The Proposed Motuoane Exploration Right 386 Application

Matjhabeng and Moqhaka Local Municipalities, Lejweleputswa and Fezili Dabi District Municipalities, Free State Province

Farm: Several Farms between Welkom, Henneman, Riebeeckstad and Virginia

Fourie, H. Dr

Palaeontological Impact Assessment: Phase 1: Field Study

Facilitated by: Environmental Impact Management Service (Pty) Ltd

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2025/06/22

Ref: Pending

Regisaurus sp. (ESI, Wits, H. Fourie)

B. Executive summary

Outline of the development project: EIMS (Pty) Ltd appointed Dr H. Fourie, a palaeontologist, to undertake a Palaeontological Impact Assessment (PIA), Field Study of The Proposed Motuoane Exploration Right 386 Application in the Matjhabeng and Moqhaka Local Municipalities, Lejweleputswa and Fezili Dabi District Municipalities, Free State Province on Farm: Several Farms between Welkom, Henneman, Riebeeckstad and Virginia.

The applicant, Motuoane Energy (Pty) Ltd intends to explore for hydrocarbons including, but not limited to Methane, Carbon dioxide, Helium and Nitrogen.

The Project includes one locality Option (see Figure 2):
Option 1: An exploration area indicated with green circles and yellow lines with the towns of Virginia south, Welkom and Riebeeckstad west; and Henneman east. The approximate size of the area is 58 000 hectares.

Legal requirements:

The **National Heritage Resources Act (Act No. 25 of 1999) (NHRA)** requires that all heritage resources, that is, all places or objects of aesthetic, architectural, historical, scientific, social, spiritual, linguistic or technological value or significance are protected. The Republic of South Africa (RSA) has a remarkably rich fossil record that stretches back in time for some 3.5 billion years and must be protected for its scientific value. Fossil heritage of national and international significance is found within all provinces of the RSA. South Africa's unique and non-renewable palaeontological heritage is protected in terms of the National Heritage Resources Act. According to this act, palaeontological 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.

The main aim of the assessment process is to document resources in the development area and identify both the negative and positive impacts that the development brings to the receiving environment. The PIA therefore identifies palaeontological resources in the area to be developed and makes recommendations for protection or mitigation of these resources.

"palaeontological" means any fossilised remains or fossil trace of animals or plants which lived in the geological past, other than fossil fuels or fossiliferous rock intended for industrial use, and any site which contains such fossilised remains or traces.

For this study, resources such as geological maps, scientific literature, institutional fossil collections, satellite images, aerial maps and topographical maps were used. It provides an assessment of the observed or inferred palaeontological heritage within the study area, with recommendations (if any) for further specialist palaeontological input where this is considered necessary.

A Palaeontological Impact Assessment is generally warranted where rock units of **LOW** to **VERY 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 area is unknown. The specialist will inform whether further monitoring and mitigation are necessary.

Types and ranges of heritage resources as outlined in Section 3 of the National Heritage Resources Act (Act No.25 of 1999):
(i) (i) objects recovered from the soil or waters of South Africa, including archaeological and palaeontological objects and material, meteorites and rare geological specimens.
This report adheres to the guidelines of Section 38 (1) of the National Heritage Resources Act (Act No. 25 of 1999).

Subject to 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 (see Section 38); (d) the re-zoning of a site exceeding 10 000 m² (1 ha) in extent; (e) or any other category of development provided for in regulations by SAHRA or a PHRA authority.

This report (**1c)** aims to provide comment and recommendations on the potential impacts that the proposed development could have on the fossil heritage of the area and to state if any mitigation or conservation measures are necessary.

Outline of the geology and the palaeontology:

The geology was obtained from map 1:100 000, Geology of the Republic of South Africa (Visser 1984) and 2726 Kroonstad (Schutte 2000) and 2826 Winburg (Visser and Nolte 1998), 1:250 000 geological maps.

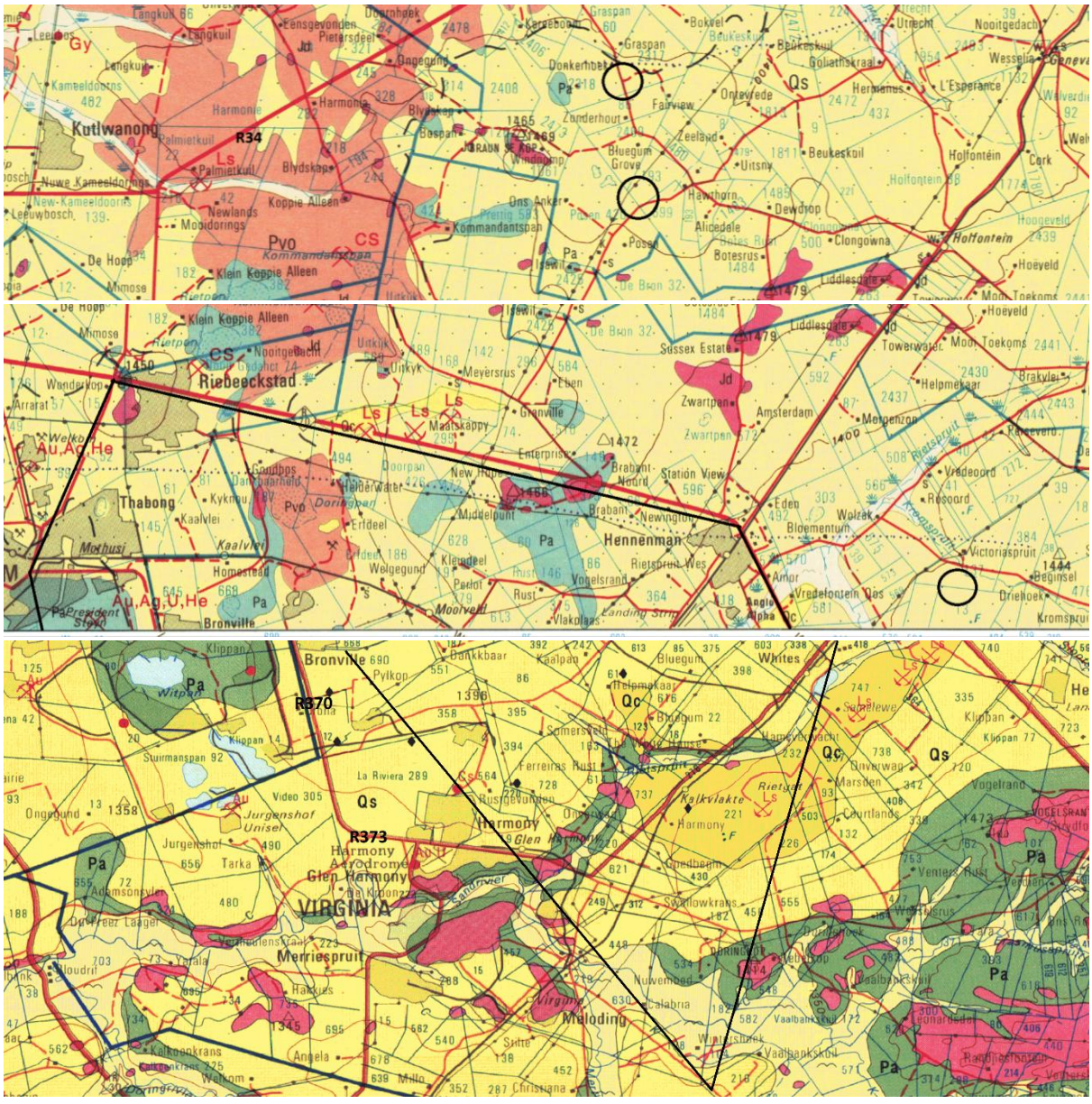


Figure: The geology of the development area.

Legend to Map and short explanation.

Qc – Limestone, tufa (dark yellow). Quaternary.
Qs – Aeolian sand (yellow). Quaternary.
Jd – Karoo Dolerite suite (pink). Jurassic.
Pa – Grey and brownish-red mudstone, sandstone, siltstone (blue). Adelaide Subgroup, Beaufort Group, Karoo Supergroup. Permian.
Pvo - Mudstone, siltstone, shale (amber). Volksrust Formation, Ecca Group, Karoo Supergroup. Permian.
…… – (black) Lineament (Possible dyke).
-----f - Fault.
------ - Concealed geological boundary.
⊥2˚ - Strike and dip.
□ - Proposed development (blocked and circled in black on Figure).

Over areas totalling fully 40% of Southern Africa the 'hard rocks', from the oldest to the Quaternary, are concealed by normally unconformable deposits – principally sand, gravel, sandstone, and limestone. Inland deposits are much more extensive than marine deposits and are terrestrial and usually not-fossiliferous. Some of these deposits date back well into the Tertiary, whereas others are still accumulating. Owing to the all-to-often lack of fossils and of rocks suitable for radiometric or palaeomagnetic dating, no clear-cut dividing line between the Tertiary and Quaternary successions could be established (Kent 1980). The alluvium sands were deposited by a river system and reworked by wind action (Snyman 1996). A thick cover of Kalahari reddish sand blankets most outcrops and is dominated by the typical Kalahari thornveld (Norman and Whitfield 2006). Several Formations are present.

