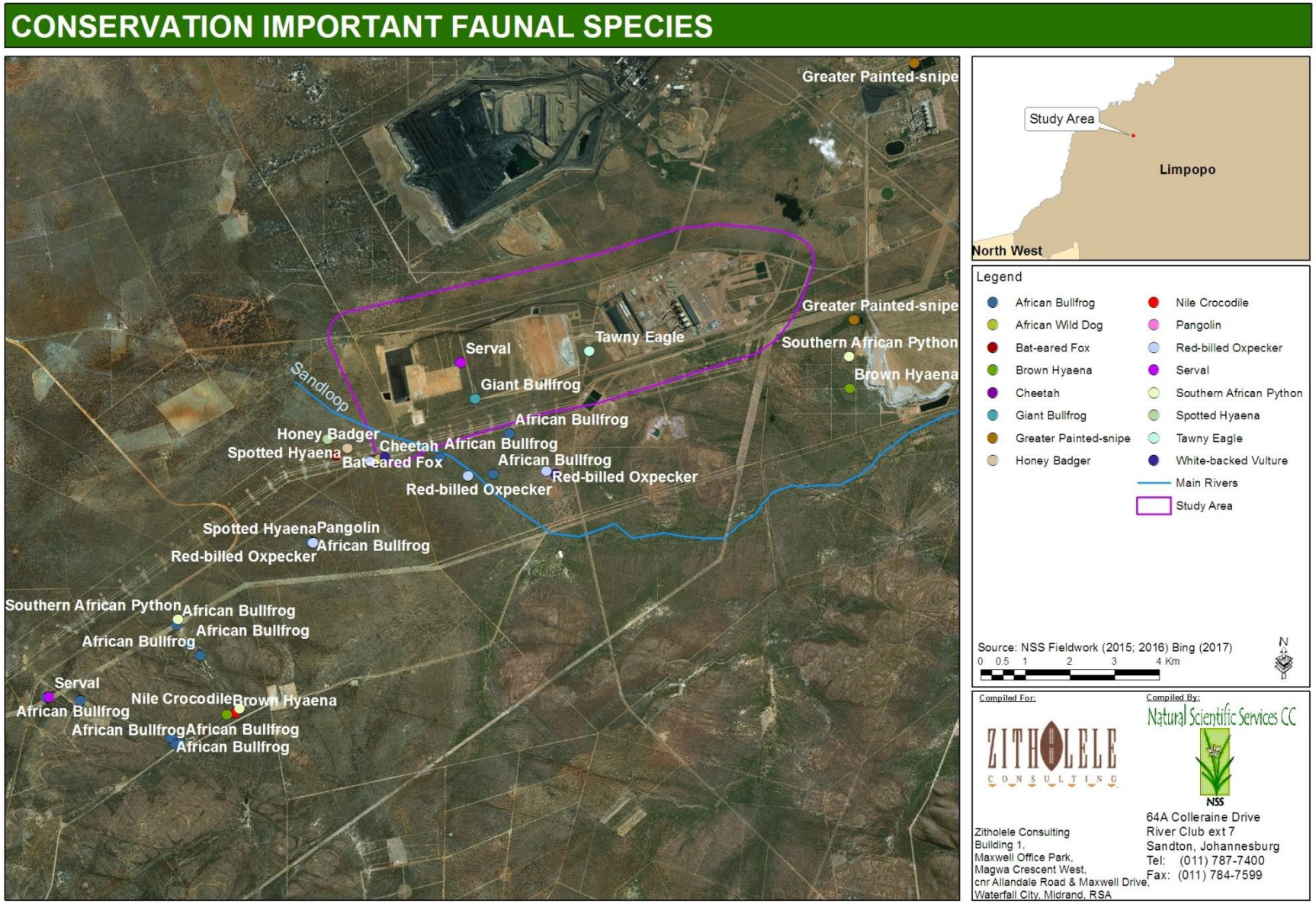


Figure 7-5 Localities of Conservation Important Fauna

Notable faunal observations in and around the FGD study area included Serval (**NT**), Brown Hyaena (**NT**), White-backed Vulture (**EN**), Tawny Eagle (**VU**) and Red-billed Oxpecker (**NT**), African Bullfrog (**PS**) and Giant Bullfrog (**NT**), and also an out of range observation of Sanderling (nearest SABAP 2 record 190km east near Polokwane), and a 300km westwards range extension on Green House Bat (*Scotophilus viridis*) based on recorded bat call data.

Local farmers reported the presence Leopard (**VU**), Cheetah (**VU**), African Wild Dog (**EN**), Spotted Hyaena (**NT**) and Pangolin (**VU**) as well as Southern African Python (**PS**) and Nile Crocodile (**EN**, now absent). African Bullfrogs were found to be particularly abundant in the more natural areas in and near the southern section of Medupi, where there are a number of breeding sites for this species. As both bullfrog species appear to utilize the same type of breeding habitat (Du Preez & Carruthers, 2009), this area and its pans might also provide suitable breeding habitat for Giant Bullfrog. However, only a dam along the southern boundary of the ADF yielded potential signs of this species in the form of a single froglet.

7.2.1 *Mammals*

Of the approximately 124 regionally-occurring mammal species some 89 species (with a LoO of 1, 2 or 3 in **Appendix 2**) are considered likely to occur, based on the species' known distributions and the diversity of available habitats where natural and semi-natural areas remain in and around the southern section of Medupi. MammalMap (2018) has records for 41 species from the four regional QDSs. To date a total of 43 mammal species (36 observed, seven anecdotal) has been recorded in the FGD study area (47 species for the greater Medupi premises). On a regional scale 18 Conservation Important (CI) mammal species occur naturally (i.e. excluding managed game species). Of these, eight are likely to occur in the study area, one of which was recorded on site, i.e. Serval (**NT**; **Figure 7-5)**.

The sandy substrates of the Limpopo Sweet Bushveld provide suitable habitat for the **VU** Pangolin and a host of CI carnivores. Observed species included Serval (**NT**) on the ADF site and Brown Hyaena (**NT**) further to the south-west. Local farmers reported the presence of illusive species such as Leopard (**VU**), Cheetah (**VU**), Spotted Hyaena (**NT**; captured on NSS motion camera but image is poor quality), Pangolin (**VU**) and African Wild Dog (**EN**). These are wide ranging, free-roaming species whose persistence in the region is threatened by persecution and structures that fragment their habitat and restrict their movement such as fences (electric and Bonnox), roads and mines. Other carnivore species which may occur include Black-footed Cat (**VU**), African Weasel (**NT**), Honey Badger (**PS**) and Cape Fox (**PS**).

Serval
(*Leptailurus serval*)

Caracal
(*Caracal caracal*)

Black-backed Jackal
(*Canis mesomelas*)

Black-backed Jackal with prey

African Civet
(*Civettictis civetta*)

Aardwolf
(*Proteles cristatus*)

Slender Mongoose
(*Galerella sanguinea*)

Warthog
(*Phacochoerus africanus*)

Giraffe
(*Giraffa camelopardalis*)

Plains Zebra
(*Equus quagga*)

Blue Wildebeest
(*Connochaetes taurinus*)

Kudu
(*Tragelaphus strepsiceros*)

Waterbuck
(*Kobus ellipsiprymnus*)

Impala
(*Aepyceros melampus*)

Common Duiker
(*Sylvicapra grimmia*)

Grey Rhebok
(*Pelea capreolus*)

Gemsbok
(*Oryx gazelle*)

Tree Squirrel
(*Paraxerus cepapi*)

Chacma Baboon
(*Papio ursinus*)

Aardvark
(*Orycteropus afer*)

Figure 7-6 Examples of some of the mammal species detected in the study area

Juliana's Golden Mole (**EN**), which has a very small and fragmented distribution, mainly between Pretoria and Polokwane, is considered highly unlikely to occur in Medupi. Three elephant shrew species may occur sympatrically in the area, but can be distinguished by habitat preference and size. Rock Elephant-shrew is restricted to rocky substrates, whereas the Bushveld (length 24 cm; mass 50 g) and Short-snouted (length 21 cm; mass 44 g) elephant-shrews occur in sandy substrates (Stuart & Stuart, 2007). Other insectivores that may occur in sandy habitats include the Reddish-grey and Lesser musk shrews, as well as Southern African Hedgehog (**NT**).

Table 7-12 Present and potentially occurring CI mammal species

ORDER & SPECIES	COMMON NAME	CONSERVATION STATUS			LoO IN FGD[1,3,5,6]	MEDUPI*	VICINITY**	ATLAS[6]
		GLOBAL RED LIST[1]	S.A. RED LIST[2,3]	S.A. TOPS LIST[4]				
AFROSORICIDA (Golden moles)								
Neamblysomus julianae	Juliana's Golden Mole	**EN (U)**	**EN**	**VU**	4			
EULIPOTYPHLA (Hedgehogs & shrews)								
Atelerix frontalis	Southern African Hedgehog	LC (S)	**NT**	**PS**	3			
CHIROPTERA (Bats)								
Cloeotis percivali	Percival's Short-eared Trident Bat	LC (U)	**EN**	**-**	4			
PHOLIDOTA (Pangolin)								
Manis temminckii	Pangolin	**VU (D)**	**VU**	**VU**	4	x		x
RODENTIA (Rodents)								
Dasymys incomtus	Water Rat	LC (U)	**NT**	**-**	4			
CARNIVORA (Carnivores)								
Crocuta crocuta	Spotted Hyaena	LC (D)	**NT**	**PS**	4			
Hyaena brunnea	Brown hyaena	**NT (S)**	**NT**	**PS**	3	x	x	x
Acinonyx jubatus	Cheetah	**VU (D)**	**VU**	**VU**	4	x		x
Panthera pardus	Leopard	**VU (D)**	**VU**	**VU**	3	x	x	x
Panthera leo	Lion	**VU (D)**	**VU**	**VU**	5			
Felis nigripes	Black-footed Cat	**VU (D)**	**VU**	**PS**	4			
Leptailurus serval	Serval	LC (S)	**NT**	**PS**	1	x		
Lycaon pictus	African Wild Dog	**EN (D)**	**EN**	**EN**	4	x		
Vulpes chama	Cape Fox	LC (S)	LC	**PS**	3			
Mellivora capensis	Honey Badger	LC (D)	LC	**PS**	3			x
Poecilogale albinucha	African Weasel	LC (U)	**NT**	**-**	2			
PROBOSCIDEA (Elephant)								
Loxodonta africana	African Elephant	**VU (I)**	LC	**PS**	5			
PERISSODACTYLA (Zebras)								
Ceratotherium simum	White Rhinoceros	**NT (I)**	**NT**	**PS**	5	x	x	
Diceros bicornis	Black Rhinoceros	**CR (I)**	**EN**	**EN**	5			
RUMINATA (Even-toed ungulates)								
Connochaetes gnou	Black Wildebeest	LC (I)	LC	**PS**	5			
Damaliscus lunatus	Tsessebe	LC (D)	**VU**	**EN**	5	x	x	
Hippotragus equinus	Roan	LC (D)	**EN**	**VU**	5			
Hippotragus niger	Sable	LC (S)	**VU**	**-**	5		x	
Redunca arundinum	Reedbuck	LC (S)	LC	**PS**	4			x
Redunca fulvorufula	Mountain Reedbuck	**EN (D)**	**EN**	**-**	4		x	

ORDER & SPECIES	COMMON NAME	CONSERVATION STATUS			LoO IN FGD[1,3,5,6]	MEDUPI*	VICINITY**	ATLAS[6]
		GLOBAL RED LIST[1]	S.A. RED LIST[2,3]	S.A. TOPS LIST[4]				
Pelea capreolus	Grey Rhebok	NT (D)	NT	-	2		x	
Ourebia ourebi	Oribi	LC (D)	EN	EN	5			
Key								
Status: CR = Critically Endangered; D = Declining; EN = Endangered; I = Increasing; LC = Least Concern; NT = Near Threatened; PS = Protected Species; S = Stable; U = Unknown; VU = Vulnerable								
Likelihood of Occurrence (LoO): 1 = Present; 2 = High; 3 = Moderate; 4 = Low; 5 = May occur as a managed population								
Sources: [1]IUCN (2017.3); [2]SANBI & EWT (unpubl.); [3]Monadjem *et al.* (2010); [4]ToPS List (2015); [5]Friedmann & Daly (2004); [6]MammalMap (2018)								
*Includes records from BEC (2006) and other NSS projects at Medupi								
**Combined records from NSS studies at Grootegeluk and Limpopo West Mines, Mafutha Project and Matimba Power Station								

Hedgehogs inhabit a diversity of habitats in the temperate to semi-arid interior of South Africa where there is thick, dry vegetation cover suitable for nesting, and an abundance of insects and other food items (Skinner & Chimimba 2005; Stuart & Stuart 2007). Although widespread, hedgehogs are nowhere common. Rupicolous fauna (e.g. Jameson's Red Rock Rabbit, Klipspringer, Rock Dassie) are largely precluded from Medupi by a lack of significant rocky outcrops. However, a distinct stony/rocky substrate south-west of Medupi may provide habitat for Rock Elephant-shrew and Namaqua Rock Mouse.

More or less heavily fenced game areas immediately south and south-west of Medupi support at least nine of the 22 regionally occurring large game species. These include Plains Zebra, Giraffe, Nyala, Blue Wildebeest, Red Hartebeest, Blesbok, Waterbuck, Eland and Gemsbok. The **NT** Grey Rhebok was seen just south of Medupi. Multiple fences along boundaries likely prevent access of larger species such as most carnivores, ungulates, Aardvark and Pangolin. Chacma Baboon (*Papio ursinus*) were observed jumping fences without much difficulty to drink at a water trough and as such it is likely that other primates such as Vervet Monkey and Lesser Galago are also present.

Analysis of bat acoustic data suggests the presence of Cape Serotine and Green House Bat. The latter species record may represent a 300km westwards range extension, although its presence cannot be conclusively supported without an actual capture. Monadjem *et al.* (2010), however, do highlight that the species is likely under sampled and probably occupies a broader range than currently known.

Several other bat species certainly occur in the study area but most likely comprise species that do not require specialised subterranean roosting habitat, such as Mauritian Tomb Bat (*Taphozous mauritianus*), Egyptian Free-tailed Bat (*Tadarida aegyptiaca*), Rusty Pipistrelle (*Pipistrellus rusticus*), Yellow-bellied House Bat (*Scotophilus dinganii*) and Midas Free-tailed Bat (*Mops midas*). The Rusty Pipistrelle has been recorded by NSS in the nearby vicinity (Grootegeluk Mine 2009-2010). It frequents savanna woodland where it roosts in rock

crevices and under tree bark (Stuart & Stuart, 2007). Smither's, Geoffroy's, Darling's and Bushveld horseshoe bats may occur based on distribution. However, their preferred roosting habitat in the form of subterranean caves or mine shafts is distinctly lacking (although it should be noted that all of these species have, occasionally, been known to roost in trees or buildings and as such their presence in Medupi, albeit low, cannot be ruled out). Little is known regarding the ecology of the Botswana Long-eared Bat (*Laephotis botswanae*) which may occur.

7.2.2 *Birds*

Of the approximately 345 regionally-occurring bird species some 304 species (with a LoO of 1, 2 or 3 in **Appendix 3**) are considered likely to occur, based on the species' known distributions and the diversity of available habitats within the FGD study area and greater Medupi. A total of 314 species was recorded in QDSs 2327CB and 2327DA and pentads 2340_2730 and 2340_2725 covering the study area during the SABAP1 (310 spp.) and 2 (218 spp.), respectively.

To date, NSS has detected 158 bird species in and near the FGD study area (183 from all studies for the greater Medupi). Of the 20 regionally occurring CI bird species, eight are likely to occur within the study area (**Table 7-14**), two of which were found to be present namely White-backed Vulture (**EN**) and Tawny Eagle (**EN**).

A single White-backed Vulture (**EN**) was observed flying high near the southern boundary of Medupi. A key aspect in designation of the area south of Medupi as a CBA1 in the Limpopo C-Plan is said to be its importance with regards to this species (LEDET pers. comm.). White-backed Vultures are generally associated with dry woodland and tall trees, which they are dependent upon for breeding. Although no nests were detected within the boundaries of Medupi, trees suitable for nesting (in terms of height, structure and species) do occur to the south and south-west. The species constructs large stick nests at the tops of tall trees (>5 m) particularly *Terminalia prunoides*, *Acacia nigrescens*, *Boscia albitrunca* and *B. foetida*, normally nesting in small colonies of two to six pairs. The total population of White-backed Vulture is estimated at less than 10 000 individuals and is in decline. The greatest threats include a loss of habitat and decreased food availability. Collision, electrocution, poisoning and drowning also threaten this species (Barnes, 2000).

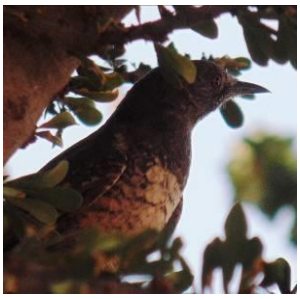
Tawny Eagle (**EN**) was observed where the ADF is located. The species inhabits mostly wooded to lightly wooded areas but is generally scarce outside of major reserves. This once widespread raptor has suffered major range contractions having lost as much as 20% of its regional population in recent years. Currently there are probably less than 800 pairs in South Africa making it one of the most threatened eagles in the country. The fact that this species may occasionally scavenge makes it particularly susceptible to poisoning. Additionally, the species suffers from persecution mainly through shooting and gin traps but drowning in sheer-walled water reservoirs accounts for many deaths too. Other threats include collision

and electrocution with transmission lines, roadkill and reduction in prey base due to habitat transformation (Barnes, 2000).

Although no longer Red Listed (Taylor *et al.* 2015), it is still worth mentioning that Red-billed Oxpeckers were observed to the south and south-west of Medupi. Although formerly widespread these birds suffered local population declines particularly in the Eastern Cape and Pilanesberg National Park as a result of hunting of game and the use of arsenic-based 'purple label' cattle dips which poison both ticks and oxpeckers. More recent ongoing re-introductions and the use of oxpecker-friendly green-label dips, together with the oxpecker's adaptability to feed on domestic livestock, are bringing them back from localised extinctions (Barnes, 2000).

Other potentially occurring avifaunal CI species recorded during NSS studies in the vicinity include the **EN** Cape and Lappet-faced Vultures (motion camera at carcass, Mafutha Project, pentad 2340_2705, farm Geelbuilt), the **VU** Greater Painted-snipe (nomadic, locally scarce species with a highly fragmented population; detected twice at Matimba Power Station during summer, pentads 2335_2735 and 2340_2735), the **NT** Kori Bustard (uncommon resident especially outside reserves; motion camera, Mafutha Project, pentad 2340_2705, farm Geelbuilt), **NT** European Roller (nonbreeding Palaearctic migrant; Mafutha Project 2340_2720) and **NT** Short-clawed Lark (uncommon resident; Mafutha Project, pentad 2340_2705, farm Geelbuilt).

European Bee-eater
(*Merops apiaster*)



Barred Wren-warbler
(*Calamonastes fasciolatus*)

Pied Crow
(Corvus albus)

Brown-hooded Kingfisher
(*Halcyon albiventris*)

Red-billed Oxpecker
(*Buphagus erythrorhynchus*)

Rufous-cheeked Nightjar
(*Caprimulgus rufigena*)

Swainson's Spurfowl
(*Francolinus swainsonii*)

Tawny Eagle
(Aquila rapax)

Pearl-spotted Owlet
(*Glaucidium perlatum*)

Southern Pied-babbler
(*Turdoides bicolor*)

Spotted Eagle-owl
(*Bubo africanus*)

Barn Swallow
(Hirundo rustica)

Figure 7-7 Examples of some of the bird species detected in the study area

Provided in **Figure 7-8** is a comparison of the numbers of bird species with different feeding habits, which are listed for pentads 2340_2725 and 2340_2730 (SABAP 2, 2018), and which have been recorded in Medupi by NSS and BEC (2006). Species were categorized according to a modified version of Newman's (2002) 12 bird categories (**Table 7-13**).

Table 7-13 Newman's (2002) modified bird categories

CATEGORY	DESCRIPTION
1. Ocean birds	Albatrosses, gannets/boobies, gulls, penguins, petrels, prions, shearwaters, skimmer, skuas, subAntartctic birds, terns, & tropic-/frigatebirds.
2. Inland water birds	Pelicans, cormorants, herons, egrets, storks, hamerkop, flamingos, spoonbill, ibises & finfoot.
3. Ducks & wading birds	Ducks, geese, grebes, coot, gallinules, crakes, flufftails, snipes, plovers, lapwings, waders, jacanas, oystercatchers, curlews, avocet & stilts.
4. Large terrestrial birds	Thicknees, pratincoles, coursers, korhaans, bustards, cranes, quail, francolins, spurfowl, buttonquail, guineafowl, ostrich & secretarybird.
5. Raptors	Vultures, kites, eagles, buzzards, sparrowhawks, hawks, harriers, falcons & kestrels.
6. Sandgrouse, doves, etc	Sandgrouse, doves, pigeons, parrots, lovebirds, trogon, turacos & go-away birds (louries), cuckoos & coucals.
7. Owls & nightjars	Owls & nightjars.
8. Aerial feeders, etc	Swallows, martins, swifts, mousebirds, bee-eaters, kingfishers, rollers, hoopoes, hornbills, barbets, woodpeckers, wryneck & honeyguides.
9. Cryptic & elusive insect-eaters	Larks, finchlarks, pipits, wagtails, drongos, black flycatcher, cuckooshrikes, crows, orioles, bulbuls, tits, babblers, thrushes, chats & robins.
10. Regular insect-eaters	Warblers, apalises, titbabblers, eremomelas, carmoropteras, grassbird, cisticolas, prinias, flycatchers, batises, shrikes, boubous, tchagras, helmetshrikes & starlings.
11. Oxpeckers & nectar feeders	Sunbirds, oxpeckers, white-eyes & queleas.
12. Seedeaters	Sparrows, weavers, widow birds, bishops, finches, firefinches, waxbills, manikins, whydahs, canaries, siskins & buntings.

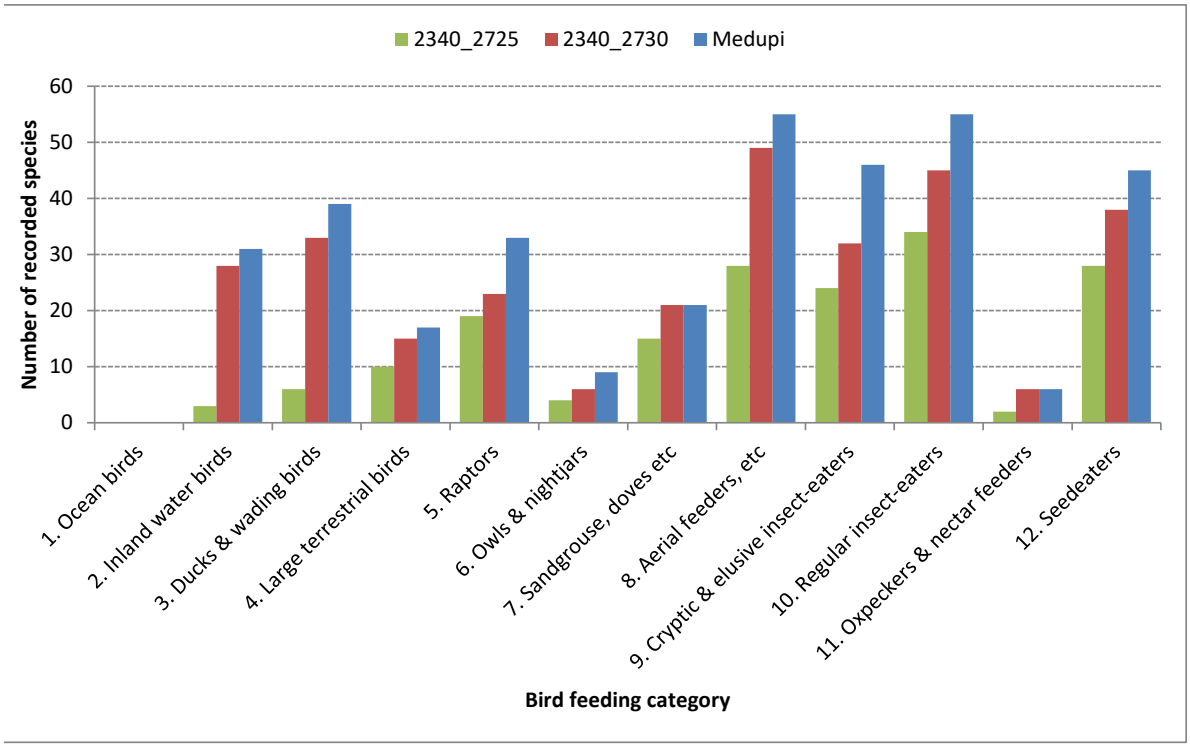


Figure 7-8 Comparison of the number of bird species with different feeding habits, recorded in pentads 2340_2725 and 2340_2730 during the SABAP 2, and in Medupi by NSS

Evidently the pattern of bird diversity recorded in Medupi is similar to that recorded in the region during the SABAP 2. The extensive tracts of relatively undisturbed Limpopo Sweet Bushveld south and south-west of Medupi supports high representations of aerial feeding, regular insect- and seed-eating species. The disproportionately high numbers of waterbird species in Medupi compared to pentad 2340_2725 is attributable to the presence of several large shallow (albeit artificial) waterbodies with extensive wading bird habitat, which is lacking southwards where very few waterbird species were detected.

Table 7-14 Present and potentially occurring CI bird species

CATEGORY & SPECIES	COMMON NAME	CONSERVATION STATUS			LoO IN FGD[3]	MEDUPI*	VICINITY**	ATLAS[3]
		GLOBAL RED LIST[1]	S.A. RED LIST[1]	S.A. TOPS LIST[2]				
2. Inland water birds								
Ciconia nigra	Black Stork	LC (U)	**VU**	-	4	4		x
Leptoptilos crumeniferus	Marabou Stork	LC (I)	**NT**	-	4	4		x
Mycteria ibis	Yellow-billed Stork	LC (D)	**EN**	-	4	4		x
Phoenicopterus roseus	Greater Flamingo	LC (I)	**NT**	-	4	4		x
Phoeniconaias minor	Lesser Flamingo	**NT (D)**	**NT**	-	4	4		x
Glareola nordmanni	Black-winged Pratincole	**NT (D)**	**NT (NB)**	-	4	4		x
3. Ducks & wading birds								
Nettapus auritus	African Pygmy-goose	LC (D)	**VU**	-	4	4		
Oxyura maccoa	Maccoa Duck	**NT (D)**	**NT**	-	4	4		x
Rostratula benghalensis	Greater Painted-snipe	LC (D)	**VU**	-	4	4	x	
4. Large terrestrial birds								

CATEGORY & SPECIES	COMMON NAME	CONSERVATION STATUS			LoO IN FGD[3]	MEDUPI*	VICINITY**	ATLAS[3]
		GLOBAL RED LIST[1]	S.A. RED LIST[1]	S.A. TOPS LIST[2]				
Sagittarius serpentarius	Secretarybird	VU (D)	VU	-	2	3		x
Ardeotis kori	Kori Bustard	NT (D)	NT	PS	4	4	x	
5. Raptors								
Gyps coprotheres	Cape Vulture	VU (D)	EN	EN	2	1	x	x
Gyps africanus	White-backed Vulture	EN (D)	EN	EN	1	1	x	x
Torgos tracheliotos	Lappet-faced Vulture	VU (D)	EN	EN	2	2	x	x
Aquila rapax	Tawny Eagle	LC (S)	EN	EN	1	1	x	x
Polemaetus bellicosus	Martial Eagle	VU (D)	EN	EN	2	2		x
Terathopius ecaudatus	Bateleur	NT (D)	EN	EN	4	4		x
Falco biarmicus	Lanner Falcon	LC (I)	VU	-	2	3		
8. Aerial feeders, etc								
Coracias garrulus	European Roller	NT (D)	NT	-	2	2	x	x
9. Cryptic & elusive insect-eaters								
Certhilauda chuana	Short-clawed Lark	LC (D)	NT	-	4	4	x	
Key								
Status: D = Declining; EN = Endangered; I = Increasing; LC = Least Concern; NB = Non-breeding; NT = Near Threatened; PS = Protected Species; S = Stable; U = Unknown population trend; VU = Vulnerable								
Likelihood of Occurrence (LoO): 1 = Present; 2 = High; 3 = Moderate; 4 = Low								
Sources: [1]Taylor *et al.* (2015); [2]ToPS List (2015); [3]SABAP 1 & 2 (2018)								
*Includes records from BEC (2006) and other NSS projects at Medupi								
**Combined records from NSS studies at Grootegeluk and Limpopo West Mines, Mafutha Project and Matimba Power Station								

7.2.3 *Reptiles*

Of some 96 regionally-occurring reptile species, 50 are considered highly likely to occur (with a LoO of 1 or 2 in **Appendix 4**), based on the species' known distributions and the diversity of available habitats in and around the FGD study area. An additional 33 species may also occur (LoO 3 in **Appendix 4**). Available atlas data include records for 47 species from the four regional QDSs (ReptileMap, 2018; Bates *et al.* 2014). At a more local scale NSS has recorded 46 species in the general vicinity (Grootegeluk and Limpopo West Mines, Mafutha Project and Matimba Power Station). To date, a total of 20 reptile species (15 observed, four anecdotal) have been detected by NSS and / or reported anecdotally within the study area (**Appendix 4** and **Figure 7-9**).

Fossorial species, terrapins and snakes in general, are underrepresented due to the difficulties involved in their detection. Of the two regionally-occurring CI reptile species, only one, the Southern African Python, is likely to occur naturally. The other species is the Nile Crocodile, which apart from occurring in the Limpopo River, is largely restricted to managed populations within reserves in the region (**Table 7-15**). Although no pythons were detected they likely occur throughout the study region and anecdotal reports were numerous, particularly near water to the south-west of Medupi. A large individual was photographed by Mr Gavin Cronk (farm manager) eating a Bushbuck ram at a dam in the south-west (**Figure 7-9**). Although currently listed as Least Concern (LC) these large snakes are classified as **Protected** Species (ToPS, 2015). They are threatened by commercial trade and listed as a

CITES Appendix II species due to high levels of persecution for their skin which is used in the leather industry. A single Nile Crocodile (**EN**) of approximately 1.5m was reportedly observed at a dam also to the south-west of Medupi. The individual was seen approximately eight years ago and has not been seen since.

The local diversity of reptiles is largely comprised of a subset of tortoises, snakes, lizards and geckos that are generally adapted to the soft red sands that characterise the Limpopo Sweet Bushveld. Although a band of rockier substrate is present to the south-west of Medupi, it is probably too small and fragmented to support any of the locally occurring yet strictly rupicolous species such as Waterberg Dragon Lizard (recorded at the base of a small rocky ridge on a neighbouring farm to the west), Wahlberg's Snake-eyed Skink, and Southern Rock Agama.

Large trees, *Boscia* spp. in particular, proved to be important microhabitats for reptiles and frequently yielded Wahlberg's Velvet Gecko, Common Dwarf Gecko, Variable Skink, Southern Rock Monitor and Southern Tree Agama. Two tortoise species were recorded south of Medupi. Leopard Tortoise was the more widespread and ubiquitous of the two, with sightings of Speke's Hinged-back Tortoise[5] being far less frequent and more closely associated with rocky substrates. No Kalahari Tent Tortoises were detected.

Observed venomous species included Puff Adder, Boomslang and Black Mamba, but species such as Vine Snake, Snouted Cobra and various other elapids certainly occur. Some interesting, less frequently encountered species (which may occur but were not detected) include; Serrated Hinged Terrapin, Serrated Tent Tortoise, Jones' Girdled Lizard, Kalahari Dwarf Worm Lizard, Cape Worm Lizard, Bicoloured Quill-snouted Snake, Jalla's Sand Snake, Two-striped Shovel-snout, Common Shield Cobra, Sundevall's Garter Snake, Eastern Tiger Snake, Limpopo Dwarf Burrowing Skink, Common Purple-glossed Snake and Eastern Bark Snake.

c.f. Speke's Hinged-back Tortoise (*Kinixys spekii*)

Leopard Tortoise (*Stigmochelys pardalis*)

Spotted Sand Lizard (*Pedioplanis l. lineoocellata*)

Waterberg Dragon Lizard (*Smaug breyeri*)

[5] Identification tentative due to sympatry with the similar congeneric Lobatse Hinged-back Tortoise.

Southern Tree Agama
(*Acanthocercus a. atricollis*)

Turner's Gecko
(*Chondrodactylus turneri*)

Common Tropical House Gecko
(*Hemidactylus mabouia*)

Common Dwarf Gecko
(*Lygodactylus c. capensis*)

Southern Rock Monitor
(*Varanus albigularis albigularis*)

Puff Adder
(*Bitis arietans arietans*)

Boomslang
(*Dispholidus typus*)

Western yellow-bellied Sand Snake
(*Psammophis subtaeniatus*)

Southern African Python (*Python natalensis*) **Image courtesy of Gavin Cronk**

Figure 7-9 Examples of some of the reptile species detected in the study area

Table 7-15 Present and potentially occurring CI reptile species

FAMILY & SPECIES	COMMON NAME	CONSERVATION STATUS			LoO IN FGD[1,3]	MEDUPI**	VICINITY***	ATLAS[3]
		GLOBAL RED LIST[1]	S.A. RED LIST[1]	S.A. ToPS LIST[2]				
PYTHONIDAE (Python)								
Python natalensis	Southern African Python	-	LC	**PS**	1*	x	x	x
CROCODYLIDAE (Crocodile)								
Crocodylus niloticus	Nile crocodile	LC	**VU**	**PS**	1*	x	x	
Key								
Status: LC = Least Concern; PS = Protected Species; VU = Vulnerable								
Likelihood of Occurrence (LoO): 1 = Present								
Sources: [1]Bates *et al.* (2014); [2]ToPS List (2015); [3]ReptileMap (2018)								
*Anecdotal records only								
**Records from other NSS studies at Medupi								
***Combined records from NSS studies at Grootegeluk and Limpopo West Mines, Mafutha Project and Matimba Power Station								

7.2.4 *Frogs*

Combined NSS surveys at Medupi show that the power station premises support 20 frog species, representing 74% of the regional amphibian diversity. Of the 27 regionally occurring species only Natal Sand Frog and Muller's Platanna are considered unlikely to occur based on their marginal distributions. FrogMap (2018) lists 22 species for the four regional QDSs. In total 16 frog species were detected within the FGD study area (**Appendix 5 and Figure 7-10**). Both of the two regionally occurring CI species, namely African and Giant Bullfrog, were recorded in the FGD study area (**Table 7-16**).

During our December 2015 visit, a high rainfall event (38mm on 8 December 2015) triggered the emergence of exceptionally high densities of winged termites, and subsequently, African Bullfrog and various other frog species appeared en masse. The breeding frenzy that ensued, drastically increased detection rate, and emphasised the exceptional abundance of amphibian species in the study area.

Both Giant and African Bullfrog occur sympatrically in the region, with the latter generally being regarded as the more ubiquitous of the two in warm bushveld regions (Du Preez and Carruthers, 2009). Whereas the Giant Bullfrog has only been recorded once in 2327CB (C. Lotter; V. Kleynhans and N. Kleynhans) and twice in 2327DA (one VMUS record submitted by L. Verburgt and one questionable Minter *et al.* 2004 record), the African Bullfrog has been recorded in all four regional QDSs (Yetman *et al*. 2015). Indeed, African Bullfrog were found to be exceptionally abundant, and likely breed at the majority of the pans / depressions in and around the FGD study area, while in contrast, Giant Bullfrog was only potentially recorded where the ADF is situated at a small (historically natural) pan which has been deepened and widened by excavation.

Plain Grass Frog
(*Ptychadena anchietae*)

Sand Frog
(*Tomopterna* sp.)

Eastern Olive Toad
(*Amietophrynus garmani*)

Mottled Shovel-nosed Frog
(*Hemisus marmoratus*)

Bushveld Rain Frog
(*Breviceps adspersus*

Common Platanna
(*Xenopus laevis*)

Bubbling Kassina
(*Kassina senegalensis*)

Red Toad
(*Schismaderma carens*)

adspersus)

Ornate Frog (*Hildebrandtia ornata*)

Boettger's Caco (*Cacosternum boettgeri*)

Banded Rubber Frog (*Phrynomantis bifasciatus*)

Southern Foam Nest Frog (*Chiromantis xerampelina*)

Giant Bullfrog froglet (*Pyxicephalus adspersus*)

African Bullfrog (*Pyxicephalus edulis*)

African Bullfrog pair in amplexus

African Bullfrog tadpoles

Figure 7-10 Examples of some of the frog species detected in the study area

The Giant Bullfrog observation was of a single froglet (identification tentative based on absence of pale half-moon on tympanum, which is usually indicative of African Bullfrog. Specimen age precluded confirmation by labial tooth row formula or adult colouration and morphology). Species distinction among froglet bullfrogs is notoriously difficult (A. Channing pers. comm.). A recent publication by Yetman and Verburgt (2015) provides the first records of Giant Bullfrog in the Lephalale region and the greater Limpopo Sweet Bushveld. The study highlights that the species is likely more widespread and common in the region than was previously thought, and that low detection levels are likely the result of irregular emergence and breeding only during sufficiently wet summers in this dry region.

Suitable breeding habitat appears to be present for both African and Giant Bullfrogs at multiple locations, but Giant Bullfrog breeding was not detected by NSS due to timing. The presence of both of these large conservation important frog species warrants the commissioning of a specialist bullfrog study to better understand the extent and occurrence of these species in the study area, and to minimise loss of breeding sites and foraging habitat from the construction of the ADF and other infrastructure. Based on this recommendation, Medupi has commissioned NSS to assess the suitability of local wetlands for bullfrog breeding, and the Endangered Wildlife Trust to relocate bullfrogs between wetlands where necessary, in collaboration with NSS.

Table 7-16 Present and potentially occurring CI frog species

FAMILY & SPECIES	COMMON NAME	CONSERVATION STATUS			LoO IN FGD[2,3]	MEDUPI**	VICINITY***	ATLAS[3]
		GLOBAL RED LIST[1]	S.A. RED LIST[2]	S.A. ToPS LIST*				
PYXICEPHALIDAE (African Common Frogs)								
Pyxicephalus edulis	African Bullfrog	LC (U)	LC	**PS***	1	x	x	x
Pyxicephalus adspersus	Giant Bullfrog	LC (D)	**NT**	**PS***	1	x		x
Key								
Status: LC = Least Concern; NT = Near Threatened; PS = Protected Species								
Likelihood of Occurrence (LoO): 1 = Present; 2 = High								
Sources: [1]ToPS List (2007); [2]IUCN (2013.1); [3]Minter *et al.* (2004); [4]Du Preez & Carruthers (2009); [5]FrogMap (2015)								
***Old ToPS (2007) status, newToPS (2015) amphibian status still pending								
**Includes records from other NSS studies at Medupi								
***Combined records from NSS studies at Grootegeluk and Limpopo West Mines, Mafutha Project and Matimba Power Station								

7.2.5 *Terrestrial Macro-invertebrates*

The focus of this component was directed towards invertebrate groups for which there is a workable body of literature, distribution data and species conservation statuses namely butterflies, dragonflies and damselflies, baboon spiders and scorpions. Some examples of the macro-invertebrates observed in the FGD study area are presented in **Figure 7-11**.

A list of the approximately 176 regionally occurring and observed butterfly species is provided in **Appendix 6**. Atlas records from the ADU's LepiMap (2018) list 88 species for the QDS covering the study area. Nine butterfly species were recorded in the study area bringing the list for the greater Medupi premises to 26 species representing 15% of the regional diversity. Clearly there is considerable scope for detection of other species with blues, tips and acraeas being particularly under-represented.

Barbet Percher (*Diplacodes luminans*) male

Barbet Percher female

Banded Groundling (*Brachythemis leucosticte*)

Natal Browns (*Coenyropsis natalii*)

Large Striped Swordtail (*Graphium antheus*)

Solifuge (order: Solifugae)

Opistacanthus asper under UV light

Opistacanthus asper

Giant Longhorn
(*Tithoes confinis*)

Figure 7-11 Examples of some of the invertebrate species detected in the study area

Distribution data for dragonflies and damselflies provided in Samways (2008) suggests that some 66 odonata species have the potential to occur in the region **Appendix 7**. However, the vast majority of these species are likely precluded by the absence of significant rivers and lakes with suitable substrate and vegetation. As such, only a subset of just less than 50 species that are frequently found away from water and / or require only temporarily inundated areas are considered highly likely to occur (see **Appendix 7**). Of the seven regionally occurring CI species[6] only five, namely the Sudan Sprite, Little Wisp, Black Emperor, Strong Skimmer and Silhouette Dropwing are considered more or less likely to occur in the FGD study area (**Table 7-17**). The Makabusi Sprite (**VU**) and Spined Fairytail (**NT**) are likely precluded by a lack of sluggish perennial rivers in the study area. The greater diversity of wetland habitat immediately south of Medupi is expected to support the greatest diversity of odonata. Three dragonfly species were identified during the NSS site visit namely Banded Groundling, Green Hooktail and Barbet Percher.

Table 7-17 Present and potentially occurring CI terrestrial macro-invertebrate species

SPECIES	COMMON NAME	STATUS	LoO IN FGD	MEDUPI	VICINITY
Dragonflies					
Chlorolestes fasciatus	Mountain Malachite	-	4		
Chlorolestes tessellatus	Forest Malachite	-	4		
Pseudagrion makabusiense	Makabusi Sprite	**VU**	4		
Pseudagrion sudanicum	Sudan Sprite	LC	3		
Agriocnemis exilis	Little Wisp	-	3		
Anax tristis	Black Emperor	-	3		
Lestinogomphus angustus	Spined Fairytail	**NT**	4		
Orthetrum stemmale	Strong Skimmer	-	3		
Trithemis donaldsoni	Denim Dropwing	-	4		
Trithemis hecate	Silhouette Dropwing	-	3		

[6] Red listed species or those species with a Dragonfly Biotic Index score of 4 or higher are considered here to be of conservation importance.

SPECIES	COMMON NAME	STATUS	LoO IN FGD	MEDUPI	VICINITY
Beetles					
Manticora spp.	Monster Tiger Beetles	**PS****	2		
Scorpions					
Opistacanthus asper	Creeping scorpions	**PS****	1	x	
Hadogenes troglodytes	Flat rock scorpions	**PS****	4		
Opistophthalmus glabifrons	Burrowing scorpions	**PS****	3		
Opistophthalmus carinatus	Burrowing scorpions	**PS****	3		
Opistophthalmus whalbergii	Burrowing scorpions	**PS****	3		x
Spiders					
Ceratogyrus bechuanicus	Starbust Horned Baboon Spider	**PS****	3		
Ceratogyrus brachycephalus	Rhino Horned Baboon Spider	**PS****	3		
Pterinochilus junodi	Soutpansberg Starburst Baboon Spider	**PS****	4		
Pterinochilus pluridentatus	-	**PS****	4		
Harpactira sp.	Common Baboon Spiders	**PS****	3		x
Key					
Status: LC = Least Concern; NT = Near-threatened; PS = Protected Species; VU = Vulnerable					
Likelihood of Occurrence (LoO): 1 = Present; 2 = High; 3 = Moderate; 4 = Low					
Sources: BEC (2006); Samways (2006); ToPS (2007); Leeming (2003); Dippenaar-Schoeman (2002); Mecenero *et al.* (2013)					
*Combined records from NSS studies at Grootegeluk and Limpopo West Mines, Mafutha Project and Matimba Power Station					
**Old ToPS (2007) status					

The distribution ranges of 11 scorpion species (**Appendix 8**) overlap Medupi and its immediate surrounds (Leeming, 2003). Under the old (2007) ToPS list, five of these species were classified as **Protected** species (one *Hadogenes,* three *Opistophthalmus* and one *Opistacanthus* species; **Table 7-17**). However, the latest (2015) ToPS list no longer recognises these species as **Protected**. The lack of rocky substrates in the FGD study area precludes *Hadogenes troglodytes* and potentially *Parabuthus transvaalicus and P. mossambicensis*. During our surveys only one species namely *Opistacanthus asper* was detected.

Dippenaar-Schoeman (2002) lists four baboon spiders for Limpopo Province namely *Ceratogyrus bechuanicus*, *C. brachycephalus*, *Pterinochilus junodi* and *P. pluridentatus* but *Harpactira* sp. may also occur. Of these, only the horned baboon spiders *Ceratogyrus bechuanicus* and *C. brachycephalus* and common baboon spiders of the genus *Harpactira* are likely to occur in the FGD area (**Table 7-17**). No baboon spiders were detected (**Appendix 9**). As with the scorpions none of these are now recognised as **Protected** species in the latest (2015) ToPS list. However the Limpopo Environmental Management Act (Act No 7 of 2003) still lists baboon spiders of the genera *Ceratogyrus*, *Harpactira* and *Pterinochilus* as requiring permits for capture, hunting or trade.

7.3. Watercourses, Wetlands and Ephemeral Systems

The Study area (**Figure 3-1**) is situated on a watershed and comprises both northwards and southwards draining systems. The hot semi-arid plains of the Limpopo Sweet Bushveld covering the study area are characterised by a series of ephemeral pans and drainage features, which we have termed Semi-Ephemeral Washes (SEWs). The southern boundary of the study area is intruded by a series of these SEWs, which all form part of a greater alluvial fan draining into the Sandloop.

The upper reaches of this system diagonally bisects the south western corner of the study area and is classified as a FEPA in recognition of its reference site suitability as an upper foothill ephemeral system that is still in a largely natural state. Results of the wetland assessment are summarised in **Table 7-18 –**
Table 7-22. The sampling points and the delineated wetlands are depicted in **Figure 7-12.** A DEM derived catchment model and channel analysis produced by NSS overlayed with the 1:100 year floodline produced by Zitholele (2016) is shown in **Figure 7-14**. Additionally **Figure 7-15** depicts the soils as classified by ESS (2015).

Four HGM units were identified, which include two south–east and one north–east draining Washes (SEW 1 – 3), and multiple inward-draining depressions (D1). In addition, two excavated areas were encountered on site (**Figure 7-17**). It should be noted that portions of the SEW 1 HGM unit forms part of the Sandloop FEPA system. As a consequence, a large portion of the HGM unit is classified as being of Highest Biodiversity Importance and Risk for Mining according to the SANBI Mining and Biodiversity Guidelines. Within these areas the MBG stipulates a 1km buffer on all FEPA listed systems. The same is true for the FEPA guidelines which state that a 1km buffer is required.

