

Proposed Mulalo 400/132KV Main  
Transmission Substation and associated  
integration of transmission and distribution power  
lines south of Secunda, Mpumalanga

PALAEONTOLOGICAL IMPACT ASSESSMENT

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24 November 2019

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# 1. Executive Summary

Shale and sandstone of the Vryheid Formation of the Ecca Group of the Karoo Supergroup underlies areas within the study site where it is not underlain by dolerite. Site C (preferred site for the erection of the Main Transmission Station) and Site B are underlain by dolerite that is non-fossiliferous.

The sedimentary rocks of the Vryheid Formation are highly fossiliferous in places and the chances are high that such layers will be exposed during development such as during excavations for the erection of pylons and other infrastructure.

The fossils that occur in the Vryheid Formation are mostly that of leaf and stem imprints of plants such as *Glossopteris*, lycopods, ferns, horsetails, conifers, cordaitaleans and ginkgoaleans. Rare fossils of silicified and coalified wood, insects, bivalves, conchostrachans and fish scales also occur in this formation.

A palaeontologist should be contacted if an exceptional fossil discovery is made in the shale or sandstone units during construction. The ECO should follow the guidelines as stipulated under the Chance Find Procedure on p. 23-24 in such an event.

## 2. Introduction

The Heritage Act of South Africa stipulates that fossils and fossil sites may not be altered or destroyed. The purpose of this document is to detail the probability of finding fossils in the study area that may be impacted by the proposed development.

The palaeontological heritage of South Africa is unsurpassed and can only be described in superlatives. The South African palaeontological record gives us insight in inter alia the origin of dinosaurs, mammals and humans. Fossils are also used to identify rock strata and determine the geological context of the subregion with other continents and played a crucial role in the discovery of Gondwanaland and the formulation of the theory of plate tectonics. Fossils are also used to study evolutionary relationships, sedimentary processes and palaeoenvironments.

The Ecca Group of the Karoo Supergroup contains a vast amount of fossil leaf imprints of plants that occurred in Southern Gondwana during the Permian. These lacustrine deposits contained plant matter that turned into coal in certain parts of the Ecca Group. The resulting coal fields form a very important mineral resource for the country.

South Africa has the longest record of palaeontological endeavour in Africa. South Africa was even one of the first countries in the world in which museums displayed fossils and palaeontologists studied earth history. South African palaeontological institutions and their vast fossil collections are world-renowned and befittingly the South African Heritage Act is one of the most sophisticated and best considered in the world.

Fossils and palaeontological sites are protected by law in South Africa. Construction in fossiliferous areas may be mitigated in exceptional cases but there is a protocol to be followed.

This is a Palaeontological Impact Assessment that was prepared in line with Regulation 28 of the National Environmental Management Act (No. 107 of 1998) Regulations on Environmental Impact Assessment. This involved an overview of the literature on the palaeontology and associated geology of the area and a visit to the study sites for a field assessment.

### 3. Terms of reference for the report

According to the South African Heritage Resources Act (Act 25 of 1999) (Republic of South Africa, 1999), certain clauses are relevant to palaeontological aspects for a terrain suitability assessment.

- **Subsection 35(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 with the detection or recovery of metals or archaeological material or objects, or use such equipment for the recovery of meteorites.
- **Subsection 35(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 procedures 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.

South Africa's unique and non-renewable palaeontological heritage is protected in terms of the NHRA. According to this act, heritage resources may not be excavated, damaged, destroyed or otherwise impacted by any development without prior assessment and without a permit from the relevant heritage resources authority.

As areas are developed and landscapes are modified, heritage resources, including palaeontological resources, are threatened. As such, both the environmental and heritage legislation require that development activities must be preceded by an assessment of the impact undertaken by qualified professionals. Palaeontological Impact Assessments (PIAs) are specialist reports that form part of the wider heritage component of:

- Heritage Impact Assessments (HIAs) called for in terms of Section 38 of the National Heritage Resources Act, Act No. 25, 1999 by a heritage resources authority.
- Environmental Impact Assessment process as required in terms of other legislation listed in s. 38(8) of NHRA;
- Environmental Management Plans (EMPs) required by the Department of Mineral Resources.