The Adelaide Subgroup consists of up to three formations (Koonap, Middleton, Balfour in the east). Mudrock predominates with subordinate sandstone and is Upper Permian in age. It overlies the Ecca Group conformably and is overlain by the Katberg Formation of the Tarkastad Subgroup. Siltstone beds are common (Cole *et al.* 2004). The Adelaide Subgroup has a maximum thickness of 1750 m. in the south (Visser 1989).

Kent (1980) described the Volksrust Formation as the 150-270 m of shale which overlies the Vryheid Formation. The deposition of this formation coincides with that of the Fort Brown and Waterford Formations in the south (Snyman 1996). It occurs from the south of Kwazulu-Natal into the Free State and is concordant (Visser 1989). Very little is written on the Volksrust Formation. It rests conformably on the Vryheid Formation.

Palaeontology – Fossils in South Africa mainly occur in rocks of sedimentary nature and not in rocks from igneous or metamorphic nature. Therefore, if there is the presence of strata the palaeontological sensitivity can generally be **VERY LOW** to **VERY HIGH**, and here locally (SG 2.2 SAHRA APMHOB, 2012):

Rock Unit	Significance/vulnerability	Recommended Action
Jurassic Dolerite	Very Low	No action required
Qs	Moderate	Desktop Study required
Qc	High	Desktop Study and Phase 1: Field Assessment likely
Beaufort Group	Very High	Desktop Study and Phase 1: Field Assessment required
Volksrust Formation	Moderate	Desktop Study required

A wide range of possible fossil remains occur in the Cenozoic, though these are often sparse, such as: mammalian bones and teeth, tortoise remains, ostrich eggshells, non-marine mollusc shells, ostracods, diatoms, and other micro fossil groups, trace fossils (e.g. calcretised termitaria, rhizoliths, burrows, vertebrate tracks), freshwater stromatolites, plant material such as peats, foliage, wood, pollens, within calc tufa. Stromatolite structures range from a centimetre to several tens of metres in size. They are the result of algal growth in shallow water, indicating a very rich growth that would have caused an enrichment in the amount of oxygen in the atmosphere. Deposits of

cenozoic aged cave breccia associated with sinkholes and karst formations contain the remains of the ancestors of man (Groenewald and Groenewald 2014).

Further to the lithostratigraphy, the Beaufort Group is divided into biostratigraphic units. The zone present in the study area is the *Daptocephalus* Assemblage Zone including the upper part of the Teekloof Formation (west of 24°), Balfour Formation (between 24 and 25° east), and Normandien Formation (east of 25° east). It is characterised by the abundance of *Dicynodon* in association with *Emydops, Pristerodon, Lystrosaurus maccaigi, Dinanomodon; Palemydops Aulacephalodon* and *Oudenodon; Diictodon,* and several Therocephalia such as *Theriognathus microps* and the Cynodont *Cynosaurus* amongst others (Rubidge 1995). Plant fossils such as *Glossopteris* and silicified wood are also present. In this area the biozone boundaries are uncertain. The *Daptocephalus* Assemblage Zone overlies the *Cistecephalus* Assemblage zone (Viglietti 2020).

The Volksrust Formation consists of a monotonous sequence of grey shale and fossils are significant, but very rarely recorded. Fossils include rare temnospondyl amphibian remains, invertebrates, minor coals with plant remains, fish scales, petrified wood, and low-diversity marine to non-marine trace fossil assemblages (Groenewald and Groenewald 2014). The bivalve *Megodesmus* is described from this formation (Groenewald 2012).

Summary of findings (**1d**): The Phase 1: Field Study was undertaken in May 2025 in the winter in cold and dry conditions. As this is a field study the season (vegetation) and time (shadows) have an influence, and the following is reported:

The Project includes one locality Option (see Figure).
Other locality options will not be feasible as areas have already been earmarked due to traces of gas already present and all options may be situated on the Quaternary sediments. Both the Beaufort Group and Volksrust Formation occur in small outcrops it is unlikely that the development will have an impact on their heritage.

Field Observation – Fieldwork was done in May 2025. It is a large area with mostly agricultural land, trees, bushes, lush grass, and fences. The target areas are very small and will consist of drilling of boreholes, therefore the impact is low, hence the area around the target was surveyed. Outcrops are absent and no fossils were found (Figure 5-12).

Recommendation:
Concerns/threats **(1g)** to be added to EMPr:

1. Threats to the National Heritage are earth moving equipment/machinery (for example haul trucks, front end loaders, excavators, graders, dozers) during construction, the sealing-in, disturbance, damage or destruction of the fossils by development, vehicle traffic, clearing, and human disturbance.
2. Special care must be taken during the clearing, digging, drilling, exploration and excavating of foundations, trenches, channels and footings and removal of overburden not to intrude fossiliferous layers.

The recommendations are (**1ni,1niA,1nii**):

1. The potential impact of the development on fossil heritage is mostly **MODERATE** sensitivity, but Beaufort sediments are present and therefore a Phase 1: Field Survey was necessary for this development (according to SAHRA protocol), if a chance fossil is found during exploration a Phase 2 Palaeontological Impact Assessment and Mitigation or conservation will be necessary.

2. Mitigation may be needed if fossils are found during the development. Overburden and interburden must be surveyed for fossils.
3. No consultation with parties was necessary. The Environmental Control Officer must familiarise him- or herself with the formation present and its fossils and follow protocol.
4. The development may go ahead with caution. The ECO if appointed must survey for fossils before and or after clearing, ground breaking, or excavating and keep a photographic record.
5. The EMPr will cover the conservation of heritage and palaeontological material that may be exposed during the development activities. For a chance find, the protocol is to immediately cease all activities, construct a 30 m no-go barrier, and contact SAHRA for further investigation. It is recommended that the EMPr be updated to include the involvement of a palaeontologist for pre-development training of the ECO.

Stakeholders: Developer – Motuoane Energy (Pty) Ltd. Tel: 0.
Environmental – EIMS (Pty) Ltd. 8 Dalmeny Road, Pine Park, Randburg, 2194. Tel: 011 789 7170.
Landowner – Several.

C. Table of Contents

D. Background information on the project

Report

This report is part of the environmental impact assessment process under the National Environmental Management Act, as amended (Act No. 107 of 1998) (NEMA) and includes Appendix 6 (May 2019) of the Environmental Impact Assessment Regulations (see Appendix 2). It also is in compliance with The Minimum Standards for Palaeontological Components of Heritage Impact Assessment Reports, SAHRA, APMHOB, Guidelines 2012, Pp 1-15 (**2**).

Outline of development (**1f)**

This report discusses and aims to provide the developer with information regarding the location of palaeontological material that will be impacted by the development. In the pre-construction phase it may necessary for the developer to apply for the relevant permit from the South African Heritage Resources Agency (SAHRA / PHRA) if fossils are present.

The applicant, Motuoane Energy (Pty) Ltd intends to explore for hydrocarbons including, but not limited to Methane, Carbon dioxide, Helium and Nitrogen. The proposed exploration activities will provide geological subsurface data to assist in the determination of whether there is an economically viable resource. Exploration success would result in long-term benefits for South Africa consisting of access to new energy sources, improved security of supply, major in-country investments in a development project, and reduced dependence on the importation of hydrocarbons.

Related Infrastructure:

1. Core and/or percussion exploration drilling (11 holes) to a depth of ±650 m
2. Seismic survey activities with a seismic vibrator (16 seismic transects)
3. Hazardous and general storage
4. Waste storage
5. Chemical toilets
6. Temporary site office
7. Temporary roads, and
8. Work area and drill pad of 50x50 m.