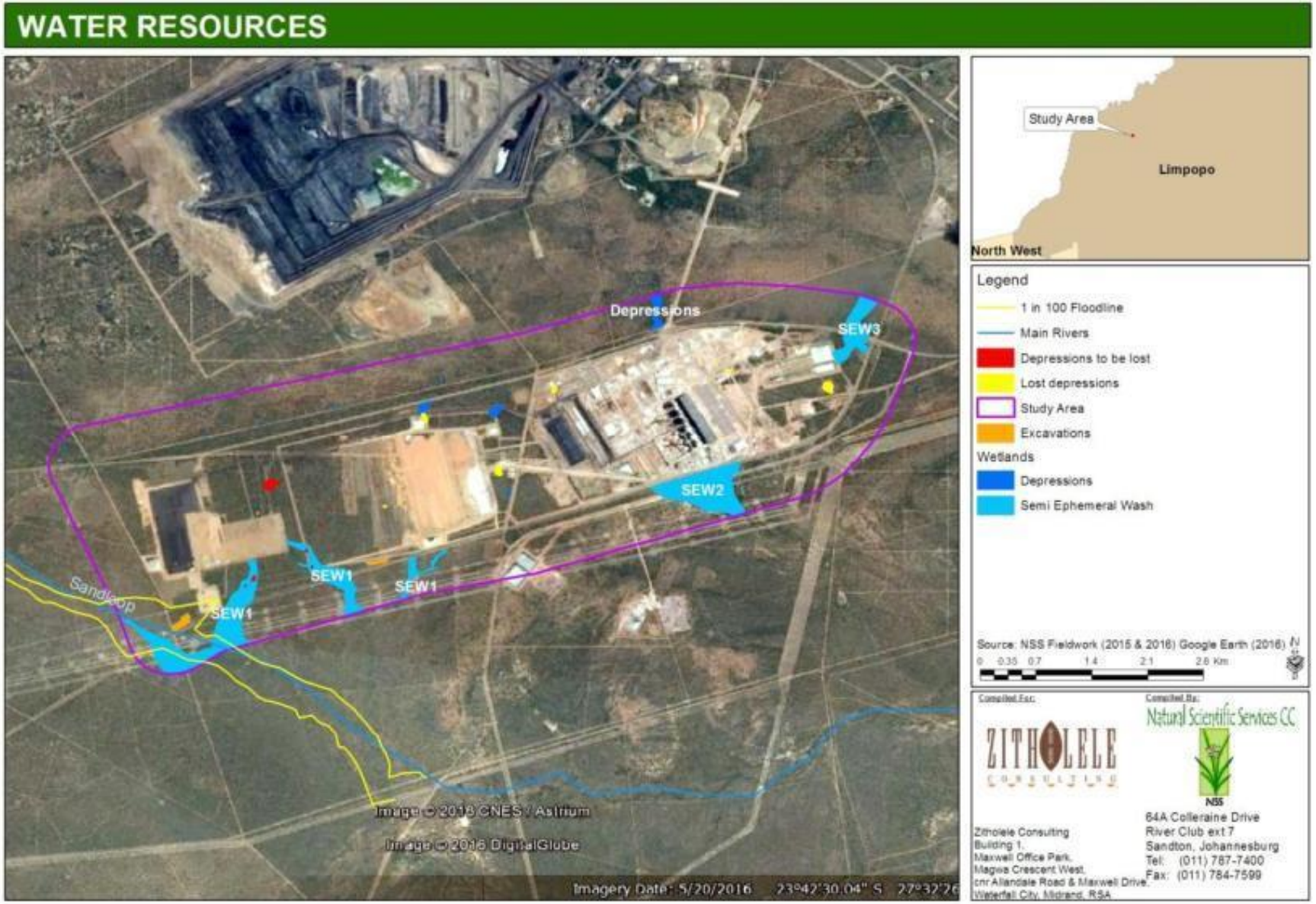


Figure 7-12 Wetland extent

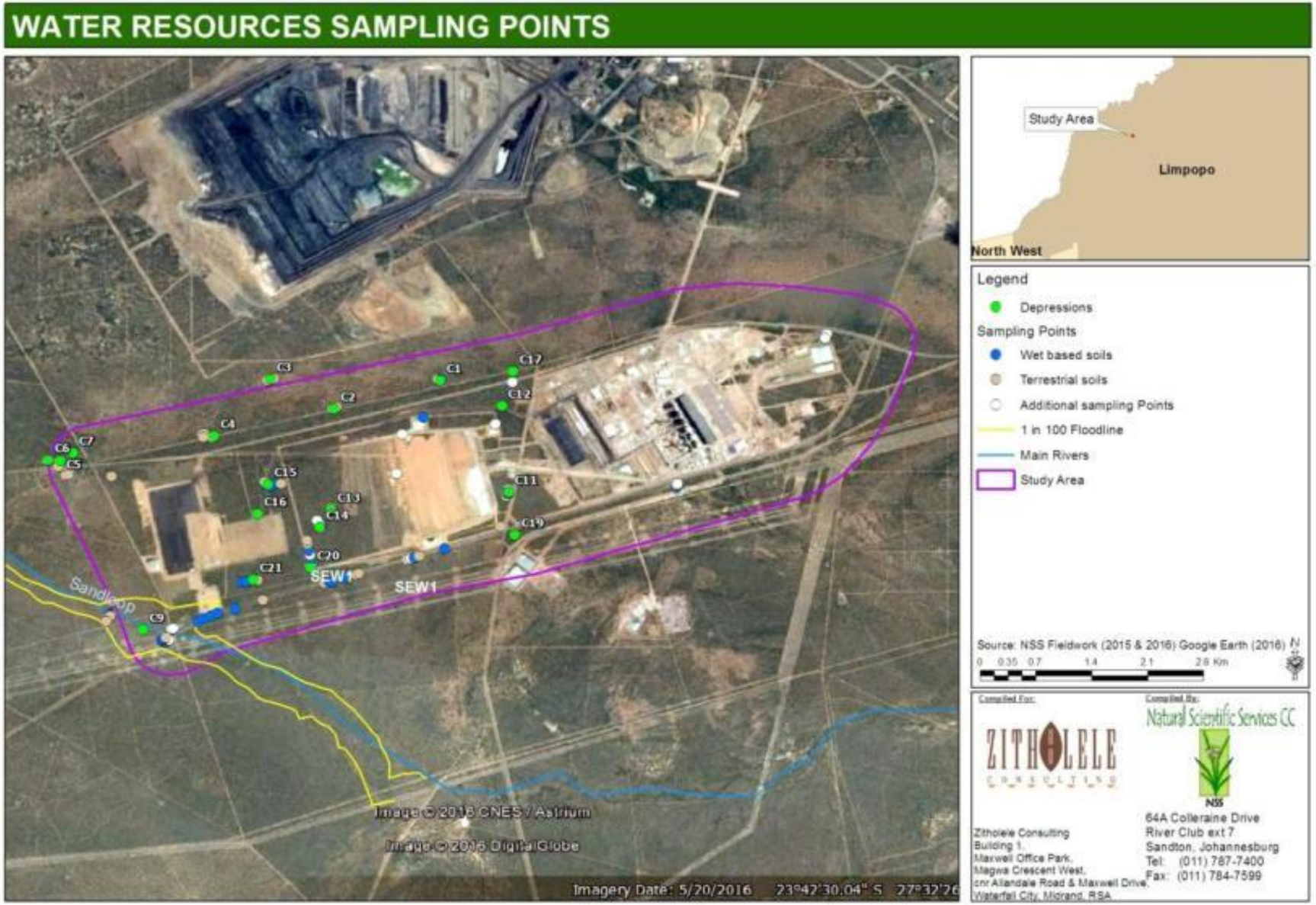
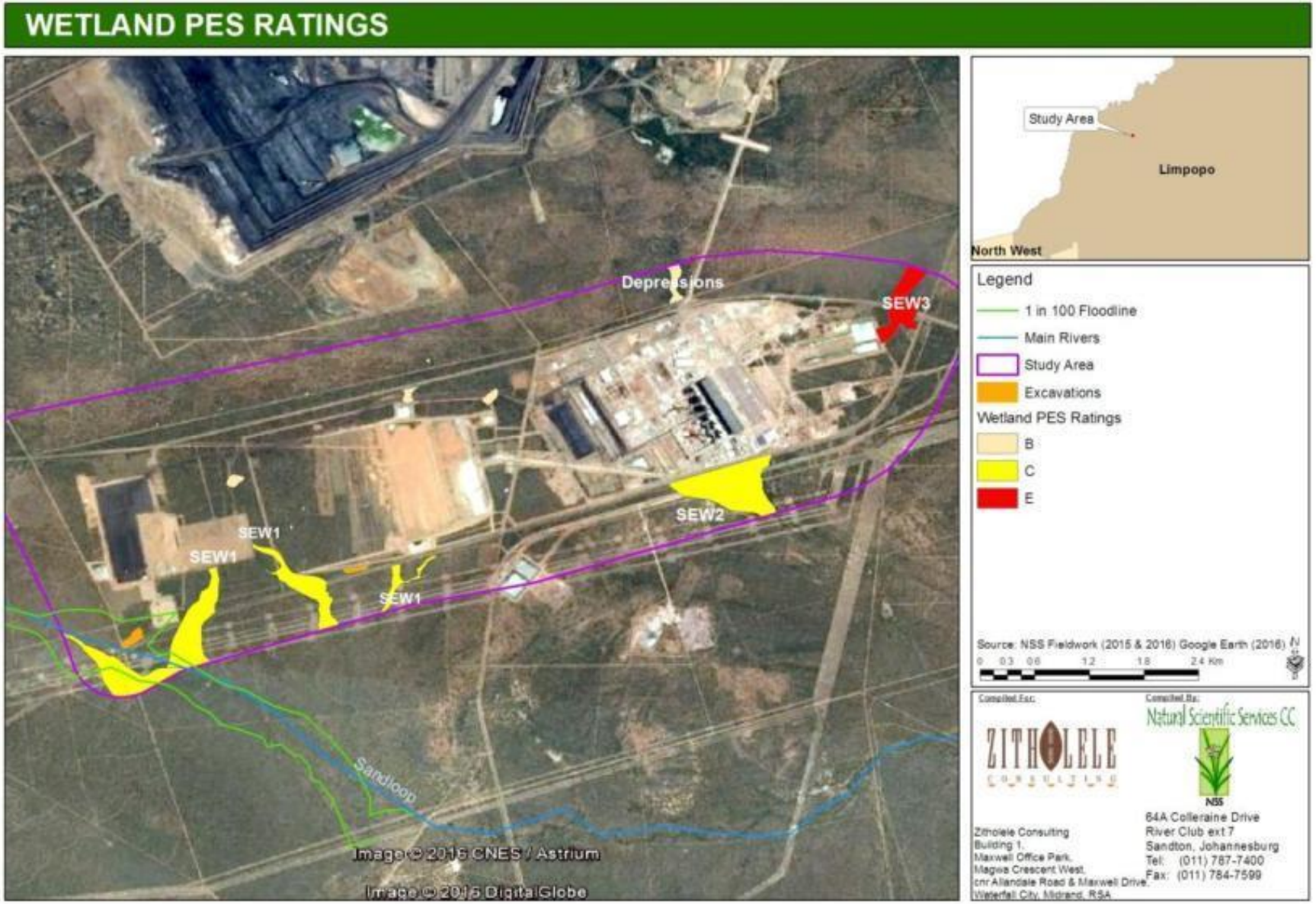


Figure 7-13 Wetland sampling points



Wetland HGM unit overall PES ratings

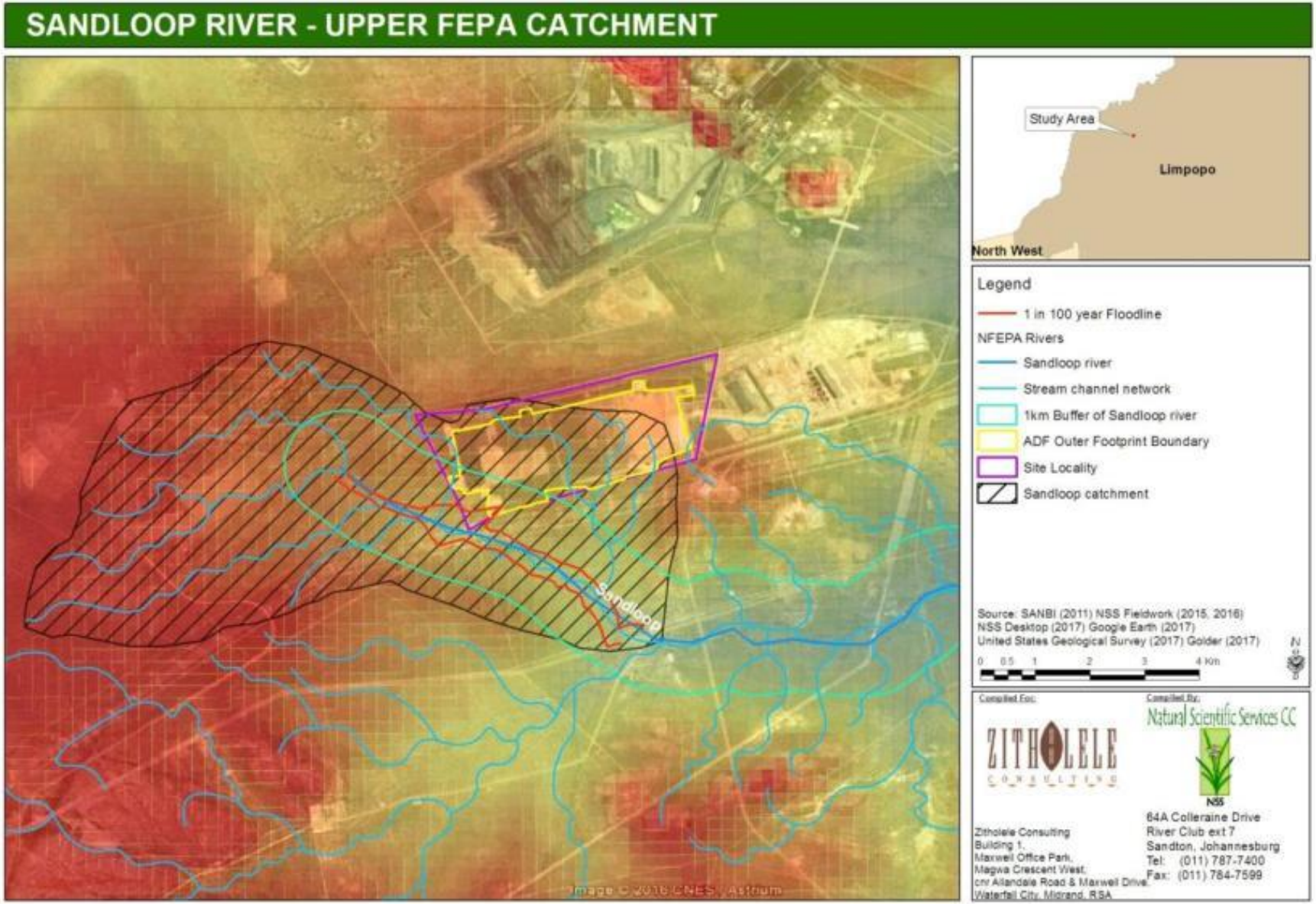


Figure 7-14 USGS DEM derived catchment and channel model showing Golder (2017) 1:100 year floodline delineation

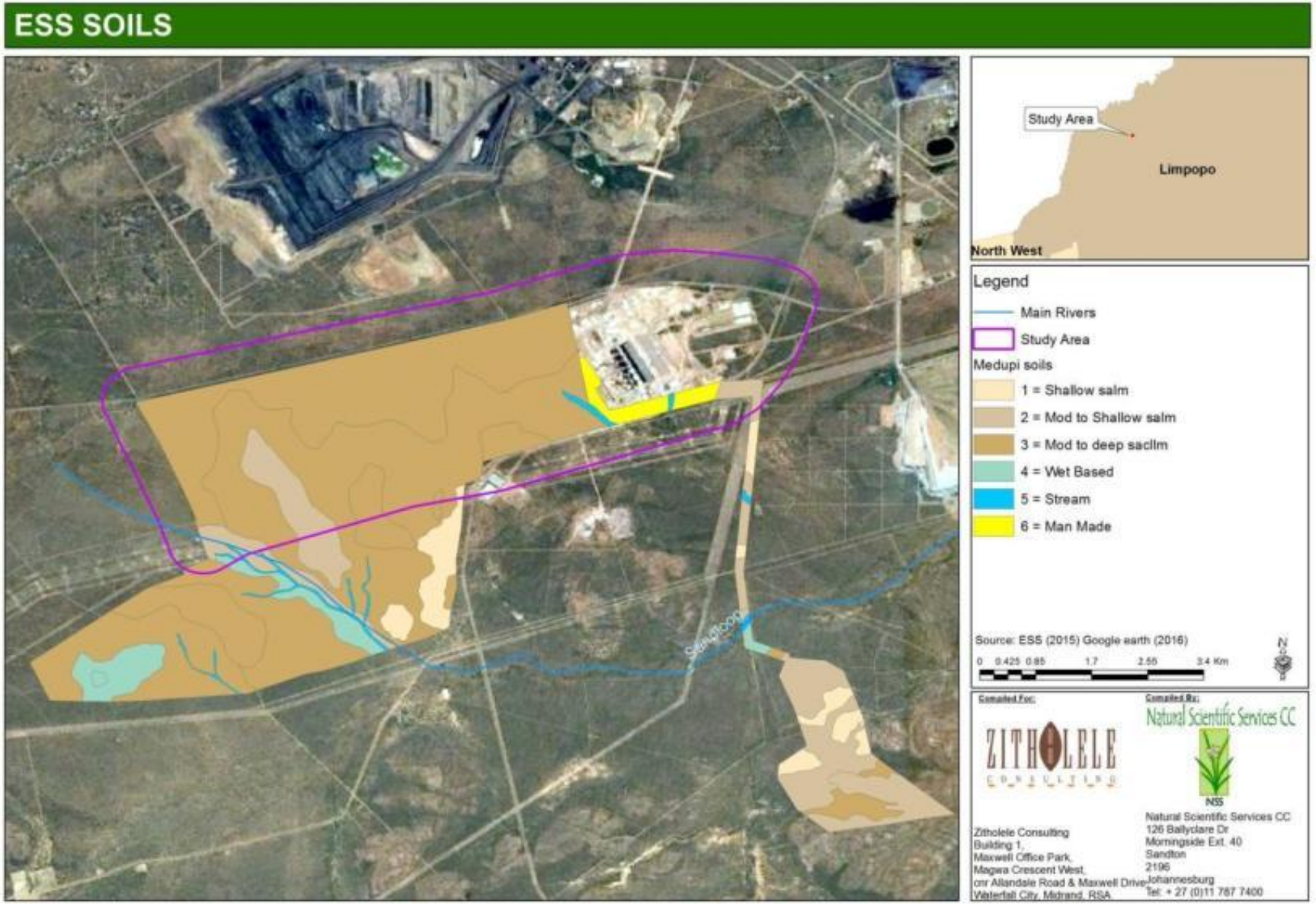


Figure 7-15 ESS (2015) soil classification map

Table 7-18 Wetland summary HGM Unit 1

HGM Unit 1 – Semi-arid Ephemeral Wash 1			
			
HGM Unit 1 and sampling points			
SETTING			
Coordinates (Centroid)	23°43'49.57"S 27°30'34.76"E	Area- 500m buffer of site (ha)	71.5
Alt (m a.s.l.)	908	Level 1: System	Inland
Aspect	South-east	Level 2a: Ecoregion	1.03
Regional vegetation	SVcb 19 LSB	Level 2b: NFEPA WetVeg	CBG 4
Quaternary catchment	A42J	Level 3: Landscape unit	Plain
Limpopo BCPLAN V2	CBA 1 and ESA 1	Level 4a:	CBG 4 Flat: **LT NP**
Waterberg TCBA	CBAI; CBAO and ON	Level 4b:	NA
MBG	B: Highest NB and risk	FEPA:	Start of Sandloop FEPA
SITE DESCRIPTION			
Overview	Semi-ephemeral washes, with pockets within the drainage showing wetland characteristics (pooling).		
Wetland indicators	Terrain relatively flat and difficult to determine slope. The soil indicators were present along some points of each system and in these areas the herbaceous vegetation layer was dense in comparison to the surrounds. Within the more permanent pooling areas, species such as *Scirpus* and *Cyperus* were evident		
Impacts	Clearing of the vegetation within the ash dump has resulted in increased exposed and hardened surface within catchment. During high flow culverts concentrate flow. Some borrow pits evident along the systems.		
Dominant species	*Non wetland species: Acacia nigrescens, A erubescens, Terminalia sericea* (taller and more leaf composition within the drainage evident); *Grewia bicolor* and *Grewia flava.* Stands of *Spirostachys africana* (Tamboti) are present along the system.		
Soil characteristics	Mixture of wet-based, and shallow, shallow-moderate, and moderate-deep sandy loamy soils		
Present Ecological State (PES)			
Hydrology	Geomorphology	Vegetation	
C	**B**	**B**	
Wetland Ecosystem Services			
Maintenance of biodiversity; Phosphate trapping; Sediment trapping; Toxicant removal; Nitrate removal			
Wetland Importance and Sensitivity			
Hydrological	Ecological	Cultural	
Moderate (2.2)	**Very High (4.0)**	**Moderate (1.5)**	

MBG: Mining & Biodiversity Guidelines; LSB: Limpopo Sweet Bushveld; CBA: Critical Biodiversity Area; ESA: Ecological Support Area; CBG4: Central Bushveld Group 4; FEPA: Freshwater Ecosystem Priority Area; ON:

Table 7-19 Wetland summary HGM Unit 2

HGM Unit 2 – Semi-arid Ephemeral Wash 2			
			
HGM Unit 2 and sampling points			
SETTING			
Coordinates (Centroid)	23°42'44.20"S 27°33'57.96"E	Area Within Site (ha)	38.0
Alt (m a.s.l.)	902	Level 1: System	Inland
Aspect	South-east	Level 2a: Ecoregion	1.03
Regional vegetation	SVcb 19 LSB	Level 2b: NFEPA WetVeg	CBG 4
Quaternary catchment	A42J	Level 3: Landscape unit	Plain
Limpopo BCPLAN V2	ESA 1	Level 4a:	NA
Waterberg TCBA	ON	Level 4b:	NA
MBG	E: Low NB and risk		
SITE DESCRIPTION			
Overview	Semi-ephemeral wash, with pockets within the drainage showing wetland characteristics (pooling).		
Wetland indicators	Terrain relatively flat and difficult to determine slope. The soil indicators were present along certain points of the system. A number of pools found along system before entering the Sandloop.		
Impacts	Likely a fair amount of water is diverted into the system compared to natural flow. MPS acts as a large hardened surface with surface / catchment area runoff increasing flood peaks substantially during high rainfall events but two natural depressions, a borrow pit and a road assist to attenuate flow, create depositional environments, and stem flow. Some excavations have formed more permanent dams. Increased roughness, saturation and nutrient loading. Pits (excavation), tailings (infilling), tailing sediment are washing onto system.		
Dominant species	*Non wetland species: Acacia nigrescens, A karoo, Dichrostachys cinerea*; *Grewia bicolor* and *Grewia flava.* Denser Grass Sward in places		
Soil characteristics	Mixture of wet-based and man-made soils		
Present Ecological State (PES)			
Hydrology	Geomorphology	Vegetation	
C	**C**	**D**	
Wetland Ecosystem Services			
Maintenance of biodiversity; Toxicant removal; Phosphate trapping; Sediment trapping; Flow attenuation			
Wetland Importance and Sensitivity			
Hydrological	Ecological	Cultural	
Moderate (2.1)	**Very High (4.0)**	**Low (1.4)**	

Table 7-20 Wetland summary HGM Unit 3

HGM Unit 3 – Semi-arid Ephemeral Wash 3			
			
HGM Unit 3 and sampling points			
SETTING			
Coordinates (Centroid)	23°41'39.64"S 27°34'59.20"E	Area Within Site (ha)	18.2
Alt (m a.s.l.)	891	Level 1: System	Inland
Aspect	North-north-east	Level 2a: Ecoregion	1.03
Regional vegetation	SVcb 19 LSB	Level 2b: NFEPA WetVeg	CBG 4
Quaternary catchment	A42J	Level 3: Landscape unit	Plain
Limpopo BCPLAN V2	ESA 1	Level 4a:	NA
Waterberg TCBA	ON	Level 4b:	NA
MBG	E: Low NB and risk		
SITE DESCRIPTION			
Overview	Semi-ephemeral washes flowing north eastward. Currently fed by MPS overflow of treated water		
Wetland indicators	Terrain indicator present; limited vegetation indicators		
Impacts	Storm water from MPS is channelled into this system but does not appear to significantly increase inundation below the control dams. High run-off from MPS's hardened surfaces during rainfall events but seems attenuated by storm water dams and the tar road. Under normal conditions effects of increased flood peaks are expected to be negligible, but because all MPS's storm water is diverted to this point *freak* high rainfall events have the potential to cause a serious impact on the systems downstream. Earth-moving impacts are also evident. A large storm water control dam in the drainage way headwaters is *starving* the system of sediment and influencing natural flow patterns. However, the intensity of this impact does not seem high, possibly due to ephemeral nature of system. Road impedes flow slightly and further traps sediment from reaching downstream reaches. There is some evidence of erosion. Flat topography and the tar road appear to prevent erosion downstream during high rainfall events. Signs that water flows fast in reach between dam outlet and tar road. Storm water dam and road reduce sediment inputs from MPS to downstream system.		
Dominant species	*Non Wetland species: Dominated by Acacia nigrescens, A karroo, etc in the wooded component*		
Soil characteristics	Mixture of man-made, wet-based, and shallow-deep sandy loamy soils		
Present Ecological State (PES)			
Hydrology	Geomorphology	Vegetation	
F	**C**	**D**	
Wetland Ecosystem Services			
Maintenance of biodiversity; Toxicant removal; Phosphate trapping; Sediment trapping; Erosion control; Flood attenuation			
Wetland Importance and Sensitivity			
Hydrological	Ecological	Cultural	
Moderate (1.7)	**High (2.7)**	**Low (1.0)**	

Table 7-21 Wetland summary HGM Unit 4

HGM Unit 4 – Depressions			
			
HGM Unit 4 and sampling points			
SETTING			
Coordinates (Centroids); Alt (m a.s.l.)		Area Within Site (ha)	9.7
23°41'58.34"S 27°32'9.96"E; 913 23°42'57.53"S 27°31'21.30"E; 914 23°42'10.23"S 27°31'26.90"E; 918 23°42'11.11"S 27°32'32.16"E; 915 23°42'15.55"S 27°30'56.53"E; 919 23°42'51.10"S; 27°31'25.61"E; 916	23°42'44.48"S 27°32'37.87"E; 915 23°42'40.87"S 27°31'1.01"E; 918 23°42'10.83"S 27°32'2.64"E; 916 23°42'20.94"S 27°30'33.70"E; 922 23°41'30.86"S 27°33'37.69"E; 900	Level 1: System	Inland
		Level 2a: Ecoregion	1.03
Regional vegetation	SVcb 19 LSB	Level 2b: NFEPA WetVeg	CBG 4
Quaternary catchment	A42J	Level 3: Landscape unit	Plain
Limpopo BCPLAN V2	ESA 1	Level 4a:	NA
Waterberg TCBA	CBAO and ON	Level 4b:	NA
MBG	E: Low NB and risk		
SITE DESCRIPTION			
Overview	Scattered, small, isolated depressions		
Wetland indicators	Soil indicators evident in most of these systems -showing signs of wetness (mottling). Vegetation shows more cover, but hydrophytes are generally lacking. There is also limited change to the terrain.		
Impacts	Cattle trampling of the depressions, which affects species such as frogs that remaining in the cracks until rain		
Dominant species	In most cases these depressions are devoid of vegetation. Where there is vegetation, it is merely denser cover of the surrounding terrestrial environment.		
Soil characteristics	Mostly moderate-deep sandy loamy soils		
Present Ecological State (PES)			
Hydrology	Geomorphology	Vegetation	
B	**B**	**C**	
Wetland Ecosystem Services			
Maintenance of biodiversity; Tourism and recreation; Phosphate trapping; Toxicant removal			
Wetland Importance and Sensitivity			
Hydrological	Ecological	Cultural	
Low (1.4)	**Very High (4.0)**	**Moderate (1.6)**	

Table 7-22 Summary information for excavations (artificial systems)

Excavations			
			
Excavations			
SETTING			
Coordinates (Centroids); Alt (m a.s.l.)		Area Within Site (ha)	West: 2.2ha; East: 0.9ha
West: 23°43'37.82"S 27°30'24.69"E; 909 East: 23°43'12.59"S 27°31'44.29"E; 910		Level 1: System	Inland
		Level 2a: Ecoregion	1.03
Regional vegetation	SVcb 19 LSB	Level 2b: NFEPA WetVeg	CBG 4
Quaternary catchment	A42J	Level 3: Landscape unit	Plain
Limpopo BCPLAN V2	ESA 1	Level 4a:	NA
Waterberg ACBA and TCBA	ESA and ON, respectively	Level 4b:	NA
MBG	B: Highest NB and risk		
SITE DESCRIPTION			
Overview	Old borrow pits or excavations now filled with water and providing a biodiversity hotspot in the greater area		
Wetland indicators	No indicators were assessed for these pits		
Impacts	Potentially limiting the inputs *of* sediment into the system and influencing natural flow patterns		
Dominant species	Limited to no vegetation within the pits, on the edges show typical Bushveld Habitat		
Soil characteristics	Mixture of wet-based, and shallow-moderate, and moderate-deep sandy loamy soils		
Present Ecological State (PES)			
NA			
Wetland Ecosystem Services			
NA			
Wetland Importance and Sensitivity			
NA			

7.4. Wetland Classification

HGM units SEW1 to 3 were classified following Ollis *et al* (2013) up to Level 3. However, did not fit with any of the Level 4 classifications. These systems are ephemeral with no channels and not considered valley bottom systems. The best description for these systems is a Wash. Washes are dry land drainage ways where water flows after heavy rainstorms, but which are otherwise dry. Washes usually indicate that there is no local groundwater connection to the valley bottom. However, they sometimes mark areas where groundwater is closer to the surface than in the surrounding landscape ("recharge windows" where a portion of the surface flow seeps down through to the groundwater aquifer), or a layer such as ferricrete is providing an impermeable layer allowing soils to become saturated above and presenting wetland characteristics. This is true to the description on the soils of the area, provided by ESS (2015). This was evident in the fieldwork where, within the larger system, water was pooling and showing signs of wetland characteristics such as soil mottling and a change in vegetation structure (denser grass swards and taller potentially more productive wooded component) (**Figure 7-18**). During the drier period of the year these trees kept their leaves for longer than the surrounding areas potentially being fed by groundwater. The denser grass swards indicate more availability of water subsurface.

The various pans were classified following Ollis *et al* (2013) up to Level 4 as Endorheic Depressions without Channelled Outflow. Pans (depressions) within South Africa are mainly characteristic of the drier parts of the country but do occur within the wetter areas (Allan *et al*. 1995). The conditions within the study site are all conclusive with the formation of pans: the area is arid (i.e. receives approximately 400mm of rainfall, with evapo-transpiration higher than rainfall), the area is underlain mainly by sandstones, and the slope is less than 1 degree. The depressions identified within the study area are small in extent and ephemeral in nature. Depressions are defined by Ollis *et al* (2013) as "a wetland or aquatic ecosystem with closed (or near closed) elevation contours, which increases in depth from the perimeter to a central area of greatest depth and within which water accumulates." Due to the large number of depressions within the CBG4 vegetation type, they are classified as Least Threatened. In terms of delineating the systems, it is the catchment of the depression that should be demarcated as sensitive. The available contour data were used to demarcate the pans, however, due to the flat terrain the scale of the contours was not fine enough for an accurate delineation. The Level 1 – 4 wetland classification (Ollis et al 2013) for the four HGM units on site is given in **Table 7-23.**

Table 7-23 Wetland classification

HGM UNIT NAME	LEVEL 1	LEVEL 2				LEVEL 3	LEVEL 4		
	System	Eco - region	NFEPA WetVeg			Landscape Unit	4a	4b	4c
			Type	Status	Protection				
SEW1	Inland	1.03	CBG4	LT	MP	Plain	N/A	N/A	N/A
SEW2	Inland	1.03	CBG4	LT	MP	Plain	N/A	N/A	N/A
SEW3	Inland	1.03	CBG4	LT	MP	Plain	N/A	N/A	N/A
D1	Inland	1.03	CBG4	LT	MP	Plain	Depression	Endorheic	Without Channelled Outflow

* Central Bushveld Group 4

Pans inundated after sufficient rainfall

SEW – Flow Patch clearly visible

Flow path for an SEW

Figure 7-16 Flow paths and water inundation

Figure 7-17 Artificial systems

7.5. Wetland Extent

The spatial distribution of the wetlands in the study site and the 500m survey buffer) was determined using a combination of standard in-field delineation techniques including terrain, soil and vegetation indicators (DWAF, 2005), available contour data, satellite imagery over a 10 year period (Google Earth). The separate and collective extent (in hectares and percent) of the four identified HGM units is presented in

Table 7-24.

Table 7-24 Wetland extent

HGM Unit	HGM Type	Ha	Extent (%)*
SEW 1	Semi-ephemeral Wash	71.5	52
SEW 2	Semi-ephemeral Wash	38.0	28
SEW 3	Semi-ephemeral Wash	18.2	13
Depressions	Depressions	9.7	7
Total		**137.3**	**100**

Soil Mottling -Depressions

Dense Vegetation within the Depressions

Soil Mottling- SEW Units

Depression

Figure 7-18 Wetland Indicators

7.6. Present Ecological State of the Wetlands

A summary of the PES of each HGM units on site is provided in **Table 7-25** and discussed in greater detail under **Table 7-18 -**

Table 7-22. The PES for SEW 1, 2 and D4 show a relatively stable and natural to moderately modified state. Whereas SEW 3 in the north eastern section of the site showed a more modified system. This is potentially due to the seepage and/ or overflow during high rainfall events of MPS clean and dirty water into the system.

Table 7-25 Summary of the overall health of the wetland based on impact score and change score

HGM Unit	Ha	Extent (%)	Hydrology		Geomorphology		Vegetation		Overall
			Impact Score	Change Score	Impact Score	Change Score	Impact Score	Change Score	Impact Score
SEW 1	72	52	3	-2	1.7	-1	1	-1	2.1
SEW 2	38	28	3.5	-1	3	-1	4.2	-1	3.6
SEW 3	18	13	9.5	-1	3.9	-1	5.8	-1	6.8
Depressions	10	7	1	-1	1	-1	2	-1	1.3
Scores									
SEW 1			C	↓↓	B	↓	B	↓	C (Lower)
SEW 2			C	↓	C	↓	D	↓	C (Upper)
SEW 3			F	↓	C	↓	D	↓	E
D 4			B	↓	B	↓	C	↓	B
Area weighted impact scores*			3.9	-1.5	2.3	-1	2.6	-1	
PES Category (See Table 6.1)			C	↓↓	C	↓	C	↓	

* The total impact score for the wetland as a whole is calculated by summing the area-weighted HGM scores for each HGM unit.

7.7. Sediment

Due to the semi-ephemeral nature of the systems on site, sediment samples were collected to determine the metal concentrations within the sediment of the systems. The results give an indication of the contamination levels within the water when the systems are flowing.

7.7.1 *Sediment Sampling Sites*

Six sediment sampling sites were chosen based on their location in 2015, upstream and downstream from the ADF and MPS, with a further two sites within two remaining depressions in the ADF footprint. The sampling sites are summarised in **Table 7-26** and illustrated in **Figure 7-19**.

7.7.2 *Metal Analysis*

The results of the total sediment metal concentrations for the high flow assessment at the eight sampling sites are presented in **Table 7-27**. Currently, no sediment quality guidelines (SQGs) exist for freshwaters in South Africa. Therefore, the shaded values in **Table 7-27** indicate any increased concentrations compared to the available international SQGs. A study by Botes & Van Staden (2005) on a site in the Olifants River, in Limpopo Province, is also provided as a comparison. No sediment data for the Sandloop was available for comparison. Therefore, this data will serve as a reference for future surveys and can be compared against to determine increasing or decreasing concentrations. The water quality samples were taken at the same sampling sites as the sediment samples for comparison. The WQ data was provided by Zitholele consulting. Only the exceeding concentrations of both the metals in the sediment and water quality data are presented in **Table 7-28**.

Table 7-26 Sediment Sampling Sites

Sampling Site	Description	Latitude (S)	Longitude (E)
MD1	Upstream site on the Sandloop River. Upstream of all three proposed site alternatives.	-23.722876°	27.490132°
MD2	Sandloop River. Located in Site 12 but downstream of Site 13.	-23.731668°	27.514446°
MD3	Pan. Located south of the ADF.	-23.747372°	27.504599°
MD4	Unnamed tributary of the Sandloop River. Located south of MPS	-23.727258°	27.528442°
MD5	Unnamed tributary of the Sandloop River. Downstream.	-23.738966°	27.548697°
MD6	Sandloop River. Downstream	-23.745971°	27.572112°
MD7	A Pan situated in close proximity to the ADF (South of the ADF)	-23.722098°	27.514976°
MD8	A Pan situated in close proximity to the ADF	-23.716043°	27.522619°

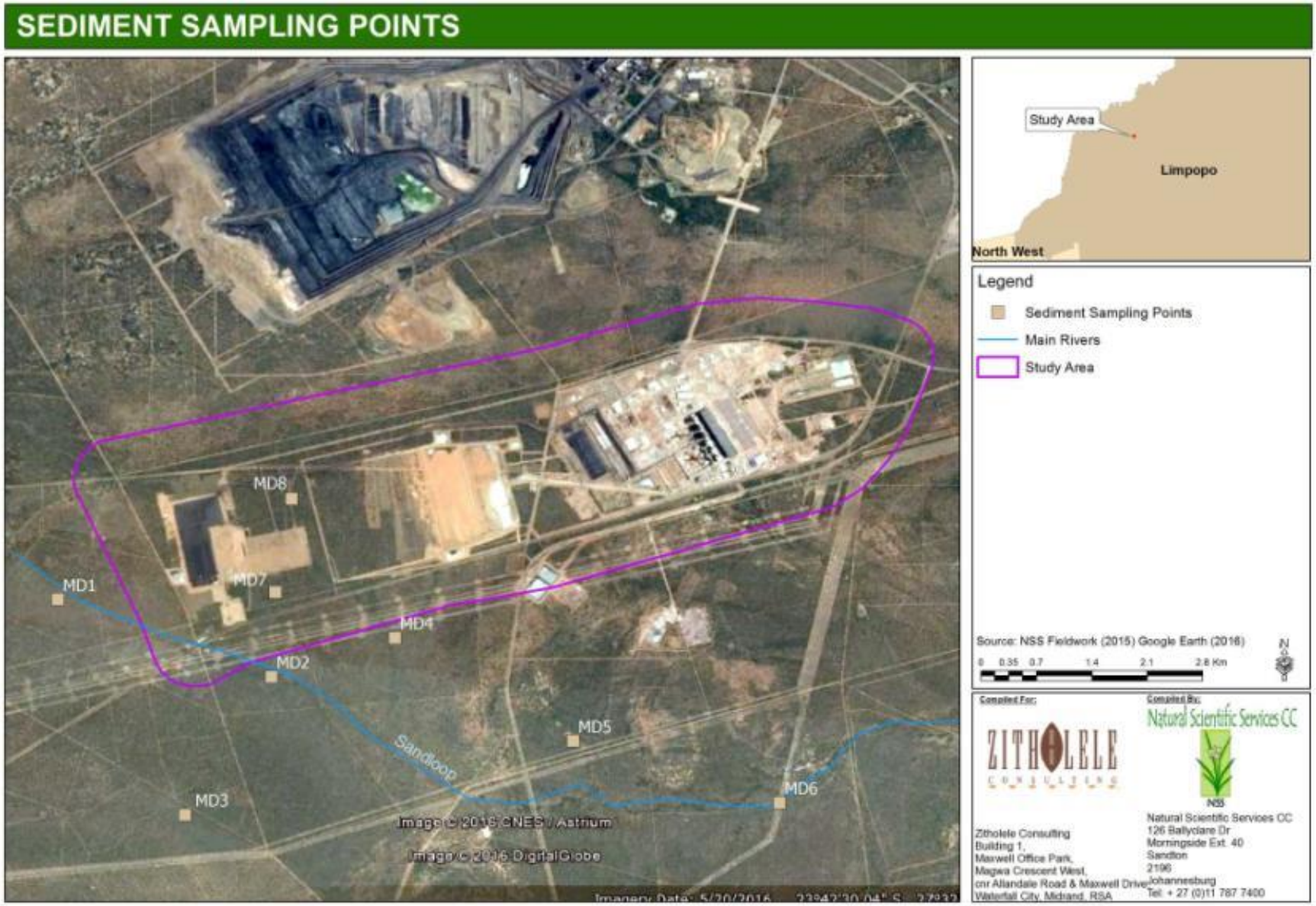


Figure 7-19 Sediment Sampling Sites

Table 7-27 Metal concentrations in the sediment samples from the study area during December 2015

Constituents	Chemical symbol	Unit	Guideline Value	Olifants River[#]	MD1	MD2	MD3	MD4	MD5	MD6	MD7	MD8
					Dec 2015	Dec 2015	Dec 2015	Dec 2015	Dec 2015	Dec 2015	Nov 2016	Nov 2016
Metals												
Aluminium	Al	mg/kg	n/a	-	16451.38	26148.15	4497.26	7585.38	8775.56	4901.48	54119.3	34604.8
Arsenic	As	mg/kg	5.9	3.33	1.35	0.89	0.36	0.70	0.80	0.37	1.63	1.26
Boron	B	mg/kg	n/a	-	6.77	5.79	BD	0.11	0.92	BD	20.32	18.33
Barium	Ba	mg/kg	n/a	24.27	120.27	126.94	25.49	50.10	71.85	32.59	346.51	250.6
Beryllium	Be	mg/kg	n/a	-	0.55	0.62	0.11	0.20	0.23	0.15	1.47	1.00
Cadmium	Cd	mg/kg	0.57	BD	0.03	0.04	0.01	0.01	0.01	0.00	0.07	0.06
Chromium	Cr	mg/kg	26	38.83	31.76	44.81	27.05	24.89	23.34	17.17	87.11	57.86
Cobalt	Co	mg/kg	20	7.57	3.96	4.27	0.87	1.91	2.72	1.72	9.72	7.78
Copper	Cu	mg/kg	16	BD	12.99	10.97	3.01	4.64	6.27	3.64	26.00	17.51
Iron	Fe	mg/kg	n/a	16090	11008.71	13629.63	3135.89	5529.10	6588.21	4071.43	22773.6	18013.3
Manganese	Mn	mg/kg	460	249.1	161.39	106.79	21.62	73.30	66.43	56.11	220.38	208.18
Molybdenum	Mo	mg/kg	10	BD	0.03	0.10	BD	0.04	0.09	BD	0.22	0.26
Nickel	Ni	mg/kg	18	10.89	13.70	18.05	3.53	6.00	8.51	5.09	39.11	33.22
Lead	Pb	mg/kg	35	BD	22.29	10.85	4.10	7.56	5.51	2.36	18.11	33.91
Selenium	Se	mg/kg	0.08	-	0.58	0.49	0.12	0.24	0.28	0.08	0.93	0.58
Silver	Ag	mg/kg	1	-	1.25	1.08	1.00	BD	0.43	0.65	4.16	7.18
Strontium	Sr	mg/kg	n/a	-	13.30	13.40	2.19	4.83	6.43	5.77	21.32	17.79
Titanium	Ti	mg/kg	n/a	-	193.18	241.95	62.27	113.76	97.43	55.17	231.66	144.93
Uranium	U	mg/k	2.50	-	0.61	0.55	0.12	0.23	0.32	0.20	0.95	0.61
Vanadium	V	mg/kg	n/a	47.46	21.97	26.22	8.08	12.80	15.03	9.29	50.5	33.31

n/a – not available; BD = Below detection limit; [#]Botes & Van Staden (2005).
Guideline values derived from Australia-New Zealand (ANZECC, 2000), Netherlands (Friday, 1998) and Canada (Friday, 1998; Hamilton, 2004; Sheppard *et al.* 2005);
Constituents shaded in red exceeded the guideline concentrations.

Table 7-28 Comparison between metal concentrations in the sediment and water samples (excluding MD7 and 8)

	Constituents	Chemical symbol	Unit	Guideline Value	MD1	MD2	MD3	MD4	MD5	MD6
					Dec 2015	Dec 2015	Dec 2015	Dec 2015	Dec 2015	Dec 2015
	Metals									
Sediment	Aluminium	Al	mg/kg	n/a	16451.38	26148.15	4497.26	7585.38	8775.56	4901.48
Water	Aluminium	Al	mg/ℓ	0.005	10.25	1.42	7.43	5.36	6.84	20.43
Sediment	Chromium	Cr	mg/kg	26	31.76	44.81	27.05	24.89	23.34	17.17
Water	Chromium	Cr	mg/ℓ	0.007	0.025	<0.01	0.013	<0.01	<0.01	0.026
Sediment	Iron	Fe	mg/kg	n/a	11008.71	13629.63	3135.89	5529.10	6588.21	4071.43
Water	Iron	Fe	mg/ℓ	0.1	11.445	0.897	7.836	2.740	3.669	4.588
Sediment	Manganese	Mn	mg/kg	460	161.39	106.79	21.62	73.30	66.43	56.11
Water	Manganese	Mn	mg/ℓ	0.18	0.252	0.013	0.048	0.015	0.132	0.447
Sediment	Selenium	Se	mg/kg	0.08	0.58	0.49	0.12	0.24	0.28	0.08
Water	Selenium	Se	mg/ℓ	0.002	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Sediment	Silver	Ag	mg/kg	1	1.25	1.08	1.00	BD	0.43	0.65
Water	Silver	Ag	mg/ℓ	n/a	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01

n/a – not available; BD = Below detection limit;

Guideline values derived from Australia-New Zealand (ANZECC, 2000), Netherlands (Friday, 1998) and Canada (Friday, 1998; Hamilton, 2004; Sheppard *et al.* 2005);

Constituents shaded in red exceeded the sediment guideline concentrations whilst constituents shaded in blue exceed the WQ guideline concentrations for aquatic ecosystems (DWAF, 1996).

Metals like **aluminium** (Al) and **iron** (Fe) are found at high concentrations in the natural geology and as such often occur in high concentrations in the sediment. Both these metals are common and no guideline values are described for it. In this study, both the aluminium and iron concentrations were also high in the water and exceeded the guideline values (**Table 7-28**). Aluminum is one of the more toxic metals within a water ecosystem and is associated with numerous biochemical effects on aquatic biota. For example, aluminum can cause neuromuscular dysfunction in fish (Colvin *et al*. 2011) and effects on fish are only usually evident at concentrations greater than 0.1 to 3.2 mg/l (Dallas & Day, 2004). At five of the sites i.e. MD1, MD3, MD4, MD5 and MD6, the aluminium concentrations were high than 3.2 mg/l, ranging 5.36 to 20.43 mg/l. However, the pH levels for these sites were neutral and may slightly limit the toxicity of aluminium. Iron is an important micronutrient but toxic at high concentrations and inhibits various enzymes. Iron compounds easily oxidize and the high concentrations observed at all the sites can result in oxygen depletion in these pans.

Many other metals do not have any recommended sediment guideline limits and include beryllium (Be), boron (B), titanium (Ti), vanadium (V), strontium (Sr) and barium (Ba). These metals do not have guidelines due to a lack of research in their occurrences in South African sediment or a lack of information on its toxicity within the sediment environment.

The metals that did have international guideline values indicated that manganese (Mn), cobalt (Co), zinc (Zn), arsenic (As), molybdenum (Mo), cadmium (Cd) and lead (Pb) did not exceed the guideline concentrations. Manganese, cadmium, molybdenum, zinc and cobalt concentrations were significantly lower than the guideline values. **Manganese** often occurs at high concentrations in the natural environment in South Africa as the geology contains high concentrations especially in the Highveld. Soluble manganese mostly occurs under low dissolved oxygen conditions, which are more than likely in these pans. The manganese concentrations in the water exceeded the guidelines at MD1 and MD6. Very little known about the effects on aquatic organisms but elevated levels of manganese are toxic to fish (Heal, 2001). **Cadmium** has the potential to be hazardous to aquatic biota and can be considered toxic and relatively accessible to aquatic organisms (DWAF, 1996). For example, Oligochaeta (earthworms) and other important soil organisms are very susceptive to cadmium poisoning and can die at very low concentrations. When cadmium concentrations in the soil are high it will impact on the soil processes, soil structure and threaten the whole soil ecosystem (Lenntech, 2016).

