PALAEONTOLOGICAL IMPACT ASSESSMENT OF THE PROPOSED DEVELOPMENT OF THE MUTSHO POWER PROJECT AND ASSOCIATED INFRASTRUCTURE ON A SITE NEAR MAKHADO (LOUIS TRICHARDT), 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 on the farm Du Toit 563 and Vrienden 589 near Makhado (Louis Trichardt), in the Limpopo Province. Three alternatives layouts for the development have been identified for investigation. According to the National Heritage Resources Act (Act No 25 of 1999, section 38), a palaeontological impact assessment is key to detect the presence of fossil material within the proposed development area and it is thus necessary to evaluate the impact of the construction and operation of the development site 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.

According to the geology of the development area, fossil heritage could be present in the Undifferentiated Karoo which has a very high Palaeontological Sensitivity as well as the Solitude Formation with a high Palaeontological Sensitivity. The Archaean Granite-Gneiss Basement, Beit Bridge Complex and Malala Drift Suite, Gumbu Group is metamorphic rocks which is unfossiliferous and has a very low palaeontological sensitivity. The farm Du Toit 563 is entirely underlain by the Undifferentiated Karoo and the Solitude Formation. The north eastern part of the farm Vrienden 589 falls in the potentially fossiliferous Undifferentiated Karoo and the unfossiliferous Archaean Granite-Gneiss Basement, Beit Bridge Complex and Malala Drift Suite, Gumbu Group. During a field survey (including all three alternative layouts) of the development footprint, no fossiliferous outcrops were found. For this reason, a **low palaeontological sensitivity** is allocated to the development footprint. Irrespective of the uncommon occurrence of fossils a solitary fossil may be of scientific value as many fossil taxa are known from a single fossil. The recording of fossils will expand our knowledge of the Palaeontological Heritage of the development area.

The scarcity of fossil heritage at the proposed development footprint indicates that the impact of the Mutsho Power Project, associated infrastructure and any of the preferred layout plans will be of a low significance in palaeontological terms. It is therefore considered that the construction and operation of the Mutsho Power Project and associated infrastructure (also applicable to all three alternative layout plans) is deemed appropriate and feasible and will not lead to detrimental impacts on the palaeontological resources of the area. Thus, the construction and operation of the facility may be authorised as the whole extent of the development footprint is not considered sensitive in terms of palaeontological resources.

In the event that fossil remains are uncovered during any phase of construction, either on the surface or unearthed by new excavations and vegetation clearance, the ECO in charge of these developments ought to be alerted immediately. These discoveries ought to be protected (if possible *in situ*) and the ECO must report to SAHRA so that appropriate mitigation (*e.g.* recording, collection) can be carried out by a professional palaeontologist.

Preceding any collection of fossil material, the specialist would need to apply for a collection permit from SAHRA. Fossil material must be curated in an accredited collection (museum or university collection), while all fieldwork and reports should meet the minimum standards for palaeontological impact studies as required by SAHRA.

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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 in support of application for an Environmental Authorization and a Waste Management License (WML) for the proposed Mutsho Power Project located on a site near Makhado in the Limpopo Province.

Three alternative layouts for the Mutsho Power Project were identified for investigation in this process. The technically preferred layout is presented in Fig. 2 where the entire development is located on the farm Vrienden 589. With this option the ash dump is situated south of the main road on the farm Vrienden 589. The second option is presented in Fig. 3. With this option the ash dump is present on both farms, on either side of the railway and road. On the third and least preferred option the entire layout is yet again on the farm Vrienden 589 and is presented in Fig. 4. With this option the ash dump has been moved towards the centre of the development.

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 660MW (export capacity below 600MW in line with DoE requirements), and will make use of Circulating Fluidised Bed (CFB) technology.

Project Description

Information provided by the developer

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

- Power island comprising of:
  - Circulating Fluidised Bed (CFB) boiler technology.
  - Electrostatic Precipitator (ESP) / Bag filtration systems and Flue / smoke stack.
  - 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.
- Strategic and Working Coal stockpiles.
- Limestone or Lime (hydrated or de-hydrated) storage and handling.
- Ash dump (dry-ashing has been assumed for the plant in order to reduce the project's water requirements, which is in alignment with the recommendations of the National Development Plan (NDP) and Integrated Energy Plan (IEP)).
- 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 delivered to the power station either by means of a new 22km railway loop, proposed for development between the Makhado Mine and the existing Huntleigh railway siding (assessed independently as part of another project), or via road transport. The present Huntleigh siding is adjoined by both properties under investigation. Coal will then be transported via overland coal conveyor to the coal stockpile located onsite. All other raw materials will either be transported to site via rail or road transport.

