AN ECOLOGICAL IMPACT ASSESSMENT FOR THE PROPOSED GLENCORE EASTERN MINES EXPANSION PROJECT, LIMPOPO PROVINCE

Prepared for: Glencore Eastern Mines
Prepared by: Exigo Sustainability

Email info@exigo3.com
Tel +27 012 751 2160
Fax +27 086 607 2406

Postnet Suite 74,
Private Bag X04,
Menlo Park, 0102

Vat nr: 4910184854
Registration nr: 2006/011434/07

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www.exigo3.com

AN ECOLOGICAL IMPACT ASSESSMENT FOR THE PROPOSED GLENCORE EASTERN MINES WASTE STORAGE FACILITIES, LIMPOPO PROVINCE ,

EIA PHASE REPORT

April 2020

Conducted on behalf of:

Glencore Eastern Mines

Compiled by:

Dr. BJ Henning Pr.Sci.Nat (PhD plant Ecology; M.Sc Botany - Soil Science related)

Reviewed by:

R. Kruger

H. Gildenhuys

REPORT DISTRIBUTION LIST

Name	Institution
Mr. H. Gildenhuys	Exigo Sustainability

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Declaration

I, Barend Johannes Henning, declare that -

- I act as the independent specialist;
- I will perform the work relating to the project in an objective manner, even if this results in views and findings that are not favourable to the project proponent;
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting the specialist report relevant to this project, including knowledge of the National Environmental Management Act, 1998 (Act No. 107 of 1998; the Act), regulations and any guidelines that have relevance to the proposed activity;
- I will comply with the Act, regulations and all other applicable legislation;
- I will take into account, to the extent possible, the matters listed in Regulation 8;
- I have no, and will not engage in, conflicting interests in the undertaking of the activity;
- I undertake to disclose to the project proponent and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the project; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority or project proponent;
- All the particulars furnished by me in this document are true and correct; and
- I realise that a false declaration is an offence in terms of Regulation 71 and is punishable in terms of section 24F of the Act.

_____

SIGNATURE OF SPECIALIST

Company: Exigo Sustainability (Pty) Ltd

Date: April 2020

Notations and terms

Alien vegetation Plants that do not occur naturally within the area but have been introduced either intentionally or unintentionally. Vegetation species that originate from outside of the borders of the biome – usually of international origin.

Anthropogenic: of human creation

Alluvium (from the Latin, alluvius, from alluere, "to wash against") is loose, unconsolidated (not cemented together into a solid rock) soil or sediments, which has been eroded, reshaped by water in some form, and redeposited in a non-marine setting. Alluvium is typically made up of a variety of materials, including fine particles of silt and clay and larger particles of sand and gravel. When this loose alluvial material is deposited or cemented into a lithological unit, or lithified, it would be called an alluvial deposit.

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

Biota: living things; plants, animals, bacteria

Bottomland: the lowlands along streams and rivers, on alluvial (river deposited) soil.

Ecologically sensitive ecosystem: One where relatively even minor disturbances may result in substantial and significant changes.

Ecoregion An ecoregion is a "recurring pattern of ecosystems associated with characteristic combinations of soil and landform that characterise that region".

Ecosystems: Include living (e.g. plants, animals) and non-living (e.g. minerals, soil, water) components, which can be defined in terms of distinguishing characteristics (e.g. a wetland ecosystem, a freshwater ecosystem, a terrestrial ecosystem, a forest ecosystem, etc.).

Endemic or range-restricted species or ecosystem: One whose distribution is confined to a particular and

often very limited geographical region.

Environment: Broadly covers our surroundings and the characteristics of those surroundings that influence our health and wellbeing. That is, the environment includes all living organisms (plants, animals and other life), the physical environment (land, water and air), as well as social, economic and cultural conditions. Sometimes we speak of 'the natural environment' and 'the built environment', to differentiate between natural and man-made systems.

Floristic: of flora (plants).

Floodplain: Wetland inundated when a river overtops its banks during flood events resulting in the wetland soils being saturated for extended periods of time.

Habitat: The place or type of site where an organism or population naturally occurs.

Indigenous vegetation Vegetation occurring naturally within a defined area.

Protected species or ecosystem: One that is protected by law from particular activities and land uses.

Seasonally wet soil: soil which is flooded or waterlogged to the soil surface for extended periods (>1 month) during the wet season, but is predominantly dry during the dry season.

Soil horizons: layers of soil that have fairly uniform characteristics and have developed through pedogenic processes; they are bound by air, hard rock or other horizons (i.e. soil material that has different characteristics).

Soil profile: the vertically sectioned sample through the soil mantle, usually consisting of two or three horizons (Soil Classification Working Group, 1991).

Species: A group of plants, animals, micro-organisms or other living organisms that are morphologically similar; that share inheritance from common ancestry; or whose genes are so similar that they can breed together and produce fertile offspring.

Temporarily wet soil: The soil close to the soil surface (i.e. within 50 cm) is wet for periods > 2 weeks during

the wet season in most years. However, it is seldom flooded or saturated at the surface for longer than a month.

Terrain unit classes: areas of the land surface with homogenous form and slope. Terrain may be seen as being made up of all or some of the following units: crest (1), scarp (2), midslope (3), footslope (4) and valley bottom (5).

Threatened species or ecosystem: Species/ Ecosystems that are at risk of going extinct in its natural range. It may be 'critically endangered' at extremely high risk, 'endangered' at very high risk, or 'vulnerable' at high risk. Species or ecosystems at low or no risk are not 'threatened', and fall into the 'near threatened' or 'least concern' categories.

Water regime: When and for how long the soil is flooded or saturated.

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Glencore Eastern Mines Waste Facilities Ecological Report

1 ASSIGNMENT

Exigo Sustainability (Pty) Ltd was appointed by Glencore Eastern Mines to conduct an EIA phase study on the ecological components (fauna and flora) for the proposed EIA phase for the proposed residue deposit project on Glencore Eastern Mines, within the Fetakgomo Greater Tubatse Local Municipality, Greater Sekhukhune District Municipality, Limpopo Province.

This report is compiled to include new infrastructure and expansions of existing infrastructure at existing mines. The following is a summary of what is included in this report:

- Thorncliffe mine:
  - New Waste Storage Facility (WSF) (Co-disposal between Tailings and Waste rock) and associated Pollution Control Dam (PCD)
  - Filter press for tailings dewatering prior to deposition
- Helena Mine:
  - Waste Rock Dump (WRD) on footprint of existing Paste Tailings Storage Facility (TSF) site as well as a new silt trap and PCD.
- Stormwater management infrastructure at both mine sites.

This report will include detailed impact assessment of the proposed development on the biodiversity of the site. This assessment is essential as it will contribute to meeting the requirements of the National Environmental Management Act (NEMA), 1998 (Act No. 107 of 1998).

The assignment is interpreted as follows: Compile an ecological study on the flora (vegetation units), fauna and general ecology of the site and determine the potential impacts of the proposed development on the fauna and flora of the area as well as proposed mitigation measures. The study will be done according to guidelines and criteria set by the Limpopo Department of Economic Development, Environment and Tourism (LEDET) for biodiversity studies. In order to compile this, the following had to be done:

1.1 INFORMATION SOURCES

1. All relevant topographical maps, aerial photographs and information (previous studies and environmental databases) related to the ecological components in the study area;
2. Requirements regarding the fauna and flora survey as requested by the LEDET;
3. Legislation pertaining to the fauna and flora study as relevant;
4. Red data species list from the South African National Biodiversity Institute (SANBI, 2016).

1.2 REGULATIONS GOVERNING THIS REPORT

1.2.1 National Environmental Management Act, 1998 (Act No. 107 of 1998) – EIA Regulations 2014 as amended

This report was prepared in terms of the National Environmental Management Act, 1998 (Act No. 107 of 1998) EIA regulations 2014 as amended Appendix 6 – Specialist reports includes a list of requirements to be included in a specialist report:

1. A specialist report or a report prepared in terms of these regulations must contain:
    a. Details of
        i. The specialist who prepared the report; and
        ii. The expertise of that specialist to compile a specialist report, including a curriculum vitae;
    b. A declaration that the specialist is independent in a form as may be specified by the competent authority;
    c. An indication of the scope of, and purpose for which, the report was prepared;
        i. An indication of the quality and age of the base data used in the specialist report
        ii. A description of exsisting impacts on the site, cumulative impacts of the proposed development and levels of acceptable change
    d. The duration, date and season of the site investigation and the relevance of the season to the outcome of the assessment;
    e. A description of the methodology adopted in preparing the report or carrying out the specialized process inclusive of equipment and modelling used;
    f. Details of an assessment of the specific identified sensitivity of the site related to the proposed activity or activities and its associated structures and infrastructure; inclusive of a site plan indentifying site alternatives
    g. An identification of any areas to be avoided, including buffers;
    h. A map superimposing the activity including the associated structures and infrastructure on the environmental sensitivities of the site including areas to be avoided and buffers;
    i. A description of any assumptions made and any uncertainties or gaps in knowledge;

j. A description of the findings and potential implications of such findings on the impact of the proposed activity or activities;

k. Any mitigation measures for inclusion in the EMPr;

l. Any conditions for inclusion in the environmental authorisation;

m. Any monitoring requirements for inclusion in the EMPr or environmental authorisation

n. A reasoned opinion –

   i. Whether the proposed activity, activities or portions thereof should be authorised;

   ii. Regarding the acceptability of the proposed activity or activities; and

   iii. If the opinion is that the proposed activity, activitiesor portions thereof should be authorised, any avoidance, management and mitigation measures that should be included in the EMPr and where applicable, the closure plan;

o. A description of any consultation process that was undertaken during the course of preparing the specialist report;

p. A summary and copies of any comments received during any consultation process and where applicable all responses thereto; and

q. Any other information requested by the competent authority.

1.2.2 The National Environmental Management Act (NEMA) (Act No. 107 of 1998)

This Act embraces all three fields of environmental concern namely: resource conservation and exploitation; pollution control and waste management; and land-use planning and development. The environmental management principles include the duty of care for wetlands and special attention is given to management and planning procedures.

1.2.3 Conservation of Agricultural Resources Act (Act No. 43 of 1983)

This Act regulates the utilization and protection of wetlands, soil conservation and all matters relating thereto; control and prevention of veld fires, control of weeds and invader plants, the prevention of water pollution resulting from farming practices and losses in biodiversity.

1.2.4 National Environmental Management Biodiversity Act (NEMBA: Act 10 0f 2004)

The following aspects of the NEMBA (2004) are important to consider in the compilation of an

ecological report. It:

- Lists ecosystems and species that are threatened or in need of national protection;
- Links to Integrated Environmental Management processes;

1.2.5 The National Forest Act (Act 84 of 1998)

The National Forest Act:

- Promotes the sustainable management and development of forests for the benefit of all;
- Creates the conditions necessary to restructure forestry in State Forests;
- Provide special measures for the protection of certain forests and protected trees;
- Promotes the sustainable use of forests for environmental, economic, educational, recreational, cultural, health and spiritual purposes.
- Promotes community forestry.

1.2.6 Limpopo Environmental Management Act (2004)

The Limpopo Environmental Management Act (2004) deals with the conservation of wild animals, fresh water fish and the conservation and protection of flora in the Limpopo Province. Animals and plants are both listed in the schedules with different degrees of protection afforded to each.

1.2.7 The National Water Act (Act No. 36 of 1998)

Chapter 4 of the National Water Act, Act 36 of 1998 specifies that:

"In general a water use must be licensed unless it is listed in Schedule I, is an existing lawful use, is permissible under a general authorisation, or if a responsible authority waives the need for a licence. The Minister may limit the amount of water which a responsible authority may allocate. In making regulations the Minister may differentiate between different water resources, classes of water resources and geographical areas."

In section 21 of the NWA water uses are listed as:

c. Impeding or diverting the flow of water in a watercourse;

i. Altering the bed, banks, course or characteristics of a watercourse;

1.3 TERMS OF REFERENCE

1.3.1 Objectives

1. The primary aim of this project is to investigate options for enhancing and / or maintaining biodiversity to mitigate the impact of the proposed development and related infrastructure

with the overall objective of preventing further loss of biodiversity. The end-product would be a tool for promoting and lobbying for the recognition of the importance of species habitat and habitat conservation. Options available to maintain the current level of floral diversity include:

a. Protection of native vegetation restored elsewhere in return for unavoidable clearing;

b. Minimisation of habitat fragmentation;

c. Minimisation of any threats to the native flora and fauna and their habitats during the construction and operational phases of the developments and;

d. Rehabilitation to establish plant communities / landscaping that will provide future habitat values.

2. To produce a clear and agreed species and habitat priorities for conservation actions. This includes the following:

i. Determine the potential ecological impacts and actions the developments will have on the biodiversity on a species and habitat level;

ii. Conduct a risk analysis of the impacts identified to determine the significance of the impacts on the fauna and flora of the study area;

iii. Protection and enhancement of vegetation / habitats of high conservation value;

iv. The retention of a substantial amount of native vegetation / habitat of adequate size and configuration to promote the conservation of the existing flora communities;

v. The retention and / or creation of vegetation links, wildlife corridors and vegetation buffers wherever possible, subject to the appropriate bush fire risk management; and

vi. The protection of water quality in the locality so as not to threaten native aquatic flora that rely on the watercourse for survival.

3. Provide recommendations on the ecological mitigation measures to be implemented by the developer and the way forward.

1.3.2 Scope

1. Detailed flora survey – in each vegetation type/plant community on site:

a. After studying the aerial photograph identify specific areas to be surveyed and

confirm location by making use of a Geographical Positioning System (GPS).

b. Conduct a site visit and list the plant species (trees, shrubs, grasses, succulents and other herbaceous species of special interest) present for plant community and ecosystem delimitation.

c. Identify potential red data plant species, possible encroacher species, medicinal plants of value and exotic plant species.

d. Indicate suitable plant species that can be used for the landscaping around the proposed developments.

2. Plant community delimitation and description
    a. Process data (vegetation and habitat classification) to determine vegetation types on an ecological basis.
    b. Describe the habitat and vegetation.

3. Fauna scoping
    a. List the potential fauna (mammal species, red data birds, reptiles, amphibians, invertebrates) present linked to the specific potential habitats that occur as identified in the vegetation survey.
    b. Analyse the data and identify potential red data fauna species, as well as other endemic or protected species of importance.
    c. Indicate species mitigation measures and management measures to be implemented to prevent any negative impacts on the fauna of the area.

4. General
    a. Identify and describe ecologically sensitive areas. Create a sensitivity map to indicate specific sensitive areas based on various environmental parameters such as natural vegetation in a good condition, rockiness, slopes, flood lines etc.
    b. Identify problem areas in need of special treatment or management, e.g. bush encroachment, erosion, degraded areas, reclamation areas.
    c. Make recommendations, impact ratings and risk assessments for each specific impact.

1.3.3 Limitations and assumptions

- In order to obtain a comprehensive understanding of the dynamics of the flora and fauna of the study area, surveys should ideally be replicated over several seasons and over a number

of years. However, due to project time constraints, such long-term studies are not feasible and this floral study was conducted over two seasons;

- The large study area did not allow for the finer level of assessment that can be obtained in smaller study areas. Therefore, data collection in this study relied heavily on data from representative, homogenous sections of vegetation units, as well as general observations, aerial photograph analysis, generic data and a desktop analysis;
- Visibility proved to be a constraint in encroached areas where plant species might have been missed beneath the densely overgrown vegetation and obstructed by surface vegetation;

Thus, even though it might be assumed that survey findings are representative of the ecosystem of the project area, it should be noted that the possibility exists that individual plants species might have been missed due to the nature of the terrain (dense vegetation). Therefore, maintaining due cognisance of the integrity and accuracy of the ecological survey, it should be noted that the ecological resources identified during the study do not necessarily represent all the ecological resources present on the property.

2 STUDY AREA

2.1 LOCATION AND DESCRIPTION OF ACTIVITY

The project area is on the Eastern Limb of the Bushveld Complex between Roossenekal (28 km) and Steelpoort (23 km), and is situated approximately 50 km north-west of the town of Lydenburg in the Limpopo Province of the Republic of South Africa. The nearest rural town is Ga-Malekane (also known as Kokwaneng) which is 15 km north-west of the mine.

Glencore Eastern Mines consist of the following mines/projects:

- Thorncliffe Mine
- Helena Mine
- Magareng Mine

The project involves the following as part of the expansion of the current mining operations (Figure 2):

This report is compiled to include new infrastructure and expansions of existing infrastructure at existing mines. The following is a summary of what is included in this report:

- Thorncliffe mine:
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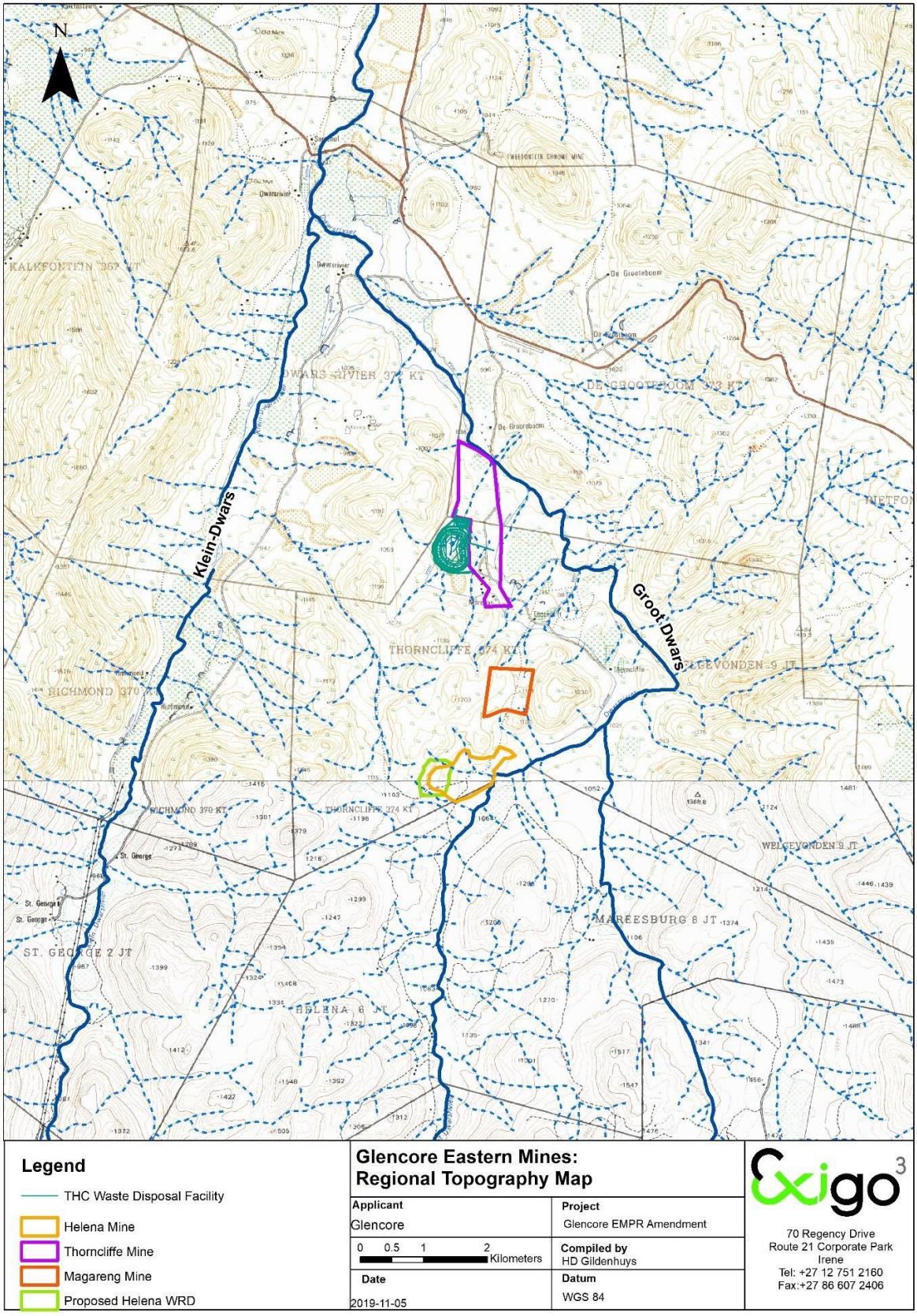

Figure 1. Regional Location Map

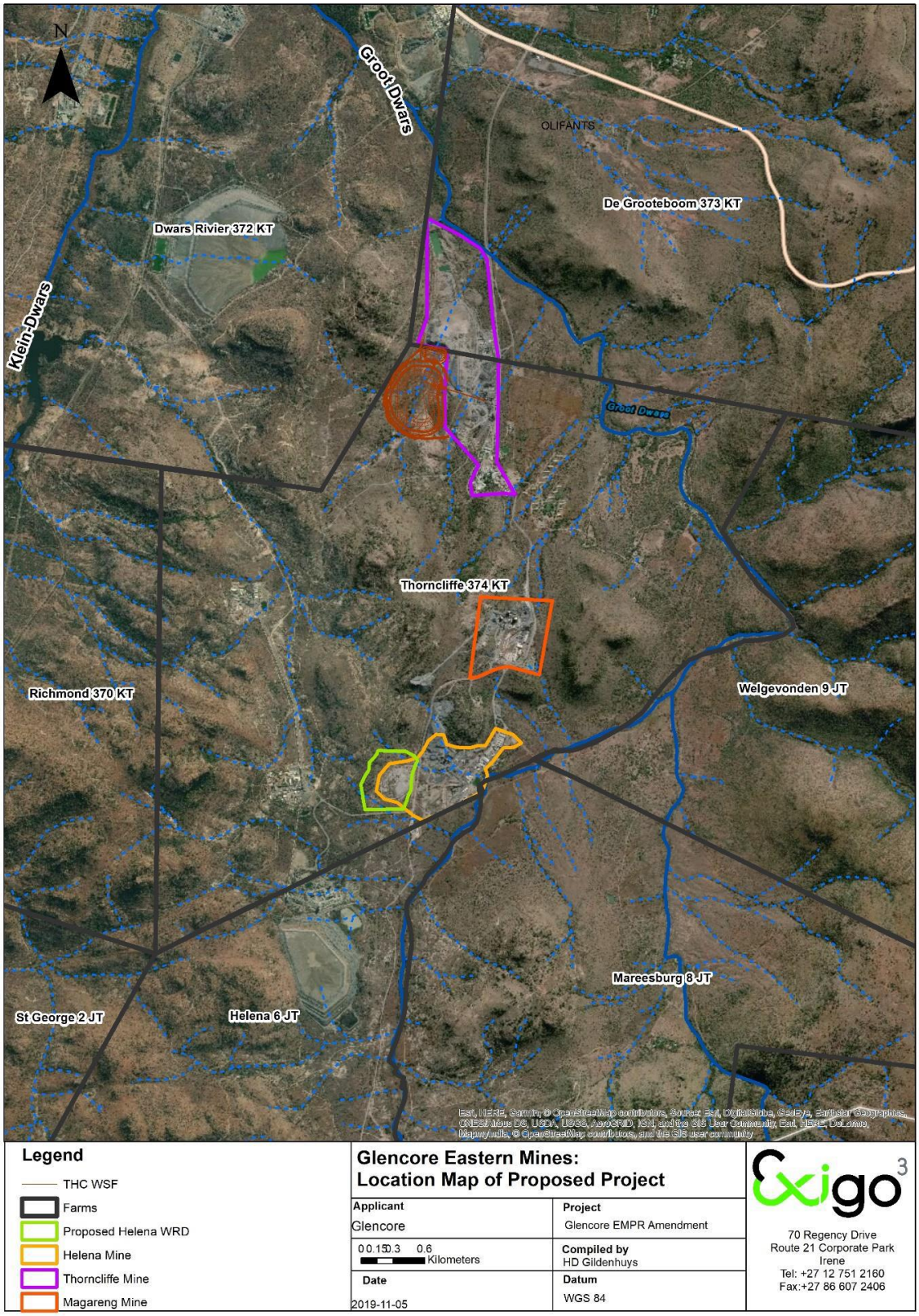

Figure 2. Satelite image showing the project area (Google Earth Pro, 2017) and proposed activities

2.2 CLIMATE

Climate in the broad sense is a major determinant of the geographical distribution of species and vegetation types. However, on a smaller scale, the microclimate, which is greatly influenced by local topography, is also important. Within areas, the local conditions of temperature, light, humidity and moisture vary greatly and it is these factors that play an important role in the production and survival of plants (Tainton, 1981). The climate for the region can be described as warm-temperate.

In terrestrial environments, limitations related to water availability are always important to plants and plant communities. The spatial and temporal distribution of rainfall is very complex and has great effects on the productivity, distribution and life forms of the major terrestrial biomes (Barbour et al. 1987).

Climate for the Sekhukune Mountain Bushveld as described by Mucina & Rutherford (2006) indicates the area to have mainly summer rainfall with a mean annual precipitation of between 500mm and 700mm. The mean monthly rainfall for the area varies between 4.8 mm and 105 mm, with maximum precipitation occurring in January. About 50 to 80 rain days per year may be expected, occurring mostly during November to March. Hail is less frequent than on the Highveld. The rainfall is unreliable.

Average daily maximum temperatures are about 32°C in January and 22°C in July. Average daily minima are about 18°C in January and 4°C in July. Days are often oppressive in summer, whereas winter nights can be very cold. Frost occurs on average during June to August. Winds are mainly light to moderate and blow from the north-easterly sector except for short periods during thunderstorms or weather changes when they have a southerly component.

2.3 GEOLOGY AND SOIL TYPES

Geology is directly related to soil types and plant communities that may occur in a specific area (Van Rooyen & Theron, 1996). A land type unit is a unique combination of soil pattern, terrain and macroclimate, the classification of which is used to determine the potential agricultural value of soils in an area. The land type units represented within the study area include the Ib30, Ib31 and Dc31 land types (Land Type Survey Staff, 1987) (ENPAT, 2001). The land type, geology and associated soil type is presented in Table 1 below as classified by the Environmental Potential Atlas, South Africa (ENPAT, 2000).

Table 1. Land types, geology and dominant soil types of the proposed development site

Landtype	Soils	Geology
Ib30	Miscellaneous land classes, rocky areas with miscellaneous soils	Ferrogabbro, ferrodiorite and magnetitite (Upper zone) and gabbro, norite and anorthosite (Main zone) of the Rustenburg Layered Suite of the Bushveld Complex; some Nebo granite.
Ib31	Miscellaneous land classes, rocky areas with miscellaneous soils	Gabbro, norite, anorthosite, pyroxenite, bronzitite and harzburgite of the Rustenburg Layered Suite, Bushveld Complex.

The soils are generally shallow and vary between soils of a colluvial nature i.e. Glenrosa, Family Dumisa to Mispah form, Family Myhill. Rockiness varies between 30% to 70% (Glenrosa) and 65% on the Mispah form. The soils are derived from norite and have a moderate (15-35%) to high (>35%) clay content, depending on their position in the landscape. The soil depth varies between shallow gravelly soils in the rocky terraces (<450mm) and non-perennial drainage channels, to deeper loamy - clay soils on the plains (450-750mm).

2.4 TOPOGRAPHY & DRAINAGE

The regional topography is rugged with steep slopes and incised valleys that strike east to west and north-east to south-west. The highest elevation is at 1500 mamsl to the south of the study area and the lowest at 850 mamsl in the north-eastern and north-western boundaries of the study areas, which is along the Klein- and Groot Dwars Rivers. The topographic gradient is steep and ranges between 1.7 % and 5 %. The floodplains along the major riverbanks are relatively flat.

2.5 LAND USE AND EXISTING INFRASTRUCTURE

The current land-use of the proposed development site is mining with the neighbouring areas being used for grazing by livestock as well as small scale subsistence crop cultivation. The major land use of the study area as classified by the Environmental Potential Atlas of South Africa (2000) as vacant / unspecified land.

3 METHODS

3.1 VEGETATION SURVEY

Two basic methods were used during the vegetation survey:

- Line transects were walked on the site surveyed to record the plant species present. Rare and threatened plant species and any botanically sensitive sites or habitats were searched for in the various vegetation units.
- The Braun-Blanquet survey technique to describe plant communities as ecological units was also used for this study. It allows for the mapping of vegetation and the comparison of the data with similar studies in the area.

The vegetation survey was conducted on site during early November 2016 and May 2017. The vegetation was in a moderate condition and most species could be identified, although some species might have been missed as a result of the large site. No further surveys were necessary considering that the area received sufficient precipitation during the wet season to allow for the identification of most plants in the study area. Specific differences between the state of vegetation or specific impacts that occurred in the area will be addressed for the different surveying periods.

3.1.1 Data recorded:

Plant names used in this report are in accordance with Arnold & De Wet (1993), with the exception of a few newly revised species. A list of all plant species present, including trees, shrubs, grasses, forbs, geophytes and succulents were compiled. All identifiable plant species were listed. Notes were additionally made of any other features that might have an ecological influence as well as potential fauna habitat that might occur.

3.1.2 Red data species

A species list of the red data species previously recorded in the vicinity of the proposed development was obtained from the South African Biodiversity Institute (SANBI), South Africa as classified by the IUCN red data list categories.

3.1.3 Protected trees

A species list of the protected tree species was obtained from the Department of Forestry. These trees are listed by the NFA (Act 84 of 1998) as protected.

3.1.4 Protected plants

A list of protected and specially protected plants was obtained from the Limpopo Environmental

Management Act (2004) and the Threatened or protected species regulations (TOPS) stipulated in NEMBA (ACT NO. 10 OF 2004).