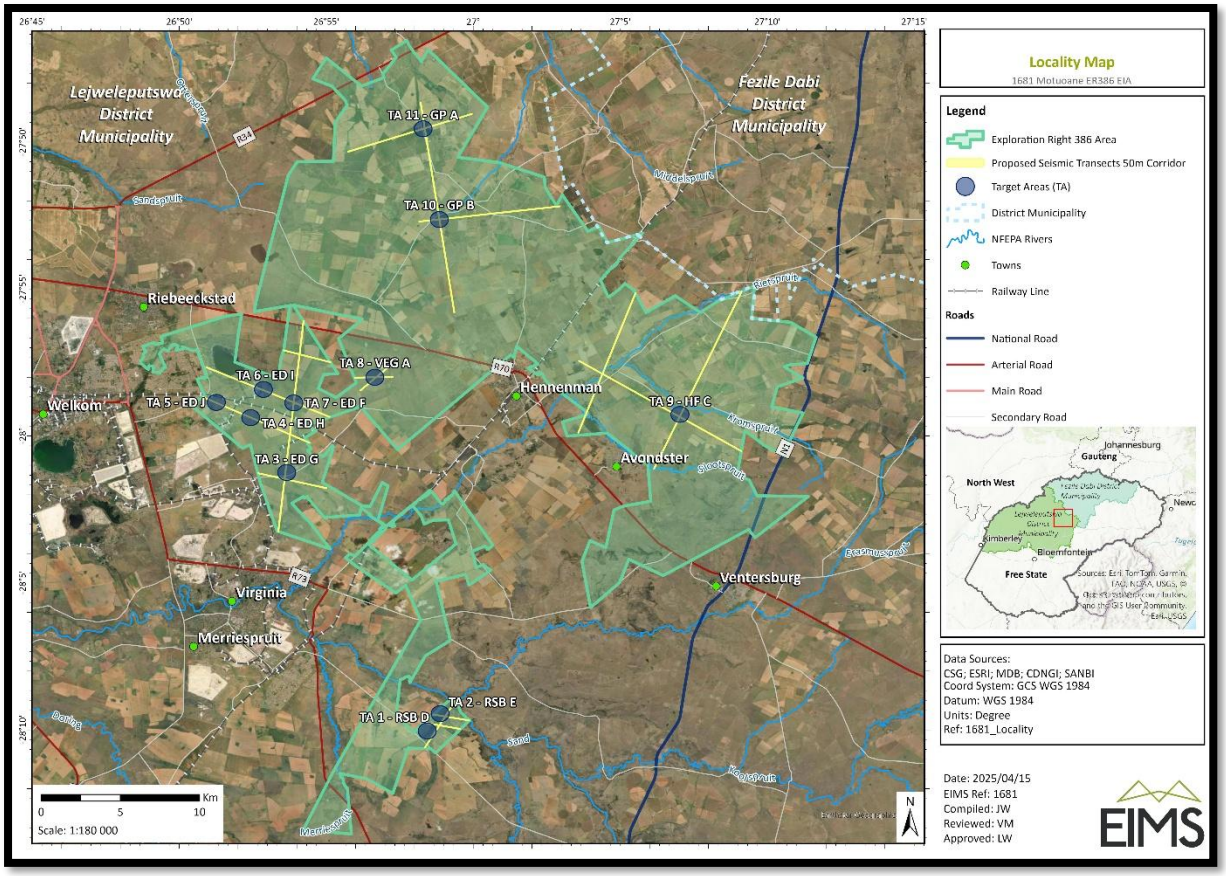


Figure 1: Figure showing location of drill holes and seismic transects (EIMS)

The Project includes one locality Option (see Figure 2) at Welkom:
Option 1: An exploration area indicated with green circles and yellow lines with the towns of Virginia south, Welkom and Riebeeckstad west; and Henneman east. The approximate size of the area is 58 000 hectares.

<u>Rezoning/ and or subdivision of land:</u> N/a.

Name of Developer and Consultant: Motuoane Energy (Pty) Ltd and EIMS (Pty) Ltd.
Terms of reference: Dr H. Fourie is a palaeontologist commissioned to do a palaeontological impact assessment: field study to ascertain if any palaeontological sensitive material is present in the development area. This study will advise on the impact on fossil heritage mitigation or conservation necessary, if any.
Short *Curriculum vitae:(**1ai, 1aii)*** Dr Fourie obtained a Ph.D from the Bernard Price Institute for Palaeontological Research (now ESI), University of the Witwatersrand. Her undergraduate degree is in Geology and Zoology. She specialises in vertebrate morphology and function concentrating on the Therapsid Therocephalia. At present she is curator of a large fossil invertebrate, Therapsid, dinosaur, amphibia, fish, reptile, and plant collections at Ditsong: National Museum of Natural History. For the past 18 years she carried out field work in the North West, Western Cape, Northern Cape, Eastern Cape, Limpopo, Mpumalanga, Gauteng, KwaZulu-Natal, and Free State Provinces and has done more than 200 PIA's since 2012. Dr Fourie has been employed at the Ditsong: National Museum of Natural History in Pretoria (formerly Transvaal Museum) for 30 years.
Legislative requirements: South African Heritage Resources Agency (SAHRA) for issue of permits if necessary. National Heritage Resources Act (Act No. 25 of 1999). An electronic copy of this report must be supplied to SAHRA (**2)**.

E. Description of property or affected environment
Location and depth:
The Proposed Motuoane Exploration Right 386 Application will be situated in the Matjhabeng and Moqhaka Local Municipalities, Lejweleputswa and Fezili Dabi District Municipalities, Free State Province on Farm: Several Farms between Welkom, Henneman, Riebeeckstad and Virginia.

The depth is determined by the infrastructure to be developed and the thickness of the formation in the development area, in this instance the related infrastructure. Details of the location and distribution of all significant fossil sites or key fossiliferous rock units are often difficult to determine due to thick topsoil, subsoil, overburden and alluvium. Depth of the overburden may vary a lot. Geological maps do not provide depth or superficial cover, it only provides mappable surface outcrops (Figure 3).

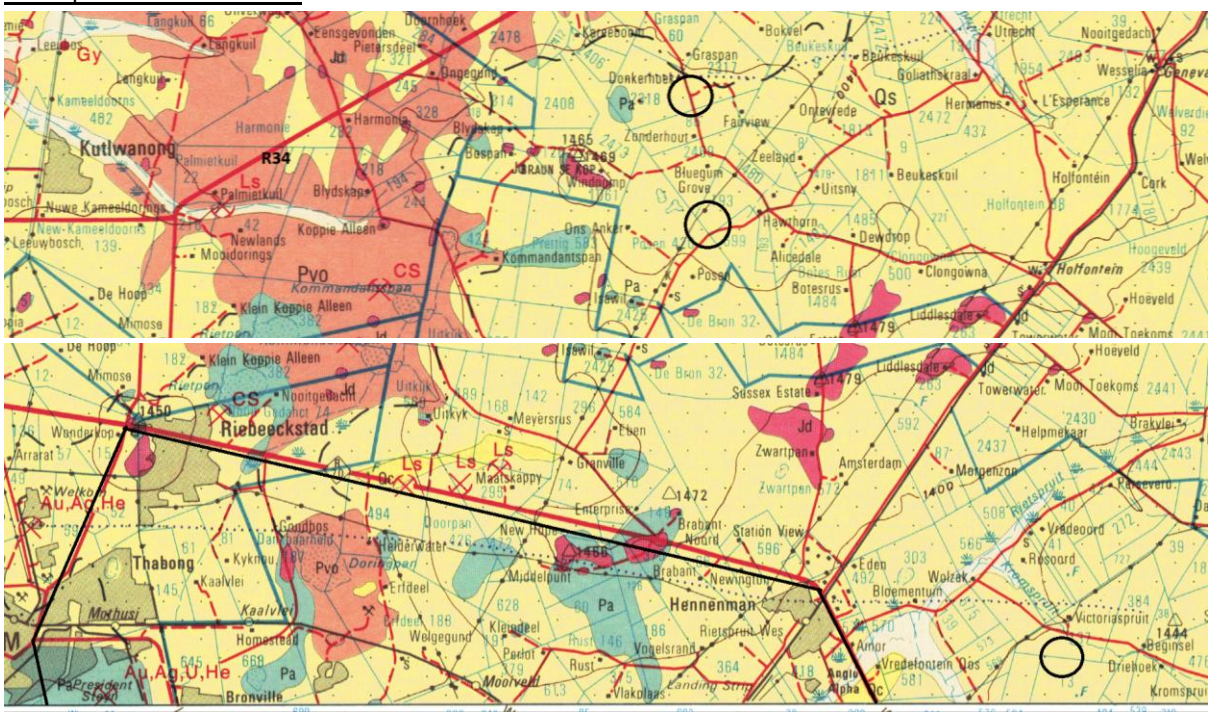
The Project includes one locality Option (see Figure 2) below:

Figure 2: Google Earth image showing location (EIMS).

The bulk of the site is underlain by the Karoo Supergroup Formations covered by vegetation, grass, trees, roads, and buildings.

F. Description of the Geological Setting

Description of the rock units:



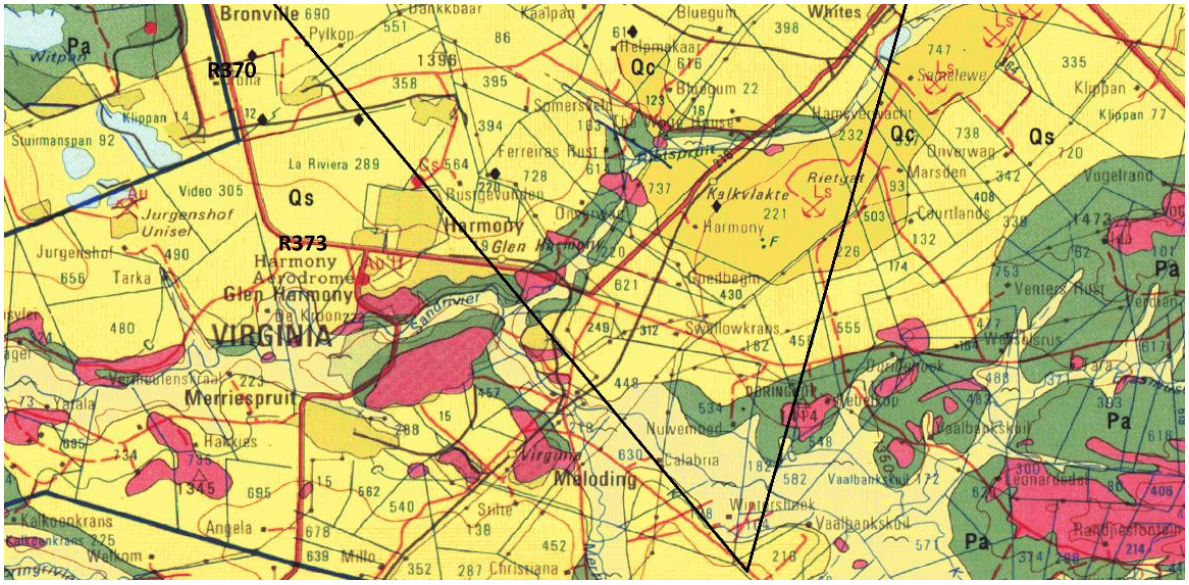


Figure 3: Geology of the development area (**1h)**.