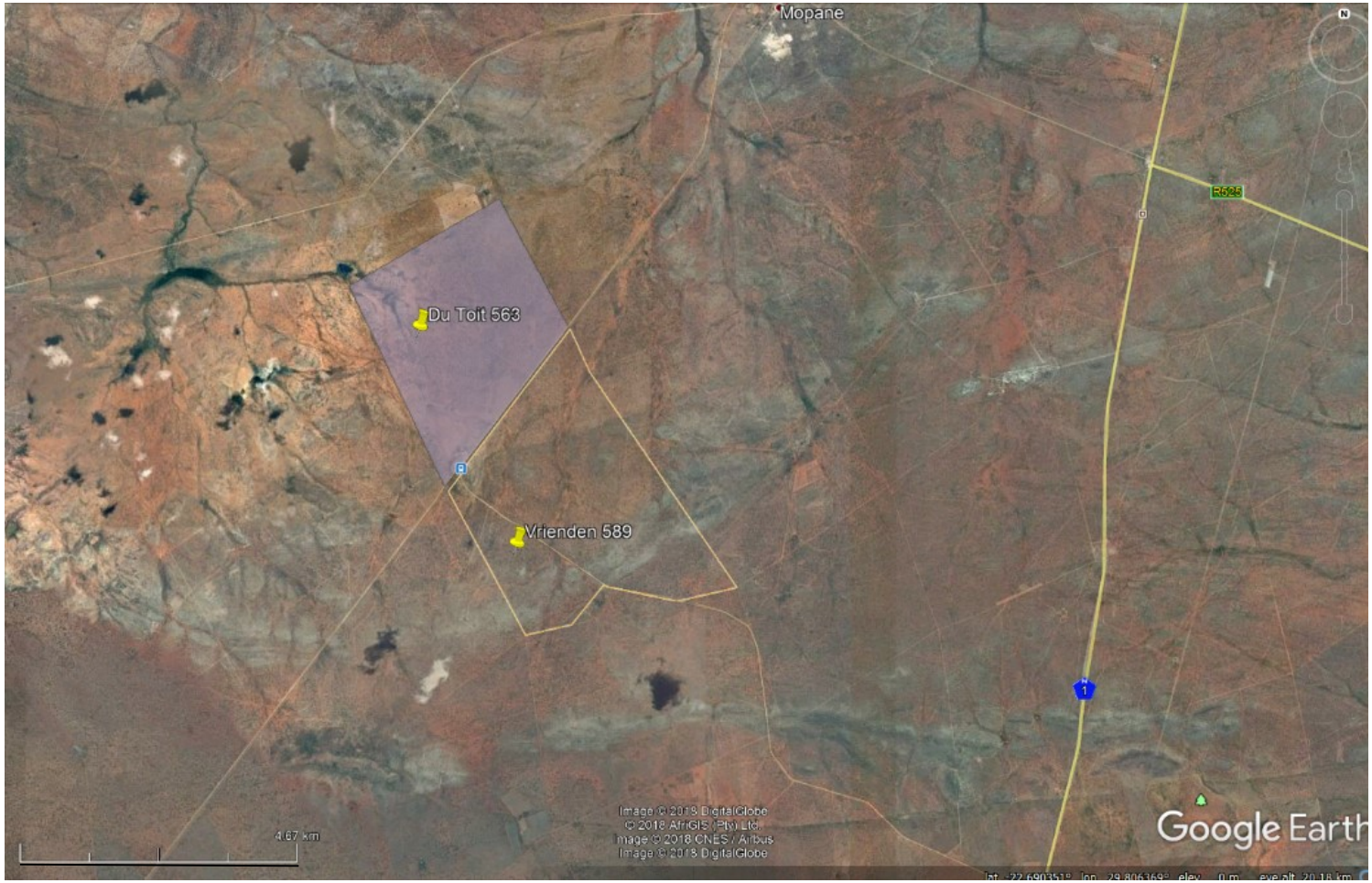

Figure 1: Google Earth Image (2017) of the location of the proposed Mutsho Power Project and associated infrastructure located on the farm Du Toit 563 and Vrienden 589, near Makhado, Limpopo Province. Scale bar represents 4.67 km.

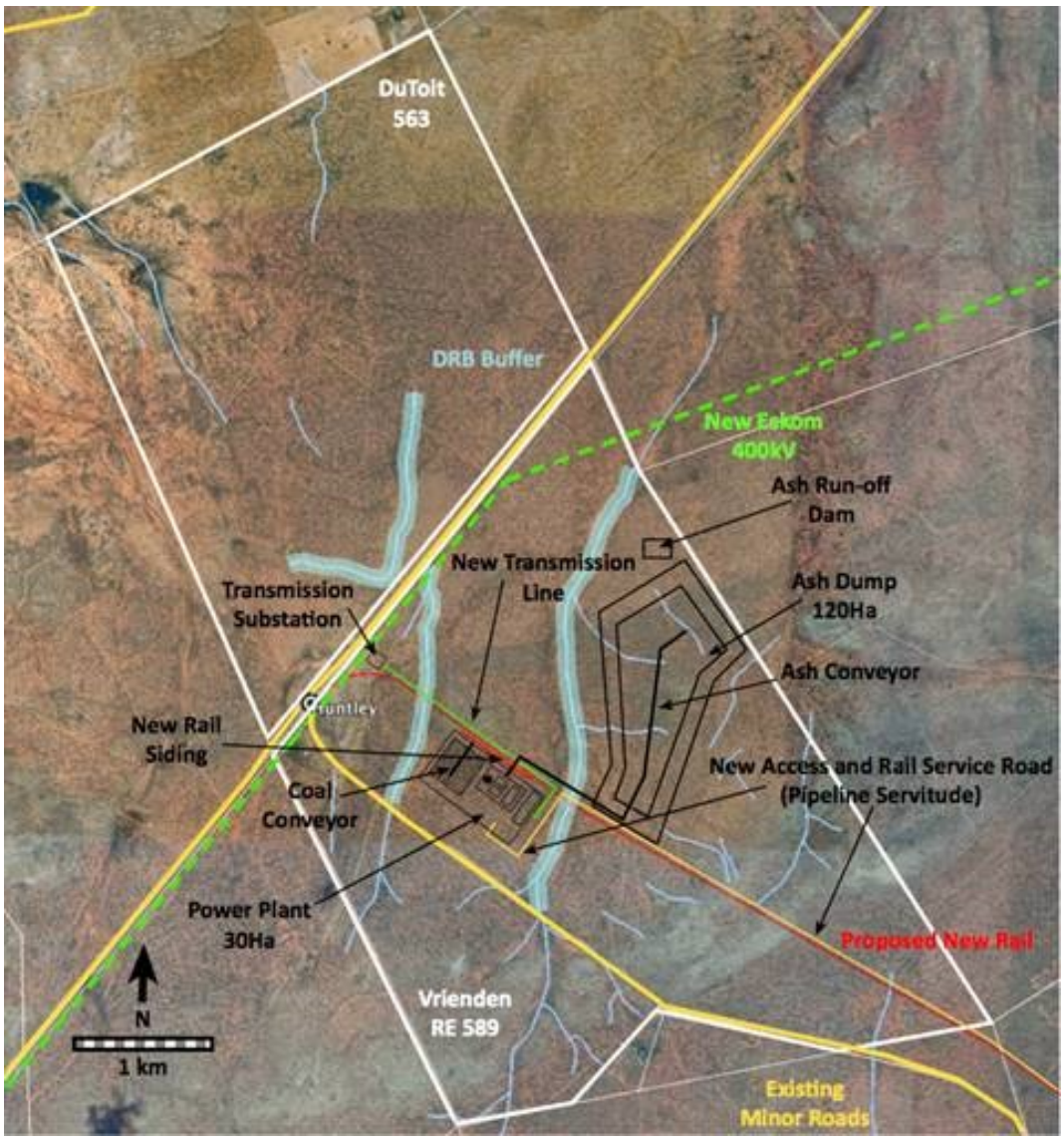

Figure 2. Location of the technically preferred option of the Mutsho Power Project and associated infrastructure located on the farm Du Toit 563 and Vrienden 589, near Makhado, Limpopo Province.