HIAs are intended to ensure that all heritage resources are protected, and where it is not possible to preserve them in situ, appropriate mitigation measures are applied. An HIA is a comprehensive study that comprises a palaeontological, archaeological, built environment, living heritage, etc specialist studies. Palaeontologists must acknowledge this and ensure that they collaborate with other heritage practitioners. Where palaeontologists are engaged for the entire HIA, they must refer heritage components for which they do not have expertise on to appropriate specialists. Where they are engaged specifically for the palaeontology, they must draw the attention of environmental consultants and developers to the need for assessment of other aspects of heritage. In this sense, Palaeontological Impact Assessments that are part of Heritage Impact Assessments are similar to specialist reports that form part of the EIA reports. The standards and procedures discussed here are therefore meant to guide the conduct of PIAs and specialists undertaking such studies must adhere to them. The process of assessment for the palaeontological (PIA) specialist components of heritage impact assessments, involves:

**Scoping stage** in line with regulation 28 of the National Environmental Management Act (No. 107 of 1998) Regulations on Environmental Impact Assessment. This involves an **initial assessment** where the specialist evaluates the scope of the project (based, for example, on NID/BIDs) and advises on the form and extent of the assessment process. At this stage the palaeontologist may also decide to compile a **Letter of Recommendation for Exemption from further Palaeontological Studies**. This letter will state that there is little or no likelihood that any significant fossil resources will be impacted by the development. This letter should present a reasoned case for exemption, supported by consultation of the relevant geological maps and key literature.

A **Palaeontological Desktop Study** – the palaeontologist will investigate available resources (geological maps, scientific literature, previous impact assessment reports, institutional fossil collections, satellite images or aerial photos

, etc) to inform an assessment of fossil heritage and/or exposure of potentially fossiliferous rocks within the study area. A Desktop studies will conclude whether a further field assessment is warranted or not. Where further studies are required, the desktop study would normally be an integral part of a field assessment of relevant palaeontological resources.

A **Phase 1 Palaeontological Impact Assessment** is generally warranted where rock units of high palaeontological sensitivity are concerned, levels of bedrock exposure within the study area are adequate; large-scale projects with high potential heritage impact are planned; and where the distribution and nature of fossil remains in the proposed project area is unknown. In the recommendations of Phase 1, the specialist will inform whether further monitoring and mitigation are necessary. The Phase 1 should identify the rock units and significant fossil heritage resources present, or by inference likely to be present, within the study area, assess the palaeontological significance of these rock units, fossil sites or other fossil heritage, comment on the impact of the development on palaeontological heritage resources and make recommendations for their mitigation or conservation, or for any further specialist studies that are required in order to adequately assess the nature, distribution and conservation value of palaeontological resources within the study area.

A **Phase 2 Palaeontological Mitigation** involves planning the protection of significant fossil sites, rock units or other palaeontological resources and/or the recording and sampling of fossil heritage that might be lost during development, together with pertinent geological data. The mitigation may take place before and / or during the construction phase of development. The specialist will require a Phase 2 mitigation permit from the relevant Heritage Resources Authority before Phase 2 may be implemented.

A **'Phase 3' Palaeontological Site Conservation and Management Plan** may be required in cases where the site is so important that development will not be allowed, or where development is to co-exist with the resource. Developers may be required to enhance the value of the sites retained on their properties with appropriate interpretive material or displays as a way of promoting access of such resources to the public.

The assessment reports will be assessed by the relevant heritage resources authority, and depending on which piece of legislation triggered the study, a response will be given in the form of a Review Comment or Record of Decision (ROD). In the case of PIAs that are part of EIAs or EMPs, the heritage resources authority will issue a comment or a record of decision that may be forwarded to the consultant or developer, relevant government department or heritage practitioner and where feasible to all three.