3.1.5 Data processing

A classification of vegetation data was done to identify, describe and map vegetation types. The descriptions of the vegetation units include the tree, shrub and herbaceous layers.

Conservation priority of each vegetation unit was assessed by evaluating the plant species composition in terms of the present knowledge of the vegetation of the Northwest Province, as well as the vegetation types and Savanna Biome of South Africa.

The following four conservation priority categories were used for each vegetation unit:

- High: Ecologically sensitive and valuable land with high species richness that should be conserved and no development allowed.
- Medium: Land that should be conserved but on which low impact development could be considered with the provision of mitigation measures.
- Medium-low: Land that has some conservation value but on which development could be considered with limited impact on the vegetation / ecosystem. It is recommended that certain sections of the vegetation be maintained.
- Low: Land that has little conservation value and that could be considered for developed with little to no impact on the vegetation / ecosystem.

3.2 FAUNA SURVEY

The fauna survey was conducted as follows:

- A site survey was done to identify potential habitats after identifying the vegetation units. Fauna observed on site or any specific indication of species was noted as confirmed in the species lists.
- A scoping survey was then conducted by comparing the habitat types identified with the preferred habitats of species occurring in the area.

The fauna survey was conducted on site during November 2016 and May 2017.

3.2.1 Data recorded:

A list of all species of fauna and their status as observed on the site or that could potentially occur on the site. Notes were made of any specific sensitive or specialized habitats that occur on the site.

3.2.2 Red data species lists

A species list of the red data species of the different faunal classes was obtained from the following references:

- Red Data Book of the Mammals of South Africa (Friedman & Daly, 2004)
- The Atlas of the Southern African Birds - digital data on quarter degree grid data (Avian Demography Unit, University of Cape Town)
- Atlas and red data book of the frogs of South Africa, Lesotho and Swaziland (Minter et al. 2004)
- South African Red Data Book – Reptiles and Amphibians. National Scientific Programmes Report no. 151;

3.2.3 Data processing

A comparison of the habitats (vegetation units) occurring on the property was made to the preferred habitats of the faunal species. In addition to species observed on the site, lists of the potential mammal, bird, reptile, amphibian and insect species were compiled and mitigating measures recommended if needed.

3.3 SENSITIVITY ASSESSMENT

The ecological sensitivity of any piece of land is based on its inherent ecosystem service and overall preservation of biodiversity.

3.3.1 Ecological function

The ecological function relates to the degree of ecological connectivity between systems within a landscape matrix. Therefore, systems with a high degree of landscape connectivity amongst one another are perceived to be more sensitive and will be those contributing to ecosystem service (e.g. wetlands) or overall preservation of biodiversity.

3.3.2 Conservation importance

Conservation importance relates to species diversity, endemism (unique species or unique processes) and the high occurrence of threatened and protected species or ecosystems protected by legislation.

3.3.3 Sensitivity scale

- High – sensitive ecosystem with either low inherent resistance or low resilience towards disturbance factors or highly dynamic systems considered being important for the

maintenance of ecosystem integrity. Most of these systems represent ecosystems with high connectivity with other important ecological systems or with high species diversity and usually provide suitable habitat for a number of threatened or rare species. These areas should be protected;

- Medium – These are slightly modified systems which occur along gradients of disturbances of low-medium intensity with some degree of connectivity with other ecological systems or ecosystems with intermediate levels of species diversity but may include potential ephemeral habitat for threatened species;
- Low – Degraded and highly disturbed / transformed systems with little ecological function and which are generally very poor in species diversity.

3.4 IMPACT RATING ASSESSMENT

An impact can be defined as any change in the physical-chemical, biological, cultural and/or socio-economic environmental system that can be attributed to human activities related to alternatives under study for meeting a project need.

The significance of the impacts will be determined through a synthesis of the criteria below (Plomp, 2004):

Probability. This describes the likelihood of the impact actually occurring:

- Improbable: The possibility of the impact occurring is very low, due to the circumstances, design or experience.
- Probable: There is a probability that the impact will occur to the extent that provision must be made therefore.
- Highly Probable: It is most likely that the impact will occur at some stage of the development.
- Definite: The impact will take place regardless of any prevention plans, and there can only be relied on mitigation actions or contingency plans to contain the effect.

Duration. The lifetime of the impact

- Short term: The impact will either disappear with mitigation or will be mitigated through natural processes in a time span shorter than any of the phases.
- Medium term: The impact will last up to the end of the phases, where after it will be negated.
- Long term: The impact will last for the entire operational phase of the project but

will be mitigated by direct human action or by natural processes thereafter.

- Permanent: Impact that will be non-transitory. Mitigation either by man or natural processes will not occur in such a way or in such a time span that the impact can be considered transient.

Scale. The physical and spatial size of the impact

- Local: The impacted area extends only as far as the activity, e.g. footprint.
- Site: The impact could affect the whole, or a measurable portion of the above mentioned properties.
- Regional: The impact could affect the area including the neighbouring areas.

Magnitude/ Severity. Does the impact destroy the environment, or alter its function.

- Low: The impact alters the affected environment in such a way that natural processes are not affected.
- Medium: The affected environment is altered, but functions and processes continue in a modified way.
- High: Function or process of the affected environment is disturbed to the extent where it temporarily or permanently ceases.

Significance. This is an indication of the importance of the impact in terms of both physical extent and time scale, and therefore indicates the level of mitigation required.

- Negligible: The impact is non-existent or unsubstantial and is of no or little importance to any stakeholder and can be ignored.
- Low: The impact is limited in extent, has low to medium intensity; whatever its probability of occurrence is, the impact will not have a material effect on the decision and is likely to require management intervention with increased costs.
- Moderate: The impact is of importance to one or more stakeholders, and its intensity will be medium or high; therefore, the impact may materially affect the decision, and management intervention will be required.
- High: The impact could render development options controversial or the project unacceptable if it cannot be reduced to acceptable levels; and/or the cost of management intervention will be a significant factor in mitigation.

The following weights will be assigned to each attribute (Table 7)

Table 2. Impact assessment matrix weights

Aspect	Description	Weight
Probability	Improbable	1
	Probable	2
	Highly Probable	4
	Definite	5
Duration	Short term	1
	Medium term	3
	Long term	4
	Permanent	5
Scale	Local	1
	Site	2
	Regional	3
Magnitude/Severity	Low	2
	Medium	6
	High	8
Significance	**Sum(Duration, Scale, Magnitude) x Probability**	
	Negligible	<20
	Low	<40
	Moderate	<60
	High	>60

The significance of each activity will be rated without mitigation measures and with mitigation measures for the development.

4 RESULTS: ECOLOGICAL ASSESSMENT

4.1 VEGETATION

4.1.1 Biomes

The project area lies within the Savanna Biome which is is the largest biome in Southern Africa. It is characterized by a grassy ground layer and a distinct upper layer of woody plants (trees and shrubs). The environmental factors delimiting the biome are complex and include altitude, rainfall, geology and soil types, with rainfall being the major delimiting factor. Fire and grazing also keep the grassy layer dominant.

4.1.2 Vegetation types

4.1.2.1 Mucina & Rutherford (2006) Classification

The most recent classification of the area by Mucina & Rutherford (2006) shows that the proposed development site is classified as Sekhukhune Mountain Bushveld. The Sekhukune Mountain Bushveld has a least threatened conservation status with 0.4% conserved and nearly 15% transformed. Transformation is mainly through dryland subsistence cultivation and urban built up.

The vegetation structure of the Sekhukune Mountain Bushveld varies from open to dense woody layer, with associated woody and herbaceous shrubs and closed to open grass layer. The landscape topography is mainly moderate to steep slopes on mountainsides and sometimes deeply incised valleys. Flat terrain occurs dispersed in between the sloping terrain.

4.1.2.2 Sekhukhuneland Centre of Endemism

The site forms part of the Sekhukhuneland Centre of Endemism (SCOE). The importance to evaluate the vegetation on the site as part of the Sekhukhuneland Centre of Endemism cannot be underestimated. Most of southern Africa's endemic plants are concentrated in only a few, relatively small areas, known as regions or centres of endemism. Not only do these centres hold clues to the origin and evolution of the botanical diversity within a particular area, but these are also areas that, if conserved, would safeguard the greatest number of plant species (Van Wyk & Smith, 2001). Sekhukhuneland have been identified through previous studies as one of the most important centres of endemism in the Mpumalanga and Limpopo Provinces. The centre falls within the rainfall shadow of the Drakensberg Escarpment, and it is relatively more arid than the areas to the east. The endemic plants of this area are primarily edaphic specialists that are derived from a unique ecology. The substrate consists of heavy soils derived from the norite, pyroxenite and anorthosite formations that predominate over the region. Endemics are both herbaceous and woody with endemism high in the Anacardiaceae, Euphorbiaceae, Liliaceae and Lamiaceae (Van Wyk & Smith, 2001). The site lies inside the Sekhukhuneland Centre of Endemism and the shallow, rocky areas of the development site can be considered especially sensitive as part of the centre of endemism, and will almost certainly show similar vegetation patterns to the endemic regions, especially since the vegetation is still in a natural state. Other important attributes of this region's flora are summarized in table 8 below:

Table 3. Attributes of the Sekhukhuneland Centre of Plant Endemism

Centre of Endemism Size:	5449.4km2
Total Number of Species / Taxa:	± 2200

Endemic / Near endemic taxa:	>100
Rate of endemism:	4.5%
Area in Limpopo Province:	2794km2
Proportion in Limpopo Province:	51.7%
Total % transformed:	28.57%

4.1.3 Vegetation Units

The proposed development sites occur on slightly undulating footslopes and steep mountainous terrain with low-lying valleys. The area is bisected by rivers. The farms surrounding this farm are primarily used for mining, livestock grazing, small-scale subsistence crop cultivation and rual developments.

Vegetation units were identified according to plant species composition, previous land-use, soil types and topography. The state of the vegetation of the proposed mining sites varies from being natural to completely degraded. The farms are currently zoned for mining.

The vegetation communities identified in the area are classified as physiographic physiognomic units, where physiognomic refers to the outer appearance of the vegetation, and physiographic refers to the position of the plant communities in the landscape. The physiographic-physiognomic units will be referred to as vegetation units in the following sections. These vegetation units are divided in terms of the topographical differences, previous land-use and soil differences that had the most definitive influence on the vegetation units. Each unit is described in terms of its characteristics. A species list is included in the Photographic Guide at the end of the document.

The broad classification is done for each of the proposed infrastructure areas as follows:

1. *Lydenburgia cassinoides –Elephanthorrhiza praetermissae* mountainous woodland (Helena, Thorncliffe sites);
2. Mixed *Combretum apiculatum –Bolusanthus speciosis* broadleaf woodland (Helena sites)
3. *Searsia keeti – Vitex obovata* shrubveld (Helena, Thorncliffe sites)
4. *Senegalia caffra – Peltophorum africanum* mixed woodland (Helena site)
5. *Sclerocarya – Dichrostachys – Vachellia* sweet bushveld (Thorncliffe expansion site)
6. Degraded areas (Helena, Thorncliffe sites);
7. Water courses and riparian woodland (Helena, Thorncliffe sites)

The vegetation units as identified during site visits, databases and aerial imagery are indicated in Figure 6, 7, 8 and 9.

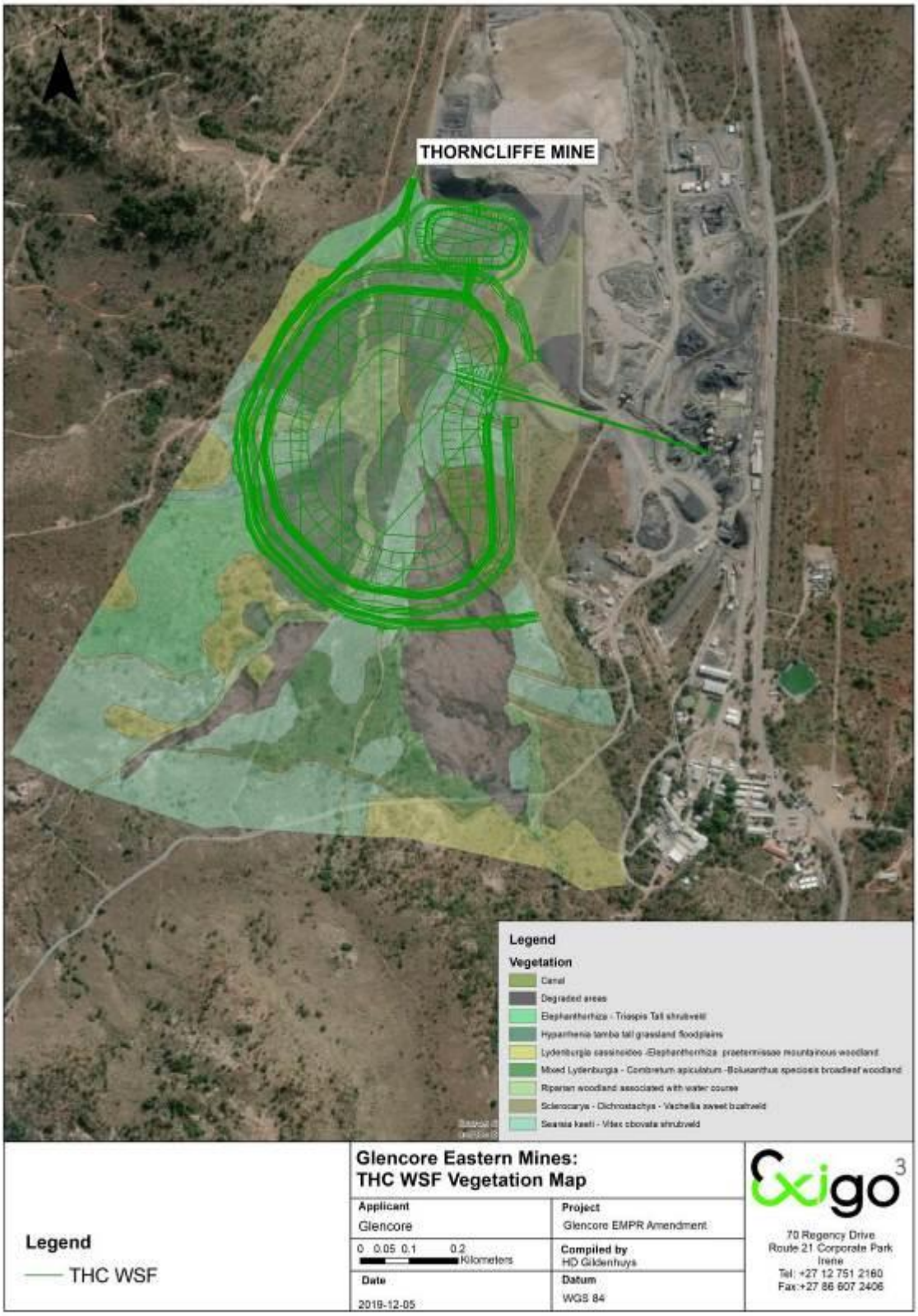

Figure 3. Vegetation Map of the project area for the proposed Thorncliffe Mining Infrastructure

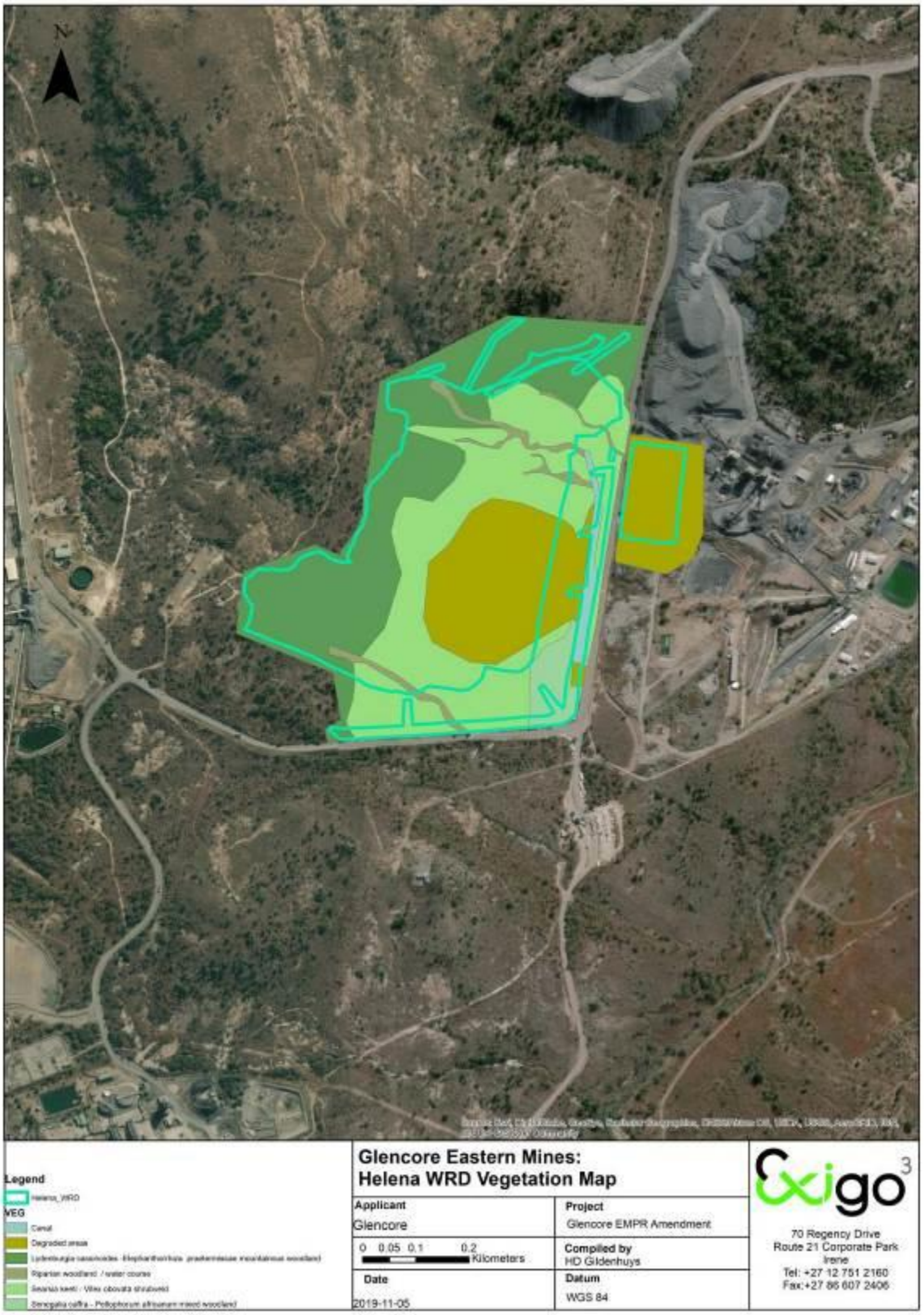

Figure 4. Vegetation Map of the project area for the proposed Helena Mining Infrastructure

4.1.3.1 *Lydenburgia cassinoides –Elephanthorrhiza praetermissae* mountainous woodland

The vegetation unit occurs on the western ridge of the proposed Thorncliffe and Helena mining infrastructure sites. Rocky outcrops and ridges in the Savanna biome of South Africa are often habitats for red data and endemic species of an area, while also supporting a unique floral and faunal species composition. This vegetation unit forms part of the rocky outcrops and ridges in the project area. The rocky ridges provide suitable habitat to protected plants, small mammals and reptiles. The rocky outcrops function as islands within the landscape and are characterized by unique microclimates in which rare species thrive. They are therefore of High Ecological Function and of High Conservational Value for the biodiversity that they support. The landscape geomorphology of the outcrops represents moderately steep slopes derived from chert or dolomite. The terrain is rocky with the rockiness varying between 50 and 60%, which occur mostly as boulders.

The vegetation can be clearly distinguished by its tall woody structure with a well developed shrub layer. The sheltered, rocky habitats support bushclumps dominated by the tall growing *Lydenburgia cassinoides* and *Catha edulis*. Many endemic and listed red data species of the Sekhukuneland Centre of Endemism occur in this habitat type. The grass layer is directly proportional to the amount of rocks present on the surface and dominated by the species *Themeda triandra*. The state of the vegetation is indicated in photograph 1, while the characteristics of the variations of this vegetation unit are summarized in Table 4.

Table 4. Botanical analysis and characteristics of *Lydenburgia cassinoides - Euclea sekhukhuniensis* shrubveld / grassland with bushclumps

State of the vegetation:	Natural / pristine
Need for rehabilitation	Low
Conservation priority	High
Soils & Geology	Shallow gravelly soils of the Mispah / Glenrosa soil forms derived from gabbro or norite
Density of woody layer	Trees: 10-20% (avg. height: 3-6m) Shrubs: 15-20% (avg. height: 1-2m)
Density of herbaceous layer	Grasses: 60-70% (avg. height: 0.8-1.2m) Forbs: <1% (avg. height: 0.8m)
Sensitivity	Medium-High

Dominant plant species	*Elephanthorhiza praetermissae* *Euclea crispa*. *Euclea sekhukhuniensis* *Lydenburgia cassinoides* *Searsia keetii* *Themeda triandra*
Red data species	*Catha edulis* *Jamesbrittenia macrantha* *Lydenburgia cassinoides*
Endemic species	*Elephanthorrhiza praetermissae* *Euclea crispa* (growth form) *Euclea sekhukhuniensis* *Grewia vernicosa* *Rhoicissus sekhukhuniensis* *Searsia sekhukuniensis* *Vitex obovata* subsp. *wilmsii*
Protected tree species (DAFF)	*Lydenburgia cassinoides*

Photograph 1. Typical tall woodland on the rocky ridge to the west of the Paste Tailings Facility

The following specific recommendations and conclusions were made for this vegetation unit:

- The vegetation unit is classified as having a medium-high sensitivity due to the dense stands of endemic species of the SCPE;
- Should any of the endemic, protected or red data species be impacted on a licence should be obtained from DAFF and / or LEDET.

4.1.3.2 Mixed *Combretum apiculatum –Bolusanthus speciosis* broadleaf woodland

This vegetation unit represent the mixed woodland documented on the site of the proposed Helena infrastructure site that represent warmer north-facing slopes associated with the project area. This section of the project area is characterised by denser woodland on a moderately undulating hilly landscape. The substrate is shallow, rocky soils (Mispah, Glenrosa soil form) derived from norite or gabbro. The indigenous woody component is dominated by woody species such as *Lydenburgia cassinoides, Euclea crispa, Combretum apiculatum, Bolusanthus speciosus, Ozoroa sphaerocarpa, Grewia vernicosa* and *Combretum molle*.

The characteristics this vegetation unit are presented in Table 5, while the state of the vegetation is presented in photograph 2.

Table 5. Botanical analysis and characteristics of the vegetation associated with the *Combretum apiculatum – Lydenburgia cassinoides* broadleaf woodland in the project area

State of the vegetation:	Slightly degraded
Need for rehabilitation	Low
Conservation priority	Medium
Soils & Geology	Shallow gravelly soils of the Mispah / Glenrosa soil forms derived from gabbro or norite
Density of woody layer	Trees: 10-20% (avg. height: 3-6m) Shrubs: 10-15% (avg. height: 1-2m)
Density of herbaceous layer	Grasses: 60-70% (avg. height: 0.8-1.2m) Forbs: <1% (avg. height: 0.8m)
Sensitivity	Medium-High
Dominant plant species	*Combretum apiculatum* *Bolusanthus speciosus* *Combretum molle* *Euclea crispa.* *Grewia vernicosa* *Lydenburgia cassinoides*

	Ozoroa sphaerocarpa *Themeda triandra*
Red data species	*Jamesbrittenia macrantha* *Lydenburgia cassinoides* *Catha edulis*
Endemic species	*Elephanthorrhiza praetermissae* *Euclea crispa* (growth form) *Euclea sekhukhuniensis* *Grewia vernicosa* *Rhoicissus sekhukhuniensis* *Searsia sekhukuniensis* *Vitex obovata* subsp. *wilmsii*
Protected tree species (DAFF)	*Lydenburgia cassinoides* *Sclerocarya birrea*
Protected flora	*Aloe cryptopoda* *Elephanthorrhiza praetermissae*

Photograph 2. Mixed *Combretum apiculatum –Bolusanthus speciosis* broadleaf woodland in the project area

The following specific recommendations and conclusions were made for this vegetation unit:

- The vegetation unit is classified as having a medium-high sensitivity due to the dense

stands of endemic species of the SCPE;

- Should any of the endemic, protected or red data species be impacted on a licence should be obtained from DAFF and / or LEDET.

4.1.3.3 Searsia keeti – Vitex obovata shrubveld

This vegetation unit occurs in the low-lying valleys on gravelly terraces adjacent to water courses. The woody structure is a low shrubveld. The characteristics of this vegetation unit are summarized in Table 6, while the state of the vegetation indicated in photograph 3.

Table 6. Botanical analysis and characteristics of the Searsia keeti – Vitex obovata shrubveld

Vegetation unit characteristics	
State of the vegetation:	Slightly degraded shrubveld
Need for rehabilitation	Low
Conservation priority	Medium
Soils & Geology	Shallow gravelly soils (Glenrosa soil form) to medium depth red-yellow apedal soils (Hutton soil)
Density of woody layer	Trees: 5-10% (avg. height: 3-6m) Shrubs: 10-15% (avg. height: 1-2m)
Density of herbaceous layer	Grasses: 70-80% (avg. height: 0.8-1.2m) Forbs: <1% (avg. height: 0.8m)
Sensitivity	Medium
Dominant plant species	*Euclea sekhukuniensis* *Grewia vernicosa* *Searsia keeti* *Vitex obovata*
Red data species	*Lydenburgia cassinoides* *Jamesbrittenia macrantha*
Endemic species	*Elephanthorrhiza praetermissae* *Euclea crispa (growth form)* *Euclea sekhukhuniensis* *Grewia vernicosa* *Rhoicissus sekhukhuniensis*

Vegetation unit characteristics	
	Searsia sekhukuniensis *Vitex obovata subsp. wilmsii*
Protected tree species (DAFF)	*Lydenburgia cassinoides* *Sclerocarya birrea*
Protected flora	*Aloe cryptopoda* *Elephanthorrhiza praetermissae*

Photograph 3. *Searsia keeti – Vitex obovata* shrubveld within the project area

The following specific recommendations and conclusions were made for this vegetation unit:

- The vegetation unit is classified as having a medium sensitivity due to the widespread status of this vegetation unit and state of degradation in the area;

4.1.3.4 *Senegalia caffra – Peltophorum africanum* mixed woodland

This vegetation unit occurs in a small section of the proposed Helena infrastructure expansion site on shallow clayey soils. The woody structure is open medium tall woodland dominated by species such as *Peltophorum africanum, Vachellia nilotica* and *Senegalia caffra*. The characteristics of this vegetation unit are summarized in Table 7, while the state of the vegetation indicated in photograph 4.

Table 7. Botanical analysis and characteristics of the *Senegalia caffra – Peltophorum africanum* mixed woodland

Vegetation unit characteristics	
State of the vegetation:	Slightly degraded woodland
Need for rehabilitation	Low
Conservation priority	Medium
Soils & Geology	Shallow to medium depth sandyclayloam soils
Density of woody layer	Trees: 10% (avg. height: 3-6m) Shrubs: 2-5% (avg. height: 1-2m)
Density of herbaceous layer	Grasses: 70-80% (avg. height: 0.8-1.2m) Forbs: <1% (avg. height: 0.8m)
Sensitivity	Medium
Dominant plant species	Peltophorum africanum Vachellia nilotica
Red data species	None observed
Endemic species	*Euclea crispa* (growth form) *Grewia vernicosa*
Protected tree species (DAFF)	None observed
Protected flora	None observed

Photograph 4. *Senegalia caffra – Peltophorum africanum* mixed woodland within the project area

The following specific recommendations and conclusions were made for this vegetation unit:

- The vegetation unit is classified as having a medium sensitivity due to the widespread status of this vegetation unit and state of degradation in the area.

4.1.3.5 Degraded terrain

The old haul roads, paste tailings facility, Waste Rock Dumps, canals and seriously eroded areas represent low sensitivity degraded areas characterised by plant species such as *Dichrostachys cinerea, Dodonaea angustifolia, Pennisetum villosum, Aristida congesta* and *Cynodon dactylon*.

The area has been degraded through mining activities or as a result of mining activities in the past. The characteristics of this vegetation unit are summarized in Table 8, while the state of the vegetation indicated in photograph 5 and 6.

Table 8. Botanical analysis and characteristics of the degraded areas

Vegetation unit characteristics	
State of the vegetation:	Degraded grassland / eroded land / mining infrastructure

Vegetation unit characteristics	
Need for rehabilitation	High
Conservation priority	Low
Soils & Geology	Red-yellow apedal loam soils derived from norite / shallow, gravelly soils
Density of woody layer	Trees: <1% (avg. height: 3-6m) Shrubs: 2-5% (avg. height: 1-2m)
Density of herbaceous layer	Grasses: 10-15% (avg. height: 0.8-1.2m) Forbs: <1% (avg. height: 0.8m)
Sensitivity	Low
Dominant species	*Dodonaea angustifolia, Dichrostachys cinerea, Aristida* species, *Hyparrhenia hirta,* Exotic weeds
Red data species	None observed
Protected species	None observed

Photograph 5. Degraded paste tailings facility on the proposed WRD site

Photograph 6. Eroded section on the site for the proposed Thorncliffe WSF

The following specific recommendations and conclusions were made for this vegetation unit:

- The vegetation unit is classified as having a low sensitivity due to the state of degradation;
- Unlimited development can be supported in the area. Care should however be taken not to impact on the adjacent riparian woodland and sensitive mountainous terrain.

