PALAEONTOLOGICAL IMPACT ASSESSMENT OF THE PROPOSED DEVELOPMENT OF THE NEW COAL-FIRED POWER PLANT AND ASSOCIATED INFRASTRUCTURE NEAR MAKHADO, LIMPOPO PROVINCE

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EXECUTIVE SUMMARY

Mutsho Power (Pty) Ltd proposes the development of a new coal-fired power plant and associated infrastructure near Makhado, in the Limpopo Province. According to the National Heritage Resources Act (Act No 25 of 1999, section 38), a palaeontological impact assessment is required to detect the presence of fossil material within the proposed development footprint and to assess the impact of the construction and operation of the project on the palaeontological resources.

The proposed footprint is underlain by sediments of the

- Undifferentiated Karoo Basin; Tshipise and Tuli Sedimentary Basin and Solitude Formation;
- and Malala drift Gneiss and Gumbu Group of the Beit Bridge Complex, Archaean Granite-Gneiss Basement.

Fossil heritage could be present in the Undifferentiated Karoo as well as the Solitude Formation which has a very high to high Palaeontological Sensitivity. The Archaean Granite-Gneiss Basement, Beit Bridge Complex and Malala Drift Suite, Gumbu Group is metamorphic rocks which is unfossiliferous and with a very low palaeontological sensitivity.

An EIA level palaeontology report will be conducted to assess the value and prominence of fossils in the development area and the effect of the proposed development on the palaeontological heritage. This consists of a Phase 1 field-based assessment by a professional palaeontologist. The purpose of the EIA Report is to elaborate on the issues and potential impacts identified during the scoping phase. This is achieved by site visits and research in the site-specific study area as well as a comprehensive assessment of the impacts identified during the scoping phase.

CONTENTS

1 INTRODUCTION

Savannah Environmental (Pty) Ltd has been appointed as the independent Environmental Consultants by Mutsho Power (Pty) Ltd for the undertaking of an integrated Environmental Impact Assessment (EIA) process to obtain Environmental Authorisation and a Waste Management License (WML) for the proposed Mutsho Power Project located on a site near Makhado in the Limpopo Province.

The proposed power station is planned to form part of the Department of Energy's (DoE's) Coal Baseload Independent Power Producer (IPP) Procurement Programme (CBIPPPP). The project will have a generation capacity of up to 600MW, and will make use either Pulverised Coal (PC) or Circulating Fluidised Bed (CFB) technology.

Project Description

The project will consists of the following key components and associated infrastructure:

- Power island comprising of:
    - Pulverised Coal (PC) with Flue Gas Desulphurisation scrubbing / clean-up; or Circulating Fluidised Bed (CFB) boiler technology.
    - Electrostatic Precipitator (ESP) / Bag filtration systems and Flue / smoke stacks.
    - Direct or indirect air-cooling systems.
    - Balance of plant components (incl. steam turbine and generator etc.).
- Coal and Limestone / Lime Rail Spur and-or Road offloading Systems.
- Upgrading or establishment of a rail siding.
- Coal crusher (for CFB); or coal milling plant (for PC).
- Strategic and Working Coal stockpiles.
- Limestone or Lime storage and handling area (for use with CFB or PC technology).
- Ammonia storage and handling area (for use in flue gas clean-up with PC technology).
- Ash dump (dry-ashing has been proposed for the plant in order to reduce the project's water requirements).
- Water infrastructure. This may include:
    - Raw water storage dams.
    - Water supply pipelines and booster stations.
    - Pollution control dam/s.
    - Water treatment plant (WTP).
    - Wastewater treatment plant (WWTP).
    - Storm water management systems.
- HV Yard and substation components with HV overhead transmission lines connecting to the Eskom infrastructure.

- Control room, office / administration, workshop, storage and logistics buildings.
- Upgrading of external roads and establishment of internal access roads.
- Security fencing and lighting.

Coal source / supply: Coal mined at the Makhado Mine will be transported to the power station either via a new 22km railway loop, proposed for development between the Makhado Mine and the existing Huntleigh railway siding, or via road transport. All other raw materials will either be transported to site via rail or road transport.