## 4. Details of the study site and the type of assessment

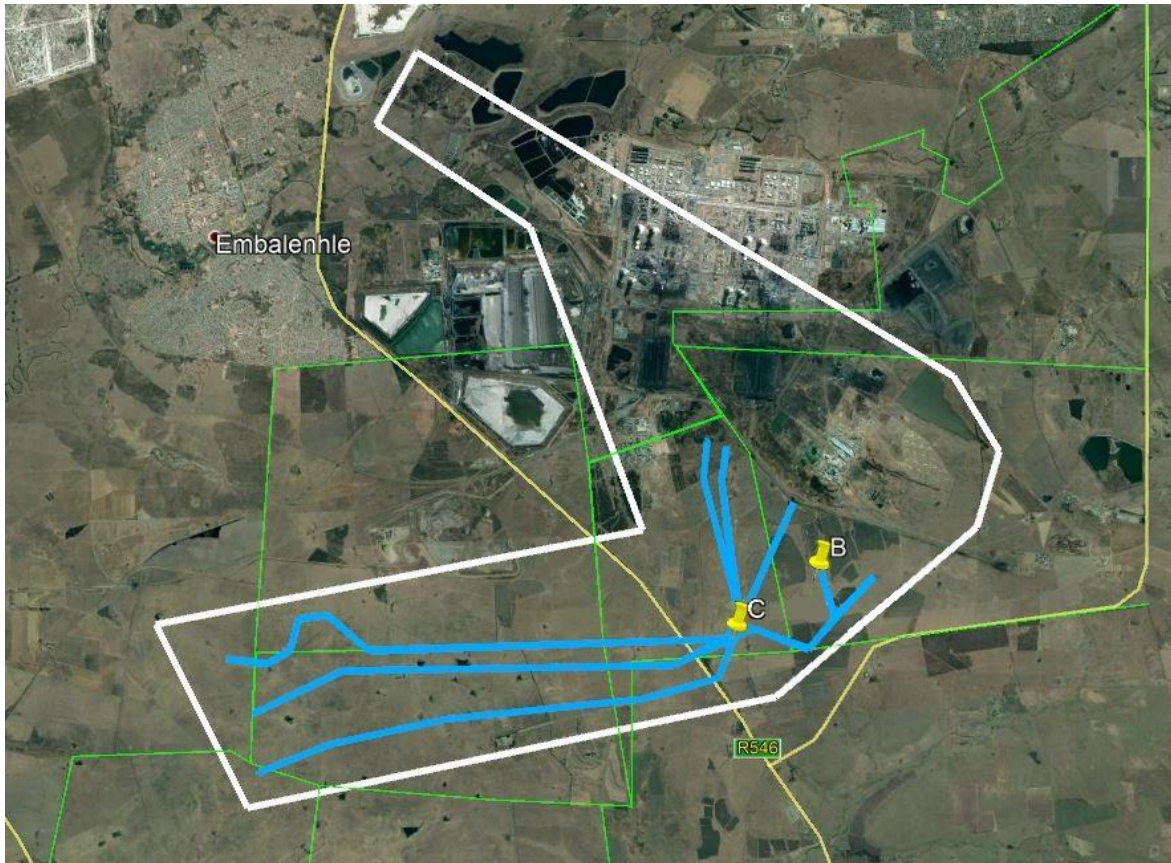