The **chromium** (Cr) concentrations exceeded the guideline concentration at site MD1, MD2 and MD3 from the December 2015 survey. The chromium concentrations at site MD7 and MD8 during the November 2016 survey also exceeded the guideline concentrations. However, site MD4 and MD5 also contained chromium concentrations that were close to the 26 mg/kg guideline. In natural ecosystems, chromium is generally a scarce metal and the concentrations are low in aquatic ecosystems. When the chromium levels are elevated it generally is a consequence of industrial activities (DWAF, 1996). A study by Botes & Van

Staden (2005) on the Lower Olifants River, known to be exposed to metal pollution, indicated concentrations of 38 mg/kg and sites MD2, MD7 and MD8 had higher concentrations in this study than the aforementioned study. Disposal of chromium-containing commercial products and coal ash from electric utilities and other industries are major sources of chromium releases into the soil (Nriagu & Pacyna, 1988). In addition, consumer products such as fertilizer may also contain chromium (Pellerin & Booker, 2000). The chromium concentrations in the water samples were high at MD1, MD3 and MD6. Chromium is an essential element that can be toxic to aquatic organisms at elevated levels. It exists in two oxidation states in aquatic systems including hexavalent chromium i.e., Cr^{6+} and trivalent Cr^{3+}, of which Cr^{6+} is the most toxic. Hexavalent chromium is allowed to cross biological membranes of aquatic organisms and thus readily penetrate gill membranes and concentrate at higher levels in various tissues (Avenant-Oldewage & Marx, 2000)

The **nickel** concentration at site MD2 exceeded the guideline value of 18 mg/kg by 0.05 mg/kg. The nickel concentrations of 10.89 mg/kg in the Botes & Van Staden (2005) study were exceeded by site MD1 and MD2 in this current study. The nickel guideline was also exceeded by the nickel concentrations measured at site MD7 and MD8 during November 2016. Nickel is a natural constituent of soil and levels vary depending on local geology and anthropogenic input but typical concentrations range from 4 to 80 mg/kg (ATSDR, 2005). Nickel content in soil can also be as low as 0.2 or as high as 450 mg/kg in some clay and loamy soils with an average of around 20 mg/kg (Lenntech, 2016). Organic matter has a strong ability to absorb the metal which is why coal and oil contain considerable amounts (ATSDR, 2005), and may indicate why these sites have exceeding concentrations in the soil.

Silver (Ag) is a naturally occurring element. It is found in the environment combined with other elements such as sulfide, chloride, and nitrate. The major source of elevated silver levels in soils is from the application of sewage sludge and sludge effluents as agricultural amendments. Additional anthropogenic sources of silver in soil include atmospheric deposition (especially from ore processing), landfilling of household refuse, sewage sludge, or industrial wastes, and leaching of metal tailings (ATSDR, 1990). The **silver** concentrations at site MD1, MD2, MD3, MD7 and MD8 exceeded the international guideline value. However, the guideline is set at 1 mg/kg while all the results from these sites ranged from 1.05 – 7.18 mg/kg. Not much is known about silver pollution within sediment in South Africa and little comparative data are available. However, silver is toxic to soil microorganisms and inhibits bacterial enzymes (ATSDR, 1990) and in solution it is extremely toxic to aquatic plants and animals (Lenntech, 2016). However, currently the silver concentrations in the water samples are below detection limits.

Lead (Pb) is a naturally occurring metal and can be found, in small amounts, in all parts of our environment. However, much of it comes from human activities including burning fossil fuels, combustion of coal and oil, mining and manufacturing (Lenntech, 2016). Lead released to air and water ultimately is deposited in soil or sediment. It is strongly adsorbed to soil and

therefore it is generally retained in the upper layers of soil and does not leach appreciably into the subsoil and groundwater (ATSDR, 2007). The natural lead content of soil typically ranges from 10 to 30 mg/kg. However, lead levels in the top layers of soil vary widely due to deposition and accumulation of atmospheric particulates from anthropogenic sources (ATSDR, 2007). Lead concentrations in the sediment did not exceed the 35 mg/kg guideline value but it was measured at 22 mg/kg at site MD2 and very close to the Guideline for MD8 (33mg/kg) which are significantly higher than measured at the other sites. Lead concentrations were not detected above the concentrations in the Botes & Van Staden (2005) study. Lead can potentially be hazardous and toxic to aquatic biota and is relatively accessible to aquatic organisms (DWAF, 1996) if high concentrations are present in the environment. Lead is toxic in high concentrations and sub-lethal concentrations result in the regression of the physiological or behavioural processes of the aquatic organism, and therefore reducing its overall fitness.

According to ATSDR (2003), **selenium** occurs naturally in the environment and can be released by both natural and manufacturing processes. It also enters water from rocks and soil, and from agricultural and industrial waste. Some selenium compounds will dissolve in water, and some will settle to the bottom as particles. Weathering of rocks and soils may result in low levels of selenium in water, which may be taken up by plants. Disposal of selenium in commercial products and waste could also increase the amount of selenium in soil. Selenium that may be present in fossil fuels combines with oxygen when burned, which may then react with water to form soluble selenium compounds (ATSDR, 2003). Selenium is most likely to enter the air through coal and oil combustion, as selenium dioxide (Lenntech, 2016) or airborne particles of selenium, such as in ash, can settle on soil or surface water (ATSDR, 2003). Due to irrigation run-off, concentrations of selenium tend to be very high in aquatic organisms in many areas (Lenntech, 2016). The forms and fate of selenium in soil depend largely on the acidity of the surroundings and its interaction with oxygen. In the absence of oxygen when the soil is acidic, the amount of selenium that can enter plants and organisms should be low. Various studies estimated natural selenium concentration of most soils to be between 0.01 and 0.2 mg/kg (Lenntech, 2016). Selenium concentrations exceeded the guideline value at all of the sites in the study area. The selenium concentrations ranged from 0.08 to 0.57 mg/kg which is above the guideline value of 0.08 mg/kg. The selenium concentrations were the highest at site MD1, MD7 and MD8. The concentrations decreased from site MD1 towards site MD6. Sites MD1, MD7 and MD8 had similar concentrations. Selenium is a necessary trace element in animals for some enzyme processes. However, elevated levels can interfere in biological substances containing sulphur due to selenium's similarity to sulphur. This can cause toxic effects in fish and invertebrates. In addition, aquatic animals absorb or accumulate extremely high concentrations of selenium that will be passed up through the food chain that can cause reproductive failure and birth defects in animals and humans (Lenntech, 2016).

The copper concentrations at site MD7 and MD8 were above the international guideline concentration of 16 mg/kg. In general, the copper concentrations at site MD7 and site MD8 were higher than the concentrations measured at site MD1 to site MD6.

In summary, the metal analysis indicated that five metals showed increased concentrations above the international guideline values. The general trend within the results indicated that the highest concentrations of the majority of the metals were seen at site MD1 and MD2 during the December 2015 survey. The concentrations of metals at the other sites were in most cases significantly lower. The November 2016 survey indicated that the metal concentrations in the samples within the ADF footprint, which exceeded guidelines values, were chromium, copper, selenium, nickel, and silver. The concentrations were generally higher than seen at sites sampled during the December 2015 sampling sites.

Anthropogenic contaminants such as metals take various pathways once they have entered the aquatic environment. These pathways include the adsorption of contaminants to the surfaces of sediments and colloids and deposition into organic debris contained in silts (ATSDR, 2012a; 2012b & 2013). These sediments then become potential sources of contamination of the water column and subsequently biota, as they play a role in the remobilisation of contaminants in these systems (Yohannes *et al.* 2013). Contaminants trapped in sediments tend to have long residence times and these sediments may serve as a constant supply of contaminants to the surrounding environment (Filgueiras *et al.* 2004). Metals are generally subject to immobilisation and deposition, and changes in properties such as pH, conductivity, temperature, dissolved oxygen and turbidity affect the speciation and distribution of many metals. The solubility of metals is found to increase under changing pH and as a result increase these metals' potential to become bioavailable as they move from sediments into the water column.

Although some of the metal concentrations were high in the sediment i.e. chromium, selenium and silver, these metal concentrations in the water samples were generally low (**Table 7-28**). This could potentially indicate that the metal concentrations measured in the sediment could be natural background concentrations and exceeding the international guidelines does not necessarily indicate pollution. However, those samples with exceeded concentrations were closest to the ADF and Coal Stockpile area. This was further confirmed with the two pan samples (MD7 and MD8) in the November 2016 analysis. In addition, the concentrations of aluminium, chromium, iron and manganese were high in the water samples. It is recommended to continue monitoring the metal concentrations at the selected sampling sites for a minimum of one survey per year if the proposed waste disposal project, near any of these sites, will be continued.

7.7.3 *Invertebrate within the Sediments*

Hot semi-arid areas such as the Lephalele region, are characterized by an abundance of small temporary or ephemeral pans, which depend on rain for their existence. These habitats

are distinguished by fluctuating and unpredictable changes in their hydrological regime and of physical and chemical conditions (Lahr, 1996). Their existence, extent and duration therefore depend on climatic factors and on morphometric and sediment characteristics. They contain a uniquely adapted fauna that copes in different ways with changing and often extreme temperatures, oxygen levels, pH, salinity and turbidity. The typical ephemeral pan is a shallow, closed basin (Belk and Cole, 1975) that usually contains a well-adapted fauna. Characteristic groups include large Branchiopoda: Anostraca or fairy shrimps, Notostraca or tadpole shrimps, and Spinicaudata and Laevicaudata (formerly grouped together as Conchostraca) or clam shrimps. These three groups of crustaceans are often referred to as phyllopods. Assemblages of species of these groups are found all over the world in hot arid and semi-arid regions.

The main strategies for these fauna are dormancy (escape in time) and dispersal (escape in space). However, these adaptations or strategies may affect the impact of toxicants on individuals, populations and communities of temporary ponds. The physiological adaptations of species found in temporary ponds are likely to alter the sensitivity to pollutants of characteristic species. According to Lahr (1996), results from laboratory experiments, for example, suggest that fairy shrimp (Branchiopoda, Anostraca) may react differently to heavy metals as the standard test species *Daphnia*. Life history strategies influence recovery rates of populations after exposure to acutely toxic substances such as heavy metals. It is also suggested that slow growth and decreased reproductive capacity of organisms caused by toxicants may, in ephemeral pans, result in the failure of annual recruitment.

According to Lahr (1995), increased agriculture and mining are likely to increase environmental contamination by pesticides, fertilizers, heavy metals and other pollutants on these sensitive and important systems. An overview in an ecotoxicological context of the adaptations of one group of temporary pond inhabitants from (semi-) arid zones, fairy shrimps (Branchiopoda,Anostraca), in particular *Streptocephalus proboscideus* (Streptocephalidae), has been presented by Brendonck & Persoone (1993). They showed that the life history traits of these animals make them attractive for application in cost-effective, cyst-based toxicity.

The aim of the invertebrate hatching within two small pans on site was to determine if any invertebrate resting eggs were present in the sediment. Initial hatchlings were identified as Anostraca, fairy shrimp; however, no further identification was possible as the hatchlings did not survive for them to be identified to a lower taxonomic level. The other taxa that hatched in the following days were mostly Daphnidae and one Notostraca, tadpole shrimp, from site MD8. The Notostraca is most probably *Triops granarius* as only two species are found in South Africa. It is important to note that during the early stage of an ephemeral pan filling with water, populations are usually below the carrying capacity of the system. Species that are r-selected will be more successful in this nonlimiting environment, which is relatively free of competition and predation (Brendonck and Persoone 1993). They grow rapidly, mature

early, and produce many offspring. However, if pools are more long-lived, the community may shift towards the K-end of the r-K continuum. Crustaceans that rapidly colonize newly filled pans from dormant stages are typical r-species. More competitive, K-selected predators, such as hemipterans and coleopterans, arrive later by aerial migration. At this stage many crustaceans disappear.

Due to the extreme rarity of ecotoxicological studies in these habitats, the impact of chemicals on temporary ponds and its inhabitants are not well known. Crisinel *et al*. (1994) compared the acute toxicity of sixteen chemicals (four heavy metals, eleven organic compounds and one organometallic compound) to nauplii of the *Streptocephalus* fairy shrimps with results from the standard test with *Daphnia magna* (Branchiopoda, Cladocera). The sensitivity of the *Streptocephalus* species to heavy metals was slightly higher than that of *D. Magna.* Mizutani *et al.* (1991), while determining the uptake of heavy metals by the fairy shrimp *Branchinecta longiantenna* (Branchinectidae), found that animals exposed to 1.0 mg L-1 zinc or cadmium expired after two days. This also seems in agreement with the results of Crisinel et al. (1994), and may explain the short lived nature of the shrimp that were hatched from MD8 and MD7.

Overall, the initial screening for invertebrate egg banks within site MD7 and MD8 were positive and it is recommended that detailed hatching studies be completed on the pans surrounding the ADF and MPS, in the long term, if any impact to these systems are predicted.

7.8. Eco-system Services

Despite their recognised importance, the scientific understanding of the functioning of wetlands in arid environments and their associated ecosystem services is incomplete (Tooth, 2015). Although the ecosystem services were not suppose to be assessed, due to the systems not being palustrine systems (Kotze *et al*, 2008), Levick *et al* (2008) highlights the services offered by these systems:

> *Semi-ephemeral and non-perennial systems provide the same ecological and hydrological functions as perennial systems by moving water, nutrients, and sediment throughout the watershed. When functioning properly, these provide landscape hydrologic connections; stream energy dissipation during high-water flows to reduce erosion and improve water quality; surface and subsurface water storage and exchange; ground-water recharge and discharge; sediment transport, storage, and deposition to aid in floodplain maintenance and development; nutrient storage and cycling; wildlife habitat and migration corridors; support for vegetation communities to help stabilize stream banks and provide wildlife services; and water supply and water-quality filtering. They provide a wide array of ecological functions including forage, cover, nesting, and movement corridors for wildlife*.

In addition to the Semi-Ephemeral Washes (SEWs) identified on site, a number of pans were identified. The presence of pans within the moisture stressed environment of the study area means that these wetlands are key providers ('hotspots') of ecosystem services, including water and food supply (Tooth, 2015). The Millennium Ecosystem Assessment (2005) and the UNEP's Global Deserts Outlook (Acura, 2006) both highlighted that in moisture stressed environments such as the study area wetland ecosystem services are unbalanced and may provide the only supply of fundamental water and food resources.

The concern with pans is that they perform few of the functions normally associated with wetlands and could therefore be seen as less important systems (Ferreira, 2012), which is not the case. In addition to the provision of water, these depressions provide a unique habitat in terms of biodiversity maintenance, precipitation of minerals and the distribution of accumulated salts and nutrients during the dry months.

In general pans can provide the following services (Kotze *et al*., 2008):

- Flood attenuation. The opportunity for attenuating floods is limited by the position of pans in the landscape, which are generally isolated from stream channels. However, they do capture runoff because of their inward draining nature, and thus they reduce the volume of surface water that would otherwise reach the stream system during storm flow conditions.
- Precipitation of minerals. Temporary pans allow for the precipitation of minerals, including phosphate minerals due to the concentrating effects of evaporation.
- Nitrogen cycling is likely to be important with some losses due to denitrification, and volatilization in the case of high pH.
- The penology, geology and climate influence the response of these pan systems to nutrient inputs. In pans that dry out completely at some stage or another (non-perennial pans), some of the accumulated salts and nutrients (such as organic nitrogen, and various phosphate and sulphate salts) can be transported out of the system by wind and be deposited on the surrounding slopes. Those remaining may dissolve again when waters enter the system again as the pan fills after rainfall events.

As a guide, NSS utilised the WET EcoServices tool to obtain an understanding on how the four HGM units would provide such services. In summary, with all four units, the main service is Biodiversity Maintenance. This is evident during high rainfall events when these areas become inundated and provide breeding and foraging habitat for an array of species. In addition to this, the Semi-Ephemeral Washes also provided services for toxicant and nitrate removal as well as phosphate and sediment trapping.

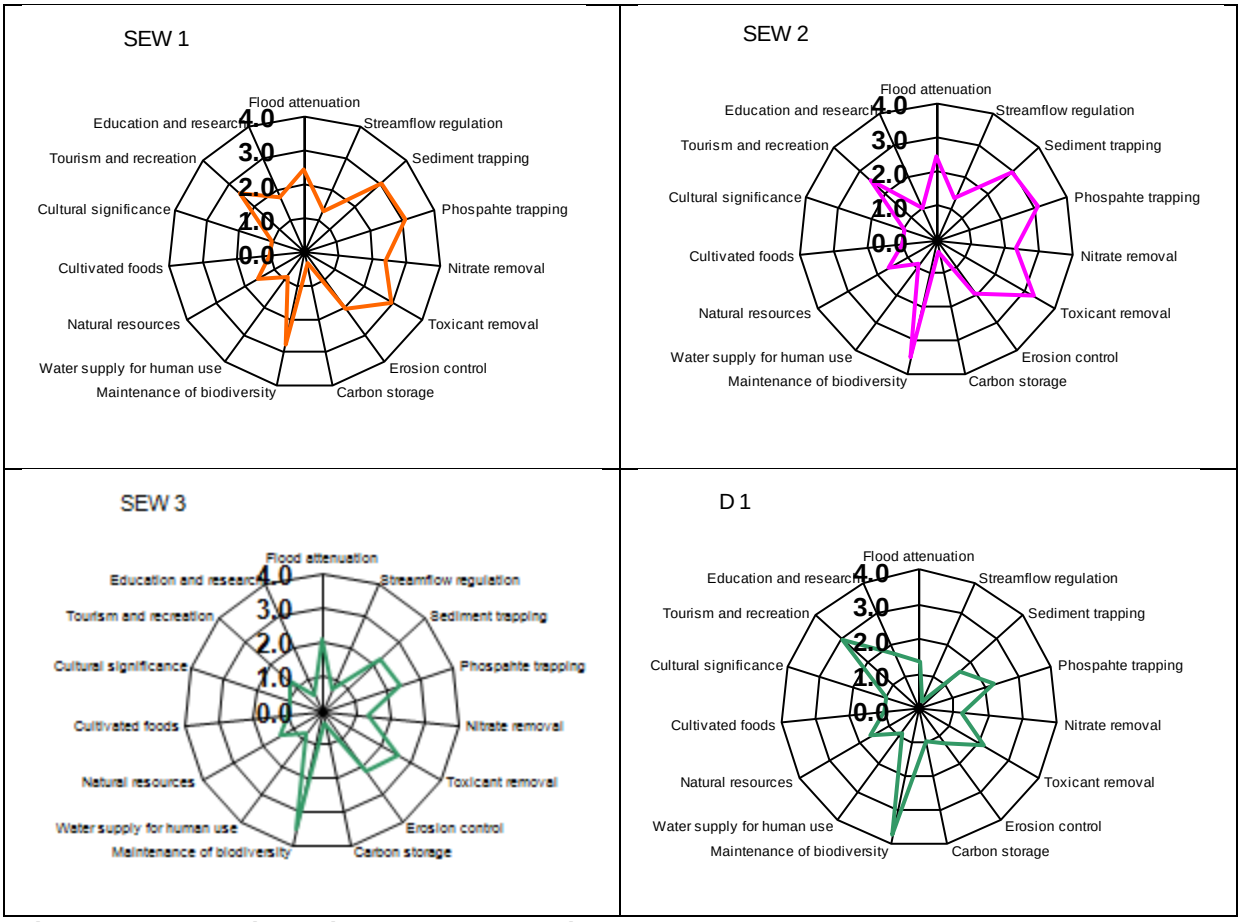


Figure 7-20 Estimated - Ecosystem Services

Combined NSS surveys shows that the MPS and ADF sites (including 500m buffer) support 20 frog species, representing 74 % of the regional amphibian diversity. During high rainfall events, NSS recorded 16 species in total within the study area (**Figure 7-10**). Both of the 2 regionally occurring CIS namely African and Giant Bullfrog were recorded in the study area. A high rainfall event (38 mm in early December 2015) during the second NSS visit triggered the emergence of exceptionally high densities of winged termites and subsequently African Bullfrog and various other species en masse around the pools within the drainage features. The breeding frenzy which insued drastically increased detection rate, and emphasised the exceptional abundance of amphibian species in the study area. Both Giant and African Bullfrog occur sympatrically in the area with the latter generally being regarded as the more ubiquitous of the two in warm bushveld regions (Du Preez and Carruthers, 2009). Indeed African Bullfrog were found to be exceptionally abundant and likely breed at the majority of the pans / depressions within the study area, while in contrast, Giant Bullfrog was only potentially recorded at one locality in the ADF footprint, a small (historically natural) pan which has been deepened and widened by excavation. The observation was of a single froglet (identification tentative based on absence of pale half moon on tympanum usually indicative of African Bullfrog but age precluded confirmation by labial tooth row formula or adult colouration and morphology). Species distinction among froglet bullfrogs is notoriously difficult (A. Channing *pers comm*.). A recent publication by NSS and Enviro-Insight (Yetman

and Verburgt, 2015) provides the first records of Giant Bullfrog in the Lephalale region and the greater Limpopo Sweet Bushveld. The study highlights that the species is likely more widespread and common in the region than was previously thought and that low detection levels are likely the result of irregular emergence and breeding in this dry region only during sufficiently wet summers. Suitable breeding habitat appears to be present for both African and Giant Bullfrog along the washes and around the depressions within the study area and it is likely that Giant Bullfrog breeds at more localities within the study area but was not detected due to timing.

Along with the emergence of frogs, comes the emergence of their predators. Numerous snakes were also detected during the surveys at a number of pools and depressions. One species dependant on these systems is the Southern African Python (*Python natalensis*) (**Figure 7-9**).

Distribution data for dragonflies and damselflies provided in Samways (2008) suggests that approximately 50 species have the potential to occur. These species are frequently found away from water and / or require only temporarily inundated areas. Of the seven regionally occurring CIS[7] only five namely Sudan Sprite, Little Wisp, Black Emperor, Strong Skimmer and Silhouette Dropwing are considered likely to occur.

In summary these semi-ephemeral systems are providing an important foraging, breeding and migration habitat for a diverse array of species and are therefore considered extremely important.

7.9. Wetland (Ecological) Importance and Sensitivity

In accordance with a recent study by the DWS (2014) on the PES, Ecological Importance (EI) and Ecological Sensitivity (ES) per Sub Quaternary Reaches for Secondary Catchments in South Africa, the Sandloop PES is moderately modified (C category) where the loss and change of natural habitats and biota have occurred but the basic ecosystem functions are still predominately unchanged. According to the DWS (2014), this river is seriously influenced by cattle grazing and land-use. The moderate EI of the Sandloop is due to the one wetland and two riparian habitat types, 12 different types of vegetation cover and three endemic species in this sub-quaternary catchment with a taxon richness of at least 25 species (wetland, riparian and aquatic vegetation). The size of stream, morphology and geomorphic habitat units determine the ES. The Sandloop has a low sensitivity to modified flow conditions and water level changes because this is an ephemeral system and has a natural lack of surface water (DWS, 2014).

[7] Red listed species or those species with a Dragonfly Biotic Index score of 4 or higher are considered here to be of conservation importance.

A summary of the Wetland Importance and Sensitivity is highlighted in **Table 7-29**. The Ecological Importance and Sensitivity of HGM scored High on a national scale given the presence of the Sandloop FEPA and its importance from a biodiversity maintenance perspective. HGM Units SEW 2 and D 4 scored a Very High whereas SEW 3 scored High. Further discussions on this are highlighted in **Section 7.1.4** above. The hydrological/functional importance or SEW1 and SEW 2 scored a Moderate due to the scores received for water quality enhancement. Direct Human Benefits for all four units received a Low/Moderate score. These systems provide little in the way of subsistence benefits but may provide benefits in terms of tourism etc., due to the number of game farms around the ADF.

Table 7-29 A Summary of the EIS for the Site

WETLAND IMPORTANCE AND SENSITIVITY		
SEW 1	**Importance**	***Confidence***
ECOLOGICAL IMPORTANCE & SENSITIVITY	**4.0**	*4.2*
HYDROLOGICAL/FUNCTIONAL IMPORTANCE	**2.2**	*4.0*
DIRECT HUMAN BENEFITS	**1.5**	*3.5*
SEW 2	**Importance**	*Confidence*
ECOLOGICAL IMPORTANCE & SENSITIVITY	**4.0**	*4.2*
HYDROLOGICAL/FUNCTIONAL IMPORTANCE	**2.1**	*4.0*
DIRECT HUMAN BENEFITS	**1.4**	*3.5*
SEW 3	**Importance**	*Confidence*
ECOLOGICAL IMPORTANCE & SENSITIVITY	**2.7**	*4.2*
HYDROLOGICAL/FUNCTIONAL IMPORTANCE	**1.7**	*4.0*
DIRECT HUMAN BENEFITS	**1.0**	*3.5*
D 4	**Importance**	*Confidence*
ECOLOGICAL IMPORTANCE & SENSITIVITY	**4.0**	*4.2*
HYDROLOGICAL/FUNCTIONAL IMPORTANCE	**1.4**	*4.0*
DIRECT HUMAN BENEFITS	**1.6**	*3.5*

8. Conservation Important Areas

Different levels of significance: - National, Provincial and Local for the study area and surrounds are highlighted within this section.

8.1. National Significance

8.1.1 *National Water Act (NWA; Act 36 of 1998)*

All wetlands / watercourses are protected within South Africa, with their legal protection extended to include buffer zones (Ferrar & Lotter, 2007). As highlighted in **Section 4**, South Africa has various pieces of legislation governing activities in and around wetlands under International, Regional and National legislation and Guidelines. The National Water Act, 1998, (Act 36 of 1998) (NWA) is the principle legal instrument relating to water resource management in South Africa. All wetlands are protected under the NWA. The NWA acknowledges:

> "*the National Government's overall responsibility for and authority over the nation's water resources and their use, including the equitable allocation of water for beneficial use, the redistribution of water, and international water matters.*"

As per Chapter 3 of the NWA: Protection of Water Resources:

> *"The protection of water resources is fundamentally related to their use, development, conservation, management and control. Parts 1, 2 and 3 of this Chapter lay down a series of measures which are together intended to ensure the comprehensive protection of all water resources. "*

The Sandloop River, the Washes and Depressions are ephemeral in nature but are still considered drainage features (watercourses) and would therefore be protected under the NWA.

8.1.2 *National Freshwater Ecosystem Priority Area*

National Freshwater Ecosystem Priority Areas (NFEPAs) provides guidance on how many rivers, wetlands and estuaries, and which ones, should remain in a natural or near-natural condition. It supports the implementation of the National Water Act (NWA), the Biodiversity Act (NEMBA) and the Protected Areas Act (NEMPAA).

For the study area, the NFEPA Project recognises the Sandloop System as a **FEPA River** (**Figure 8-1**). This system is rated regionally as having a Moderately Modified (or C) PES. The NFEPA guidelines indicate that FEPAs should be regarded as ecologically important and as generally sensitive to changes in water quality and quantity, owing to their role in protecting freshwater ecosystems and supporting sustainable use of water resources.

Wetland and river FEPAs currently in a good ecological condition should be managed to maintain this condition. Those currently not in a good condition should be rehabilitated to the best attainable ecological condition. Land-use practices or activities that will lead to deterioration in the current condition of a FEPA are considered unacceptable, and land-use practices or activities that will make rehabilitation of a FEPA difficult or impossible are also considered unacceptable.

"Applications for mining and prospecting in FEPAs and associated sub-quaternary catchments should be subject to rigorous environmental and water assessment and authorisation processes, as mining has a widespread and major negative impact on freshwater ecosystems" (Driver *et al*. 2011). Furthermore: mining in any form should not be permitted in FEPAs, or within 1km of a riverine FEPA buffer. No prospecting should occur in FEPAs or within 1km of a riverine FEPA buffer. Care should be taken to reduce the risks of aquifer penetration when drilling, wherever this occurs.

8.1.3 *Priority Areas*

During the National Spatial Biodiversity Assessment (NSBA), nine Priority Areas were identified for biodiversity conservation in South Africa (Driver *et al*. 2004). Priority Areas were allocated where broad-scale habitat remained unprotected or was inadequately conserved.
There are no listed SANBI Priority Areas within the study area.

8.1.4 *Threatened Ecosystems*

A list of Threatened Ecosystems within the nine national Priority Areas was gazetted on 9 December 2011 in NEM: BA (Act 10 of 2004). The identified Threatened Ecosystems occupy 9.5% of South Africa and were selected according to six criteria including: 1) irreversible habitat loss; 2) ecosystem degradation; 3) rate of habitat loss; 4) limited habitat extent and imminent threat; 5) threatened plant species associations; and 6) threatened animal species associations. The purpose of listing threatened ecosystems is primarily to reduce the rate of ecosystem and species extinction. This includes preventing further degradation and loss of structure, function and composition of threatened ecosystems.

There are currently no Threatened Ecosystems within the larger region around the study site. The closest vegetation type under threat is the Springbokflats Thornveld.

8.1.5 *Mining and Biodiversity Guideline: Mainstreaming biodiversity into the mining sector (2003).*

The Mining and Biodiversity Guidelines document (MBG) (DEA *et al.* 2013), was consulted for this project, as a number of activities on site are defined within GN704 (GG20119, June 1999) as a mining related activity. The MBG highlights the Sandloop River and surrounding habitat as having **Highest Importance** for Biodiversity (**Figure 8-4**).

8.2. Provincial Significance

8.2.1 *Limpopo Biodiversity Conservation Plan (C-Plan 2)*

According to the Limpopo C-Plan, the study area is situated within a provincial Ecological Support Area (ESA) and Critical Biodiversity Area 1 (CBA). CBA's *"are the portfolio of sites that are required to meet the region's biodiversity targets, and need to be maintained in the appropriate condition for their category.* ESAs "*are not essential for meeting biodiversity targets but play an important role in supporting the ecological functioning of Critical Biodiversity Areas (CBA) and/or in delivering ecosystem services."* Landscape Corridors provide the best landscape connectivity to support and enable biodiversity to adapt to the impacts of climate change. Local corridors represent "*fine scale connectivity pathways that contribute to connectivity between climate change focal areas*." Species-specific ESAs are "*required for the persistence of specific species*".

8.2.2 *Waterberg Bioregional Plan*

The Waterberg District Bioregional Plan (WDBP; Desmet *et al.* 2016) was developed from the Limpopo Conservation Plan (C-Plan) version 2 (Desmet *et al*. 2013) together with input from stakeholders and available integrated spatial planning tools for the District. Consequently, some differences exist between Terrestrial and Aquatic Critical Biodiversity Areas (CBAs) that have been identified in the WDBP, and similar areas that were identified in the Limpopo C-Plan. Draft WDBP data for the Medupi study area are depicted in **Figure 8-3**. The primary conservation concern should be the preservation of a buffer around the Sandloopspruit FEPA (where the C-Plan CBA 1 and the WDBP Aquatic ESA and Terrestrial CBA 1 are indicated), whilst preservation of terrestrial habitat (where the C-Plan ESA and the WDBP Terrestrial CBA 2 are indicated) should be regarded as a secondary priority.

8.3. Local Significance

Areas of local significance are those areas within the study area that have been highlighted because of their:

- Ecological Sensitivity (including renewability/success for rehabilitation);
- Level/Extent of Disturbance.
- Presence of CI species, (identified at the vegetation unit/habitat level); and
- Conservation Value (at a regional, national, provincial and local scale);

The identified vegetation units within the study site were qualitatively assigned Low to High biodiversity conservation importance or significance. This was based on results of the different sampling runs over the years (as highlighted in the methodology), previous assessments in the area, and our collective professional experience with ecological systems and processes.

It is important to bear in mind the 1:100 year floodline as delineated by Golder (2017) - see **Figure 7-12**. As all wetlands are deemed Protected and Important (Sensitive), this map therefore also highlights the following:

- All Wetland Areas are marked as High
- A 1km Medium-High Buffer is provided to the Sandloop System (in line with FEPA; MBG and the Limpopo C-Plan).

As the area is so flat a 100m Buffer is placed on all Washes and Depressions – This is marked as Medium-High

The qualitative assessment criteria are summarized in **Table 8-1** and mapped in **Figure 8-5.**

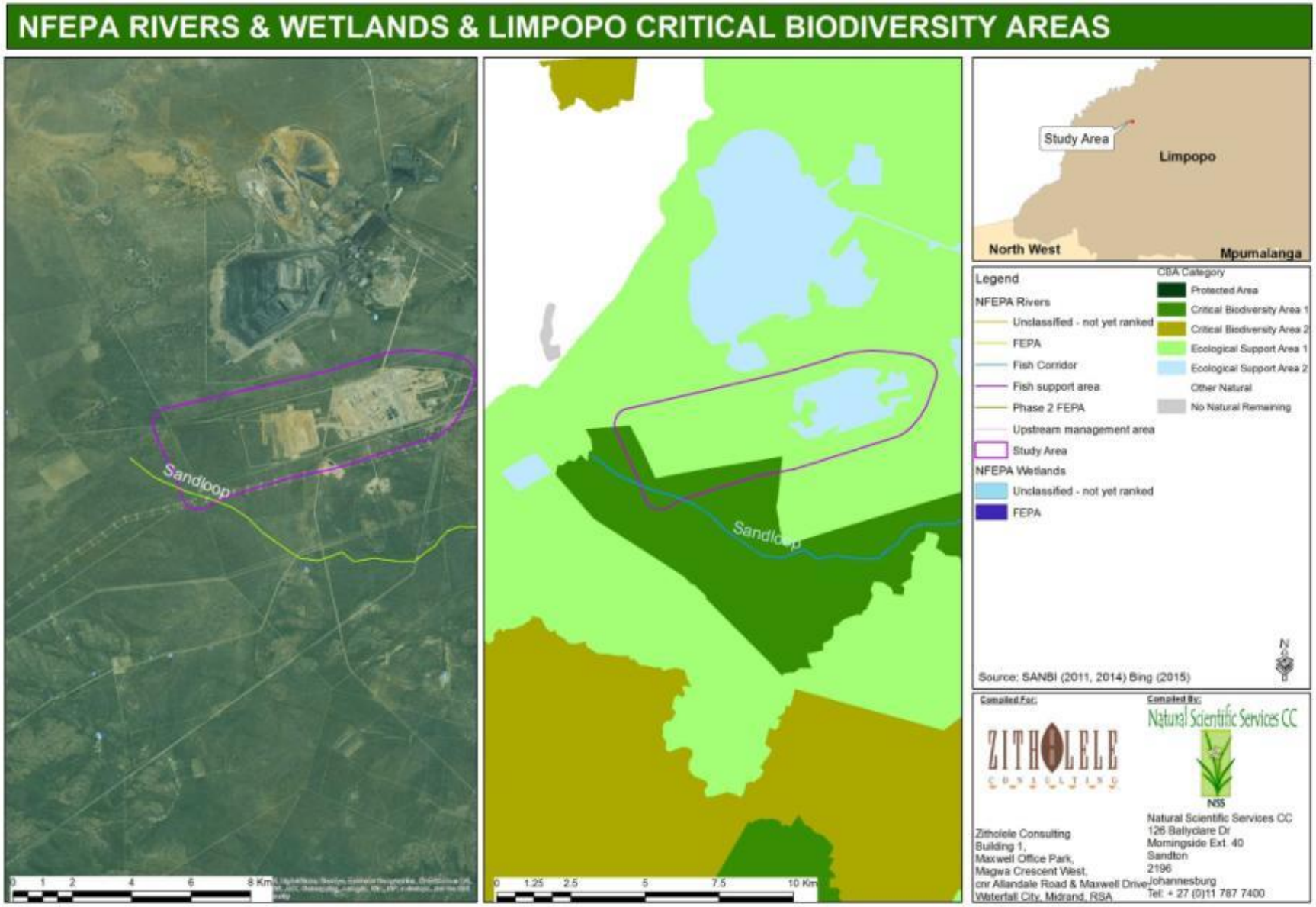


Figure 8-1 Freshwater Ecosystem Priority Areas and Limpopo Cplan for the greater study area

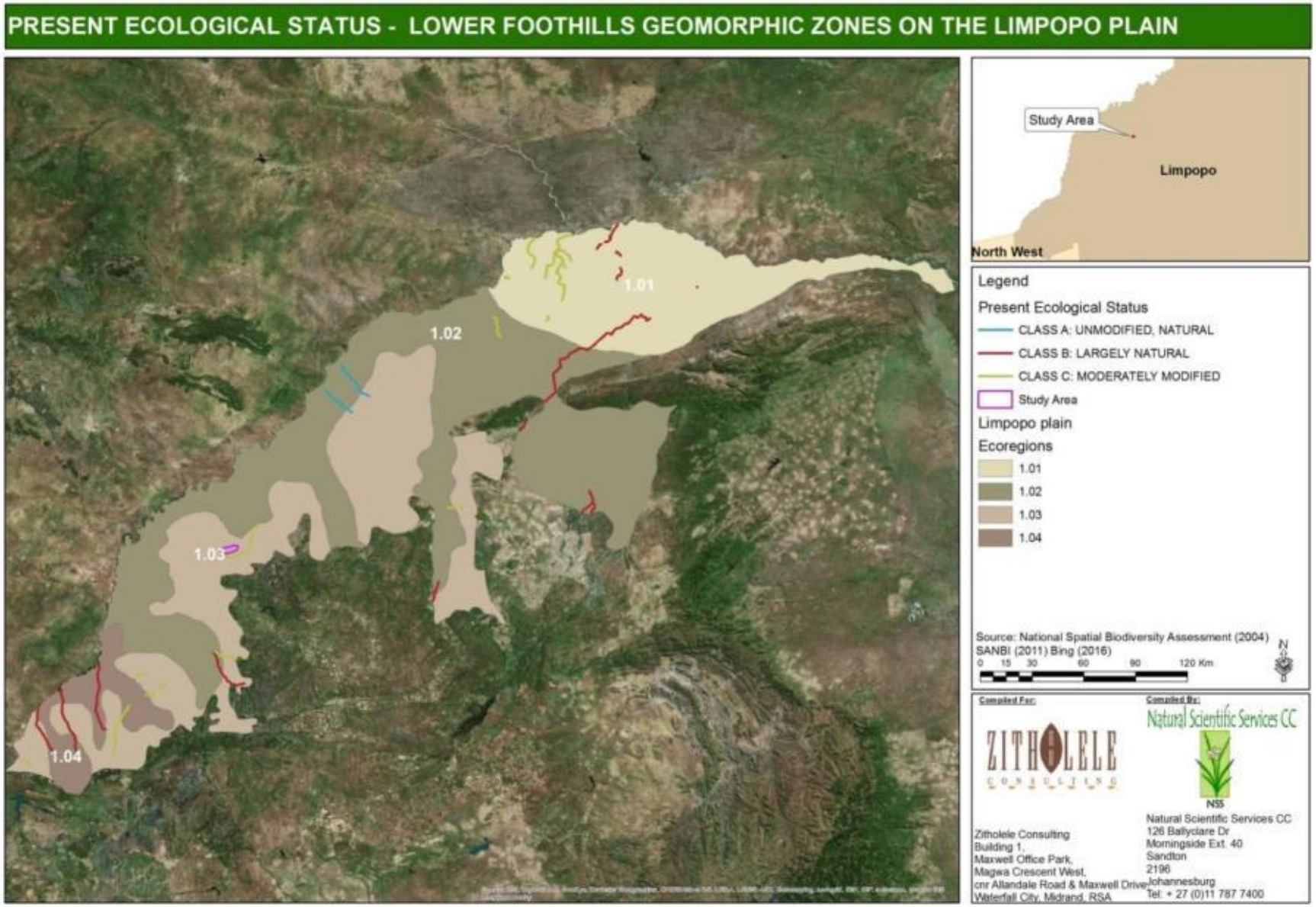


Figure 8-2 Limpopo Plains Ecoregions and Present Ecological State

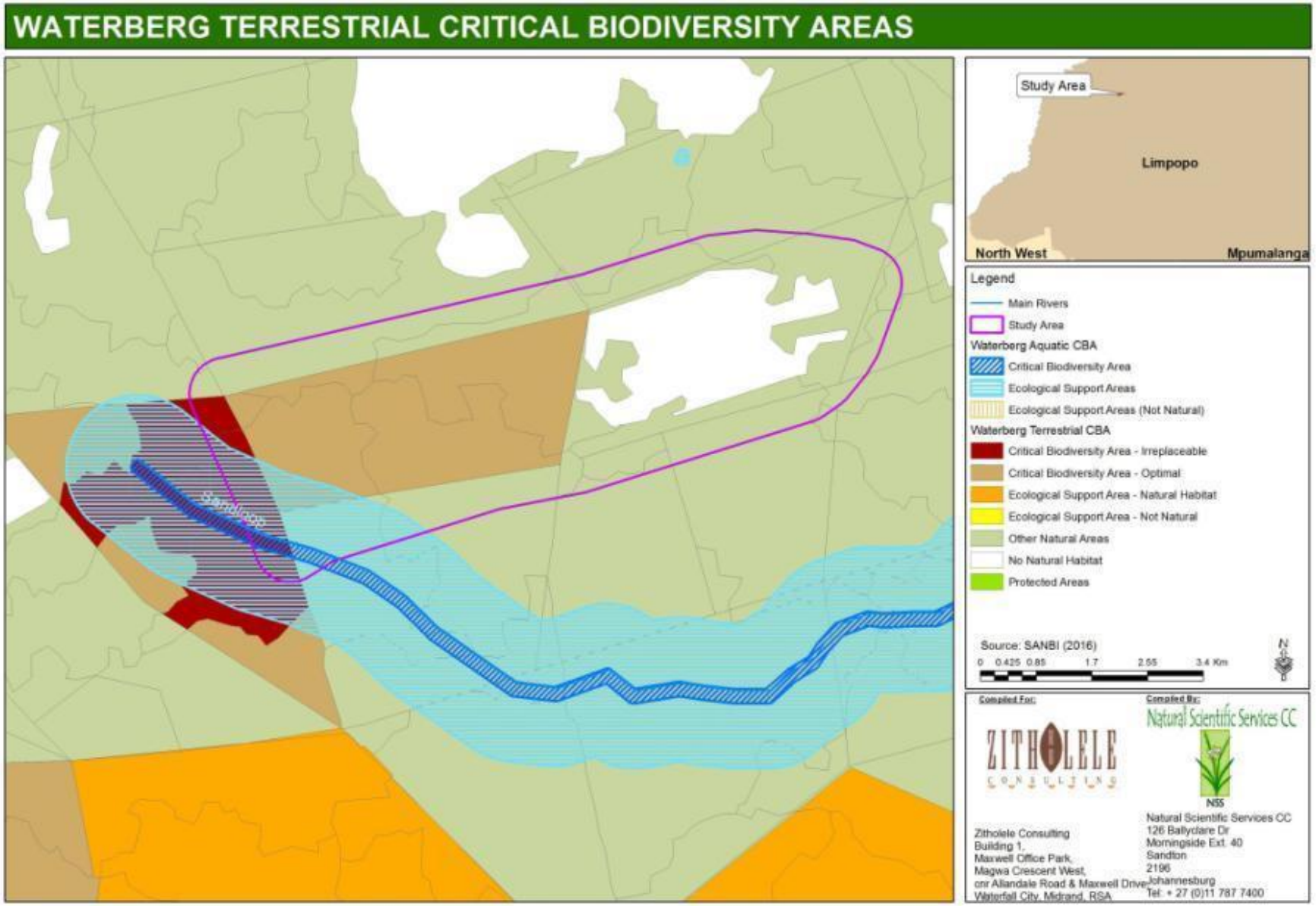


Figure 8-3 Waterberg Critical Biodiversity and Ecological Support Areas

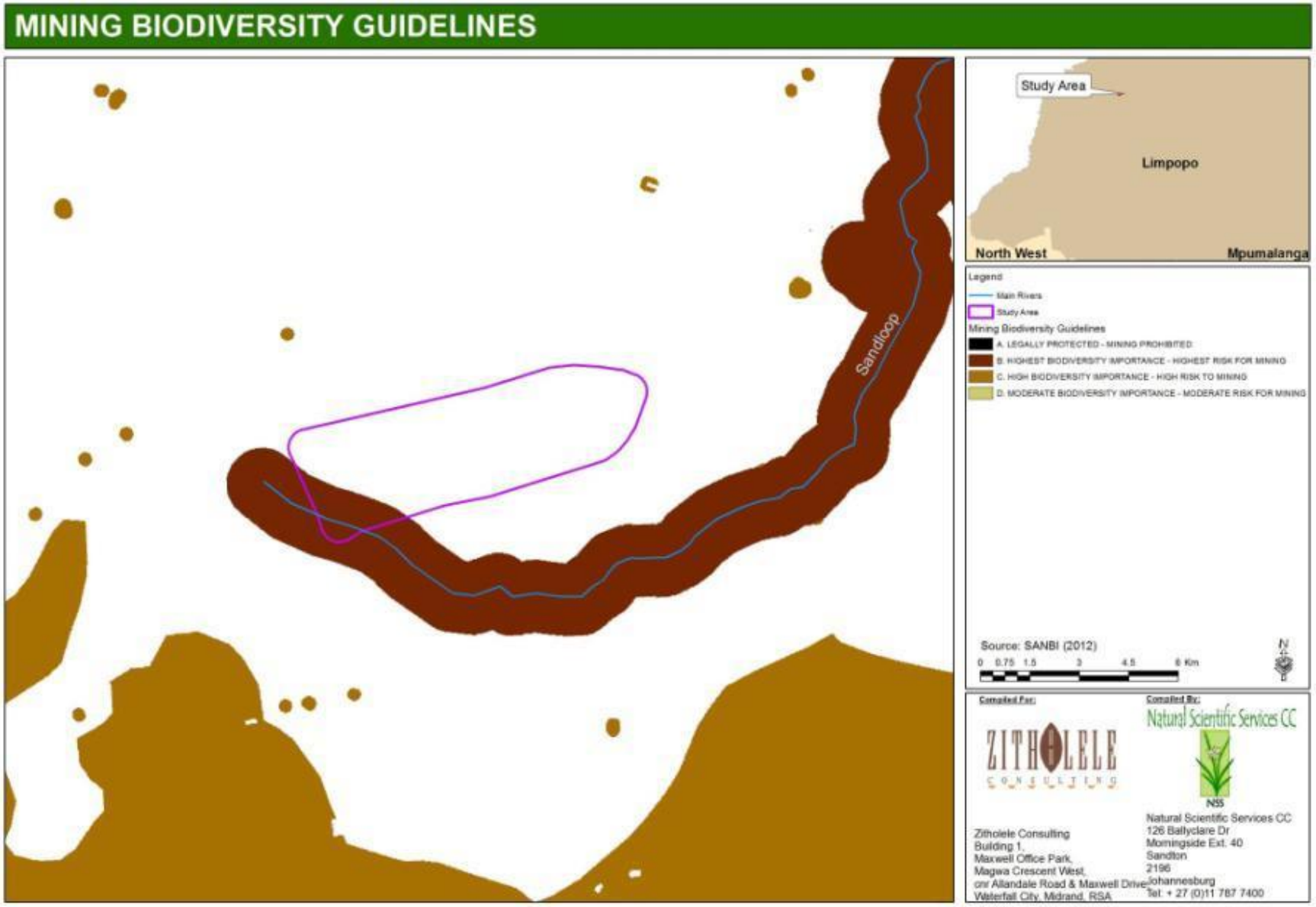


Figure 8-4 Mining and Biodiversity Guidelines for the greater study area

Table 8-1 Sensitivity rating of different habitats / floral communities in the study area.