Legend to Map and short explanation.

Qc – Limestone, tufa (dark yellow). Quaternary.

Qs – Aeolian sand (yellow). Quaternary.

Jd – Karoo Dolerite suite (pink). Jurassic.

Pa – Grey and brownish-red mudstone, sandstone, siltstone (blue). Adelaide Subgroup, Beaufort Group, Karoo Supergroup. Permian.

Pvo - Mudstone, siltstone, shale (amber). Volksrust Formation, Ecca Group, Karoo Supergroup. Permian.

…… – (black) Lineament (Possible dyke).

--f— Fault.

----- - Concealed geological boundary.

⊥2˚ - Strike and dip.

□ – Approximate position of development (blocked or circled in black).

Mining Activities on Figure above:

Au – Gold Ag – Silver CS – Brick Clay Ls – Limestone He – Helium U – Uranium.

Mining past and present may have an influence on the project.

Over areas totalling fully 40% of Southern Africa the 'hard rocks', from the oldest to the Quaternary, are concealed by normally unconformable deposits – principally sand, gravel, sandstone, and limestone. Inland deposits are much more extensive than marine deposits and are terrestrial and usually not-fossiliferous. Some of these deposits date back well into the Tertiary, whereas others are still accumulating. Owing to the all-to-often lack of fossils and of rocks suitable for radiometric or palaeomagnetic dating, no clear-cut dividing line between the Tertiary and Quaternary successions could be established (Kent 1980). The alluvium sands were deposited by a river system and reworked by wind action (Snyman 1996). A thick cover of Kalahari reddish sand blankets most outcrops and is dominated by the typical Kalahari thornveld (Norman and Whitfield 2006). Several Formations are present: Riverton Formation, Windsorton Gravel Formation, Florisbad Formation, Aliwal North Formation, Amanzi Formation (Unnamed, Rietheuwel, Enqhura Members), Taung Calc-tufa Formation, Masocheni Formation, Cornelia Formation, Kromdraai Formation, Makapansgat Formation, Sterkfontein Formation, and Swartkrans Formation (Kent 1980).

Large areas of the southern African continent are covered by the Karoo Supergroup (Figure 3). It covers older geological formations with an almost horizontal blanket. Several basins are present with the main Karoo basin in the central part of south Africa and several smaller basins towards Lebombo, Springbok Flats and Soutpansberg. An estimated age is 150 – 180 Ma. And a maximum thickness of 7000 m is reached in the south. Three formations overlie the Beaufort Group, they are the Molteno, Elliot and Clarens Formations. The Elliot Formation is also known as the Red Beds and the old Cave Sandstone is known as the Clarens Formation. At the top is the Drakensberg Basalt Formation with its pillow lavas, pyroclasts, etc. (Kent 1980, Snyman 1996).

Dolerite dykes (Jd) occur throughout the Karoo Supergroup. Structural geological features such as dykes and faults can have a measurable influence on ground water flow and mass transport. Permian sediments are extensively intruded and thermally metamorphosed (baked) by sub-horizontal sills and steeply inclined dykes of the Karoo Dolerite Suite (Jd). These early Jurassic (183 Ma) basic intrusions baked the adjacent mudrocks and sandstones to form splintery hornfels and quartzites respectively. Thermal metamorphism by dolerite intrusions tends to reduce the palaeontological heritage potential of the adjacent sediments.

The rocks of the Beaufort Group were deposited by large, northward-flowing, meandering rivers in which sand accumulated, flanked by extensive floodplains where periodic floods deposited mud. Following the end-Permian mass extinction, the meandering rivers were replaced by multi-channelled, braided river systems that deposited sand rather than the silts and muds of the earlier meandering rivers (McCarthy and Rubidge 2005). Two Subgroups are present in the Beaufort Group, namely the upper Tarkastad Subgroup and the lower Adelaide Subgroup.

The Adelaide Subgroup consists of up to three formations (Koonap, Middleton, Balfour in the east). Mudrock predominates with subordinate sandstone and is Upper Permian in age. It overlies the Ecca Group conformably and is overlain by the Katberg Formation of the Tarkastad Subgroup. Siltstone beds are common (Cole *et al.* 2004). The Koonap Formation is the lowermost unit of the Beaufort Group and reaches a thickness of 1 300 m. (Kent 1980). The Balfour Formation is distinguished from the Middleton Formation by the lack of 'red' mudstone and is ±2 150 m. thick, whereas the Middleton Formation is ±1 600 m. thick (sheet info, Kent 1980). The Abrahamskraal and Teekloof Formations form part of the Adelaide Subgroup in the west (Snyman 1996) with the Member Poortjie at the top of the Teekloof Formation. Chert is present in the Abrahamskraal Formation. The Adelaide Subgroup has a maximum thickness of 1 750 m. in the south (Visser 1989).

The Ecca Group is early to mid-Permian (545-250 Ma) in age. Sediments of the Ecca group are lacustrine and marine to fluvio-deltaic (Snyman 1996). The Ecca group is known for its coal (mainly the Vryheid Formation) (five coal seams) and uranium. Coalfields formed due to the accumulation of plant material in shallow and large swampy deltas (see Appendix 1). The Ecca Group conformably overlies the Dwyka Group and is conformably overlain by the Beaufort Group, Karoo Supergroup. It consists essentially of mudrock (shale), but sandstone-rich units occur towards the margins of the present main Karoo basin in the south, west and north-east, with coal seams also being present in the north-east (Kent 1980, Johnson 2009).

Kent (1980) described the Volksrust Formation as the 150-270 m of shale which overlies the Vryheid Formation. The deposition of this formation coincides with that of the Fort Brown and Waterford Formations in the south (Snyman 1996). It occurs from the south of Kwazulu-Natal into the Free State and is concordant (Visser 1989). Very little is written on the Volksrust Formation. It rests conformably on the Vryheid Formation. Fossils consist of fish scales and wood. This formation reaches thicknesses of 170-270 m (Visser 1989). A monotonous sequence of grey shale is present and fossils are significant, but very rarely recorded. Fossils include rare temnospondyl amphibian remains, invertebrates, minor coals with plant remains, petrified wood, and low-diversity marine to non-marine trace fossil assemblages (Groenewald and Groenewald 2014).

Figure 4: Lithostratigraphic column of the Karoo Supergroup in development area (Caston 1979).

Field Observation – Fieldwork was done in May 2025. It is a large area with mostly agricultural land, trees, bushes, lush grass, and fences. The target areas are very small and will consist of drilling of boreholes, therefore the impact is low, hence the area around the target was surveyed. Outcrops are absent and no fossils were found (Figure 5-12).

Figure 5: Area TA 11 – GP A south of the R 34 Road.

Figure 6: Area TA 10 – GP B north of the R 70 Road.

Figure 7: Area TA 8 – VEG A south of the R 70 Road.

Figure 8: Area TA 3 – ED G east of the mine.

Figure 9: Area TA 5 – ED J nearest to Welkom.

Figure 10: Area TA 6 – ED east of Welkom. TA 7 – ED F and TA 4 – ED H also in this area was not accessible.

Figure 11: Area TA 1 – RSB E and further back TA 2 RSB E southeast of Virginia.

Figure 12: Area TA9 – HF C near Avondster Henneman.

G. Background to Palaeontology of the area

Summary: When rock units of moderate to very high palaeontological sensitivity are present within the development footprint, a desk top and or field scoping (survey) study by a professional palaeontologist is usually warranted. The main purpose of a field scoping (survey) study would be to identify any areas within the development footprint where specialist palaeontological mitigation during the construction phase may be required (SG 2.2 SAHRA AMPHOB, 2012).

A wide range of possible fossil remains occur in the Cenozoic, though these are often sparse, such as: mammalian bones and teeth, tortoise remains, ostrich eggshells, non-marine mollusc shells, ostracods, diatoms, and other micro fossil groups, trace fossils (e.g. calcretised termitaria, rhizoliths, burrows, vertebrate tracks), freshwater stromatolites, plant material such as peats, foliage, wood, pollens, within calc tufa. Stromatolite structures range from a centimetre to several tens of metres in size. They are the result of algal growth in shallow water, indicating a very rich growth that would have caused an enrichment in the amount of oxygen in the atmosphere. Deposits of cenozoic aged cave breccia associated with sinkholes and karst formations contain the remains of the ancestors of man (Groenewald and Groenewald 2014).