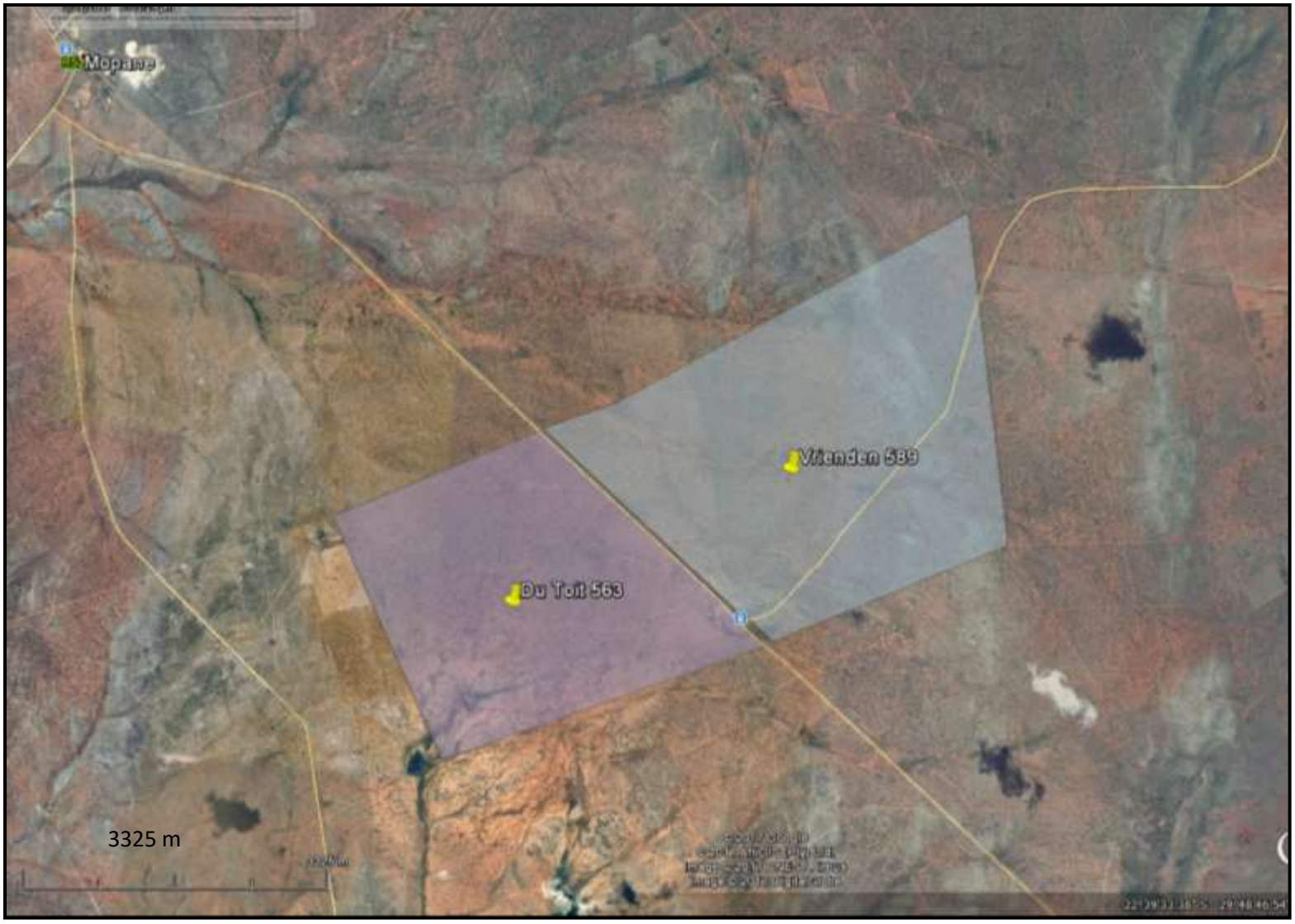

Figure 1: Google Earth Image of the location of the proposed Mutsho Power Project and associated infrastructure located on the farm Du Toit 563 and Vrienden 589, near Makhado, Limpopo Province.