UNIT	HABITAT & FLORAL COMMUNITY	CURRENT CONDITION & IMPACTS	SUCCESS FOR REHABILITA-TION	CI SPECIES	REGIONAL CONSERVATION VALUE	OVERALL SIGNIFICANCE *
Natural Areas						
	Acacia erubescens - Grewia Thornveld	• Understorey has limited herbaceous cover (sampling in the mid summer season) – only tree cover dominant. • Limited cover for faunal species and limited floral diversity • 2.26% of the study area	Difficult to rehabilitate to a similar natural state due to the soil structure and arid conditions. Extended effort will be required to ensure successful rehabilitation. According to Kevin *et al* (2010), moisture is the most important ecological factor necessary for successful rehabilitation of denuded patches in semi-arid environments.	• Limited Herpetofauna and avifaunal species utilise this area • Scattered PT species	• Least Concern Vegetation Unit • Limpopo C-Plan – CBA and within FEPA buffer	**MEDIUM**
	Acacia nigrescens - Grewia Open Veld	• Typical Habitat for the region with a diversity of tree, grass and forb species • Understorey –grass layer more dominant than shrub • Limited alien invasives present • Fragmentation is occurring • 9.19% of the study area		• Habitat utilisation for numerous faunal species. • Potential foraging area for Giant Bullfrog • PT floral species present	• Least Concern Vegetation Unit • Limpopo C-Plan - ESA	**MEDIUM**
	Acacia nigrescens – Combretum apiculatum dominated woodland	• Typical Habitat for the region with a diversity of tree, grass and forb species • Limited alien invasives present • Fragmentation is occurring • 22.87% of the study area		• Habitat utilisation for numerous faunal species. • Potential foraging area for Giant Bullfrog • PT floral species present	• Least Concern Vegetation Unit • Limpopo C-Plan – CBA and ESA	**MEDIUM-HIGH**
	A nigrescens-Dicrostachys-Grewia fragmented Thornveld	• Although fragmented similar to the *Acacia nigrescens –Combretum apiculatum* dominated woodland • Limited alien invasives present • Fragmentation is strong • 8.27% of the study area		• Habitat utilisation for numerous faunal species. • Potential foraging area for Giant Bullfrog • PT floral species present	• Least Concern Vegetation Unit • Limpopo C-Plan – CBA and ESA	**MEDIUM-LOW**
	Acacia mixed woodland	• Highly fragmented • Alien Invasives present – edge effects occurring • Increase in species such as *Dichrostachys cinerea* • 6.59% of the study area		• Potential foraging area for Giant Bullfrog • PT floral species present	• Least Concern Vegetation Unit • Limpopo C-Plan - ESA	**MEDIUM-LOW**
Wetland Areas						
	Acacia	• Similar habitat to the *A nigrescens*	The flats will be difficult to	• Most faunal species rely on	• Least Concern Vegetation	**VERY HIGH**

UNIT	HABITAT & FLORAL COMMUNITY	CURRENT CONDITION & IMPACTS	SUCCESS FOR REHABILITA-TION	CI SPECIES	REGIONAL CONSERVATION VALUE	OVERALL SIGNIFICANCE *
	dominated Wetland Flat Depressions Artificial water points / Waterbodies	dominated woodlands. Depressions lack vegetation cover • +4% of the study area	rehabilitate, however, NSS in association with Eskom Engineers will be looking at reconstruction depressions outside of the FGD Study Area	these systems in such an arid environment • Breeding area for African and Giant Bullfrog as well as a range of other species • PT floral species present	Unit • NFEPA • CBA (Limpopo and Waterberg); as well as Limpopo C-Plan - ESA	
Transformed Areas						
	Conveyor and associated areas; ADF, MPS, Cleared areas and stockpiles; Gravel road and fence line	• Highly transformed • High human presence/activity • 46.61% of the study area	As per statement above	• *Sclerocarya birrea* seedlings present on edges of soil stockpile areas. • Potential for CI species to occur are limited	• Least Concern Vegetation Unit • Limpopo C-Plan - ESA	**LOW**

KEY: ESA – Ecological Support Area; PT: Protected Tree

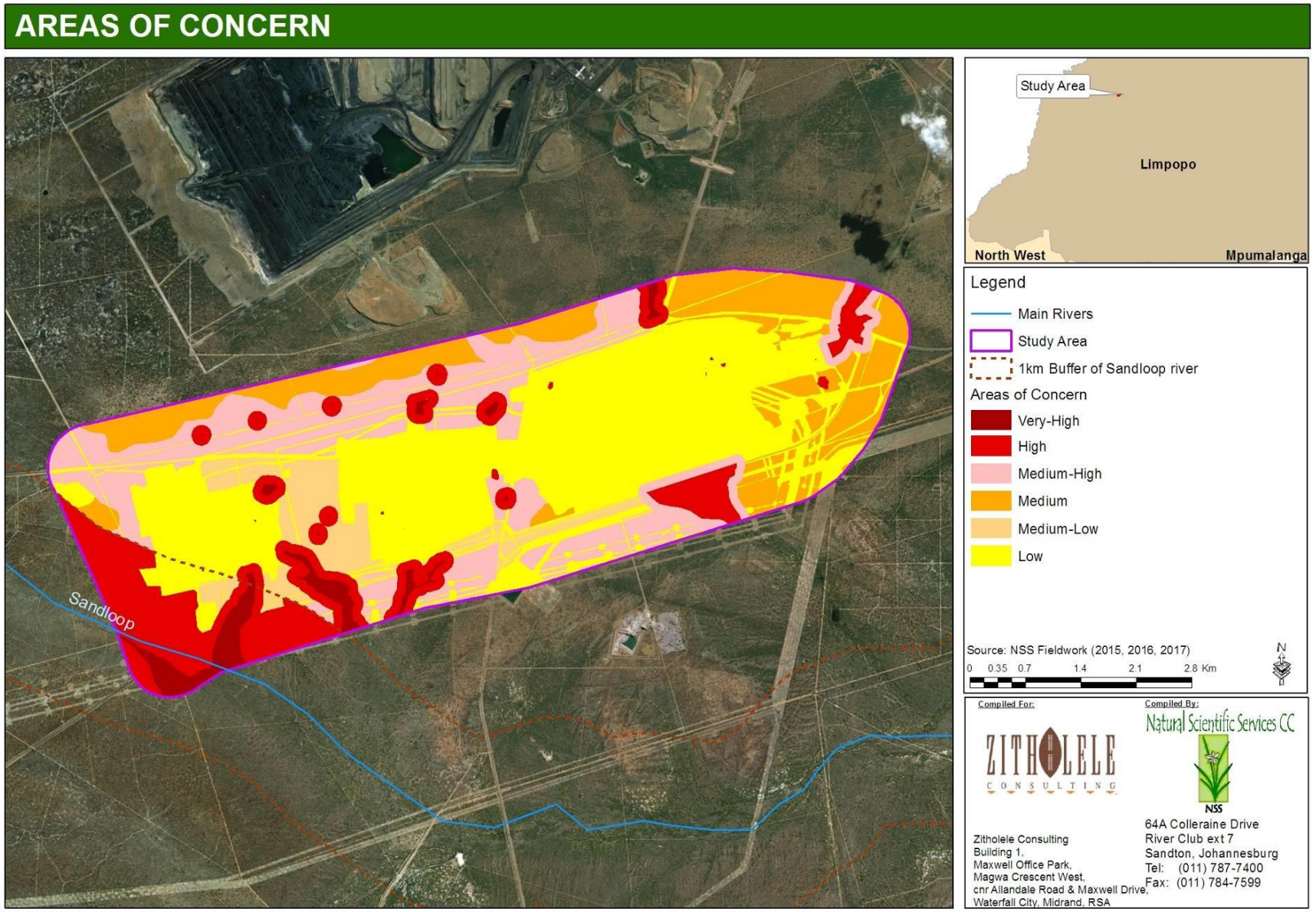


Figure 8-5 Local Significance (Areas of Concern shown only within the study area)

9. Impact Assessment

This impact assessment covers both the ADF and FGD plant and associated infrastructure areas at Medupi Power Station as it pertains to wetlands and aquatic biota, as well as terrestrial fauna and flora. Our assessment was completed according to the methodology prescribed by Zitholele, and in the context of:

- Various meetings with Zitholele and Eskom.
- Meetings with DWS.
- A workshop at Zitholele with all relevant specialists and engineers.
- Results from the desktop and field based investigations of fauna, flora, wetlands and aquatic invertebrates conducted over a period spanning 2014 to the present.
- Based on request from Eskom Medupi Management this included the amalgamation of three separate studies which included:
    - Terrestrial Biodiversity Assessment for the ADF Site Alternatives.
    - Medupi PowerStation: Railway Yard Ecological Assessment.
    - Wetland Assessment for the Proposed Ash Disposal Facility at Medupi Power Station.
- Relevant international, national and provincial legislation and policies.
- The national and provincial significance of wetlands and their local biodiversity, as highlighted e.g. by the NFEPA, the Mining and Biodiversity Guideline, etc.
- Significance Rating for the wetlands and associated buffer zones.

It is important to note that a number of mitigation measures have been specified in conceptual engineering plans to prevent contamination of the environment as a result of the FGD plant (refer to engineering reports). Additionally the design philosophy of the ADF and associated infrastructure has incorporated a number of measures aimed at reducing adverse effects to the environment. These are outlined in a number of reports as relevant to the ADF from Jones & Wagner (PTY) LTD (Report Numbers.: JW057/10/B754; JW68/14/D650 – Rev B; JW253/14/E009 – Rev0). Key mitigation measures as relevant from these reports are summarised below:

- The MPS ADF will be the first of Eskom's ash disposal facilities to be lined. Additionally the PCD and storm water management systems will be lined.
- An amendment application by Eskom has been submitted to the respective authority for the installation of a Class C liner system. This liner design is set in terms of the norms and standards.

It should be noted that Eskom's MPS received a Record of Decision (Ref: 12/12/20/695) on 19 September 2006 for the Construction of Medupi Power Station (MPS), that specifically excluded Environmental Authorisation (EA) for the above-ground ashing facility, pending

further investigation. On 23 October 2009 (Ref:12/9/11/L50/6), through further inputs requested by DEAT, Eskom was granted EA for the Ash Disposal Facility (ADF). However, the EIA process conducted in 2006 and in 2008 did not identify the presence of wetlands on site. Subsequent investigations conducted by NSS in 2014 as part of the site selection for the FGD waste disposal facility revealed the possibility for the presence of wetlands within the current ADF area. NSS was commissioned to conduct a wetland assessment for this area. Fieldwork in 2015 and again in late 2016 confirmed the presence of a number of depressions and semi-arid ephemeral wash wetlands within the area earmarked for the construction of the ADF. Discovery of wetlands within the proposed infrastructure footprint at such a late stage, during site clearance and construction of the ADF, has obviously presented a number of challenges regarding the protection of these water courses. Areas of current disturbance are shown in **Figure 9-8**.

Ideally no development should occur within the 1:100 year floodline and 1 km buffer on the Sandloop FEPA. However, given the circumstances NSS suggested that MPS should develop several infrastructure design alternatives from an engineering perspective that seek to primarily avoid development within this area altogether or, if impossible, illustrate designs that minimise the extent and impact of the footprint on the various HGM units identified as well as the 1:100 year floodline and Sandloop buffer. Since the initial drafting of this report Eskom has commissioned a study by Golder to revisit the 1:100 year floodline which has subsequently been reduced in extent and now only marginally clips the south western boundary of Site 13. In terms of changes to the ADF design some changes have been made but these are very small and still encroach similarly on the FEPA buffer and would still see the loss of pans C20 (bullfrog breeding site) and C21 (possible bullfrog breeding site). Encouragingly however, C11 appears to have been spared based on the current layout supplied to NSS.

NOTE: The methodologies for this impact assessment require that impacts are grouped according to activities. Therefore the most conservative risk rating for each activity has been provided.

Definitions for the Existing, Cumulative and Residual impacts are provided below:

- *Existing impacts* – The Coal stockpiles and associated traffic movement, the initial construction of the Medupi ADF (including Earthworks, clearing of vegetation etc) as well as the MPS.
- *Cumulative impacts* - These include the *Existing* defined impacts as well as the completion of the ADF, the FGD retrofit and the disposal of ash and gypsum at the ADF, as well as the transport of sludge and salts to an existing licensed facility.
- *Residual impacts* – This relates to post mitigation considering the *Cumulative Impacts* and assumes that mitigation has been effectively implemented.

Immense vegetation clearing

Coal deposition on roads and surrounds

Clearing of vegetation and topsoil

Seepage from the Pollution Control Dams

Berms and impeded flow

Unnecessary destruction of surrounding vegetation

Storm water collection southern portion of the ADF

Coal spills on railway

Vegetation clearing

Vegetation clearing

Large earthen trench around Site 13

Sources of sedimentation

Figure 9-1 Impacts in the Study Area

9.1. Activity: Site clearing

9.1.1 *Impact: Loss of wetland systems*

Description: Clearing of vegetation can result in the destruction of wetland habitat and ecosystem services. Although it is evident that a large portion of the vegetation has already been cleared and potentially a number of Depressions (pans) and extensions to the Semi-Ephemeral Washes, further loss of the systems that remain within the boundary is inevitable, specifically within the current area set aside for the ADF Footprint (Alternative 5). The existing overall impact risk of the historical clearing of vegetation is, therefore, rated as Very High (or flawed). Without mitigation, the overall cumulative impact risk of clearing vegetation for the ADF is rated as Very High (or flawed).

Mitigation: With effective mitigation, the overall residual impact risk of clearing vegetation could be reduced to High. The following mitigation is recommended:

- Alternatives 1 and 3 present the least amount of wetland loss compared to Alternatives 2, 4 and 5. Alternative 5 is the current proposed footprint area which is not an ideal situation but is currently said to be the only practical solution after some realignment of the ADF design in the south-western corner.
- Within Site 13 efforts should be made to situate tools, materials and infrastructure so as to minimise loss of wetland resources.
- Continue to stockpile topsoil and avoid mixing with deeper layers to retain viability of the seed bank.
- Eskom's EO should regularly monitor progress and implementation of mitigation measures.
- Vegetation should preferably be cleared during winter, when many fauna are less active or have migrated. If this is not possible a faunal specialist should be on site during clearing processes.
- Clear approved areas only. Site visits reveal that this has the potential to spill over into other areas very easily.
- Demarcate and restrict anthropogenic disturbances to the construction area.
- Where possible in the removal process, species such as geophytes should be collected and stored in a nursery for future rehabilitative efforts around the mine. Grass seeds can also be collected and stored and used during operation in a number of rehabilitation exercises.
- Construction crews should be informed about the importance of biodiversity through an induction process. Awareness of potentially harmful animals such as snakes should also be raised. The appointed EO on site should be trained to handle snakes.

9.1.2 *Impact: Loss of ephemeral pan habitat for bullfrogs and aquatic biota*

Description: Potentially the most direct, adverse and tangible impact on biodiversity as a result of the development of this project involves the loss of ephemeral wetland habitat upon which a diverse group of amphibians and a unique assemblage of aquatic invertebrates depend. These systems also provide a valuable source of water and refuge in an otherwise arid landscape and, based on our motion camera evidence, are regularly visited by a wide diversity of terrestrial fauna of which many are considered to be conservation important species. Additionally of high significance in this regard would be the potential unearthing of Giant or African Bullfrogs the likelihood of which is deemed to be moderate to high given the proximity to known bullfrog breeding sites situated inside and outside of the site. This impact is most applicable to the ADF as, due to the high degree of fragmentation and disturbance, bullfrogs have likely already been extirpated from the railway yard / FGD area.

STATUS	EXTENT (ha)
Depressions already lost	3.9
Current depressions	12.1 ha
Depressions to be lost	2.4

Mitigation: With effective mitigation, the overall residual impact risk of clearing vegetation could be reduced to Moderate. The following mitigation is recommended:

- It was originally suggested in the first drafts of this report that efforts should be made to carefully design and install infrastructure (including tools and materials) so as to minimise the loss of wetland resources particularly Pans C11, C21 and C20 (known bullfrog breeding site) and the eastern tributary of SEW 1. At the time the conceptual ADF design cut pan C20 in half and the middle of the three proposed PCD footprint areas covers pan C21. It was suggested that a northerly shift in the geometry of the southern ADF boundary could spare C20 and that a shift in PCD positioning should be considered in earnest to conserve these pans.
- It has subsequently emerged following the workshop held at Zitholele with the Eskom engineers that this would not be feasible.
- It was previously recommended that should this be the case i.e. that pans C11, C20 and C21 are to be destroyed, a bullfrog specialist should be commissioned to capture and relocate bullfrogs to a nearby secure pan with full Eskom labour support. Any other overwintering bullfrogs unearthed during clearing activities should also be relocated to a nearby pan (preferably within Site 12).
- These measures (to commission a bullfrog study and relocate bullfrogs to new artificially engineered habitats) were strongly supported and in fact recommended during a meeting (30 November 2017) with P. Ackerman at DWS head office as well as by discussions with Dr Caroline Lötter an authority on bullfrogs.
- At the time of writing this updated and consolidated report NSS has been commissioned to conduct a wetland rehabilitation and offset plan. A significant

portion of this plan involves close collaboration with Eskom's amphibian specialist from EWT with the overarching aim of relocating bullfrogs to newly created pan habitat outside of the site. Exact methodologies and mitigation measures in this regard will be outlined in the reports which emanate from this relocation project.

- At least some of the larger relocated individuals should be tracked through radio telemetry or GPS data loggers.
- Bullfrogs are explosive breeders that emerge for brief periods of the year following strong downpours. As such the overall success of relocation efforts relies heavily on diligent and accurate rainfall monitoring by Eskom and the issuing of prompt alerts of high rainfall events to the relevant specialists (NSS and Eskom's amphibian specialist from EWT).
- Any overwintering bullfrogs unearthed during clearing activities (or otherwise) should be reported to the appointed EWT amphibian specialist or if unavailable NSS.
- The appointed EO and several other staff members on site should be trained to handle bullfrogs and snakes.
- Any bullfrogs found after the relocation efforts should be relocated to one off the newly created pans that have shown signs of bullfrog establishment (consult EWT or NSS for advice if necessary).

9.1.3 *Impact: Loss of Acacia Woodland Habitat*

Description: Clearing activities during construction will result in the direct loss of remaining vegetation within the ADF and FGD. However, the area in which the rail yard is to be constructed (eastern section) is already disturbed and contains soil stockpiles. This section of the site has largely been transformed already and therefore the impact is expected to be of low significance here. However, following the workshop held at Zitholele it was suggested that a conservative approach should be taken that the entire railyard / FGD area would be cleared. The potential loss of these more natural pockets of Limpopo Sweet Bushveld within the railway yard / FGD area as well as that within the much larger ADF area this impact is considered to have a high cumulative impact and a moderate residual impact.

Mitigation: The following mitigation applies:

- Clearing needs to occur only within the footprint of the proposed ADF (Alternative 5) and the FGD / railway yard area. If at all possible vegetation in the western corner of the railway yard area must remain intact and undisturbed.
- The area of construction should be fenced to prevent encroachment into surrounding vegetation.
- Any bulbous species or PT species that can be transplanted must be removed.
- Alien species must be controlled under the MPS Alien Control Programme.

Figure 9-2 Existing clearing of *Acacia* woodland for the ADF

9.1.4 *Impact: Potential increase in alien vegetation species*

Description: Clearing activities during construction will result in an initial decline in the alien species that are currently on disturbed areas. This, although positive may only last for the clearing phase of construction. During construction and operation alien species can increase due to all the disturbances. Furthermore, seedbanks for species such as *Nicotina glauca* have already established on site.

Mitigation: The following mitigation applies:

- Clearing needs to occur only within the footprint areas and all Category species must be removed during this process.
- Alien species must be monitored and controlled under the MPS Alien Control Programme.
- Construction crew must be made aware of the species that occur on site specifically Category 1 species and must be trained in the basics for recognition and removal.

9.1.5 *Impact: Potential loss of CI floral species*

Description: Clearing activities during construction will result in the direct loss of remaining vegetation and therefore specific CI species. There are a number of Protected Tree species present in the area including *Sclerocarya birrea* subsp. *caffra* (marula), *Boscia albitrunca and Spirostachys Africana. Sclerocarya birrea* is a keystone plant species, which is rated as one of the most highly valued indigenous trees because of its multiple uses. It is identified as a key species to support the

livelihood of rural communities and it is central to various commercial activities. It is also widely used by game in protected areas and by humans in communal areas for its fruit, wood and medicinal properties (Tshimomola, 2017). As a keystone large tree species in southern Africa it has been recorded as declining at an unprecedented rate in areas such as the Kruger National Park (KNP) (Helm & Witkowski, 2012)). Studies conducted in the KNP showed the loss of adult marula trees in some areas over the last decade exceeded 25%, with rainfall having a strong influence on mortality rates temporally and spatially. Overall, marula populations continue to decline and further local extinctions are possible, not just in the KNP. Given the clearly unacceptable trends of decline, it is imperative that these Protected species be conserved across the country where possible.

Boscia albitrunca was not recognised as a Protected tree species in South Africa in terms of section 12 of the National Forests Act, 1998 (Act No. 84 of 1998), but has more recently been added due to its role as a Keystone species. This was clearly evident during the NSS surveys where this species was providing browse to livestock and game, shade and food and shelter to other species including invertebrates and birds.

Mitigation: MPS has removed tree species successfully during the construction phase of their MPS. Therefore the same would apply here. The Environmental Officer (EO), or trained botanist will be required to tag all Protected Trees within the footprint for removal and relocation. These individual plants will need to be monitored over the long term. Permits will be required for the removal process with DAFF. Any other species that may be identified as CI must either be translocated (if possible) or specific mitigation must be compiled by a qualified botanist in collaboration with the MPS EO.

9.1.6 *Impact: Potential loss of CI faunal species (excluding bullfrogs and raptors)*

Description: This impact relates to CI vertebrate species other than bullfrogs and raptors. Impact to these faunal groups are discussed in isolation elsewhere in the impact assessment. Clearing activities during construction may potentially result in the direct mortality of CI faunal vertebrates or result in their displacement. Although a wealth of CI species has been found to occur in the properties to the south of the FGD study area (Site 12 and 2) the impact as it relates to the ADF and FGD infrastructure is expected to be of Low significance. This is due to the area's high degree of vegetation and sensory disturbance levels which appears to have resulted in a low diversity and conservation status of potentially occurring CI vertebrate species (other than bullfrogs) within the FGD study area. This impact on the loss of CI invertebrate species is deemed to have a low significance as well. This is because although there is some chance of losing CI baboon spider and scorpion species

during clearing, the severity at a regional scale is low given the expansiveness of similar remaining bushveld habitat.

Mitigation: Clear in winter. It is recommended that immediately prior to clearing that a walk down be conducted by in conjunction with a suitable specialist, preferably one with expertise in arachnids, to intensively search the site preferably in the height of the rainy season (December) to detect and relocate any baboon or trapdoor spiders or scorpions frogs, tortoises. If any of these species are encountered during development the specialist with should advise upon and oversee oversee relocation.

9.1.7 *Impact: Potential loss of CI raptor species.*

Description: This impact is deemed to be of low significance due to the very low likelihood as no nests were observed on within the FGD study area. Although suitable nesting structure (Trees > 5m) was present (but limited), disturbance levels from the power station and current clearing activities is probably too high. However if nests were overlooked and are destroyed the significance of this impact would be high given the high (Vulnerable) conservation status of these raptors. Loss of foraging habitat is considered to be of low significance due to small extent and fragmented nature of the site that currently supports low game densities.

Mitigation: Mitigation is limited and likelihood is very low. However if a nest of CI raptor species is encountered, its location should be marked, and it should be reported to the relevant authorities before construction continues. Normally a minimum 1km radius buffer or exclusion zone should is applied to such points but given the complex nature of this project would require in depth consultation with an appropriately experienced ornithologist. As far as possible large trees above 5m should be marked and safeguarded in the unaffected areas.

9.1.8 *Impact: Loss of foraging habitat for game species.*

Description: This is an impact with greatest relevance to the rail way yard area. It is considered to be of low likelihood but has the potential to be problematic if managed incorrectly. The extent of remaining natural vegetation is already highly fragmented and barely large enough to support viable herds of game without significant grazing supplementation. Currently the proposed disturbance footprint within the railway yard area does not encroach appreciably into the main patch of natural vegetation but if it ends up exceeding this area the Kudu and Impala present on site may be left with too little foraging habitat and would need to be captured and relocated.

Mitigation: Clearly demarcate the footprint area. Minimise disturbance footprint and restrict construction and operation activities to within the proposed footprint area. The

EO must monitor the carrying capacity relative the game within the Railyard area and act accordingly to ensure that there is enough grazing land for the existing game within this area, otherwise implement capture and relocation. If the game are to be kept then standard game keeping management principles must be adhered to and a management plan drawn up for the game. All relevant permits must then also be in place.

9.2. Activity: Construction and operation of the ADF and FGD infrastructure

9.2.1 *Impact: Loss of catchment area and consequent decrease in water inputs as a result of the necessary containment of dirty water runoff*

Description: Currently the MPS project as a whole has displaced a large proportion of wetland catchment area and has undoubtedly acted to reduce water inputs. Flows which do remain have been largely concentrated and directed into wetlands south of the greater project area. This situation is likely to be exacerbated in the future under the construction of the storm water infrastructure which is required to prevent dirty water from the FGD and ADF from entering the environment. The ephemeral depressions, washes and Sandloop FEPA in the focal area rely heavily on diffuse source water inputs from surface and subsurface flows following rainfall events that are in turn governed by the region's erratic and intense summer rainfall patterns. The contents of the ADF are classified as hazardous waste and therefore any water runoff directly from the facility, by necessity (due to, *inter alia*, water quality implications), will be contained within a closed system and separated from clean water and the receiving environment. An unavoidable consequence of this is the loss of a significant portion of the catchment area for the depressions and wash wetlands on site, and the upper reaches of the Sandloop FEPA. The catchment of these systems was modelled by NSS using USGS derived digital elevation data together with a channel analysis. The resultant catchment area was calculated as 4320.5 ha. It should be noted that our estimate on catchment area is largely congruent with that of the surface water study (4467 ha) conducted by Zitholele (2016). This report includes catchment losses as a result of the MPS which increases catchment losses to 49.5 % (Zitholele, 2016). Our estimates are thus more conservative in that they deal with catchment losses directly as a result of the construction of the ADF alone. Results of the extent of catchment loss for the various infrastructure alternatives are given in **Table 9-1**. This table shows that regardless of the alternative (Alternative 5) opted for, the degree of catchment loss as a result of the construction of the ADF remains high with the current footprint resulting in a loss of 584.93 ha (13.54%). This level of catchment loss will likely result in a reduction in surface water inputs to these wetland systems and should be regarded as significant especially in light of the arid, water stressed nature of the receiving environment.

Table 9-1 Extent of catchment loss for the various infrastructure alternatives

INFRASTRUCTURE ALTERNATIVE	CATCHMENT LOSS
Alt 1	526.2 ha (12.2 %)
Alt 2	602 ha (13.9)
Alt 3	586.1 ha (13.6)
Alt 4	625.58 ha (14.5)
Alt 5	584.93 (13.54)

Mitigation: The mitigation with regards to catchment loss is limited and the residual impact risk remains High. Efforts should be centred on minimising catchment loss by minimizing the ADF, PCD, coal stockpile and other associated infrastructure to as small an area as possible. Particularly, efforts should be made to minimise any further encroachment into the Sandloop 1:100 year floodline and 1 km buffer. Release of clean water into the environment needs to be carefully engineered such that it enters the watercourses in a diffuse not concentrated flow to prevent erosion. This involves the use of flow attenuation and spreading structures at outlet points. The large earthen trench around the site compounds this issue and requires re-thinking from an engineering perspective. If found to be of value it should constructed so as to handle surface runoff in high rainfall events such as was observed during the previous site visit. If its purpose cannot be convincingly motivated it should be removed, re-landscaped and revalidated.

9.2.2 *Impact: Increased faunal mortality*

Description: Particularly relevant for species with low dispersal abilities e.g. fossorial species, tortoises, chameleons and various other reptile and frog species. During construction clearing will likely dispatch any species in the path of clearing. During operation, continued mortality is expected as vehicle and train activity increases but the effects of this are deemed to have Moderate impact..

Mitigation: The site should be searched prior to clearing by an appropriately qualified specialist and any less mobile fauna relocated. Maintain existing tortoise road signs and insert new ones where necessary. Continue to enforce speed regulation controls such as speed humps and limits.

9.3. Activity: Harvesting of hillwash material (topsoil) within the ADF footprint

9.3.1 *Impact: Potential loss of wetlands and deterioration in downstream Sandloop wetland drivers*

Description: These somewhat cryptic wetlands were originally not identified by the appointed specialists during the environmental authorisation process for the MPS

and subsequently the ADF. An EA was granted in 2009 (Ref12/9/11/L50/6). Some of the depressions and washes were consequently lost through construction activities. Nevertheless a number of these systems still remain and have the potential to retain much of their integrity and ecological functioning. The main impact associated with the harvesting of hillwash material is the potential direct loss of depressions and semi-arid ephemeral wash wetlands and their vegetation as well as deterioration in the downstream hydrological and geomorphological drivers of the Sandloop through changes in water distribution and retention patterns and increased sedimentation respectively. Without mitigation this impact has the potential to significantly impact water courses on a national scale with legal ramifications but also the potential loss of charismatic species such as bullfrogs.

Mitigation: Following mitigation measures and recommendations made in this report these impacts can be reduced from a High to a Medium and construction could conceivably occur without detrimentally damaging the ecological integrity and biotic functioning of these systems. With effective mitigation, the overall cumulative negative impact risk due to earth works could be reduced to Moderate. The residual impact is rated as Medium and not Low as there is still the potential for a loss in water inputs (due to a collection in scraped areas) to the depressions and washes which rely so heavily on surface water inundation following rainfall events as well as the ever present potential for increased sedimentation and biotic isolation and fragmentation of these systems as connecting vegetation is cleared around them. The following mitigation measures are recommended:

- Harvesting of hill wash material must be prohibited within at least 100 m of the delineated edge of all identified depressions and semi-arid ephemeral wash wetlands.
- Harvesting of hillwash material should not encroach upon the delineated 1:100 year floodline boundary and the 1 km buffer on the Sandloop FEPA).
- Ensure that harvesting of hill wash material does not take place within a 500 m radial buffer of the identified bullfrog breeding site (Depression C 20) and within a 100 m of C20 and C11.
- Ensure that the responsible on site personnel have the delineated wetlands and their associated buffers on their GPSs.
- Make sure that these areas are clearly demarcated with high visibility fencing and prohibit all activities within these areas with signage that indicates it is an environmentally sensitive area. Keep scraping neat and systematic.
- Stockpile topsoil in an area situated as far as possible from all identified wetlands to avoid sedimentation.
- Ensure that measures are taken to contain topsoil during rainfall events and prevent it washing into the environment. Attempt to maintain the natural stratigraphy of the topsoil when stockpiling.

- Ensure that all guidelines and standards are met with regards to the stockpiling of topsoil.
- The stipulations within the ROD (12/12/20/695) must be adhered to as well as the EA (Ref: 12/9/11/L50/6).
- Additionally a Risk Assessment performed by a suitably qualified professional will need to be conducted that takes cognisance of the identified wetlands and the national importance of the Sandloop FEPA.

9.4. Activity: Earth Works (associated with construction of the ADF)

9.4.1 *Impact: Deterioration in wetland drivers*

Description: Current impacts associated with the earth works specifically during the current construction of the ADF were rated as **High** and include:

- The clearing of the ADF which has displaced a number of pans and portions of the upper Sandloop tributaries but also encroaches on the Sandloop FEPA buffer. Additionally soil berms created adjacent to the ADF are impeding flow - see **Figure 9-2** above.
- Erosion and sedimentation. Large V-drains have been dug around the ADF. As these are not lined with concrete or other stabilising structures some breakthrough has taken place along the southern boundary. Indeed some of these breakthroughs have been facilitated by earthmoving equipment in an attempt to drain the flooded trenches into one of the eastern-most tributary of HGM unit 1. Currently these berms are not adequate for heavy rainfall and at certain points, these trenches have failed with sediments etc been washed downstream.
- An increase in herbaceous alien flora is transported along these channels and washes towards the Sandloop system.

Future impacts from excavating, levelling, compacting and dumping material can cause:

- Further dust, erosion and sedimentation downstream;
- Further loss of fossorial fauna such as many of the frogs shown in **Figure 7-10**.
- Proliferation of alien flora and therefore an increase in competition with indigenous species.

As these activities are already underway the Cumulative Impact is seen to remain as High. In terms of positive impacts, the earthworks through excavations etc have created “wetland” habitat for faunal species such as the African and Giant Bullfrog. These areas also are deep enough to stay wet for longer and provide a source of drinking water to small animals. This is, however, considered of Moderate significance (both current and cumulative).

Mitigation: With effective mitigation, the overall cumulative negative impact risk due to earth works could be reduced to Moderate.

- The ultimate aim of the construction of the ADF and associated infrastructure would have been to attempt to ideally remain outside of or at least opt for infrastructure layout that minimises the disturbance footprint within the 1:100 year floodline and the 1 km FEPA buffer.
- Eskom's EO to be on site regularly, and to monitor progress and implementation of mitigation measures.
- Daily wetting of exposed surfaces during earth works to control dust (refer to Air Quality IA for further mitigation measures).
- Erosion Management Plan to be compiled and implemented. Measures that could be considered include:
  - Placing biodegradable sand bags around stockpiles, the construction footprint, etc. As the topography is flat, these are recommended as opposed to berms.
  - Re-investigate the design of the Storm Water Management, specifically the canals within the southern section of the current ADF footprint. These are failing in large rainstorm events. The stormwater management and water balance calculations need to be consulted or revisited to ensure that the volumes of surface water floodpeaks have not been not underestimated. The water entering channel immediately around the ADF must be a closed system. The outer channel surrounding the entire ADF needs to be reinforced with erosion protection measures such as concrete or ground reinforcing materials like Terratame 2, particularly along the southern and western boundaries of the ADF site. If this structure is not deemed necessary by J&W following the installation of the planned stormwater management infrastructure then it should be removed and rehabilitated. Ideally design alternatives of the ADF, stormwater and associated infrastructure by the engineers that takes cognisance of the large erratic storm flows volumes and the sensitivity of pans, washes and Sandloop FEPA needs to be conceived and presented to the relevant specialists for comment.
  - Prevent further overflow of water from the dams to the east of MPS.
  - Rehabilitation of areas disturbed both inside and outside of Site 13, these areas should be identified in the rehabilitation plan.
  - Once an infrastructure footprint area has been finalised ensure rehabilitation of all remaining disturbances outside this area, for example removal of berms, infill and re-vegetation of borrow pits (Only locally indigenous flora should be used for re-vegetation of disturbed areas).
  - During earthwork sessions a faunal specialist should be on hand for any species that will require translocation during the construction phase.

- The new ADF ideally should be designed according to the Waste Classification and Management Regulations and Supporting Norms and Standards 2013.

9.5. Activity: Increased Traffic, Machinery & Human Activity

9.5.1 *Impact: Increased sensory disturbance to fauna*

Description: Increased sensory disturbance from lights, traffic, railway noise and increased human activity is likely to displace a wide range of faunal species. Given the site's proximity to the heavily lit and noisy power station this impact is likely to have a moderate effect on local fauna.

Mitigation: Keep lighting to a minimum during construction but most significantly during operation. Lights should be angled downwards and hooded to lower light pollution. Restrict unnecessary access to the remaining patches of natural vegetation.

9.5.2 *Impact: Construction related increases in the deposition of residues and dust as well as roadkill of wetland dependant fauna*

Description: Current and future impacts in the study area include:

- Coal transport and deposition of coal on the road and side surfaces. As the topography is relatively flat, with heavy rains this material is transported by the Semi-ephemeral Washes downstream towards the Sandloop. The sediment sample analysis suggests potential links between the high heavy metal content in a number of the samples close to or on site with the coal operations.
- Collision of vehicles with fauna, in particular, many of the frogs, which migrate between their burrow and breeding sites following heavy rainfall.
- An increase in dust and ultimately an increase in sedimentation towards the NFEPA Sandloop system. It is important to note that the railway line that runs adjacent to the southern boundary of the proposed ADF is subject to coal spills. Although this is not a fault on Eskom Medupi's part, the MPS staff do proactively take measures to clean these spills on occasion (F. Sono, Eskom *pers. comm*).

The existing overall impact risk from traffic and human activity was rated as Moderate. Increased traffic, machinery and human activity, especially during construction of the ADF, will likely cause increased pollution (refer to the sediment analysis of the depressions on site), dust and erosion. Impacts from increased traffic, machinery and human activity will be of greatest magnitude during the short-term

construction phase. The overall cumulative impact risk from traffic and human activity was rated as High.

Mitigation: With effective mitigation, the overall cumulative impact risk from increased traffic and human activity could be reduced to a Moderate rating. To mitigate impacts from traffic and human activity the following should be applied:

- Remain outside of the Sandloop buffer area;
- Service and maintain vehicles regularly;
- Eskom must ensure that all trucks before leaving the storage area shall be completely covered with a tarpaulin or any other effective measure/device. Trucks must not be over-loaded to ensure no spillage during transportation;
- Reduce coal movement as much as possible during high wind events;
- Proper drainage system shall be provided in the coal storage area so that water drained from sprinkling and runoff is collected at a common tank and can be reused after treatment.
- Traffic and construction activities should be limited to daylight hours.
- Regular surface wetting is required;
- Demarcate and restrict anthropogenic disturbances to the construction area.
- Measures such as speed humps, signage and fines should be implemented to reduce speeding and any off-road driving.
- Off-road driving must be prohibited in all surrounding natural areas as this could increase the risks of erosion.

9.6. Activity: Construction clearing and resultant increase in exposed surfaces during construction of the FGD plant, ADF and associated infrastructure.

9.6.1 *Impact: Increase in floodpeaks, sediment loads and erosion to wetlands*

Description: Construction of the FGD, ADF and associated infrastructure is likely to increase the extent of bare soil surfaces. Runoff from these large areas during high rainfall events may significantly increase sediment loads into the receiving wetland systems (mainly SEW 1 and 2). Soil erosivity associated with the aeolian sands on site is high. Consequently any concentration in flow from the construction sites during high rainfall events is likely to cause some erosion of the head of the wash systems.

Mitigation: The mitigation in this regard centres on stormwater management and minimising the extent of unnecessarily cleared ground. It is important that earthen drain around the outer boundary of Site 13 is improved to prevent break through as was observed following heavy rains in December 2015. This drain should be lined and reinforced. If any outlet or overflow points are made to release water accumulated in this trench during construction then it should be done so at multiple points, each fitted with flow attenuation structures and should tie in with the natural

drainage patterns and not at arbitrary points (See **Figure 7-12**). Regarding the FGD and associated infrastructure to the east it would be preferable if the planned stormwater infrastructure could be constructed first. In any event attempt wherever possible to conduct the majority of construction during winter. The design philosophy of rehabilitation following the advancing face of the ADF should be implemented, with the primary goal being to establish a stable, indigenously vegetated topsoil cap as soon as possible.

- Erosion and Storm Water Management Plan must be revised to allow for heavy rainfall events.
- Pamphlets should be designed and included into induction processes. These should include as a minimum:
    - Wetlands and their importance.
    - The role of the nearby FEPA and surrounding habitat;
    - General environmental management processes such as recycling; littering, species (e.g. bullfrog) harvesting, etc.

9.7. Activity: Trucking Waste to Holfontein

9.7.1 *Impact: Spills, roadkills and other traffic associated impacts*

Description: There are no current impacts on this activity and the waste is yet to be transported to a waste Disposal Facility. "*The trucking of Type 1 wastes to Holfontein will be carried out for a limited period, until the second EIA is approved and the salts and sludge can be disposed of at Site 13 and the additional site*" (*pers.comm*. Zitholele). The cumulative impact risk from trucking the waste was rated as Moderate. Potential future impacts could include:

- Spills of this waste from trucking.
- Collision of vehicles with fauna, in particular, many of the frogs, which migrate between their burrow and breeding sites following heavy rainfall.
- Vehicle accidents along the route, and potential spills.

Mitigation: With effective mitigation, the overall cumulative impact risk from increased trucking could be reduced to Moderate. To mitigate impacts from trucking the following should be applied:

- Service and maintain vehicles regularly;
- Drivers must undergo regular testing in terms of drivers skills etc;
- Waste in the trucks must be sealed for the transportation;
- Trucking should be limited to daylight hours, with frequent stopping along the route to allow for rest breaks;
- A Hazard Plan must be compiled with the procedure following a spill clearly defined. This Plan must include the relevant 'Clean-Up' companies and their contact details.

9.8. Activity: Storage of substrates and by-products associated with the ADF and FGD operation.

9.8.1 *Impact: Contamination of wetlands from storage facilities associated with the ADF and FGD– Consequences for bullfrogs and aquatic invertebrates.*

Description: The cumulative impact is rated as High while the residual impact may be reduced to Moderate. We have adopted a precautionary approach in not dropping it to low given observed stormwater infrastructure and coal PCD failure and overtopping respectively and given the increasing intensity of rainfall events that has been observed.

The existing impacts of contamination to bullfrogs, aquatic invertebrates and other biota dependant on the ephemeral pans and washes within the study area centre on elevated coal and heavy metal concentrations within the sediments and water column. Sediment analysis revealed heavy metal deposition within the ephemeral systems particularly at pans closest to the current activities on the MPS and ADF sites. In addition to this, the invertebrate hatching procedure yielded Fairy Shrimp within the first three days. However, these hatchlings did not survive. Past studies have shown that heavy metals have affected the population dynamics of this genus. With the high levels recorded within the sediment samples, this may be the cause of the hatchlings not surviving. Poor operation and maintenance of the FGD and ADF could lead to further heavy metal deposition in the ephemeral systems and thereby altering and reducing invertebrate population dynamics within these systems. A cumulative effect on altering and reducing invertebrate population dynamics within the ephemeral systems was also rated as High.

In the near future the flue gas desulphurisation process poses a potential contamination hazard to nearby water courses (SEW 2) and associated biota. Potential contaminants include the limestone which is used as a sorbent, gypsum the by-product of the desulphurisation process and manganese a substance present in the limestone. Although the limestone and gypsum themselves are not regarded as toxic, the high pH levels associated with lime slurry (pH 12.5) may be lethal to aquatic biota. Increased water hardness is an additional impact. SEW 2 is highly ephemeral and likely does not support fish however it does support a number of amphibian and aquatic invertebrate species. Effects to these organisms from highly alkaline waters may include death, damage to outer surfaces such as eyes and skin and an inability to dispose of metabolic wastes. Frog embryo development, in particular, has been to shown to be drastically impaired at pH levels above 11.5 (Padhye & Ghate, 1988). High pH may also increase the toxicity of other substances. For example, the toxicity

of ammonia is ten times more severe at a pH of 8 than it is at pH 7. Ammonia is toxic to aquatic life when it appears in alkaline conditions.

It emerged from the workshop held at Zitholele on 11 December 2017 that the exact source for the limestone and therefore its exact composition was thus unknown. It was further noted, however, that the limestone used usually comprises a high manganese content. Manganese generally occurs at high concentrations in the natural environment in South Africa especially in the Highveld. Our readings of manganese from downstream pans taken prior to construction of the FGD show acceptable levels within the sediments and slightly exceeding levels in the water column. The manganese concentrations in the water exceeded the guideline at MD1 and MD6. Very little known about the effects on aquatic organisms but elevated levels of manganese are toxic to fish (Heal, 2001). A thesis by Reimer (1999) investigated the effects of manganese on aquatic fish, macroinvertebrates and algae in British Columbia using lethal dose (LD_{50}) testing for acute and chronic levels. The author found that acute levels range between 0.6 mg/L to 3.8 (exposure less than 95 minutes) and chronic levels range between 0.6 to 1.9 mg/L but importantly that the actual LD_{50} concentration decreased with increasing water hardness. Manganese becomes biologically active when it enters its soluble state. Soluble manganese mostly occurs under low dissolved oxygen conditions. Therefore the naturally low dissolved oxygen levels and high water hardness within the regions pans together with the potential for increased water hardness from the stockpiles of limestone (calcium carbonate) to be stored within the FGD project area provide an environment conducive to manganese toxicity. However the concentrations of manganese that have the potential to be leached from the limestone stockpiles and slurry are unknown and need to be established.

One of the potential sources for contamination includes spillages of gypsum during transportation via the conveyor system from the waste water treatment plant to the storage area and in turn from the storage area to its ultimate destination be it the ADF or a prospective buyer. Under this scenario the main mitigating factor is likely to be the dirty water system which feeds into the MPS dirty water dam. Another potential source for contamination is spillages from trucks. Lastly the slurry / sorbent dams themselves may be a source for contamination due to overtopping (mis-calculated water balance and extreme rainfall events). The gypsum offtake structure itself is another potential source for contamination following high rainfall events. Oil transformer and pit areas pose a risk of hydrocarbon contamination. In the event of a spill oil and other hydrocarbons are likely to have the most significant and long lasting impact. Gypsum is not likely to a have a major toxicological impact although it may be associated with increase pH levels as will be the case for lime slurry. However the likelihood of such a contamination event is expected to be low given the proposed mitigation in the design philosophy (KnightPiesold, 2017) together with the arid nature

of the site, the ephemeral nature of the wetland systems and the distance of the storage areas from SEW 2 (ca. 800 m) hence this impact has been given a Moderate significance rating.

Mitigation: A number of mitigation measures are proposed from an engineering perspective (KnightPiesold, 2017) which may assist in preventing such contaminants from entering the receiving wetland (SEW 2):

- Measures to reduce the risk of contamination from the trucking spills include a concrete slab layer beneath roads and kerb inlets to the dirty water system.
- It is however imperative that spilt material is regularly cleaned up and that all drains inlets and stormwater infrastructure is regularly inspected for blockages and cleared out.
- The gypsum offtake structure may be a problem following high rainfall events, however a concrete bunding and a central depression is proposed to prevent spills. Again it is important to ensure this area is kept tidy and regularly cleaned out.
- At the oil transformer areas the pits are proposed to be bunded and have a concrete base of 100 mm thick. These pits need to be emptied regularly.
- Additionally manganese levels in the stockpiles as well as the environment should be monitored through regular water quality testing at the pans immediately south of the FGD and compared to current baseline levels.
- All of these measures, however, are designed to cope with a 1 in 50 year peak 24 hour rainfall event. However should an extreme rainfall event occur that exceeds this estimate or if maintenance (clearing drains etc.) has been inadequate these structures may fail and contaminants may enter SEW 2.

Other recommended mitigation includes:

- Regular surface and ground water quality monitoring is required to be continued at the current sediment sampling sites.
- Investigate remediation options for current and potential future surface and groundwater contamination e.g. phytoremediation.
- Sediment analysis of depressions and the ephemeral washes must be conducted yearly and compared with the current results for the site. This will then indicate whether heavy metal concentrations are increasing during the Operation Phase of MPS and its ADF.
- Annual monitoring of the aquatic invertebrate assemblage should be conducted at the various remaining sediment sampling sites.
- Amphibian assemblages should be monitored at key sediment sampling sites as well as the newly created pans once a year by means of acoustic, visual encounter transects.

- Measures should be implemented to minimise erosion on site, and potential sedimentation and contamination of the downstream ephemeral watercourse and associated dams;
- It is advised that water quality at local boreholes (if present) be monitored before and during construction of the site. The exact duration, frequency and positioning of the sampling points should be determined from the geohydrological studies commissioned for the site.

Table 9-2 Impact ratings – Construction Phase

CONSTRUCTION PHASE									
Activity	**Nature of Impact**	**Impact type**	**Extent**	**Duration**	**Potential Intensity**	**Likelihood**	**Rating**	**Mitigation**	**Interpretation**
Site clearing	Direct Impact: Loss of wetland systems.	Existing	1	5	16	1	22 - FLAW	With effective mitigation, the overall residual impact risk of clearing vegetation could be reduced to High. The following mitigation is recommended: • Efforts should be made to situate tools, materials and infrastructure so as to minimise loss of wetland resources. • Continue to stockpile topsoil and avoid mixing with deeper layers to retain viability of the seed bank. • EO should regularly monitor progress and implementation of mitigation measures. •Clear during winter. If this is not possible a faunal specialist should be on site during clearing processes. • Clear approved areas only. Site visits reveal that this has the potential to spill over into other areas very easily. • Demarcate and restrict disturbances to the construction area. • Where possible geophytes should be collected and stored in a nursery. Grass seeds can also be collected and stored. • Construction crews should be informed about the importance of biodiversity. The appointed EO on site should be trained to handle snakes and bullfrogs.	Loss of Wetlands and Watercourses/Washes on site for both MPS and the existing cleared area for the ADF and the impact on the NFEPA (Sandloop) is seen as a loss on a National scale.
		Cumulative	3	5	16	1	24 - FLAW		With the further construction of the ADF and loss of more wetlands/ washes and pans, this will remain a Very High Impact
		Residual	3	4	8	1	15 - HIGH		With mitigation (FGD) the residual impact will be slightly reduced due to a portion of the ADF staying out of the Sandloop buffer and implementing a wetland offset and rehabilitation plan.
Site clearing	Direct Impact: Loss of ephemeral pan habitat for bullfrogs	Existing	2	5	4	1	11 - HIGH	• It was previously recommended that pans C11, C20 and C21	To date operations at Medupi have seen the loss of 3.9 ha of suitable pan habitat.