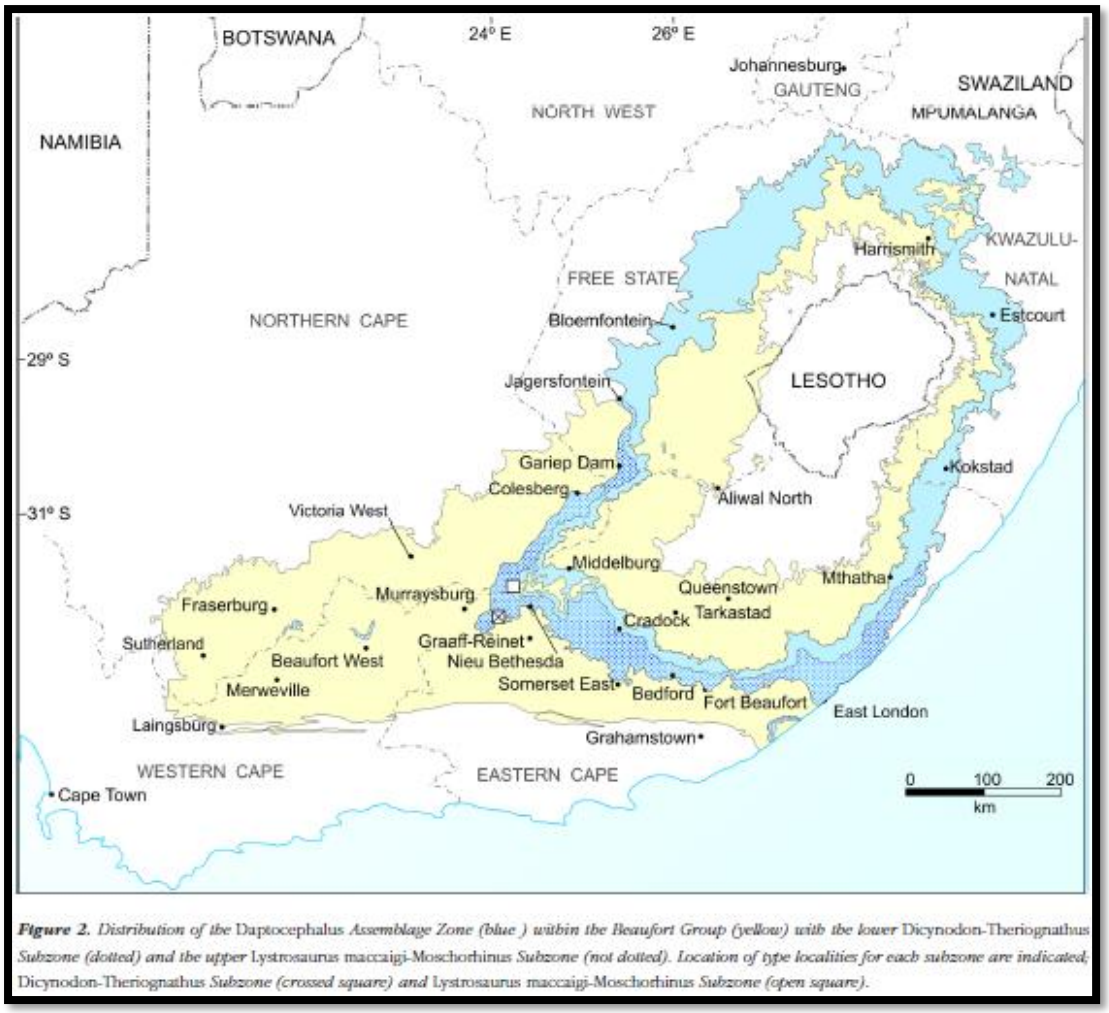


Figure 2. *Distribution of the* Daptocephalus *Assemblage Zone (blue) within the Beaufort Group (yellow) with the lower* Dicynodon-Theriognathus *Subzone (dotted) and the upper* Lystrosaurus maccaigi-Moschorhinus *Subzone (not dotted). Location of type localities for each subzone are indicated;* Dicynodon-Theriognathus *Subzone (crossed square) and* Lystrosaurus maccaigi-Moschorhinus *Subzone (open square).*

Figure 13: Extent of the Karoo Supergroup and position of the different Assemblage Zones (Viglietti 2020).

The rocks of the Karoo Supergroup are internationally acclaimed for their richness and diversity of fossils. The rocks of the Beaufort Group of South Africa cover approximately one-third of the land surface and have yielded an abundance of well-preserved therapsids and other tetrapods which have been used to subdivide this Group into nine faunal Assemblage Zones.

Further to the lithostratigraphy, the Beaufort Group is divided into biostratigraphic units. Zones present in the study area are the *Daptocephalus* Assemblage Zone including the upper part of the Teekloof Formation (west of 24°), Adelaide Subgroup, Balfour Formation (between 24 and 25° east), and Normandien Formation (east of 25° east). It is characterised by the abundance of *Dicynodon* in association with *Emydops, Pristerodon, Lystrosaurus maccaigi, Dinanomodon; Palemydops Aulacephalodon* and *Oudenodon; Diictodon,* and several Therocephalia such as *Theriognathus microps* and the Cynodont *Cynosaurus* amongst others (Rubidge 1995). Plant fossils such as *Glossopteris* and silicified wood are also present. In this area the biozone boundaries are uncertain. The *Daptocephalus* Assemblage Zone overlies the *Cistecephalus* Assemblage zone (Viglietti 2020).

Well preserved fossils of therapsids occur in mudrock horizons, and are usually found as dispersed, isolated specimens associated with an abundance of calcareous nodules. An abundant and varied therapsid fauna as well as amphibian and fish fossils have been recovered from the lower half of the stratigraphic levels assigned to the *Daptocephalus* Assemblage Zone in the main Karoo basin. However, in the upper levels the fauna shows a marked decrease in diversity (Rubidge 1995).

The Volksrust Formation consists of a monotonous sequence of grey shale and fossils are significant, but very rarely recorded. Fossils include rare temnospondyl amphibian remains, invertebrates, minor coals with plant remains, fish scales, petrified wood, and low-diversity marine to non-marine trace fossil assemblages (Groenewald and Groenewald 2014). The bivalve *Megodesmus* is described from this formation (Groenewald 2012).

Fossils in South Africa mainly occur in rocks of sedimentary nature and not in rocks from igneous or metamorphic nature. Therefore, if there is the presence of strata the palaeontological sensitivity is generally **VERY LOW** to **VERY HIGH**, but here locally as below (**1f**):

Table 1: Taken from Palaeotechnical Report (Almond *et al.* 2009) (**1cA)**.

Q; Qs; Q-s; Qw; Qd; Qg Diamondeferous gravel (Qa) Masotcheni (Qm); River Terrace Gravel (Qg)		Aeolian sand, alluvium, colluvium, spring tufa (calcareous) and sinter (siliceous), lake deposits, peats, pedocretes or duricrusts (calcrete, ferricrete), soils and gravel	Very wide range of possible fossil remains, though these are often sparse, such as: mammalian bones and teeth, tortoise remains, ostrich eggshells, non-marine mollusc shells, ostracods, diatoms and other microfossil groups, trace fossils (e.g. calcretised termitaria, rhizoliths, burrows, vertebrate tracks), freshwater stromatolites, plant material such as peats, foliage, wood, pollens	Extensive alluvial and colluvial deposits are not well studied. Refer to archaeological publications for possible reference to important fossil assemblages from these units.
Qc; Q16; T12; Q-c		Calcrete , pandune and surface limestone		
Balfour (Pb) Normandien (Pa; Pn; Pne) Estcourt (Pe, Pes)	Palingkloof/ Harrismith	Brightly coloured mudstone and siltstone. Playa lake deposits associated with arrid braided river environments	Petrified wood, tetrapod faunas of the Lystrosaurus Assemblage Zone (dicynodonts, cynodonts, therocephalians, procolophonids, archosaurs etc), including rich lacustrine biotas of amphibians, fish; trace fossils including vertebrate burrows, coprolites	
	Schoondraai	Meandering river channel sandstone	Diverse terrestrial and freshwater tetrapods of *Pristerognathus* to Dicynodon Assemblage Zones (amphibians, true reptiles, synapsids – especially therapsids), palaeoniscoid fish, freshwater bivalves, trace fossils (including tetrapod trackways), sparse to rich assemblages of vascular plants (*Glossopteris* Flora, including spectacular petrified logs), insects Richest Permo-Triassic tetrapod fauna from Pangaea / Gondwana	Key evidence for evolution of mammalian characters among therapsids Continental record of Late Permian Mass Extinction Events (e.g. Bethulie) Northern outcrop area mainly Dicynodon Assemblage Zone
	Rooinek	Meandering river channel sandstone		
	Frankfort	Coarse-grained sandstone and carbonaceous shale, deltaic deposits	Trace Fossils, plant fossils of *Glossopteris*	
Volksrust (Pvo)		Basinal dark mudrocks with phosphatic / carbonate / sideritic concretions, minor coals Offshore shelf, but possibly also nearshore / lacustrine / lagoonal deposits	Rare temnospondyl amphibian remains, invertebrates (bivalves, insects), minor coals with plant remains, petrified wood, organic microfossils (acritarchs), low-diversity marine to non-marine trace fossil assemblages Late Permian *Cistecephalus* Assemblage Zone biotas	

Table 2: Criteria used (Fossil Heritage Layer Browser/SAHRA) (**1cB)**:

Rock Unit	Significance/vulnerability	Recommended Action
Jurassic Dolerite	Very Low	No action required
Qs	Moderate	Desktop Study required
Qc	High	Desktop Study and Phase 1: Field Assessment likely
Beaufort Group	Very High	Desktop Study and Phase 1: Field Assessment required
Volksrust Formation	Moderate	Desktop Study required

Databases and collections: Ditsong: National Museum of Natural History. Evolutionary Studies Institute, University of the Witwatersrand (ESI).
Impact: **VERY HIGH** for the Adelaide Subgroup, **HIGH** for Quaternary (Qc), **MODERATE** for the Quaternary (Qs) and Volksrust Formation, Karoo Supergroup. There are significant fossil resources that may be impacted by the development (mudstone, shale) and if destroyed are no longer available for scientific research or other public good (Almond, *et al.* 2009).