1.1 LEGISLATION

Cultural Heritage in South Africa is governed by the National Heritage Resources Act (Act 25 of 1999). This Palaeontological Environmental Impact Assessment forms part of the Heritage Impact Assessment (HIA) and complies with the requirements of the above mentioned Act. In accordance with Section 38, an HIA is required to assess any potential impacts to palaeontological heritage within the site.

SECTION 35 OF THE NATIONAL HERITAGE RESOURCES ACT 25 OF 1999

- The protection of archaeological and palaeontological sites and material and meteorites is the responsibility of a provincial heritage resources authority.
- All archaeological objects, palaeontological material and meteorites are the property of the State.
- Any person who discovers archaeological or palaeontological objects or material or a meteorite in the course of development or agricultural activity must immediately report the find to the responsible heritage resources authority, or to the nearest local authority offices or museum, which must immediately notify such heritage resources authority.
- No person may, without a permit issued by the responsible heritage resources authority—
    - Destroy, damage, excavate, alter, deface or otherwise disturb any archaeological or palaeontological site or any meteorite;
    - Destroy, damage, excavate, remove from its original position, collect or own any archaeological or palaeontological material or object or any meteorite;
    - Trade in, sell for private gain, export or attempt to export from the Republic any category of archaeological or palaeontological material or object, or any meteorite; or
    - Bring onto or use at an archaeological or palaeontological site any excavation equipment or any equipment which assist in the detection or recovery of metals or archaeological and palaeontological material or objects, or use such equipment for the recovery of meteorites.
- When the responsible heritage resources authority has reasonable cause to believe that any activity or development which will destroy, damage or alter any archaeological or palaeontological site is under way, and where no application for a permit has been submitted and no heritage resources management procedure in terms of section 38 has been followed, it may—
    - Serve on the owner or occupier of the site or on the person undertaking such development an order for the development to cease immediately for such period as is specified in the order; and/or
    - Carry out an investigation for the purpose of obtaining information on whether or not an archaeological or palaeontological site exists and whether mitigation is necessary.

2 Objective

According to the South African Heritage Resources Agency (SAHRA) Archaeology, Palaeontology and Meteorites (APM) Guidelines: Minimum Standards for the Archaeological and Palaeontological Components of Impact Assessment Reports, the aims of the palaeontological impact assessment are:

- To identify exposed and subsurface rock formations that are considered to be palaeontologically significant;
- To assess the level of palaeontological significance of these formations;
- To comment on the impact of the development on these exposed and/or potential fossil resources; and
- To make recommendations as to how the developer should conserve or mitigate damage to these resources.

The objective is therefore to conduct a Palaeontological Impact Assessment, which forms of part of the Heritage Impact Assessment (HIA) and the EIA Report, to determine the impact of the development on potential palaeontological material at the site.

When a palaeontological desktop/scoping study is conducted, the potentially fossiliferous rocks (i.e. groups, formations, members, etc.) represented within the study area are determined from geological maps. The known fossil heritage within each rock unit is collected from published scientific literature; fossil sensitivity maps; consultations with professional colleagues, previous palaeontological impact studies in the same region and the databases of various institutions may be consulted. This data is then used to assess the palaeontological sensitivity of each rock unit of the study area on a desktop level. The likely impact of the proposed development on local fossil heritage is subsequently established on the basis of the palaeontological sensitivity of the rocks and the nature and scale of the development itself (extent of new bedrock excavated).

If rocks of moderate to high palaeontological sensitivity are present within the study area, a Phase 1 field-based assessment by a professional palaeontologist is necessary. Generally, damaging impacts on palaeontological heritage occur during the construction phase. These excavations will modify the existing topography and may disturb, damage, destroy or permanently seal-in fossils at or below the ground surface that are then no longer available for scientific study.

When specialist palaeontological mitigation is suggested, it may take place prior to construction or, even more successfully, during the construction phase when new, potentially fossiliferous bedrock is still exposed and available for study. Mitigation usually involves the careful sampling, collection and recording of fossils, as well as relevant data concerning the surrounding sedimentary matrix. Excavation of the fossil heritage will require a permit from SAHRA and the material must be housed

in a permitted institution. With appropriate mitigation, many developments involving bedrock excavation will have a *positive* impact on our understanding of local palaeontological heritage.