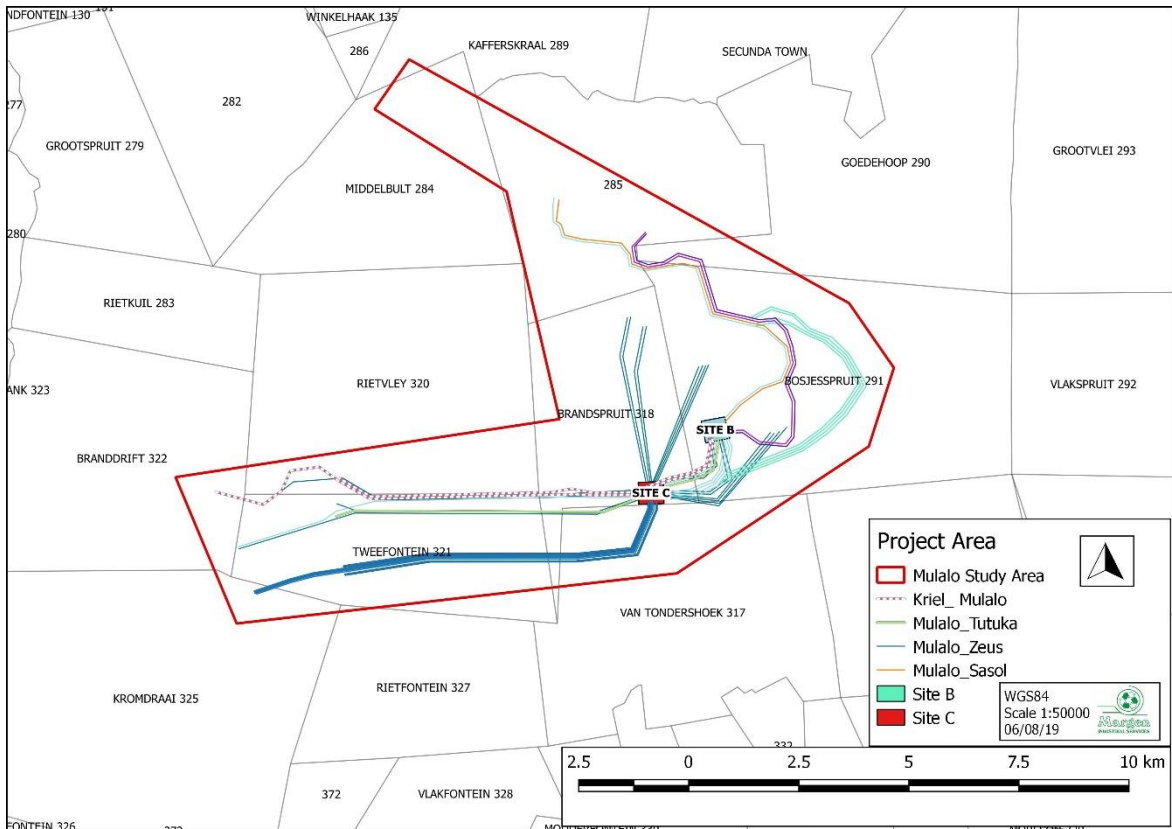
Figure 1: Google Earth photo indicating the study site (white polygon)