The Project includes one locality Option with several palaeontological sensitivity (see Figure 2) (**1j)**:
Option 1: An exploration area indicated with green circles and yellow lines with the towns of Virginia south, Welkom and Riebeeckstad west; and Henneman east. The approximate size of the area is 58 000 hectares.

H. Description of the Methodology (1e)
The palaeontological impact assessment field study was undertaken in May 2025. A Phase 1: Field Study includes a survey of the affected portion with photographs taken (in 7.1 mega pixels) of the site with a digital camera (Canon PowerShot A470). Additionally, a Global Positioning System (GPS) (Garmin eTrex 10) is used to record fossiliferous finds and outcrops (bedrock) when the area is not covered with topsoil, subsoil, overburden, vegetation, grassland, trees or waste. The survey did identify the Karoo Supergroup. A literature survey is included and the study relied heavily on geological maps.

SAHRA document 7/6/9/2/1 requires track records/logs from archaeologists not palaeontologists as palaeontologists concentrate on outcrops which may be recorded with a GPS. Isolated occurrences of rocks usually do not constitute an outcrop. Fossils can occur in dongas, as nodules, in fresh rock exposures, and in riverbeds. Finding fossils require the experience and technical knowledge of the professional palaeontologist, but that does not mean that an amateur can't find fossils. The geology of the region is used to predict what type of fossil and zone will be found in any particular region. Archaeozoologists concentrate on more recent fossils in the quaternary and tertiary deposits.

Assumptions and Limitations (**1i)**:-
The accuracy and reliability of the report **may be** limited by the following constraints:

1. Most development areas have never been surveyed by a palaeontologist or geophysicist.
2. Variable accuracy of geological maps and associated information.
3. Poor locality information on sheet explanations for geological maps.
4. Lack of published data.
5. Lack of rocky outcrops.
6. Inaccessibility of site – accessible.
7. Insufficient data from developer and exact lay-out plan for all structures - sufficient.

A Phase 2 Palaeontological Impact Assessment: Mitigation will include:

1. Recommendations for the future of the site.
2. Description of work done (including number of people and their responsibilities).
3. A written assessment of the work done, fossils excavated, not removed or collected and observed.
4. Conclusion reached regarding the fossil material.
5. A detailed site plan.
6. Possible declaration as a heritage site or Site Management Plan.

The National Heritage Resources Act No. 25 of 1999 further prescribes.

Act No. 25 of 1999. National Heritage Resources Act, 1999.
National Estate: 3 (2) (f) archaeological and palaeontological sites,
(i)(1) objects recovered from the soil or waters of South Africa, including archaeological and palaeontological objects and material, meteorites and rare geological specimens,
Heritage assessment criteria and grading: (a) Grade 1: Heritage resources with qualities so exceptional that they are of special national significance;
(b) Grade 2: Heritage resources which, although forming part of the national estate, can be considered to have special qualities which make them significant within the context of a province or a region; and (c) Grade 3: Other heritage resources worthy of conservation.
SAHRA is responsible for the identification and management of Grade 1 heritage resources.
Provincial Heritage Resources Authority (PHRA) identifies and manages Grade 2 heritage resources.
Local authorities identify and manage Grade 3 heritage resources.

No person may damage, deface, excavate, alter, remove from its original position, subdivide or change the planning status of a provincially protected place or object without a permit issued by a heritage resources authority or local authority responsible for the provincial protection.
Archaeology, palaeontology and meteorites: Section 35.
(2) Subject to the provisions of subsection (8) (a), all archaeological objects, palaeontological material and meteorites are the property of the State.
(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.

Mitigation involves planning the protection of significant fossil sites, rock units or other palaeontological resources and/or excavation, 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 a Phase 2 may be implemented.

The Mitigation is done in order to rescue representative fossil material from the study area to allow and record the nature of each locality and establish its age before it is destroyed and to make samples accessible for future research. It also interprets the evidence recovered to allow for education of the public and promotion of palaeontological heritage.

Should further fossil material be discovered during the course of the development (*e. g.* during bedrock excavations), this must be safeguarded, where feasible *in situ,* and reported to a palaeontologist or to the Heritage Resources authority. In situations where the area is considered palaeontologically sensitive (*e. g.* Karoo Supergroup Formations, ancient marine deposits in the interior or along the coast) the palaeontologist might need to monitor all newly excavated bedrock. The developer needs to give the palaeontologist sufficient time to assess and document the finds and, if necessary, to rescue a representative sample.

When a Phase 2 palaeontological impact study is recommended, permission for the development to proceed can be given only once the heritage resources authority has received and approved a Phase 2 report and is satisfied that (a) the palaeontological resources under threat have been adequately recorded and sampled, and (b) adequate development on fossil heritage, including, where necessary, *in situ* conservation of heritage of high significance. Careful planning, including early consultation with a palaeontologist and heritage management authorities, can minimise the impact of palaeontological surveys on development projects by selecting options that cause the least amount of inconvenience and delay.

Three types of permits are available; Mitigation, Destruction and Interpretation. The specialist will apply for the permit at the beginning of the process (SAHRA 2012).

I. Description of significant fossil occurrences

All Karoo Supergroup geological formations are ranked as VERY LOW to VERY HIGH, and here the impact is potentially VERY HIGH for the Beaufort Group, HIGH for Quaternary (Qc), MODERATE for the Quaternary (Qs) and Volksrust Formation as on the SAHRIS paleo map below which does not differ from the Palaeotech Report:

A wide range of possible fossil remains occur in the Cenozoic, though these are often sparse, such as: mammalian bones and teeth, tortoise remains, ostrich eggshells, non-marine mollusc shells, ostracods, diatoms, and other micro fossil groups, trace fossils (e.g. calcretised termitaria, rhizoliths, burrows, vertebrate tracks), freshwater stromatolites, plant material such as peats, foliage, wood, pollens, within calc tufa. Stromatolite structures range from a centimetre to several tens of metres in size. They are the result of algal growth in shallow water, indicating a very rich growth that would have caused an enrichment in the amount of oxygen in the atmosphere. Deposits of cenozoic aged cave breccia associated with sinkholes and karst formations contain the remains of the ancestors of man (Groenewald and Groenewald 2014).

The Jurassic Dolerite does not contain fossils.

Further to the lithostratigraphy, the Beaufort Group is divided into biostratigraphic units. Zones present in the study area are the *Daptocephalus* Assemblage Zone including the upper part of the Teekloof Formation (west of 24°), Balfour Formation (between 24 and 25° east), and Normandien Formation (east of 25° east). It is characterised by the abundance of *Dicynodon* in association with *Emydops, Pristerodon, Lystrosaurus maccaigi, Dinanomodon; Palemydops Aulacephalodon* and *Oudenodon; Diictodon,* and several Therocephalia such as *Theriognathus microps* and the Cynodont *Cynosaurus* amongst others (Rubidge 1995). Plant fossils such as *Glossopteris* and silicified wood are also present. In this area the biozone boundaries are uncertain. The *Daptocephalus* Assemblage Zone overlies the *Cistecephalus* Assemblage zone (Viglietti 2020).

Well preserved fossils of therapsids occur in mudrock horizons, and are usually found as dispersed, isolated specimens associated with an abundance of calcareous nodules. An abundant and varied therapsid fauna as well as amphibian and fish fossils have been recovered (Rubidge 1995).

The Volksrust Formation consists of a monotonous sequence of grey shale and fossils are significant, but very rarely recorded. Fossils include rare temnospondyl amphibian remains, invertebrates, minor coals with plant remains, fish scales, petrified wood, and low-diversity marine to non-marine trace fossil assemblages (Groenewald and Groenewald 2014). The bivalve *Megodesmus* is described from this formation (Groenewald 2012).

Details of the location and distribution of all significant fossil sites or key fossiliferous rock units are often difficult to be determined due to thick topsoil, subsoil, overburden and alluvium. Depth of the overburden may vary a lot.

The threats are (**1g,ni,nii,o,p**):-

- Earth moving equipment/machinery (front end loaders, excavators, graders, dozers) during construction,
- The sealing-in or destruction of fossils by development, vehicle traffic, and human disturbance. See Description of the Geological Setting (F) above.