3 GEOLOGICAL AND PALAEONTOLOGICAL HISTORY

The proposed footprint is underlain by sediments of the

- Undifferentiated Karoo Basin; Tshipise and Tuli Sedimentary Basin and Solitude Formation; and
- Malala drift Gneiss and Gumbu Group of the Beit Bridge Complex, Archaean Granite-Gneiss Basement (Fig.2).

Fossil heritage could be present in the Undifferentiated Karoo as well as the Solitude Formation which has a high to very high Palaeontological Sensitivity. The Archaean Granite-Gneiss Basement, Beit Bridge Complex and Malala Drift Suite, Gumbu Group is metamorphic rocks which is unfossiliferous and with a very low palaeontological sensitivity.

Palaeontological Sensitivity Almond et al (2008) and Groenewald et al., (2014)	**Group**	**Group/Formation**	**Lithology**	**Period**	**Fossils /Exposures**
High to very high Palaeontological sensitivity/vulnerability	Undifferentiated Karoo		Sandstone, conglomerateshale, mudstone, and **coal deposits**	Permian-Triassic	Very poor levels of surface exposure (most data obtained from borehole cores
High to very high Palaeontological sensitivity/vulnera	Karoo	Solitude	Reddish and grey mudrocks, sandstones	Upper part possibly = Elliot Lower	Upper part possibly = Elliot Lower part probably =

bility			and minor coals, meandering fluvial setting	part probably = Molteno	Molteno Coal floras including *Dicroidium* in basal Solitude succession. Dinosaur remains supposedly
Very Low Palaeontological sensitivity/vulnerability grey	Archaean Granite-Gneiss Basement	Malala Drift Suite Beit Bridge Complex	Leucogneiss with metaquartzite, hornblende granitoid gneiss, amphibolite, metapelite and calc-silicate rocks	Early to Late Archaean (3.6 –2.4 Ga) (Swazian / Randian)	No fossils recorded
Very Low Palaeontological sensitivity/vulnerability grey	Archaean Granite-Gneiss Basement	Beit Bridge Complex; Gumbu Group	Calc-silicate rocks and marble, together with leucogneisses and subordinate pink hornblende granitoid gneiss, metaquartzite and	Early to Late Archaean (3.6 –2.4 Ga) (Swazian / Randian)	No fossils recorded