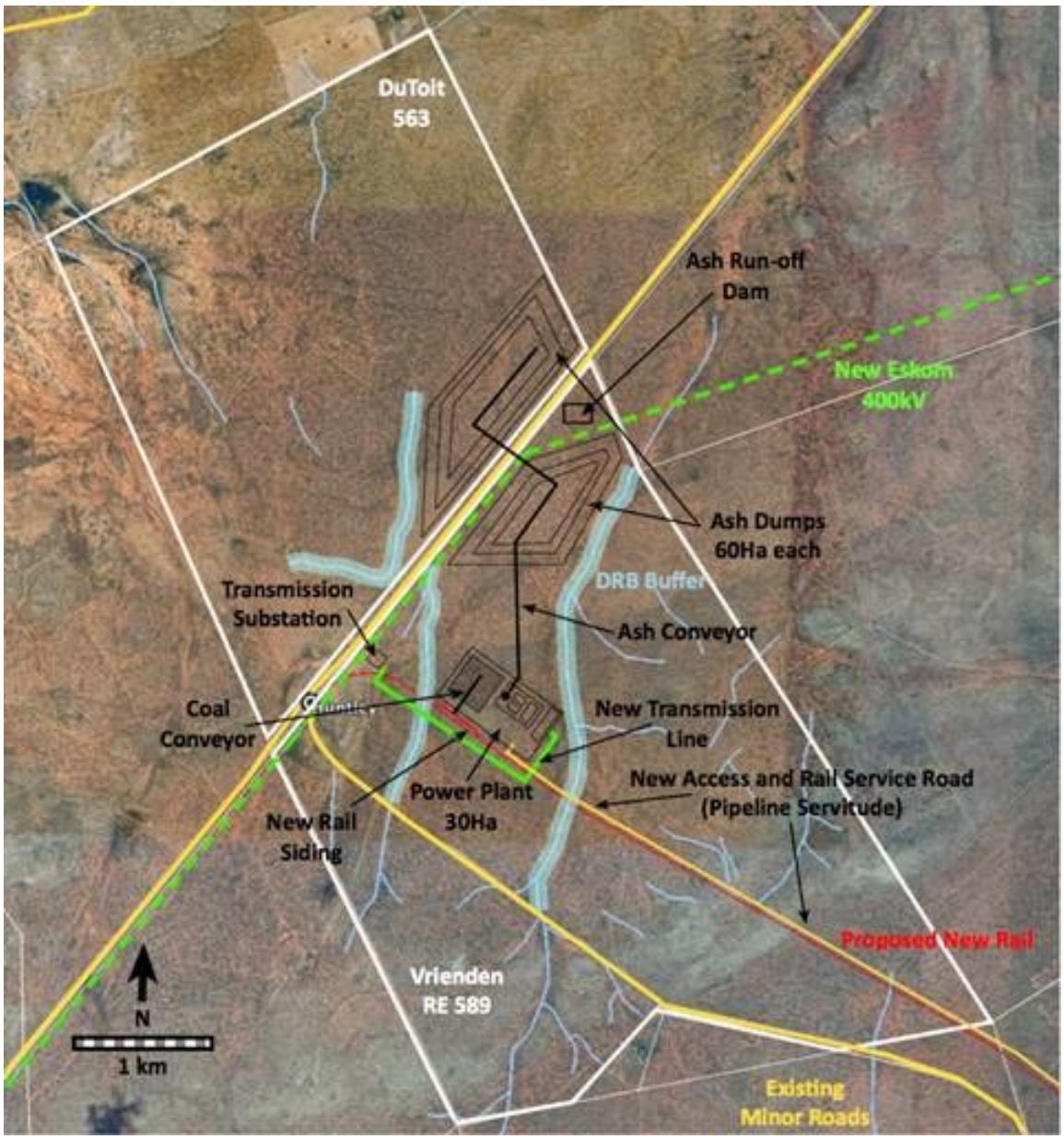

Figure 3. Location of the proposed preferred alternative of the Mutsho Power Project and associated infrastructure located on the farm Du Toit 563 and Vrienden 589, near Makhado, Limpopo Province.