4.1.3.6 *Sclerocarya – Dichrostachys – Vachellia* sweet bushveld

This vegetation unit occurs in a small section of the proposed Thorncliffe expansion site on red or black clayey soils derived from gabbros. The woody structure is dense, medium tall woodland dominated by species such as *Dichrostachys cinerea, Vachellia karroo* and *Sclerocarya birreaa*. The characteristics of this vegetation unit are summarized in Table 9, while the state of the vegetation indicated in photograph 7.

Table 9. Botanical analysis and characteristics of the Sclerocarya – Dichrostachys – Vachellia sweet bushveld

Vegetation unit characteristics	
State of the vegetation:	Slightly degraded woodland
Need for rehabilitation	Medium
Conservation priority	Medium
Soils & Geology	Deep red or black clayey soils derived from gabbro
Density of woody layer	Trees: 10-15% (avg. height: 3-6m) Shrubs: 15-25% (avg. height: 1-2m)
Density of herbaceous layer	Grasses: 70-80% (avg. height: 0.8-1.2m) Forbs: <1% (avg. height: 0.8m)
Sensitivity	Medium
Dominant plant species	*Vachellia karroo* *Vachellia nilotica* *Sclerocarya birrea* *Dichrostachys cinerea*
Red data species	None observed
Endemic species	None observed
Protected tree species (DAFF)	*Sclerocarya birrea*
Protected flora	None observed

The following specific recommendations and conclusions were made for this vegetation unit:

- The vegetation unit is classified as having a medium sensitivity due to the widespread status of this vegetation unit and state of degradation in the area;

Photograph 7. *Sclerocarya – Dichrostachys – Vachellia* sweet bushveld

4.1.3.7 Water courses and riparian woodland

The wetland classification system of the National Water Act classifies the HGM unit associated with the drainage channels as channels. A channel (river, including the banks) is an open conduit with clearly defined margins that (i) continuously or periodically contains flowing water, or (ii) forms a connecting link between two water bodies. Dominant water sources include concentrated surface flow from upstream channels and tributaries, diffuse surface flow or interflow, and/or groundwater flow. Water moves through the system as concentrated flow and usually exits as such but can exit as diffuse surface flow because of a sudden change in gradient. Unidirectional channel-contained horizontal flow characterises the hydrodynamic nature of these units. As a result of the erosive forces associated with concentrated flow, channels characteristically have relatively obvious active channel banks. At Level 4A of the classification system, the entire active channel (including wetlands occurring on the banks, i.e. in the riparian zone) is treated as a unit.

These channels are not “true” wetlands as stipulated in the National Water Act due to the soils not indicating wetness in the top 50cm and therefore represent rivers.

Section 1.1 (xi) of the National Water Act (1998) described “instream habitat'' as the area which includes the physical structure of a watercourse and the associated vegetation in relation to the bed of the watercourse. The water course on the site is a non-perennial channels. It forms shallow

channels in some areas where it bisect rocky areas, although in the lower lying areas it often divert into deeper ravines with well-defined banks. The channel has a sandy riverbed with some small pebbles and rocks along its bottom. No herbaceous vegetation grows in the deeper ravines other woody riparian species.

Riparian Habitat are described by the National Water Act (1998) Section 1.1 (xxi) as follows: “riparian habitat'' includes the physical structure and associated vegetation of the areas associated with a watercourse which are commonly characterised by alluvial soils, and which are inundated or flooded to an extent and with a frequency sufficient to support vegetation of species with a composition and physical structure distinct from those of adjacent land areas”.

In the case of the study area the water courses support clearly identified riparian woodland where the channels have clearly defined banks (Photograph 6 and 7).

Typical woody species of the riparian include *Catha edulis, Lydenburgia cassinoides, Hippobromus pauciflorus* and *Schotia brahypetala*. The grassland areas of the mountain streams are dominated by hygrophilous grass species such as *Setaria spahcelata*.

The riparian zone and channels still plays many essential roles in the functioning of the ecosystem, including:

- Flow regulation: the riparian vegetation slows the flow of water, both by physically blocking the passage of water, and by absorbing the water into its root systems. This moderates the impacts of flooding on surrounding areas.
- Water quality regulation: the riparian vegetation acts as a buffer or filter between nutrients, sediments, contaminants, and bacteria from the surrounding land and air, and the river channel itself. The riparian vegetation therefore prevents soil, pesticides, fertilizers and oil from entering the river and impacting on in-stream communities.
- Habitat provision: The riparian zone is an important habitat for many plants and animals, because it is an area of transition between the land and the river. These relatively steep environmental gradients (moisture, temperature, topography, and soil) generally support higher levels of biodiversity than more homogeneous areas.
- Corridor functions: because it follows the river, the riparian zone serves as a corridor, connecting two or more habitats that may otherwise be isolated by land transformation of areas in between. Many species of animals use corridors to disperse, and find food and mates.

The characteristics of this vegetation unit are summarized in Table 10, while the state of the vegetation indicated in photographs 8 and 9.

Table 10. Botanical analysis and characteristics of the main water courses

Vegetation unit characteristics	
State of the vegetation:	Varies from pristine to degraded
Need for rehabilitation	Medium
Conservation priority	High
Characteristics	Channel with riparian woodland along the banks, while smaller channels are characterised by tall grassland bisecting rocky terrain.
Soils & Geology	Alluvial soils of the Rensburg / Oakleaf soil forms
Density of woody layer (riparian woodland)	Trees: 30-40% (avg. height: 3-6m) Shrubs: 2-5% (avg. height: 1-2m)
Density of herbaceous layer	Grasses: 40-50% (avg. height: 0.8-1.2m) Forbs: 1-2% (avg. height: 0.8m)
Sensitivity	High
Red data species	*Lydeburgia cassinoides* *Searsia sekhukhuniensis* *Searsia batophylla*
Protected species	*Lydeburgia cassinoides* *Catha edulis*

The following general recommendations are made for the drainage channels:

- The vegetation associated with drainage channels and riparian woodland is classified as a high sensitivity area with a high conservation priority. No alteration of these important drainage areas is recommended without a Water Use Licence obtained from DWS. In such a case the stormwater should be managed in a diversion canal;
- Mitigating measures should be implemented to prevent erosion of roads across drainage lines;

Photograph 8. Riparian vegetation associated with the proposed WRD site

Photograph 9. Shallow flow channel and riparian vegetation associated with the proposed WSF site

4.2 FLORA: SPECIES LEVEL ASSESSMENT

South Africa has been recognized as having remarkable plant diversity with high levels of

endemism. The major threats to plants in the study area are urban expansion, non-sustainable harvesting, collecting, overgrazing/browsing, mining and agriculture. The objective of this section was to compile a list of plant species for which there is conservation concern. This included threatened, rare, declining, protected and endemic species.

4.2.1 Species of concervation concern

Species of conservation concern are species that have a high conservation importance in terms of preserving South Africa's high floristic diversity and include not only threatened species, but also those classified in the categories Extinct in the Wild (EW), Regionally Extinct (RE), Near Threatened (NT), Critically Rare, Rare, Declining and Data Deficient – Insufficient Information (DDD). It should also be noted that not all species listed as protected are threatened or vice versa.

A list of SCC plant species previously recorded in the study area in which the proposed development is planned was obtained from the Plants of Southern Africa (POSA) database of SANBI. Figure 10 indicates the classification system used by Sanbi for SCC:

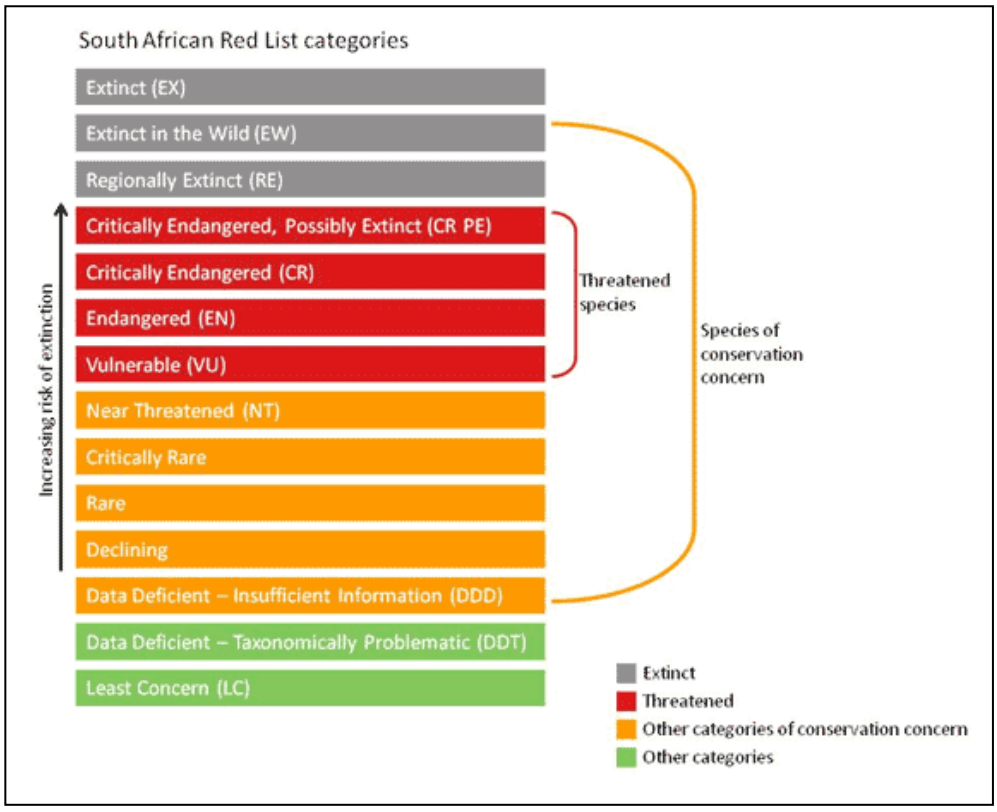

Figure 5. South African red list categories indicating the categories to be used for Species of Conservation Concern

A list of red data plant species previously recorded in the study area in which the proposed development is planned was obtained from the Plants of Southern Africa (POSA) database of SANBI. There are various categories for Red Data Book species, such as 'Endangered', 'Vulnerable',

'Rare' and 'Near threatened' as listed in the Red Data List of Southern African Plants (Hilton-Taylor 1996). The following red data species was listed and confirmed for the project area (Table 11)

Table 11. Red data species documented during the surveys

Species Name	*Conservation Status*
Jamesbrittenia macrantha	***Near threatened***
Lydenburgia cassinoides (Photograph 10)	***Near threatened***
Searsia batophylla	***Vulnerable***
Searsia sekhukhuniensis (Photograph 11)	***Rare***

Photograph 10. *Lydenburgia cassinoides* in the project area

Photograph 11. *Searsia sekhukhuniensis* in the project area

4.2.2 Protected tree species (NFA)

The National Forest Act (no.84 of 1998: National Forest Act, 1998) provides a list of tree species that are considered important in a South African perspective as a result of scarcity, high utilization, common value, etc. In terms of the National Forest Act of 1998, these 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 DWAF (or a delegated authority). Obtaining relevant permits are therefore required prior to any impact on these individuals. Taking cognizance of the data obtained from the field surveys, the following tree species occur in the area:

- *Catha edulis;*
- *Lydenburgia cassinoides*
- *Sclerocarya birrea*

A licence application should therefore be submitted to DAFF before any of these trees can be removed during construction.

4.2.3 Endemic plants

The area forms part of the Sekhukhuneland Centre of Endemism, more specifically the Steelpoort Subcentre. This vegetation unit is not heavily disturbed and its vast range of habitat still harbours high plant diversity with many endemics, many of which still await formal description.

Endemic plants observed in the area include the following species (Table 12):

Table 12. Endemic species documented In the project area

Species Name	*Endemic status*
Elephantorrhiza praetermissa	Endemic Sekhukhune
Euclea sp. nov. aff. linearis	Endemic Sekhukhune
Euclea sekhukhuniensis (Photograph 12)	Endemic Sekhukhune
Grewia verniscosa Schinz	Endemic SA
Gymnosporia sp. A	Endemic Sekhukhune
Lydenburgia cassinoides	Red data, Endemic Sekhukhune
Rhoicissus sekhukhuniensis	Endemic Sekhukhune
Searsia sekhukhuniensis	Endemic Sekhukhune
Triaspis glaucophylla	Endemic SA
Vitex obovata s. wilmsii (Photograph 13)	Endemic Sekhukhune (host plant to *Pycnia silvia*)

Photograph 12. *Euclea sekhukhuniensis* in the project area

Photograph 13. Leaves of *Vitex obovata s. wilmsii* host plant of the red data cicada beatle *Pycnia silva*

4.2.4 Protected Plants (LEMA)

Plant species are also protected according to the Limpopo Environmental Management Act. According to this Act, no person may pick, import, export, transport, possess, cultivate or trade in a specimen of a specially protected or protected plant species. The Appendices to the Act provide an extensive list of species that are protected, comprising a significant component of the flora expected to occur on site. Communication with Provincial authorities indicates that a permit is required for all these species, if they are expected to be affected by the proposed project.

After a detailed survey was conducted during November 2016 and May 2017, the following protected plant species was found on site:

- *Aloe cryptopoda;*
- *Elephantorrhiza praetermissa;*

4.2.5 Medicinal plants

Medicinal plants are an important aspect of the daily lives of many people and an important part of the

Southern African cultural heritage. The impact of the proposed development on populations of medicinal plants will be very little, although certain plants play an important role in the culture. The following medicinal plant species occur in the project area (Van Wyk & Gericke, 1997) as indicated in Table 13:

Table 13. Medicinal plant species and their habitats in the project area

Species	Indigenous / exotic	Status	Habitat of species
Vachellia karroo	Indigenous	Widespread	Riparian woodland / floodplains / old fields on fertile soils
Vachellia tortilis	Indigenous	Widespread	Woodlands on loamy to clayey soils including floodplains / old fields on fertile soils
Datura stramonium	Exotic	Widespread	Old fields / disturbed land
Dichrostachys cinerea	Indigenous	Widespread	Degraded woodland / natural woodland areas on sandy soils
Dombeya rotundifolia	Indigenous	Widespread	Riparian woodland / mountainous areas
Ehretia rigida	Indigenous	Localized	Termitaria / riparian woodland
Elephanthorhiza elephanthina	Indigenous	Widespread	Sandy plains
Euclea undulata	Indigenous	Widespread	Floodplains along rivers, riparian woodland and on termitaria
Grewia bicolor	Indigenous	Widespread	All habitats of area
Gomphocarpus fruticosa	Indigenous	Localized	Along floodplains of rivers / in seasonal zones of rivers
Lippia javanica	Indigenous	Widespread	Old fields / disturbed land
Pavonia burchellii	Indigenous	Localized	Shady areas under trees / among rocks
Ricinus communis	Exotic	Widespread	Varied habitats / disturbed land along river courses
Sclerocarya birrea	Indigenous	Widepsread0	Sandy plains
Terminalia sericea	Indigenous	Widespread	Deep sandy soils on plains
Typha capensis	Indigenous	Localized	In standing water of pans / rivers
Vernonia oligocephala	Indigenous	Widespread	Throughout many vegetation units of Savanna Biome
Ximenia caffra	Indigenous	Widespread	Bushveld / rocky terrain, termite mounds
Ziziphus mucronata	Indigenous	Widespread	Riparian woodland / floodplains / old fields on fertile soils

The following recommendations for the site can be made regarding medicinal plants of importance:

- The project area should be assessed with regards to the most popular medicinal plants that may potentially become Red Data plants in the future. A management strategy in association with the users as well as nurseries should be established to maintain sustainable utilization patterns;

- Develop a comprehensive medicinal plant monitoring and evaluation system that uses indicators describing driving forces, states and impacts of key variables. This needs to be implemented at various levels along the supply and demand chain, and will facilitate the early identification of non-sustainable harvesting levels, improved policy, and regulations and law enforcement;
- Promote the substitution of rare and endangered plants with more common alternatives;
- Provide background research for the establishment of an alternative health farm. Specific emphasis should be placed on the traditional use of medicinal plants by various cultural groups.
- Persons collecting plants and animals should have the necessary permits from the relevant provincial department as well as have the permission for such activities from the Management Authority. This should also apply to traditional healers and scientists and general information sessions should be held to educate people of such requirements.

4.2.6 Management of red data, protected and endemic plant species

The following specific management measures and guidelines should be implemented for red data, endemic and protected plant species documented on the proposed development site:

- Should impact be unavoidable the following principles would apply. A detailed species rescue, relocation and re-introduction plan should be developed and implemented by a qualified person before any excavations or disturbance commence. This plan should at the least address the following:
    - Harvesting of seeds from herbaceous and woody vegetation to be used in the ex situ nursery and future rehabilitation.
    - Intact removal of protected plant species under permit. Permits should be obtained from the LEDET where protected flora is to be disturbed or relocated. Plant material that is to be “rescued” must be potted up into bags utilising local soil obtained from the previously stored topsoil heap. Adequate root systems per plant material type must be carefully excavated and retained in order for plant material to remain viable. Search and Rescue activities would include the removal of grass clumps, smaller transplantable shrubs and trees and endangered species such as geophytes and succulents should be placed into bags using local soil.
- Options to be considered for the above-mentioned protected and general floral specimens:

- Suitable translocation areas: e.g. protected areas;
- Translocation to suitable areas earmarked for public open spaces, restoration and rehabilitation, both on and off-site.
- Use of removed plants in an indigenous nursery for future restoration and rehabilitation programs.
- Translocation to other areas suitable for survival of the removed specimens.

- Proper habitat suitability assessments before reintroductions to reduce the risk of mortalities in both source and destination populations.

- Compile a Protected Plant policy for the study area. This should list those species under threat, reasons for their demise and measures that must be taken to ensure for their continued existence, including access to adequate and appropriate areas of suitable habitat condition.

4.2.7 Invasive alien species

Invasive alien plants pose a direct threat not only to South Africa's biological diversity, but also to water security, the ecological functioning of natural systems and the productive use of land. They intensify the impact of fires and floods and increase soil erosion. Of the estimated 9000 plants introduced to this country, 198 are currently classified as being invasive. It is estimated that these plants cover about 10% of the country and the problem is growing at an exponential rate.

The Alien and Invasive Species Regulations (GNR 599 of 2014) are stipulated as part of the National Environmental Management: Biodiversity Act (10/2004). The regulation listed a total of 559 alien species as invasive and further 560 species are listed as prohibited and may not be introduced into South Africa. Below is a brief explanation of the four categories of Invasive Alien Plants as per the regulation.

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

Category 2 plants. No permits will be issued for Category 2 plants to exist in riparian zones.

- Category 3: Invasive species regulated by activity. An individual plant permit is required to undertake any of the following restricted activities (import, possess, grow, breed, move, sell, buy or accept as a gift) involving a Category 3 species. No permits will be issued for Cat 3 plants to exist in riparian zones.

The fight against invasive alien plants is spearheaded by the Working for Water (WfW) programme, launched in 1995 and administered through the DWA. This programme works in partnership with local communities, to whom it provides jobs, and also with Government departments including the Departments of Environmental Affairs and Tourism, Agriculture, and Trade and Industry, provincial departments of agriculture, conservation and environment, research foundations and private companies.

WfW currently runs over 300 projects in all nine of South Africa's provinces. Scientists and field workers use a range of methods to control invasive alien plants. These include:

- Mechanical methods - felling, removing or burning invading alien plants.
- Chemical methods - using environmentally safe herbicides.
- Biological control - using species-specific insects and diseases from the alien plant's country of origin. To date 76 bio-control agents have been released in South Africa against 40 weed species.
- Integrated control - combinations of the above three approaches. Often an integrated approach is required in order to prevent enormous impacts.
- Vehicles often transport many seeds and some may be of invader species, which may become established along the roads through the area, especially where the area is disturbed. The construction phase of the development will almost certainly carry the greatest risk of alien invasive species being imported to the site, and the high levels of habitat disturbance also provide the greatest opportunities for such species to establish themselves, since most indigenous species are less tolerant of disturbance. The biggest risk is that invasive alien species such as the seeds of noxious plants may be carried onto the site along with materials that have been stockpiled elsewhere at already invaded sites.
- Continued movement of personnel and vehicles on and off the site, as well as occasional delivery of materials required for maintenance, will result in a risk of importation of alien species throughout the life of the project. The following alien invasives and exotic plant

species were recorded on site during the surveys as stipulated in the Alien and Invasive Species Regulations (GNR 599 of 2014) (Table 14):

Table 14. Declared weeds and invader plants of the study area

Species	Category
Achyranthes aspera	1b
Argemone ochroleuca	1b
Cirsium vulgare	1b
Datura stramonium	1b
Melia azedarach	1b
Xanthium strumarium	1b

According to the amended regulations (No. R280) of March 2001 of the Conservation of Agricultural Resources Act 1983 (Act no. 43 of 1983), it is the legal duty of the land user/landowner to control invasive alien plants occurring on the land under their control. The State has the right to clear invasive plants at the landowner's expense if the landowner refuses to remove invasive plants.

4.2.8 General

An important aspect relating to the proposed development should be to protect and manage biodiversity (structure and species composition) of the vegetation types which are represented on the proposed development site. Vegetation removal should be limited to footprint areas and the unnecessary impact on the surrounding grasslands, water courses, riparian woodland and forests outside the development footprint should be avoided as far as possible.

4.3 FAUNAL ASSESSMENT

4.3.1 Overview

A healthy environment is inhabited by animals that vary from micro-organisms to birds and mammals. The species composition and diversity are often parameters taken into consideration when determining the state of the environment. A comprehensive survey of all animals is a time consuming task that will take a long time and several specialists to conduct. The alternative approach to such a study is to do a desktop study from existing databases and conduct a site visit to verify the habitat requirements and condition of the habitat. If any rare or endangered species are discovered in the desktop study to be negatively influenced by the proposed development, specialist surveys will be conducted.

The number of mammal species supported by a plant community depends on several factors like the primary production, seasonal availability of resources, floral heterogeneity, diversity of plant structure, nature of the substratum and previous history (Delany, 1982). Each mammal species have a particular niche, which can be regarded as the sum of all ecological requirements of a species namely food, space, shelter and physical conditions. Mills & Hes (1997) stated that the distribution and abundance of animal species does not rigorously follow that of plant communities or biomes. Instead, mammal species seem to have certain preferences for a specific habitat type (Skinner & Smithers, 1990). Several authors have shown this preference of mammals to certain habitats through analysis (Beardall et al. 1984; Ben-Shahar, 1991; Dekker et al. 1996).

4.4 Fauna Habitats

The number of mammal species supported by a plant community depends on several factors like the primary production, seasonal availability of resources, floral heterogeneity, diversity of plant structure, nature of the substratum and previous history (Delany, 1982). Each mammal species has a particular niche, which can be regarded as the sum of all ecological requirements of a species namely food, space, shelter and physical conditions. Mills & Hes (1997) stated that the distribution and abundance of animal species does not rigorously follow that of plant communities or biomes. Instead, mammal species seem to have certain preferences for a specific habitat type (Skinner & Smithers, 1990). Several authors have shown this preference of mammals to certain habitats through analysis (Beardall et al. 1984; Ben-Shahar, 1991; Dekker et al. 1996).

A survey was conducted during November 2016 and May 2017 to identify specific fauna habitats, and to compare these habitats with habitat preferences of the different fauna groups (birds, mammals, reptiles, amphibians) occurring in the quarter degree grid. The area represents mixed

woodland vegetation components with a diverse vegetation structure and height class. A detailed species list for the fauna of the area is included in Appendix C, D and E.

The regional fauna has not been as extensively studied and is not known to exhibit many unique features. The area has been settled for many centuries, and the fauna is usually considered impoverished due to overgrazing and other man-induced impacts. There are three main faunal habitat types present on the site that might be impacted on by the proposed project.

4.4.1 Habitat A: Woodland habitat associated with rocky area

The rocky habitats on site are an important habitat for various fauna species of conservation concern of which the most important would be reptiles (South African python), bats and smaller mammal species. The rocky ridges occupy isolated pockets of the project area. The ridges and outcrops create important microhabitats for fauna on site.

Although larger mammal species may not be as common in this habitat type, smaller species such as the Jameson's red rock rabbit are important prey species to predators in this habitat type. Other typical nocturnal animals which may occur in this habitat type include large spotted genet, small spotted genet, and species with a wide habitat tolerance such as porcupine.

4.4.2 Habitat B: Mixed woodland associated with plains and valleys

The woodland area of the lower-lying plains and open valleys play an important role as habitat for various generalized fauna species. Birds and arboreal reptiles would utilize the larger trees species for breeding, roosting and foraging, while smaller mammals such as rodents will utilize the areas with a denser grass layer.

4.4.3 Habitat C: Open water habitat types (wetlands; rivers) and riparian woodland

Wetlands, open water habitats and riparian woodland also form fragmented and specialised habitats. They are essential breeding grounds for many frogs, and serve as feeding grounds for threatened cranes, other waterbirds, otters and numerous frog-eating snakes. They are easily impacted by water abstraction for commercial farming, siltation from soil erosion caused by overgrazing, pollution from urban sewage, insecticide and herbicide run-off from agricultural lands, and petroleum spillage on roads. With burgeoning human populations, isolated yet essential water sources are under increasing pressure.

The open water habitat type is associated with the perennial rivers and dams in the project area. The shallow water habitat that occurs along the dam shores and rivers throughout the year is more suitable for waterbirds that forage along its banks. Threatened birds prefer these dense

habitat types associated with riparian woodland in the area. The riparian woodland along the banks of the riverine systems is important habitat for various birds, mammals and Herpetofauna (reptiles and amphibians).

4.5 Common fauna documented and potentially occurring in the project area

As a result of anthropogenic disturbance in the larger area and the limitations created by game fences, only the most tolerant generalists of the larger vertebrates still occur in the project area outside the nature reserves. Examples are grey duiker, bushbuck, steenbok and baboon. The more sensitive habitat-specialist species like honey badger, leopard, brown hyena and caracal have retreated into areas of lower disturbance such as the surrounding ridges and riparian woodland.

4.5.1 Mammals

Large mammals that occurred historically at the site, are absent from the area, owing to anthropogenic impacts in recent centuries. This loss of large species means that the mammal diversity at the site is far from its original natural state not only in terms of species richness but also with regards to functional roles in the ecosystem.

Large predators that still roam freely in the area include leopard and brown hyena (red data). Antelope species such as kudu, bushbuck and duiker might potentially migrate through the area and are not restricted by game fences. Smaller mammal species such as honey badgers and serval can become habituated to anthropogenic influences, while other species such as brown hyena will rather move away from the construction activities and will seldom use the area. The dominant species composition therefore comprises of widespread taxa with some species having specialised life history traits.

Most mammal species are highly mobile and will move away during construction. The impact will also be low if one compares the footprint of the development and the overall range of individual species. It is therefore considered highly unlikely that the species will be affected negatively by the development of the proposed mining.

The connectivity1 of the project site is excellent. Of significance is the role of the river and riparian zone as zoogeographical dispersal corridors.

4.5.2 Birds (avifauna)

Four major bird habitat systems were identified within the borders of the study site, including

1 C**onnectivity (habitat connectivity)** - Allowing for the conservation or maintenance of continuous or connected habitats, so as to preserve movements and exchanges associated with the habitat.

riparian vegetation, microphyllous woodland, broadleaf woodland and degraded grassland.

The riparian vegetation consists of non-perennial river system with riparian vegetation and grassland along slopes where channels are narrow. The river systems are non-perennial though and therefore waterbirds will only periodically utilize this area for foraging. Due to the nature of the river, fish are not likely to occur in it and birds that feed on fish thus won't be attracted to the site. Frogs might occur during the summer months in the pools and small dams will attract bird species such as Hadeda, herons and hamerkops. The dominant vegetation within the riparian zone includes/consists of large Acacia and broadleaved trees, which grow taller due to the availability of water when compared to trees further away from the river. The largest surface area on site consists of woodland. Acacia trees generally attract many insects and in turn attract a good diversity of typical Acacia savanna bird species. The ground cover between the trees consists of mainly short grasses interspersed with shrubs. This riparian vegetation will favour bird species typically associated with a bushveld habitat.

Microphyllous woodland usually supports much higher bird numbers compared to the broadleaved woodlands. The area represents microphyllous woodland and supports many smaller bird species such as Ashy Tit, Pied Babbler, Burntnecked Eremomela, Marico Flycatcher, PriritBatis, Crimsonbreasted Shrike, Longtailed Shrike, Whitebrowed Sparrowweaver, Scalyfeathered Finch, Violeteared Waxbill and Blackfaced Waxbill.

The broadleaved woodland occurring in the study area has quite a higher diversity of birds as a result of the crossover of habitats. Typical examples of broad-leaved-woodland birds are Pallid Flycatcher, Greencapped Eremomela and White-bellied Korhaan.

Degraded grasslandss (including old fields) sometimes cover extensive areas, and have become an artificial habitat that attracts a wide range of generalist species. Old fields represents a significant feeding area for many bird species in any landscape for the following reasons: through opening up the soil surface, land preparation makes many insects, seeds, bulbs and other food sources suddenly accessible to birds and other predators; the grasses are often eaten themselves by birds, or attract insects which are in turn eaten by birds.