CONSTRUCTION PHASE									
Activity	**Nature of Impact**	**Impact type**	**Extent**	**Duration**	**Potential Intensity**	**Likelihood**	**Rating**	**Mitigation**	**Interpretation**
	and aquatic biota.	Cumulative	2	5	8	1	15 - HIGH	should be conserved but if not possible, a bullfrog specialist should be commissioned to capture and relocate bullfrogs to a nearby secure pan with full Eskom labour support. Any other overwintering bullfrogs unearthed during clearing activities should also be relocated to a suitable nearby pan off site.. • Follow the mitigation that will arise from the bullfrog relocation project by NSS and EWT. • It is recommended that some of the larger relocated individuals be tracked through radio telemetry or GPS data loggers. • The overall success of relocation efforts relies heavily on diligent and accurate rainfall monitoring by Eskom and the issuing of prompt alerts of high rainfall events to the relevant specialists (NSS and Eskom's amphibian specialist from EWT). • Any overwintering bullfrogs unearthed during clearing activities (or otherwise) should be reported to the appointed EWT amphibian specialist or if unavailable NSS. • The appointed EO and several other staff members on site should be trained to handle bullfrogs and snakes or a trained specialist be contracted to execute this role. • Any bullfrogs found after the relocation efforts should be relocated to one of the newly created pans that have shown signs of bullfrog establishment (consult EWT or NSS for advice if	The construction of the ADF, based on the provided infrastructure layout will result in the loss of a further 2.4 ha bringing the total pan loss as a result of Medupi operations to 6.3 ha.
		Residual	1	2	4	1	7 - MOD		With the implementation of the mitigation and relocation project which involves the creation of new pan habitat this impact may be reduced to Moderate as favoured habitat will still be lost and there is no guarantee of the success of relocation.

CONSTRUCTION PHASE									
Activity	**Nature of Impact**	**Impact type**	**Extent**	**Duration**	**Potential Intensity**	**Likelihood**	**Rating**	**Mitigation**	**Interpretation**
								necessary).	
Site clearing	Direct Impact: Potential loss of vegetation units.	Existing	1	5	2	1	8 - MOD	• Clearing needs to occur only as necessary for the footprint of the ADF (Alternative 5) and the FGD / railway yard area. If at all possible vegetation in the western corner of the railway yard area must remain intact and undisturbed. • The area of construction should be fencedto prevent encroachment into surrounding vegetation. • Any bulbous and PT species that can be transplanted must be removed. • Alien species must be controlled under the MPS Alien Control Programme.	Clearing has already commenced.
		Cumulative	1	5	2	1	8 - MOD		Loss of vegetation will continue to increase within infrastructure footprint area.
		Residual	1	5	2	1	8 - MOD		Mitigation is limited regarding the loss of vegetation.
Site clearing	Direct Impact: Potential increase in alien vegetation species.	Existing	1	3	4	1	8 - MOD	• Clearing needs to occur only as necessary for the footprint areas and all Category species must be removed during this process. • Alien species must be monitored and controlled under the MPS Alien Control Programme. • Construction crew must be made aware of the species that occur on site specifically Category 1 species and must be trained in the	Exists and is extensive (weedy annuals) particularly in disturbed areas within the railway yard area.
		Cumulative	3	5	4	1	12 - HIGH		Likely to increase without mitigation

CONSTRUCTION PHASE									
Activity	**Nature of Impact**	**Impact type**	**Extent**	**Duration**	**Potential Intensity**	**Likelihood**	**Rating**	**Mitigation**	**Interpretation**
		Residual	1	1	2	0.5	2 - LOW	basics for recognition and removal.	With mitigation can be largely reduced and further spread prevented.
Site clearing	<u>Direct Impact:</u> Potential loss of CI floral species.	Existing	1	5	4	1	10 - HIGH	MPS has removed tree species successfully during the construction phase of their power station. Therefore the same would apply here. The Environmental Officer (EO) or trained botanist will be required to tag all Protected Trees within the footprint for removal and relocation. These individual plants will need to be monitored over the long term. Permits will be required for the removal process with DAFF. Any other species that may be identified as CI must either be translocated (if possible) or specific mitigation must be compiled by a qualified botanist in collaboration with the MPS EO.	Many CI trees have been felled already.
		Cumulative	1	5	4	1	10 - HIGH		Situation likely to continue.
		Residual	1	5	2	1	8 - MOD		Loss is permanent.
Site clearing	<u>Direct Impact:</u> Potential loss of CI faunal species (excluding bullfrogs and raptors).	Existing	1	5	4	0.5	5 - MOD	Clear in winter if possible. It is recommended that immediately prior to clearing that a walkdown be conducted by Eskom and a suitable specialist, preferably one with expertise in arachnids, to intensively search the site preferably in the height of the rainy season (December) to detect and relocate any baboon or trapdoor spiders or scorpions frogs, tortoises. If any of these species are encountered during development the specialist the expertise should advise upon and oversee relocation.	Several species have likely been killed / extirpated as a result of current clearing activities.
		Cumulative	1	5	8	0.5	7 - MOD		Will be exacerbated.
		Residual	1	5	4	0.2	2 - LOW		Can be reduced to low if efforts are taken to construct in winter and safely relocate any CI specie encountered.

CONSTRUCTION PHASE									
Activity	**Nature of Impact**	**Impact type**	**Extent**	**Duration**	**Potential Intensity**	**Likelihood**	**Rating**	**Mitigation**	**Interpretation**
Site clearing	Direct Impact: Potential loss of CI raptor species .	Existing	1	5	4	0.5	5 - MOD	Mitigation is limited and likelihood is very low. However if a nest of CI raptor species is encountered its location should be marked and it should be reported to the relevant authorities before construction continues. Normally a minimum 1 km radius buffer or exclusion zone should is applied to such points but given the complex nature of this project would require in depth consultation with an appropriately experienced ornithologist. As far as possible large	Nests may have been destroyed already.
		Cumulative	1	5	8	0.5	7 - MOD		If raptor nests are destroyed it would be of a Moderate significance.
		Residual	1	5	4	0.2	2 - LOW		Following mitigation may be reduced to low.
Site clearing	Direct Impact: Loss of foraging habitat for game species.	Existing	1	5	2	1	8 - MOD	Mitigation: Clearly demarcate the footprint area. Minimise disturbance footprint and restrict construction and operation activities to within the proposed footprint area. The EO must monitor the carrying capacity relative the game within the Railyard area and act accordingly to ensure that there is enough grazing land for the existing game within this area, otherwise implement capture and relocation. If the game are to be kept then standard game keeping management principles must be adhered to and a management plan drawn up for the game. All relevant permits must then also be in place.	Currently infrastructure is encroaching on grazing habitat for the game in the railway yard.
		Cumulative	1	5	4	1	10 - HIGH		Should this continue unabated the consequence would be high for the game resulting in mortalities.
		Residual	1	5	2	0.2	2 - LOW		If the game and their grazing are appropriately managed the impact can be reduced to low.

CONSTRUCTION PHASE									
Activity	**Nature of Impact**	**Impact type**	**Extent**	**Duration**	**Potential Intensity**	**Likelihood**	**Rating**	**Mitigation**	**Interpretation**
Construction and operation of the ADF and FGD stormwater infrastructure	<u>Direct & Indirect:</u> Loss of catchment area and consequent decrease in water inputs as a result of the necessary containment of dirty water runoff.	Existing	2	3	2	0.5	4 - MOD	Mitigation with regards to catchment loss is limited and the residual impact risk remains High. Efforts should be centred on minimising catchment loss by minimizing the ADF, PCD, coal stockpile and other associated infrastructure to as small an area as possible. Particularly, efforts should be made to minimise any further encroachment into the Sandloop 1:100 year floodline and 1 km buffer. Release of clean water into the environment needs to be carefully engineered such that it enters the watercourses in a diffuse not concentrated flow to prevent erosion. This involves the use of flow attenuation and spreading structures at outlet points. The large earthen trench around the ADF site compounds this issue and requires re-thinking from an engineering perspective. If found to be of value it should be constructed so as to handle surface runoff in high rainfall events such as was observed during the previous site visit. If its purpose cannot be convincingly motivated it should be removed, re-landscaped and revalidated.	Some loss of catchment area has already occurred due to construction activities. A large tar road and a railway bisect the catchment. Additionally earthen trenches around the ADF site impede inputs to a degree although a break in the south-western corner allows outflow. The pans washes and Sandloop still receive notable flow from the ADF site.
		Cumulative	3	4	4	1	11 - HIGH		Without mitigation construction of the ash facility is likely to only result in a slight decrease in catchment water inputs into SEW 1 due to evaporative and dispersive losses. This loss is not anticipated to be as a high as it would be under the necessary mitigation scenario where v-drains and liners are installed that completely contain and isolate water from the facility (however a lack of these structures , as flow impeding as they may be, are required to avoid other serious environmental implications e.g. water quality) .

CONSTRUCTION PHASE									
Activity	**Nature of Impact**	**Impact type**	**Extent**	**Duration**	**Potential Intensity**	**Likelihood**	**Rating**	**Mitigation**	**Interpretation**
		Residual	3	3	4	1	10 - HIGH		It is a necessity that clean and dirty water separation take place at the ADF and FGD. Runoff directly from these areas would be considered dirty water (the majority) and therefore need to be contained within a closed system to prevent it from entering the environment. Under Alternative 5 the ADF and associated PCDs and infrastructure would cover 584.93 (13.54%) of the Sandloop Catchment. Therefore construction of the ADF throughout the western and southern most extent of the study area would result in a loss of a large portion of the Sandloop catchment. This is likely to result in a considerable reduction in surface water (dominant source) input into the SEW 1 HGM unit.
	<u>Direct Impact:</u> Increased faunal mortality.	Existing	1	2	2	1	5 - MOD	The site should be searched prior to clearing by an appropriately qualified specialist and any less mobile fauna relocated. Maintain existing tortoise road signs and insert new ones where necessary. Continue to enforce speed regulation controls such as speed humps and limits.	
		Cumulative	1	2	2	1	5 - MOD		
		Residual	1	2	2	0.5	3 - MOD		

CONSTRUCTION PHASE									
Activity	**Nature of Impact**	**Impact type**	**Extent**	**Duration**	**Potential Intensity**	**Likelihood**	**Rating**	**Mitigation**	**Interpretation**
Harvesting of hill wash material (topsoil) within the ADF footprint	Potential direct loss of depressions and semi-arid ephemeral wash wetlands and their vegetation as well as in downstream hydrological and geomorphological drivers through changes in water distribution and retention patterns and increased sedimentation respectively.	Existing	2	5	2	1	9 - MOD	Collection of hill wash material must be prohibited within at least 100 m of the delineated edge of all identified depressions and semi-arid ephemeral wash wetlands. Additionally harvesting of hillwash material should not encroach upon the delineated 1:100 year floodline boundary (which largely mirrors the 1 km buffer on the Sandloop FEPA). Ensure that harvesting of hill wash material does not take place within a 500 m radial buffer of the identified bullfrog breeding site (Depression C 20). Ensure that the responsible on site personnel have the delineated wetlands and their associated buffers on their GPSs. Make sure that these areas are clearly demarcated with high visibility fencing or markings and prohibit all activities within these areas with signage that indicates it is an environmentally sensitive area. Keep scraping neat and systematic. Stockpile topsoil in an area situated as far as possible	These somewhat cryptic wetlands were originally not idenfied by the appointed specialists during the environmental authorisation process for the ADF. An EA was granted in 2008, an inevitable consequence of this, however, was that some of the depressions and washes were lost through construction activities. Nevertheless a number of these systems still remain and with proper management have the potential to retain much of their integrity and ecological functioning.
		Cumulative	3	5	8	1	16 - HIGH		Without mitigation this impact has the potential to significantly impact water courses on a national scale and would pose legal challenges not least for encroaching on the 1:100 year floodline which supports the Sandloop FEPA but also for removing the identified wetlands.

CONSTRUCTION PHASE									
Activity	**Nature of Impact**	**Impact type**	**Extent**	**Duration**	**Potential Intensity**	**Likelihood**	**Rating**	**Mitigation**	**Interpretation**
		Residual	2	5	4	0.5	6 - MOD	from all identified wetlands to avoid sedimentation. Ensure that measures are taken to contain topsoil during rainfall events and prevent it washing into the environment. Attempt to maintain the natural stratigraphy of the topsoil when stockpiling. Ensure that all guidelines and standards are met with regards to the stockpiling of topsoil.	Following mitigation measures and recommendations made in this report these impacts can be reduced from a High to a Medium and construction could conceivably occur without detrimentally damaging the ecological integrity and biotic functioning of these systems. The residual impact is rated as Medium as there is still the potential for a loss in water inputs (due to a collection in scraped areas) to the depressions and washes which rely so heavily on surface water inundation following rainfall events as well as the ever present potential for increased sedimentation and biotic isolation and fragmentation of these systems as connecting vegetation is cleared around them.

CONSTRUCTION PHASE									
Activity	**Nature of Impact**	**Impact type**	**Extent**	**Duration**	**Potential Intensity**	**Likelihood**	**Rating**	**Mitigation**	**Interpretation**
Earth Works: Excavations, specifically for the ADF	Indirect Positive Impact: Current artificial wetlands (excavations) and potentially additional artificial wetlands	Existing	1	3	1	0.75	4 - MOD	This is seen as positive impact for breeding habitat for in the short term for species such as African and Giant Bullfrog. These excavations fill up when it rains and allows for competition and breeding to occur	Creating artificial systems seen as a positive short term impact in an area where pans and wetlands have been destroyed
		Cumulative	1	4	1	0.5	3 - MOD		The cumulative positive impact on wetland creation is not seen to increase in significance - potentially only a few additional areas will be created and these will be temporary in nature.
		Residual	1	4	1	0.75	5 - MOD		Discussion as per the cumulative and existing impacts
Earth Works: Ground excavations, levelling, compaction, creation of berms, deposition, etc., specifically for the ADF	Direct & Indirect: Deterioration in wetland drivers.	Existing	2	4	8	1	14 - HIGH	• Minimise disturbance within 1:100 year floodline and the 1 km FEPA buffer). • Daily wetting of exposed surfaces during earth works to control dust. • Erosion Management Plan to be compiled and implemented. • Placing biodegradable sand bags around stockpiles, the construction footprint, etc. As the topography is flat, these are recommended as opposed to berms. • Ensure that the volumes of surface water floodpeaks can be accommodated in the stormwater infrastructure. • The water entering channel immediately around the ADF must	At present, the current activities in the construction of the ADF is causing an increase in bare surfaces and run-off in to the existing Storm Water Channels. During high rainfall events, these channels are not coping with the flow and breaks in the channels and overtopping is occurring.
		Cumulative	2	4	16	0.75	17 - HIGH		As above - the current impacts will be enhanced

CONSTRUCTION PHASE									
Activity	**Nature of Impact**	**Impact type**	**Extent**	**Duration**	**Potential Intensity**	**Likelihood**	**Rating**	**Mitigation**	**Interpretation**
		Residual	1	2	4	0.5	4 - MOD	be a closed system. The current outer channel surrounding the entire ADF needs to be reinforced with erosion protection measures such as concrete or ground reinforcing materials, particularly along the southern and western boundaries of the ADF site. The stormwater and associated infrastructure must take cognisance of the large erratic storm flows volumes. • Prevent further overflow of water from the current coal PCD. • Rehabilitation of areas disturbed both inside and outside of Site 13, these areas should be identified in the rehabilitation plan.	With mitigation (FGD) the residual impact will be moderate: *Activities will remain outside buffer of Sandloop; *Improved Storm Water Design; * Bare areas will be vegetated
Traffic, machinery & human activity	<u>Indirect:</u> Increased sensory disturbance to fauna	Existing	2	2	4	1	8 - MOD	Keep lighting to a minimum during construction but most significantly during operation. Lights should be angled downwards and hooded to lower light pollution. Restrict unnecessary access to the remaining patches of natural vegetation.	Currently fairly high levels of disturbance.
		Cumulative	2	3	8	0.75	10 - HIGH		Likely to increase.
		Residual	1	2	4	0.5	4 - MOD		Unlikely to decrease much below current levels.
Traffic, machinery & human activity	<u>Direct & Indirect:</u> Increased pollution; Increased dust & erosion and ultimately degradation of surrounding wetlands.	Existing	2	2	4	1	8 - MOD	Mitigation would require frequent maintenance of trucks, ongoing driver training, covering of vehicles. Maintenance of all machinery must be kept up to date; Regular wetting of the road network and revegetation of bare areas that are not required for lay	Current impacts on wetlands and associated biodiversity is seen in the sediment analysis and may be attributed to coal deposition along the road networks and in the storm water channels etc.

CONSTRUCTION PHASE									
Activity	**Nature of Impact**	**Impact type**	**Extent**	**Duration**	**Potential Intensity**	**Likelihood**	**Rating**	**Mitigation**	**Interpretation**
		Cumulative	2	3	8	0.75	10 - HIGH	down areas etc.	With continued construction of the ADF and the use of the Coal Stockpile to the west, the impact on the watercourses and wetland is considered High
		Residual	1	2	4	0.5	4 - MOD		With mitigation the impact will be reduced to a low Moderate as due to the immensity of the operations, it is not possible to completely prevent dust etc.
Clearing and resultant increase in exposed surfaces during construction of the FGD plant, ADF and associated infrastructure	Indirect: Increase in floodpeaks, sediment loads and erosion to wetlands.	Existing	2	3	4	1	9 - MOD	Implement planned stormwater management and minimise the extent of unnecessarily cleared ground. Upgrade the earthen drain around the outer boundary of the Site to prevent break through following heavy rains . This drain should be lined and reinforced (preferably concrete). Any outlet or overflow points for PCDs or drains should be done so at multiple points, each fitted with flow attenuation structures and should tie in with the natural drainage patterns and not at arbitrary points (See Figure 7 1).	Recent clearing has exposed large tracts of land within a portion of the proposed ADF. Stormwater infrastructure is rudimentary at present and there is a large potential for sediment runoff and erosion.

CONSTRUCTION PHASE									
Activity	**Nature of Impact**	**Impact type**	**Extent**	**Duration**	**Potential Intensity**	**Likelihood**	**Rating**	**Mitigation**	**Interpretation**
		Cumulative	2	3	4	1	9 - MOD	Regarding the FGD and associated infrastructure it would be preferable if the planned stormwater infrastructure could be constructed first. Conduct the majority of construction during winter. Continuously rehabilitate following the advancing face of the ADF.	Without mitigation (appropriate stormwater infrastructure) the current situation would be exacerbated.
		Residual	1	2	1	0.5	2 - LOW		With the installation of the proposed stormwater infrastructure the risk of sedimentation and erosion is really reduced.

Table 9-3 Impact ratings – Operation / Decommissioning Phase

OPERATIONAL PHASE									
Activity	**Nature of Impact**	**Impact type**	**Extent**	**Duration**	**Potential Intensity**	**Likelihood**	**Rating**	**Mitigation**	**Interpretation**
Operation of the ADF and FGD stormwater infrastructure	Direct & Indirect: Loss of catchment area and consequent decrease in water inputs as a result of the necessary containment of dirty water runoff.	Existing	2	3	2	0.5	4 - MOD	See related impacts in construction (**Table 9.2**).	See related impacts in construction (**Table 9.2**).
		Cumulative	3	4	4	1	11 - HIGH		
		Residual	3	3	4	1	10 - HIGH		
	Direct Impact: Increased faunal mortality.	Existing	1	2	2	1	5 - MOD	See related impacts in construction (**Table 9.2**).	See related impacts in construction (**Table 9.2**).
		Cumulative	1	2	2	1	5 - MOD		
		Residual	1	2	2	0.5	3 - MOD		
Trucking waste to a registered waste disposal facility	Direct	Existing	0	0	0	0	0 - LOW	One cannot predict how many and where accidents may occur. Mitigation would require frequent maintenance of trucks, ongoing driver training, frequent stopping etc.	N/A as not yet in commencement
	Spills - Sedimentation and Surface water contamination	Cumulative	3	2	8	0.5	7 - MOD		With the trucking of the waste, there is a potential for spillages to occur along the route through accidents and uncovered trailers
		Residual	3	2	4	0.5	5 - MOD		The number of incidences are expected to reduce with proper management - vehicle maintenance, driver training

OPERATIONAL PHASE									
Activity	**Nature of Impact**	**Impact type**	**Extent**	**Duration**	**Potential Intensity**	**Likelihood**	**Rating**	**Mitigation**	**Interpretation**
Storage of substrates and by-products associated with the FGD operation	Direct	Existing	3	5	4	1	12 - HIGH	Prevent contaminants from entering the receiving wetland (SEW 2). Install planned concrete slab layer beneath roads and kerb inlets to the dirty water system. Regularly clean spilt materials and inspect drain inlets and stormwater infrastructure for blockages. Install planned concrete bunding and central depression at gypsum off take area. Keep this area tidy and regularly cleaned out. Install planned bunding on oil pits and have a concrete base of 100 mm thick. Empty regularly. Establish baseline manganese levels in the stockpiles as well as the environment. Thereafter monitor levels through regular water quality testing at the pans immediately south of the FGD and compare to current baseline levels.	N/A as not yet in commencement
	Contamination of wetlands from storage facilities associated with the ADF and FGD– Consequences for bullfrogs and aquatic invertebrates.	Cumulative	3	5	8	1	16 - HIGH		With mitigation this impact could be reduced but is still regarded as a moderate impact as the risk of contamination can never be completely ruled out considering the extreme climatic events of late and the increased intensity of rainfall predicted with climate change in the near future especially considering that the infrastructure (including stormwater) is based on 1 in 50 year rainfall events and not 1 in 100 years.
		Residual	3	3	4	0.5	5 - MOD		

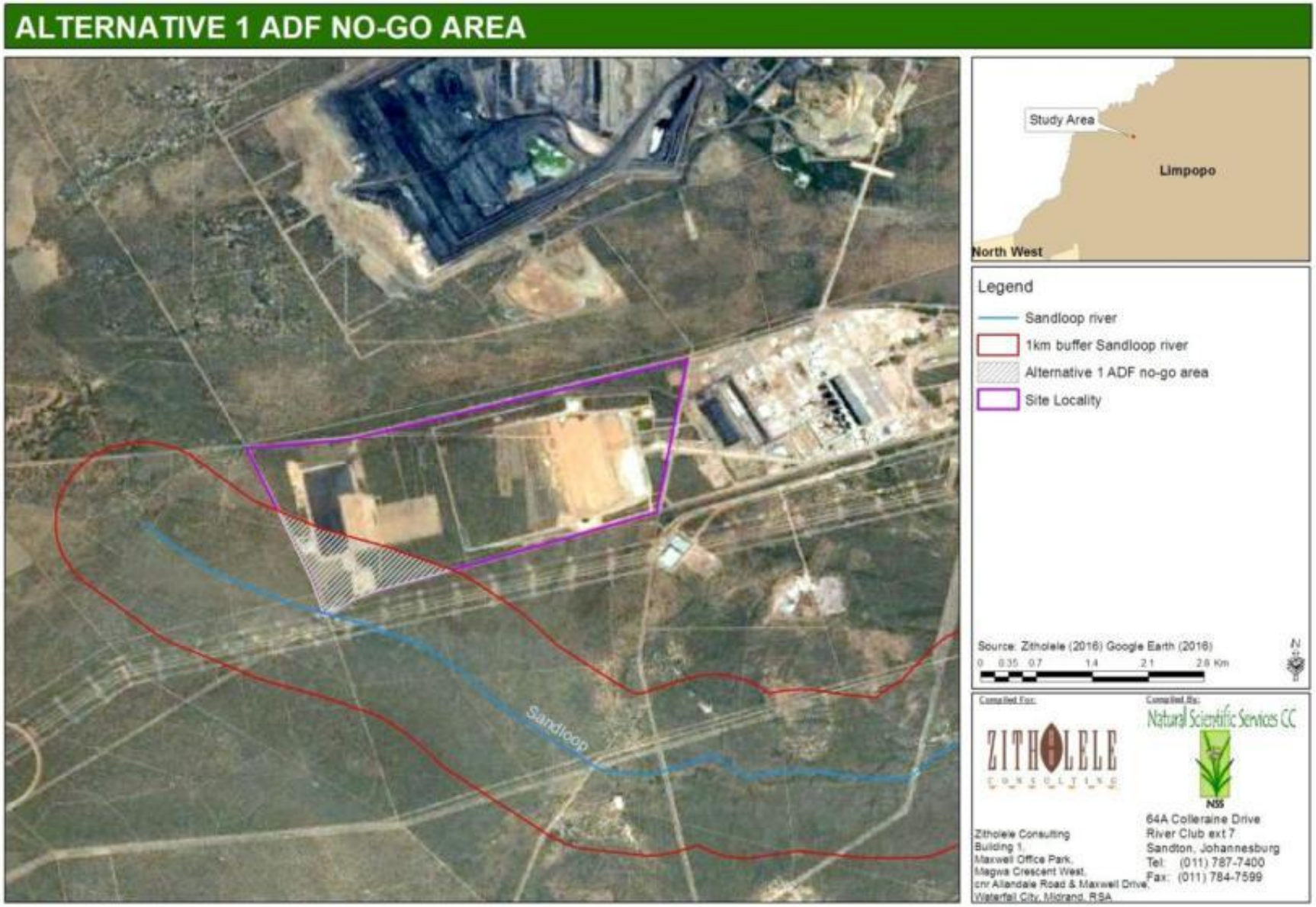


Figure 9-3 Infrastructure Alternative 1 (1 km buffer on Sandloop FEPA)

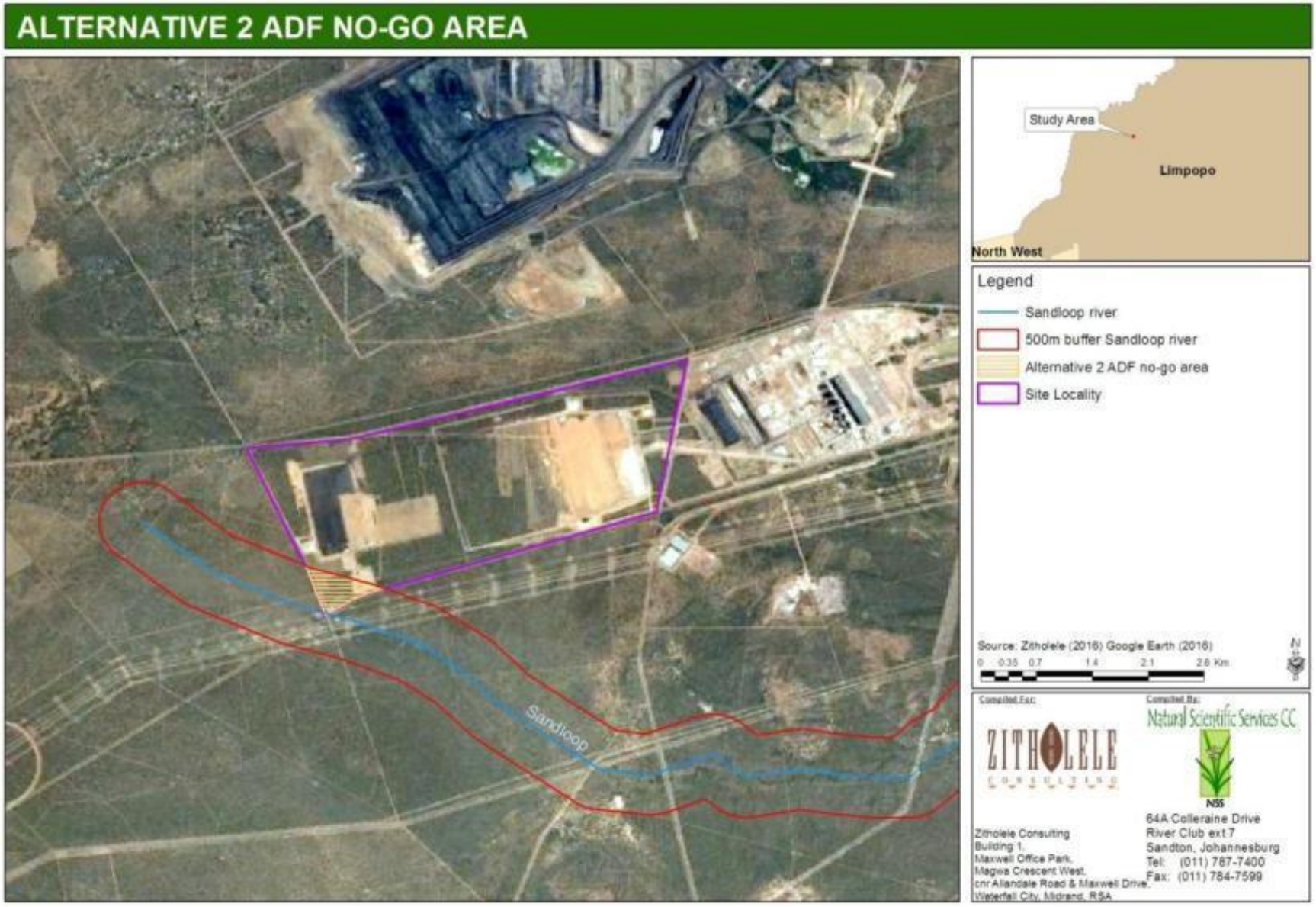


Figure 9-4 Infrastructure Alternative 2 (500 m buffer on Sandloop FEPA)

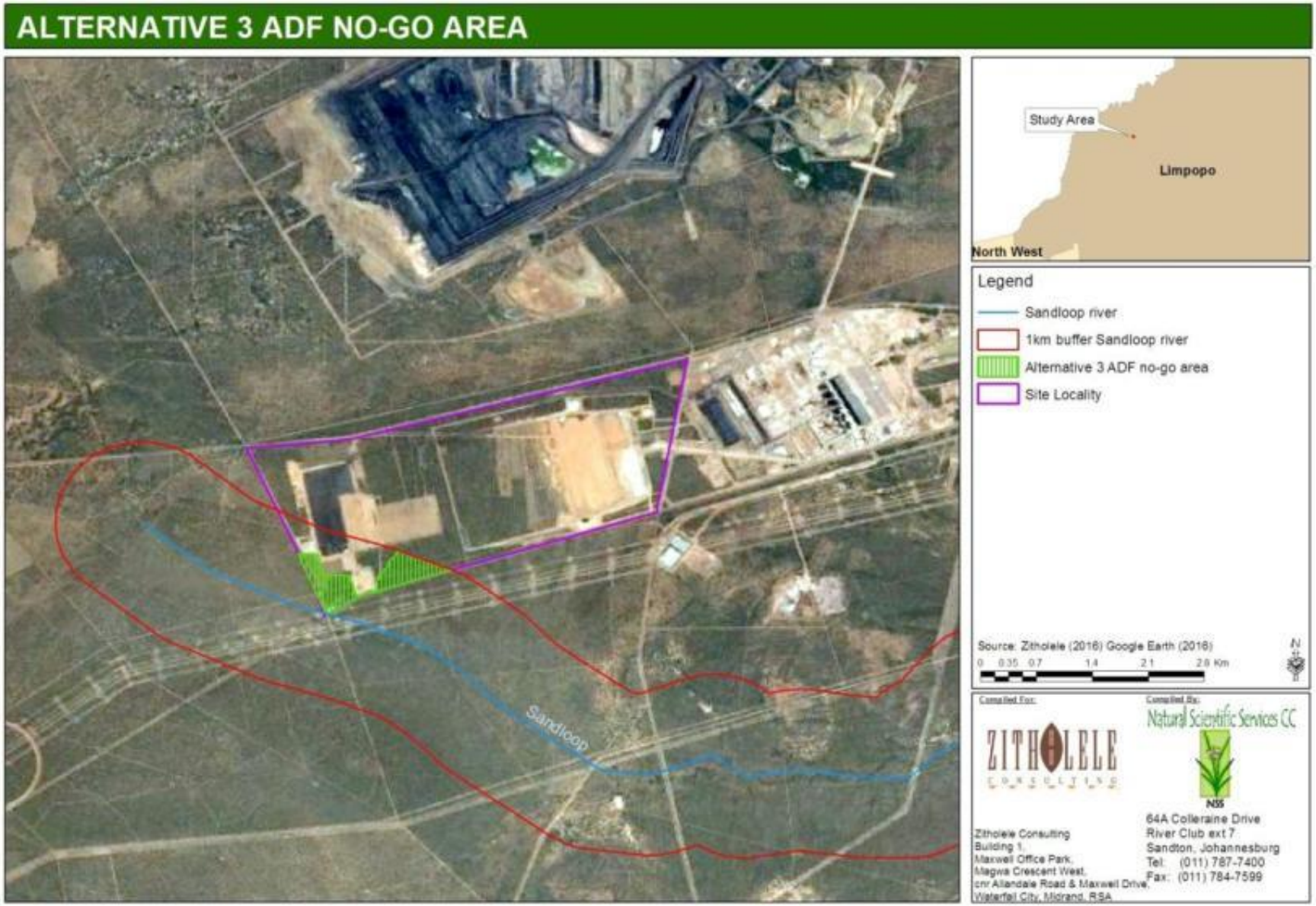


Figure 9-5 Infrastructure Alternative 3 (1 km buffer on Sandloop FEPA excluding previously disturbed areas)

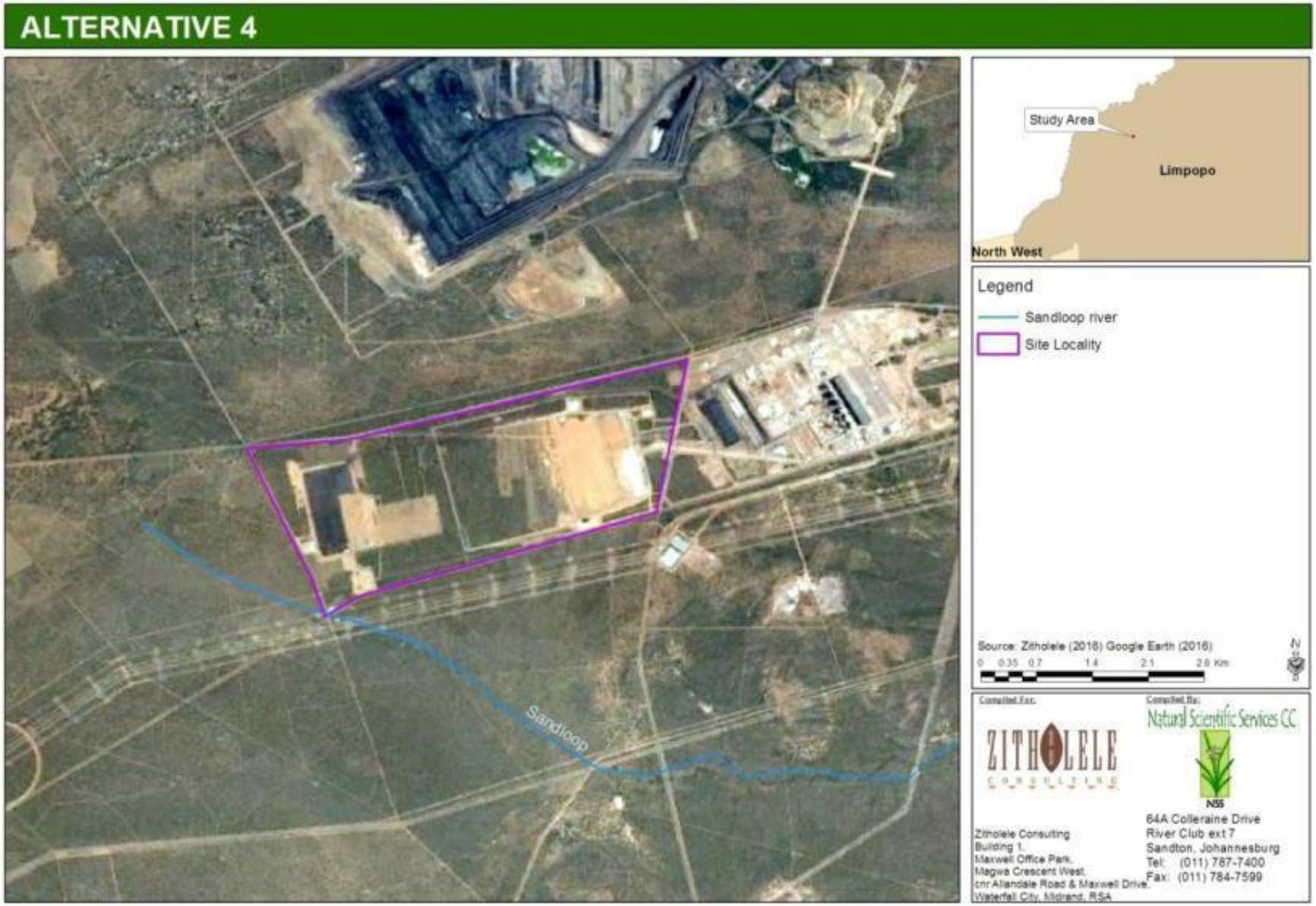


Figure 9-6 Infrastructure Alternative 4 (entire Site 13)

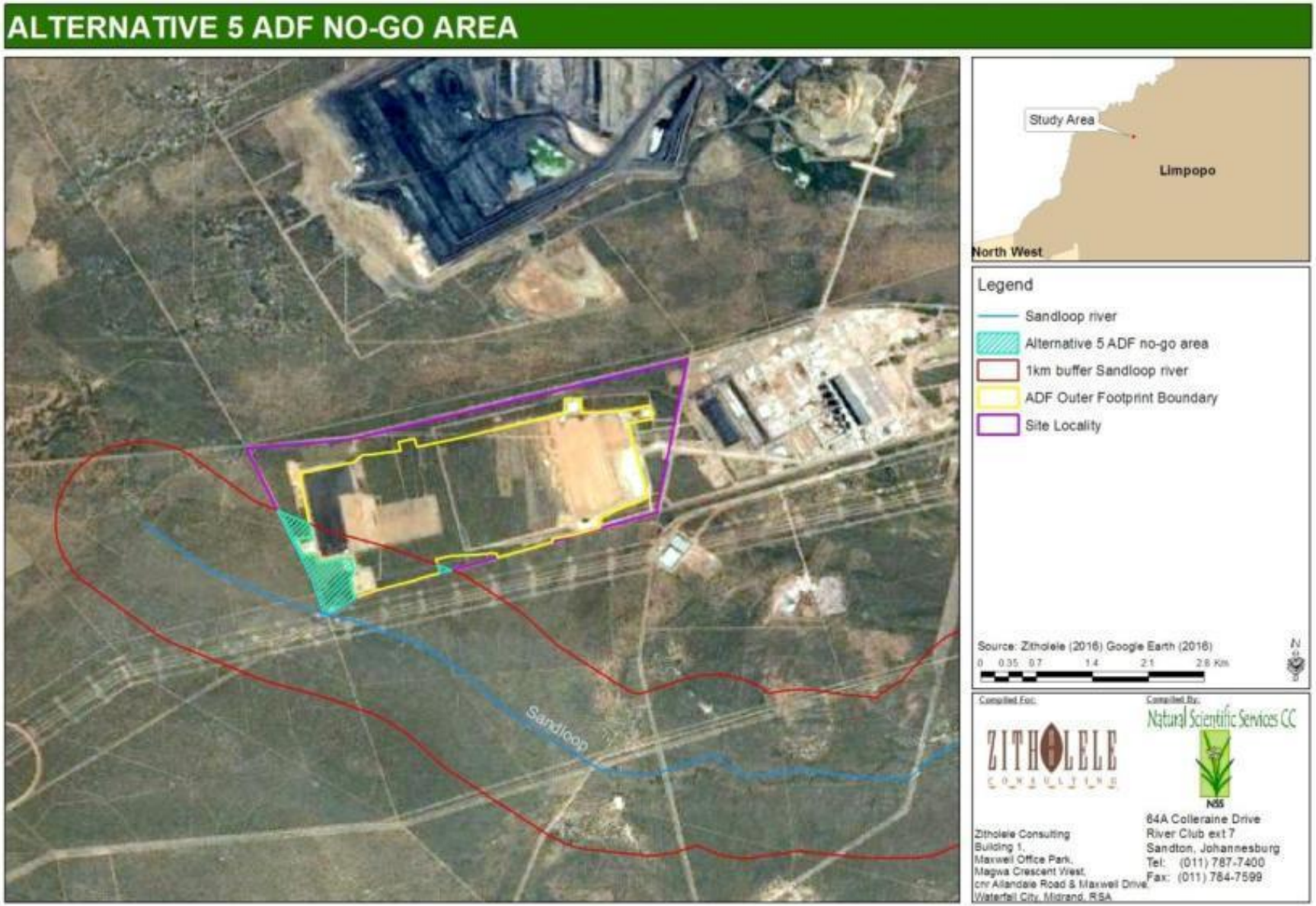


Figure 9-7 Infrastructure Alternative 5 (current proposed footprint area supplied by Jones and Wagner)

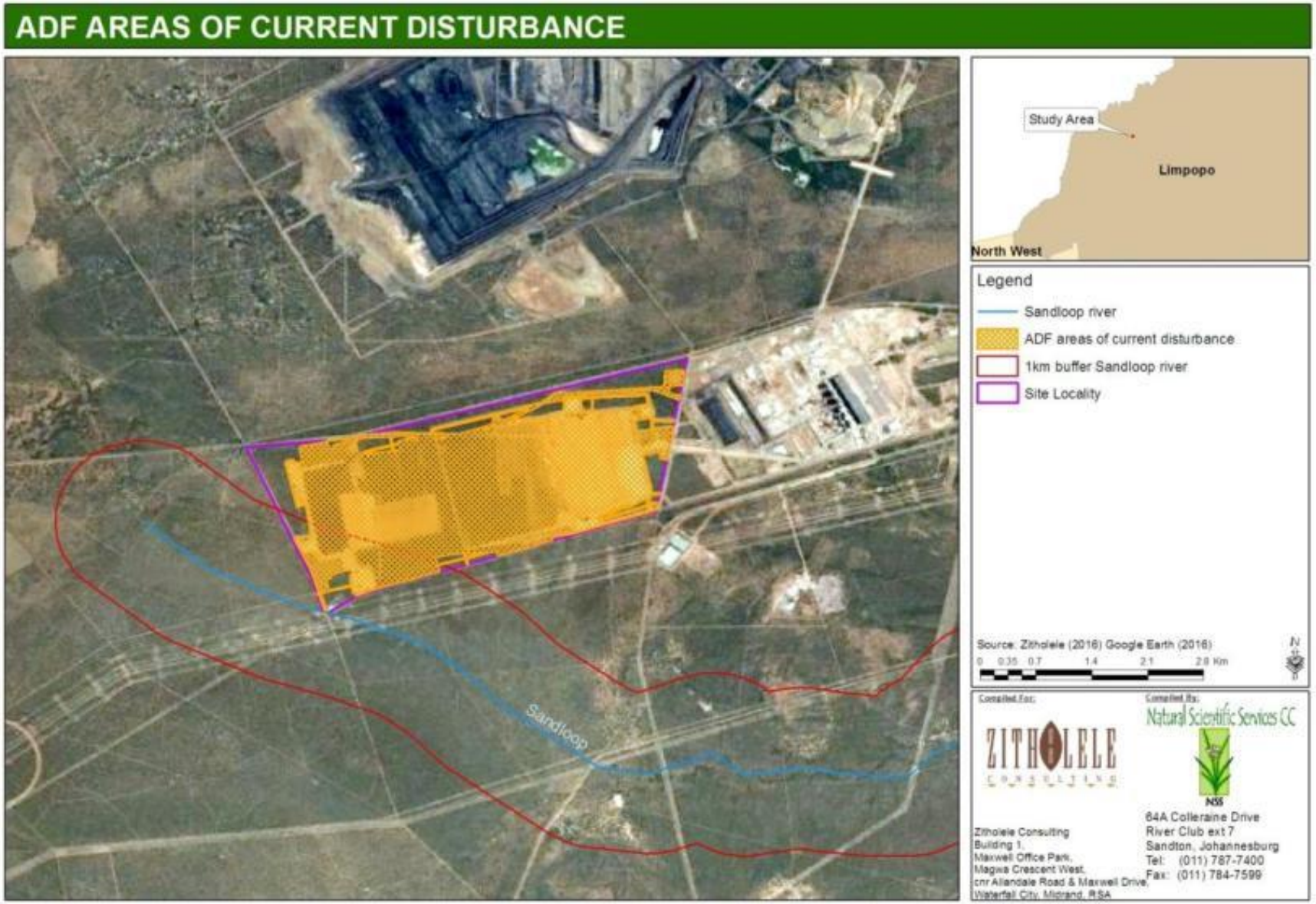


Figure 9-8 Areas of current disturbance

10. Predicted Ecological State: Targets and Strategies

Taking a proactive approach, in lieu of detailed infrastructure design alternatives (from an engineering perspective) that seek to minimise the effects of the proposed development on the Sandloop FEPA, NSS has generated five conceptual footprint area alternatives. These alternatives are illustrated in **Figure 9-3** to **Figure 9-7** and can be summarised as follows:

- **Alternative 1:** ADF and associated infrastructure is kept outside of a 1 km buffer on the Sandloop FEPA. Optimal.
- **Alternative 2:** ADF and associated Infrastructure is kept outside of the 500 m buffer on the Sandloop FEPA
- **Alternative 3:** ADF and associated Infrastructure is kept outside the 1 km buffer but only for areas not already transformed by activities as defined in **Figure 9-5**.
- **Alternative 4**: ADF and associated infrastructure fill Site 13.
- **Alternative 5**: Current footprint area for the ADF and some of the associated infrastructure as supplied by the commissioned engineers (Jones and Wagner).

10.1.1 *Predicted Health Change to SEW 1 (Upper Sandloop Tributaries).*

A comparison between the current and anticipated ecological health of the SEW 1 HGM unit (Upper Sandloop Tributaries within 500 m Site 13) in terms of hydrology, geomorphology and vegetation under the four layout alternatives for scenarios with and without mitigation is provided in **Table 10-1** below. The wetland drivers most adversely affected are likely to be hydrology and geomorphology with the most adverse effects anticipated for Alternative 4 which is considered flawed and the least for Alternative 1 which is considered optimal. Alternatives 3, 5 and 2 represent situations that are not optimal.

It is NSS' opinion that Alternative 1 should be opted for, however, it has subsequently emerged from extended correspondence with Eskom and the Engineering team that the design cannot be adjusted to fit this area. Alternatives 1 and (to a lesser extent) 3 represent the best case scenarios from an environmental perspective but are unlikely to be realised. The chosen alternative at present is Alternative 5 which represents a better case scenario than Alternative 2 but is still likely to have a significant negative effect on the health of SEW 1 and the downstream Sandloop. Under the current scenario (Alternative 5) and following mitigation health scores are anticipated to decrease (from present state) by at least one order of magnitude (post mitigation) on all wetland drivers (2.1 C to 3.5 D).

10.1.2 *Predicted Health Change to SEW 2 (System downstream of FGD plant).*

Although the ADF relates mostly to SEW 1 the FGD plant and associated storage facilities relate mostly to SEW 2. A comparison between the current and anticipated ecological health of the SEW 2 HGM unit in terms of hydrology, geomorphology and vegetation for scenarios of with and without mitigation is provided in **Table 10-2**.

Table 10-1 Predicted SEW 1 health scores for the four infrastructure alternatives with and without mitigation showing anticipated change in wetland functionality.