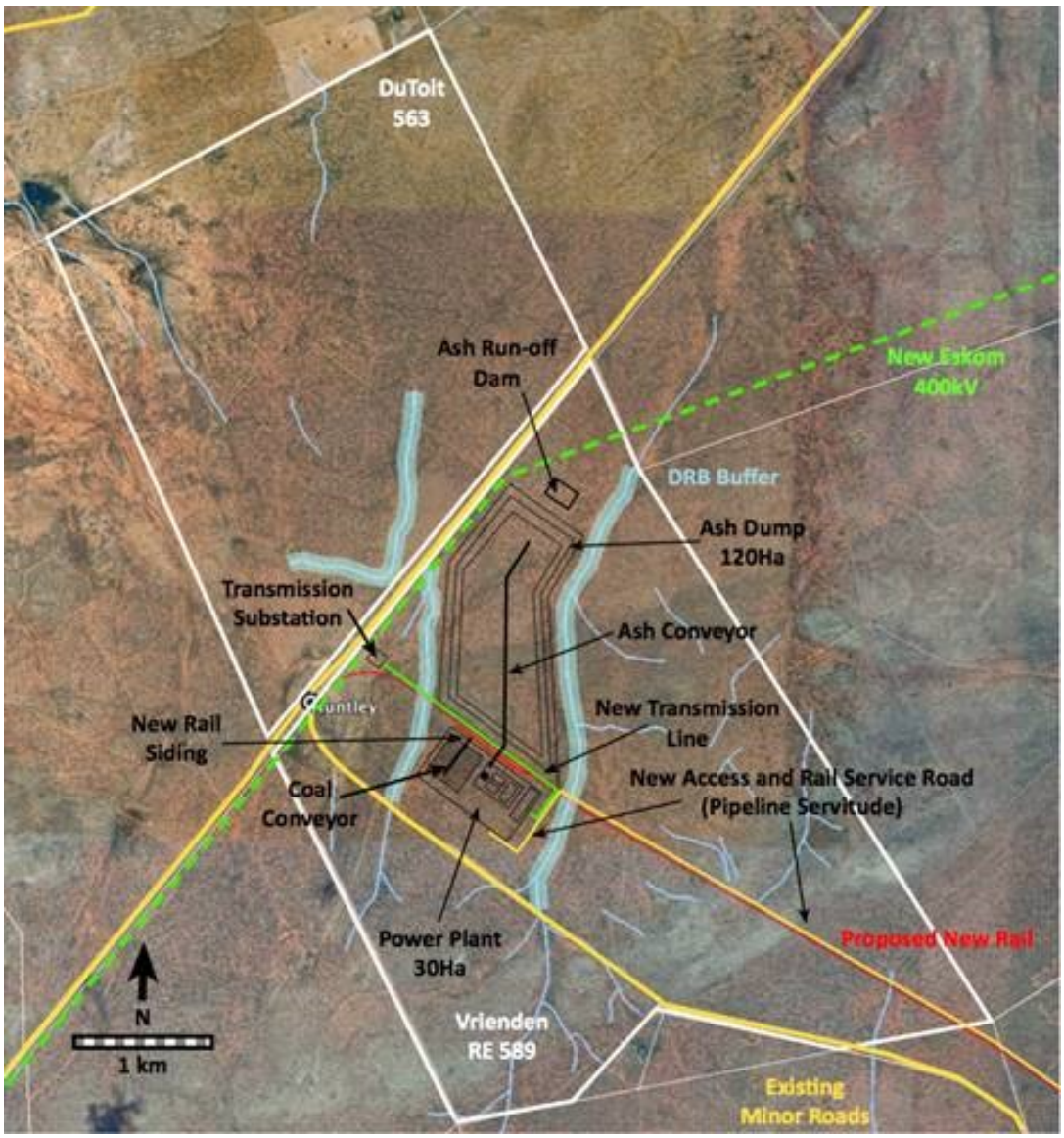

Figure 4. Location of the proposed preferred alternative of the Mutsho Power Project and associated infrastructure located on the farm Du Toit 563 and Vrienden 589, near Makhado, Limpopo Province.

2 LEGISLATION

NATIONAL HERITAGE RESOURCES ACT (ACT 25 OF 1999)

Cultural Heritage in South Africa, includes all heritage resources, and is protected by the National Heritage Resources Act (Act 25 of 1999). Heritage resources as defined in Section 3 of the Act include **"all objects recovered from the soil or waters of South Africa, including archaeological and palaeontological objects and material, meteorites and rare geological specimens**". Palaeontological heritage is unique and non-renewable and is protected by the above mentioned Act. Palaeontological resources

may not be unearthed, moved, broken or destroyed by any development without prior assessment and without a permit from the relevant heritage resources authority.

This Palaeontological Environmental Impact Assessment forms part of the Heritage Impact Assessment (HIA) and adheres to the conditions of the Act. According to **Section 38**, an HIA is required to assess any potential impacts to palaeontological heritage within the development footprint.

ACCORDING TO SECTION 35 OF THE NATIONAL HERITAGE RESOURCES ACT 1999, DEALING WITH ARCHAEOLOGY, PALAEONTOLOGY AND METEORITES:

35. (1) Subject to the provisions of section 8, the protection of archaeological and palaeontological sites and material and meteorites is the responsibility of a provincial heritage resources authority: Provided that the protection of any wreck in the territorial waters and the maritime cultural zone shall be the responsibility of SAHRA.

(2) Subject to the provisions of subsection (8) *(a)*, all archaeological objects, palaeontological material and meteorites are the property of the State. The responsible heritage authority must, on behalf of the State, at its discretion ensure that such objects are lodged with a museum or other public institution that has a collection policy acceptable to the heritage resources authority and may in so doing establish such terms and conditions as it sees fit for the conservation of such objects.

(3) 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.

(4) No person may, without a permit issued by the responsible heritage resources authority—

(a) Destroy, damage, excavate, alter, deface or otherwise disturb any archaeological or palaeontological site or any meteorite;

(b) Destroy, damage, excavate, remove from its original position, collect or own any archaeological or palaeontological material or object or any meteorite;

(c) 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

(d) 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.

(5) 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—

(a) 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;

(b) 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;

(c) if mitigation is deemed by the heritage resources authority to be necessary, assist the person on whom the order has been served under paragraph (a) to apply for a permit as required in subsection (4); and (d) recover the costs of such investigation from the owner or occupier of the land on which it is believed an archaeological or palaeontological site is located or from the person proposing to undertake the development if no application for a permit is received within two weeks of the order being served.

(6) The responsible heritage resources authority may, after consultation with the owner of the land on which an archaeological or palaeontological site or a meteorite is situated, serve a notice on the owner or any other controlling authority, to prevent activities within a specified distance from such site or meteorite.

(7) *(a)* Within a period of two years from the commencement of this Act, any person in possession of any archaeological or palaeontological material or object or any meteorite which was acquired other than in terms of a permit issued in terms of this Act, equivalent provincial legislation or the National Monuments Act, 1969 (Act No. 28 of 1969), must lodge with the responsible heritage resources authority lists of such objects and other information prescribed by that authority. Any such object which is not listed within the prescribed period shall be deemed to have been recovered after the date on which this Act came into effect. *(b)* Paragraph *(a)* does not apply to any public museum or university. *(c)* The responsible authority may at its discretion, by notice in the *Gazette* or the *Provincial Gazette*, as the case may be, exempt any institution from the requirements of paragraph *(a)* subject to such conditions as may be specified in the notice, and may by similar notice withdraw or amend such exemption.

(8) An object or collection listed under subsection (7) — *(a)* Remains in the ownership of the possessor for the duration of his or her lifetime, and SAHRA must be notified who the successor is; and *(b)* must be regularly monitored in accordance with regulations by the responsible heritage authority.