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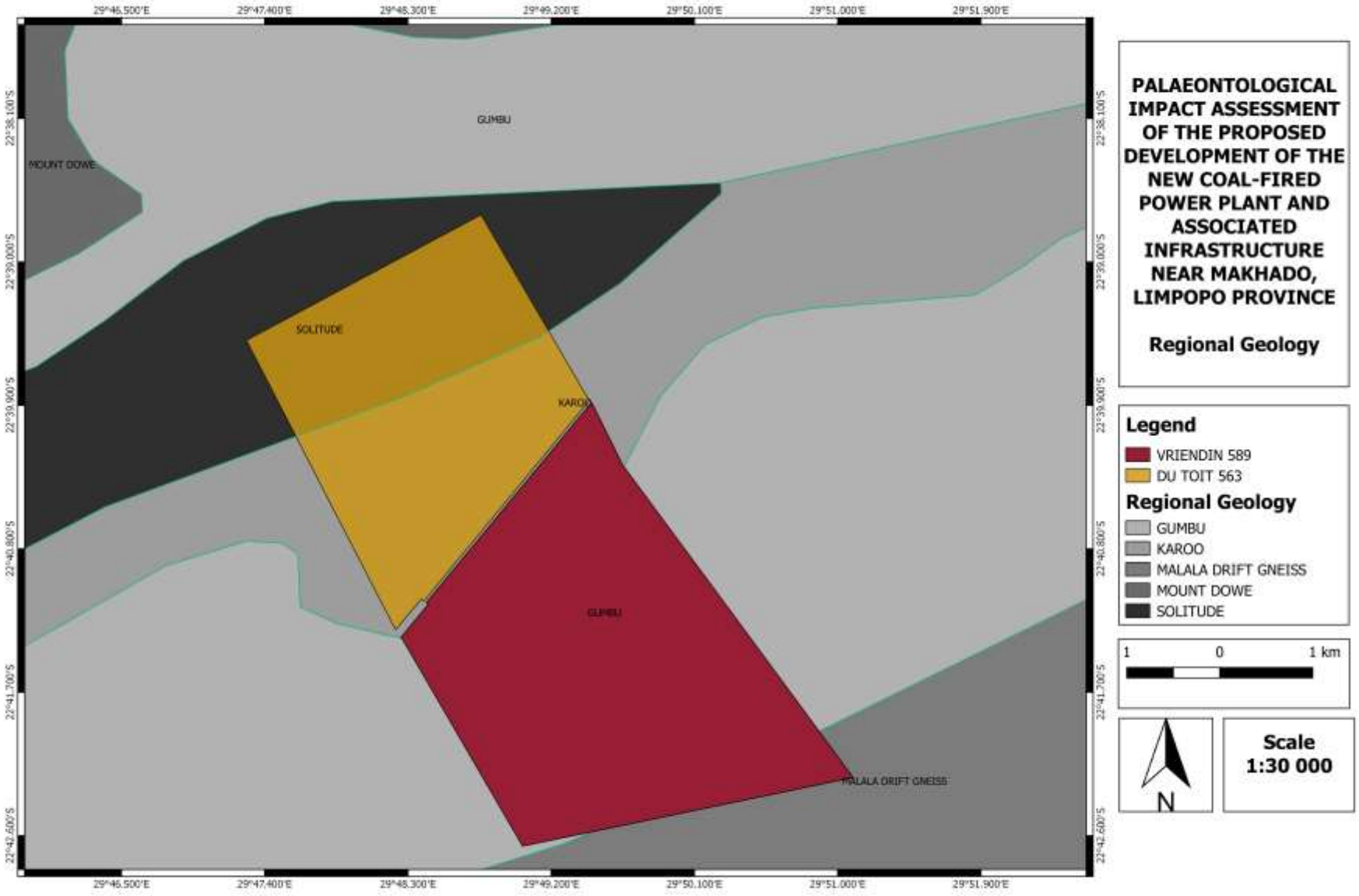

Figure 2: The surface geology of the proposed Mutsho Power Project and associated infrastructure located on the farm Du Toit 563 and Vrienden 589, near Makhado, Limpopo Province. The site is completely underlain by the Karoo Basin, Solitude Formation, Malala drift Gneiss, and Gumbu Group, Beit Bridge.

4 GEOGRAPHICAL LOCATION OF THE SITE

Mutsho Power proposes the development of a new coal-fired power plant and associated infrastructure on a site near Makhado, in the Limpopo Province. A minimum footprint of roughly 600ha is required for the proposed power station and associated infrastructure. The type of technology selected for implementation would ultimately influence the final project layout and development footprint (i.e. the area of land required for development). While the physical power generation components (i.e. power island), require approximately 50ha, supporting areas for the establishment of coal and other raw material stockpiles, and an ash dump over life of plant, increase the development footprint.

5 METHODS

A Palaeontological Scoping study was conducted to assess the potential risk to palaeontological material (fossil and trace fossils) in the proposed area of development. The author's experience, aerial photos (using Google, 2015), topographical and geological maps and other reports from the same area were used to assess the proposed area of the development

5.1 ASSUMPTIONS AND LIMITATIONS

The accuracy and reliability of desktop Palaeontological Impact Assessments as components of heritage impact assessments are normally limited by the following restrictions:

- Old fossil databases that have not been kept up-to-date or are not computerised. These databases do not always include relevant locality or geological information. South Africa has a limited number of professional palaeontologists that carry out fieldwork and most development study areas have never been surveyed by a palaeontologist.
- The accuracy of geological maps where information may be based solely on aerial photographs and small areas of significant geology have been ignored. The sheet explanations for geological maps are inadequate and little to no attention is paid to palaeontological material.
- Impact studies and other reports (*e.g*. of commercial mining companies) - is not readily available for desktop studies.