The study site (Fig. 1) is situated on the Farms Brandspruit (Site C), Bosjesspruit (Site B), Van Tondershoek, Tweefontein and Rietvley and extends into the Secunda Petrochemical Plant to the north (see Fig. 2).

The area is used for farming and is covered with grass and agricultural fields (see Figs. 4-16). The geology is obscured by thick soil and vegetation, limiting access to the underlying rocks which are limited to a few ex situ rocks exposed by excavations (see Fig. 17).

Geomorphologically the study area is characterised by a gently undulating landscape consistent with the erosion of the almost horizontally orientated underlying sandstone and mudstone layers of the Ecca Group and dolerite sills.

Parts of the study area have a VERY HIGH PALAEOONTOLOGICAL SENSITIVITY while others have NO PALAEOONTOLOGICAL SENSITIVITY (SAHRA, 2019). The relevant literature and geological maps for the region in which the development is proposed to take place, have been studied and the site has been visited on 23 November 2019 for a Palaeontological Impact Assessment.



**Figure 2: Map showing the farms that will be impacted by the proposed development**

## 5. Geological setting of the study site

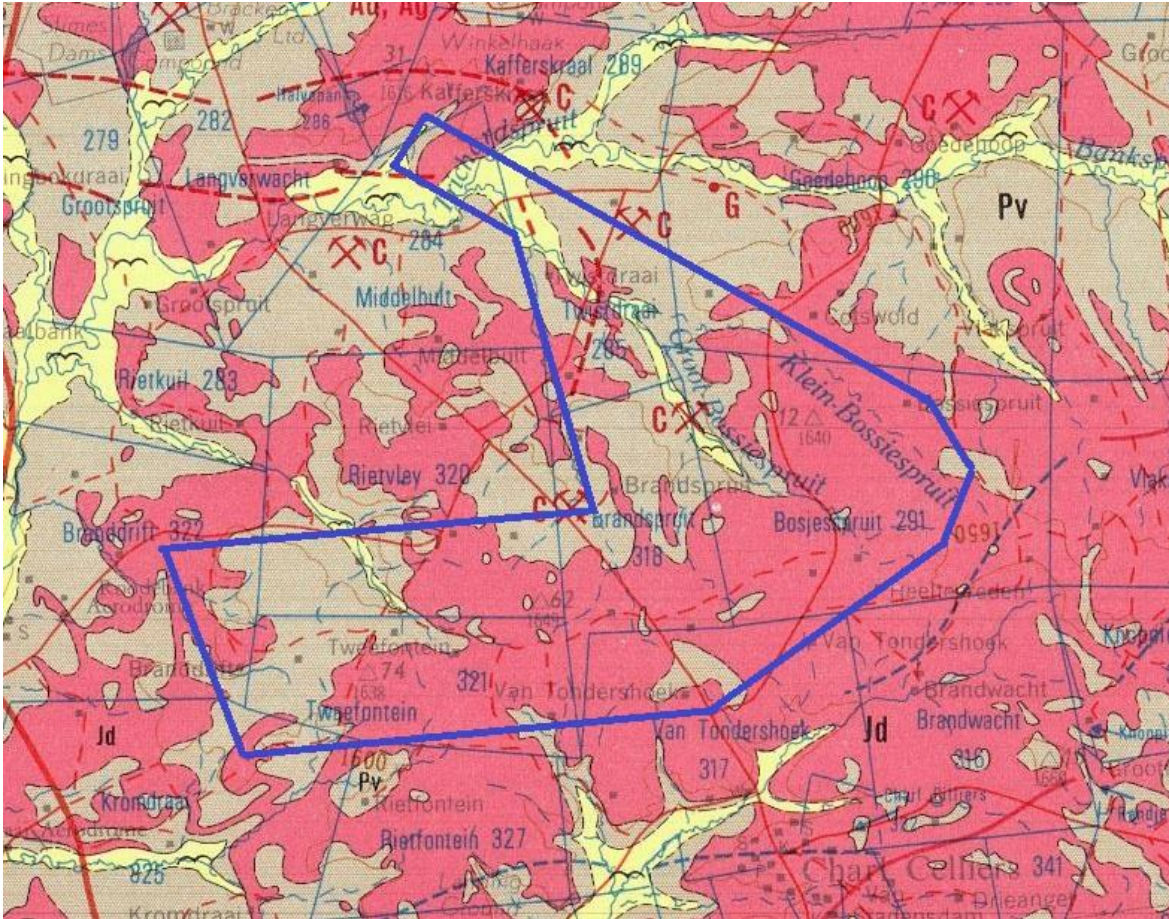


Figure 3: Geology map of the study site (blue polygon) and surroundings (adapted from the East Rand 2628 1:250 000 Geology Map)

### GEOLOGICAL MAP LEGEND

	Lithology	Stratigraphy		Age
	Alluvium			Quaternary
<b>Jd</b>	Dolerite			Jurassic
<b>Pv</b>	Shale, subordinate sandstone, coal	Vryheid Formation of the Ecca Group	Karoo Supergroup	Permian

The study area is underlain by dolerite and sedimentary rocks consisting mostly of shale (metamorphosed mudstone), shaly sandstone, sandstone, grit, gravel, conglomerate and coal of the Vryheid Formation of the Ecca Group of the Karoo Supergroup (see Fig. 3). The Karoo Supergroup sediments were deposited in valleys and basins that existed in the pre-Karoo topography in the region. The

Karoo Supergroup rocks overlie unconformably the older Waterberg Group and Transvaal Supergroup rocks (Johnson *et al.* 2009).

The Vryheid Formation was formed when glacial and fluvio-glacial sediments were deposited in shallow marine to fluvio-deltaic environments approximately 280 Ma ago. In places coal seams are associated with these fluvial valley deposits. The coal seams formed in peat swamps which originated on alluvial plains or more rarely in back swamps (Johnson, *et al.*, 2009). The Vryheid Formation is found mainly in the northern and western parts of the study area while the remainder of the study area (including the localities of Sites B and C) is mainly underlain by dolerite (see Fig. 3). Dolerite intruded into the older sedimentary units comprising the Karoo Supergroup approximately 182.5 Mya. These igneous intrusions exposed the surrounding sedimentary rocks to thermal metamorphism.

Alluvium that is associated with Quaternary river beds used to be found in the northern part of the study site that has been highly transformed by the establishment of coal mines and the Secunda petrochemical plant in that area.