4.5.2.1 Herpetofauna (Reptiles and Amphibians)

Species such as the southern rock python, the black mamba, puff adder, boomslang, vine snake, spotted bush snake and several members of the green snakes (*Philothamnus* spp.) is expected to occur in the study area., although the presence of these snakes is dependant on the presence of their prey species (rodents, frogs etc.). The general habitat type for reptiles consists of open

shrubveld to denser bushveld. Arboreal species are the more prominent components of the local herpetofauna. However, the following conservation actions should be considered as part of the development to ensure that the pythons are not impacted on:

- Protection of optimal habitats (riverine woodland; rocky habitats) in the surrounding area of the developments;
- Individual pythons found on site could be relocated to reserves in ther area;
- Conservation Education and Awareness Creation for local communities: All efforts must be made to promote conservation education and awareness creation on the need to reduce hunting/poaching at all levels whereby, decision makers, general public, schools and local communities must be carried along;
- Employment and Alternative Employment: The creation and provision of employment, alternative employment opportunities to the teeming populations of unemployed youths, hunters and poachers will go a long way to discourage poachers, hunters, etc. from continuing in their trade which results directly in pet animals which end up in the international markets or intercepted once in a long while in transit.

The amphibians appear to be poorly represented on site. The most probable habitat to find frogs is in the seasonal pools associated with the drainage channels although this do not represent optimal habitats due to a lack of breeding habitat and water plants which will attract insect for foraging. The riparian zone of the drainage channels probably harbours a number of amphibian species but no particular hotspot for amphibian diversity is known from the site.

4.5.2.2 Invertebrates

Insects and spiders are very good indicators of the plant diversity and ecological sensitivity of an area. Butterflies can be used in the field as indicators of biodiversity. An insect and spider desktop survey was done in addition to the field observations. All of the potential invertebrate habitats are well represented by a high family richness of insects and spiders. Spiders occur throughout all the habitats, and both web builders and active hunters find their ways in trapping and actively hunt around for potential food.

The plants and associated invertebrate assemblages of the Sekhukhune Centre of Endemism (SCE) remain poorly known; high levels of floral endemism are evident from recent research. One example of restricted, endemic invertebrates that are likely to utilize the study area as habitat is the cicada, *Pycna sylvia* (Distant, 1899). It was collected from the Groot Dwars River Valley in

November 2001 (Transvaal Museum). It was the first time the species was collected in 95 years. The distribution range of *P. sylvia* extends across the Groot Dwars River Valley, the Klein Dwars River Valley and areas of natural vegetation in the Roossenekal – Steelpoort district along the R555 road. The proposed development sites include potential habitat for *P. sylvia* based on the presence of its host plant *Vitex obovata subspecies wilmsii* and also habitat for many of the Red Data species listed in Table 15.

Apparently *Pycna sylvia* is mostly found at or in the vicinity of dense stands of the host plant (Malherbe, Burger & Stephen, 2004). This tree was observed to be fairly widespread in the local area but also in larger areas in the region. At the site *Vitex obovata* subsp. *wilmsii* is widely scattered and individuals often appear stunted and not large. The site does not appear to be ideal habitat for the cicada. The Vitex obovate plants occur at a low density in the area and the impact on *P. Sylvia* is therefore considered as Low.

4.6 Red data fauna

Some red data fauna do potentially occur in the vicinity of the proposed mining upgrades, especially in the natural riparian woodland areas, natural woodland and outcrops. Table 15 below lists potential red data species occurring in the study area.

Table 15. Red data fauna species potentially occurring in the study area

English Name	Conservation Status	Probability of occurrence on site
BIRDS		
Falcon, Lanner	Vulnerable	Medium
Ibis, Southern Bald	Vulnerable	Low
Vulture, Cape	Endangered	Medium
MAMMALS		
African weasel	Near threatened	Low
Brown Hyena	Near threatened	Low
Dark-footed forest shrew	Vulnerable	Low
Pangolin	Vulnerable	Low
Serval	Near threatened	Low
South African Hedgehog	Near threatened	Medium
Spotted necked otter	Vulnerable	High
Water Rat	Near threatened	High
Welwitsch's Hairy Bat	Near threatened	Medium
HERPETOFAUNA		
South African Python	Vulnerable	Medium
INVERTEBRATES		
Pycna syliva	Endemic	High

The following impacts might occur during the development phase on fauna populations of the area:

- Destruction/permanent loss of individuals of rare, endangered, endemic and/or protected species through habitat loss or fragmentation.
- Disturbance of remnant terrestrial wild mammal, avian, amphibian and insect fauna would probably occur through physical habitat destruction, noise, traffic and movement of people.
- Potential increase in feral animals and impact on indigenous fauna e.g. cats, rats.
- Illegal hunting or disturbance

The following management measures are proposed regarding the conservation of these and other fauna which might occur on the property:

- The development would not have a significant impact on the above-mentioned red data fauna since adequate and natural habitat/vegetation would be available on the peripheral grassland and mountainous areas outside the study area. The most probable habitat to find any of the red data species in the study area would be in the more natural areas of the mountainous regions and ravines. Most of the site do not represent suitable habitat considering the anthropogenic influences in the area and the degraded state of the vegetation in general. Fauna will therefore rather move away from the area and utilize adjacent, more natural areas.
- The removal of vegetation should be confined to the footprints of the mining areas. This will be on small sections in relation to the total available surrounding habitat for fauna. Development also won't influence the natural feeding and movement patterns of the existing fauna in the area.
- If one considers the habitat descriptions of the red data species, most of them are not directly threatened by habitat loss. The impact of development on the red data species would therefore be less than predicted.
- The protection of different habitat types in the area will be important to ensure the survival of the different animals due to each species' individual needs and requirements. Sufficient natural corridor sections should be protected around the proposed development footprints to allow fauna to move freely between the different vegetation units on the property. The drainage channels still represent highly sensitive areas in the area and mitigation measures should be implemented to ensure that the habitats are

protected.

- The few taller (>3m) indigenous trees within this area provide resting/perching sites for larger birds like vultures, birds of prey, arboreal reptiles and mammals that might occur/pass through the area and should be preserved. The larger trees should be protected as far as possible and be incorporated into the proposed development.

  The removal of large dead trees is not advised as these trees provide smaller habitats for bat species as well as rodents. The grass layer on the other hand also provides a valuable food source (insects, reptiles, small mammals that occur in/on the grass layer) for fauna.

- A monitoring programme needs to be implemented by a specialist if any rare species are confirmed on the property.

The following practical recommendations with regard to the fauna of the area apply with regards to the construction of the road upgrades:

- Where trenches pose a risk to animal safety, they should be adequately cordoned off to prevent animals falling in and getting trapped and/or injured. This could be prevented by the constant excavating and backfilling of trenches during road upgrades construction.
- No animals may be poached. Many animals are protected by law and poaching or other interference could result in a fine or jail term.
- Do not feed any wild animals on site.
- Poisons for the control of problem animals should rather be avoided since the wrong use thereof can have disastrous consequences for the raptors occurring in the area. The use of poisons for the control of rats, mice or other vermin should only be used after approval from an ecologist.
- Roads in the area should be designed without vertical pavements to allow for the movement of small mammals. Small culverts underneath the road could provide easy migration of smaller fauna.
- Waste bins and foodstuffs should be made scavenger proof.

Monitoring of the environmental aspects is recommended for the future phases of the proposed development should the authorities approve the application. The monitoring phase would ensure that negative impacts on the fauna and flora of the area are limited to a minimum during the construction phase.

5 DISCUSSION OF IMPACTS ON FLORA AND FAUNA FOR DIFFERENT MINING PHASES

The objective of this section was to identify impacts and provide a list of actions and potential impacts associated with the various mining phases namely the planning and design phase, construction phase, operational phase, decommission phase and closure phase for the various mining components:

- Waste Storage facilities;
- Waste rock dumps;
- Pollution Control Dams;

5.1 PLANNING AND DESIGN PHASE

Planning and design is necessary to ensure that mitigation and impact management can be effectively implemented and minimise impacts in the future. The planning and design phase of the mine will involve the following actions:

- Obtaining of flora species permits (if relevant);
- Avoidance of sensitive habitats through identification of alternatives;

No specific direct impacts will occur on the fauna and flora of the area during the planning and design phase.

5.2 CONSTRUCTION PHASE

The development and start-up of the waste storage facilities cover the period of time when considerable changes take place as the mine infrastructure are constructed. The most immediate impacts are seen as disruptions and disturbances to flora communities due to site clearance for construction of the WSF, PCDs and WRDs. This is usually a significant change to the visual appeal of the area.

Exposure of rocks, ore and soils to rainfall and wind may lead to atmospheric contamination by dusts and increased erosion of the site as well as sedimentation of local water courses. An increase in the movement of construction vehicles will result in an increase in the dust levels in the area.

The following impacts will occur during the Construction Phase of the proposed Glencore Eastern Mines Expansion Project:

- The construction phase of the mining development will result in loss of and damage to natural habitats if the vegetation is cleared for the development of infrastructure (WSF and sections of the WRD). Rehabilitation of some areas would be possible but there is

likely to be long-term damage in large areas. Most habitat destruction will occur during the construction phase. Vegetation communities are likely to be impacted on a very small spatial scale in comparison to the extent of the vegetation communities' total area in the region;

- The mining development will inevitably result in natural movement patterns being disrupted and, to a varying degree depending on how different species react to these barriers will result in the fragmentation of natural populations. The fencing of the mining area and construction of mining infrastructure will have a large, significant impact in fragmenting the habitats on and around the site.
- The construction activities associated with the mining developments may result in widespread soil disturbance and is usually associated with accelerated soil erosion. Soil erosion promotes a variety of terrestrial ecological changes associated with disturbed areas, including the establishment of alien invasive plant species, altered plant community species composition and loss of habitat for indigenous flora;
- Construction work of the magnitude contemplated for the proposed development will always carry a substantial risk of soil and water pollution, with large construction vehicles contributing substantially due to oil and fuel spillages. If not promptly dealt with, spillages or accumulation of waste matter can contaminate the soil and surface or ground water, leading to potential medium/long-term impacts on the flora of the site;
- The environmental impacts of wind-borne dust, gases and particulates from the construction activities associated with the proposed development will have an impact on the vegetation of the area when dust settles on plant material reducing the amount of light reaching the chlorophyll in the leaves, thereby reducing photosynthesis, which in turn reduces plant productivity, growth and recruitment;
- Continued movement of personnel and vehicles on and off the site during the construction phase, as well as occasional delivery of materials required for maintenance, will result in a risk of importation of alien species. Vehicles often transport many seeds and some may be of invader species, which may become established along the road, especially where the area is disturbed. The construction almost certainly carries by far the greatest risk of alien invasive species being imported to the site, and the high levels of habitat disturbance also provide the greatest opportunities for such species to establish themselves, since most indigenous species are less tolerant of disturbance. The biggest risk is that seeds of noxious plants may be carried onto the site along with

materials that have been stockpiled elsewhere at already invaded sites.

- Disturbance of remnant terrestrial wild mammal, avian, amphibian and insect fauna would probably occur through physical habitat destruction, noise, traffic and movement of people. The impact of the construction would be MODERATE considering that animals would move away from the area, while some ground-burrowing species such as moles and reptiles might be killed in the process. There are however no specific red data species that would be critically impacted on by the constructional phase.
- Potential increase in feral animals and impact on indigenous fauna e.g. cats, rats.
- Illegal hunting or disturbance.
- Operation or disturbance during breeding season can precipitate long-term cumulative effect on populations.

The following impacts on the flora and fauna apply to both aspects of the Glencore Eastern Mines Expansion Project for the various components during the construction phase:

5.2.1 Waste Storage facility (Co-disposal)

- **Activity 1:** Vegetation clearing
- **Related impacts**
  - Habitat destruction or disturbance to ecosystems leading to reduction in the overall extent of a particular habitat;
  - Fragmentation of fauna habitats;
  - Potential establishment and spread of declared weeds and alien invader plants
- **Activity 2:** Topsoil and subsoil stripping
- **Related impacts**
  - Increased Soil erosion and sedimentation;
  - Habitat degradation due to dust;
- **Activity 3: Vehicle movement**
  - Spillages of harmful substances to the ecosystem;
  - Habitat degradation due to dust;
  - Road mortalities of fauna

5.2.2 Waste rock dumps

- **Activity 1:** Vegetation clearing

- **Related impacts**
    - Habitat destruction or disturbance to ecosystems leading to reduction in the overall extent of a particular habitat;
    - Fragmentation of fauna habitats;
    - Potential establishment and spread of declared weeds and alien invader plants
- **Activity 2:** Topsoil and subsoil stripping
    - Increased Soil erosion and sedimentation;
    - Habitat degradation due to dust;
- **Activity 3: Vehicle movement**
    - Spillages of harmful substances to the ecosystem;
    - Habitat degradation due to dust;
    - Road mortalities of fauna

5.2.3 Cumulative Impact

The cumulative impacts associated with the construction phase are the same as discussed above for the different mining components. The rating will be higher compared to the individual component ratings as the landscape scarring of are permanent features affecting the species diversity and composition of the general vegetation patterns of the study area.

5.3 OPERATIONAL PHASE

The routine operational phases account for most of the environmental impacts associated with mining and are considered to have the greatest potential to drive environmental change. The extent to which mining operational activities act as drivers of environmental change depends in part on the type, scale, duration and magnitude of the activities, and the sensitivity of the receiving environment.

The removal and storage (stockpiling) of ore in the operational phase is usually the most intensive activity on any mine operation. These activities are characterized by large-scale disturbance due to noise and generation of dust from the movement of vehicles and possible wind-blown dust from stockpiles at the recovery plant.

Typical activities of the operational phase will include:

- Processing of ore in the processing plant (already constructed);
- Storage of tailings (WSF height is approx. 45 m.)

- Disposal of waste rock on WRD;
- Transporting of people and equipment;
- Transportation of product off-site;
- Transportation of supplies to the site;
- Handling and storage of hazardous materials and substances;
- Domestic waste generation, storage and disposal;
- Water storage facilities;
- Hazardous waste storage and disposal;

A short description of the impacts associated with the operational phase is included below:

- The operational phase of the mine will have a very low impact on the vegetation of the proposed mining development site. Considering that most infrastructure (plant etc.) have already been constructed during this mining phase, the only impacts that might create habitat disturbance or loss of plant communities might be loss of plant communities and flora species of significance on the laydown areas of the waste rock and stockpiles that used to represent natural vegetation communities.
- The spread of alien invasive plants on site is more intense during the operational phase of the mine due to the movement of vehicles over an extended area on and from the site, causing a higher risk of potentially spreading the seeds or vegetative material from invasive species. Although construction creates the suitable conditions for establishment of invasive species, the operational phase certainly carries by far the greatest risk of alien invasive species being spread through the area and even through the wetland systems to the greater region. This risk is further influenced by increased run-off as a result of exposed areas and hardened surfaces created during the construction phase of the mine.
- The increased hardened surfaces around infrastructure and exposed areas created alongside the roads and additional surface areas created on the slopes of the stockpiles and waste rock dumps will have a definite impact on the potential erosion of exposed areas that will eventually cause sedimentation in the wetlands and streams of the area. Soil erosion promotes a variety of terrestrial ecological changes associated with disturbed areas, including the establishment of alien invasive plant species, altered plant community species composition and loss of habitat for indigenous flora.

- During the operational phase heavy machinery and vehicles as well as sewage and domestic waste would be the main contributors to potential pollution problems.
- The impact of the operational phase of the mine relates more to the habitat loss of fauna as a result of specific mining activities. Furthermore, developments can threaten migration routes or flight paths as a result of noise and dust pollution. Cumulative impact of illegal collecting, road kills or power line related deaths reduce population viability in the long-term. Some mining related habitats also favour species leading to un-natural competition with endemic fauna. Much of the impacts of the fauna related to the construction phase of the mining development also apply to the operational phase of the mine.

The following impacts on the flora and fauna apply to both the Glencore Eastern Mines Expansion Project for the various components during the operational phase:

5.3.1 Waste rock dumps and Waste Storage Facilities (WSF)

- **Activity 1: Stockpiling of waste rock**
- **Related impacts**
    - Habitat destruction or disturbance to ecosystems leading to reduction in the overall extent of a particular habitat;
    - Fragmentation of fauna habitats;
    - Potential establishment and spread of declared weeds and alien invader plants;
    - Spillages of harmful substances to the ecosystem;
    - Increased Soil erosion and sedimentation (increased runoff from laydown areas);
    - Habitat degradation due to dust;
- **Activity 2: Materials handling and storage**
    - Spillages of harmful substances to the ecosystem;
    - Habitat degradation due to dust;
    - Road mortalities of fauna
- **Activity 3: Disposal of tailings:**
    - Spillages of harmful substances to the ecosystem;

5.3.2 Support infrastructure

- **Activity 1: Materials handling and storage**

- Spillages of harmful substances to the ecosystem;
- Habitat degradation due to dust;
- Road mortalities of fauna

- **Activity 2: Storm water management:**
  - Increased Soil erosion and sedimentation;
- **Activity 3: Vehicle movement during construction of surface infrastructureand access road**
  - Spillages of harmful substances to the ecosystem;
  - Habitat degradation due to dust;
  - Road mortalities of fauna

5.3.3 Cumulative Impact

The cumulative impacts associated with the operational phase are the same as discussed above for the different mining components. The rating will be higher compared to the individual component ratings, especially if one considers that water extraction and dust pollution will be increased through the operation of the mines. This will contribute to a loss of diversity and species composition over the larger area of the Vegetation Type. Cumulative effects only become critical if there are no other suitable habitats in the adjacent areas.

5.4 DECOMMISION PHASE

This phase starts when all the economically exploitable mineral reserves in an area have been extracted. The actions which mark this phase include:

- Cessation of mining;
- Removal of mine infrastructure;
- Backfilling of the mined out areas

The only major impacts on the vegetation during this phase would be the potential increased invasion of alien species and weeds on the cleared areas, while the risks of spreading fires will also still exist. Otherwise, there should be no further negative impact on surrounding vegetation during decommissioning.

5.4.1 Support infrastructure

- **Activity 1: Demolition of mining infrastructure**
- **Related impacts**

- Potential establishment and spread of declared weeds and alien invader plants;
- Spillages of harmful substances to the ecosystem;
- Habitat degradation due to dust;
- Road mortalities of fauna

5.4.2 Cumulative Impact

The cumulative impacts associated with the decommissioning phase are the same as discussed above for the different mining components.

5.5 CLOSURE PHASE

The closure phases of the mine involve rehabilitation actions to mitigate impacts caused during the construction and operational phase of the mine. Some of the rehabilitation actions include the following:

- Ripping and rehabilitation of all haul roads;
- Rehabilitation of the WSF and WRD;
- Seeding of ripped and rehabilitated surfaces;

Amongst the more pronounced post-closure impacts on flora are landscape scarring in the form of unrehabilitated mine facilities, discard dumps as well as continuing environmental damage from wind-blown dusts and the dispersal of contaminated solid waste. If mitigation measures are correctly implemented there should be not be any further significant impact on the surrounding natural vegetation after closure though.

The following impacts are associated with the closure phase of the mine:

- Soil compaction is likely to occur over much of the rehabilitated area as a consequence of the storage and placement of soil and the change in structure following replacement. The poor soil cover associated with the cleared areas, stockpiles and WRD also renders the site more susceptible to erosion and soil loss. It is probable that these soils will be transferred through the rehabilitated landscape into the draining water courses and receiving water bodies as described earlier. The rehabilitation of the site and decreased surfaces will however still reduce the risk of erosion and sedimentation carried into the wetlands and rivers during the closure phase, compared to the other phases;
- During the closure phase of the mine the risk of spillages are still pertinent, although the impact will mainly be limited to potential spillages from vehicles. The impact will therefore be greatly reduced as a result of concurrent rehabilitation;

- Dust generation can temporarily increase during closure phases of the mine. This is due to rehabilitation activities. During this phase, the impacts should last for a short period. The impact of dust on the vegetation will however be at a reduced intensity during the closure phase compared to the construction and operational phases of the mine as a result of the rehabilitation measures. The revegetation of exposed areas will play a major role in this regard.
- The control of alien invasive species will be more pertinent during the closure phase of the mine and the risk of spreading is therefore reduced. Although the movement of vehicles on site during rehabilitation will still have a potential impact on the spreading of alien invasive species, the intensity of spread of alien invasive plants on site is more intense during the operational phase of the mine due to the movement of vehicles over an extended area on and from the site, causing a higher risk of potentially spreading the seeds or vegetative material from invasive species;
- The impact on fauna mortality will continue during the closure phase as a result of rehabilitation activities on site.

5.5.1 WRD, and WSF

- **Activity 1: Rehabilitation**
- **Related impacts**
    - Positive impact through habitat improvement in rehabilitated areas;
    - Potential establishment and spread of declared weeds and alien invader plants;
    - Spillages of harmful substances to the ecosystem;
    - Habitat degradation due to dust;
    - Road mortalities of fauna

5.5.2 Support infrastructure

- **Related impacts**
    - Positive impact through habitat improvement in rehabilitated areas;
    - Potential establishment and spread of declared weeds and alien invader plants;
    - Spillages of harmful substances to the ecosystem;
    - Habitat degradation due to dust;
    - Road mortalities of fauna

5.5.3 Cumulative Impact

The impacts associated with the rehabilitation of the mining sites are positive considering that the rehabilitated land will improve habitats in the area, even though it still represent degraded land.

6 QUANTITATIVE IMPACT ASSESSMENT

Table 16 indicate the impacts described above and specific ratings of significance the impact will potentially have on the ecosystem during the proposed mining activities according to the layout plan of the mining development:

Table 16. Quantitative impact assessment for the various mining components and mining phases

Nr	Impact	Activity	Without or With Mitigation	Nature (Negative or Positive Impact)	Probability		Duration		Scale		Magnitude/ Severity		Significance		Mitigation Measures	Mitigation Effect
					Magnitude	Score	Magnitude	Score	Magnitude	Score	Magnitude	Score	Score	Magnitude		
Planning Phase																
1	Delay of mining onset	Eradication of protected trees / flora through permit application	**WOM**	**Negative**	Definite	5	Short term	1	Local	1	Low	2	20	Negligible	Apply and obtain permits from DAFF after liaison with relevant officials and site visit to the area	Can be avoided, managed or mitigated
			WM	**Negative**	Highly Probable	4	Short term	1	Local	1	Low	2	16	Negligible		Can be reversed
Construction Phase																
2	Habitat destruction / fragmentation of fauna habitats	Clearing of vegetation for construction of infrastructure, access roads etc. causing direct habitat destruction / fragmentation	**WOM**	Negative	Definite	5	Permanent	5	Local	1	High	8	70	High	Refer to Table 17	May cause irreplaceable loss of resources
			WM	Negative	Definite	5	Permanent	5	Local	1	Medium	6	60	Moderate		Can be avoided, managed or mitigated
3	Soil erosion and sedimentation	Topsoil & subsoil stripping, exposure of soils, ore and rock to wind and rain during construction causing erosion and sedimentation	**WOM**	Negative	Definite	5	Long term	4	Site	2	Medium	6	60	Moderate	Refer to Table 17	May cause irreplaceable loss of resources
			WM	Negative	Highly Probable	4	Long term	4	Local	1	Low	2	28	Low		Can be avoided, managed or mitigated
4	Spreading and establishment of alien invasive species	Vegetation clearing / vehicle movement	**WOM**	Negative	Highly Probable	4	Permanent	5	Site	2	High	8	60	Moderate	Refer to Table 17	May cause irreplaceable loss of resources
			WM	Negative	Highly Probable	4	Long term	4	Site	2	Low	2	32	Low		Can be reversed
5	Habitat degradation due to dust	Vegetation clearing / vehicle movement	**WOM**	Negative	Definite	5	Long term	4	Regional	3	High	8	75	High	Refer to Table 17	May cause irreplaceable loss of resources
			WM	Negative	Definite	5	Long term	4	Site	2	Medium	6	60	Moderate		Can be reversed
6	Spillages of harmfull substances	Heavy machinery and vehicle movement on site	**WOM**	Negative	Highly Probable	4	Permanent	5	Site	2	High	8	60	Moderate	Refer to Table 17	May cause irreplaceable loss of resources
			WM	Negative	Highly Probable	4	Long term	4	Site	2	Low	2	32	Low		Can be reversed
7	Road mortalities of fauna / impact of human activities on site	Heavy machinery and vehicle movement on site; Construction of infrastructure, roads etc. on site	**WOM**	Negative	Highly Probable	4	Long term	4	Regional	3	Medium	6	52	Moderate	Refer to Table 17	May cause irreplaceable loss of resources
			WM	Negative	Probable	2	Medium term	3	Site	2	Low	2	14	Negligible		Can be avoided, managed or mitigated
Operational Phase																
8	Habitat destruction / fragmentation of fauna habitats	Storage of waste, laydown areas of WRDs and stockpiles	**WOM**	Negative	Definite	5	Permanent	5	Local	1	High	8	70	High	Refer to Table 17	May cause irreplaceable loss of resources
			WM	Negative	Definite	5	Permanent	5	Local	1	Medium	6	60	Moderate	Refer to Table 17	Can be avoided, managed or mitigated
9	Soil erosion and sedimentation	Increased hardened surfaces around infrastructure and exposed areas around laydown areas of WRDs and stockpiles as well as WSF	**WOM**	Negative	Definite	5	Long term	4	Site	2	High	8	70	High	Refer to Table 17	May cause irreplaceable loss of resources
			WM	Negative	Highly Probable	4	Long term	4	Site	2	Medium	6	48	Moderate	Refer to Table 17	Can be avoided, managed or mitigated
10	Spreading and establishment of alien invasive species	Heavy machinery and vehicle movement on site	**WOM**	Negative	Highly Probable	4	Permanent	5	Site	2	Medium	6	52	Moderate	Refer to Table 17	May cause irreplaceable loss of resources
			WM	Negative	Highly Probable	4	Long term	4	Site	2	Low	2	32	Low	Refer to Table 17	Can be reversed
11	Habitat degradation due to dust	Heavy machinery and vehicle movement on site	**WOM**	Negative	Definite	5	Long term	4	Regional	3	High	8	75	High	Refer to Table 17	May cause irreplaceable loss of resources

Nr	Impact	Activity	Without or With Mitigation	Nature (Negative or Positive Impact)	Probability		Duration		Scale		Magnitude/ Severity		Significance		Mitigation Measures	Mitigation Effect
			WM	Negative	Definite	5	Medium term	3	Site	2	Medium	6	55	Moderate	Refer to Table 17	Can be reversed
12	Spillages of harmfull substances	Heavy machinery and vehicle movement on site	**WOM**	Negative	Highly Probable	4	Long term	4	Regional	3	Medium	6	52	Moderate	Refer to Table 17	May cause irreplaceable loss of resources
			WM	Negative	Probable	2	Medium term	3	Site	2	Low	2	14	Negligible	Refer to Table 17	Can be reversed
13	Road mortalities of fauna / impact of human activities on site	Heavy machinery and vehicle movement on site; workers accommodated on site causing poaching, wood collection, fires etc.	**WOM**	Negative	Highly Probable	4	Long term	4	Regional	3	Medium	6	52	Moderate	Refer to Table 17	May cause irreplaceable loss of resources
			WM	Negative	Probable	2	Medium term	3	Site	2	Low	2	14	Negligible	Refer to Table 17	Can be avoided, managed or mitigated
Closure and Decommissioning Phase																
13	Improvement of habitat through revegetation / succession over time	Rehabilitation of mining site	**WOM**	Positive	Highly Probable	4	Long term	4	Local	1	Low	2	28	Low +	Refer to Table 17	Can be avoided, managed or mitigated
			WM	Positive	Definite	5	Permanent	5	Local	1	Medium	6	60	Moderate +	Refer to Table 17	Can be reversed
	Soil erosion and sedimentation	Demolition of mining infrastructure / Cessation of mining / rehabilitation of mining site	**WOM**	Negative	Highly Probable	4	Long term	4	Site	2	Medium	6	48	Moderate	Refer to Table 17	May cause irreplaceable loss of resources
			WM	Negative	Probable	2	Medium term	3	Local	1	Low	2	12	Negligible	Refer to Table 17	Can be avoided, managed or mitigated
14	Spreading and establishment of alien invasive species	Demolition of mining infrastructure / Cessation of mining / rehabilitation of mining site	**WOM**	Negative	Highly Probable	4	Long term	4	Site	2	Medium	6	48	Moderate	Refer to Table 17	May cause irreplaceable loss of resources
			WM	Negative	Probable	2	Medium term	3	Site	2	Low	2	14	Negligible	Refer to Table 17	Can be reversed
	Habitat degradation due to dust	Demolition of mining infrastructure / Cessation of mining / rehabilitation of mining site / vehicle movement on site	**WOM**	Negative	Highly Probable	4	Long term	4	Site	2	High	8	56	Moderate	Refer to Table 17	May cause irreplaceable loss of resources
15			**WM**	Negative	Probable	2	Medium term	3	Site	2	Medium	6	22	Low	Refer to Table 17	Can be reversed
	Spillages of harmfull substances	Heavy machinery and vehicle movement on site	**WOM**	Negative	Highly Probable	4	Medium term	3	Regional	3	Medium	6	48	Moderate	Refer to Table 17	May cause irreplaceable loss of resources
16			**WM**	Negative	Probable	2	Short term	1	Site	2	Low	2	10	Negligible	Refer to Table 17	Can be avoided, managed or mitigated
	Road mortalities of fauna / impact of human activities on site	Heavy machinery and vehicle movement on site	**WOM**	Negative	Highly Probable	4	Long term	4	Regional	3	Medium	6	52	Moderate	Refer to Table 17	May cause irreplaceable loss of resources
17			**WM**	Negative	Probable	2	Medium term	3	Site	2	Low	2	14	Negligible	Refer to Table 17	Can be avoided, managed or mitigated
Post-Closure Phase																
	Improvement of habitat through revegetation / succession over time	Natural Successional processes	**WOM**	Positive	Highly Probable	4	Long term	4	Local	1	Low	2	28	Low +	Refer to Table 17	Can be avoided, managed or mitigated
18			**WM**	Positive	Definite	5	Permanent	5	Local	1	Medium	6	60	Moderate +	Refer to Table 17	Can be reversed
	Soil erosion and sedimentation	Exposed surfaces / unrehabilitated areas on site post closure / poor monitoring during LoM	**WOM**	Negative	Highly Probable	4	Medium term	3	Site	2	Medium	6	44	Moderate	Refer to Table 17	May cause irreplaceable loss of resources
19			**WM**	Negative	Probable	2	Short term	1	Local	1	Low	2	8	Negligible	Refer to Table 17	Can be avoided, managed or mitigated
	Spreading and establishment of alien invasive species	Exposed surfaces / poor monitoring of revegetation on site	**WOM**	Negative	Highly Probable	4	Medium term	3	Site	2	Medium	6	44	Moderate	Refer to Table 17	May cause irreplaceable loss of resources
20			**WM**	Negative	Probable	2	Short term	1	Local	1	Low	2	8	Negligible	Refer to Table 17	Can be avoided, managed or mitigated

7 ECOLOGICAL MANAGEMENT PLAN AND MITIGATION MEASURES FOR THE PROPOSED GLENCORE EASTERN MINES EXPANSION PROJECT

A management system has been developed to comply with the objectives and principles set out in this document. This system is based on the principle of managing the potential environmental impacts using the best available technology, not entailing excessive cost. In this way, the technology is effective, but does not seriously impair economic stability of the development. Management measures required for the different phases of the mine which relates to biodiversity is presented in Table 17 below.