MITIGATION	WETLAND HEALTH SCORE				HECTARES (ha)			OPINION
						Functional Wetland		
	Hydrology	Geomorphology	Vegetation	Overall	Total Wetland Extent	Extent	Loss From Current State	
Current								
	3 (C)	1.7(B)	1 (B)	**2.1 (Lower C)**	71.5	56.8	-	Goal
Alternative 1								
With	4 (D)	2.1 (C)	2 (C)	**2.9 (C)**	61.4	43.8	**13.1**	Optimal
Without	4 (D)	2.7 (C)	2.4 (C)	**3.2 (C)**	61.4	42.0	**14.8**	-
Alternative 3								
With	4 (D)	2.7 (C)	2.6 (C)	**3.2 (C)**	61.4	41.6	**15.2**	Not Optimal 1
Without	4 (D)	3.3 (C)	2.8 (C)	**3.5 (C Upper)**	61.4	40.2	**16.6**	-
Alternative 5								
With	4 (D)	3.7 (C)	2.7(C)	**3.5 (C)**	55.9	36.3	**20.5**	Not Optimal 2
Without	4 (D)	4 (D)	3 (C)	**3.7 (C Upper)**	55.9	35.2	**21.6**	-
Alternative 2								
With	6.5 (E)	2.6 (C)	2.8 (C)	**4.15 (D)**	53.5	30.4	**26.5**	Not Optimal 3
Without	6.5 (E)	4.5 (D)	3.5 (C)	**5.1 (D)**	53.5	24.9	**31.9**	-
Alternative 4								
With	6.5 (E)	2.6 (C)	2.5 (C)	**4.2 (D)**	53.4	30.8	**26.1**	Flawed
Without	7 (E)	5.9 (D)	3.5 (C)	**5.7 (D Upper)**	53.4	23.0	**33.8**	-

*Red block represents the current design alternative presented by engineers.

Table 10-2 Predicted health scores for SEW 2 as a result of the FGD plant for scenarios with and without mitigation showing anticipated change in wetland functionality.

MITIGATION	WETLAND HEALTH SCORE				HECTARES (ha)		
						Functional Wetland	
	Hydrology	Geomorphology	Vegetation	Overall	Total Wetland Extent	Extent	Loss From Current State
Current State							
	3.5 (C)	3 (C)	4.2 (D)	**3.6 (C)**	38.0	24.3	-
Anticipated State							
With	4 (D)	3.6 (C)	5.2 (D)	**4.2 (D Lower)**	61.4	22.0	**2.3**
Without	7 (E)	4.3 (D)	5.7 (D)	**5.8 (D Upper)**	61.4	16.0	**8.3**

Currently the system is rated as a having a C (Moderately Modified) ecological health. However the construction of the FGD and associated storage facilities is anticipated to

reduce the health of this system to a Upper D (Largely modified) without mitigation and a Lower D with mitigation. The drivers likely to be most adversely affected include hydrology and vegetation. In terms of hydrology, without mitigation, one would expect an increase in floodpeaks as a result of the increase in exposed, impermeable surfaces such as compacted areas, concrete, tar and other structures including the stockpiles themselves. This would likely be accompanied by a greater concentration in flow and consequently increased risk for erosion. Without appropriate mitigation the increased exposed surfaces, limestone and other stockpiles would pose a risk of considerable sedimentation of the system following rainfall events. Deposition and erosion in turn will decrease the state of the vegetation along this system. With implementation of the planned stormwater infrastructure and other suggested mitigation the it is anticipated that there will be less erosion and deposition , however there will still be a reduction in overall water inputs due to catchment loss and the presence of stormwater infrastructure channelling water into Medupi's large eastern dams. Additionally all the mitigation is designed under a 1 in 50 year flood event and considering the increasing rainfall intensity in the past few years the risk remains that mitigation may fail hence the post mitigation rating.

10.1.3 *Strategic Approach.*

In terms of biodiversity the overall goal of the project should be to minimise loss to biodiversity wherever possible. This may be achieved through commitment to the listed mitigation, effective rehabilitation of the ADF and the relocation of bullfrogs and other amphibians to newly created habitat elsewhere. The overall objective of the project as it relates to wetlands should be to ensure that there is no net loss in wetland functionality from the current state as a result of the construction of the FGD plant (and associated storage facilities / infrastructure) and the ADF. Given the relatively pristine state of the Sandloop in the vicinity of the ADF this ideal situation may be best approached by ensuring that an adequate area of the upper Sandloop is set aside for long term protection and that all remaining natural areas within the railway yard and Site 13 which have been disturbed are rehabilitated. Additionally it should be noted that the ephemeral pans within the FGD study area are important havens for wildlife not least bullfrogs which have been confirmed breeding within the study area. By the end of the said project, based on the infrastructure layout plans provided MPS would have seen the loss of 3.6 ha of this pan habitat. Although this appears to be a small size, it is significant when considering that this represents 20 possible breeding locations. As per Macfarlane *et al*. (2014) long term protection of these wetland systems entails, *inter alia*, "*the implementation of legal mechanisms (e.g. declaration of a Protected Environment or Nature Reserve under the National Environmental Management: Protected Areas Act, a legally binding conservation servitude, or a long term Biodiversity Agreement under NEMA) and putting in place appropriate management structures and actions"*.

The predicted wetland health scores for SEW 1 and 2 allows for the estimation of the extent of functional wetland that is likely to be lost from the present ecological state under each infrastructure alternative both with and without mitigation (**Table 10-1** and **Table 10-2**). It is

important to note here that these values represent the basic hectare equivalents for one of three offset themes as outlined in *Wetland Offsets: A best Practice Guideline for South Africa*" Macfarlane *et al*. (2014) namely Ecosystem Services and Water Resources. Assessment of the two other themes in terms of hectare equivalents namely Ecosystem Conservation, and Species of Conservation Concern, lies beyond the scope of this report and will need to be addressed in the subsequent wetland offset plan. Additionally, given the nature of the project, presence of conservation important species (bullfrogs) and the national importance of the Sandloop FEPA, the use of modifiers to augment default offset ratios based on the three hectare equivalent theme estimations is strongly recommended. Preliminary communications with Eskom affirm their commitment to commissioning a wetland rehabilitation and stage 1 offset plan that will serve to offset functional losses to SEW 1, SEW 2 and D4 (pans), by conserving the Sandloop and associated depressions within their properties, specifically Site 12 as well as initiating the artificial recreation of pan habitat, the extent to which is to be decided in the upcoming rehabilitation and offset plan by NSS. Two pressing and urgent issues were recently identified after fieldwork on Google Earth. These are depicted in **Figure 9-8** and discussed in the bullet points below.

Coal contamination of watercourse from PCD 4 overflow

April 2016 March 2017

Transformation of depression C15

February 2016 March 2017

Figure 10-1 Areas of recent disturbance

With this in mind the following preliminary strategy is advised:

- Two urgent issues need to be addressed promptly:
    - It is evident that an overflow event from the coal stockpile PCD 4 into the watercourse on the south-western boundary of Site 13 via its spillway has occurred. Spillways are designed to protect the integrity of the structure under high capacity. The problem here is that the lined stormwater infrastructure has not been constructed and this effluent is entering the environment. This is a recent impact that needs to be dealt with swiftly to avoid further contamination of the Sandloop. Clean up the coal spillage within the watercourse and reassess the capacity of the coal PCD from an engineering perspective.
    - One of the depressions (C15) in the centre of Site 13 has been completely re-shaped into a square. Such alteration of the bed of any depression or wash cannot be allowed to happen prior to the issuing of the water use licence from DWS.
- Eskom should support the recently commissioned wetland rehabilitation and bullfrog relocation / pan restoration projects in terms of rainfall reporting, labour, machinery and engineering resources to enable the successful creation of new pan habitat within Site 12 and the successful relocation and establishment of bullfrogs therein.
- A few issues emerged during the workshop held at Zitholele with the relevant specialists and engineers that NSS feels needs addressing:
    - The precise origin and composition of the limestone to be brought in for the FGD process is yet unknown. It is advised that the source and manganese content (and any other metals) as well as the pH of the slurry formed from a combination with rain and groundwater be determined as soon as possible.
    - It was mentioned that the rehabilitation of the ADF will follow the advancing face. It was then mentioned that water coming off rehabilitated areas would be considered clean water and would enter the clean water system. A question was raised as to where this “clean water” would be stored prior to discharge into the environment. The Eskom engineers pointed out that the ADF PCDs closest to the rehabilitated side would be converted from dirty to clean water facilities to hold this water. How this transition from dirty to clean water systems is carried out is yet uncertain and may pose a significant challenge.
- Although an attempt has been made to augment the south-western corner of the ADF efforts should be taken to wherever possible minimise any further loss / encroachment into pan habitat, the upper Sandloop catchment and areas, within the 1:100 year floodline and the 1 km buffer on the Sandloop FEPA.
- Although Alternatives 1 and 3 (conservation of most of the western limb of SEW 1 within the site) were preferable correspondence with Eskom and the relevant engineers suggests an infrastructure footprint congruent with Alternative 5 will be opted for and is final. This not an optimal situation and will require stringent rehabilitation and offset measures to be implemented.

- During the development of the FGD plant, storage facilities, ash facility and associated infrastructure adhere to best practice guidelines and recommended mitigation measures as outlined in this report.
- Ensure that the stipulations within the ROD (12/12/20/695) are adhered to as well as those stipulated in the EA (Ref: 12/9/11/L50/6).
- Attempt wherever possible to avoid development within at least 100 m from any pan or semi-arid ephemeral wash outside of the footprint area as depicted in **Figure 7-12**.
- Although the loss of some wetland features on site is inevitable given the nature of this project it is imperative that every effort be taken to ensure the long term, *in situ*, conservation of the depressions C11 and where possible C20 (bullfrog breeding site) and C21 together with a minimum 100 m radial buffer around their delineated edges.
- Normally best practice guidelines on Giant Bullfrogs (Yetman and Fergusson, 2011) advocate a minimum 500 m radial buffer and idealistic 1 km buffer on breeding sites. However the froglets could not be positively distinguished as either Giant Bullfrog or African Bullfrog. The latter being of lower conservation importance. However the, bullfrog relocation project (in progress) would circumvent this situation through capture and relocation of all adults, tadpoles and froglets during the peak of the breeding season to newly created pans in Site 12. The full assistance of Eskom labour should be at the specialist's disposal for assistance in relocating the bullfrogs.
- If it has not already been removed, the possibility of adjusting the eastern boundary of the Phase 3A Temporary Storage Area to avoid the loss of depression C15 should be considered in earnest.
- Given the pristine nature of the upper Sandloop FEPA, long term protection and management is advocated as the primary offset strategy supplemented by rectification measures were deemed necessary.
- Commission a comprehensive wetland rehabilitation and offset investigation.
- The wetland delineations and preliminary ecosystem health based hectare equivalents as outlined in this report should be used to inform the wetland offset plan, and updated as deemed necessary. The two other themes in terms of hectare equivalents namely Ecosystem Conservation and Species of Conservation Concern need to be assessed in the wetland offset plan. Additionally, given the nature of the project and the national importance of the Sandloop FEPA, the use of modifiers to augment default offset ratios based on the three hectare equivalent theme estimations is strongly recommended.

11. Conclusion

In spite of the study area being situated within the otherwise flat and relatively homogenous Limpopo Sweet Bushveld (dominated by *Acacia* and *Combretum* species), fieldwork by NSS has revealed a wealth of biodiversity and uncovered the presence of a number water resources. It is the presence of these pans and semi-arid ephemeral washes wetlands, such

as the Sandloop FEPA and associated tributaries that breathe life into the otherwise arid landscape. In terms of fauna the MPS and immediate surrounds was found to support a large proportion of the regions diversity of which many species are of conservation importance. Perhaps most noteworthy and directly impacted in this regard are bullfrogs. At least one breeding site was confirmed within the FGD study area with several others south and along the Sandloop System. There remains some uncertainty regarding the identification of the individuals observed on site as both bullfrog species may occur within the study area. Regardless both are large, charismatic, explosive breeding frogs that are facing high levels of habitat loss and persecution. Although limited in floral species, the pans also support an exceptional diversity of other amphibian species, reptiles, birds and mammals and the bullfrogs therefore act as good surrogates for the conservation of much wider range of species. Naturally one of the most significant impacts emanating from ADF development is the loss of the largely natural pans and water courses that support this diversity. The importance of the matter and the need to rehabilitate and offset wetland loss as well as re-create pan habitat was affirmed by DWS head office and has been duly acknowledged by Eskom with such studies set in motion. Although not particularly diverse in terms of flora, a significant amount of largely natural remaining *Acacia* veld remains which does support a number of Protected tree species and potentially one Near-Threatened herbaceous species. Vegetation units of particular significance included the *Acacia nigrescens –Combretum apiculatum* dominated woodland and the vegetation associated with the pans and ephemeral washes, which were rated Very High and Moderate -High sensitivity respectively for their natural state and importance in supporting conservation important species.

In terms of wetlands our field surveys revealed a number of small Semi-arid Ephemeral Washes and Depression wetlands within the study area (Site 13) earmarked for the construction of the ADF. These and other wetlands were originally not identified by the appointed specialists during the environmental authorisation process for the MPS and subsequently the ADF (EA granted in 2009, Ref12/9/11/L50/6). An inevitable consequence of this situation, however, is that some of the depressions and washes were lost through construction activities. Nevertheless a number of these systems still remain and have the potential to retain much of their integrity and ecological functioning. The wetlands identified on site were all rated with High conservation importance. Of greatest importance are those wetlands that are situated, and which feed into, the upper reaches of the Sandloop. Maintenance of these wetlands that fall into the 1km buffer Sandloop FEPA, as well as maintenance of the buffer itself is of utmost importance. Discovery of wetlands within the proposed infrastructure footprint at such a late stage of the project, obviously presents a number of challenges regarding the sustainable protection of these water courses. The only pragmatic solution now lies in an approach that seeks to; (i) minimise further direct losses to the wetland resources and dependant biota on site by means of strategic placement and design of infrastructure, (ii) decrease the amount of functional loss to these wetlands and the Sandloop FEPA through strict adherence to the stipulated mitigation and (iii) offset these losses by means of setting aside a portion of the upper Sandloop for long term conservation

following the outcomes of a comprehensive wetland offset and monitoring plan that takes cognisance of the national conservation importance of the Sandloop FEPA.

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13. Appendices

13.1. Appendix 1 Floral species recorded in the QDGS

Family	*Species*	Threat status	Growth forms
FABACEAE	*Abrus laevigatus E.Mey.*	LC	Climber
MALVACEAE	*Abutilon austro-africanum Hochr.*	LC	Dwarf shrub
MALVACEAE	*Abutilon pycnodon Hochr.*	LC	Herb, shrub
FABACEAE	*Acacia caffra (Thunb.) Willd.*	LC	Shrub, tree
FABACEAE	*Acacia fleckii Schinz*	LC	Shrub, tree
FABACEAE	*Acacia mellifera (Vahl) Benth. subsp. detinens (Burch.) Brenan*	LC	Shrub, tree
FABACEAE	*Acacia senegal (L.) Willd. var. rostrata Brenan*	LC	Shrub, tree
FABACEAE	*Acacia tortilis (Forssk.) Hayne subsp. heteracantha (Burch.) Brenan*	LC	Shrub, tree
EUPHORBIACEAE	*Acalypha caperonioides Baill. var. caperonioides*	DDT	Dwarf shrub, herb
EUPHORBIACEAE	*Acalypha indica L. var. indica*	LC	Dwarf shrub, herb, shrub
CUCURBITACEAE	*Acanthosicyos naudinianus (Sond.) C.Jeffrey*	LC	Herb, succulent
POACEAE	*Acroceras macrum Stapf*	LC	Graminoid
FABACEAE	*Aeschynomene indica L.*	LC	Herb, shrub
RUBIACEAE	*Agathisanthemum bojeri Klotzsch subsp. bojeri*	LC	Herb, shrub
FABACEAE	*Albizia harveyi E.Fourn.*	LC	Tree
HYACINTHACEAE	*Albuca glauca Baker*	LC	Geophyte
OROBANCHACEAE	*Alectra orobanchoides Benth.*	LC	[No lifeform defined]
FABACEAE	*Alistilus bechuanicus N.E.Br.*	LC	Herb
ASTERACEAE	*Ambrosia artemisiifolia L.*	Not Evaluated	Herb
POACEAE	*Andropogon schirensis Hochst. ex A.Rich.*	LC	Graminoid
POACEAE	*Anthephora pubescens Nees*	LC	Graminoid
APONOGETONACEAE	*Aponogeton junceus Lehm.*	LC	Geophyte, herb, hydrophyte, tenagophyte
POACEAE	*Aristida adscensionis L.*	LC	Graminoid
POACEAE	*Aristida canescens Henrard subsp. canescens*	LC	Graminoid
POACEAE	*Aristida congesta Roem. & Schult. subsp. congesta*	LC	Graminoid
POACEAE	*Aristida spectabilis Hack.*	LC	Graminoid

Family	*Species*	Threat status	Growth forms
POACEAE	*Aristida stipitata Hack. subsp. graciliflora (Pilg.) Melderis*	LC	Graminoid
POACEAE	*Aristida stipitata Hack. subsp. stipitata*	LC	Graminoid
ASPARAGACEAE	*Asparagus cooperi Baker*	LC	Dwarf shrub, shrub
ASPARAGACEAE	*Asparagus cooperi Baker*	LC	Dwarf shrub, shrub
ASPARAGACEAE	*Asparagus exuvialis Burch. forma exuvialis*	Not Evaluated	Shrub
ASPARAGACEAE	*Asparagus nelsii Schinz*	LC	Shrub
ACANTHACEAE	*Asystasia schimperi T.Anderson*	LC	Herb
ASTERACEAE	*Athrixia elata Sond.*	LC	Dwarf shrub
SCROPHULARIACEAE	*Bacopa floribunda (R.Br.) Wettst.*	LC	Herb, hydrophyte
ACANTHACEAE	*Barleria affinis C.B.Clarke*	LC	Dwarf shrub, herb, shrub
ACANTHACEAE	*Barleria galpinii C.B.Clarke*	LC	Herb, shrub
ACANTHACEAE	*Barleria lancifolia T.Anderson subsp. lancifolia*	LC	Dwarf shrub, herb, shrub
ACANTHACEAE	*Barleria mackenii Hook.f.*	LC	Herb, shrub
ACANTHACEAE	*Barleria rehmannii C.B.Clarke*	LC	Dwarf shrub, herb
FABACEAE	*Bauhinia petersiana Bolle subsp. macrantha (Oliv.) Brummitt & J.H.Ross*	LC	Climber, shrub, tree
FABACEAE	*Bauhinia petersiana Bolle subsp. macrantha (Oliv.) Brummitt & J.H.Ross*	LC	Climber, shrub, tree
ACANTHACEAE	*Blepharis breyeri Oberm.*	LC	Dwarf shrub, shrub
ACANTHACEAE	*Blepharis diversispina (Nees) C.B.Clarke*	LC	Dwarf shrub, herb, shrub
ACANTHACEAE	*Blepharis maderaspatensis (L.) Roth*	LC	Herb
CAPPARACEAE	*Boscia albitrunca (Burch.) Gilg & Gilg-Ben.*	LC	Shrub, tree
CAPPARACEAE	*Boscia foetida Schinz subsp. rehmanniana (Pestal.) Toelken*	LC	Tree
POACEAE	*Bothriochloa bladhii (Retz.) S.T.Blake*	LC	Graminoid
POACEAE	*Brachiaria nigropedata (Ficalho & Hiern) Stapf*	LC	Graminoid
BRYACEAE	*Bryum capillare Hedw.*		Bryophyte
CYPERACEAE	*Bulbostylis hispidula (Vahl) R.W.Haines subsp. pyriformis (Lye) R.W.Haines*	LC	Cyperoid, herb, mesophyte
CYPERACEAE	*Bulbostylis humilis (Kunth) C.B.Clarke*	LC	Cyperoid, herb, mesophyte
CAPPARACEAE	*Cadaba termitaria N.E.Br.*	LC	Shrub
POACEAE	*Cenchrus ciliaris L.*	LC	Graminoid
CERATOPHYLLACEAE	*Ceratophyllum demersum L. var. demersum*	LC	Hydrophyte
PEDALIACEAE	*Ceratotheca triloba (Bernh.) Hook.f.*	LC	Herb
FABACEAE	*Chamaecrista absus (L.) H.S.Irwin & Barneby*	LC	Herb
FABACEAE	*Chamaecrista biensis (Steyaert) Lock*	LC	Herb

Family	*Species*	Threat status	Growth forms
VERBENACEAE	*Chascanum hederaceum (Sond.) Moldenke var. hederaceum*	LC	Herb
VERBENACEAE	*Chascanum incisum (H.Pearson) Moldenke*	LC	Herb
VERBENACEAE	*Chascanum pinnatifidum (L.f.) E.Mey. var. pinnatifidum*	LC	Herb
GENTIANACEAE	*Chironia purpurascens (E.Mey.) Benth. & Hook.f. subsp. humilis (Gilg) I.Verd.*	LC	Herb
ANTHERICACEAE	*Chlorophytum recurvifolium (Baker) C.Archer & Kativu*	LC	Herb
ACANTHACEAE	*Chorisochora transvaalensis (A.Meeuse) Vollesen*	LC	Suffrutex
CAPPARACEAE	*Cleome angustifolia Forssk. subsp. petersiana (Klotzsch ex Sond.) Kers*	LC	Herb
CAPPARACEAE	*Cleome hirta (Klotzsch) Oliv.*	LC	Herb
CAPPARACEAE	*Cleome rubella Burch.*	LC	Herb
LAMIACEAE	*Clerodendrum ternatum Schinz*	LC	Dwarf shrub
EUPHORBIACEAE	*Clutia pulchella L. var. pulchella*	LC	Dwarf shrub, herb, shrub
CUCURBITACEAE	*Coccinia sessilifolia (Sond.) Cogn.*	LC	Climber, herb, succulent
COMBRETACEAE	*Combretum apiculatum Sond. subsp. apiculatum*	LC	Shrub, tree
COMMELINACEAE	*Commelina benghalensis L.*	LC	Herb
COMMELINACEAE	*Commelina erecta L.*	LC	Herb
COMMELINACEAE	*Commelina livingstonii C.B.Clarke*	LC	Herb
BURSERACEAE	*Commiphora mollis (Oliv.) Engl.*	LC	Tree
BURSERACEAE	*Commiphora neglecta I.Verd.*	LC	Succulent, tree
BURSERACEAE	*Commiphora pyracanthoides Engl.*	LC	Shrub, tree
MALVACEAE	*Corchorus asplenifolius Burch.*	LC	Herb
MALVACEAE	*Corchorus kirkii N.E.Br.*	LC	Shrub
MALVACEAE	*Corchorus psammophilus Codd*	Threatened	Herb
CARYOPHYLLACEAE	*Corrigiola litoralis L. subsp. litoralis var. litoralis*	LC	Herb
ASTERACEAE	*Cotula anthemoides L.*	LC	Herb
CRASSULACEAE	*Crassula capitella Thunb. subsp. sessilicymula (Mogg) Toelken*	LC	Herb, succulent
FABACEAE	*Crotalaria distans Benth. subsp. distans*	LC	Herb
FABACEAE	*Crotalaria orientalis Burtt Davy ex I.Verd. subsp. orientalis*	LC	Dwarf shrub, herb
FABACEAE	*Crotalaria sphaerocarpa Perr. ex DC. subsp. sphaerocarpa*	LC	Herb
APOCYNACEAE	*Cryptolepis oblongifolia (Meisn.) Schltr.*	LC	Scrambler, shrub
CUCURBITACEAE	*Cucumis africanus L.f.*	LC	Herb
CUCURBITACEAE	*Cucumis myriocarpus Naudin subsp. myriocarpus*	LC	Herb
COMMELINACEAE	*Cyanotis speciosa (L.f.) Hassk.*	LC	Herb, succulent
POACEAE	*Cymbopogon pospischilii (K.Schum.) C.E.Hubb.*	Not	Graminoid

Family	*Species*	Threat status Evaluated	Growth forms
CYPERACEAE	*Cyperus chersinus (N.E.Br.) Kük.*	LC	Cyperoid, herb, mesophyte
CYPERACEAE	*Cyperus margaritaceus Vahl var. margaritaceus*	LC	Cyperoid, herb, mesophyte
POACEAE	*Dactyloctenium giganteum Fisher & Schweick.*	LC	Graminoid
EUPHORBIACEAE	*Dalechampia capensis A.Spreng.*	LC	Dwarf shrub
ASTERACEAE	*Denekia capensis Thunb.*	LC	Herb
PEDALIACEAE	*Dicerocaryum senecioides (Klotzsch) Abels*	LC	Herb
DICHAPETALACEAE	*Dichapetalum cymosum (Hook.) Engl.*	LC	Dwarf shrub
FABACEAE	*Dichrostachys cinerea (L.) Wight & Arn. subsp. africana Brenan & Brummitt var. africana*	LC	Shrub, tree
ACANTHACEAE	*Dicliptera minor C.B.Clarke subsp. minor*	LC	Herb
ASTERACEAE	*Dicoma tomentosa Cass.*	LC	Dwarf shrub, herb
POACEAE	*Digitaria debilis (Desf.) Willd.*	LC	Graminoid
POACEAE	*Digitaria eriantha Steud.*	LC	Graminoid
POACEAE	*Digitaria eriantha Steud.*	LC	Graminoid
EBENACEAE	*Diospyros lycioides Desf. subsp. lycioides*	LC	Shrub
EBENACEAE	*Diospyros lycioides Desf. subsp. nitens (Harv. ex Hiern) De Winter*	LC	Shrub
HYACINTHACEAE	*Dipcadi glaucum (Burch. ex Ker Gawl.) Baker*	LC	Geophyte
HYACINTHACEAE	*Dipcadi gracillimum Baker*	LC	Geophyte
HYACINTHACEAE	*Dipcadi marlothii Engl.*	LC	Geophyte
HYACINTHACEAE	*Dipcadi papillatum Oberm.*	LC	Geophyte
HYACINTHACEAE	*Dipcadi platyphyllum Baker*	LC	Geophyte
HYACINTHACEAE	*Dipcadi viride (L.) Moench*	LC	Geophyte
APOCYNACEAE	*Diplorhynchus condylocarpon (Müll.Arg.) Pichon*	LC	Shrub, tree
FABACEAE	*Dolichos junodii (Harms) Verdc.*	LC	Herb
HYACINTHACEAE	*Drimia angustifolia Baker*	LC	Geophyte
APOCYNACEAE	*Duvalia polita N.E.Br.*	LC	Succulent
ACANTHACEAE	*Dyschoriste fischeri Lindau*	LC	Dwarf shrub, shrub
ACANTHACEAE	*Dyschoriste rogersii S.Moore*	LC	Dwarf shrub, shrub
POACEAE	*Echinochloa holubii (Stapf) Stapf*	LC	Graminoid
CYPERACEAE	*Eleocharis limosa (Schrad.) Schult.*	LC	Cyperoid, emergent hydrophyte, helophyte, herb
POACEAE	*Eleusine coracana (L.) Gaertn. subsp. africana (Kenn.-O'Byrne) Hilu & de Wet*	LC	Graminoid

Family	*Species*	Threat status	Growth forms
ENTODONTACEAE	*Entodon cymbifolius Wager & Dixon*		Bryophyte, epiphyte
POACEAE	*Eragrostis aspera (Jacq.) Nees*	LC	Graminoid
POACEAE	*Eragrostis barbinodis Hack.*	LC	Graminoid
POACEAE	*Eragrostis biflora Hack. ex Schinz*	LC	Graminoid
POACEAE	*Eragrostis hierniana Rendle*	LC	Graminoid
POACEAE	*Eragrostis lehmanniana Nees var. chaunantha (Pilg.) De Winter*	LC	Graminoid
POACEAE	*Eragrostis lehmanniana Nees var. lehmanniana*	LC	Graminoid
POACEAE	*Eragrostis pallens Hack.*	LC	Graminoid
POACEAE	*Eragrostis pallens Hack.*	LC	Graminoid
POACEAE	*Eragrostis sarmentosa (Thunb.) Trin.*	LC	Graminoid
POACEAE	*Eragrostis superba Peyr.*	LC	Graminoid
ERIOCAULACEAE	*Eriocaulon abyssinicum Hochst.*	LC	Herb, hydrophyte, tenagophyte
ERIOSPERMACEAE	*Eriospermum flagelliforme (Baker) J.C.Manning*	LC	Geophyte
ERIOSPERMACEAE	*Eriospermum porphyrovalve Baker*	LC	Geophyte
BRASSICACEAE	*Erucastrum griquense (N.E.Br.) O.E.Schulz*	LC	Herb
EBENACEAE	*Euclea undulata Thunb.*	LC	Shrub, tree
POACEAE	*Eulalia aurea (Bory) Kunth*	NT*	Graminoid
EUPHORBIACEAE	*Euphorbia neopolycnemoides Pax & K.Hoffm.*	LC	Herb
EUPHORBIACEAE	*Euphorbia rhombifolia Boiss.*	LC	Shrub, succulent
EUPHORBIACEAE	*Euphorbia tirucalli L.*	LC	Shrub, succulent, tree
EUPHORBIACEAE	*Euphorbia waterbergensis R.A.Dyer*	Rare	Shrub, succulent
CONVOLVULACEAE	*Evolvulus alsinoides (L.) L.*	LC	Herb
FABRONIACEAE	*Fabronia pilifera Hornsch.*		Bryophyte, epiphyte
ASTERACEAE	*Felicia mossamedensis (Hiern) Mendonça*	LC	Herb
MORACEAE	*Ficus glumosa Delile*	LC	Succulent, tree
RUBIACEAE	*Gardenia volkensii K.Schum. subsp. spatulifolia (Stapf & Hutch.) Verdc.*	LC	Tree
ASTERACEAE	*Geigeria burkei Harv. subsp. burkei var. burkei*	LC	Herb
ASTERACEAE	*Geigeria filifolia Mattf.*	LC	Herb
GISEKIACEAE	*Gisekia pharnacioides L. var. pharnacioides*	LC	Herb
MOLLUGINACEAE	*Glinus bainesii (Oliv.) Pax*	LC	Dwarf shrub
APOCYNACEAE	*Gomphocarpus tomentosus Burch. subsp. tomentosus*	LC	Herb, shrub
MALVACEAE	*Gossypium herbaceum L. subsp. africanum (Watt) Vollesen*	LC	Shrub

Family	*Species*	Threat status	Growth forms
MALVACEAE	*Grewia avellana Hiern*	LC	Shrub
MALVACEAE	*Grewia avellana Hiern*	LC	Shrub
MALVACEAE	*Grewia flava DC.*	LC	Shrub
MALVACEAE	*Grewia flavescens Juss.*	LC	Shrub
MALVACEAE	*Grewia occidentalis L. var. occidentalis*	LC	Shrub, tree
MALVACEAE	*Grewia retinervis Burret*	LC	Shrub
MALVACEAE	*Grewia subspathulata N.E.Br.*	LC	Shrub
PEDALIACEAE	*Harpagophytum procumbens (Burch.) DC. ex Meisn. subsp. transvaalense Ihlenf. & H.E.K.Hartmann*	Not Evaluated	Herb
ASTERACEAE	*Helichrysum nudifolium (L.) Less. var. oxyphyllum (DC.) Beentje*	LC	Herb
ASTERACEAE	*Helichrysum zeyheri Less.*	LC	Dwarf shrub, shrub
BORAGINACEAE	*Heliotropium ciliatum Kaplan*	LC	Herb
BORAGINACEAE	*Heliotropium ciliatum Kaplan*	LC	Herb
BORAGINACEAE	*Heliotropium ovalifolium Forssk.*	LC	Herb
MALVACEAE	*Hermannia boraginiflora Hook.*	LC	Dwarf shrub
MALVACEAE	*Hermannia grisea Schinz*	LC	Dwarf shrub
MALVACEAE	*Hermannia modesta (Ehrenb.) Mast.*	LC	Dwarf shrub, herb
MALVACEAE	*Hermannia modesta (Ehrenb.) Mast.*	LC	Dwarf shrub, herb
MALVACEAE	*Hermannia stellulata (Harv.) K.Schum.*	LC	Herb
MALVACEAE	*Hermannia tomentosa (Turcz.) Schinz ex Engl.*	LC	Herb
AMARANTHACEAE	*Hermbstaedtia odorata (Burch.) T.Cooke var. albi-rosea Suess.*	LC	Herb
AMARANTHACEAE	*Hermbstaedtia odorata (Burch.) T.Cooke var. albi-rosea Suess.*	LC	Herb
AMARANTHACEAE	*Hermbstaedtia odorata (Burch.) T.Cooke var. aurantiaca (Suess.) C.C.Towns.*	LC	Herb
AMARANTHACEAE	*Hermbstaedtia odorata (Burch.) T.Cooke var. aurantiaca (Suess.) C.C.Towns.*	LC	Herb
AMARANTHACEAE	*Hermbstaedtia odorata (Burch.) T.Cooke var. odorata*	LC	Herb
POACEAE	*Heteropogon contortus (L.) Roem. & Schult.*	LC	Graminoid
MALVACEAE	*Hibiscus calyphyllus Cav.*	LC	Dwarf shrub, herb
MALVACEAE	*Hibiscus micranthus L.f. var. micranthus*	LC	Herb, shrub
MALVACEAE	*Hibiscus nigricaulis Baker f.*	LC	Herb
MALVACEAE	*Hibiscus physaloides Guill. & Perr.*	LC	Herb
MALVACEAE	*Hibiscus platycalyx Mast.*	LC	Shrub
MALVACEAE	*Hibiscus praeteritus R.A.Dyer*	LC	Herb
MALVACEAE	*Hibiscus pusillus Thunb.*	LC	Herb

Family	*Species*	Threat status	Growth forms
MALVACEAE	*Hibiscus schinzii Gürke*	LC	Herb
MALVACEAE	*Hibiscus sidiformis Baill.*	LC	Herb
MALVACEAE	*Hibiscus syriaca L.*	Not Evaluated	Shrub
MALVACEAE	*Hibiscus vitifolius L. subsp. vulgaris Brenan & Exell*	LC	Herb, shrub
ASTERACEAE	*Hirpicium bechuanense (S.Moore) Roessler*	LC	Dwarf shrub
APOCYNACEAE	*Huernia transvaalensis Stent*	LC	Succulent
APOCYNACEAE	*Huernia zebrina N.E.Br. subsp. magniflora (E.Phillips) L.C.Leach*	Not Evaluated	Succulent
HYPERICACEAE	*Hypericum lalandii Choisy*	LC	Herb
FABACEAE	*Indigofera bainesii Baker*	LC	Dwarf shrub, herb
FABACEAE	*Indigofera daleoides Benth. ex Harv. var. daleoides*	LC	Herb
FABACEAE	*Indigofera filipes Benth. ex Harv.*	LC	Dwarf shrub, herb, shrub
FABACEAE	*Indigofera flavicans Baker*	LC	Herb
FABACEAE	*Indigofera ingrata N.E.Br.*	LC	Herb
FABACEAE	*Indigofera nebrowniana J.B.Gillett*	LC	Dwarf shrub, herb
FABACEAE	*Indigofera sordida Benth. ex Harv.*	LC	Herb
CONVOLVULACEAE	*Ipomoea adenioides Schinz var. adenioides*	LC	Dwarf shrub, shrub
CONVOLVULACEAE	*Ipomoea coptica (L.) Roth ex Roem. & Schult.*	LC	Climber, herb
CONVOLVULACEAE	*Ipomoea crassipes Hook. var. crassipes*	LC	Herb, succulent
CONVOLVULACEAE	*Ipomoea gracilisepala Rendle*	LC	Herb
CONVOLVULACEAE	*Ipomoea hackeliana (Schinz) Hallier f.*	LC	Herb
CONVOLVULACEAE	*Ipomoea magnusiana Schinz*	LC	Herb
CONVOLVULACEAE	*Ipomoea obscura (L.) Ker Gawl. var. obscura*	LC	Herb
CONVOLVULACEAE	*Ipomoea robertsiana Rendle*	LC	Suffrutex
ACANTHACEAE	*Justicia exigua S.Moore*	LC	Herb
ACANTHACEAE	*Justicia exigua S.Moore*	LC	Herb
ACANTHACEAE	*Justicia flava (Vahl) Vahl*	LC	Dwarf shrub, herb
CUCURBITACEAE	*Kedrostis foetidissima (Jacq.) Cogn.*	LC	Climber, herb, succulent
KIRKIACEAE	*Kirkia acuminata Oliv.*	LC	Tree
KIRKIACEAE	*Kirkia wilmsii Engl.*	LC	Tree
RUBIACEAE	*Kohautia caespitosa Schnizl. subsp. brachyloba (Sond.) D.Mantell*	LC	Herb
RUBIACEAE	*Kohautia cynanchica DC.*	LC	Herb

Family	*Species*	Threat status	Growth forms
RUBIACEAE	*Kohautia virgata (Willd.) Bremek.*	LC	Herb
CYPERACEAE	*Kyllinga alba Nees*	LC	Cyperoid, herb, mesophyte
AMARANTHACEAE	*Kyphocarpa angustifolia (Moq.) Lopr.*	LC	Herb
FABACEAE	*Lablab purpureus (L.) Sweet subsp. uncinatus Verdc.*	LC	Climber, herb
IRIDACEAE	*Lapeirousia sandersonii Baker*	LC	Geophyte, herb
LAMIACEAE	*Leucas capensis (Benth.) Engl.*	LC	Dwarf shrub
LAMIACEAE	*Leucas sexdentata Skan*	LC	Herb
MOLLUGINACEAE	*Limeum fenestratum (Fenzl) Heimerl var. fenestratum*	LC	Herb
LESKEACEAE	*Lindbergia pseudoleskeoides Dixon*		Bryophyte, epiphyte
VERBENACEAE	*Lippia wilmsii H.Pearson*	LC	Shrub
POACEAE	*Loudetia flavida (Stapf) C.E.Hubb.*	LC	Graminoid
ONAGRACEAE	*Ludwigia adscendens (L.) Hara subsp. diffusa (Forssk.) P.H.Raven*	LC	Herb, hydrophyte
CAPPARACEAE	*Maerua angolensis DC. subsp. angolensis*	LC	Shrub, tree
APOCYNACEAE	*Marsdenia sylvestris (Retz.) P.I.Forst.*	LC	Climber
POACEAE	*Megaloprotachne albescens C.E.Hubb.*	LC	Graminoid
MALVACEAE	*Melhania acuminata Mast. var. acuminata*	LC	Dwarf shrub
MALVACEAE	*Melhania forbesii Planch. ex Mast.*	LC	Dwarf shrub, shrub
POACEAE	*Melinis repens (Willd.) Zizka subsp. grandiflora (Hochst.) Zizka*	LC	Graminoid
CONVOLVULACEAE	*Merremia verecunda Rendle*	LC	Herb
SAPOTACEAE	*Mimusops zeyheri Sond.*	LC	Shrub, tree
CUCURBITACEAE	*Momordica repens Bremek.*	LC	Herb, succulent
ACANTHACEAE	*Monechma divaricatum (Nees) C.B.Clarke*	LC	Shrub, suffrutex
GERANIACEAE	*Monsonia angustifolia E.Mey. ex A.Rich.*	LC	Herb
GERANIACEAE	*Monsonia glauca R.Knuth*	LC	Herb
FABACEAE	*Neorautanenia ficifolia (Benth. ex Harv.) C.A.Sm.*	LC	Climber, herb, succulent
FABACEAE	*Neorautanenia mitis (A.Rich.) Verdc.*	LC	Dwarf shrub, herb, succulent
AMARYLLIDACEAE	*Nerine laticoma (Ker Gawl.) T.Durand & Schinz*	LC	Geophyte
LYTHRACEAE	*Nesaea rigidula (Sond.) Koehne*	LC	Herb
ASTERACEAE	*Nidorella resedifolia DC. subsp. resedifolia*	LC	Herb
NYMPHAEACEAE	*Nymphaea nouchali Burm.f. var. caerulea (Savigny) Verdc.*	LC	Epihydate, herb, hydrophyte
HYACINTHACEAE	*Ornithogalum tenuifolium F.Delaroche subsp. tenuifolium*	Not Evaluated	Geophyte

Family	*Species*	Threat status	Growth forms
SANTALACEAE	*Osyris lanceolata Hochst. & Steud.*	LC	Shrub
FABACEAE	*Otoptera burchellii DC.*	LC	Climber, herb, shrub
POLYGONACEAE	*Oxygonum dregeanum Meisn. subsp. canescens (Sond.) Germish. var. canescens*	LC	Herb
POLYGONACEAE	*Oxygonum sinuatum (Hochst. & Steud. ex Meisn.) Dammer*		Herb
ANACARDIACEAE	*Ozoroa paniculosa (Sond.) R.& A.Fern. var. paniculosa*	LC	Shrub, tree
POACEAE	*Panicum maximum Jacq.*	LC	Graminoid
POACEAE	*Panicum maximum Jacq.*	LC	Graminoid
POACEAE	*Panicum repens L.*	LC	Graminoid
POACEAE	*Panicum schinzii Hack.*	LC	Graminoid
RUBIACEAE	*Pavetta harborii S.Moore*	LC	Shrub
MALVACEAE	*Pavonia clathrata Mast.*	LC	Herb, shrub
MALVACEAE	*Pavonia transvaalensis (Ulbr.) A.Meeuse*	LC	Dwarf shrub, herb
RUBIACEAE	*Pentanisia angustifolia (Hochst.) Hochst.*	LC	Herb
APOCYNACEAE	*Pergularia daemia (Forssk.) Chiov. subsp. daemia*	LC	Climber
POACEAE	*Perotis patens Gand.*	LC	Graminoid
POLYGONACEAE	*Persicaria attenuata (R.Br.) Soják subsp. africana K.L.Wilson*	LC	Helophyte, herb, hydrophyte
POLYGONACEAE	*Persicaria limbata (Meisn.) H.Hara*	Not Evaluated	Helophyte, herb
NYCTAGINACEAE	*Phaeoptilum spinosum Radlk.*	LC	Shrub
VERBENACEAE	*Phyla nodiflora (L.) Greene var. nodiflora*	Not Evaluated	Herb
APOCYNACEAE	*Piaranthus atrosanguineus (N.E.Br.) Bruyns*	LC	Succulent
POACEAE	*Pogonarthria squarrosa (Roem. & Schult.) Pilg.*	LC	Graminoid
POACEAE	*Pogonarthria squarrosa (Roem. & Schult.) Pilg.*	LC	Graminoid
POLYGONACEAE	*Polygonum plebeium R.Br.*	LC	Herb
FABACEAE	*Pomaria burchellii (DC.) B.B.Simpson & G.P.Lewis subsp. burchellii*	LC	Herb
URTICACEAE	*Pouzolzia mixta Solms var. mixta*	LC	Shrub, succulent, tree
VERBENACEAE	*Priva africana Moldenke*	LC	Herb
ASTERACEAE	*Pseudognaphalium luteo-album (L.) Hilliard & B.L.Burtt*		Herb
LESKEACEAE	*Pseudoleskea leskeoides (Paris) Müll.Hal.*		Bryophyte, epiphyte
PEDALIACEAE	*Pterodiscus ngamicus N.E.Br. ex Stapf*	LC	Herb, succulent
FABACEAE	*Ptycholobium contortum (N.E.Br.) Brummitt*	LC	Dwarf shrub, herb
CYPERACEAE	*Pycreus pelophilus (Ridl.) C.B.Clarke*	LC	Cyperoid, helophyte, herb,

Family	*Species*	Threat status	Growth forms
			mesophyte
CYPERACEAE	*Pycreus polystachyos (Rottb.) P.Beauv. var. polystachyos*	LC	Cyperoid, helophyte, herb, mesophyte
FABACEAE	*Requienia pseudosphaerosperma (Schinz) Brummitt*	LC	Herb, shrub
BIGNONIACEAE	*Rhigozum brevispinosum Kuntze*	LC	Shrub
FABACEAE	*Rhynchosia spectabilis Schinz*	LC	Dwarf shrub, herb, shrub
FABACEAE	*Rhynchosia totta (Thunb.) DC. var. totta*	LC	Climber, herb
RICCIACEAE	*Riccia atropurpurea Sim*		Bryophyte
RICCIACEAE	*Riccia congoana Steph.*		Bryophyte
RICCIACEAE	*Riccia okahandjana S.W.Arnell*		Bryophyte
RUBIACEAE	*Rubia horrida (Thunb.) Puff*	LC	Herb
ACANTHACEAE	*Ruellia patula Jacq.*	LC	Herb
APOCYNACEAE	*Sarcostemma viminale (L.) R.Br. subsp. viminale*	LC	Climber, succulent
EUPHORBIACEAE	*Schinziophyton rautanenii (Schinz) Radcl.-Sm.*	LC	Tree
POACEAE	*Schmidtia pappophoroides Steud.*	LC	Graminoid
POACEAE	*Schmidtia pappophoroides Steud.*	LC	Graminoid
ANACARDIACEAE	*Searsia rigida (Mill.) F.A.Barkley var. margaretae (Burtt Davy ex Moffett) Moffett*	LC	Shrub
GENTIANACEAE	*Sebaea leiostyla Gilg*	LC	Herb
APOCYNACEAE	*Secamone parvifolia (Oliv.) Bullock*	LC	Climber
SCROPHULARIACEAE	*Selago lacunosa Klotzsch*	LC	Herb
SCROPHULARIACEAE	*Selago welwitschii Rolfe var. australis Hilliard*	LC	Suffrutex
AMARANTHACEAE	*Sericorema remotiflora (Hook.f.) Lopr.*	LC	Herb
MALVACEAE	*Sida chrysantha Ulbr.*	LC	Dwarf shrub
MALVACEAE	*Sida ovata Forssk.*	LC	Dwarf shrub, herb
SOLANACEAE	*Solanum catombelense Peyr.*	LC	Dwarf shrub, shrub
SOLANACEAE	*Solanum lichtensteinii Willd.*	LC	Dwarf shrub, shrub
SOLANACEAE	*Solanum tomentosum L. var. tomentosum*	LC	Dwarf shrub, herb, shrub
MALPIGHIACEAE	*Sphedamnocarpus pruriens (A.Juss.) Szyszyl. subsp. pruriens*	LC	Climber, shrub
EUPHORBIACEAE	*Spirostachys africana Sond.*	LC	Shrub, tree
POACEAE	*Stipagrostis uniplumis (Licht.) De Winter var. uniplumis*	LC	Graminoid
OROBANCHACEAE	*Striga bilabiata (Thunb.) Kuntze subsp. bilabiata*	LC	Herb, parasite
OROBANCHACEAE	*Striga elegans Benth.*	LC	Herb, parasite
OROBANCHACEAE	*Striga gesnerioides (Willd.) Vatke*	LC	Herb, parasite

Family	*Species*	Threat status	Growth forms
ARACEAE	*Stylochaeton natalensis Schott*	LC	Herb
MYRTACEAE	*Syzygium cordatum Hochst. ex C.Krauss subsp. cordatum*	LC	Shrub, tree
PORTULACACEAE	*Talinum arnotii Hook.f.*	LC	Dwarf shrub, succulent
PORTULACACEAE	*Talinum crispatulum Dinter*	LC	Dwarf shrub, succulent
ASTERACEAE	*Tarchonanthus camphoratus L.*	LC	Shrub, tree
FABACEAE	*Tephrosia purpurea (L.) Pers. subsp. leptostachya (DC.) Brummitt var. leptostachya*	LC	Herb
FABACEAE	*Tephrosia purpurea (L.) Pers. subsp. leptostachya (DC.) Brummitt var. pubescens Baker*	LC	Herb
FABACEAE	*Tephrosia purpurea (L.) Pers. subsp. leptostachya (DC.) Brummitt var. pubescens Baker*	LC	Herb
FABACEAE	*Tephrosia zoutpansbergensis Bremek.*	LC	Dwarf shrub, shrub
COMBRETACEAE	*Terminalia sericea Burch. ex DC.*	LC	Tree
SANTALACEAE	*Thesium resedoides A.W.Hill*	LC	Herb, parasite, shrub
EUPHORBIACEAE	*Tragia dioica Sond.*	LC	Dwarf shrub, herb
POACEAE	*Tragus berteronianus Schult.*	LC	Graminoid
ZYGOPHYLLACEAE	*Tribulus terrestris L.*	LC	Herb
ZYGOPHYLLACEAE	*Tribulus zeyheri Sond. subsp. zeyheri*	LC	Dwarf shrub, herb
POACEAE	*Triraphis schinzii Hack.*	LC	Graminoid
MALVACEAE	*Triumfetta pilosa Roth var. effusa (E.Mey. ex Harv.) Wild*	LC	Shrub
CUCURBITACEAE	*Trochomeria macrocarpa (Sond.) Hook.f. subsp. macrocarpa*	LC	Climber, herb, succulent
MELIACEAE	*Turraea obtusifolia Hochst.*	LC	Climber, shrub, tree
POACEAE	*Urochloa brachyura (Hack.) Stapf*	LC	Graminoid
POACEAE	*Urochloa brachyura (Hack.) Stapf*	LC	Graminoid
VAHLIACEAE	*Vahlia capensis (L.f.) Thunb. subsp. vulgaris Bridson var. linearis E.Mey. ex Bridson*	LC	Herb
RUBIACEAE	*Vangueria infausta Burch. subsp. infausta*	LC	Tree
VERBENACEAE	*Verbena officinalis L.*	Not Evaluated	Herb
ASTERACEAE	*Verbesina encelioides (Cav.) Benth. & Hook. var. encelioides*	Not Evaluated	Herb
ASTERACEAE	*Vernonia fastigiata Oliv. & Hiern*	LC	Herb
ASTERACEAE	*Vernonia sutherlandii Harv.*	LC	Herb
FABACEAE	*Vigna frutescens A.Rich. subsp. frutescens var. frutescens*	LC	Climber, herb
FABACEAE	*Vigna unguiculata (L.) Walp. subsp. protracta (E.Mey.) B.J.Pienaar*	LC	Herb
VISCACEAE	*Viscum tuberculatum A.Rich.*	LC	Parasite, shrub, succulent