Large areas of South Africa have not been studied palaeontologically. Fossil data collected from different areas but in similar Assemblage Zones might however provide insight on the possible occurrence of fossils in an unexplored area. Desktop studies therefore **usually assume the presence of unexposed** fossil heritage within study areas of similar geological formations. Where considerable exposures of bedrocks or potentially fossiliferous superficial sediments are present in the study area, the reliability of a Palaeontological Impact Assessment may be significantly improved through field-survey by a professional palaeontologist.

6 IMPACT ASSESSMENTS

A scoping assessment of the impact significance of the proposed 600 MW new coal-fired power plant and associated infrastructure near Makhado, in the Limpopo Province on local fossil heritage is presented here:

6.1 Nature of the impact

Infrastructure associated with the new coal-fired power plant **includes:** (Information supplied by Savannah):

- Power island comprising of:
    - Pulverised Coal (PC) with Flue Gas Desulphurisation scrubbing / clean-up; or Circulating Fluidised Bed (CFB) boiler technology.
    - Electrostatic Precipitator (ESP) / Bag filtration systems and Flue / smoke stacks.
    - Direct or indirect air-cooling systems.
    - Balance of plant components (incl. steam turbine and generator etc.).
- Coal and Limestone / Lime Rail Spur and-or Road offloading Systems.
- Upgrading or establishment of a rail siding.
- Coal crusher (for CFB); or coal milling plant (for PC).
- Strategic and Working Coal stockpiles.
- Limestone or Lime (hydrated or de-hydrated) storage and handling area (for use with CFB or PC technology).
- Ammonia storage and handling area (for use in flue gas clean-up with PC technology).
- Ash dump (dry-ashing has been proposed for the plant in order to reduce the project's water requirements).
- Water infrastructure. This may include:
    - Raw water storage dams.
    - Water supply pipelines and booster stations.
    - Pollution control dam/s.
    - Water treatment plant (WTP).
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    - Storm water management systems.
- HV Yard and substation components with HV overhead transmission lines connecting to the Eskom infrastructure.
- Control room, office / administration, workshop, storage and logistics buildings.
- Upgrading of external roads and establishment of internal access roads.
- Security fencing and lighting.

The excavations and site clearance will involve substantial excavations into the superficial sediment cover as well as locally into the underlying bedrock. These excavations will modify the existing topography and may disturb, damage, destroy or permanently seal-in fossils at or below the ground surface that are then no longer available for scientific research.

6.2 Sensitive areas

The site is underlain by the Undifferentiated Karoo Basin; Tshipise and Tuli Sedimentary Basin and Solitude Formation; and Malala drift Gneiss and Gumbu Group of the Beit Bridge Complex, Archaean Granite-Gneiss Basement (Fig.2). The Archaean Granite-Gneiss Basement is metamorphic in origin and thus unfossiliferous while the Undifferentiated Karoo Basin and Solitude Formation has a high to very high palaeontological Sensitivity.

6.3 Geographical extent of impact

The impact on fossil materials and thus palaeontological heritage will be limited to the construction phase when new excavations into fresh potentially fossiliferous bedrock take place. The extent of the area of potential impact is thus restricted to the project site and therefore categorised as **local**.

6.4 Duration of impact

The expected duration of the impact is assessed as potentially permanent to long term. In the absence of mitigation procedures (should fossil material be present within the affected area) the damage or destruction of any palaeontological materials will be **permanent.**

6.5 Potential significance of the impact

Should the project progress without due care to the possibility of fossils being present at the proposed site with the resultant damage, destruction or inadvertent relocation of any affected fossils will be **permanent and irreversible**. Thus, any fossils occurring within the study area are potentially scientifically and culturally significant and any negative impact on them would be of **high significance**.

6.6 Severity / benefit scale

The development of the proposed development and associated infrastructure is **beneficial** on not only a local level, but regional and national levels as well. The facility will provide a long term benefit to the community in terms of creating jobs and would thus provide an economical boost to the area.