## 6. Site Visit



Figure 4: Site C facing North  $26^{\circ}37'06.08''\text{S}$   $29^{\circ}09'49.41''\text{E}$



Figure 5: Site C facing East  $26^{\circ}37'06.08''\text{S}$   $29^{\circ}09'49.41''\text{E}$



Figure 6: Site C facing South 26°37'06.08"S 29°09'49.41"E



Figure 7: Site C facing West 26°37'06.08"S 29°09'49.41"E



Figure 8: Brandspruit Farm facing North from 26°36'51.6"S 29°09'57.3"E



Figure 9: Site B facing North 26°36'32.34"S 29°10'42.49"E



Figure 10: Site B facing East 26°36'32.34"S 29°10'42.49"E



Figure 11: Site B facing South 26°36'33.0"S 29°10'39.3"E





Figure 12 Tweefontein Farm facing North 26°36'51.6"S 29°09'57.3"E



Figure 13 Tweefontein Farm facing East 26°37'15.5"S 29°09'08.0"E



Figure 14 Tweefontein Farm facing West 26°37'15.5"S 29°09'08.0"E



Figure 15 Tweefontein Farm facing East 26°37'34.4"S 29°08'44.5"E



Figure 16 Tweefontein Farm facing West 26°37'34.4"S 29°08'44.5"E



Figure 17 Sandstone on Boschesspruit Farm 26°37'06.00"S 29°10'40.7"E

## 7. Palaeontological potential of the study site

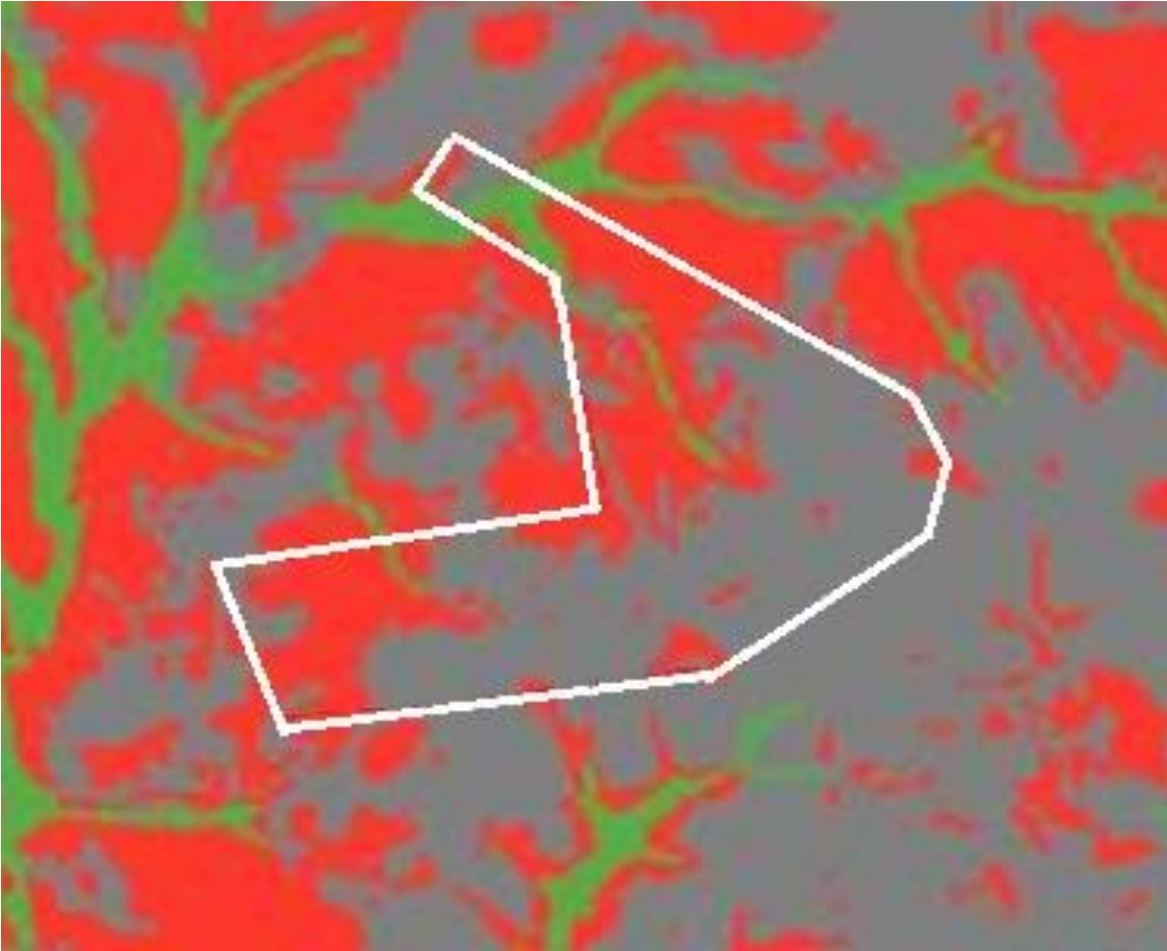


Figure 18: Palaeosensitivity map of the study site (white polygon) and surroundings (SAHRA, 2019)

Colour	Palaeontological Significance	Action
RED	VERY HIGH	Field assessment and protocol for finds are required.
GREEN	MODERATE	Desktop study is required.
GREY	INSIGNIFICANT / ZERO	No palaeontological studies are required.