Table 17. Ecological Management Plan to be implemented as part of the Environmental Management Programme Report for the Glencore Eastern Mines Expansion Project

Components	Activity	Aspect	Impact	Legal requirements	Objectives	Performance criteria	Mitigation Measures	Time frame	Responsible person
Flora and Fauna Planning and Design phase									
Pre-mining	Eradication of protected trees / flora through permit application	Flora	Eradication of protected trees / red data species	Section 15(1) of the National Forests Act, 1998	Obtain permits for the eradication of protected trees	Application forms completed as obtained from DAFF regarding specific species, numbers of trees and ecological conditions of the site	Apply and obtain permits from DAFF and LEDET after liaison with relevant officials	2 months	Ecologist / Environmental Assessment Practitioner (EAP)
Construction Phase									
Support infrastructure, WSF and WRD	Clearing of vegetation	Fauna & Flora	Habitat destruction	NEMA Regulation 543 Section 32 NEMBA Section 56 (1), 57 (1), 57 (2) and 57 (4) Limpopo Environmental Management Act	• Prevent edge effects • Keep mining development footprint restricted to layout plans • To limit the habitat loss due to the increase of the mining footprint	Keep mining development footprint restricted to layout plans	• The removal of the isolated indigenous trees and shrubs should only occur on the construction footprint area of the development and not over the larger area. Where possible, vegetation should be retained in between infrastructural elements associated with the project; • Conduct flora species search and rescue efforts before ground clearing begins in order to reduce negative impacts on species of concern; • Remove and relocate any plants of botanical or ecological significance as indicated by the ecologist or Environmental Control Officer (ECO); • Clearly demarcate the entire development footprint prior to initial site clearance and prevent construction personnel from leaving the demarcated area; • Monitoring should be implemented during the construction activities to ensure that minimal impact is caused to the flora of the area; • The ECO should advise the construction team in all relevant matters to ensure minimum destruction and damage to the environment. The ECO should enforce any measures that he/she deem necessary. Regular environmental training should be provided to construction workers to ensure the protection of the habitat, fauna and flora and their sensitivity to conservation; • Where trenches pose a risk to animal safety, they should be adequately cordoned off to prevent animals falling in and getting trapped and/or injured. This could be prevented by the constant excavating and backfilling of trenches during construction. • Poisons for the control of problem animals should rather be avoided since the wrong use thereof can have disastrous consequences for the raptors occurring in the area. Poisons for the control of rats, mice or other vermin should only be used after approval from an ecologist.	Continuous	Contractor / ECO
Support infrastructure, WSF and WRD	Clearing of vegetation	Fauna	Habitat fragmentation	NEMA Regulation 543 Section 32 NEMBA Section 56 (1), 57 (1), 57 (2) and 57 (4) Limpopo Environmental Management Act	• To limit the impact on wildlife habitat • To limit the loss in carrying capacity • To prevent negative impact on fauna populations through infrastructure development	Keep mining development footprint restricted to layout plans	• Use existing facilities (e.g., access roads, parking lots, graded areas) to the extent possible to minimize the amount of new disturbance. • Ensure protection of important resources by establishing protective buffers to exclude unintentional disturbance. All possible efforts must be made to ensure as little disturbance as possible to the sensitive habitats such as ravines and moist grassland pockets during construction. • During construction, sensitive habitats must be avoided by construction vehicles and equipment, wherever possible, in order to reduce potential impacts. Only necessary damage must be caused and, for example, unnecessary driving around in the veld or bulldozing natural habitat must not take place.	Continuous	Contractor / ECO
Support infrastructure, WSF and WRD	Topsoil & subsoil stripping	Fauna & Flora	Soil erosion and sedimentation	CONSERVATION OF AGRICULTURAL RESOURCES ACT 43 OF 1983	• To prevent the loss of soil through the expansion of the WRD • To prevent the loss of	Management of storm water on site; Minimize time that soil is left	• Cover disturbed soils as completely as possible, using vegetation or other materials; • Minimize the amount of land disturbance and develop and implement stringent erosion and dust control practices.	Continuous	Contractor / ECO

Components	Activity	Aspect	Impact	Legal requirements	Objectives	Performance criteria	Mitigation Measures	Time frame	Responsible person
				NEMA Regulation 543 Section 32	topsoil capability during stockpiling • To prevent the contamination of soils due to spillages of reagents • To prevent soil erosion	exposed after vegetation is cleared that will cause erosion and sedimentation	• Sediment trapping, erosion and storm water control should be addressed by a hydrological engineer in a detailed storm water management plan; • All aspects related to dust and air quality should be addressed by an air quality specialist in a specialist report; • Protect sloping areas and drainage channel banks that are susceptible to erosion and ensure that there is no undue soil erosion resultant from activities within and adjacent to the construction camp and Work Areas; • Repair all erosion damage as soon as possible to allow for sufficient rehabilitation growth; • Gravel roads must be well drained in order to limit soil erosion;		
Support infrastructure, WSF and WRD	Heavy machinery & vehicle movement on site	Fauna & Flora	Spillages	National Environmental Management: Waste Act, 2008 (Act No. 59 of 2008) Section 11(1)	• To prevent contamination of flora due to the spillages of hydrocarbons and reagents used in the process and during transportation of these substances • To reduce the risk of contamination of soils due to increased fuel deliveries	Active monitoring of potential spillages	• Ensure that mining related waste or spillage and effluent do not affect the sensitive habitat boundaries and associated buffer zones. • This risk of spillages of reagents and hydrocarbons on the soil during transportation can be reduced with proper maintenance of vehicles. This would include a rigorous and proactive maintenance program • This risk can be further reduced through an adequate program of training of drivers and crews. This would include defensive driver training, basic vehicle maintenance, and emergency control of spills. In order for the vehicle crews to be adequately able to control any spills at an early stage, the vehicles must be properly equipped with spill containment equipment (booms, sandbags, spades, absorbent pads, etc.). Responsibility for training lies with the transport contractor. Adequate training, maintenance, and equipment of transport crews should be included as a requirement for transport contracts. • All employees will be trained in cleaning up of a spillage. The necessary spill kits containing the correct equipment to clean up spills will be made available at strategic points in the plant area	Continuous	Contractor / ECO
Support infrastructure, WSF and WRD			Road mortalities of fauna	NEMBA Section 56 (1), 57 (1), 57 (2) and 57 (4) NEMA Regulation 543 Section 32	Prevent fauna mortalities as a result of vehicle movement	Control of vehicle speed Control of vehicle movement	• More fauna are normally killed the faster vehicles travel. A speed limit should be enforced (speed on site max 40 km/hour; Outside of the site 80 km/h. In Rain max 40 km/h). It can be considered to install speed bumps in sections where the speed limit tends to be disobeyed. (Speed limits will also lessen the probability of road accidents and their negative consequences). • Travelling at night should be avoided or limited as much as possible. No travelling at night should be allowed without approval by site manager;	Continuous	Contractor / ECO
Support infrastructure, WSF and WRD	Vegetation clearing, topsoil & subsoil stripping, vehicle movement on site	Flora	Potential establishment and spread of declared weeds and alien invader plants	Alien and Invasive Species Regulations (GNR 599 of 2014) as part of the National Environmental Management: Biodiversity Act (10/2004)	To implement an alien invasive eradication programme to manage and control alien species on the mine	Prevent and control of spreading and establishment of alien invasive species on the mining area and larger region	• Control involves killing the alien invasive plants present, killing the seedlings which emerge, and establishing and managing an alternative plant cover to limit re-growth and re-invasion. The control of these species should even begin prior to the construction phase considering that small populations of the Alien and Invasive Species occur around the sites; • Institute strict control over materials brought onto site, which should be inspected for seeds of noxious plants and steps taken to eradicate these before transport to the site. Routinely fumigate or spray all materials with appropriate low-residual herbicides prior to transport to site or in a quarantine area on site. The contractor is responsible for the control of weeds and invader plants within the construction site for the duration of the construction phase; • Rehabilitate disturbed areas as quickly as possible to reduce the area where invasive species would be at a strong advantage and most easily able to establish; • Institute a monitoring programme to detect alien invasive species early, before they become established and, in the case of weeds, before the release of seeds; • Institute an eradication/control programme for early intervention if invasive species are detected, so that their spread to surrounding natural ecosystems can be prevented; • A detailed plan should be developed for control of noxious weeds and invasive plants that could colonize the area as a result of new surface	Continuous	Contractor / ECO

Components	Activity	Aspect	Impact	Legal requirements	Objectives	Performance criteria	Mitigation Measures	Time frame	Responsible person
							disturbance activities at the site. The plan should address monitoring, weed identification, the manner in which weeds spread, and methods for treating infestations.		
Support infrastructure, WSF and WRD	Vegetation Clearing, Vehicle movement on site	Flora & Fauna	Habitat degradation due to dust	National Environmental Management Air Quality Act 39 of 2004 Section 32	• To reduce dust emission levels to acceptable norms in terms of aesthetics, health and annoyance • To implement a dust monitoring programme which will enable the mine to determine the impacts associated with its activities • To manage the operations in such a way as to ensure that the impact on the air quality is prevented and reduced.	To limit exposure to sensitive receptors resulting from dust and fumes from, mine vehicles and transportation systems and windborne dust from surface working	• Dampening, when necessary, of dust areas or other dust suppression methods such as dust-aside or more environmentally friendly methods. • Re-vegetation of impacted areas is to be conducted on an on-going basis. • Place dust generating activities where maximum protection can be obtained from natural features. • Locating dust generating activities where prevailing winds will blow dust away from users. • Minimize the need to transport and handle materials by placing adequate storage facilities close to processing areas. • Minimize the re-handling of material which obviously has cost benefits as well. • Exposed material should be protected from the wind by keeping it within voids or protecting them by topographical features where possible. • Reduce the drop heights wherever practicable. • Protect activities from wind by erecting a screen or using a natural barrier, where possible. • The general vehicle speed should be restricted as there is a direct relationship between the speed and vehicle entrained emissions. • Monitoring, modelling and emission measurements should be regarded as complementary components in any integrated approach to exposure assessment or determining compliance against air quality criteria.	Continuous	Contractor / ECO
OPERATIONAL PHASE									
Support infrastructure, WSF and WRD	Laydown areas of stockpiles and WRDs	Flora	Habitat destruction	NEMA Regulation 543 Section 32 NEMBA Section 56 (1), 57 (1), 57 (2) and 57 (4) NEMA Regulation 543 Section 32 Limpopo Environmental Management Act	Refer to Construction Phase objectives	Refer to Construction Phase criteria	• Final profile lines of rehabilitated areas must fit in with the character of the topography in the area. • Concurrent rehabilitation should occur during the operational phase on all exposed areas created by construction as well as roads, stockpiles and WRD. Only indigenous species should be used for rehabilitation. The following programmes should be implemented as part of the operational phase of the mine: o Concurrent rehabilitation programme o Alien invasive programme o Fire management programme o Educational and training programme on the conservation and ecological systems • Refer to mitigation measures needed during the construction phase as measures required during the operational phase will be similar.	Continuous	Contractor / ECO
	Laydown areas of stockpiles and WRDs	Fauna	Fragmentation of fauna habitats	NEMA Regulation 543 Section 32 NEMBA Section 56 (1), 57 (1), 57 (2) and 57 (4) NEMA Regulation 543 Section 32 Limpopo Environmental Management Act	Refer to Construction Phase objectives	Refer to Construction Phase criteria	Refer to mitigation measures needed during the operational phase that are similar to the mitigation measures for impacts during the construction phase.	Continuous	Contractor / ECO
	Laydown areas of WRDs and stockpiles, crushing and stockpiling	Flora	Increased Soil erosion and sedimentation;	CONSERVATION OF AGRICULTURAL RESOURCES ACT 43 OF 1983 NEMA Regulation 543 Section 32	Refer to Construction Phase objectives	Refer to Construction Phase criteria	• Rehabilitation: revegetate or stabilise all disturbed areas as soon as possible. • Conservation of topsoil should be prioritized on site and done as follows: o Topsoil should be handled twice only - once to strip and stockpile, and secondly to replace, level, shape and scarify; o Stockpile topsoil separately from subsoil; o Stockpile in an area that is protected from storm water runoff and wind;	Continuous	Contractor / ECO

Components	Activity	Aspect	Impact	Legal requirements	Objectives	Performance criteria	Mitigation Measures	Time frame	Responsible person
							○ Topsoil stockpiles should not exceed 2.0 m in height and should be protected by a mulch cover where possible; ○ Maintain topsoil stockpiles in a weed free condition; ○ Topsoil should not be compacted in any way, nor should any object be placed or stockpiled upon it; ○ Stockpile topsoil for the minimum time period possible i.e. strip just before the relevant activity commences and replace as soon as it is completed. • Refer to mitigation measures needed during the operational phase that are similar to the mitigation measures for impacts during the construction phase.		
	Laydown areas of WRDs and stockpiles, materials handling and transportation, crushing and stockpiling	Flora	Spillages of harmful substances to the ecosystem;	National Environmental Management: Waste Act, 2008 (Act No. 59 of 2008) Section 11(1)	Refer to Construction Phase objectives	Refer to Construction Phase criteria	• Vehicle maintenance only done in designated areas – spill trays, sumps to be used and managed according to the correct procedures. • Vehicles and machines must be maintained properly to ensure that oil spillages are kept to a minimum. • Fuel and oil storage facilities should be bunded with adequate storm water management measures. • Operational and Maintenance plan and schedule for management of sewage facilities should be compiled. An emergency plan should be compiled to deal with system failures and should include a down-stream notification procedure • Routine checks should be done on all mechanical instruments for problems such as leaks, overheating, vibration, noise or any other abnormalities. All equipment should be free of obstruction, be properly aligned and be moving at normal speed. Mechanical maintenance must be according to the manufacturer's instructions • Refer to mitigation measures needed during the operational phase that are similar to the mitigation measures for impacts during the construction phase	Continuous	Contractor / ECO
	Laydown areas of WRDs and stockpiles, materials handling and transportation, crushing and stockpiling	Fauna	Road mortalities of fauna	NEMBA Section 56 (1), 57 (1), 57 (2) and 57 (4) NEMA Regulation 543 Section 32 NEMA Regulation 543 Section 32	Refer to Construction Phase objectives	Refer to Construction Phase criteria	Refer to mitigation measures needed during the construction phase as measures required during the operational phase will be similar.	Continuous	Contractor / ECO

Components	Activity	Aspect	Impact	Legal requirements	Objectives	Performance criteria	Mitigation Measures	Time frame	Responsible person
	Laydown areas of WRDs and stockpiles, materials handling and transportation, crushing and stockpiling	Flora & Fauna	Habitat degradation due to dust;	National Environmental Management Air Quality Act 39 of 2004 Section 32	Refer to Construction Phase objectives	Refer to Construction Phase criteria	• Re-vegetation is to be conducted on an ongoing basis. • Dust fallout monitoring to be conducted according to the requirements of the legislation And Air Quality Impact Assessment Report; • Place dust generating activities where maximum protection can be obtained from natural features. • Locating dust generating activities where prevailing winds will blow dust away from users. • Minimize the need to transport and handle materials by placing adequate storage facilities close to processing areas. • Exposed material should be protected from the wind by keeping it within voids or protecting them by topographical features where possible. • Reduce the drop heights wherever practicable. • Protect activities from wind by erecting a screen or using a natural barrier. • Fine spray or fog suppression can also be used in loading bays. • All roads on site should be dampened or treated with a binding agent. • The general vehicle speed should be restricted as there is a direct relationship between the speed and vehicle entrained emissions. • Monitoring, modelling and emission measurements should be regarded as complementary components in any integrated approach to exposure assessment or determining compliance against air quality criteria • Refer to mitigation measures needed during the operational phase that are similar to the mitigation measures for impacts during the construction phase	Continuous	Contractor / ECO
	Laydown areas of stockpiles and WRDs	Flora	Potential establishment and spread of declared weeds and alien invader plants	Alien and Invasive Species Regulations (GNR 599 of 2014) as part of the National Environmental Management: Biodiversity Act (10/2004)	Refer to Construction Phase objectives	Refer to Construction Phase criteria	Refer to mitigation measures needed during the construction phase as measures required during the operational phase will be similar.		Ecologist / ECO
DECOMMISSIONING PHASE									
Support infrastructure, WSF and WRD	Cessation of mining Demolition of mining infrastructure	Flora	Potential establishment and spread of declared weeds and alien invader plants	Alien and Invasive Species Regulations (GNR 599 of 2014) as part of the National Environmental Management: Biodiversity Act (10/2004)	Refer to Construction Phase objectives	Refer to Construction Phase criteria	To leave all affected areas in a safe condition Refer to mitigation measures needed during the construction phase as measures required during the decommissioning phase will be similar.	Continuous	Ecologist / ECO
	Demolition of mining infrastructure	Fauna & Flora	Habitat degradation due to dust;	National Environmental Management Air Quality Act 39 of 2004 Section 32	Refer to Construction Phase objectives	Refer to Construction Phase criteria	Refer to mitigation measures needed during the construction phase as measures required during the decommissioning phase will be similar.	Continuous	Contractor / ECO
	Demolition of mining infrastructure	Fauna	Road mortalities of fauna	NEMBA Section 56 (1), 57 (1), 57 (2) and 57 (4) NEMA Regulation 543 Section 32	Refer to Construction Phase objectives	Refer to Construction Phase criteria	Refer to mitigation measures needed during the construction phase as measures required during the decommissioning phase will be similar.	Continuous	Contractor / ECO
	Demolition of mining infrastructure	Fauna & Flora	Spillages of harmful substances to the ecosystem;	National Environmental Management: Waste Act, 2008 (Act No. 59 of 2008) Section 11(1)	Refer to Construction Phase objectives	Refer to Construction Phase criteria	Refer to mitigation measures needed during the construction phase as measures required during the decommissioning phase will be similar.	Continuous	Contractor / ECO
CLOSURE PHASE & POST CLOSURE PHASES									
Support infrastructure, WSF and WRD	Rehabilitation	Fauna & Flora	Improvement of habitat through revegetation over time	NEMA Regulation 543 Section 32	• To ensure that the mining areas rehabilitated	Rehabilitate within development footprint to ensure revegetation and	• Plant vegetation species for rehabilitation that will effectively bind the loose material and which can absorb run-off from the mining areas.	Continuous	Ecologist / ECO

Components	Activity	Aspect	Impact	Legal requirements	Objectives	Performance criteria	Mitigation Measures	Time frame	Responsible person
					according to prescriptions • To shape and prepare the rehabilitation areas to blend in with the surrounding environment. • To rehabilitate all disturbed areas to a suitable post closure land use • To manage the social impact of closure on personnel who became redundant due to closure • To keep all the post closure monitoring in place and to ensure that the necessary reporting is done to the authorities and interested and affected parties	rehabilitation impacts are kept within the mining footprint areas	• Rehabilitate all the land where infrastructure has been demolished. • Monitor the establishment of the vegetation cover on the rehabilitated sites to the point where it is self-sustaining. • Protect rehabilitation areas until the area is self-sustaining. • Diversion trenches and storm water measures must be maintained • Water management facilities will stay operational and maintained and monitored until such a stage is reached where it is no longer necessary. • The mining areas will be shaped to make it safe. • All the monitoring and reporting on the management and rehabilitation issues to the authorities will continue till closure of the mine is approved.		
	Rehabilitation	Flora	Potential establishment and spread of declared weeds and alien invader plants	Alien and Invasive Species Regulations (GNR 599 of 2014) as part of the National Environmental Management: Biodiversity Act (10/2004)	Refer to Construction Phase objectives	Refer to Construction Phase criteria	• Monitor and manage invader species and alien species on the rehabilitated land until the natural vegetation can outperform the invaders or aliens.	Continuous	Contractor / ECO
	Rehabilitation	Fauna & Flora	Habitat degradation due to dust;	National Environmental Management Air Quality Act 39 of 2004 Section 32	To comply to all the necessary post closure air quality objectives	Refer to Construction Phase criteria	Refer to mitigation measures needed during the construction phase as measures required during the closure phase will be similar.	Continuous	Contractor / ECO
	Rehabilitation	Fauna	Road mortalities of fauna	NEMBA Section 56 (1), 57 (1), 57 (2) and 57 (4) NEMA Regulation 543 Section 32	Refer to Construction Phase objectives	Refer to Construction Phase criteria	Refer to mitigation measures needed during the construction phase as measures required during the decommissioning phase will be similar.	Continuous	Contractor / ECO
	Rehabilitation	Fauna & Flora	Spillages of harmful substances to the ecosystem;	National Environmental Management: Waste Act, 2008 (Act No. 59 of 2008) Section 11(1)	Refer to Construction Phase objectives	Refer to Construction Phase criteria	Refer to mitigation measures needed during the construction phase as measures required during the decommissioning phase will be similar.	Continuous	Contractor / ECO

8 SENSITIVITY ANALYSIS AND CONSERVATION ANALYSIS TOOLS

There are several assessments for South Africa as a whole, as well as on provincial levels that allow for detailed conservation planning as well as meeting biodiversity targets for the country's variety of ecosystems. These guides are essential to consult for development projects, and will form an important part of the sensitivity analysis. Areas earmarked for conservation in the future, or that are essential to meet biodiversity and conservation targets should not be developed, and have a high sensitivity as they are necessary for overall functioning. In addition, sensitivity analysis in the field based in much finer scale data can be used to ground truth the larger scale assessments and put it into a more localised context.

8.1 CRITICAL BIODIVERSITY & ECOLOGICAL SUPPORT AREAS OF THE PROJECT AREA

The purpose of the Limpopo Conservation Plan version 2 (LCPv2) is to develop the spatial component of a bioregional plan (i.e. map of Critical Biodiversity Areas (CBA) and associated land-use guidelines).

The Limpopo Conservation Plan categories for the proposed mining area are presented in Figure 6. The following can be concluded regarding developments:

The mining project is located in the following areas:

- The proposed mining expansion areas are located in a CBA 1 area;

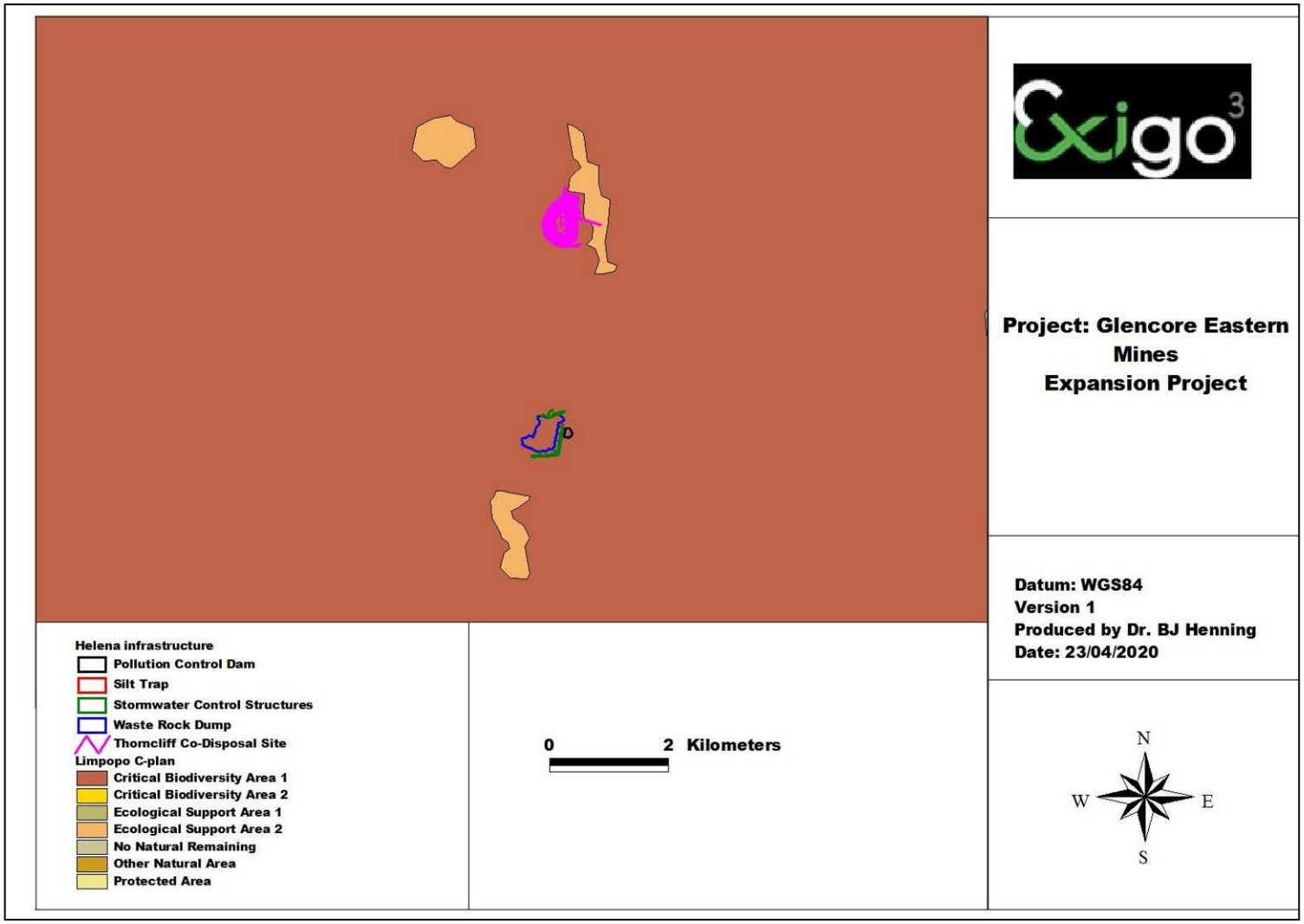

Figure 6. Terrestrial CBA areas of the study area (2014)

8.2 PROTECTED AREAS NETWORK AND NATIONAL PROTECTED AREAS EXPANSION STRATEGY (NPAES)

Officially protected areas, either Provincially or Nationally that occur close to a project site could have consequences as far as impacts on these areas are concerned. For the proposed development site and associated infrastructure however, the Gustav Klingbell Nature Reserve is located far east of the study area (Figure 7).

The NPAES are areas designated for future incorporation into existing protected areas (both National and informal protected areas). These areas are large, mostly intact areas required to meet biodiversity targets, and suitable for protection. They may not necessarily be proclaimed as protected areas in the future and are a broad scale planning tool allowing for better development and conservation planning. The NPAES is linked to the Mpumalanga Mesic Grasslands and overlaps with the project area.