Family	*Species*	Threat status	Growth forms
LAMIACEAE	*Vitex rehmannii Gürke*	LC	Tree
CAMPANULACEAE	*Wahlenbergia undulata (L.f.) A.DC.*	LC	Herb
MALVACEAE	*Waltheria indica L.*	LC	Herb
FABACEAE	*Xanthocercis zambesiaca (Baker) Dumaz-le-Grand*	LC	Tree
CONVOLVULACEAE	*Xenostegia tridentata (L.) D.F.Austin & Staples subsp. angustifolia (Jacq.) Lejoly & Lisowski*	LC	Herb
OLACACEAE	*Ximenia americana L. var. microphylla Welw. ex Oliv.*	LC	Shrub, tree
XYRIDACEAE	*Xyris capensis Thunb.*	LC	Helophyte, herb, hydrophyte
RHAMNACEAE	*Ziziphus mucronata Willd. subsp. mucronata*	LC	Shrub, tree
FABACEAE	*Zornia linearis E.Mey.*	LC	Herb

13.2. Appendix 1a Additional photographic evidence of floral species on site

Clerodendrum ternatum

Alistilus bechuanicus

Evolvulus alsinoides

Kyllinga alba

Chlorophytum recurvifolium

Oxygonum dregeanum

Heliotropium species

Cyperus margaritaceus

13.3. Appendix 2 Mammal list for the study area

ORDER[1] & SPECIES	COMMON NAME	CONSERVATION STATUS			MEDUPI LoO[4,5,6]	FGD LoO[4,5,6]	NSS	EMPR[7]	VICINITY*	ATLAS[6]			
		GLOBAL RED LIST[1]	S.A. RED LIST[2]	S.A. ToPS LIST[3]						2327CB	2327DA	2327CD	2327DC
AFROSORICIDA (Golden moles)													
Neamblysomus julianae	Juliana's Golden Mole	**EN (U)**	**EN**	-	4	4							
MACROSCELIDEA (Elephant-shrews)													
Elephantulus brachyrhynchus	Short-snouted Elephant-shrew	LC (U)	LC	-	3	3							
Elephantulus intufi	Bushveld Elephant-shrew	LC (S)	LC	-	2	2			x				
Elephantulus myurus	Rock Elephant-shrew	LC (S)	LC	-	2	2							2
EULIPOTYPHLA (Hedgehogs & shrews)													
Atelerix frontalis	Southern African Hedgehog	LC (S)	**NT**	-	3	3							
Crocidura cyanea	Reddish-grey Musk Shrew	LC (S)	LC	-	2	2			x				
Crocidura fuscomurina	Tiny Musk Shrew	LC (U)	LC	-	4	4							
Crocidura hirta	Lesser Red Musk Shrew	LC (U)	LC	-	2	2							
Crocidura mariquensis	Swamp Musk Shrew	LC (U)	**NT**	-	4	4							
Myosorex cafer	Dark-footed Forest Shrew	LC (U)	LC	-	4	4							
CHIROPTERA (Bats)													
Epomophorus wahlbergi	Wahlberg's Epauletted Fruit Bat	LC (S)	LC	-	4	4							
Rousettus aegyptiacus	Egyptian Rousette	LC (S)	LC	-	4	4							
Rhinolophus smithersi	Smither's Horseshoe Bat	**NT (S)**	**NT**	-	3	3							
Rhinolophus clivosus	Geoffroy's Horseshoe Bat	LC (U)	LC	-	3	3							
Rhinolophus darlingi	Darling's Horseshoe Bat	LC (U)	LC	-	3	3							
Rhinolophus simulator	Bushveld Horseshoe Bat	LC (D)	LC	-	3	3							
Cloeotis percivali	Percival's Short-eared Trident Bat	LC (U)	**EN**	-	4	4							
Hipposideros caffer	Sundevall's Leaf-nosed bat	LC (D)	LC	-	4	4							2
Taphozous mauritianus	Mauritian Tomb Bat	LC (U)	LC	-	2	2			x				2
Tadarida aegyptiaca	Egyptian Free-tailed Bat	LC (U)	LC	-	2	2							
Mops midas	Midas Free-tailed Bat	LC (D)	LC	-	2	2					2		

ORDER[1] & SPECIES	COMMON NAME	CONSERVATION STATUS			MEDUPI LoO[4,5,6]	FGD LoO[4,5,6]	NSS	EMPR[7]	VICINITY*	ATLAS[6]			
		GLOBAL RED LIST[1]	S.A. RED LIST[2]	S.A. ToPS LIST[3]						2327CB	2327DA	2327CD	2327DC
Miniopterus natalensis	Natal Long-fingered Bat	LC (U)	LC	-	4	4							
Hypsugo anchietae	Anchieta's Pipistrelle	LC (U)	LC	-	4	4							
Pipistrellus hesperidus	Dusky Pipistrelle	LC (U)	LC	-	3	3							
Pipistrellus rusticus	Rusty Pipistrelle	LC (U)	LC	-	2	2			x				2
Neoromicia capensis	Cape Serotine	LC (S)	LC	-	1	1	x		x				2
Pipistrellus zuluensis	Zulu Serotine	LC (U)	LC	-	3	3							2
Myotis welwitschii	Welwitsch's Myotis	LC (U)	LC	-	4	4							
Myotis tricolor	Temminck's Myotis	LC (U)	LC	-	4	4							
Laephotis botswanae	Botswana Long-eared Bat	LC (S)	LC	-	3	3							
Scotophilus dinganii	Yellow-bellied House Bat	LC (U)	LC	-	2	2			x		4		3
Scotophilus viridis	Green House Bat	LC (U)	LC	-	1	1							
Nycteris thebaica	Egyptian Slit-faced Bat	LC (U)	LC	-	2	2							2
PRIMATES (Primates)													
Galago moholi	Southern Lesser Galago	LC (S)	LC	-	1	1			x				2
Papio ursinus	Chacma Baboon	LC (S)	LC	-	1	1	x	x	x				
Cercopithecus pygerythrus	Vervet Monkey	LC (S)	LC	-	1	1		x	x				
PHOLIDOTA (Pangolin)													
Manis temminckii	Pangolin	**VU (D)**	**VU**	**VU**	1	1*					2		
LAGOMORPHA (Hares & rabbits)													
Lepus saxatilis	Scrub Hare	LC (D)	LC	-	1	1	x		x	1	3		1
Pronolagus randensis	Jameson's Red Rock Rabbit	LC (U)	LC	-	3	3			*				
RODENTIA (Rodents)													
Cryptomys hottentotus	Common Mole-rat	LC (S)	LC	-	1	1	x		x				
Hystrix africaeaustralis	Porcupine	LC (S)	LC	-	1	1		x	x				2
Pedetes capensis	Springhare	LC (U)	LC	-	2	2			x				3
Xerus inauris	Cape Ground Squirrel	LC (S)	LC	-	2	2			x				
Paraxerus cepapi	Tree Squirrel	LC (S)	LC	-	1	1		x	x				
Graphiurus murinus	Woodland Dormouse	LC (S)	LC	-	2	2							

ORDER[1] & SPECIES	COMMON NAME	CONSERVATION STATUS			MEDUPI LoO[4,5,6]	FGD LoO[4,5,6]	NSS	EMPR[7]	VICINITY*	ATLAS[6]			
		GLOBAL RED LIST[1]	S.A. RED LIST[2]	S.A. ToPS LIST[3]						2327CB	2327DA	2327CD	2327DC
Acomys spinosissimus	Spiny Mouse	LC (S)	LC	-	2	2							1
Lemniscomys rosalia	Single-striped Mouse	LC (S)	LC	-	2	2							
Rhabdomys pumilio	Striped Mouse	LC (S)	LC	-	4	4							
Dasymys incomtus	Water Rat	LC (U)	NT	-	3	3							
Mus indutus	Desert Pygmy Mouse	LC (S)	LC	-	3	3							
Mus minutoides	Pygmy Mouse	LC (S)	LC	-	3	3			x				
Mastomys coucha	Multimammate Mouse	LC (S)	LC	-	2	2			x				
Mastomys sp.	Multimammate mice	-	-	-	-								1
Thallomys paedulcus	Tree Rat	LC (U)	LC	-	2	2							
Aethomys namaquensis	Namaqua Rock Mouse	LC (S)	LC	-	2	2							
Aethomys ineptus	Tete Veld Rat	LC (U)	LC	-	4	4							
Otomys angoniensis	Angoni Vlei Rat	LC (S)	LC	-	4	4							
Otomys irroratus	Vlei Rat	LC (S)	LC	-	3	3							
Gerbillurus paeba	Hairy-footed Gerbil	LC (S)	LC	-	3	3							
Tatera leucogaster	Bushveld Gerbil	LC (S)	LC	-	1	1	x	x	x				2
Tatera brantsii	Highveld Gerbil	LC (U)	LC	-	4	4							
Saccostomus campestris	Pouched Mouse	LC (S)	LC	-	2	2			x				
Dendromus melanotis	Grey Climbing Mouse	LC (S)	LC	-	3	3							
Dendromus mystacalis	Chestnut Climbing Mouse	LC (S)	LC	-	4	4							
Steatomys pratensis	Fat Mouse	LC (S)	LC	-	3	3							
CARNIVORA (Carnivores)													
Proteles cristatus	Aardwolf	LC (S)	LC	-	1	1			x	2			
Crocuta crocuta	Spotted Hyaena	LC (D)	NT	PS	4	4							
Hyaena brunnea	Brown hyaena	NT (S)	NT	PS	1	1			x	3	3		2
Acinonyx jubatus	Cheetah	VU (D)	VU	VU	1	1*				4		1	
Panthera pardus	Leopard	VU (D)	VU	PS	1	1*			x	8	8	8	23
Panthera leo	Lion	VU (D)	LC	VU	5	5							

ORDER[1] & SPECIES	COMMON NAME	CONSERVATION STATUS			MEDUPI LoO[4,5,6]	FGD LoO[4,5,6]	NSS	EMPR[7]	VICINITY*	ATLAS[6]			
		GLOBAL RED LIST[1]	S.A. RED LIST[2]	S.A. ToPS LIST[3]						2327CB	2327DA	2327CD	2327DC
Caracal caracal	Caracal	LC (U)	LC	-	1	1				4	2		
Felis silvestris	African Wild Cat	LC (D)	LC	-	1	1*			x				
Felis nigripes	Black-footed Cat	VU (D)	VU	PS	3	3							
Leptailurus serval	Serval	LC (S)	NT	PS	1	1							
Civettictis civetta	African Civet	LC (U)	LC	-	1	1			x				1
Genetta genetta	Small-spotted Genet	LC (S)	LC	-	2	2			x				1
Genetta tigrina	Large-spotted Genet	LC (U)	LC	-	1	1			x				1
Cynictis penicillata	Yellow Mongoose	LC (S)	LC	-	4	4							
Galerella sanguinea	Slender Mongoose	LC (S)	LC	-	1	1	x		x				
Ichneumia albicauda	White-tailed Mongoose	LC (S)	LC	-	2	2							
Atilax paludinosus	Water Mongoose	LC (D)	LC	-	1	1							1
Mungos mungo	Banded Mongoose	LC (S)	LC	-	1	1			x				2
Helogale parvula	Dwarf Mongoose	LC (S)	LC	-	2	2							
Otocyon megalotis	Bat-eared Fox	LC (U)	LC	PS	1	1*			x	2			
Lycaon pictus	African Wild Dog	EN (D)	EN	EN	1	1*							
Vulpes chama	Cape Fox	LC (S)	LC	PS	2	2							
Canis mesomelas	Black-backed Jackal	LC (S)	LC	-	1	1		x	x	2	1		1
Aonyx capensis	Cape Clawless Otter	NT (D)	NT	-	3	3							
Mellivora capensis	Honey Badger	LC (D)	LC	-	2	2						1	
Poecilogale albinucha	African Weasel	LC (U)	NT	-	2	2							
Ictonyx striatus	Striped Polecat	LC (S)	LC	-	2	2							
TUBULIDENTATA (Aardvark)													
Orycteropus afer	Aardvark	LC (U)	LC	PS	1	1		x	x				
PROBOSCIDEA (Elephant)													
Loxodonta africana	African Elephant	VU (I)	LC	PS	5	5							
HYRACOIDEA (Hyraxes)													
Procavia capensis	Rock Hyrax	LC (U)	LC	-	3	3			x				
Heterohyrax brucei	Yellow-spotted Rock Hyrax	LC (U)	LC	-	4	4							

ORDER[1] & SPECIES	COMMON NAME	CONSERVATION STATUS			MEDUPI LoO[4,5,6]	FGD LoO[4,5,6]	NSS	EMPR[7]	VICINITY*	ATLAS[6]			
		GLOBAL RED LIST[1]	S.A. RED LIST[2]	S.A. ToPS LIST[3]						2327CB	2327DA	2327CD	2327DC
PERISSODACTYLA (Zebras)													
Ceratotherium simum	White Rhinoceros	**NT (I)**	**NT**	**PS**	1	5		x	x				
Diceros bicornis	Black Rhinoceros	**CR (I)***	**EN**	**EN**	5	5							
Equus quagga	Plains Zebra	LC (S)	LC	**PS****	1	1			x				
SUIFORMES (Pigs & hogs)													
Potamochoerus larvatus	Bushpig	LC (S)	LC	-	4	4			x				
Phacochoerus africanus	Warthog	LC (S)	LC	-	1	1	x	x	x		1		
RUMINATA (Even-toed ungulates)													
Giraffa camelopardalis	Giraffe	LC (D)	LC	-	1	1			x		2		1
Syncerus caffer	Cape Buffalo	LC (D)	LC	-	5	5			x				
Tragelaphus strepsiceros	Kudu	LC (S)	LC	-	1	1	x	x	x				
Tragelaphus angasii	Nyala	LC (S)	LC	-	1	1			x				
Tragelaphus scriptus	Bushbuck	LC (S)	LC	-	1	1*		x	x				1
Tragelaphus oryx	Eland	LC (S)	LC	-	1	1		x	x		1		
Connochaetes gnou	Black Wildebeest	LC (I)	LC	**PS****	5	5							
Connochaetes taurinus	Blue Wildebeest	LC (S)	LC	**PS****	1	1			x				1
Alcelaphus buselaphus	Red Hartebeest	LC (D)	LC	**PS****	1	1		x	x		1		1
Damaliscus pygargus phillipsi	Blesbok	LC (S)*	LC	**PS****	1	1		x	x				
Damaliscus lunatus	Tsessebe	LC (D)	**VU**	**PS****	1	5		x	x				
Hippotragus equinus	Roan	LC (D)	**EN**	**EN**	5	5							
Hippotragus niger	Sable	LC (S)	**VU**	**VU**	1	5		x	x				
Sylvicapra grimmia	Common Duiker	LC (S)	LC	-	1	1	x		x				
Redunca arundinum	Reedbuck	LC (S)	LC	-	4	4							1
Redunca fulvorufula	Mountain Reedbuck	**EN (D)**	**EN**	-	4	4			x				
Kobus ellipsiprymnus	Waterbuck	LC (D)	LC	-	1	1			x				1
Pelea capreolus	Grey Rhebok	**NT (D)**	**NT**	-	1	1	x						
Antidorcas marsupialis	Springbok	LC (I)	LC	-	5	5							

ORDER[1] & SPECIES	COMMON NAME	CONSERVATION STATUS			MEDUPI LoO[4,5,6]	FGD LoO[4,5,6]	NSS	EMPR[7]	VICINITY*	ATLAS[6]			
		GLOBAL RED LIST[1]	S.A. RED LIST[2]	S.A. ToPS LIST[3]						2327CB	2327DA	2327CD	2327DC
Ourebia ourebi	Oribi	LC (D)	**EN**	**EN**	5	5							
Raphicerus campestris	Steenbok	LC (S)	LC	-	1	1	x	x	x				
Aepyceros melampus	Impala	LC (S)	LC	-	1	1	x	x	x		1		1
Oreotragus oreotragus	Klipspringer	LC (S)	LC	-	3	3			x				2
Oryx gazelle	Gemsbok	LC (S)	LC	-	1	1							
Key													
Status: CR = Critically Endangered; D = Declining; DD = Data Deficient; EN = Endangered; I = Increasing; LC = Least Concern; NT = Near Threatened; PS = Protected Species; S = Stable; U = Unknown; VU = Vulnerable													
Likelihood of Occurrence (LoO): 1 = Present; 2 = High; 3 = Moderate; 4 = Low; 5 = May occur as a managed population													
Sources: [1]IUCN (2017.3); [2]SANBI & EWT (unpubl.); [3]ToPS List (2015); [4]Friedmann & Daly (2004); [5]Monadjem *et al.* (2010); [6]MammalMap (2018); [7]BEC (2006)													
*Combined records from NSS studies at Grootegeluk and Limpopo West Mines, Mafutha Project and Matimba Power Station													
**Species listed to ensure that they are managed in an ecologically sustainable manner (ToPS List, 2015)													

13.4. Appendix 3 Bird list for the study area

CATEGORY & SCIENTIFIC NAME	COMMON NAME	CONSERVATION STATUS			MEDUPI LoO[3]	FGD LoO[3]	NSS	EMPR[4]	VICINITY*	SABAP2	
		GLOBAL RED LIST[1]	S.A. RED LIST[1]	S.A. ToPS LIST[2]						2340_2730	2340_2725
2. Inland water birds											
Anhinga rufa	African Darter	LC	LC		4	4			x	x	
Ardea cinerea	Grey Heron	LC	LC		1	1	x		x	x	
Ardea goliath	Goliath Heron	LC	LC		4	4				x	
Ardea melanocephala	Black-headed Heron	LC	LC		4	4			x	x	
Ardea purpurea	Purple Heron	LC	LC		4	4				x	
Ardeola ralloides	Squacco Heron	LC	LC		1	1	x		x	x	
Bostrychia hagedash	Hadeda Ibis	LC	LC		1	1	x		x	x	
Bubulcus ibis	Western Cattle Egret	LC	LC		1	1	x		x	x	x
Butorides striata	Green-backed Heron	LC	LC		4	4				x	
Chlidonias leucopterus	White-winged Tern	LC	LC		4	4				x	
Chroicocephalus cirrocephalus	Grey-headed Gull	LC	LC		4	4				x	
Ciconia abdimii	Abdim's Stork	LC	**NT**		3	3			x	x	
Ciconia ciconia	White Stork	LC	LC		3	3				x	x
Ciconia nigra	Black Stork	LC	**VU**		4	4				x	
Egretta alba	Great Egret	LC	LC		4	4				x	
Egretta garzetta	Little Egret	LC	LC		1	1	x		x	x	
Egretta intermedia	Yellow-billed Egret	LC	LC		3	3				x	
Glareola nordmanni	Black-winged Pratincole	**NT**	**NT**		4	4				x	x
Ixobrychus minutus	Little Bittern	LC	LC		4	4					
Ixobrychus sturmii	Dwarf Bittern	LC	LC		4	4					
Leptoptilos crumeniferus	Marabou Stork	LC	**NT**		4	4				x	
Mycteria ibis	Yellow-billed Stork	LC	**EN**		4	4				x	
Nycticorax nycticorax	Black-crowned Night Heron	LC	LC		1	1	x	x	x		

CATEGORY & SCIENTIFIC NAME	COMMON NAME	CONSERVATION STATUS			MEDUPI LoO[3]	FGD LoO[3]	NSS	EMPR[4]	VICINITY*	SABAP2	
		GLOBAL RED LIST[1]	S.A. RED LIST[1]	S.A. ToPS LIST[2]						2340_2730	2340_2725
Phalacrocorax africanus	Reed Cormorant	LC	LC		1	1	x		x	x	
Phalacrocorax lucidus	White-breasted Cormorant	LC	LC		4	4			x	x	
Phoeniconaias minor	Lesser Flamingo	NT	NT		4	4				x	
Phoenicopterus roseus	Greater Flamingo	LC	NT		4	4				x	
Platalea alba	African Spoonbill	LC	LC		1	1	x		x	x	
Plegadis falcinellus	Glossy Ibis	LC	LC		3	3				x	
Scopus umbretta	Hamerkop	LC	LC		1	1	x		x	x	
Threskiornis aethiopicus	African Sacred Ibis	LC	LC		2	2				x	
3. Ducks & wading birds											
Actitis hypoleucos	Common Sandpiper	LC	LC		1	1	x		x	x	
Actophilornis africanus	African Jacana	LC	LC		4	4				x	
Alopochen aegyptiaca	Egyptian Goose	LC	LC		1	1	x	x	x	x	x
Amaurornis flavirostra	Black Crake	LC	LC		4	4			x	x	
Anas capensis	Cape Teal	LC	LC		4	4			x	x	
Anas erythrorhyncha	Red-billed Teal	LC	LC		1	1	x		x	x	
Anas hottentota	Hottentot Teal	LC	LC		4	4				x	
Anas smithii	Cape Shoveler	LC	LC		4	4				x	
Anas sparsa	African Black Duck	LC	LC		4	4				x	
Anas undulata	Yellow-billed Duck	LC	LC		1	1	x		x	x	
Calidris ferruginea	Curlew Sandpiper	NT	LC		4	4					
Calidris minuta	Little Stint	LC	LC		4	4				x	
Charadrius pecuarius	Kittlitz's Plover	LC	LC		1	1	x			x	
Charadrius tricollaris	Three-banded Plover	LC	LC		1	1	x		x	x	
Crecopsis egregia	African Crake	LC	LC		4	4					
Dendrocygna bicolor	Fulvous Whistling Duck	LC	LC		4	4				x	

CATEGORY & SCIENTIFIC NAME	COMMON NAME	CONSERVATION STATUS			MEDUPI LoO[3]	FGD LoO[3]	NSS	EMPR[4]	VICINITY*	SABAP2	
		GLOBAL RED LIST[1]	S.A. RED LIST[1]	S.A. ToPS LIST[2]						2340_2730	2340_2725
Dendrocygna viduata	White-faced Whistling Duck	LC	LC		1	1	x		x	x	x
Fulica cristata	Red-knobbed coot	LC	LC		1	1	x		x	x	
Gallinago nigripennis	African Snipe	LC	LC		4	4			x	x	
Gallinula chloropus	Common Moorhen	LC	LC		1	1	x		x	x	
Himantopus himantopus	Black-winged Stilt	LC	LC		1	1	x		x	x	
Netta erythrophthalma	Southern Pochard	LC	LC		4	4			x	x	
Nettapus auritus	African Pygmy Goose	LC	**VU**		4	4					
Oxyura maccoa	Maccoa Duck	**NT**	**NT**		4	4				x	
Philomachus pugnax	Ruff	LC	LC		1	1	x		x	x	
Plectropterus gambensis	Spur-winged Goose	LC	LC		1	1	x		x	x	
Rallus caerulescens	African Rail	LC	LC		4	4					
Recurvirostra avosetta	Pied Avocet	LC	LC		1	1	x			x	
Rostratula benghalensis	Greater Painted-snipe	LC	**NT**		4	4			x		
Sarkidiornis melanotos	Knob-billed Duck	LC	LC		1	1	x	x	x	x	x
Tachybaptus ruficollis	Little Grebe	LC	LC		1	1	x		x	x	
Thalassornis leuconotus	White-backed Duck	LC	LC		4	4				x	
Tringa glareola	Wood Sandpiper	LC	LC		1	1	x		x	x	x
Tringa nebularia	Common Greenshank	LC	LC		1	1	x		x	x	
Tringa stagnatilis	Marsh Sandpiper	LC	LC		4	4			x	x	
Tringa totanus	Common Redshank				4	4					
Vanellus armatus	Blacksmith Lapwing	LC	LC		1	1	x	x	x	x	x
Vanellus coronatus	Crowned Lapwing	LC	LC		1	1	x	x	x	x	x
Vanellus senegallus	African Wattled Lapwing	LC	LC		1	1	x			x	
4. Large terrestrial birds											
Afrotis afraoides	Northern Black Korhaan	LC	LC		3	3					

CATEGORY & SCIENTIFIC NAME	COMMON NAME	CONSERVATION STATUS			MEDUPI LoO[3]	FGD LoO[3]	NSS	EMPR[4]	VICINITY*	SABAP2	
		GLOBAL RED LIST[1]	S.A. RED LIST[1]	S.A. ToPS LIST[2]						2340_2730	2340_2725
Ardeotis kori	Kori Bustard	**NT**	**NT**	**PS**	4	4			x	x	x
Burhinus capensis	Spotted Thick-knee	LC	LC		2	2			x	x	x
Burhinus vermiculatus	Water Thick-knee	LC	LC		4	4			x	x	
Coturnix coturnix	Common Quail	LC	LC		1	1	x		x	x	
Coturnix delegorguei	Harlequin Quail	LC	LC		3	3				x	
Cursorius temminckii	Temminck's Courser	LC	LC		3	3			x	x	
Dendroperdix sephaena	Crested Francolin	LC	LC		1	1	x	x		x	x
Lophotis ruficrista	Red-crested Korhaan	LC	LC		1	1	x	x		x	x
Numida meleagris	Helmeted Guineafowl	LC	LC		1	1	x		x	x	x
Peliperdix coqui	Coqui Francolin	LC	LC		2	2				x	x
Pternistis natalensis	Natal Spurfowl	LC	LC		1	1	x	x		x	
Pternistis swainsonii	Swainson's Spurfowl	LC	LC		1	1	x	x		x	x
Rhinoptilus chalcopterus	Bronze-winged Courser	LC	LC		3	3			x	x	x
Sagittarius serpentarius	Secretarybird	**VU**	**VU**		3	3				x	x
Struthio camelus	Common Ostrich	LC	LC		1	1	x		x	x	x
Turnix sylvaticus	Common (Kurrichane) Buttonquail	LC	LC		3	3			x		
5. Raptors											
Accipiter badius	Shikra	LC	LC		1	1	x				x
Accipiter melanoleucus	Black Sparrowhawk	LC	LC		4	4					
Accipiter minullus	Little Sparrowhawk	LC	LC		2	2			x	x	x
Accipiter ovampensis	Ovambo Sparrowhawk	LC	LC		2	2				x	
Aquila nipalensis	Steppe Eagle	**EN**	LC		3	3					x
Aquila rapax	Tawny Eagle	LC	**EN**	**EN**	1	1	x		x	x	x
Aquila spilogaster	African Hawk Eagle	LC	LC		1	1	x			x	
Aquila verreauxii	Verreauxs' Eagle	LC	**VU**		2	2				x	

CATEGORY & SCIENTIFIC NAME	COMMON NAME	CONSERVATION STATUS			MEDUPI LoO[3]	FGD LoO[3]	NSS	EMPR[4]	VICINITY*	SABAP2	
		GLOBAL RED LIST[1]	S.A. RED LIST[1]	S.A. ToPS LIST[2]						2340_2730	2340_2725
Buteo buteo	Common (Steppe) Buzzard	LC	LC		1	1	x			x	x
Buteo rufofuscus	Jackal Buzzard	LC	LC		1	2		x	x		
Circaetus cinereus	Brown Snake Eagle	LC	LC		1	1	x		x	x	x
Circaetus pectoralis	Black-chested Snake Eagle	LC	LC		1	1	x		x	x	x
Circus pygargus	Montagu's Harrier	LC	LC		4	4				x	
Clanga pomarina	Lesser Spotted Eagle	LC	LC		4	4					
Elanus caeruleus	Black-shouldered Kite	LC	LC		1	1	x		x	x	x
Falco amurensis	Amur Falcon	LC	LC		2	2				x	x
Falco biarmicus	Lanner Falcon	LC	VU		3	3					
Falco rupicolus	Rock Kestrel	LC	LC		4	4				x	x
Gyps africanus	White-backed Vulture	CR	CR	EN	1	1	x		x	x	x
Gyps coprotheres	Cape Vulture	EN	EN	EN	1	1	x		x		x
Haliaeetus vocifer	African Fish Eagle	LC	LC		3	3			x	x	
Hieraaetus pennatus	Booted Eagle	LC	LC		2	2					x
Hieraaetus wahlbergi	Wahlberg's Eagle	LC	LC		1	1	x		x	x	x
Kaupifalco monogrammicus	Lizard Buzzard	LC	LC		2	2			x	x	
Melierax canorus	Pale Chanting Goshawk	LC	LC		1	1	x		x	x	x
Melierax gabar	Gabar Goshawk	LC	LC		1	1	x		x	x	x
Milvus aegyptius	Yellow-billed Kite	LC	LC		2	2				x	
Milvus migrans	Black Kite	LC	LC		2	2			x	x	
Pandion haliaetus	Western Osprey	LC	LC		4	4					
Polemaetus bellicosus	Martial Eagle	VU	EN	EN	2	2				x	
Polyboroides typus	African Harrier-Hawk	LC	LC		1	1	x		x	x	
Terathopius ecaudatus	Bateleur	NT	EN	EN	4	4				x	x
Torgos tracheliotos	Lappet-faced Vulture	EN	EN	EN	2	2			x		x

CATEGORY & SCIENTIFIC NAME	COMMON NAME	CONSERVATION STATUS			MEDUPI LoO[3]	FGD LoO[3]	NSS	EMPR[4]	VICINITY*	SABAP2	
		GLOBAL RED LIST[1]	S.A. RED LIST[1]	S.A. ToPS LIST[2]						2340_2730	2340_2725
6. Owls & nightjars											
Bubo africanus	Spotted Eagle-Owl	LC	LC		1	1	x		x	x	x
Bubo lacteus	Verreaux's Eagle-Owl	LC	LC		1	1	x				
Caprimulgus pectoralis	Fiery-necked Nightjar	LC	LC		2	2			x	x	
Caprimulgus rufigena	Rufous-cheeked Nightjar	LC	LC		1	1	x		x		x
Caprimulgus tristigma	Freckled Nightjar	LC	LC		1	1	x		x	x	
Glaucidium perlatum	Pearl-spotted Owlet	LC	LC		1	1	x	x	x	x	x
Otus senegalensis	African Scops Owl	LC	LC		1	1	x			x	
Ptilopsis granti	Southern White-faced Owl	LC	LC		1	1	x				x
Tyto alba	Western Barn Owl	LC	LC		2	2			x	x	
7. Sandgrouse, doves etc											
Centropus burchellii	Burchell's Coucal	LC	LC		1	1	x		x	x	
Chrysococcyx caprius	Diederik Cuckoo	LC	LC		1	1	x	x	x	x	x
Chrysococcyx klaas	Klaas's Cuckoo	LC	LC		1	1	x	x	x	x	x
Clamator glandarius	Great Spotted Cuckoo	LC	LC		2	2			x	x	
Clamator jacobinus	Jacobin Cuckoo	LC	LC		1	1	x	x	x	x	x
Clamator levaillantii	Levaillant's Cuckoo	LC	LC		2	2			x	x	x
Columba guinea	Speckled Pigeon	LC	LC		1	1	x		x	x	x
Columba livia	Rock Dove	LC	LC		2	2				x	
Corythaixoides concolor	Grey Go-away-bird	LC	LC		1	1	x	x	x	x	x
Cuculus clamosus	Black Cuckoo	LC	LC		1	1	x	x	x	x	x
Cuculus gularis	African Cuckoo	LC	LC		2	2				x	x
Cuculus solitarius	Red-chested Cuckoo	LC	LC		1	1	x			x	x
Oena capensis	Namaqua Dove	LC	LC		1	1	x	x	x	x	x
Poicephalus meyeri	Meyer's Parrot	LC	LC		2	2				x	

CATEGORY & SCIENTIFIC NAME	COMMON NAME	CONSERVATION STATUS			MEDUPI LoO[3]	FGD LoO[3]	NSS	EMPR[4]	VICINITY*	SABAP2	
		GLOBAL RED LIST[1]	S.A. RED LIST[1]	S.A. ToPS LIST[2]						2340_2730	2340_2725
Pterocles bicinctus	Double-banded Sandgrouse	LC	LC		2	2			x	x	
Pterocles burchelli	Burchell's Sandgrouse	LC	LC		3	3			x	x	x
Streptopelia capicola	Cape Turtle Dove	LC	LC		1	1	x	x	x	x	x
Streptopelia semitorquata	Red-eyed Dove	LC	LC		1	1	x	x	x	x	x
Streptopelia senegalensis	Laughing Dove	LC	LC		1	1	x	x	x	x	x
Treron calvus	African Green Pigeon	LC	LC		3	3				x	
Turtur chalcospilos	Emerald-spotted Wood Dove	LC	LC		1	1	x	x	x	x	x
8. Aerial feeders, etc											
Alcedo cristata	Malachite Kingfisher	LC	LC		4	4				x	
Apus affinis	Little Swift	LC	LC		1	1	x	x	x	x	x
Apus apus	Common Swift	LC	LC		1	1	x	x	x	x	x
Apus barbatus	African Black Swift	LC	LC		2	2			x	x	
Apus caffer	White-rumped Swift	LC	LC		1	1	x		x	x	
Apus horus	Horus Swift	LC	LC		3	3					
Campethera abingoni	Golden-tailed Woodpecker	LC	LC		1	1	x	x	x	x	x
Campethera bennettii	Bennett's Woodpecker	LC	LC		2	2				x	
Cecropis abyssinica	Lesser Striped Swallow	LC	LC		1	1	x	x	x	x	
Cecropis cucullata	Greater Striped Swallow	LC	LC		1	2		x	x	x	
Cecropis semirufa	Red-breasted Swallow	LC	LC		1	1	x	x	x	x	x
Ceryle rudis	Pied Kingfisher	LC	LC		1	1	x		x	x	
Colius colius	White-backed Mousebird	LC	LC		1	1	x		x		
Colius striatus	Speckled Mousebird	LC	LC		2	2			x	x	x
Coracias caudatus	Lilac-breasted Roller	LC	LC		1	1	x		x	x	x
Coracias garrulus	European Roller	LC	**NT**		2	2			x	x	x
Coracias naevius	Purple Roller	LC	LC		1	1	x	x		x	x

CATEGORY & SCIENTIFIC NAME	COMMON NAME	CONSERVATION STATUS			MEDUPI LoO[3]	FGD LoO[3]	NSS	EMPR[4]	VICINITY*	SABAP2	
		GLOBAL RED LIST[1]	S.A. RED LIST[1]	S.A. ToPS LIST[2]						2340_2730	2340_2725
Cypsiurus parvus	African Palm Swift	LC	LC		3	3				x	
Delichon urbicum	Common House Martin	LC	LC		2	2			x	x	
Dendropicos fuscescens	Cardinal Woodpecker	LC	LC		1	1	x		x	x	x
Dendropicos namaquus	Bearded Woodpecker	LC	LC		1	1	x	x	x	x	x
Halcyon albiventris	Brown-hooded Kingfisher	LC	LC		1	1	x	x	x	x	x
Halcyon chelicuti	Striped Kingfisher	LC	LC		3	3					
Halcyon leucocephala	Grey-headed Kingfisher	LC	LC		3	3					
Halcyon senegalensis	Woodland Kingfisher	LC	LC		1	1	x		x	x	
Hirundo albigularis	White-throated Swallow	LC	LC		2	2			x	x	
Hirundo dimidiata	Pearl-breasted Swallow	LC	LC		1	1	x		x	x	
Hirundo fuligula	Rock Martin	LC	LC		3	3			x	x	
Hirundo rustica	Barn Swallow	LC	LC		1	1	x	x	x	x	x
Indicator indicator	Greater Honeyguide	LC	LC		1	1	x		x	x	x
Indicator minor	Lesser Honeyguide	LC	LC		1	1	x			x	
Ispidina picta	African Pygmy Kingfisher	LC	LC		4	4				x	
Lybius torquatus	Black-collared Barbet	LC	LC		2	2				x	x
Megaceryle maxima	Giant Kingfisher	LC	LC		3	3				x	
Merops apiaster	European Bee-eater	LC	LC		1	1	x		x	x	x
Merops bullockoides	White-fronted Bee-eater	LC	LC		2	2			x	x	x
Merops hirundineus	Swallow-tailed Bee-eater	LC	LC		1	1	x		x	x	x
Merops nubicoides	Southern Carmine Bee-eater	LC	LC		2	2			x	x	x
Merops persicus	Blue-cheeked Bee-eater	LC	LC		1	2		x		x	
Merops pusillus	Little Bee-eater	LC	LC		1	1	x	x	x	x	x
Phoeniculus purpureus	Green Wood-hoopoe	LC	LC		1	1	x	x	x	x	x
Pogoniulus chrysoconus	Yellow-fronted Tinkerbird	LC	LC		1	1	x			x	

CATEGORY & SCIENTIFIC NAME	COMMON NAME	CONSERVATION STATUS			MEDUPI LoO[3]	FGD LoO[3]	NSS	EMPR[4]	VICINITY*	SABAP2	
		GLOBAL RED LIST[1]	S.A. RED LIST[1]	S.A. ToPS LIST[2]						2340_2730	2340_2725
Prodotiscus regulus	Brown-backed Honeybird	LC	LC		4	4			x		
Rhinopomastus cyanomelas	Common Scimitarbill	LC	LC		1	2		x	x	x	x
Riparia cincta	Banded Martin	LC	LC		4	4					
Riparia paludicola	Brown-throated Martin	LC	LC		1	1	x			x	
Riparia riparia	Sand Martin	LC	LC		4	4				x	
Tachymarptis melba	Alpine Swift	LC	LC		2	2				x	
Tockus leucomelas	Southern Yellow-billed Hornbill	LC	LC		1	1	x	x	x	x	x
Tockus nasutus	African Grey Hornbill	LC	LC		1	1	x	x	x	x	x
Tockus rufirostris	Southern Red-billed Hornbill	LC	LC		1	1	x	x	x	x	x
Trachyphonus vaillantii	Crested Barbet	LC	LC		1	1	x	x	x	x	x
Tricholaema leucomelas	Acacia Pied Barbet	LC	LC		2	2			x	x	x
Upupa africana	African Hoopoe	LC	LC		1	2		x	x	x	x
Urocolius indicus	Red-faced Mousebird	LC	LC		1	1	x	x	x	x	x
9. Cryptic & elusive insect-eaters											
Acrocephalus arundinaceus	Great Reed Warbler	LC	LC		3	3					
Acrocephalus baeticatus	African Reed Warbler	LC	LC		4	4				x	
Acrocephalus gracilirostris	Lesser Swamp Warbler	LC	LC		4	4				x	
Acrocephalus palustris	Marsh Warbler	LC	LC		4	4					
Anthus caffer	Bushveld Pipit	LC	LC		2	2				x	
Anthus cinnamomeus	African Pipit	LC	LC		2	2			x	x	x
Anthus leucophrys	Plain-backed Pipit	LC	LC		2	2					x
Anthus lineiventris	Striped Pipit	LC	LC		3	3					
Anthus similis	Long-billed Pipit	LC	LC		3	3				x	
Anthus vaalensis	Buffy Pipit	LC	LC		2	2					
Apalis thoracica	Bar-throated Apalis	LC	LC		2	2				x	

CATEGORY & SCIENTIFIC NAME	COMMON NAME	CONSERVATION STATUS			MEDUPI LoO[3]	FGD LoO[3]	NSS	EMPR[4]	VICINITY*	SABAP2	
		GLOBAL RED LIST[1]	S.A. RED LIST[1]	S.A. ToPS LIST[2]						2340_2730	2340_2725
Bradypterus baboecala	Little Rush Warbler	LC	LC		4	4				x	
Calamonastes fasciolatus	Barred Wren-Warbler	LC	LC		1	1	x	x	x	x	x
Calandrella cinerea	Red-capped Lark	LC	LC		3	3			x	x	x
Calendulauda africanoides	Fawn-coloured Lark	LC	LC		2	2				x	x
Calendulauda sabota	Sabota Lark	LC	LC		1	1	x			x	x
Camaroptera brachyura	Green-backed Camaroptera	LC	LC		4	4				x	x
Camaroptera brevicaudata	Grey-backed Camaroptera	LC	LC		1	1	x	x	x	x	x
Certhilauda chuana	Short-clawed Lark	LC	**NT**		4	4			x		
Chlorocichla flaviventris	Yellow-bellied Greenbul	LC	LC		3	3					
Cisticola aberrans	Lazy Cisticola	LC	LC		3	3					
Cisticola aridulus	Desert Cisticola	LC	LC		1	1	x		x	x	x
Cisticola chiniana	Rattling Cisticola	LC	LC		1	1	x	x	x	x	x
Cisticola fulvicapilla	Neddicky	LC	LC		1	1	x		x	x	x
Cisticola juncidis	Zitting Cisticola	LC	LC		2	2			x	x	x
Cisticola rufilatus	Tinkling Cisticola	LC	LC		3	3			x		x
Cisticola tinniens	Levaillant's Cisticola	LC	LC		2	2				x	
Eremomela icteropygialis	Yellow-bellied Eremomela	LC	LC		2	2				x	x
Eremomela usticollis	Burnt-necked Eremomela	LC	LC		1	1	x		x	x	x
Eremopterix leucotis	Chestnut-backed Sparrow-lark	LC	LC		3	3				x	x
Eremopterix verticalis	Grey-backed Sparrow-lark	LC	LC		2	2				x	
Hippolais icterina	Icterine Warbler	LC	LC		3	3			x		
Hippolais olivetorum	Olive-tree Warbler	LC	LC		3	3			x		
Macronyx capensis	Cape Longclaw	LC	LC		2	2					
Mirafra africana	Rufous-naped Lark	LC	LC		2	2			x	x	x
Mirafra passerina	Monotonous Lark	LC	LC		1	1	x		x	x	

CATEGORY & SCIENTIFIC NAME	COMMON NAME	CONSERVATION STATUS			MEDUPI LoO[3]	FGD LoO[3]	NSS	EMPR[4]	VICINITY*	SABAP2	
		GLOBAL RED LIST[1]	S.A. RED LIST[1]	S.A. ToPS LIST[2]						2340_2730	2340_2725
Mirafra rufocinnamomea	Flappet Lark	LC	LC		3	3			x		
Motacilla aguimp	African Pied Wagtail	LC	LC		4	4			x	x	
Motacilla capensis	Cape Wagtail	LC	LC		1	1	x		x	x	
Phylloscopus trochilus	Willow Warbler	LC	LC		1	2		x	x	x	x
Pinarocorys nigricans	Dusky Lark	LC	LC		4	4			x		x
Prinia flavicans	Black-chested Prinia	LC	LC		2	2			x	x	x
Prinia subflava	Tawny-flanked Prinia	LC	LC		1	1	x		x	x	x
Pycnonotus nigricans	African Red-eyed Bulbul	LC	LC		2	2			x	x	x
Pycnonotus tricolor	Dark-capped Bulbul	LC	LC		1	1	x		x	x	x
Sylvietta rufescens	Long-billed crombec	LC	LC		1	1	x	x	x	x	x
10. Regular insect-eaters											
Acridotheres tristis	Common Myna				1	1	x		x		
Anthoscopus caroli	Grey Penduline-Tit	LC	LC		2	2					
Anthoscopus minutus	Cape Penduline-Tit	LC	LC		1	1	x			x	x
Batis molitor	Chinspot Batis	LC	LC		1	1	x	x	x	x	x
Bradornis mariquensis	Marico flycatcher	LC	LC		1	1	x		x	x	x
Bradornis pallidus	Pale flycatcher	LC	LC		3	3			x		
Campephaga flava	Black Cuckooshrike	LC	LC		1	1	x				
Cercomela familiaris	Familiar Chat	LC	LC		1	1	x		x	x	
Chlorophoneus sulfureopectus	Orange-breasted Bush-Shrike	LC	LC		1	1	x		x		
Cinnyricinclus leucogaster	Violet-backed Starling	LC	LC		2	2			x	x	x
Corvinella melanoleuca	Magpie Shrike	LC	LC		1	1	x	x	x	x	x
Corvus albus	Pied Crow	LC	LC		1	1	x		x	x	
Cossypha caffra	Cape Robin-Chat	LC	LC		1	1	x			x	
Cossypha humeralis	White-throated Robin-Chat	LC	LC		2	2			x	x	

CATEGORY & SCIENTIFIC NAME	COMMON NAME	CONSERVATION STATUS			MEDUPI LoO[3]	FGD LoO[3]	NSS	EMPR[4]	VICINITY*	SABAP2	
		GLOBAL RED LIST[1]	S.A. RED LIST[1]	S.A. ToPS LIST[2]						2340_2730	2340_2725
Creatophora cinerea	Wattled Starling	LC	LC		1	1	x		x	x	x
Dicrurus adsimilis	Fork-tailed Drongo	LC	LC		1	1	x	x	x	x	x
Dryoscopus cubla	Black-backed Puffback	LC	LC		1	1	x	x	x	x	
Erythropygia leucophrys	White-browed Scrub Robin	LC	LC		1	1	x			x	x
Erythropygia paena	Kalahari Scrub Robin	LC	LC		1	1	x			x	x
Eurocephalus anguitimens	Southern White-crowned Shrike	LC	LC		1	1	x		x	x	x
Lamprotornis australis	Burchell's Starling	LC	LC		1	1	x	x		x	x
Lamprotornis chalybaeus	Greater Blue-eared Starling	LC	LC		2	2			x	x	x
Lamprotornis nitens	Cape Glossy Starling	LC	LC		1	1	x		x	x	x
Laniarius atrococcineus	Crimson-breasted Shrike	LC	LC		1	1	x	x	x	x	x
Laniarius ferrugineus	Southern Boubou	LC	LC		2	2					
Lanius collaris	Southern (Common) Fiscal	LC	LC		2	2			x	x	x
Lanius collurio	Red-backed Shrike	LC	LC		1	1	x	x	x	x	x
Lanius minor	Lesser Grey Shrike	LC	LC		1	1	x		x	x	x
Malaconotus blanchoti	Grey-headed Bush-Shrike	LC	LC		1	1	x	x		x	x
Melaenornis pammelaina	Southern Black flycatcher	LC	LC		2	2				x	
Muscicapa caerulescens	Ashy Flycatcher	LC	LC		4	4					
Muscicapa striata	Spotted flycatcher	LC	LC		1	1	x		x	x	x
Myioparus plumbeus	Grey Tit-flycatcher	LC	LC		2	2				x	
Myrmecocichla formicivora	Ant-eating Chat	LC	LC		2	2			x	x	x
Nilaus afer	Brubru	LC	LC		1	1	x	x	x	x	x
Oenanthe pileata	Capped Wheatear	LC	LC		2	2			x	x	x
Onychognathus morio	Red-winged Starling	LC	LC		1	1	x		x	x	
Oriolus larvatus	Black-headed Oriole	LC	LC		1	1	x	x	x	x	x
Oriolus oriolus	Eurasian Golden Oriole	LC	LC		3	3				x	x