The proposed development will take place in an area that is partially underlain by rocks that are considered to have a High Palaeontological Sensitivity and are found mostly in the western and the northern parts of the study site (see Fig. 18).

Fossils have been found on the farms and the mines in the region. These Permian fossils are mostly leaf and stem imprints of *Glossopteris*, lycopods, ferns, horsetails, cordaitaleans, conifers and ginkgoaleans. Rare fossils of silicified and coalified wood, insects, bivalves, conchostrachans and fish scales have also been

found in the shales and sandstones of the Vryheid Formation in the Free State (Groenewald & Groenewald, 2014).

The study area falls within the Ecca Group of the Karoo Supergroup. The Ecca Group is renowned for its fossil content. The Ecca Group is characterized by shale, mudstone, sandstone and seams of coal (Johnson *et al.*, 2009). The near horizontal layering of the geological strata and erosion of the adjacent and underlying rock strata results in a gently undulating landscape covered to a great extent by soil. Exposures of the underlying geology are therefore exceptionally scarce in the northern part of the Main Karoo Basin and are mostly limited to gullies, river banks, road cuttings and the mines in the region.

The Ecca Group of the Karoo Supergroup contain vast amounts of Permian leaf imprints of plants such as *Glossopteris* (Kovács-Endrödy, 1991). Millions of tons of fossiliferous material yielding mostly *Glossopteris* leaf imprints have been exposed at well-studied sites in the northern rim of the Main Karoo Basin such as Hammanskraal (Kovács-Endrödy, 1976), Witbank (Bamford, 2004) and Vereeniging (Rayner, 1986) and at Ryedale (Pack *et al.*, 2000).

Fossilised leaf imprints are not found evenly distributed throughout the Ecca Group, but in pockets such as in the eMalahleni and Vereeniging areas where the physical and chemical conditions during deposition resulted in the preservation of not only the structure of the leaves but also in some cases the organic material itself. The structure of the fossilised leaves is better preserved in the shales than in the sandstone units. The leaf structures are mostly lost in the coal layers.

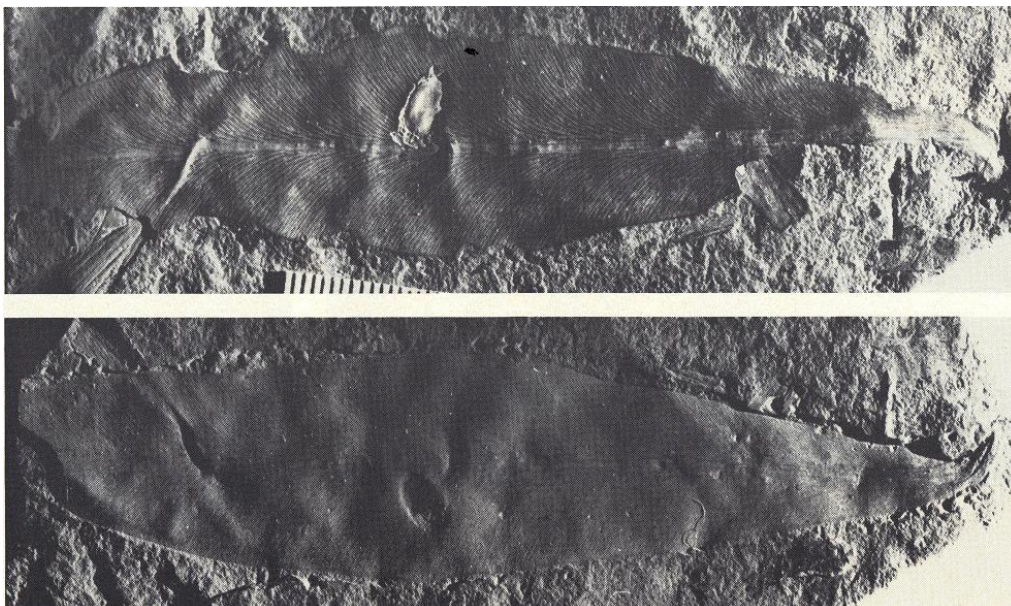


Figure 19: *Glossopteris* leaf imprint (from Kovács-Endrödy, 1976)