A potential **secondary advantage** of the construction of the project would be that the excavations may uncover fossils that were hidden beneath the surface exposures and, as such, would have remained unknown to science.

6.7 STATUS

Probability of the impact occurring

There is a possibility that fossil heritage will be recorded in the study area. Probable significant impacts on palaeontological heritage during the construction phase are **high**, but the intensity of the impact on fossil heritage is rated as **medium**.

Intensity

The intensity of the impact on fossil heritage is rated as **medium.**

7 DAMAGE MITIGATION, REVERSAL AND POTENTIAL IRREVERSIBLE LOSS

7.1 Mitigation

Should fossil material exist within the area proposed for the development any negative impact upon it could be mitigated by surveying, recording, describing and sampling of well-preserved fossils by a professional palaeontologist. This should take place after the initial vegetation clearance but *before* the ground is levelled for construction. Excavation of fossil heritage will require a permit from SAHRA and the material must be housed in a permitted institution. In the event that an excavation is impossible or inappropriate the fossil or fossil locality could be protected and the site of any planned construction and infrastructure moved.

7.2 Degree to which the impact can be mitigated

The site is underlain by the Undifferentiated Karoo Basin; Tshipise and Tuli Sedimentary Basin and Solitude Formation; and Malala drift Gneiss and Gumbu Group of the Beit Bridge Complex, Archaean Granite-Gneiss Basement.). The Archaean Granite-Gneiss Basement is metamorphic in origin and thus unfossiliferous while the Undifferentiated Karoo Basin and Solitude Formation has a high to very high palaeontological Sensitivity. Recommended mitigation of the inevitable damage and destruction of fossil heritage within the proposed site would involve the surveying, recording, description and collecting of fossils within the development footprint by a professional palaeontologist. This work should take place after the initial vegetation clearance has taken place but *before* the ground is levelled for construction. However, the significance of the impact following the mitigation will remain low.

7.3 Degree of irreversible loss

Impacts on fossil heritage are generally irreversible. Well-documented records and further palaeontological studies of any fossils exposed during construction would represent a positive impact from a scientific perspective. The possibility of a negative impact on the palaeontological heritage of the area can be reduced by the implementation of adequate mitigation procedures. If mitigation is properly undertaken the benefit scale for the project will lie within the beneficial category.

7.4 Degree to which the impact may cause irreplaceable loss of resources

It is thus **possible** that exceptional fossil material is present on the development area. By taking a precautionary approach, an insignificant loss of fossil resources is expected.

7.5 Cumulative impacts

The cumulative effect of the development is low as there is now other similar developments in the area.

8 FINDINGS AND RECOMMENDATIONS

The proposed footprint is underlain by sediments of the

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An EIA level palaeontology report will be conducted to assess the value and prominence of fossils in the development area and the effect of the proposed development on the palaeontological heritage. This consists of a Phase 1 field-based assessment by a professional palaeontologist. The purpose of the EIA Report is to elaborate on the issues and potential impacts identified during the scoping phase. This is achieved by site visits and research in the site-specific study area as well as a comprehensive assessment of the impacts identified during the scoping phase.

9 IMPACT TABLE

Impacts:

There is a possibility that trace fossils, mesosaurid reptiles, palaeoniscoid fish, palynomorphs and petrified wood will be recorded in the proposed development site. Probable significant impacts on palaeontological heritage during the construction phase are high.

Desktop Sensitivity Analysis of the Site:

ISSUE	NATURE OF IMPACT	EXTENT OF IMPACT	NO-GO AREAS
Loss of Palaeontological Heritage:	Construction of the Mutsho Power Project and associated infrastructure will permanently modify the existing topography and may disturb damage,	Long term Local impact and limited to the construction phase	At this point in time no-go areas have not been identified

	destroy or permanently seal-in fossils at or below the ground surface and are then no longer available for scientific research or as cultural heritage. Any fossils occurring in the project area are potentially scientifically and culturally significant and any negative impact on them would be of high significance. The Rooiberg Group is known not to be fossiliferous. The Ecca Group is especially known for trace fossils. This Group is also known for mesosaurid reptiles, palaeoniscoid fish, palynomorphs and petrified wood as well as for the occurrence of coal beds. The destruction or inadvertent relocation of any affected fossils will be permanent and irreversible.		
Description of expected significance of impact Significance: Should the project progress without due care to the possibility of fossils being present at the proposed site within the Undifferentiated Karoo Basin; Tshipise and Tuli Sedimentary Basin and Solitude Formation; and Malala drift Gneiss and Gumbu Group of the Beit Bridge Complex, Archaean Granite-Gneiss Basement (Fig.2). The resultant damage, destruction or inadvertent relocation of any affected fossils will be permanent and irreversible. Thus, any fossils occurring within the study area are potentially scientifically and culturally significant and any negative impact on them would be of high significance.			

Consequence: The excavations and site clearance will involve substantial excavations into the superficial sediment cover as well as locally into the underlying bedrock. These excavations will modify the existing topography and may disturb, damage, destroy or permanently seal-in fossils at or below the ground surface that are then no longer available for scientific research.

Duration: The expected duration of the impact is assessed as potentially permanent g term. In the absence of mitigation procedures (should fossil material be present within the affected area) the damage or destruction of any palaeontological materials will be permanent.

Probability of the impact occurring: There is a possibility that fossil heritage will be recorded in the proposed study area. Probable significant impacts on palaeontological heritage during the construction phase are high, but the intensity of the impact on fossil heritage is rated as medium.

Degree to which the impact may cause IRREPLACEABLE LOSS OF RESOURCES: Stratigraphic and geographical distribution of fossils in the development footprint is documented in the literature. It is thus possible that exceptional fossil material is present on the development area. By taking a precautionary approach, a insignificant loss of fossil resources is expected.

DEGREE TO WHICH THE IMPACT CAN BE MITIGATED:

Recommended mitigation of the inevitable damage and destruction of fossil heritage within the proposed site would involve the surveying, recording, description and collecting of fossils within the development footprint by a professional palaeontologist. This work should take place after the initial vegetation clearance has taken place but *before* the ground is levelled for construction. However, the significance of the impact following the mitigation will remain low.

DEGREE OF IRREVERSIBLE LOSS

Impacts on fossil heritage are generally irreversible. Well-documented records and further palaeontological studies of any fossils exposed during construction would represent a positive impact from a scientific perspective. The possibility of a negative impact on the palaeontological heritage of the area can be reduced by the implementation of adequate mitigation procedures, although the significance of the impact after mitigation will still remain low. If mitigation is properly undertaken the benefit scale for the project will lie within the beneficial category.

Gaps in knowledge and recommendations for further study

Regardless of the sparse and sporadic occurrence of fossils in this biozone a single fossil can have a huge scientific importance as many vertebrate fossil taxa are known from a single fossil. It is not possible to accurately assess the exceptional value of fossil heritage at the site, without an EIA.
Cumulative impacts The cumulative effect of the development within the proposed location is considered to be low.
Methodology An EIA level palaeontology report will be conducted to assess the value and prominence of fossils in the development area and the effect of the proposed development on the palaeontological heritage. This consists of a Phase 1 field-based assessment by a professional palaeontologist. The purpose of the EIA Report is to elaborate on the issues and potential impacts identified during the scoping phase. This is achieved by site visits and research in the site-specific study area as well as a comprehensive assessment of the impacts identified during the scoping phase.

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11 QUALIFICATIONS AND EXPERIENCE OF THE AUTHOR

The author (Elize Butler) has an MSc in Palaeontology from the University of the Free State, Bloemfontein, South Africa. She has been working in Palaeontology for more than twenty three years. She has been conducting Palaeontological Impact Assessments since 2014.

12 DECLARATION OF INDEPENDENCE

I Elize Butler, declare that I am an independent consultant and have no business, financial, personal or other interest in the proposed project, application or appeal in respect of which I was appointed other than fair remuneration for work performed in connection with the activity, application or appeal. There are no circumstances that compromise my objectivity in this work.