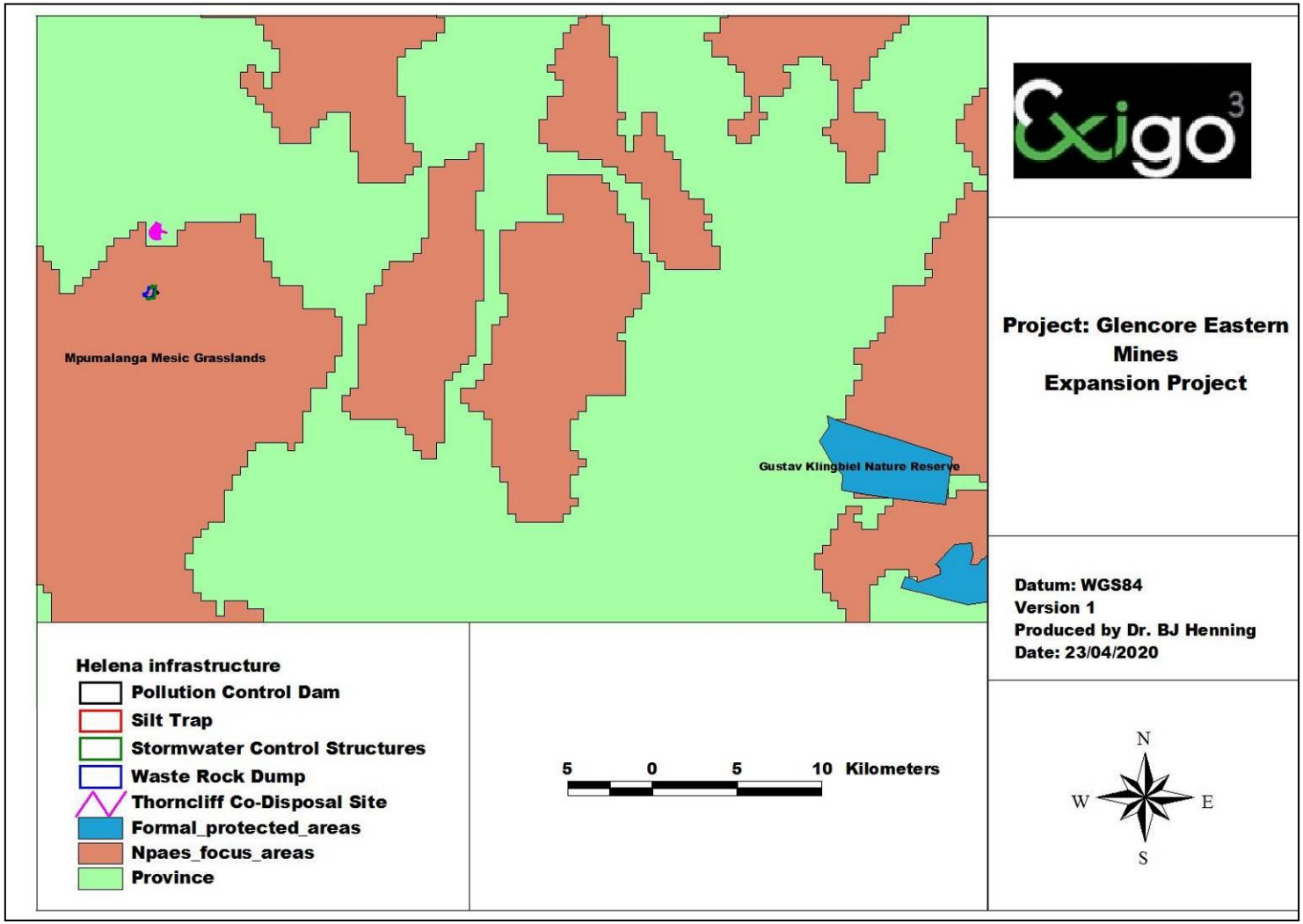

Figure 7. Protected areas in close proximity to the project area

8.3 IMPORTANT BIRD AREAS

An Important Bird Area (IBA) is an area recognized as being globally important habitat for the conservation of bird populations. Currently there are about 10,000 IBAs worldwide. At present, South Africa has 124 IBA's, covering over 14 million hectares of habitat for our threatened, endemic and congregatory birds. Yet only million hectares of the total land surface covered by our IBA's legally protected. The BirdLife SA IBA programme continues a programme of stewardship which will ultimately achieve formal protection (Birdlife, 2013).

No IBA is located within close proximity to the project area, with the closest IBA located roughly 20 kilometers south of the site, namely the Steenkampsberg (Figure 8).

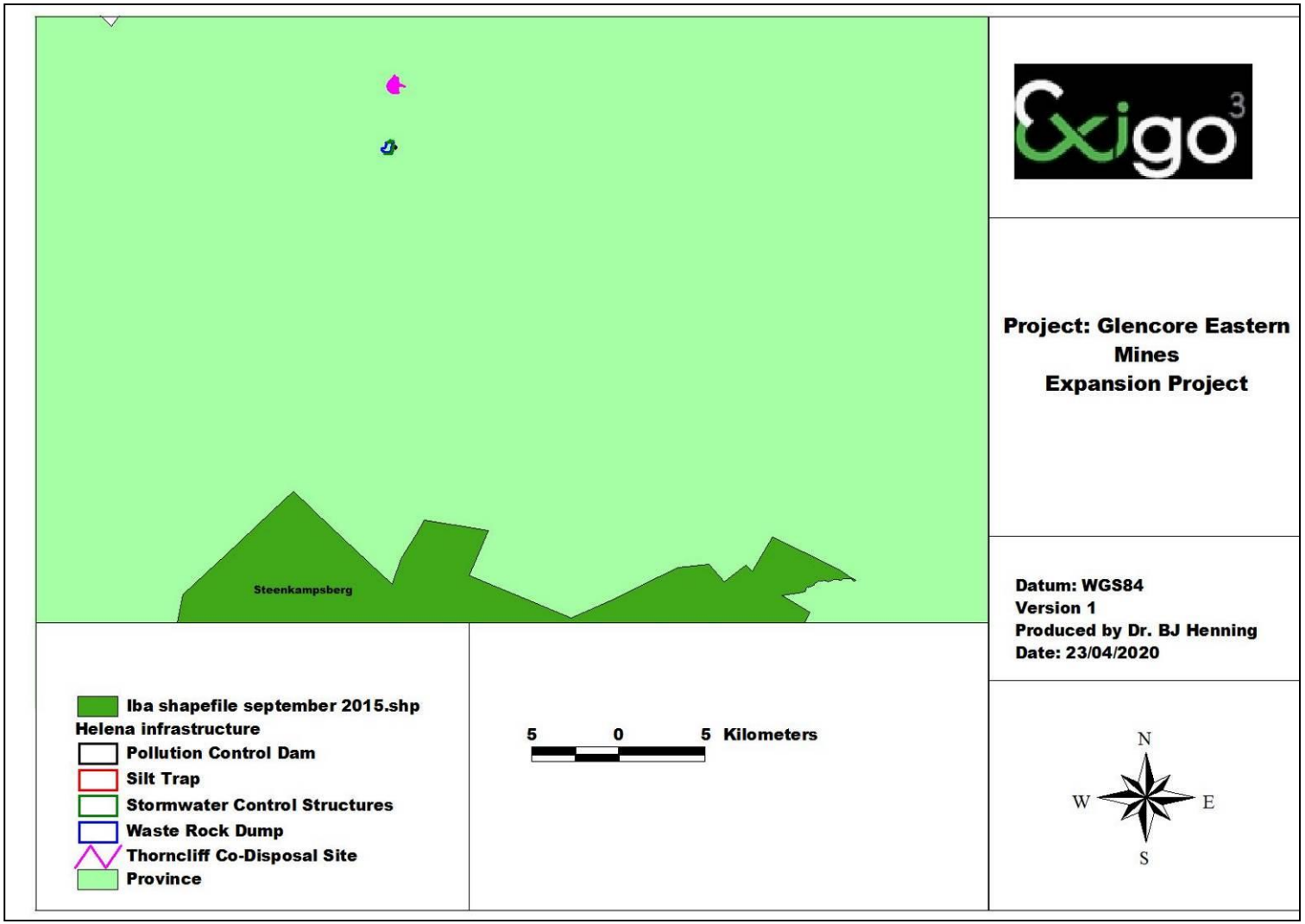

Figure 8. Location of the project area in relation to IBAs

8.4 NATIONALLY THREATENED ECOSYSTEMS

The list of national Threatened Ecosystems has been gazetted (NEM:BA: National list of ecosystems that are threatened and in need of protection) and result in several implications in terms of development within these areas. Four basic principles were established for the identification of threatened ecosystems. These include:

- The approach must be explicit and repeatable;
- The approach must be target driven and systematic, especially for threatened ecosystems;
- The approach must follow the same logic as the IUCN approach to listing threatened species, whereby a number of criteria are developed and an ecosystem is listed based on its highest ranking criterion; and
- The identification of ecosystems to be listed must be based on scientifically credible, practical and simple criteria, which must translate into spatially explicit identification of ecosystems.

Areas were delineated based on as fine a scale as possible and are defined by one of several assessments: These areas are essential for conservation of the country's ecosystems as well as meeting conservation targets. The Sekhukune Mountainlands vegetation type is a listed threatened vegetation type located within the project area (Figure 9).

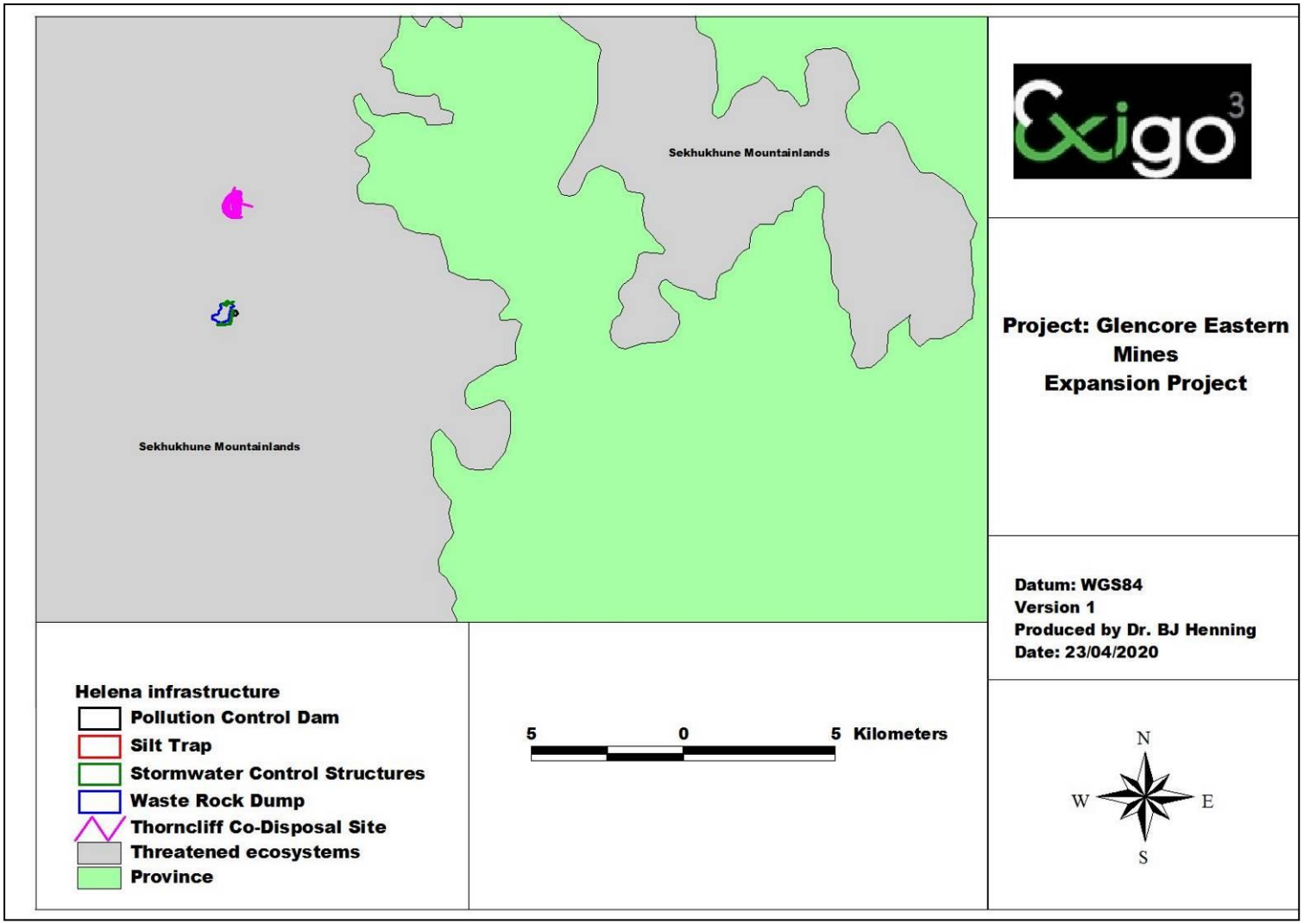

Figure 9. Location of the project area in relation to National List of Terrestrial Threatened Ecosystems (2011)

8.5 ECOLOGICAL SENSITIVITY CLASSES

Following the ecological surveys, the classification of the study area into different sensitivity classes and development zones was based on information collected at various levels on different environmental characteristics. Factors which determined sensitivity classes were as follows:

- Presence, density and potential impact of development on rare, endemic and protected plant species;
- Conservation status of vegetation units;
- Soil types, soil depth and soil clay content;
- Previous land-use;
- State of the vegetation in general as indicated by indicator species.

Below included is the sensitivity map for the different areas (Figure 10 and Figure 11). Only criteria applicable to the specific vegetation units were used to determine the sensitivity of the specific unit.

Table 18 compare the different options from an ecological point of view for the Helena WRD expansion site, while Figure 10 indicate the overlay of the preferred and alternative footprint areas on the sensitivity map.

Table 19 compare the different mining infrastructure options from an ecological point of view for the Thorncliffe expansion site, while Figure 11 indicate the overlay of the preferred and alternative footprint areas on the sensitivity map.

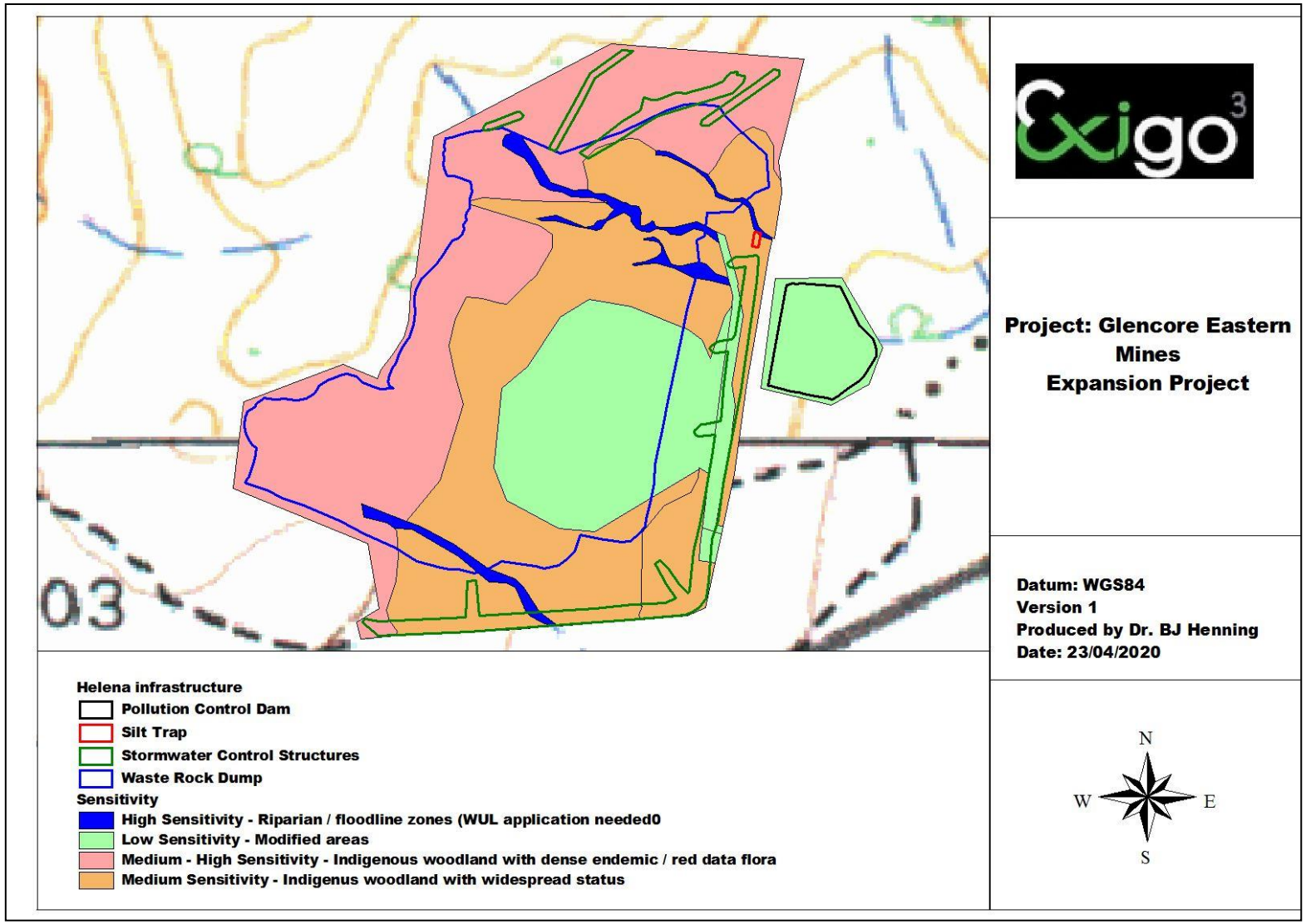

Figure 10. Sensitivity Map of the project area for the proposed Helena Mining WRD expansion site

Table 18. Preferred and alternative layout options for the proposed Helena WRD

Options	Positives	Negatives	Recommendation
Preferred WRD footprint	• Impact on lower surface area of natural habitat types • Topography flatter and more suitable • Less impact on red data and endemic plant species / fauna habitat • Lower impact on drainage channels of area • Location on a large degraded (Paste Tailings facility) section in the landscape	• Impact on small drainage channels bisecting area • Slight Impact on habitat for endemic plant species	**Most suitable option from an ecological point of view**
Alternative WRD footprint	• Further away from the Dwarsriver	• Topography unsuitable - rocky ridge • High impact on red data / endemic plant species habitat • Impact on drainage channel bisecting area • Location largely on pristine habitats	**Not suitable from ecological point of view**

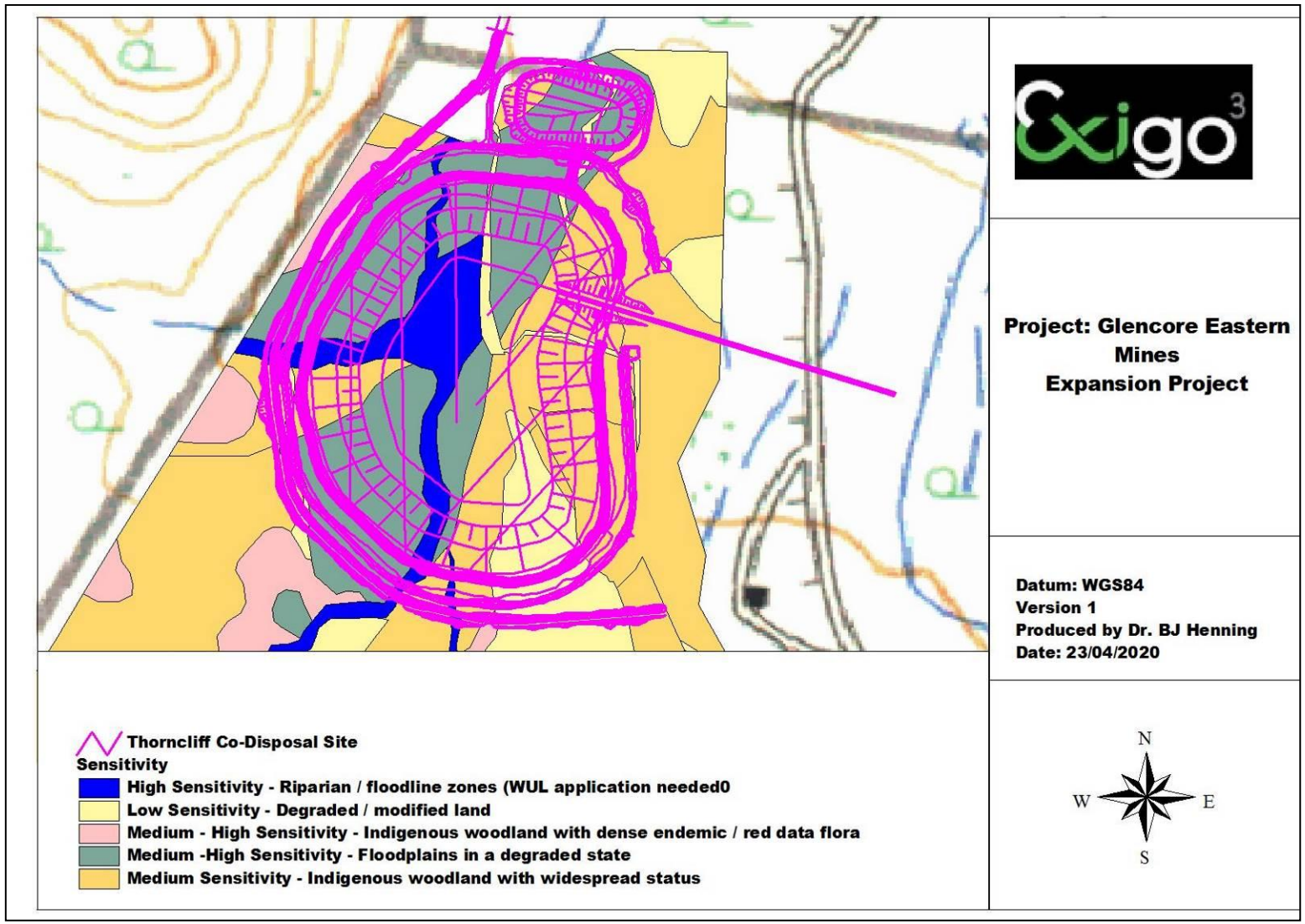

Figure 11. Sensitivity Map of the project area for the proposed Thorncliffe WSF and WRD sites

Table 19. Preferred and alternative layout options for the proposed Thorncliffe WSF

Options	Positives	Negatives	Recommendation
Preferred WSF footprint	• Impact on lower surface area of natural habitat types • Topography flatter and more suitable • Less impact on red data and endemic plant species / fauna habitat • Lower impact on drainage channels of area • Location on a large degraded (eroded) section in the landscape	• Impact on drainage channel bisecting area – potential impact on Dwars River system downstream • Slight Impact on habitat for endemic plant species	**Most suitable option from an ecological point of view**
Alternative WSF footprint	• Further away from the Dwarsriver	• Topography unsuitable - rocky ridge • High impact on red data / endemic plant species habitat • Impact on drainage channel bisecting area – potential impact on Dwars River system downstream • Location largely on pristine habitats	**Not suitable from ecological point of view**

9 IMPACT STATEMENT AND VIABILITY OF MINING PROJECT

The proposed mining activities that form part of the Glencore Eastern Mines Waste Residue Facilities Project will definitely impact on the flora and fauna of the area. The following can be concluded with regards to the impacts:

- Vegetation clearing and topsoil stripping will have the most definite and permanent direct negative impact on the flora and fauna of the area during the construction phase of the mining expansion infrastructure. The clearance will eradicate all vegetation and displace fauna that will migrate to neighbouring areas;
- The laydown areas of WRDs and stockpiles during the operational phase of the mine will have a direct, significant negative impact on the vegetation and fauna habitats, considering that most of the vegetation in the larger area can be considered as pristine;
- The indirect impacts such as soil erosion, fauna mortalities, spillages and establishment of alien invasive species are relevant for all mining phases, although with strict implementation of the mitigation measures and action plans for the various components, the impacts can be minimized;
- Considering the cumulative impacts of the mining phases on the fauna and flora of the area, it can be concluded that the current state of the vegetation and fauna habitats, will cause some negative impacts, although the implementation of a rehabilitation and revegetation plan will allow the vegetation to recover over time and the fauna to return to the area;
- The mining development can be considered as viable, although strict mitigation and monitoring will need to be implemented throughout all of the mining phases to ensure the impacts are kept to a minimum.

10 CONCLUSION

All aspects of the environment, especially living organisms, are vulnerable to disturbance of their habitat. The mining activities will completely modify the natural vegetation and faunal habitats. The importance of monitoring, rehabilitation and implementation of mitigation processes to prevent negative impacts on the environment during and after the closure phases of the mines should be considered a VERY HIGH priority. Any negative impacts created by such actions and processes will ultimately scar the environment and negatively impact on the ecosystem both on a local and global scale. The proposed site for the mining operation occurs largely in a pristine environment with red data and endemic plant species throughout the area. The project area consists of sensitive drainage features, endemic woodland and rocky outcrops providing a unique habitat for a variety of plant species to establish as well as perching and breeding areas for larger birds of prey. The riverine woodland and ridges provide valuable corridors and feeding and breeding areas for red data and other birds, reptiles and amphibians. Many features of the study area contribute to its ecological sensitivity and it is recommended to be considered during the environmental impact process. Provided that the mitigation measures and recommendations are adhered to as stated in the report, the development of the mining expansion sites (WRDs and WSF) can be supported, although under strict conditions with regards to permit applications for red data and protected species, monitoring, rehabilitation and management measures.

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12 APPENDIX A. PLANT SPECIES LISTS FOR SITE

Woody species
Aloe marlothii
Catha edulis
Combretum apiculatum
Combretum hereroense
Combretum zeyheri
Cussonia paniculata
Dichrostachys cinerea
Diospyros lycioides
Dombeya rotundifolia
Elpehanthorrhiza praetermissae
Euclea crispa
Euclea sekhukhuniensis
Faurea saligna
Ficus glumosa
Grewia vernicosa
Gymnosporia sp.
Hippobromus pauciflorus
Kairomia speciosa
Kirkia wilmsii
Lydenburgia cassinoides
Mimusops zeyheri
Mundulea sericea
Sclerocarya birrea
Searsia keetii
Searsia sekhukuniensis
Senegalia caffra
Spirostachys africana
Strychnos cocculoides
Triaspis glaucophylla
Vachellia karroo
Vachellia nilotica
Vitex poara s. wilmsii
Ziziphus mucronata
Grass species
Aristida canescens
Aristida congesta
Aristida junciformes
Botriochloa insculpta
Brachiaria serrata
Hyparrhenia hirta

Hyparrhenia tamba
Hyperhtelia dissolute
Loudetia simplex
Melinis repens
Panicum maximum
Schizachyrium sanguineum
Setaria sphacelata
Themeda triandra
Triraphis andropogonoides
Tristachya leucothrix
Urelytrum agrypyroides
Dwarf shrubs, Forbs, geophytes & succulents
Aloe cryptopoda
Argemona ochroleuc
Berkheya seminivea
Bulbostylis burchelli
Commelina erecta
Datura stramonium
Dicoma anomala
Euphorbia schinzii
Gnidia caffra
Lippia javanica
Myrothamnes flabellifolius
Rhoicissis sekhukuniensis
Rhynchosia nitens
Schkuria pinnata
Selaginella dregei
Senecio microglossus
Senecio venosus
Tagetes minuta
Tinnea rhodesiana
Vigna vexillata
Xerophyta viscosa

13 APPENDIX B. PLANT SPECIES LIST FOR QDS

Family Name	Species Name
FABACEAE	*Senegalia ataxacantha*
FABACEAE	*Vachellia borleae*
FABACEAE	*Vachellia gerrardii subsp. gerrardii var. gerrardii*
FABACEAE	*Senegalia grandicornuta*
FABACEAE	*Vachellia karroo*
LORANTHACEAE	*Agelanthus natalitius subsp. zeyheri*
POACEAE	*Agrostis eriantha var. eriantha*
POACEAE	*Agrostis lachnantha var. lachnantha*
LAMIACEAE	*Ajuga ophrydis*
ROSACEAE	*Alchemilla capensis*
ROSACEAE	*Alchemilla cryptantha*
ROSACEAE	*Alchemilla woodii*
OROBANCHACEAE	*Alectra orobanchoides*
OROBANCHACEAE	*Alectra sessiliflora var. sessiliflora*
APIACEAE	*Alepidea setifera*
POACEAE	*Alloteropsis semialata subsp. eckloniana*
ASPHODELACEAE	*Aloe castanea*
ASPHODELACEAE	*Aloe chortolirioides var. woolliana*
ASPHODELACEAE	*Aloe cooperi subsp. cooperi*
ASPHODELACEAE	*Aloe cryptopoda*
ASPHODELACEAE	*Aloe greatheadii var. davyana*
ASPHODELACEAE	*Aloe pretoriensis*
ASPHODELACEAE	*Aloe reitzii var. reitzii*
THELYPTERIDACEAE	*Amauropelta oppositiformis*
ASTERACEAE	*Amphiglossa triflora*
PORTULACACEAE	*Anacampseros subnuda subsp. subnuda*
COLCHICACEAE	*Androcymbium melanthioides subsp. transvaalense*
POACEAE	*Andropogon appendiculatus*
POACEAE	*Andropogon lacunosus*
POACEAE	*Andropogon mannii*
POACEAE	*Andropogon ravus*
POACEAE	*Andropogon schirensis*
ANEURACEAE	*Aneura pinguis*
APIACEAE	*Annesorhiza wilmsii*
BRYACEAE	*Anomobryum julaceum*
FABACEAE	*Argyrolobium speciosum*
FABACEAE	*Argyrolobium tomentosum*
FABACEAE	*Argyrolobium tuberosum*
FABACEAE	*Argyrolobium wilmsii*
IRIDACEAE	*Aristea sp.*