HERITAGE RESOURCES MANAGEMENT

38. (1) Subject on the provisions of subsections (7), (8) and (9), any person who intends to undertake a development categorised as (a) the construction of a road, wall, power line, pipeline, canal or other similar form of linear development or barrier exceeding 300 m in length; (b) the construction of a bridge or similar structure exceeding 50 m in length; (c) any development or other activity which will change the character of a site—(i) exceeding 5 000 m^2 in extent; or (ii) involving three or more existing erven or subdivisions thereof; or (iii) involving three or more erven or divisions thereof which have been consolidated within the past five years; or (iv) the costs of

which will exceed a sum set in terms of regulations by SAHRA or a provincial heritage resources authority; (d) the re-zoning of a site exceeding 10 000 m² in extent; (e) or any other category of development provided for in regulations by SAHRA or a Provincial heritage resources authority.

3 OBJECTIVE

The **objective of a Palaeontological Impact Assessment is to determine the impact of the development on potential palaeontological material** at the site.

According to the "SAHRA APM Guidelines: Minimum Standards for the Archaeological and Palaeontological Components of Impact Assessment Reports" the aims of the palaeontological impact assessment are: 1) to identify the palaeontological importance of the exposed and subsurface rock formations in the development footprint; 2) to evaluate the palaeontological importance of the formations; 3) to determine the impact of the development on fossil heritage; and 4) to recommend how the developer ought to protect or mitigate damage to fossil heritage.

When a palaeontological desktop study is compiled, the potentially fossiliferous rocks (i.e. groups, formations, etc.) present within the study area are established from 1:250 000 geological maps. The topography of the development area is identified using 1:50 000 topography maps as well as Google Earth Images of the development area. Fossil heritage within each rock section is obtained from previous palaeontological impact studies in the same region, the PalaeoMap from SAHRIS; and databases of various institutions (identifying fossils found in locations specifically in areas close to the development area). The palaeontological importance of each rock unit of the development area is then calculated. The possible impact of the proposed development footprint on local fossil heritage is established on the following criteria: 1) the palaeontological importance of the rocks; 2) the type and scale of the development footprint; and 3) quantity of bedrock excavated.

In the event that rocks of moderate to high palaeontological sensitivity are present within the study area, a field-based assessment by a professional palaeontologist is required. Based on both the desktop data and field examination of the sedimentary rock exposures, the impact significance of the planned development is measured with recommendations for any further studies or mitigation. In general destructive impacts on palaeontological heritage only occur during construction. The excavations will transform the current topography and may destruct or permanently seal-in fossils at or below the ground surface. Fossil Heritage will then no longer be accessible for scientific research.

Mitigation comprises the sampling, collection and recording of fossils and may precede construction or, more ideally, occur during construction when potentially fossiliferous bedrock is exposed. Preceding the excavation of any fossil heritage a permit from SAHRA must be obtained and the material will have to be housed in a permitted

institution. When mitigation is applied correctly, a positive impact is possible because our knowledge of local palaeontological heritage may be increased.

4 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.5).

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.

The farm Du Toit 563 is entirely underlain by the Undifferentiated Karoo and the Solitude Formation. The north eastern part of the farm Vrienden 589 falls in the potentially fossiliferous Undifferentiated Karoo and the unfossiliferous Archaean Granite-Gneiss Basement, Beit Bridge Complex and Malala Drift Suite, Gumbu Group (Fig.5).

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 conglomerate shale, mudstone and **coal deposits**	Permian -Triassic	Very poor levels of surface exposure (most data obtained from borehole cores
High to very high Palaeontological sensitivity/ vulnerability	Karoo	Solitude	Reddish and grey mudrocks, sandstones and minor	Upper part possibly = Elliot Lower	Upper part possibly = Elliot Lower part probably =

Palaeontological Sensitivity Almond et al (2008) and Groenewald et al., (2014)	**Group**	**Group/ Formation**	**Lithology**	**Period**	**Fossils /Exposures**
			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 amphibolite	Early to Late Archaean (3.6 – 2.4 Ga) (Swazian / Randian)	No fossils recorded