J. Recommendation (1j,1l)

a. There is no objection (see Recommendation B) to the development, it was necessary to request a Phase 1 Palaeontological Impact Assessment: Field Study to determine whether the development will affect fossiliferous outcrops as the palaeontological sensitivity is mostly **MODERATE** with Beaufort sediments also present. If chance fossils are found during exploration a Phase 2 Palaeontological Assessment: Mitigation is recommended. Protocol is attached (Appendix 2).
b. Preferred choice: Only one locality Option is presented and possible.
c. The following should be conserved: if any palaeontological material is exposed during clearing, exploration, excavating, or drilling the PHRA must be notified. All construction activities must be stopped, a 30 m no-go barrier constructed, and a palaeontologist should be called in to determine proper mitigation measures.
d. This report must be submitted to SAHRA together with the Heritage Impact Assessment.

Sampling and collecting **(6m,6k)**:
Wherefore a permit is needed from the South African Heritage Resources Agency (SAHRA / PHRA).

a. Objections: Cautious. See heritage value and recommendation.
b. Conditions of development: See Recommendation.
c. Areas that may need a permit: Yes, if a fossil is found.
d. Permits for mitigation: If fossils are found, Needed from SAHRA/ECHRA prior to Mitigation.

K. Conclusions

a. All the land involved in the development was assessed and none of the property is unsuitable for development (see Recommendation B).
b. All information needed for the Palaeontological Impact Assessment was provided by the Consultant. All technical information was provided by EIMS (Pty) Ltd.
c. Areas that would involve mitigation and may need a permit from the South African Heritage Resources Agency are discussed.
d. No consultation with parties was necessary.

e. The following should be conserved: if any palaeontological material is exposed during digging, excavating, drilling or blasting, SAHRA/PHRA must be notified. All development activities must be stopped and a palaeontologist should be called in to determine proper mitigation measures.
f. This project may benefit the economy, the life expectancy of the community, the growth of the community and social development in general.
g. Condition in which development may proceed: It is further suggested that a Section 37(2) agreement of the Occupational, Health and Safety Act 85 of 1993 is signed with the relevant contractors to protect the environment (fossils/dongas) and adjacent areas as well as for safety and security reasons.

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Declaration (1b)

I, Heidi Fourie, declare that I am an independent consultant and have no business, financial, personal or other interest in the proposed development project for which I was appointed to do a palaeontological assessment. There are no circumstances that compromise the objectivity of me performing such work.

I accept no liability, and the client, by receiving this document, indemnifies me against all actions, claims, demands, losses, liabilities, costs, damages and expenses arising from or in connection with services rendered, directly or indirectly by the use of the information contained in this document.

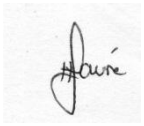
It may be possible that the Palaeontological Impact Assessment may have missed palaeontological resources in the project area as outcrops are not always present or visible while others may lie below the overburden of earth and may only be present once development commences.

This report may not be altered in any way and any parts drawn from this report must make reference to this report.

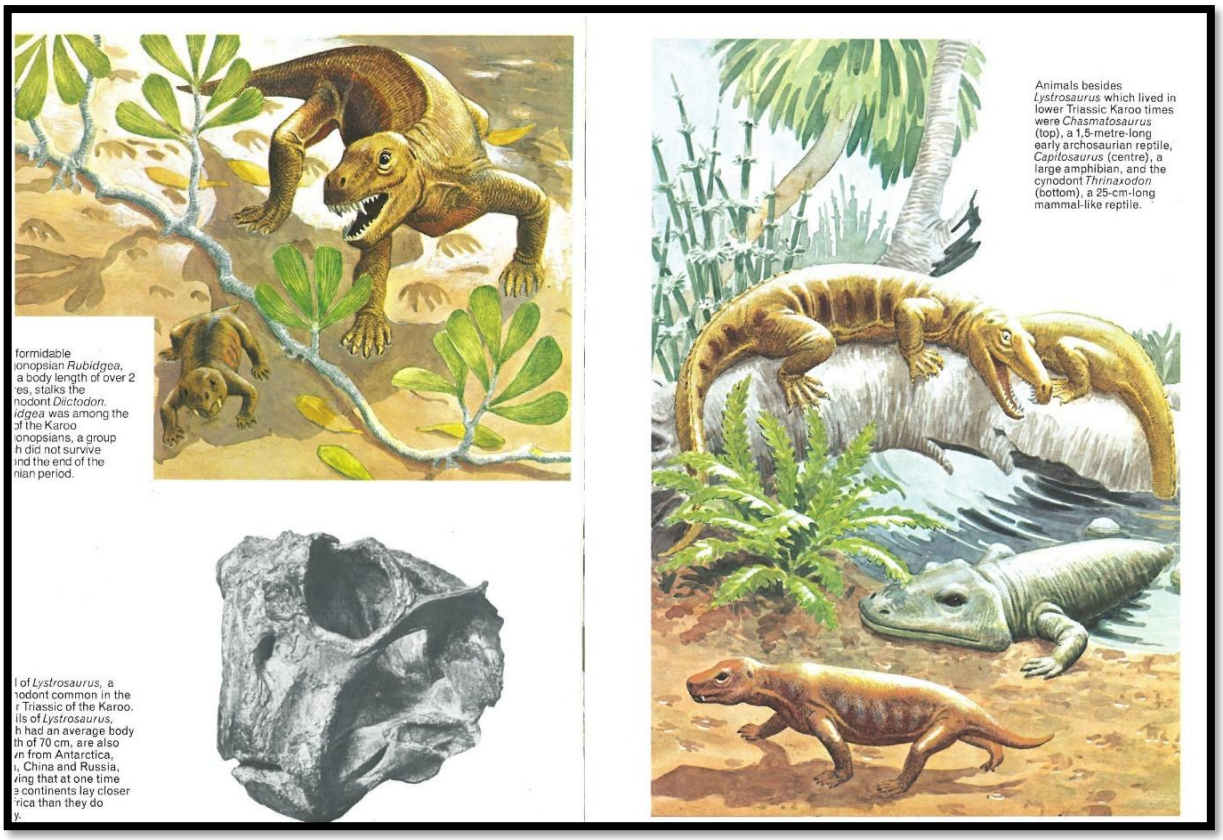
POPI Act 2013 Statement

It provides that everyone has the right to privacy and includes a right to protection against the unlawful collection, retention dissemination and use of personal information contained in this document and pertains to the phone and contact details, signature and contents.

As per the Declaration Section none of the information may be shared without the permission of the author.

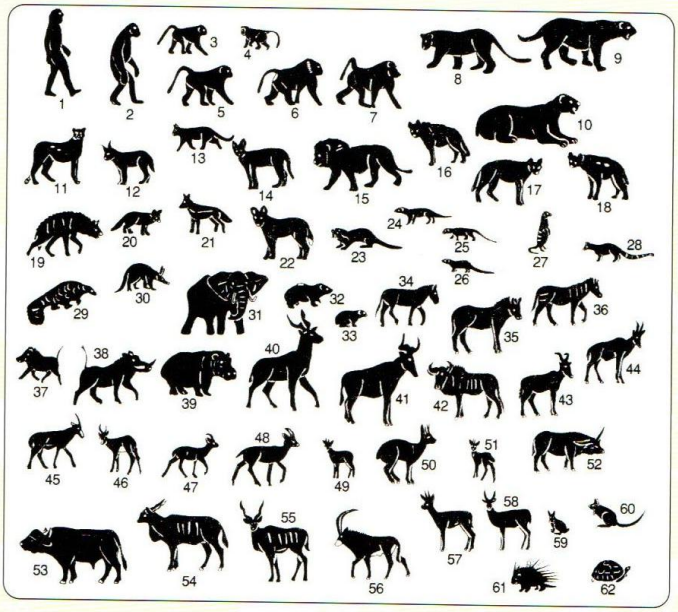


Heidi Fourie
2025/06/22



Karoo scene (Cluver 1978)

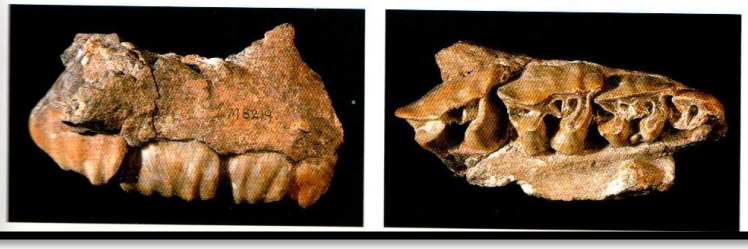
Appendix 1: Examples of Quaternary age fossils (Cluver 1978).