CATEGORY & SCIENTIFIC NAME	COMMON NAME	CONSERVATION STATUS			MEDUPI LoO[3]	FGD LoO[3]	NSS	EMPR[4]	VICINITY*	SABAP2	
		GLOBAL RED LIST[1]	S.A. RED LIST[1]	S.A. ToPS LIST[2]						2340_2730	2340_2725
Parus cinerascens	Ashy Tit	LC	LC		1	1	x		x		x
Parus niger	Southern Black Tit	LC	LC		1	1	x	x	x	x	x
Prionops plumatus	White-crested Helmet-Shrike	LC	LC		1	1	x			x	x
Saxicola torquatus	African StoneChat	LC	LC		2	2				x	
Sigelus silens	Fiscal Flycatcher	LC	LC		1	1	x			x	
Sylvia communis	Common Whitethroat	LC	LC		4	4					
Sylvia subcaerulea	Chestnut-vented Tit-Babbler	LC	LC		2	2			x	x	x
Tchagra australis	Brown-crowned Tchagra	LC	LC		1	1	x		x	x	x
Tchagra senegalus	Black-crowned Tchagra	LC	LC		1	1	x	x	x	x	x
Terpsiphone viridis	African Paradise Flycatcher	LC	LC		1	1	x	x		x	x
Thamnolaea cinnamomeiventris	Mocking Cliff Chat	LC	LC		3	3			x	x	
Turdoides bicolor	Southern Pied Babbler	LC	LC		1	1	x	x	x	x	x
Turdoides jardineii	Arrow-marked Babbler	LC	LC		1	1	x		x	x	x
Turdus libonyanus	Kurrichane Thrush	LC	LC		1	1	x		x	x	
Turdus litsitsirupa	Groundscraper Thrush	LC	LC		1	1	x		x	x	x
Turdus smithi	Karoo Thrush	LC	LC		2	2					
11. Oxpeckers & nectar feeders											
Buphagus erythrorynchus	Red-billed Oxpecker	LC	LC		1	1	x		x	x	
Chalcomitra amethystina	Amethyst Sunbird	LC	LC		1	1	x			x	
Cinnyris mariquensis	Marico Sunbird	LC	LC		1	1	x			x	x
Cinnyris talatala	White-bellied Sunbird	LC	LC		1	1	x	x		x	x
Zosterops pallidus	Orange River White-eye	LC	LC		3	3				x	
Zosterops virens	Cape White-eye	LC	LC		1	1	x		x	x	
12. Seedeaters											
Amadina erythrocephala	Red-headed Finch	LC	LC		2	2				x	x

CATEGORY & SCIENTIFIC NAME	COMMON NAME	CONSERVATION STATUS			MEDUPI LoO[3]	FGD LoO[3]	NSS	EMPR[4]	VICINITY*	SABAP2	
		GLOBAL RED LIST[1]	S.A. RED LIST[1]	S.A. ToPS LIST[2]						2340_2730	2340_2725
Amadina fasciata	Cut-throat Finch	LC	LC		2	2			x	x	x
Amandava subflava	Orange-breasted Waxbill	LC	LC		2	2				x	
Anaplectes rubriceps	Red-headed Weaver	LC	LC		1	1	x				
Anomalospiza imberbis	Cuckoo Finch	LC	LC		3	3				x	
Bubalornis niger	Red-billed Buffalo Weaver	LC	LC		1	1	x	x	x	x	x
Crithagra atrogularis	Black-throated Canary	LC	LC		2	2			x	x	x
Crithagra flaviventris	Yellow Canary	LC	LC		2	2			x	x	x
Crithagra mozambica	Yellow-fronted Canary	LC	LC		2	2			x	x	
Emberiza capensis	Cape Bunting	LC	LC		4	4					
Emberiza flaviventris	Golden-breasted Bunting	LC	LC		1	1	x		x	x	x
Emberiza impetuani	Lark-like Bunting	LC	LC		3	3				x	
Emberiza tahapisi	Cinnamon-breasted Bunting	LC	LC		3	3			x	x	x
Estrilda astrild	Common Waxbill	LC	LC		1	1	x			x	
Estrilda erythronotos	Black-faced Waxbill	LC	LC		1	1	x		x	x	x
Euplectes afer	Yellow-crowned Bishop	LC	LC		1	1	x		x		x
Euplectes albonotatus	White-winged Widowbird	LC	LC		2	2			x	x	
Euplectes ardens	Red-collared Widowbird	LC	LC		3	3				x	
Euplectes orix	Southern Red Bishop	LC	LC		2	2			x	x	
Gymnoris superciliaris	Yellow-throated Petronia	LC	LC		3	3			x	x	x
Lagonosticta rhodopareia	Jameson's Firefinch	LC	LC		1	1	x		x	x	x
Lagonosticta senegala	Red-billed Firefinch	LC	LC		1	1	x		x	x	x
Lonchura cucullata	Bronze Mannikin	LC	LC		2	2				x	
Ortygospiza fuscocrissa	African Quail-finch	LC	LC		1	1	x			x	x
Passer diffusus	Southern Grey-headed Sparrow	LC	LC		1	1	x		x	x	x
Passer domesticus	House Sparrow				2	2			x	x	x

CATEGORY & SCIENTIFIC NAME	COMMON NAME	CONSERVATION STATUS			MEDUPI LoO[3]	FGD LoO[3]	NSS	EMPR[4]	VICINITY*	SABAP2	
		GLOBAL RED LIST[1]	S.A. RED LIST[1]	S.A. ToPS LIST[2]						2340_2730	2340_2725
Passer melanurus	Cape Sparrow	LC	LC		1	2		x		x	x
Passer motitensis	Great Sparrow	LC	LC		2	2				x	x
Plocepasser mahali	White-browed Sparrow-Weaver	LC	LC		1	1	x		x	x	x
Ploceus capensis	Cape Weaver	LC	LC		3	3					
Ploceus cucullatus	Village Weaver	LC	LC		1	1	x	x		x	x
Ploceus intermedius	Lesser Masked Weaver	LC	LC		2	2				x	
Ploceus ocularis	Spectacled Weaver	LC	LC		4	4					
Ploceus velatus	Southern Masked Weaver	LC	LC		1	1	x	x	x	x	x
Pytilia melba	Green-winged Pytilia	LC	LC		1	1	x		x	x	x
Quelea quelea	Red-billed Quelea	LC	LC		1	1	x		x	x	x
Sporopipes squamifrons	Scaly-feathered Finch	LC	LC		2	2			x	x	x
Uraeginthus angolensis	Blue Waxbill	LC	LC		1	1	x	x	x	x	x
Uraeginthus granatinus	Violet-eared Waxbill	LC	LC		1	1	x		x	x	x
Vidua chalybeata	Village Indigobird	LC	LC		1	1	x		x	x	x
Vidua funerea	Dusky Indigobird	LC	LC		3	3					
Vidua macroura	Pin-tailed Whydah	LC	LC		2	2			x	x	
Vidua paradisaea	Long-tailed Paradise Whydah	LC	LC		1	1	x		x	x	x
Vidua purpurascens	Purple Indigobird	LC	LC		4	4					
Vidua regia	Shaft-tailed Whydah	LC	LC		1	1	x	x	x	x	x
Key											
Status: CR = Critically Endangered; EN = Endangered; LC = Least Concern; NT = Near Threatened; PS = Protected Species; VU = Vulnerable											
Likelihood of Occurrence (LoO): 1 = Present; 2 = High; 3 = Moderate; 4 = Low											
Sources: [1]Taylor *et al.* (2015); [2]ToPS List (2015); [3]SABAP2 (2018); [4]BEC (2006)											
*Combined records from NSS studies at Grootegeluk and Limpopo West Mines, Mafutha Project and Matimba Power Station											

13.5. Appendix 4 Reptile list for the study area

FAMILY & SPECIES	COMMON NAME	CONSERVATION STATUS		MEDUPI LoO[1,3]	FGD LoO[1,3]	NSS	EMPR[5]	VICINITY*	ATLAS[3]			
		RED LIST[1]	S.A. ToPS LIST[2]						2327CB	2327DA	2327CD	2327DC
PELOMEDUSIDAE (Terrapins)												
Pelomedusa subrufa	Marsh Terrapin	2LC	-	1	1		x	x		1		
Pelusios sinuatus	Serrated Hinged Terrapin	2LC	-	2	2							
TESTUDINIDAE (Tortoises)												
Kinixys lobatsiana	Lobatse Hinged Tortoise	1LC	-	3	3							
Kinixys spekii	Speke's Hinged-back Tortoise	2LC	-	1	1							
Psammobates oculifer	Serrated Tent Tortoise	1LC	-	2	3			x	2	1		
Stigmochelys pardalis	Leopard Tortoise	1LC	-	1	1		x	x	1	6		1
CROCODYLIDAE (Crocodiles)												
Crocodylus niloticus	Nile crocodile	2VU	EN	5	5			x				
GEKKONIDAE (Geckos)												
Afroedura nov sp. 10 [waterbergensis]	Flat Gecko		-	4	4							7
Chondrodactylus turneri	Turner's Gecko	1LC	-	2	2			x	1			
Hemidactylus mabouia	Common Tropical House Gecko	2LC	-	1	1			x	1	1		2
Homopholis wahlbergii	Wahlberg's Velvet Gecko	1LC	-	1	1			x				1
Lygodactylus capensis capensis	Common Dwarf Gecko	1LC	-	1	1			x	1	1		1
Lygodactylus ocellatus ocellatus	Spotted Dwarf Gecko	1LC (End)	-	2	2							
Pachydactylus affinis	Transvaal Gecko	1LC (End)	-	2	2							2
Pachydactylus capensis	Cape Gecko	2LC	-	2	2			x		1		2
Pachydactylus punctatus	Speckled Gecko	2LC	-	4	4							
Ptenopus garrulus garrulus	Common Barking Gecko	1LC	-	2	3			x	1			
AMPHISBAENIDAE (Worm Lizards)												
Monopeltis capensis	Cape Worm Lizard	1LC	-	3	3							
Zygaspis quadrifrons	Kalahari Dwarf Worm Lizard	2LC	-	2	2			x	1	4		
LACERTIDAE (Lacertid lizards)												
Heliobolus lugubris	Bushveld Lizard	2LC	-	2	2			x		2		
Ichnotropis capensis	Ornate Rough-scaled Lizard	1LC	-	2	2			x	1	3		

FAMILY & SPECIES	COMMON NAME	CONSERVATION STATUS		MEDUPI LoO[1,3]	FGD LoO[1,3]	NSS	EMPR[5]	VICINITY*	ATLAS[3]			
		RED LIST[1]	S.A. ToPS LIST[2]						2327CB	2327DA	2327CD	2327DC
Meroles squamulosus	Savanna Lizard	1LC	-	1	1			x				1
Nucras holubi	Holub's Sandveld Lizard	2LC	-	2	3			x				
Nucras intertexta	Spotted Sandveld Lizard	2LC	-	2	3		x					
Nucras ornata	Ornate Sandveld Lizard	2LC	-	3	3							
Pedioplanis lineoocellata lineoocellata	Spotted Sand Lizard	2LC	-	1	1	x			1			
Pedioplanis lineoocellata pulchella	Spotted Sand lizard	1LC	-	3	3							1
CORDYLIDAE (Girdled lizards)												
Cordylus jonesii	Jones' Girdled Lizard	1LC	-	3	3			x		2		2
Cordylus vittifer	Common Girdled Lizard	1LC	-	3	3							
Smaug breyeri	Waterberg Dragon Lizard	1LC (End)	-	2	3			x				2
Smaug vandami	Van Dam's Dragon Lizard	1LC (End)	-	3	4							
Platysaurus minor	Waterberg Flat Lizard	1LC (End)	-	3	4							
GERRHOSAURIDAE (Plated lizards)												
Broadleysaurus major	Rough-scaled Pated Lizard	2LC	-	2	3			x				
Gerrhosaurus flavigularis	Yellow-throated Plated Lizard	2LC	-	2	2			x				1
Metabosaurus validus	Common Giant Plated Lizard	1LC	-	4	4			x				
Gerrhosaurus auritus	Kalahari Plated Lizard	NE	-	2	3				1	1		
SCINCIDAE (Skinks)												
Acontias occidentalis	Savanna Legless Skink	LC	-	3	3					1		
Afroablepharus maculicollis	Spotted-neck Snake-eyed Skink	2LC	-	3	3							
Afroablepharus wahlbergii	Wahlberg's Snake-eyed Skink	2LC	-	2	3			x		1		
Mochlus sundevallii	Sundevall's Writhing Skink	2LC	-	2	2			x	1	1		1
Trachylepis capensis	Cape Skink	2LC	-	2	2			x				
Trachylepis margaritifer	Rainbow Skink	2LC	-	3	4							
Trachylepis punctatissima	Speckled Rock Skink	2LC	-	3	3			x		1		1
Trachylepis punctulata	Speckled Sand Skink	2LC	-	2	3							
Trachylepis striata	Striped Skink	2LC	-	1	1			x				1
Trachylepis varia	Variable Skink	2LC	-	1	1	x		x		1		9
Trachylepis variegata	Variegated Skink	2LC	-	2	3			x				

FAMILY & SPECIES	COMMON NAME	CONSERVATION STATUS		MEDUPI LoO[1,3]	FGD LoO[1,3]	NSS	EMPR[5]	VICINITY*	ATLAS[3]			
		RED LIST[1]	S.A. ToPS LIST[2]						2327CB	2327DA	2327CD	2327DC
Scelotes limpopoensis limpopoensis	Limpopo Dwarf Burrowing Skink	1LC	-	3	3							
VARANIDAE (Monitor lizards)												
Varanus albigularis albigularis	Southern Rock Monitor	2LC	-	1	1		x	x		2		
Varanus niloticus	Nile Monitor	2LC	-	3	3							
CHAMAELEONIDAE (Chamaeleons)												
Chamaeleo dilepis	Common Flap-neck Chameleon	2LC	-	1	1*			x		3		
AGAMIDAE (Agamas)												
Agama aculeata distanti	Eastern Ground Agama	1LC (End)	-	2	2			x		1		
Agama armata	Northern Ground Agama	2LC	-	2	2			x				
Agama atra	Southern Rock Agama	1LC	-	3	3							
Acanthocercus atricollis atricollis	Southern Tree Agama	1LC	-	1	1	x	x	x		1		1
TYPHLOPIDAE (Blind snakes)												
Afrotyphlops bibronii	Bibron's Blind Snake	1LC	-	4	4							
Rhinotyphlops lalandei	Delalande's Beaked Blind Snake	2LC	-	3	3							
LEPTOTYPHLOPIDAE (Worm & thread snakes)												
Leptotyphlops distanti	Distant's Thread Snake	1LC	-	3	3							
Leptotyphlops incognitus	Incognito Thread Snake	1LC	-	3	3							
Leptotyphlops scutifrons	Peters' Thread Snake	1LC	-	2	2			x				
PYTHONIDAE (Pythons)												
Python natalensis	Southern African Python	2LC	**PS**	1	1*			x		1		
VIPERIDAE (Adders & vipers)												
Bitis arietans arietans	Puff Adder	2LC	-	1	1			x		1		1
Causus defilippii	Snouted Night Adder	2LC	-	2	3							
Causus rhombeatus	Rhombic Night Adder	2LC	-	2	2							
LAMPROPHIIDAE (Slug-eaters, house snakes, wolf snakes, grass snakes, sand snakes & mole snakes)												
Amblyodipsas polylepis polylepis	Common Purple-glossed Snake	1LC	-	3	3							
Amblyodipsasventrimaculata	Kalahari Purple-glossed Snake	1LC	-	3	3				1	1		
Aparallactus capensis	Black-headed Centipede-eater	2LC	-	2	3							

FAMILY & SPECIES	COMMON NAME	CONSERVATION STATUS		MEDUPI LoO[1,3]	FGD LoO[1,3]	NSS	EMPR[5]	VICINITY*	ATLAS[3]			
		RED LIST[1]	S.A. ToPS LIST[2]						2327CB	2327DA	2327CD	2327DC
Atractaspis bibronii	Bibron's Stiletto Snake	2LC	-	2	2					1		1
Xenocalamus bicolor bicolor	Bicoloured Quill-snouted Snake	1LC	-	2	2			x				
Boaedon capensis	Common House Snake	2LC	-	2	2			x		1		
Gonionotophis nyassae	Black File Snake	2LC	-	4	4							
Lycodonomorphus inornatus	Olive Ground Snake	1LC (End)	-	2	2					1		
Lycodonomorphus rufulus	Brown Water Snake	1LC	-	3	3							
Lycophidion capense capense	Cape Wolf Snake	2LC	-	2	2					1		
Lycophidion variegatum	Variegated Wolf Snake	2LC	-	4	4							
Hemirhagerrhis nototaenia	Eastern Bark Snake	2LC	-	3	3							
Psammophis angolensis	Dwarf Sand Snake	2LC	-	4	4							
Psammophis brevirostris	Short-snouted Grass Snake	1LC	-	2	2							
Psammophis jallae	Jalla's Sand Snake	2LC	-	2	2							
Psammophis subtaeniatus	Western yellow-bellied Sand Snake	2LC	-	1	1		x	x		1		1
Psammophylax tritaeniatus	Striped Grass Snake	2LC	-	2	2			x				
Prosymna stuhlmannii	East African Shovel-snout	2LC	-	4	4							
Prosymna bivittata	Two-striped Shovel-snout	LC	-	3	3					2		
Pseudaspis cana	Mole Snake	2LC	-	2	2			x		1		
ELAPIDAE (Cobras, mambas & relatives)												
Aspidelaps scutatus scutatus	Common Shield Cobra	1LC	-	2	2							
Dendroaspis polylepis	Black Mamba	2LC	-	1	1			x			1	1
Elapsoidea sundevallii	Sundevall's Garter Snake	1LC	-	2	2			x	1	1		
Naja annulifera	Snouted Cobra	2LC	-	2	2					1		1
Naja mossambica	Mozambique Spitting Cobra	2LC	-	1	1*		x			1		
COLUBRIDAE (Herald snakes, egg-eaters, boomslang, green snakes)												
Crotaphopeltis hotamboeia	Red-lipped Snake	2LC	-	3	3							
Dasypeltis scabra	Rhombic Egg-eater	2LC	-	2	2			x		1		
Dispholidus typus	Boomslang	2LC	-	1	1			x		3		2
Philothamnus hoplogaster	South-eastern Green Snake	2LC	-	4	4							
Philothamnus natalensis occidentalis	Western Natal Green Snake	1LC (End)	-	3	3							
Philothamnus semivariegatus	Spotted Bush Snake	2LC	-	2	2			x				

FAMILY & SPECIES	COMMON NAME	CONSERVATION STATUS		MEDUPI LoO[1,3]	FGD LoO[1,3]	NSS	EMPR[5]	VICINITY*	ATLAS[3]			
		RED LIST[1]	S.A. ToPS LIST[2]						2327CB	2327DA	2327CD	2327DC
Telescopus semiannulatus semiannulatus	Eastern Tiger Snake	2LC	-	2	2			x				
Thelotornis capensis capensis	Southern Twig Snake	1LC	-	2	2							
Key												
Status: D = Declining; End = Endemic; LC = Least Concern; NT = Near Threatened; PS = Protected Species; U = Unknown; VU = Vulnerable												
Likelihood of Occurrence (LoO): 1 = Present; 2 = High; 3 = Moderate; 4 = Low; 5 = May occur as a managed population												
Sources: [1]Bates *et al*. (2014); [2]ToPS List (2015); [3]IUCN (2013.1); [4]ReptileMap (2014); [5]BEC (2006)												
*Combined records from NSS studies at Grootegeluk and Limpopo West Mines, Mafutha Project and Matimba Power Station												

13.6. Appendix 5 Frog list for the study area

FAMILY & SPECIES	COMMON NAME	CONSERVATION STATUS			MEDUPI LoO[4,5]	FGD LoO[4,5]	NSS	EMPR[6]	VICINITY*	ATLAS[5]			
		GLOBAL RED LIST[1]	S.A. RED LIST[2]	S.A. ToPS LIST[3]						2327CB	2327DA	2327CD	2327DC
BREVICIPITIDAE													
Breviceps adspersus adspersus	Bushveld Rain Frog	LC (U)*	LC	-	1	1	x		x	1	2	1	
BUFONIDAE (Toads)													
Sclerophrys garmani	Olive Toad	LC (U)	LC	-	1	1	x		x	1	2	1	2
Sclerophrys gutturalis	Guttural Toad	LC (I)	LC	-	1	1	x		x		1		1
Sclerophrys pusilla	Flat-backed Toad	LC (S)	LC	-	3	3					1		4
Sclerophrys capensis	Raucous Toad	LC (D)	LC	-	3	3					1		
Poyntonophrynus fenoulheti	Northern Pygmy Toad	LC (U)	LC	-	2	2			x				3
Schismaderma carens	Red Toad	LC (U)	LC	-	1	1	x		x				
HEMISOTIDAE (Shovel-nosed Frogs)													
Hemisus marmoratus	Mottled Shovel-nosed Frog	LC (U)	LC	-	1	1	x						1
HYPEROLIIDAE (Kassinas, Rattling frogs & Reed frogs)													
Kassina senegalensis	Bubbling Kassina	LC (U)	LC	-	1	1	x	x	x	1	4	1	5
MICROHYLIDAE (Rubberfrogs)													
Phrynomantis bifasciatus	Banded Rubber Frog	LC (U)	LC	-	1	1	x	x	x	1	2	1	2
PHRYNOBATRACHIDAE (Puddle Frogs)													
Phrynobatrachus natalensis	Snoring Puddle Frog	LC (S)	LC	-	1	1	x		x		1		3
PIPIDAE (Platannas)													
Xenopus laevis	Common Platanna	LC (I)	LC	-	1	1	x	x			1		2
Xenopus muelleri	Muller's Platanna	LC (U)	LC	-	4	4							5
PTYCHADENIDAE (Grass & Ornate Frogs)													
Hildebrandtia ornata	Ornate Frog	LC (U)	LC	-	1	1	x		x	1	1	1	
Ptychadena anchietae	Plain Grass Frog	LC (U)	LC	-	1	1	x		x	1	2	1	2
Ptychadena mossambica	Broad-banded Grass Frog	LC (U)	LC	-	1	2		x				1	1
Ptychadena porosissima	Striped Grass Frog	LC (U)	LC	-	1	3		x					
PYXICEPHALIDAE (African Common Frogs)													
Amietia delalandii	Delalande's River Frog	LC (S)	LC	-	3	3							1

FAMILY & SPECIES	COMMON NAME	CONSERVATION STATUS			MEDUPI LoO[4,5]	FGD LoO[4,5]	NSS	EMPR[6]	VICINITY*	ATLAS[5]			
		GLOBAL RED LIST[1]	S.A. RED LIST[2]	S.A. ToPS LIST[3]						2327CB	2327DA	2327CD	2327DC
Cacosternum boettgeri	Boettger's Caco	LC (U)	LC	-	1	1	x	x	x			1	
Pyxicephalus adspersus	Giant Bullfrog	LC (D)	NT	PS	3	1**	x			1	2		
Pyxicephalus edulis	African Bullfrog	LC (U)	LC	PS	1	1	x		x	1	2	1	1
Tomopterna cryptotis	Tremolo Sand Frog	LC (S)	LC	-	1	1	x		x	1	2	1	1
Tomopterna krugerensis	Knocking Sand Frog	LC (U)	LC	-	1	1		x	x	1		1	
Tomopterna marmorata	Russet-backed Sand Frog	LC (U)	LC	-	3	3							
Tomopterna natalensis	Natal Sand Frog	LC (U)	LC	-	4	4							
RHACOPHORIDAE (Foam Nest Frogs)													
Chiromantis xerampelina	Southern Foam Nest Frog	LC (U)	LC	-	1	1	x	x			2	1	2
Key													
Status: LC = Least Concern; I = Increasing; NT = Near Threatened; PS = Protected Species; S = Stable; U = Unknown													
Likelihood of Occurrence (LoO): 1 = Present; 2 = High; 3 = Moderate; 4 = Low													
Sources: [1]IUCN (2017.3); [2]Minter *et al*. (2004); [3]ToPS List (2007); [4]Du Preez & Carruthers (2009); [5]FrogMap (2018); [6]BEC (2006)													
*Combined records from NSS studies at Grootegeluk and Limpopo West Mines, Mafutha Project and Matimba Power Station													
**Tentative identification													

13.7. Appendix 6 Butterfly list for the study area

FAMILY & SPECIES	COMMON NAME	STATUS[1]	MEDUPI LoO[1,2]	FGD LoO[1,2]	NSS	EMPR[2]	VICINITY*	ATLAS			
								2327CB	2327DA	2327CD	2327DC
HESPERIIDAE (Sandmen, skippers, policemen & sylphs)											
Abantis tettensis	Spotted Paradise Skipper	1LC	2	2							
Abantis venosa	Veined Paradise Skipper	1LC	3	3							
Afrogegenes hottentota	Marsh Hottentot Skipper	1LC	3	3							1
Caprona pillaana	Ragged Skipper	1LC	1	1	x						
Coeliades forestan forestan	Striped Policeman	1LC	3	3							
Coeliades pisistratus	Two-pip Policeman	1LC	2	2							1
Gegenes hottentota	Marsh Hottentot Skipper	1LC	3	3							1
Gegenes niso niso	Common Hottentot Skipper	1LC	3	3							1
Gegenes pumilio gambica	Dark Hottentot	1LC	3	3							2
Gomalia elma elma	Green-marbled Skipper	1LC	2	2							1
Kedestes callicles	Pale Ranger	LC	1	1	x		x		1		
Leucochitonea levubu	White-cloaked Skipper	1LC	4	4							
Metisella willemi	Netted Sylph	1LC	4	4							
Parosmodes morantii morantii	Morant's Orange	1LC	3	3							
Pelopidas mathias	Black-banded Swift	1LC	3	3							
Pelopidas thrax	White-banded Swift	1LC	3	3							1
Platylesches neba	Flower-girl Hopper	1LC	3	3							1
Sarangesa motozi	Forest Elfin	1LC	2	2						1	
Sarangesa phidyle	Small Elfin	1LC	2	2							1
Spialia asterodia	Star Sandman	1LC	4	4							
Spialia colotes transvaaliae	Bushveld Sandman	1LC	2	2							1
Spialia delagoae	Delagoa Sandman	1LC	2	2							
Spialia depauperata australis	Wandering sandman	1LC	3	3							
Spialia diomus ferax	Common Sandman	1LC	1	1	x						1
Spialia dromus	Forest Sandman	1LC	2	2							
Spialia mafa mafa	Mafa sandman	1LC	2	2							1
Spialia spio	Mountain sandman	1LC	3	3					1		

FAMILY & SPECIES	COMMON NAME	STATUS[1]	MEDUPI LoO[1,2]	FGD LoO[1,2]	NSS	EMPR[2]	VICINITY*	ATLAS			
								2327CB	2327DA	2327CD	2327DC
Tsitana tsita	Dismal Sylph	1LC	3	3							
PAPILIONIDAE (Swallowtails, swordtails & handkerchiefs)											
Graphium antheus	Large Striped Swordtail	1LC	1	1							
Graphium morania	White lady	1LC	3	3							
Papilio dardanus cenea	Flying handkerchief	1LC	4	4					1		
Papilio demodocus demodocus	Citrus swallowtail	1LC	2	2						1	2
Papilio nireus lyaeus	Green-banded swallowtail	1LC	2	2					2		1
PIERIDAE (Whites, tips & travellers)											
Belenois aurota	Brown-veined white	1LC	1	1	x	x	x		8	1	4
Belenois creona severina	African common white	1LC	1	1	x			1	1		3
Belenois gidica abyssinica	African veined white	1LC	2	2							1
Belenois zochalia zochalia	Forest White	1LC	4	4							
Catopsilia florella	African migrant	1LC	2	2					1		2
Colias electo electo	African clouded yellow	1LC	2	2							
Colotis annae annae	Scarlet tip	1LC	1	2	x				2	1	4
Colotis antevippe gavisa	Red tip	1LC	1	1	x						3
Colotis auxo auxo	Sulphur orange tip	1LC	2	2							2
Colotis celimene amina	Lilac tip	1LC RLD	3	3							
Colotis euippe omphale	Smoky orange tip	1LC	2	2						1	4
Colotis evagore antigone	Small orange tip	1LC	2	2					2	1	5
Colotis evenina evenina	Orange tip	1LC	2	2					5	1	2
Colotis ione	Bushveld purple tip	1LC	2	2							1
Colotis pallene	Bushveld orange tip	1LC	2	2			x			1	2
Colotis regina	Queen purple tip	1LC	2	2					1	1	1
Colotis vesta argillaceus	Veined Arab	1LC	1	1	x				2	1	5
Eurema brigitta brigitta	Broad-bordered grass yellow	1LC	1	1	x		x		3	1	3
Eurema hecabe solifera	Common Grass Yellow	1LC	2	2							
Mylothris agathina agathina	Common dotted border	1LC	2	2					3		2
Mylothris rueppellii haemus	Twin dotted border	1LC	2	2							1

FAMILY & SPECIES	COMMON NAME	STATUS[1]	MEDUPI LoO[1,2]	FGD LoO[1,2]	NSS	EMPR[2]	VICINITY*	ATLAS			
								2327CB	2327DA	2327CD	2327DC
Pinacopteryx eriphia eriphia	Zebra white	1LC	1	1	x		x		2	1	2
Pontia helice helice	Common meadow white	1LC	2	2							
Teracolus agoye agoye	Speckled sulphur tip	1LC	2	2					2		
Teracolus eris eris	Banded gold tip	1LC	1	1	x				1	1	3
Teracolus subfasciatus	Lemon traveller	1LC	2	2						1	3
NYMPHALIDAE (Acraeas, monarchs, pansies, browns, ringlets & charaxes)											
Acraea acara acara	Acara acraea	1LC	2	2							
Acraea aglaonice	Window Acraea	1LC	3	3							
Acraea anemosa	Broad-bordered acraea	1LC	1	1	x		x				
Acraea axina	Little acraea	1LC	2	2					1		2
Acraea barberi	Barber's acraea	1LC	2	2							
Acraea caldarena caldarena	Black-tipped acraea	1LC	2	2							1
Acraea horta	Garden acraea	1LC	4	4							
Acraea lygus	Lygus acraea	1LC	3	3							
Acraea natalica	Natal acraea	1LC	2	2					1		1
Acraea neobule neobule	Wandering donkey acraea	1LC	2	2			x		2		1
Acraea oncaea	Rooibok Acraea	1LC	3	3					4		1
Acraea stenobea	Suffused acraea	1LC	2	2							1
Brakefieldia perspicua perspicua	Eyed Bush Brown	1LC	2	2							4
Byblia anvatara acheloia	Joker	1LC	1	1						1	1
Byblia ilithyia	Spotted joker	1LC	2	2			x		4	2	3
Catacroptera cloanthe cloanthe	Pirate	1LC	3	3							
Charaxes achaemenes achaemenes	Bushveld charaxes	1LC	2	2					1	1	3
Charaxes brutus natalensis	White-barred charaxes	1LC	3	3					2		
Charaxes candiope	Green-veined charaxes	1LC	2	2							1
Charaxes jahlusa rex	Pearl-spotted charaxes	1LC	2	2							
Charaxes phaeus	Demon charaxes	1LC	2	2					1		1
Charaxes saturnus saturnus	Foxy charaxes	1LC	2	2					1	1	3
Charaxes vansoni	Van Son's charaxes	1LC	3	3							2
Charaxes varanes varanes	Pearl charaxes	1LC	3	3					1		

FAMILY & SPECIES	COMMON NAME	STATUS[1]	MEDUPI LoO[1,2]	FGD LoO[1,2]	NSS	EMPR[2]	VICINITY*	ATLAS			
								2327CB	2327DA	2327CD	2327DC
Charaxes zoolina	Club-tailed charaxes	1LC	4	4							
Coenyropsis natalii natalii	Natal brown	1LC	1	1							
Danaus chrysippus orientis	African monarch	1LC	1	1	x	x	x		4	1	2
Hamanumida daedalus	Guinea-fowl butterfly	1LC	1	1	x		x		3	1	4
Heteropsis perspicua perspicua	Eyed bush brown	1LC	2	2							4
Hypolimnas misippus	Common diadem	1LC	1	1			x		2		2
Junonia hierta cebrene	Yellow pansy	1LC	2	2			x		4	1	4
Junonia oenone oenone	Blue pansy	1LC	2	2			x		1		2
Junonia orithya madagascariensis	Eyed pansy	1LC	2	2			x				1
Melanitis leda	Twilight brown	1LC	3	3							2
Neptis saclava marpessa	Spotted sailer	1LC	4	4							1
Phalanta phalantha aethiopica	African Leopard	1LC	2	2							
Physcaeneura panda	Dark-webbed ringlet	1LC	1	1							
Precis antilope	Darker commodore	1LC	3	3							
Precis archesia archesia	Garden commodore	1LC	2	2							
Precis ceryne ceryne	Marsh commodore	1LC	3	3							
Precis octavia sesamus	Gaudy Commodore	1LC	3	3							
Protogoniomorpha anacardii nebulosa	Clouded Mother-of-pearl	1LC	3	3							1
Stygionympha wichgrafi wichgrafi	Wichgraf's hillside brown	1LC	3	3							
Telchinia encedon encedon	White-barred acraea	1LC	3	3							
Telchinia rahira rahira	Marsh acraea	1LC	2	2							
Telchinia serena	Dancing acraea	1LC	1	1	x				2		4
Vanessa cardui	Painted lady	1LC	1	2		x	x	1			2
Ypthima asterope hereroica	African ringlet	1LC	2	2							
Ypthima impura paupera	Impure ringlet	1LC	3	3							
LYCAENIDAE (Coppers, blues & relatives)											
Actizera lucida	Rayed blue	1LC	3	3							
Alaena amazoula amazoula	Yellow zulu	1LC	4	4							
Aloeides aranda	Aranda copper	1LC	3	3							
Aloeides damarensis damarensis	Damara copper	1LC	3	3					1		

FAMILY & SPECIES	COMMON NAME	STATUS[1]	MEDUPI LoO[1,2]	FGD LoO[1,2]	NSS	EMPR[2]	VICINITY*	ATLAS			
								2327CB	2327DA	2327CD	2327DC
Aloeides damarensis mashona	Damara copper	1LC	2	2							
Aloeides taikosama	Dusky copper	1LC	1	1	x						
Anthene amarah amarah	Black striped hairtail	1LC	2	2							
Anthene definita definita	Common hairtail	1LC	2	2							
Anthene dulcis dulcis	Mashuna hairtail	1LC	3	3							
Anthene livida livida	Pale hairtail	1LC	2	2							
Anthene millari	Millar's hairtail	1LC	3	3							
Anthene otacilia otacilia	Trimen's hairtail	1LC	3	3							
Axiocerses amanga amanga	Bush scarlet	1LC	2	2					1		1
Axiocerses coalescens	Black-tipped scarlet	1LC	4	4							
Axiocerses tjoane tjoane	Eastern scarlet	1LC	2	2							
Azanus jesous	Topaz babul blue	1LC	1	1	x				1		2
Azanus mirza	Mirza babul blue	1LC	4	4							
Azanus moriqua	Thorn-tree babul blue	1LC	1	1	x						
Azanus ubaldus	Velvet-spotted babul blue	1LC	3	3							3
Cacyreus lingeus	Bush bronze	1LC	4	4							
Cacyreus marshalli	Common geranium bronze	1LC	3	3					1		
Cacyreus virilis	Mocker bronze	1LC	3	3							
Chilades trochylus	Grass jewel	1LC	2	2				1	1		1
Cigaritis ella	Ella's bar	1LC	4	4							
Cigaritis mozambica	Mozambique bar	1LC	3	3							
Cigaritis natalensis	Natal bar	1LC	2	2							
Cigaritis phanes	Silvery bar	1LC	4	4					1		
Cnodontes penningtoni	Pennington's buff	1LC	3	3							2
Crudaria leroma	Silver spotted grey	1LC	2	2							
Cupidopsis cissus cissus	Common meadow blue	1LC	3	3							
Cupidopsis jobates jobates	Tailed meadow blue	1LC	2	2							
Eicochrysops messapus mahallakoaena	Cupreous blue	1LC	3	3							
Eicochrysops messapus messapus	Cupreous blue	1LC	3	3							
Euchrysops dolorosa	Sabie smoky blue	1LC	2	2							

FAMILY & SPECIES	COMMON NAME	STATUS[1]	MEDUPI LoO[1,2]	FGD LoO[1,2]	NSS	EMPR[2]	VICINITY*	ATLAS			
								2327CB	2327DA	2327CD	2327DC
Euchrysops malathana	Common smoky blue	1LC	3	3						1	1
Euchrysops osiris	Osiris smoky blue	1LC	4	4					1		
Euchrysops subpallida	Ashen smoky blue	1LC	4	4							
Hypolycaena philippus philippus	Purplebrown hairstreak	1LC	2	2					1		
Iolaus alienus alienus	Brown-line sapphire	1LC	3	3					1		
Iolaus pallene	Saffron sapphire	1LC	3	3					1		
Iolaus silarus silarus	Straight-line sapphire	1LC	2	2							1
Iolaus silas	Southern sapphire	1LC	4	4							
Iolaus trimeni	Trimen's sapphire	1LC	3	3							
Lachnocnema durbani	D'Urban's woolly legs	1LC	3	3							
Lampides boeticus	Pea blue	1LC	2	2					4		1
Lepidochrysops glauca	Silvery blue	1LC	2	2							
Lepidochrysops patricia	Patricia blue	1LC	3	3							
Lepidochrysops plebeia plebeia	Twin-spot blue	1LC	4	4							
Leptomyrina gorgias gorgias	Common black-eye	1LC	3	3							
Leptomyrina henningi henningi	Henning's black-eye	1LC	1	1	x						1
Leptomyrina sp.	-	-	-	-					1		
Leptotes babaulti	Babault's zebra blue	1LC	1	1	x						
Leptotes pirithous pirithous	Common zebra blue	1LC	2	2							2
Pseudonacaduba sichela sichela	Dusky blue	1LC	2	2							1
Stugeta bowkeri bowkeri	Bowker's marbled sapphire	1LC	3	3							
Stugeta bowkeri tearei	Bowker's marbled sapphire	1LC	2	2							
Tarucus sybaris sybaris	Dotted blue	1LC	2	2					2		1
Tuxentius calice	White pie	1LC	2	2							1
Tuxentius melaena melaena	Black pie	1LC	2	2							
Uranothauma nubifer nubifer	Black heart	1LC	2	2							
Virachola antalus	Brown playboy	1LC	2	2					1		1
Virachola dinochares	Apricot playboy	1LC	3	3							1
Zintha hintza hintza	Hintza pierrot	1LC	2	2							
Zizeeria knysna knysna	Sooty blue	1LC	2	2							1

FAMILY & SPECIES	COMMON NAME	STATUS[1]	MEDUPI LoO[1,2]	FGD LoO[1,2]	NSS	EMPR[2]	VICINITY*	ATLAS			
								2327CB	2327DA	2327CD	2327DC
Zizula hylax	Gaika blue	1LC	2	2							1
Key											
Status: LC = Least Concern; RLD = Rare Low Density; 1 = Global											
Likelihood of Occurrence (LoO): 1 = Present; 2 = High; 3 = Moderate; 4 = Low											
Sources: [1]Mecenero *et al*. (2013); [2]LepiMap (2018); [3]BEC (2006);											
*Combined records from NSS studies at Grootegeluk and Limpopo West Mines, Mafutha Project and Matimba Power Station											

13.8. Appendix 7 Present and potentially occurring dragonfly and damselfly species within the study area

FAMILY & SPECIES	COMMON NAME	CONSERVATION STATUS		DBI[1]	MEDUPI LoO[3]	FGD LoO[3]	NSS	EMPR[4]	VICINITY*
		GLOBAL RED LIST[1]	S.A. RED LIST[2]						
CALOPTERYGIDAE (Demoiselles)									
Phaon iridipennis	Glistening Demoiselle	-	-	2	2	2			
CHLOROCYPHIDAE (Jewels)									
Platycypha caligata	Dancing Jewel	-	-	2	4	4			
SYNLESTIDAE (Malachites)									
Chlorolestes fasciatus	Mountain Malachite	-	-	4	4	4			
Chlorolestes tessellatus	Forest Malachite	-	-	4	4	4			
LESTIDAE (Spreadwings)									
Lestes pallidus	Pale Spreadwing	-	-	2	2	2			
Lestes plagiatus	Highland Spreadwing	-	-	2	3	3			
Lestes tridens	Spotted Spreadwing	-	-	3	2	2			
PLATYCNEMIDIDAE (Featherlegs)									
Mesocnemis singularis	Riverjack	-	-	3	4	4			
Elattoneura glauca	Common Threadtail	-	-	1	3	3			
COENAGRIONIDAE (Pond Damsels)									
Ceriagrion glabrum	Common Citril	-	-	0	2	2			
Pseudagrion hamoni	Drab Sprite	-	-	2	3	3			
Pseudagrion kersteni	Kersten's Sprite	-	-	1	4	4			
Pseudagrion makabusiense	Makabusi Sprite	LC	**VU**	4	4	4			
Pseudagrion massaicum	Masai Sprite	-	-	1	4	4			
Pseudagrion salisburyense	Slate Sprite	-	-	1	2	2			
Pseudagrion sublacteum	Cherry-eye Sprite	-	-	2	3	3			
Pseudagrion sudanicum	Sudan Sprite	LC	LC	4	3	3			
Ischnura senegalensis	Marsh Bluetail	-	-	0	2	2			
Africallagma glaucum	Swamp Bluet	-	-	1	2	2			
Azuragrion nigridorsum	Sailing Bluet	-	-	3	2	2			
Agriocnemis exilis	Little Wisp	-	-	4	3	3			
Agriocnemis pinheyi	Pinhey's Wisp	-	-	2	3	3			
AESHNIDAE (Hawkers)									
Anax ephippiger	Vagrant Emperor	-	-	2	2	2			
Anax imperator	Blue Emperor	-	-	1	2	2			
Anax speratus	Orange Emperor	-	-	1	2	2			
Anax tristis	Black Emperor	-	-	4	3	3			
GOMPHIDAE (Clubtails)									
Ictinogomphus ferox	Common Tigertail	-	-	2	3	3			
Lestinogomphus angustus	Spined Fairytail	LC	**NT**	4	4	4			
Ceratogomphus pictus	Common Thorntail	-	-	2	2	2			
Paragomphus cognatus	Boulder Hooktail	-	-	1	3	3			
Paragomphus genei	Green Hooktail	-	-	3	1	1	x		
CORDULIIDAE (Emeralds)									
Phyllomacromia contumax	Two-banded Cruiser	-	-	3	2	2			

FAMILY & SPECIES	COMMON NAME	CONSERVATION STATUS		DBI[1]	MEDUPI LoO[3]	FGD LoO[3]	NSS	EMPR[4]	VICINITY*
		GLOBAL RED LIST[1]	S.A. RED LIST[2]						
LIBELLULIDAE (Skimmers & relatives)									
Orthetrum abbotti	Little Skimmer	-	-	2	3	3			
Orthetrum chrysostigma	Epaulet Skimmer	-	-	2	3	3			
Orthetrum hintzi	Hintz's Skimmer	-	-	3	3	3			
Orthetrum icteromelas	Spectacled Skimmer	-	-	2	3	3			
Orthetrum julia	Julia Skimmer	-	-	1	4	4			
Orthetrum machadoi	Machado's Skimmer	-	-	3	2	2			
Orthetrum stemmale	Strong Skimmer	-	-	4	3	3			
Orthetrum trinacria	Long Skimmer	-	-	1	2	2			
Nesciothemis farinosa	Black-tailed Skimmer	-	-	1	4	4			
Palpopleura jucunda	Yellow-veined Widow	-	-	2	2	2			
Palpopleura lucia	Lucia Widow	-	-	2	3	3			
Palpopleura portia	Portia Widow	-	-	2	3	3			
Acisoma panorpoides	Grizzled Pintail	-	-	2	4	4			
Diplacodes lefebvrii	Black Percher	-	-	3	4	4			
Diplacodes luminans	Barbet Percher	-	-	3	1	1	x		
Crocothemis erythraea	Broad Scarlet	-	-	0	2	2			
Crocothemis sanguinolenta	Little Scarlet	-	-	3	2	2			
Brachythemis leucosticta	Banded Groundling	-	-	2	1	1			x
Sympetrum fonscolombii	Nomad	-	-	0	2	2			
Trithemis annulata	Violet Dropwing	-	-	1	4	4			
Trithemis arteriosa	Red-veined Dropwing	-	-	0	3	3			
Trithemis donaldsoni	Denim Dropwing	-	-	4	4	4			
Trithemis furva	Navy Dropwing	-	-	0	4	4			
Trithemis hecate	Silhouette Dropwing	-	-	4	3	3			
Trithemis kirbyi	Kirby's Dropwing	-	-	0	1	1	x		
Trithemis pluvialis	Riffle-and-Reed Dropwing	-	-	2	4	4			
Trithemis stictica	Jaunty Dropwing	-	-	1	4	4			
Zygonyx torridus	Ringed Cascader	-	-	2	4	4			
Rhyothemis semihyalina	Phantom Flutterer	-	-	1	3	3			
Tholymis tillarga	Twister	-	-	3	3	3			
Pantala flavescens	Pantala	-	-	0	2	2			
Tramea basilaris	Keyhole Glider	-	-	0	2	2			
Urothemis assignata	Red Basker	-	-	3	3	3			
Urothemis edwardsii	Blue Basker	-	-	2	3	3			

Key

Status: LC = Least Concern; NT = Near Threatened; VU = Vulnerable;

Likelihood of Occurrence (LoO): 1 = Present; 2 = High; 3 = Moderate; 4 = Low

Dragonfly Biotic Index (DBI): An index developed by Samways (2008) based on three criteria: geographical distribution, conservation status and sensitivity to change in habitat and ranges from a minimum of 0 (very common, widespread species which is highly tolerant of human disturbance) to 9 (range-restricted, threatened and sensitive endemic).

Sources: [1]IUCN (2017.3); [2]Samways (2006); [3]Samways (2008); [4]BEC (2006)

13.9. Appendix 8 Present and potentially occurring scorpion species within the study area

FAMILY & SPECIES	COMMON NAME	MEDUPI LoO[1]	FGD LoO[1]	NSS	EMPR[2]	VICINITY*
Parabuthus mossambicensis	Thick-tailed scorpions	2	2			x
Parabuthus granulatus	Thick-tailed scorpions	3	3			
Parabuthus transvaalicus	Thick-tailed scorpions	3	3			
Uroplectes planimanus	Stinger scorpions	2	2			
Uroplectes carinatus	Stinger scorpions	1	2	x		
Uroplectes vittatus	Stinger scorpions	2	2			x
Opistacanthus asper	Creeping scorpions	1	1	x		
Hadogenes troglodytes	Rock scorpions	3	3			
Opistophthalmus glabifrons	Burrowing scorpions	3	3			
Opistophthalmus carinatus	Burrowing scorpions	3	3			
Opistophthalmus wahlbergii	Burrowing scorpions	3	3			x
Key						
Likelihood of Occurrence (LoO): 1 = Present; 2 = High; 3 = Moderate						
Sources: [1]Leeming (2003); [2]BEC (2006)						
*Combined records from NSS studies at Grootegeluk and Limpopo West Mines, Mafutha Project and Matimba Power Station						

13.10. Appendix 9 Present and potentially occurring baboon spider species within the study area

SPECIES	COMMON NAME	MEDUPI LoO[1]	FGD LoO[1]	NSS	EMPR[2]	VICINITY*
Ceratogyrus bechuanicus	Starbust Horned Baboon Spider	2	2			
Ceratogyrus brachycephalus	Rhino Horned Baboon Spider	2	2			
Ceratogyrus sp.	-	3	3			x
Pterinochilus junodi	Soutpansberg Starburst Baboon Spider	4	4			
Pterinochilus pluridentatus	-	4	4			
Harpactira sp.	-	3	3			x
Key						
Likelihood of Occurrence (LoO): 1 = Present; 2 = High; 3 = Moderate; 4 = Low						
Sources: [1]Dippenaar-Schoeman (2002); [2]BEC (2006)						
*Combined records from NSS studies at Grootegeluk and Limpopo West Mines, Mafutha Project and Matimba Power Station						