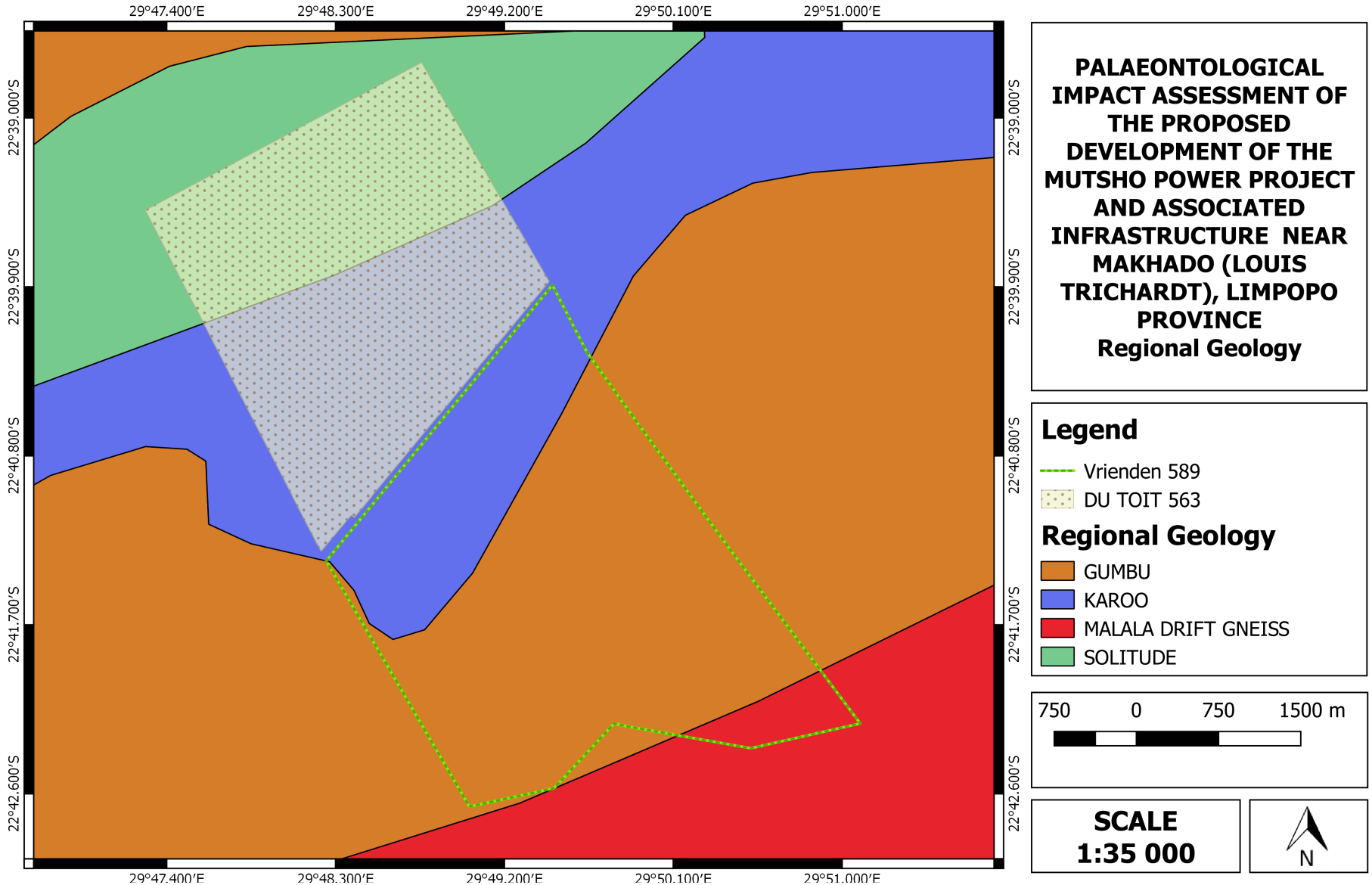

Figure 5: The surface geology of the proposed Mutsho Power Project and associated infrastructure located on the farm Du Toit 563 and Vrienden 589, near Makhado, Limpopo Province. The site is completely underlain by the Undifferentiated Karoo Basin and Solitude Formation, as well as the Malala drift Gneiss, and Gumbu Group, Beit Bridge. Map was drawn by QGIS Desktop 2.18.14.

5 GEOGRAPHICAL LOCATION OF THE SITE

Mutsho Power (Pty) Ltd is proposing the development of a new coal-fired power plant and associated infrastructure on the farms Du Toit 563 and Vrienden 589, near Makhado, in the Limpopo Province. A minimum footprint of roughly 350ha is necessary for the planned power station and associated infrastructure. While the physical power generation components (Power Island) require only in the region of 30 ha, supporting areas for the establishment of coal and other raw material stockpiles, and an ash dump over life of plant, enlarge the development footprint.

6 METHODS

As part of the Palaeontological Impact Assessment, a field-survey of the development footprint was conducted in January 2018 to assess the potential risk to palaeontological material (fossil and trace fossils) in the proposed footprint of the development. A physical field-survey was conducted on foot and by vehicle within the proposed development footprint. The results of the field-survey, the author's experience, aerial photos (using Google Earth, 2018), topographical and geological maps were used to assess the proposed development footprint. No consultations were undertaken for this Impact Assessment.

6.1 Assumptions and limitations

The accurateness of Palaeontological Desktop Impact Assessments is reduced by old fossil databases that do not always include relevant locality or geological formations. The geology in various remote areas of South Africa may be less accurate because it is based entirely on aerial photographs. The accuracy of the sheet explanations for geological maps is inadequate as the focus was never intended to be on palaeontological material.

South Africa in its entirety has not been studied palaeontologically. Similar Assemblage Zones but in different areas, might provide information on the presence of fossil heritage in an unmapped area. Desktop studies of similar geological formations generally assume that unexposed fossil heritage is present within the development area. Thus, the accuracy of Palaeontological Impact Assessment is improved by a field-survey.

7 FIELD OBSERVATIONS

The following photographs were taken on a site visit to the sites proposed for the new Mutsho Power Project and associated infrastructure in January 2018.

Figure 3. Flat topography of the farm Du Toit 563. The Farm is completely underlain by the Undifferentiated Karoo as well as the Solitude Formation. During the field survey no fossiliferous outcrops were found.

Figure 4. Flat topography of the farm Du Toit 563. The Farm is completely underlain by the Undifferentiated Karoo as well as the Solitude Formation. During the field survey no fossiliferous outcrops were found.

Figure 5. Flat topography of the farm Vrienden 589. The Farm is underlain by a small portion of the Undifferentiated Karoo Basin, Solitude Formation in the north and the Malala drift Gneiss, and Gumbu Group, Beit Bridge towards the south. During the field survey no fossiliferous outcrops were found.

8 ASSESSMENT OF IMPACTS

An assessment of the impact significance of the proposed 600 MW new coal-fired power plant and associated infrastructure on the farm Du Toit 563 and Vrienden 589 near Makhado, in the Limpopo Province on local fossil heritage is presented here:

8.1 Nature of the impact

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

- Power island comprising of:
  - 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.
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- Limestone or Lime (hydrated or de-hydrated) storage and handling area.
- Ash dump (dry-ashing has been assumed for the plant in order to reduce the project's water requirements, which is in alignment with the recommendations of the National Development Plan (NDP) and Integrated Energy Plan (IEP)).
- 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.

The excavations and site clearance of vegetation will consist of significant excavations into the uppermost sediment cover as well as into the underlying bedrock. These

excavations will transform the present topography and may disrupt, destroy or permanently close-in fossils that are then unavailable for research.

8.2 Geographical extent of impact

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

8.3 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.**

8.4 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. During a field survey (including all three alternative layouts) of the development footprint, no fossiliferous outcrops were found. For this reason, a **low palaeontological sensitivity** is allocated to the development footprint.

8.5 Potential significance of the impact

If the project progresses without care to the chance of fossils being present at the proposed site with the resultant damage and destruction 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**.

8.6 Severity / benefit scale

A potential **secondary advantage** of the construction of the project would be that the excavations may uncover fossils and would have remained unknown to science.