There is a high volume but low species diversity of fossil material from this region. Large and well described collections of fossil material from this region are housed

at the Council for Geoscience, the University of the Witwatersrand and the Botanical Research Institute. *Glossopteris* leaves are abundant in Ecca Group sediments in Gauteng, Free State, Mpumalanga and KwaZulu-Natal and could be considered to be amongst the most common fossils in South Africa.

The alluvium in the study area is considered to be of Moderate Palaeontological Sensitivity. There is a possibility to find scarce mammal, reptile, bird, amphibian and fish bones, ostrich egg shells, mollusc shells, crustacean fossils, microfossils, trace fossils including termitaria, burrows, root casts, trackways, plant material including peat, leaves, wood and pollen in Quaternary aged deposits (Groenewald & Groenewald, 2014).

Dolerite, being of igneous nature, is non fossiliferous. The southeastern part of the study area, where the Main Transmission Station is to be built, is underlain by dolerite.

#### References:

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Rayner, R.J. (1986) *Azaniadendron*, a new genus of lycopod from South Africa. *Review of Palaeobotany and Palynology* 47:129–143.

SAHRA (2019) Palaeosensitivity Map <http://www.sahra.org.za/sahris/map/palaeo>

## **8. Conclusion and recommendations for the study site:**

The region is known for its fossiliferous shales and sandstones and it is highly probable that fossils will be encountered when the intact bedrock under the soil cover and layer of eroded rock is exposed during construction.

A thick layer of soil obscures the underlying geology and outcrops are scarce. The few rocks that were found in the study area were coarse-grained sandstone. No fossiliferous rocks were found during the site inspection.

The proposed site for the construction of the Main Transmission Station (Site C) is underlain by non-fossiliferous dolerite.

If an exceptionally fossil-rich layer of shale or sandstone is exposed during construction of pylons or other infrastructure to the north, west or east of the Main Transmission Station however, it is advised that the ECO must follow the Chance Palaeontological Find Procedure as stipulated below and to contact a palaeontologist for further advice.

### **PROCEDURE FOR CHANCE PALAEONTOLOGICAL FINDS**

Extracted and adapted from the National Heritage Resources Act, 1999  
Regulations Reg No. 6820, GN: 548.

The following procedure must be considered in the event that previously unknown fossils or fossil sites are exposed or found during the life of the project:

1. Surface excavations should continuously be monitored by the ECO and any fossil material be unearthed the excavation must be halted.
2. If fossiliferous material has been disturbed during the excavation process it should be put aside to prevent it from being destroyed.
3. The ECO then has to take a GPS reading of the site and take digital pictures of the fossil material and the site from which it came.
4. The ECO then should contact a palaeontologist and supply the palaeontologist with the information (locality and pictures) so that the palaeontologist can assess the importance of the find and make recommendations.
5. If the palaeontologist is convinced that this is a major find an inspection of the site must be scheduled as soon as possible in order to minimise delays to the development.

From the photographs and/or the site visit the palaeontologist will make one of the following recommendations:

- a. The material is of no value so development can proceed, or:
  - b. Fossil material is of some interest and a representative sample should be collected and put aside for further study and to be incorporated into a recognised fossil repository after a permit was obtained from SAHRA for the removal of the fossils, after which the development may proceed, or:
  - c. The fossils are scientifically important and the palaeontologist must obtain a SAHRA permit to excavate the fossils and take them to a recognised fossil repository, after which the development may proceed.
7. If any fossils are found then a schedule of monitoring will be set up between the developer and palaeontologist in case of further discoveries.



## 9. Declaration of Independence:

I, Jacobus Francois Durand declare that I am an independent consultant and have no business, financial, personal or other interest in the proposed development, 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 the objectivity of my performing such work.



Palaeontological specialist:

**Dr JF Durand (Sci. Nat.)**

BSc Botany & Zoology (RAU), BSc Zoology (WITS), Museology Dipl. (UP),  
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