Family Name	Species Name
POACEAE	*Aristida aequiglumis*
POACEAE	*Aristida canescens subsp. canescens*
POACEAE	*Aristida diffusa subsp. burkei*
POACEAE	*Aristida junciformis subsp. junciformis*
POACEAE	*Aristida rhiniochloa*
ASTERACEAE	*Artemisia afra var. afra*
POACEAE	*Arundinella nepalensis*
APOCYNACEAE	*Asclepias albens*
APOCYNACEAE	*Asclepias aurea*
APOCYNACEAE	*Asclepias cucullata subsp. cucullata*
APOCYNACEAE	*Asclepias cultriformis*
APOCYNACEAE	*Asclepias macropus*
APOCYNACEAE	*Asclepias multicaulis*
APOCYNACEAE	*Asclepias sp.*
CYPERACEAE	*Ascolepis capensis*
ASPARAGACEAE	*Asparagus asparagoides*
ASPARAGACEAE	*Asparagus suaveolens*
APOCYNACEAE	*Aspidoglossum glabrescens*
ASPLENIACEAE	*Asplenium sp.*
ASTERACEAE	*Aster lydenburgensis*
AYTONIACEAE	*Asterella bachmannii*
AYTONIACEAE	*Asterella wilmsii*
ASTERACEAE	*Athrixia elata*
WOODSIACEAE	*Athyrium schimperi*
IRIDACEAE	*Babiana bainesii*
POTTIACEAE	*Barbula bolleana*
ACANTHACEAE	*Barleria rotundifolia*
RHAMNACEAE	*Berchemia zeyheri*
ASTERACEAE	*Berkheya echinacea subsp. echinacea*
ASTERACEAE	*Berkheya insignis*
ASTERACEAE	*Berkheya subulata var. subulata*
ASTERACEAE	*Berkheya zeyheri subsp. zeyheri*
POACEAE	*Bewsia biflora*
ACANTHACEAE	*Blepharis subvolubilis*
FABACEAE	*Bolusanthus speciosus*
CAPPARACEAE	*Boscia albitrunca*
CAPPARACEAE	*Boscia foetida subsp. rehmanniana*
SCROPHULARIACEAE	*Bowkeria cymosa*
ORCHIDACEAE	*Brachycorythis pubescens*
ASTERACEAE	*Brachylaena ilicifolia*
APOCYNACEAE	*Brachystelma minor*

Family Name	Species Name
APOCYNACEAE	*Brachystelma stellatum*
HEDWIGIACEAE	*Braunia secunda*
BRYACEAE	*Bryum argenteum*
BRYACEAE	*Bryum capillare*
BRYACEAE	*Bryum cellulare*
OROBANCHACEAE	*Buchnera simplex*
OROBANCHACEAE	*Buchnera sp.*
BUDDLEJACEAE	*Buddleja auriculata*
ASPHODELACEAE	*Bulbine latifolia var. latifolia*
CYPERACEAE	*Bulbostylis schoenoides*
OROBANCHACEAE	*Buttonia sp.*
DICRANACEAE	*Campylopus atroluteus*
DICRANACEAE	*Campylopus bicolor subsp. atroluteus*
DICRANACEAE	*Campylopus introflexus*
DICRANACEAE	*Campylopus pilifer*
DICRANACEAE	*Campylopus pilifer var. pilifer*
DICRANACEAE	*Campylopus robillardei*
PARMELIACEAE	*Canoparmelia eruptens*
RUBIACEAE	*Canthium suberosum*
APOCYNACEAE	*Carissa bispinosa*
CYPERACEAE	*Carpha capitellata*
CELASTRACEAE	*Catha edulis*
RUBIACEAE	*Cephalanthus natalensis*
RUBIACEAE	*Cephalanthus sp.*
DIPSACACEAE	*Cephalaria zeyheriana*
PEDALIACEAE	*Ceratotheca triloba*
APOCYNACEAE	*Ceropegia ampliata var. ampliata*
APOCYNACEAE	*Ceropegia meyeri*
APOCYNACEAE	*Ceropegia stapeliiformis subsp. serpentina*
SCROPHULARIACEAE	*Chaenostoma floribundum*
SCROPHULARIACEAE	*Chaenostoma neglectum*
ACANTHACEAE	*Chaetacanthus sp.*
PTERIDACEAE	*Cheilanthes hirta*
PTERIDACEAE	*Cheilanthes hirta var. hyaloglandulosa*
PTERIDACEAE	*Cheilanthes hyaloglandulosa*
PTERIDACEAE	*Cheilanthes involuta var. obscura*
PTERIDACEAE	*Cheilanthes multifida subsp. lacerata*
PTERIDACEAE	*Cheilanthes viridis var. glauca*
GENTIANACEAE	*Chironia krebsii*
GENTIANACEAE	*Chironia palustris subsp. palustris*
ANTHERICACEAE	*Chlorophytum cooperi*

Family Name	Species Name
ANTHERICACEAE	*Chlorophytum cyperaceum*
ANTHERICACEAE	*Chlorophytum transvaalense*
ASTERACEAE	*Cineraria parvifolia*
CAPPARACEAE	*Cleome angustifolia subsp. petersiana*
CAPPARACEAE	*Cleome hirta*
LAMIACEAE	*Clerodendrum ternatum*
CYPERACEAE	*Coleochloa setifera*
COMBRETACEAE	*Combretum hereroense*
COMBRETACEAE	*Combretum molle*
COMBRETACEAE	*Combretum sp.*
COMBRETACEAE	*Combretum zeyheri*
COMMELINACEAE	*Commelina africana var. africana*
COMMELINACEAE	*Commelina africana var. lancispatha*
BURSERACEAE	*Commiphora glandulosa*
BURSERACEAE	*Commiphora mollis*
CONVOLVULACEAE	*Convolvulus natalensis*
ASTERACEAE	*Conyza pinnata*
MALVACEAE	*Corchorus asplenifolius*
ASTERACEAE	*Cotula hispida*
CRASSULACEAE	*Cotyledon orbiculata var. oblonga*
ACANTHACEAE	*Crabbea angustifolia*
CRASSULACEAE	*Crassula acinaciformis*
CRASSULACEAE	*Crassula alba*
CRASSULACEAE	*Crassula alba var. alba*
CRASSULACEAE	*Crassula alba var. pallida*
CRASSULACEAE	*Crassula brevifolia subsp. brevifolia*
CRASSULACEAE	*Crassula capitella subsp. nodulosa*
CRASSULACEAE	*Crassula lanceolata subsp. lanceolata*
CRASSULACEAE	*Crassula lanceolata subsp. transvaalensis*
CRASSULACEAE	*Crassula pellucida subsp. brachypetala*
CRASSULACEAE	*Crassula sarcocaulis subsp. sarcocaulis*
CRASSULACEAE	*Crassula setulosa var. deminuta*
CRASSULACEAE	*Crassula setulosa var. setulosa forma setulosa*
CRASSULACEAE	*Crassula sp.*
CRASSULACEAE	*Crassula vaginata subsp. vaginata*
SCROPHULARIACEAE	*Craterostigma sp.*
SCROPHULARIACEAE	*Craterostigma wilmsii*
IRIDACEAE	*Crocosmia paniculata*
ACANTHACEAE	*Crossandra greenstockii*
FABACEAE	*Crotalaria monteiroi var. galpinii*
FABACEAE	*Crotalaria monteiroi var. monteiroi*

Family Name	Species Name
EUPHORBIACEAE	*Croton gratissimus var. gratissimus*
LAURACEAE	*Cryptocarya transvaalensis*
POACEAE	*Ctenium concinnum*
CUCURBITACEAE	*Cucumis anguria var. longaculeatus*
CUCURBITACEAE	*Cucumis myriocarpus subsp. myriocarpus*
ARALIACEAE	*Cussonia natalensis*
ARALIACEAE	*Cussonia paniculata subsp. sinuata*
COMMELINACEAE	*Cyanotis pachyrrhiza*
COMMELINACEAE	*Cyanotis speciosa*
AMARANTHACEAE	*Cyathula cylindrica var. cylindrica*
OROBANCHACEAE	*Cycnium racemosum*
POACEAE	*Cymbopogon prolixus*
CYPERACEAE	*Cyperus austro-africanus*
CYPERACEAE	*Cyperus congestus*
CYPERACEAE	*Cyperus cyperoides subsp. cyperoides*
CYPERACEAE	*Cyperus cyperoides subsp. pseudoflavus*
CYPERACEAE	*Cyperus decurvatus*
CYPERACEAE	*Cyperus denudatus var. denudatus*
CYPERACEAE	*Cyperus esculentus var. esculentus*
CYPERACEAE	*Cyperus keniensis*
CYPERACEAE	*Cyperus rupestris var. rupestris*
CYPERACEAE	*Cyperus schlechteri*
VITACEAE	*Cyphostemma sp.*
VITACEAE	*Cyphostemma spinosopilosum*
AMARYLLIDACEAE	*Cyrtanthus breviflorus*
AMARYLLIDACEAE	*Cyrtanthus stenanthus var. major*
POACEAE	*Dactylis glomerata*
MESEMBRYANTHEMACEAE	*Delosperma sp.*
CARYOPHYLLACEAE	*Dianthus basuticus subsp. basuticus var. basuticus*
CARYOPHYLLACEAE	*Dianthus basuticus subsp. fourcadei*
CARYOPHYLLACEAE	*Dianthus zeyheri subsp. natalensis*
FABACEAE	*Dichilus lebeckioides*
FABACEAE	*Dichilus pilosus*
FABACEAE	*Dichilus strictus*
FABACEAE	*Dichrostachys cinerea subsp. africana var. africana*
ACANTHACEAE	*Dicliptera fruticosa*
ASTERACEAE	*Dicoma anomala subsp. anomala*
ASTERACEAE	*Dicoma anomala subsp. gerrardii*
ASTERACEAE	*Dicoma gerrardii*
IRIDACEAE	*Dierama nebrownii*
IRIDACEAE	*Dierama pauciflorum*

Family Name	Species Name
POACEAE	*Digitaria monodactyla*
POACEAE	*Diheteropogon filifolius*
PHYSCIACEAE	*Dimelaena oreina*
ASTERACEAE	*Dimorphotheca jucunda*
DIOSCOREACEAE	*Dioscorea sylvatica var. brevipes*
DIOSCOREACEAE	*Dioscorea sylvatica var. sylvatica*
EBENACEAE	*Diospyros austro-africana var. microphylla*
EBENACEAE	*Diospyros lycioides subsp. guerkei*
EBENACEAE	*Diospyros lycioides subsp. nitens*
EBENACEAE	*Diospyros whyteana*
HYACINTHACEAE	*Dipcadi gracillimum*
HYACINTHACEAE	*Dipcadi marlothii*
HYACINTHACEAE	*Dipcadi rigidifolium*
HYACINTHACEAE	*Dipcadi viride*
ORCHIDACEAE	*Disa alticola*
ORCHIDACEAE	*Disa cooperi*
ORCHIDACEAE	*Disa fragrans subsp. fragrans*
ORCHIDACEAE	*Disa rhodantha*
ORCHIDACEAE	*Disa stachyoides*
ORCHIDACEAE	*Disa versicolor*
ORCHIDACEAE	*Disa zuluensis*
MELASTOMATACEAE	*Dissotis canescens*
HYACINTHACEAE	*Drimia intricata*
HYACINTHACEAE	*Drimiopsis atropurpurea*
DROSERACEAE	*Drosera burkeana*
DROSERACEAE	*Drosera collinsiae*
DROSERACEAE	*Drosera dielsiana*
ACANTHACEAE	*Dyschoriste erecta*
ACANTHACEAE	*Dyschoriste fischeri*
ACANTHACEAE	*Dyschoriste rogersii*
ACANTHACEAE	*Dyschoriste sp.*
CELASTRACEAE	*Elaeodendron transvaalense*
ELAPHOGLOSSACEAE	*Elaphoglossum acrostichoides*
FABACEAE	*Elephantorrhiza praetermissa*
POACEAE	*Elionurus muticus*
ASTERACEAE	*Emilia transvaalensis*
SAPOTACEAE	*Englerophytum magalismontanum*
POACEAE	*Enneapogon scoparius*
POACEAE	*Eragrostis caesia*
POACEAE	*Eragrostis capensis*
POACEAE	*Eragrostis curvula*

Family Name	Species Name
POACEAE	*Eragrostis gummiflua*
POACEAE	*Eragrostis patentipilosa*
POACEAE	*Eragrostis planiculmis*
POACEAE	*Eragrostis racemosa*
POACEAE	*Eragrostis sclerantha subsp. sclerantha*
ERICACEAE	*Erica alopecurus var. alopecurus*
ERICACEAE	*Erica caffrorum*
ERICACEAE	*Erica caffrorum var. caffrorum*
ERICACEAE	*Erica cerinthoides var. cerinthoides*
ERICACEAE	*Erica denticulata var. denticulata*
ERICACEAE	*Erica drakensbergensis*
ERICACEAE	*Erica revoluta*
ERICACEAE	*Erica woodii*
ERIOCAULACEAE	*Eriocaulon sonderianum*
ERIOSPERMACEAE	*Eriospermum cooperi var. cooperi*
ERIOSPERMACEAE	*Eriospermum flagelliforme*
ERIOSPERMACEAE	*Eriospermum ornithogaloides*
EBENACEAE	*Euclea crispa subsp. crispa*
EBENACEAE	*Euclea daphnoides*
EBENACEAE	*Euclea linearis*
EBENACEAE	*Euclea sekhukhuniensis*
EBENACEAE	*Euclea sp.*
EBENACEAE	*Euclea undulata*
HYACINTHACEAE	*Eucomis autumnalis subsp. clavata*
HYACINTHACEAE	*Eucomis montana*
HYACINTHACEAE	*Eucomis pallidiflora*
HYACINTHACEAE	*Eucomis vandermerwei*
POACEAE	*Eulalia villosa*
ORCHIDACEAE	*Eulophia aculeata subsp. aculeata*
ORCHIDACEAE	*Eulophia foliosa*
ORCHIDACEAE	*Eulophia hereroensis*
ORCHIDACEAE	*Eulophia hians var. nutans*
ORCHIDACEAE	*Eulophia leontoglossa*
ORCHIDACEAE	*Eulophia ovalis var. bainesii*
ORCHIDACEAE	*Eulophia parvilabris*
ORCHIDACEAE	*Eulophia streptopetala*
EUPHORBIACEAE	*Euphorbia barnardii*
EUPHORBIACEAE	*Euphorbia enormis*
EUPHORBIACEAE	*Euphorbia schinzii*
ASTERACEAE	*Euryops brevipapposus*
ASTERACEAE	*Euryops transvaalensis subsp. setilobus*

Family Name	Species Name
PROTEACEAE	*Faurea saligna*
ASTERACEAE	*Felicia clavipilosa subsp. transvaalensis*
ASTERACEAE	*Felicia filifolia subsp. filifolia*
POACEAE	*Festuca caprina*
POACEAE	*Festuca costata*
POACEAE	*Festuca scabra*
CYPERACEAE	*Ficinia gracilis*
MORACEAE	*Ficus ingens*
MORACEAE	*Ficus sur*
POACEAE	*Fingerhuthia africana*
PHYLLANTHACEAE	*Flueggea virosa subsp. virosa*
IRIDACEAE	*Freesia laxa subsp. laxa*
CYPERACEAE	*Fuirena pubescens var. pubescens*
FUNARIACEAE	*Funaria bergiana*
ASTERACEAE	*Geigeria burkei subsp. fruticulosa*
GERANIACEAE	*Geranium wakkerstroomianum*
ASTERACEAE	*Gerbera jamesonii*
ASTERACEAE	*Gerbera piloselloides*
ASTERACEAE	*Gerbera viridifolia*
IRIDACEAE	*Gladiolus calcaratus*
IRIDACEAE	*Gladiolus crassifolius*
IRIDACEAE	*Gladiolus dalenii subsp. dalenii*
IRIDACEAE	*Gladiolus densiflorus*
IRIDACEAE	*Gladiolus ferrugineus*
IRIDACEAE	*Gladiolus reginae*
IRIDACEAE	*Gladiolus rehmannii*
IRIDACEAE	*Gladiolus sericeovillosus subsp. calvatus*
IRIDACEAE	*Gladiolus vinosomaculatus*
THYMELAEACEAE	*Gnidia caffra*
THYMELAEACEAE	*Gnidia canoargentea*
THYMELAEACEAE	*Gnidia capitata*
THYMELAEACEAE	*Gnidia kraussiana var. kraussiana*
THYMELAEACEAE	*Gnidia sp.*
APOCYNACEAE	*Gomphocarpus fruticosus*
OROBANCHACEAE	*Graderia linearifolia*
PROTEACEAE	*Grevillea robusta*
MALVACEAE	*Grewia bicolor var. bicolor*
MALVACEAE	*Grewia flava*
MALVACEAE	*Grewia occidentalis var. occidentalis*
MALVACEAE	*Grewia vernicosa*
CELASTRACEAE	*Gymnosporia buxifolia*

Family Name	Species Name
CELASTRACEAE	*Gymnosporia sp.*
CELASTRACEAE	*Gymnosporia tenuispina*
ORCHIDACEAE	*Habenaria barbertoni*
ORCHIDACEAE	*Habenaria dregeana*
ORCHIDACEAE	*Habenaria lithophila*
ORCHIDACEAE	*Habenaria tridens*
AMARYLLIDACEAE	*Haemanthus humilis subsp. hirsutus*
AMARYLLIDACEAE	*Haemanthus montanus*
SCROPHULARIACEAE	*Halleria lucida*
POACEAE	*Harpochloa falx*
SCROPHULARIACEAE	*Hebenstretia angolensis*
SCROPHULARIACEAE	*Hebenstretia dura*
SCROPHULARIACEAE	*Hebenstretia integrifolia*
SCROPHULARIACEAE	*Hebenstretia sp.*
ASTERACEAE	*Helichrysum acutatum*
ASTERACEAE	*Helichrysum adenocarpum subsp. adenocarpum*
ASTERACEAE	*Helichrysum albilanatum*
ASTERACEAE	*Helichrysum athrixiifolium*
ASTERACEAE	*Helichrysum aureolum*
ASTERACEAE	*Helichrysum aureonitens*
ASTERACEAE	*Helichrysum aureum var. argenteum*
ASTERACEAE	*Helichrysum aureum var. monocephalum*
ASTERACEAE	*Helichrysum callicomum*
ASTERACEAE	*Helichrysum cephaloideum*
ASTERACEAE	*Helichrysum difficile*
ASTERACEAE	*Helichrysum galpinii*
ASTERACEAE	*Helichrysum harveyanum*
ASTERACEAE	*Helichrysum interjacens*
ASTERACEAE	*Helichrysum lepidissimum*
ASTERACEAE	*Helichrysum melanacme*
ASTERACEAE	*Helichrysum miconiifolium*
ASTERACEAE	*Helichrysum mimetes*
ASTERACEAE	*Helichrysum mixtum var. mixtum*
ASTERACEAE	*Helichrysum molestum*
ASTERACEAE	*Helichrysum nudifolium*
ASTERACEAE	*Helichrysum nudifolium var. nudifolium*
ASTERACEAE	*Helichrysum nudifolium var. pilosellum*
ASTERACEAE	*Helichrysum obductum*
ASTERACEAE	*Helichrysum oreophilum*
ASTERACEAE	*Helichrysum pallidum*
ASTERACEAE	*Helichrysum platypterum*

Family Name	Species Name
ASTERACEAE	*Helichrysum polycladum*
ASTERACEAE	*Helichrysum reflexum*
ASTERACEAE	*Helichrysum rugulosum*
ASTERACEAE	*Helichrysum spiralepis*
ASTERACEAE	*Helichrysum splendidum*
ASTERACEAE	*Helichrysum subglomeratum*
ASTERACEAE	*Helichrysum swynnertonii*
ASTERACEAE	*Helichrysum thapsus*
ASTERACEAE	*Helichrysum truncatum*
BRASSICACEAE	*Heliophila acuminata*
BRASSICACEAE	*Heliophila rigidiuscula*
POACEAE	*Hemarthria altissima*
MALVACEAE	*Hermannia antonii*
MALVACEAE	*Hermannia brachymalla*
MALVACEAE	*Hermannia cristata*
MALVACEAE	*Hermannia lancifolia*
MALVACEAE	*Hermannia modesta*
MALVACEAE	*Hermannia montana*
MALVACEAE	*Hermannia staurostemon*
MALVACEAE	*Hermannia transvaalensis*
IRIDACEAE	*Hesperantha coccinea*
IRIDACEAE	*Hesperantha schlechteri*
POACEAE	*Heteropogon contortus*
MALVACEAE	*Hibiscus meyeri subsp. meyeri*
MALVACEAE	*Hibiscus microcarpus*
MALVACEAE	*Hibiscus pusillus*
MALVACEAE	*Hibiscus trionum*
ASTERACEAE	*Hilliardiella nudicaulis*
SAPINDACEAE	*Hippobromus pauciflorus*
PEDALIACEAE	*Holubia saccata*
APOCYNACEAE	*Huernia insigniflora*
APOCYNACEAE	*Huernia stapelioides*
APOCYNACEAE	*Huernia zebrina subsp. insigniflora*
HYPERICACEAE	*Hypericum aethiopicum subsp. sonderi*
ASTERACEAE	*Hypochaeris radicata*
HYPOXIDACEAE	*Hypoxis argentea var. argentea*
HYPOXIDACEAE	*Hypoxis filiformis*
HYPOXIDACEAE	*Hypoxis galpinii*
HYPOXIDACEAE	*Hypoxis rigidula var. rigidula*
HYPOXIDACEAE	*Hypoxis sp.*
AQUIFOLIACEAE	*Ilex mitis var. mitis*

Family Name	Species Name
FABACEAE	*Indigastrum costatum subsp. macrum*
FABACEAE	*Indigofera alternans var. alternans*
FABACEAE	*Indigofera egens*
FABACEAE	*Indigofera hedyantha*
FABACEAE	*Indigofera hilaris var. hilaris*
FABACEAE	*Indigofera longibarbata*
FABACEAE	*Indigofera lydenbergensis*
FABACEAE	*Indigofera sanguinea*
FABACEAE	*Indigofera schinzii*
FABACEAE	*Indigofera sp.*
CONVOLVULACEAE	*Ipomoea bathycolpos*
CONVOLVULACEAE	*Ipomoea crassipes var. crassipes*
CONVOLVULACEAE	*Ipomoea oblongata*
CONVOLVULACEAE	*Ipomoea ommanneyi*
CYPERACEAE	*Isolepis costata*
CYPERACEAE	*Isolepis inyangensis*
SCROPHULARIACEAE	*Jamesbrittenia aurantiaca*
SCROPHULARIACEAE	*Jamesbrittenia huillana*
SCROPHULARIACEAE	*Jamesbrittenia macrantha*
SCROPHULARIACEAE	*Jamesbrittenia silenoides*
OLEACEAE	*Jasminum multipartitum*
OLEACEAE	*Jasminum quinatum*
EUPHORBIACEAE	*Jatropha latifolia var. angustata*
EUPHORBIACEAE	*Jatropha latifolia var. latifolia*
JUNCACEAE	*Juncus oxycarpus*
ACANTHACEAE	*Justicia anagalloides*
ACANTHACEAE	*Justicia odora*
CRASSULACEAE	*Kalanchoe luciae subsp. luciae*
CRASSULACEAE	*Kalanchoe rotundifolia*
LAMIACEAE	*Karomia speciosa forma speciosa*
MESEMBRYANTHEMACEAE	*Khadia alticola*
MESEMBRYANTHEMACEAE	*Khadia beswickii*
KIRKIACEAE	*Kirkia wilmsii*
ASTERACEAE	*Kleinia stapeliiformis*
ASPHODELACEAE	*Kniphofia ensifolia subsp. ensifolia*
ASPHODELACEAE	*Kniphofia rigidifolia*
POACEAE	*Koeleria capensis*
RUBIACEAE	*Kohautia caespitosa subsp. brachyloba*
CYPERACEAE	*Kyllinga erecta var. erecta*
AMARANTHACEAE	*Kyphocarpa angustifolia*
FABACEAE	*Lablab purpureus subsp. uncinatus*

Family Name	Species Name
ASTERACEAE	*Laggera decurrens*
VERBENACEAE	*Lantana mearnsii var. latibracteolata*
HYACINTHACEAE	*Ledebouria cooperi*
HYACINTHACEAE	*Ledebouria lepida*
HYACINTHACEAE	*Ledebouria marginata*
HYACINTHACEAE	*Ledebouria sandersonii*
POACEAE	*Leersia hexandra*
FABACEAE	*Leobordea carinata*
FABACEAE	*Leobordea foliosa*
FABACEAE	*Leobordea mucronata*
LAMIACEAE	*Leonotis leonurus*
LAMIACEAE	*Leonotis ocymifolia*
LAMIACEAE	*Leucas capensis*
MOLLUGINACEAE	*Limeum pauciflorum*
SCROPHULARIACEAE	*Linaria vulgaris*
LINACEAE	*Linum thunbergii*
VERBENACEAE	*Lippia javanica*
VERBENACEAE	*Lippia wilmsii*
LOBELIACEAE	*Lobelia erinus*
LOBELIACEAE	*Lobelia flaccida subsp. flaccida*
POACEAE	*Lolium multiflorum*
ASTERACEAE	*Lopholaena segmentata*
FABACEAE	*Lotononis eriantha*
FABACEAE	*Lotononis laxa*
FABACEAE	*Lotononis pulchra*
FABACEAE	*Lotononis wilmsii*
POACEAE	*Loudetia simplex*
SOLANACEAE	*Lycium horridum*
LYCOPODIACEAE	*Lycopodium clavatum*
CELASTRACEAE	*Lydenburgia cassinoides*
CAPPARACEAE	*Maerua cafra*
MAESACEAE	*Maesa lanceolata*
SCROPHULARIACEAE	*Manulea rhodantha subsp. aurantiaca*
CYPERACEAE	*Mariscus macer*
CYPERACEAE	*Mariscus sumatrensis*
CELASTRACEAE	*Maytenus undata*
SCROPHULARIACEAE	*Melanospermum transvaalense*
OROBANCHACEAE	*Melasma scabrum var. scabrum*
MALVACEAE	*Melhania rehmannii*
POACEAE	*Melinis nerviglumis*
FABACEAE	*Melolobium wilmsii*

Family Name	Species Name
POACEAE	*Merxmuellera macowanii*
POACEAE	*Microchloa caffra*
POACEAE	*Microchloa kunthii*
SAPOTACEAE	*Mimusops zeyheri*
ANEMIACEAE	*Mohria nudiuscula*
ANEMIACEAE	*Mohria vestita*
LOBELIACEAE	*Monopsis decipiens*
GERANIACEAE	*Monsonia angustifolia*
GERANIACEAE	*Monsonia attenuata*
GERANIACEAE	*Monsonia glauca*
IRIDACEAE	*Moraea elliotii*
IRIDACEAE	*Moraea trifida*
FABACEAE	*Mundulea sericea subsp. sericea*
ORCHIDACEAE	*Mystacidium capense*
CELASTRACEAE	*Mystroxylon aethiopicum subsp. schlechteri*
AMARYLLIDACEAE	*Nerine rehmannii*
ASTERACEAE	*Nidorella auriculata*
BUDDLEJACEAE	*Nuxia gracilis*
OCHNACEAE	*Ochna inermis*
OCHNACEAE	*Ochna serrulata*
LAMIACEAE	*Ocimum serratum*
LAMIACEAE	*Ocimum tubiforme*
OLEACEAE	*Olea capensis subsp. enervis*
OLEACEAE	*Olea europaea subsp. africana*
OLINIACEAE	*Olinia emarginata*
OLINIACEAE	*Olinia rochetiana*
APOCYNACEAE	*Orbea carnosa subsp. carnosa*
APOCYNACEAE	*Orbea carnosa subsp. keithii*
FABACEAE	*Ormocarpum kirkii*
FABACEAE	*Ormocarpum trichocarpum*
HYACINTHACEAE	*Ornithogalum tenuifolium subsp. tenuifolium*
COLCHICACEAE	*Ornithoglossum vulgare*
LAMIACEAE	*Orthosiphon fruticosus*
FABACEAE	*Otholobium wilmsii*
ASTERACEAE	*Othonna natalensis*
OXALIDACEAE	*Oxalis semiloba subsp. semiloba*
ANACARDIACEAE	*Ozoroa sphaerocarpa*
APOCYNACEAE	*Pachycarpus asperifolius*
APOCYNACEAE	*Pachycarpus macrochilus*
APOCYNACEAE	*Pachycarpus transvaalensis*
POACEAE	*Panicum maximum*