8.7 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**.

Intensity

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

9 DAMAGE MITIGATION, REVERSAL AND POTENTIAL IRREVERSIBLE LOSS

9.1 Mitigation

In the event that fossil material does exist within the area proposed for the development, any negative impact upon it could be mitigated by recording and sampling of well-preserved fossils by a professional palaeontologist. (Please see chance find procedure at the end of this report). This should precede vegetation clearance and occur *before* the ground is levelled for construction. A collecting permit from SAHRA is required before any fossil heritage may be excavated and the material must be housed in an accredited institution.

9.2 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. Suggested mitigation of the unavoidable damage and destruction of fossil heritage within the proposed site would involve the recording, and sampling of well-preserved fossils within the development footprint by a professional palaeontologist. This should precede vegetation clearance and occur *before* the ground is levelled for construction. Due to the expected low occurrence of fossils on the site, the significance of the impact following the mitigation will remain low.

9.3 Degree of irreversible loss

Impacts on fossil heritage are generally irreversible. Well-documented records and other palaeontological studies of any fossils uncovered during construction would signify a positive impact from a scientific view. The possibility of a negative impact on the palaeontological heritage of the area can be reduced by the implementation of suitable mitigation procedures. With proper mitigation the benefit scale for the project will lie within the beneficial category.

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

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

9.5 Cumulative impacts

The cumulative effect of the development is low as there is no other similar developments in the area.

10 ASSESSMENT OF IMPACTS

10.1 Assessment Methodology

Direct, indirect and cumulative impacts of the impacts identified above will be assessed according to the following standard methodology:

- The **nature** which shall include a description of what causes the effect, what will be affected and how it will be affected.
- The **extent** wherein it will be indicated whether the impact will be local (limited to the immediate area or site of development) or regional, and a value between 1 and 5 will be assigned as appropriate (with 1 being low and 5 being high).
- The **duration** wherein it will be indicated whether:
    - The lifetime of the impact will be of very short duration (0 - 1 years) – assigned a score of 1;
    - The lifetime of the impact will be of short duration (2 - 5 years) – assigned a score of 2;
    - Medium-term (5 - 15 years) – assigned a score of 3;
    - Long-term (> 15 years) – assigned a score of 4; or
    - Permanent – assigned a score of 5.
- The **magnitude** quantified on a scale from 0 - 10 where 0 is small and will have no effect on the environment, 2 is minor and will result in an impact on processes, 4 is low and will cause a slight impact on processes, 6 is moderate and will result in processes continuing but in a modified way, 8 is high (processes are altered to the extent that they temporarily cease) and 10 is very high and results in complete destruction of patterns and permanent cessation of processes.
- The **probability** of occurrence, which shall describe the likelihood of the impact actually occurring. Probability will be estimated on a scale of 1 - 5 where 1 is very improbable (probably will not happen), 2 is improbable (some possibility, but of low likelihood), 3 is probable (distinct possibility), 4 is highly probable (most likely) and 5 is definite (impact will occur regardless of any prevention measures).
- The **significance** which shall be determined through a syntheses of the characteristics described above and can be assessed as low, medium or high; and
- The **status**, which is described as positive, negative or neutral.
- The degree to which the impact can be reversed.
- The degree to which the impact may cause irreplaceable loss of resources.
- The degree to which the impact can be mitigated.

The **significance** is calculated by combining the criteria in the following formula:

S = (E + D + M) x P

S = Significance weighting

E = Extent

D = Duration

M = Magnitude

P = Probability

The **significance weightings** for each potential impact are as follows:

- < 30 points: Low (i.e. where this impact would not have a direct influence on the decision to develop in the area);
- 30 – 60 points: Medium (i.e. where the impact could influence the decision to develop in the area unless it is effectively mitigated); and
- > 60 points: High (i.e. where the impact must have an influence on the decision process to develop in the area).

Nature: The excavations and clearing of vegetation during the construction phase will consist of digging into the superficial sediment cover as well as underlying deeper bedrock. These excavations will change the existing topography and may possibly disturb, destroy or permanently close-in fossils at or below the ground surface. These fossils will then be lost for research.

Impacts on Palaeontological Heritage are likely to happen only within the construction phase. No impacts are expected to occur during the operation phase.

	Without mitigation	**With mitigation**
Extent	Local(1)	Local(1)
Duration	Long term/permanent (5)	Long term/permanent (5)
Magnitude	Minor (2)	Minor (1)
Probability	Improbable (1)	Improbable (1)
Significance	**Low (8)**	**Low (7)**
Status (positive or negative)	Negative	Neutral
Reversibility	Irreversible	Irreversible
Irreplaceable loss of resources?	No	No
Can impacts be mitigated?	Yes	Yes

Mitigation: Not necessary

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. The lack of appropriate exposure at the proposed development footprint (including all three alternative sites) indicates that the impact of the development is of low significance in palaeontological terms.

Chance find Procedure

- When a chance find is made the person must instantly stop all work near the find.
- The site must be secured to protect it from any additional damage
- The finder of the fossil heritage must immediately report the find to his/her direct supervisor, according to the reporting protocols instituted by the Mine/development management. The supervisor must in turn report the find to his/her manager and the ECO. The ECO must report the find to the relevant Authorities and a relevant palaeontologist.
- The ECO must appoint a relevant palaeontologist to investigate and access the chance find and site.
- Both ECO and palaeontologist must ensure that accurate records and documentation are kept. The documentation must start with the initial chance find report, including records of all actions taken, persons involved and contacted, comments received and findings.
- These documents will be necessary to request authorizations and permits from the relevant Authorities to continue with the work on site
- The reports and all other documents will be submitted to SAHRA by the palaeontologist.
- The report will include recommendations for additional specialist work if necessary, or request approval to continue with the development.
- Once the required approvals have been issued, the Mine/development may carry on with the development.
- The ECO will close off the chance find procedure and would be required to implement any requirements issued by the Authority and to add it to the operational management plan.