Family Name	Species Name
POACEAE	*Panicum natalense*
PARMELIACEAE	*Parmelia isidiza*
PARMELIACEAE	*Parmelinella wallichiana*
PARMELIACEAE	*Parmotrema grayanum*
THYMELAEACEAE	*Passerina montana*
RUBIACEAE	*Pavetta lanceolata*
RUBIACEAE	*Pavetta schumanniana*
FABACEAE	*Pearsonia cajanifolia subsp. cajanifolia*
FABACEAE	*Pearsonia cajanifolia subsp. cryptantha*
FABACEAE	*Pearsonia grandifolia subsp. latibracteolata*
FABACEAE	*Pearsonia sessilifolia subsp. sessilifolia*
FABACEAE	*Pearsonia uniflora*
ASTERACEAE	*Pegolettia lanceolata*
GERANIACEAE	*Pelargonium luridum*
GERANIACEAE	*Pelargonium multicaule subsp. subherbaceum*
FABACEAE	*Peltophorum africanum*
POACEAE	*Pennisetum sphacelatum*
RUBIACEAE	*Pentanisia angustifolia*
POACEAE	*Pentaschistis chippindalliae*
POACEAE	*Pentaschistis natalensis*
POLYGONACEAE	*Persicaria meisneriana*
ACANTHACEAE	*Petalidium oblongifolium*
SCROPHULARIACEAE	*Phygelius aequalis*
PHYLLANTHACEAE	*Phyllanthus parvulus*
PHYLLANTHACEAE	*Phyllanthus parvulus var. garipensis*
PHYLLANTHACEAE	*Phyllanthus sp.*
PHYTOLACCACEAE	*Phytolacca octandra*
APOCYNACEAE	*Piaranthus atrosanguineus*
APIACEAE	*Pimpinella transvaalensis*
PITTOSPORACEAE	*Pittosporum viridiflorum*
PLANTAGINACEAE	*Plantago virginica*
LAMIACEAE	*Plectranthus hadiensis var. tomentosus*
POACEAE	*Poa annua*
POACEAE	*Poa binata*
MNIACEAE	*Pohlia baronii*
MNIACEAE	*Pohlia cruda*
CARYOPHYLLACEAE	*Pollichia campestris*
POLYGALACEAE	*Polygala hottentotta*
POLYGALACEAE	*Polygala houtboshiana*
POLYGALACEAE	*Polygala krumanina*
POLYGALACEAE	*Polygala leptophylla*

Family Name	Species Name
POLYGALACEAE	*Polygala producta*
POLYGALACEAE	*Polygala sp.*
POLYGALACEAE	*Polygala sphenoptera var. sphenoptera*
POLYTRICHACEAE	*Polytrichum commune*
PROTEACEAE	*Protea caffra subsp. caffra*
PROTEACEAE	*Protea caffra X parvula*
PROTEACEAE	*Protea parvula*
PROTEACEAE	*Protea roupelliae subsp. roupelliae*
PROTEACEAE	*Protea rubropilosa*
PROTEACEAE	*Protea welwitschii*
MOLLUGINACEAE	*Psammotropha mucronata var. mucronata*
MOLLUGINACEAE	*Psammotropha myriantha*
ASTERACEAE	*Psiadia punctulata*
RUBIACEAE	*Psydrax obovata subsp. obovata*
PTERIDACEAE	*Pteris buchananii*
FABACEAE	*Pueraria lobata var. lobata*
CYPERACEAE	*Pycreus nitidus*
CYPERACEAE	*Pycreus rehmannianus*
LAMIACEAE	*Rabdosiella calycina*
APOCYNACEAE	*Raphionacme galpinii*
APOCYNACEAE	*Raphionacme procumbens*
POACEAE	*Rendlia altera*
HYACINTHACEAE	*Resnova humifusa*
RHAMNACEAE	*Rhamnus prinoides*
BIGNONIACEAE	*Rhigozum sp.*
VITACEAE	*Rhoicissus sekhukhuniensis*
VITACEAE	*Rhoicissus sp.*
VITACEAE	*Rhoicissus tridentata subsp. cuneifolia*
VITACEAE	*Rhoicissus tridentata subsp. tridentata*
ANACARDIACEAE	*Rhus keetii*
ANACARDIACEAE	*Rhus sp.*
FABACEAE	*Rhynchosia adenodes*
FABACEAE	*Rhynchosia minima var. minima*
FABACEAE	*Rhynchosia nervosa var. nervosa*
RUBIACEAE	*Richardia scabra*
PARMELIACEAE	*Rimelia cetrata*
LAMIACEAE	*Rotheca louwalbertsii*
ROSACEAE	*Rubus ludwigii subsp. ludwigii*
POLYGONACEAE	*Rumex acetosella subsp. angiocarpus*
POLYGONACEAE	*Rumex crispus*
POLYGONACEAE	*Rumex dregeanus subsp. montanus*

Family Name	Species Name
POLYGONACEAE	*Rumex sagittatus*
ORCHIDACEAE	*Satyrium neglectum subsp. neglectum var. neglectum*
ASTERACEAE	*Schistostephium crataegifolium*
POACEAE	*Schizachyrium sanguineum*
HYACINTHACEAE	*Schizocarphus nervosus*
ORCHIDACEAE	*Schizochilus cecilii subsp. transvaalensis*
APOCYNACEAE	*Schizoglossum bidens subsp. galpinii*
ASTERACEAE	*Schkuhria pinnata*
CYPERACEAE	*Schoenoplectus muriculatus*
FABACEAE	*Schotia brachypetala*
CYPERACEAE	*Scleria dieterlenii*
ANACARDIACEAE	*Searsia dentata*
ANACARDIACEAE	*Searsia discolor*
ANACARDIACEAE	*Searsia engleri*
ANACARDIACEAE	*Searsia gerrardii*
ANACARDIACEAE	*Searsia keetii*
ANACARDIACEAE	*Searsia leptodictya forma leptodictya*
ANACARDIACEAE	*Searsia pyroides var. pyroides*
ANACARDIACEAE	*Searsia sekhukhuniensis*
ANACARDIACEAE	*Searsia tumulicola var. meeuseana forma meeuseana*
ANACARDIACEAE	*Searsia tumulicola var. meeuseana forma pumila*
ANACARDIACEAE	*Searsia wilmsii*
ANACARDIACEAE	*Searsia zeyheri*
GENTIANACEAE	*Sebaea grandis*
GENTIANACEAE	*Sebaea longicaulis*
GENTIANACEAE	*Sebaea sedoides var. confertiflora*
CONVOLVULACEAE	*Seddera suffruticosa*
SELAGINELLACEAE	*Selaginella dregei*
SELAGINELLACEAE	*Selaginella mittenii*
SCROPHULARIACEAE	*Selago capitellata*
SCROPHULARIACEAE	*Selago compacta*
SCROPHULARIACEAE	*Selago lydenburgensis*
ASTERACEAE	*Senecio barbatus*
ASTERACEAE	*Senecio conrathii*
ASTERACEAE	*Senecio gerrardii*
ASTERACEAE	*Senecio glaberrimus*
ASTERACEAE	*Senecio gregatus*
ASTERACEAE	*Senecio lygodes*
ASTERACEAE	*Senecio macrocephalus*
ASTERACEAE	*Senecio microglossus*
ASTERACEAE	*Senecio oxyriifolius subsp. oxyriifolius*

Family Name	Species Name
ASTERACEAE	*Senecio serratuloides*
ASTERACEAE	*Senecio speciosus*
ASTERACEAE	*Senecio subcoriaceus*
FABACEAE	*Senna italica subsp. arachoides*
ASTERACEAE	*Seriphium plumosum*
PEDALIACEAE	*Sesamum triphyllum var. triphyllum*
POACEAE	*Setaria nigrirostris*
POACEAE	*Setaria sphacelata var. sphacelata*
POACEAE	*Setaria sphacelata var. torta*
MALVACEAE	*Sida rhombifolia*
CARYOPHYLLACEAE	*Silene burchellii var. burchellii*
SOLANACEAE	*Solanum rigescens*
FABACEAE	*Sphenostylis angustifolia*
POACEAE	*Sporobolus centrifugus*
LAMIACEAE	*Stachys natalensis var. galpinii*
MENISPERMACEAE	*Stephania abyssinica var. tomentella*
POACEAE	*Stiburus alopecuroides*
POACEAE	*Stiburus conrathii*
POACEAE	*Stipagrostis hirtigluma subsp. patula*
ASTERACEAE	*Stoebe vulgaris*
GESNERIACEAE	*Streptocarpus sp.*
GESNERIACEAE	*Streptocarpus vandeleurii*
OROBANCHACEAE	*Striga asiatica*
OROBANCHACEAE	*Striga gesnerioides*
ARACEAE	*Stylochaeton natalensis*
POACEAE	*Styppeiochloa gynoglossa*
PALLAVICINIACEAE	*Symphyogyna brasiliensis*
LAMIACEAE	*Syncolostemon albiflorus*
LAMIACEAE	*Syncolostemon canescens*
LAMIACEAE	*Syncolostemon concinnus*
LAMIACEAE	*Syncolostemon parvifolius*
POTTIACEAE	*Syntrichia chisosa*
MYRTACEAE	*Syzygium cordatum*
LORANTHACEAE	*Tapinanthus forbesii*
LORANTHACEAE	*Tapinanthus quequensis*
LORANTHACEAE	*Tapinanthus rubiginosus*
SCROPHULARIACEAE	*Teedia lucida*
FABACEAE	*Tephrosia longipes subsp. longipes var. longipes*
COMBRETACEAE	*Terminalia prunioides*
LAMIACEAE	*Tetradenia brevispicata*
SCROPHULARIACEAE	*Tetraselago wilmsii*

Family Name	Species Name
RUTACEAE	*Thamnosma africana*
SANTALACEAE	*Thesium burkei*
SANTALACEAE	*Thesium impeditum*
SANTALACEAE	*Thesium sp.*
LAMIACEAE	*Tinnea galpinii*
LAMIACEAE	*Tinnea rhodesiana*
ASTERACEAE	*Tolpis capensis*
POTTIACEAE	*Tortula atrovirens*
ASPHODELACEAE	*Trachyandra saltii var. saltii*
POACEAE	*Trachypogon spicatus*
MALPIGHIACEAE	*Triaspis glaucophylla*
MALPIGHIACEAE	*Triaspis hypericoides subsp. nelsonii*
POTTIACEAE	*Trichostomum brachydontium*
POACEAE	*Triraphis andropogonoides*
POACEAE	*Tristachya biseriata*
POACEAE	*Triticum sp.*
MALVACEAE	*Triumfetta obtusicornis*
ALLIACEAE	*Tulbaghia acutiloba*
ALLIACEAE	*Tulbaghia leucantha*
MELIACEAE	*Turraea obtusifolia*
POACEAE	*Urelytrum agropyroides*
RUBIACEAE	*Vangueria infausta subsp. infausta*
RUTACEAE	*Vepris reflexa*
VERBENACEAE	*Verbena bonariensis*
VERBENACEAE	*Verbena venosa*
ASTERACEAE	*Vernonia galpinii*
ASTERACEAE	*Vernonia staehelinoides*
FABACEAE	*Vigna vexillata var. vexillata*
VISCACEAE	*Viscum combreticola*
VISCACEAE	*Viscum rotundifolium*
VISCACEAE	*Viscum verrucosum*
LAMIACEAE	*Vitex obovata subsp. wilmsii*
CAMPANULACEAE	*Wahlenbergia androsacea*
CAMPANULACEAE	*Wahlenbergia capillacea subsp. capillacea*
CAMPANULACEAE	*Wahlenbergia lycopodioides*
CAMPANULACEAE	*Wahlenbergia sp.*
CAMPANULACEAE	*Wahlenbergia squamifolia*
CAMPANULACEAE	*Wahlenbergia undulata*
MALVACEAE	*Waltheria indica*
SOLANACEAE	*Withania somnifera*
CONVOLVULACEAE	*Xenostegia tridentata subsp. angustifolia*

Family Name	Species Name
VELLOZIACEAE	*Xerophyta retinervis*
OLACACEAE	*Ximenia americana var. americana*
APOCYNACEAE	*Xysmalobium pedifoetidum*
ARACEAE	*Zantedeschia albomaculata subsp. macrocarpa*
ARACEAE	*Zantedeschia jucunda*
ARACEAE	*Zantedeschia pentlandii*
ARACEAE	*Zantedeschia rehmannii*
RHAMNACEAE	*Ziziphus mucronata subsp. mucronata*
FABACEAE	*Zornia milneana*

14 APPENDIX C. BIRD SPECIES LIST FOR QDS

Common_name	Taxon_name
Apalis, Bar-throated	*Apalis thoracica*
Apalis, Yellow-breasted	*Apalis flavida*
Barbet, Acacia Pied	*Tricholaema leucomelas*
Barbet, Black-collared	*Lybius torquatus*
Barbet, Crested	*Trachyphonus vaillantii*
Batis, Chinspot	*Batis molitor*
Bee-eater, European	*Merops apiaster*
Bee-eater, Little	*Merops pusillus*
Bee-eater, White-fronted	*Merops bullockoides*
Bishop, Southern Red	*Euplectes orix*
Bishop, Yellow-crowned	*Euplectes afer*
Boubou, Southern	*Laniarius ferrugineus*
Bulbul, Dark-capped	*Pycnonotus tricolor*
Bunting, Cinnamon-breasted	*Emberiza tahapisi*
Bunting, Golden-breasted	*Emberiza flaviventris*
Bush-shrike, Gorgeous	*Telophorus quadricolor*
Bush-shrike, Grey-headed	*Malaconotus blanchoti*
Bush-shrike, Orange-breasted	*Telophorus sulfureopectus*
Buzzard, Steppe	*Buteo vulpinus*
Canary, Black-throated	*Crithagra atrogularis*
Canary, Yellow-fronted	*Crithagra mozambicus*
Chat, Familiar	*Cercomela familiaris*
Cisticola, Desert	*Cisticola aridulus*
Cisticola, Lazy	*Cisticola aberrans*
Cisticola, Rattling	*Cisticola chiniana*
Cisticola, Zitting	*Cisticola juncidis*
Cliff-chat, Mocking	*Thamnolaea cinnamomeiventris*
Cormorant, Reed	*Phalacrocorax africanus*
Cormorant, White-breasted	*Phalacrocorax carbo*
Coucal, Burchell's	*Centropus burchellii*
Crombec, Long-billed	*Sylvietta rufescens*
Crow, Cape	*Corvus capensis*
Crow, Pied	*Corvus albus*
Cuckoo, Diderick	*Chrysococcyx caprius*
Cuckoo, Jacobin	*Clamator jacobinus*
Cuckoo, Klaas's	*Chrysococcyx klaas*
Cuckoo, Red-chested	*Cuculus solitarius*
Dove, Laughing	*Streptopelia senegalensis*
Dove, Namaqua	*Oena capensis*
Dove, Red-eyed	*Streptopelia semitorquata*

Common_name	Taxon_name
Drongo, Fork-tailed	*Dicrurus adsimilis*
Eagle, Wahlberg's	*Aquila wahlbergi*
Egret, Cattle	*Bubulcus ibis*
Falcon, Lanner	*Falco biarmicus*
Finch, Cut-throat	*Amadina fasciata*
Finch, Red-headed	*Amadina erythrocephala*
Finch, Scaly-feathered	*Sporopipes squamifrons*
Firefinch, Jameson's	*Lagonosticta rhodopareia*
Firefinch, Red-billed	*Lagonosticta senegala*
Fiscal, Common (Southern)	*Lanius collaris*
Flycatcher, Fiscal	*Sigelus silens*
Flycatcher, Marico	*Bradornis mariquensis*
Flycatcher, Spotted	*Muscicapa striata*
Francolin, Crested	*Dendroperdix sephaena*
Go-away-bird, Grey	*Corythaixoides concolor*
Goose, Egyptian	*Alopochen aegyptiacus*
Grebe, Little	*Tachybaptus ruficollis*
Greenbul, Sombre	*Andropadus importunus*
Greenbul, Yellow-bellied	*Chlorocichla flaviventris*
Guineafowl, Helmeted	*Numida meleagris*
Hamerkop, Hamerkop	*Scopus umbretta*
Harrier-Hawk, African	*Polyboroides typus*
Heron, Black-headed	*Ardea melanocephala*
Heron, Grey	*Ardea cinerea*
Honeyguide, Greater	*Indicator indicator*
Hoopoe, African	*Upupa africana*
House-martin, Common	*Delichon urbicum*
Ibis, Hadeda	*Bostrychia hagedash*
Ibis, Southern Bald	*Geronticus calvus*
Indigobird, Purple	*Vidua purpurascens*
Indigobird, Village	*Vidua chalybeata*
Kestrel, Rock	*Falco rupicolus*
Kingfisher, Brown-hooded	*Halcyon albiventris*
Kingfisher, Giant	*Megaceryle maximus*
Kingfisher, Pied	*Ceryle rudis*
Kite, Yellow-billed	*Milvus aegyptius*
Lapwing, Blacksmith	*Vanellus armatus*
Lapwing, Crowned	*Vanellus coronatus*
Lark, Rufous-naped	*Mirafra africana*
Lark, Sabota	*Calendulauda sabota*
Martin, Brown-throated	*Riparia paludicola*

Common_name	Taxon_name
Martin, Rock	*Hirundo fuligula*
Masked-weaver, Southern	*Ploceus velatus*
Mousebird, Red-faced	*Urocolius indicus*
Mousebird, Speckled	*Colius striatus*
Myna, Common	*Acridotheres tristis*
Neddicky, Neddicky	*Cisticola fulvicapilla*
Oriole, Black-headed	*Oriolus larvatus*
Oxpecker, Red-billed	*Buphagus erythrorhynchus*
Paradise-flycatcher, African	*Terpsiphone viridis*
Paradise-whydah, Long-tailed	*Vidua paradisaea*
Pigeon, Speckled	*Columba guinea*
Pipit, African	*Anthus cinnamomeus*
Plover, Three-banded	*Charadrius tricollaris*
Prinia, Black-chested	*Prinia flavicans*
Prinia, Tawny-flanked	*Prinia subflava*
Puffback, Black-backed	*Dryoscopus cubla*
Pytilia, Green-winged	*Pytilia melba*
Quailfinch, African	*Ortygospiza atricollis*
Quelea, Red-billed	*Quelea quelea*
Raven, White-necked	*Corvus albicollis*
Robin-chat, White-throated	*Cossypha humeralis*
Rock-thrush, Sentinel	*Monticola explorator*
Sandpiper, Common	*Actitis hypoleucos*
Scimitarbill, Common	*Rhinopomastus cyanomelas*
Scrub-robin, Kalahari	*Cercotrichas paena*
Scrub-robin, White-browed	*Cercotrichas leucophrys*
Shrike, Lesser Grey	*Lanius minor*
Shrike, Red-backed	*Lanius collurio*
Snake-eagle, Black-chested	*Circaetus pectoralis*
Sparrow, Cape	*Passer melanurus*
Sparrow, Great	*Passer motitensis*
Sparrow, House	*Passer domesticus*
Sparrow, Southern Grey-headed	*Passer diffusus*
Sparrowlark, Chestnut-backed	*Eremopterix leucotis*
Sparrow-weaver, White-browed	*Plocepasser mahali*
Spurfowl, Natal	*Pternistis natalensis*
Spurfowl, Swainson's	*Pternistis swainsonii*
Starling, Cape Glossy	*Lamprotornis nitens*
Starling, Red-winged	*Onychognathus morio*
Starling, Violet-backed	*Cinnyricinclus leucogaster*
Sunbird, Amethyst	*Chalcomitra amethystina*

Common_name	Taxon_name
Sunbird, Marico	*Cinnyris mariquensis*
Sunbird, White-bellied	*Cinnyris talatala*
Swallow, Barn	*Hirundo rustica*
Swallow, Greater Striped	*Hirundo cucullata*
Swallow, Lesser Striped	*Hirundo abyssinica*
Swallow, Pearl-breasted	*Hirundo dimidiata*
Swallow, Wire-tailed	*Hirundo smithii*
Swift, African Black	*Apus barbatus*
Swift, Alpine	*Tachymarptis melba*
Swift, Little	*Apus affinis*
Swift, White-rumped	*Apus caffer*
Tchagra, Black-crowned	*Tchagra senegalus*
Tchagra, Brown-crowned	*Tchagra australis*
Tinkerbird, Yellow-fronted	*Pogoniulus chrysoconus*
Tit, Southern Black	*Parus niger*
Tit-babbler, Chestnut-vented	*Parisoma subcaeruleum*
Turtle-dove, Cape	*Streptopelia capicola*
Vulture, Cape	*Gyps coprotheres*
Wagtail, Cape	*Motacilla capensis*
Waxbill, Black-faced	*Estrilda erythronotos*
Waxbill, Blue	*Uraeginthus angolensis*
Waxbill, Common	*Estrilda astrild*
Waxbill, Violet-eared	*Granatina granatina*
Weaver, Spectacled	*Ploceus ocularis*
Weaver, Village	*Ploceus cucullatus*
Whydah, Pin-tailed	*Vidua macroura*
Whydah, Shaft-tailed	*Vidua regia*
Widowbird, White-winged	*Euplectes albonotatus*
Wood-dove, Emerald-spotted	*Turtur chalcospilos*
Woodpecker, Golden-tailed	*Campethera abingoni*

15 APPENDIX D MAMMAL SPECIES LIST

Scientific name	Vernacular name	Probability of occurrence
Acomys spinosissimus	Spiny mouse	High
Aepyceros melampus	Impala	Confirmed
Aethomys ineptus	Tete veld rat	Medium
Aethomys namaquensis	Namaqua rock mouse	High
Canis mesomelas	Black backed jackal	High
Caracal caracal	Caracal	Medium
Cercopithecus aethiops pygerythrus	Vervet monkey	High
Civettictis civetta	African civet	High
Connochaetes taurinus taurinus	blue wildebeest	Confirmed
Crocidura cyanea	Reddish grey musk shrew	High
Crocidura fuscomurina	Tiny musk shrew	High
Crocidura hirta	Lesser red musk shrew	High
Crocidura silacea	Lesser Grey Brown Musk Shrew	High
Cryptomys hottentotus	Common molerat	High
Elephantulus brachyrhynchus	Short-snouted elephant shrew	High
Elephantulus myurus	Rock elephant shrew	High
Epomophorus wahlbergi	Wahlberg's epauletted fruit bat	High
Equus burchellii	plains zebra	Confirmed
Erinaceus frontalis	**South African Hedgehog**	**Marginal**
Felis silvestris	African wild cat	Medium
Galago moholi	Southern Lesser bushbaby	High
Galerella sanguinea	Slender mongoose	High
Genetta genetta	Small spotted genet	High
Genetta tigrina	Large spotted genet	High
Graphiurus murinus	Woodland dormouse	High
Graphiurus platyops	Rock dormouse	High
Helogale parvula	Dwarf mongoose	High
Hipposideros caffer	Sundevall's leaf nosed bat	High
Hyaena brunnea	**Brown hyena**	**Low**
Hystrix africaeaustralis	Porcupine	High
Ichneumia albicauda	White-tailed mongoose	Medium
Ictonyx striatus	Striped polecat	High
Kobus ellipsiprymnus ellypsiprymnus	waterbuck	Confirmed
Lemniscomys rosalia	Single striped mouse	High
Lepus capensis	Cape hare	Medium
Lepus saxatilis	Schrub hare	High
Manis temminckii	Pangolin	Low
Mastomys coucha	Multimammate mouse	High
Mellivora capensis	**Honey badger**	**Low**
Miniopterus schreibersii	**Schreibers' long fingered bat**	**High**
Mungos mungo	Banded mongoose	High
Mus munitoides	Pygmy mouse	High

Scientific name	Vernacular name	Probability of occurrence
Myotis tricolour	**Temminck's hairy bat**	**Low**
Myotis welwitschii	**Welwitsch's hairy bat**	**Very low**
Neoromicia capensis	Cape serotine bat	High
Nycteris thebaica	Common slit-faced bat	High
Oreotragus oreotragus	Klipspringer	High
Orycteropus afer	Antbear	Medium
Panthera pardus	Leopard	Low
Papio ursinus	Chacma baboon	Low
Paraxerus cepapi	Tree squirrel	High
Pedetes capensis	Springhare	High
Pelea capreolus	Grey rhebuck	Low
Phacochoerus aethiopicus	Warthog	Low
Pippistrellus rusticus	**Rusty bat**	**Marginal**
Poecilogale albinucha	African weasel	Marginal
Procavia capensis	Rock dassie	Medium
Proteles cristatus	aardwolf	Low
Raphicerus campestris	Steenbok	High
Redunca fulvorufula	Mountain reedbuck	Medium
Rhinolophus clivosus	**Geoffroy's horseshoe bat**	**Medium**
Rhinolophus darlingi	**Darling's horseshoe bat**	**Marginal**
Rhinolophus hildebrandtii	**Hildebrandt's Horseshoe bat**	**Marginal**
Rhinolophus simulator	Bushveld horseshoe bat	High
Rousettus aegyptiacus	Egyptian fruit bat	Marginal
Saccostomus campestris	Pouched mouse	High
Scotophilus dinganii	Yellow house bat	Medium
Scotophilus viridus	Lesser yellow house bat	Low
Steatomys pratensis	Fat mouse	High
Suncus infinitesimus	Least dwarf shrew	Medium
Suncus lixus	Greater dwarf shrew	High
Suncus varilla	Lesser dwarf shrew	Marginal
Sylvicapra grimmia	Common duiker	Confirmed
Tadarida aegyptiaca	Egyptian free-tailed bat	High
Tatera leucogaster	Bushveld gerbil	High
Thallomys paedulcus	Tree rat	High
Tragelaphus scriptus	Bushbuck	Low
Tragelaphus strepsiceros	Kudu	Low

16 APPENDIX E HERPETOFAUNA LIST

Scientific name	Common name	Probability of occurrence	Status
FROGS & TOADS			
Breviceps adspersus	Bushveld Rain Frog	High	Not threatened
Bufo garmani	Olive Toad	Medium	Not threatened
Bufo gutturalis	Guttural Toad	High	Not threatened
Ptychadena anchietae	Plain grass frog	High	Not threatened
Tomopterna natalensis	Natal Sand Frog	High	Not threatened
REPTILES			
Acanthocercus atricollis	Southern tree agama	High	Not threatened
Agama atra	Southern rock agama	Marginal	Not threatened
Aparallactus capensis	Cape centipede eater	High	Not threatened
Atractaspis bibronii	Southern Burrowing Asp	High	Not threatened
Bitis arietans	Puffadder	High	Not threatened
Causus rhombeatus	Common night adder	High	Not threatened
Chamaeleo dilepis	Flap-neck chameleon	High	Not threatened
Crotaphopeltis hotamboeia	Red-lipped snake	High	Not threatened
Dasypeltis egg eater	Common egg eater	High	Not threatened
Dendroaspis polylepis	Black mamba	High	Not threatened
Dispholidus typus	Boomslang	High	Not threatened
Duberria lutrix	Common slug eater	High	Not threatened
Elapsoidea sunderwallii	Sundevall's garter snake	High	Not threatened
Geochelone pardalis	Leopard tortoise	High	Not threatened
Gerrhosaurus flavigularis	Yellow-throated plated lizard	High	Not threatened
Gerrhosaurus nigrolineatus	Black lined plated lizard	Marginal	Not threatened
Gerrhosaurus validus	Giant plated lizard	High	Not threatened
Hemidactylus mabouia	Moreau's tropical house gecko	High	Not threatened
Homoroselaps dorsalis	**Striped Harlequin Snake**	**Low**	**Near Threatened**
Lamprophis swazicus	**Swazi Rock Snake**	**Moderate**	**Near Threatened**
Homopjolis wahlbergii	Wahlberg's velvet gecko	Marginal	Not threatened
Homoroselaps lacteus	Spotted Harlequin snake	High	Not threatened
Ichnotropis squamulosa	Common rough scaled lizard	High	Not threatened
Kinixys spekii	Speke's Hinged Tortoise	High	Not threatened
Lamprophis fuliginosus	Brown house snake	High	Not threatened
Lamprophis guttatus	Spotted house snake	High	Not threatened
Leptotyphlops conjuntus	Cape and eastern thread snakes	High	Not threatened
Leptotyphlops nigricans	Black thread snake	Medium	Not threatened
Leptotyphlops scutifrons	Peter's thread snake	High	Not threatened
Lycophidion capense	Cape wolf snake	High	Not threatened
Lygodactylus capensis	Cape dwarf gecko	High	Not threatened
Lygodactylus nigropunctatus	Black-spotted dwarf gecko	Medium	Not threatened
Lygodactylus ocellatus	Spotted dwarf gecko	Marginal	Not threatened
Mabuya quinquetaeniata	Rainbow skink	High	Not threatened

Scientific name	Common name	Probability of occurrence	Status
Mabuya striata	Striped skink	High	Not threatened
Mabuya varia	Variable skink	High	Not threatened
Mehelya capensis	Cape file snake	High	Protected species
Mehelya nyassae	Black file snake	High	Protected species
Monopeltis infuscata	Dusky spade-snouted worm lizard	High	Not threatened
Naja annulifera	Snouted cobra	High	Not threatened
Naja mossambica	Mosambique spitting cobra	High	Not threatened
Nucras holubi	Holub's sandveld lizard	Marginal	Not threatened
Nucras intertexta	Spotted sandveld lizard	Low	Not threatened
Nucras ornata	Ornate sandveld lizard	Medium	Not threatened
Pachydactylus vansoni	Van Son's Thick toed gecko	High	Not threatened
Panaspis spp.	Spotted-necked snake eyed skink	Marginal	Not threatened
Panaspis wahlbergii	Wahlberg's snake eyed skink	High	Not threatened
Pedioplanis lineocellata	Spotted sand lizard	Medium	Not threatened
Philothamnus semivariegatus	Spotted bush snake	High	Not threatened
Platysaurus intermedius	Common flat lizard	Marginal	Not threatened
Platysaurus orientalis	Sekhukune flat lizard	High	Red data species
Prosymna sundevallii	Sundevall's shovel snout	High	Not threatened
Psammophis subtaeniatus	Stripe-bellied sand snake	High	Not threatened
Psammophylax tritaeniatus	Striped skaapsteker	High	Not threatened
Python natalensis	**South African Python**	**High**	**Vulnerable**
Rhinotyphlops lalandei	Delalande's beaked blind snake	High	Not threatened
Thelotornis capensis	Vine snake	High	Not threatened
Varanus albigularis	Rock Monitor	High	Not threatened