Residual Risk:
Loss of palaeontological heritage if impacts are not avoided

12 ASSESSMENT OF CUMULATIVE IMPACTS

Nature: Cumulative impacts on fossil remains preserved at or beneath the ground surface.		
	Cumulative Contribution of Proposed Project	**Cumulative Impact without Proposed Project**
Extent	Local (1)	Low (1)
Duration	Permanent (5)	Permanent (5)
Magnitude	Minor (2)	Minor (2)
Probability	Improbable (2)	Improbable (1)
Significance	**Low (16)**	**Low (8)**
Status (positive/negative)	Positive	Positive
Reversibility	Low	Low
Loss of resources?	No	No
Can impacts be mitigated?	Yes	Unknown
Confidence in findings: High.		
Mitigation: Not necessary 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. The lack of appropriate exposure at the proposed development footprint (including all three alternative sites) indicates that the impact of the development is of low significance in palaeontological terms.		

13 RECOMMENDATIONS CONCERNING FOSSIL HERITAGE MANAGEMENT DURING THE CONSTRUCTION PHASE

OBJECTIVE: Prevent the loss of Palaeontological Heritage	

Project component/s	Damaging impacts on palaeontological heritage occur during the **construction** phase which will modify the existing topography. The proposed development of the 600 MW new coal-fired power plant and associated infrastructure on the farm Du Toit 563 and Vrienden 589 near Makhado, in the Limpopo Province include:
	• Power island comprising of:
	  o Circulating Fluidised Bed (CFB) boiler technology.
	  o Electrostatic Precipitator (ESP) / Bag filtration

	systems and Flue / smoke stacks. o Direct or indirect air-cooling systems. o 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. • Strategic and Working Coal stockpiles. • Limestone or Lime (hydrated or de-hydrated) storage and handling area. • Ash dump (dry-ashing has been assumed for the plant in order to reduce the project's water requirements, which is in alignment with the recommendations of the National Development Plan (NDP) and Integrated Energy Plan (IEP)). • Water infrastructure. This may include: o Raw water storage dams. o Water supply pipelines and booster stations. o Pollution control dam/s. o Water treatment plant (WTP). o Wastewater treatment plant (WWTP). o 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.
Potential Impact	Destruct, destroy or permanently close-in fossils at or below the ground surface that are then no longer available for research
Activity/risk source	• Activities associated with the construction of the 600 MW new coal-fired power plant and associated infrastructure
Mitigation: Target/Objective	Protection of identified fossils uncovered during the construction phase.

Mitigation: Action/control	**Responsibility**	**Timeframe**
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-	EO	Construction phase

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. The lack of appropriate exposure at the proposed development footprint (including all three alternative sites) indicates that the impact of the development is of low significance in palaeontological terms		

11 FINDINGS AND RECOMMENDATIONS

Mutsho Power (Pty) Ltd proposes the development of a new coal-fired power plant and associated infrastructure on the farm Du Toit 563 and Vrienden 589 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 key to detect the presence of fossil material within the proposed development and it is thus necessary to assess the impact of the construction and operation of the development site 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.

Three layout alternatives for the Mutsho Power Project were identified. According to the geology of the development footprint, fossil heritage could be present in the Undifferentiated Karoo which has a very high Palaeontological Sensitivity as well as the Solitude Formation with a high Palaeontological Sensitivity. The Archaean Granite-Gneiss Basement, Beit Bridge Complex and Malala Drift Suite, Gumbu Group is metamorphic rocks which is unfossiliferous and has a very low palaeontological sensitivity. The farm Du Toit 563 is entirely underlain by the Undifferentiated Karoo and the Solitude Formation. The north eastern part of the farm Vrienden 589 falls in the potentially fossiliferous Undifferentiated Karoo and the unfossiliferous Archaean Granite-Gneiss Basement, Beit Bridge Complex and Malala Drift Suite, Gumbu Group. During a field survey (including all three alternative layouts) of the development footprint, **no**

fossiliferous outcrops were found. For this reason, a **low palaeontological sensitivity** is allocated to the development footprint. Irrespective of the uncommon occurrence of fossils a solitary fossil may be of scientific value as many fossil taxa are known from a single fossil. The recording of fossils will expand our knowledge of the Palaeontological Heritage of the development area.

The scarcity of fossil heritage at the proposed development footprint indicates that the impact of the Mutsho Power Project, associated infrastructure and all three preferred layout plans will be of a low significance in palaeontological terms. It is therefore considered that the construction and operation of the Mutsho Power Project, associated infrastructure as well as all three alternative layout plans (and with all three alternatives equal) is deemed appropriate and feasible and will not lead to detrimental impacts on the palaeontological resources of the area. Thus, the construction and operation of the facility may be authorised as the whole extent of the development footprint is not considered sensitive in terms of palaeontological resources.

In the event that fossil remains are discovered during any phase of construction, either on the surface or unearthed by fresh excavations, the ECO in charge of these developments ought to be alerted immediately. These discoveries ought to be protected (preferably *in situ*) and the ECO must report to SAHRA so that appropriate mitigation (*e.g.* recording, collection) can be carry out by a professional palaeontologist.

Preceding any collection of fossil material, the specialist would need to apply for a collection permit from SAHRA. Fossil material must be curated in an approved collection which comprises a museum or university collection, while all fieldwork and reports should meet the minimum standards for palaeontological impact studies proposed by SAHRA.

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13 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.

14 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.

15 PROTOCOL FOR FINDS

Chance find Procedure

- When a chance find is made the person must instantly stop all work near the find.
- The site must be secured to protect it from any additional damage
- The finder of the fossil heritage must immediately report the find to his/her direct supervisor, according to the reporting protocols instituted by the Mine/development management. The supervisor must in turn report the find to his/her manager and the ECO. The ECO must report the find to the relevant Authorities and a relevant palaeontologist.
- The ECO must appoint a relevant palaeontologist to investigate and access the chance find and site.
- Both ECO and palaeontologist must ensure that accurate records and documentation are kept. The documentation must start with the initial chance find report, including records of all actions taken, persons involved and contacted, comments received and findings.
- These documents will be necessary to request authorizations and permits from the relevant Authorities to continue with the work on site
- The reports and all other documents will be submitted to SAHRA by the palaeontologist.

- The report will include recommendations for additional specialist work if necessary, or request approval to continue with the development.
- Once the required approvals have been issued, the Mine/development may carry on with the development.
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