Silhouette representation of the larger vertebrates whose remains are represented in Members 1-3 of the Swartkrans site on the outskirts of the town of Krugersdorp. Numbers after each taxon comprise minimum numbers of individuals represented in the remains of the lower bank (Member 1), hanging remnant (Member 1), Member 2 and Member 3 respectively.
Courtesy of Dr C.K. Brain.
Museum of Natural History, Pretoria

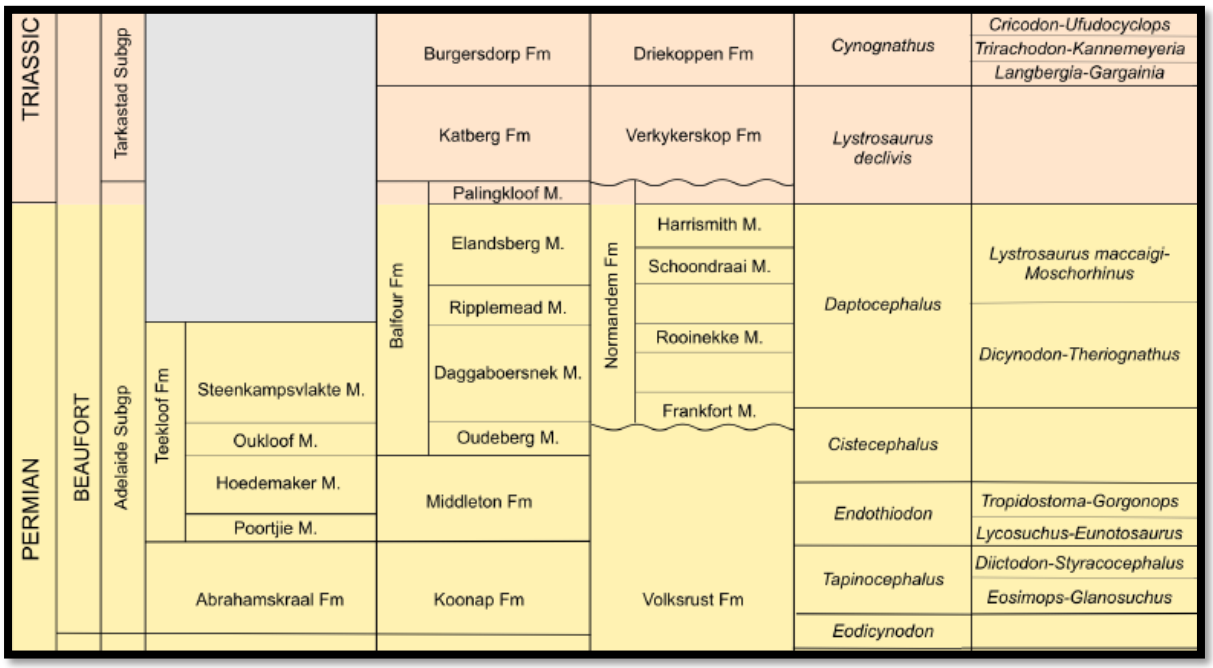
FAUNA FROM MEMBERS 1 - 3, SWARTKRANS (Makapanian Mammal Age)
Courtesy Dr B. Brain, - Museum of Natural History, Pretoria

1: *Homo erectus* (man) 1,3,2,0. **2**: *Australopithecus robustus* (robust apeman) 13,87,17,9. **3**: *Parapapio jonesi* 0,8,0,0. **4**: *Cercopithecoides* sp. 1,0,0,0. **5**: *Papio hamadryas robinsoni* 6,38,8,11. **6**: *Theropithecus oswaldi danieli* 1,17,1,14. **7**: *Dinopithecus ingens* 1,26,0,0. **8**: *Panthera pardus* (leopard) 4,12,2,5. **9**: *Dinofelis* sp. (false sabre-toothed cat) 0,1,0,0. **10**: *Megantereon* sp. (dirk-toothed cat) 0,1,0,1. **11**: *Acinonyx jubatus* (cheetah) 0,1,0,1. **12**: *Felis caracal* (caracal) 1,0,0,0. **13**: *Felis lybica* (African wild cat) 0,0,0,1. **14**: *Felis serval* (serval) 1,0,0,0. **15**: *Panthera leo* (lion) 1,1,0,0. **16**: *Hyaena brunnea* (brown hyaena) 1,4,2,3. **17**: *Chasmaporthetes nitidula* (hunting hyaena) 2,8,1,2. **18**:*Crocuta crocuta* (spotted hyaena) 0,2,1,1. **19**: *Proteles* sp. (large fossil aardwolf) 1,1,0,1. **20**: *Vulpes* sp. (fox) 0,2,0,3. **21**: *Canis mesomelas* (black-backed jackal) 3,4,4,5. **22**: Large canid gen. and sp. indet. 0,0,1,1. **23**: *Aonyx capensis* (Cape clawless otter) 2,0,1,2. **24**: *Atilax* sp. (water mongoose) 0,0,1,1. **25**: *Cynictis penicillata* (yellow mongoose) 0,0,1,1. **26**: *Herpestes ichneumon* (large grey mongoose) 1,0,0,0. **27**: *Suricata suricatta* (suricate) 0,0,2,1. **28**: *Genetta tigrina* (large-spotted genet) 0,0,0,1. **29**: *Manis* sp. (pangolin) 0,0,0,1. **30**: *Orycteropus afer* (antbear) 1,0,1,1. **31**: cf. *Elphas* sp. 2,0,0,1. **32**: *Procavia transvaalensis* (large fossil dassie) 3,8,3,5. **33**: *Procavia antiqua* (fossil dassie) 17,16,10,11. **34**: *Hipparion lybicum steytleri* (three-toed horse) 1,1,1,1. **35**: *Equus capensis* (giant Cape horse) 2,6,3,5. **36**: *Equus burchelli* (Burchell's zebra) 0,0,0,1. **37**: *Phacochoerus* sp. (warthog) 1,0,3,1. **38**: cf. *Tapinochoerus meadowsi* (large fossil pig) 1,7,1,1. **39**: *Hippopotamus* sp. (hippopotamus) 1,0,0,1. **40**: Giraffid 0,1,1,1. **41**: *Megalotragus* sp. (giant hartebeest) 0,3,1,3. **42**: *Connochaetes* sp. (wildebeest) 7,19,7,7. **43**: Medium alcelaphine: *Alcelaphus* sp. or *Beatragus* sp. (hartebeest) 3,22,3,6. **44**: *Rabaticerus porrocornutus* 0,2,0,0. **45**: *Damaliscus* sp. (blesbok) 2,4,6,6. **46**: *Antidorcas marsupialis australis* (springbok) 11,0,10,18. **47**: *Antidorcas recki* 0,6,2,1. **48**: cf. *Gazella* sp. (gazelle) 5,6,5,14. **49**: *Oreotragus oreotragus* (klipspringer) 1,0,0,1. **50**: *Oreotragus major* (fossil klipspringer) 0,1,0,0. **51**: *Raphicerus campestris* (steenbok) 1,0,1,3. **52**: *Makapania* sp. (musk ox) 0,3,0,0. **53**: *Syncerus* sp. (buffalo) 2,3,2,3. **54**: *Taurotragus oryx* (eland) 0,0,1,1. **55**: *Tragelaphus strepsiceros* (kudu) 0,4,0,1. **56**: *Hippotragus* cf. *niger* (sable) 0,0,1,3. **57**: *Pelea* sp. (rhebck) 0,2,0,2. **58**: *Redunca arundinum* (reedbuck) 0,1,0,0. **59**: Lagomorph gen. and sp. indet. (hare) 9,0,4,7. **60**: *Pedetes* sp. (springhare) 1,0,1,1. **61**: *Hystrix africaeaustralis* (porcupine) 2,2,1,2. **62**: *Chelonia* indet. (tortoise) 1,0,2,2.



Left: Teeth of the white rhino *Ceratotherium simum* from Makapansgat. **Right**: View from above shows the sharp cutting edges of the tooth row of this predominant grazer. Specimen 170 mm long.
In the collection of the Bernard Price Institute for Palaeontological Research, University of the Witwatersrand, Johannesburg.
Photograph C.S. MacRae

Appendix 2: Biozonation range of the Beaufort Group (EC 4th column from right) (Smith *et al.* 2020).



Appendix 3: Protocol for Chance Finds and Management Plan (also include Section B) **(1k,m,q)**

This section covers the recommended protocol for a Phase 2 Mitigation process as well as for reports where the Palaeontological Sensitivity is **LOW**; this process guides the palaeontologist / palaeobotanist on site and should not be attempted by the layman / developer.

- As part of the Environmental Authorisation conditions, an Environmental Control Officer (ECO) will be appointed to oversee the development activities in line with the legally binding Environmental Management Programme (EMPr). The EMPr already covers the conservation of heritage and palaeontological material that may be exposed during development activities.
- For a chance find, the protocol is to immediately cease all activities, construct a 30 m no-go barrier, and contact SAHRA for further investigation.
- Construction workers must be informed that this is a no-go area. Any fossil find must be placed in a safe area.
- It is recommended that the EMPr be updated to include the involvement of a palaeontologist for pre-development training of the ECO and possibly during the digging and excavation phase of the development.
- The ECO must visit the site after clearing, excavations, blasting or drilling and keep a photographic record.
- The developer may have to survey the areas affected by the development and indicate on plan where the construction / development may take place. Trenches may have to be dug to ascertain how deep the sediments are above the bedrock (can be a few hundred metres). This will give an indication o/f the depth of the topsoil, subsoil, and overburden, if need be trenches should be dug deeper to expose the interburden.

Mitigation will involve recording, rescue and judicious sampling of the fossil material present in the layers sandwiched between the geological / coal layers. It must include information on number of taxa, fossil abundance, preservational style, and taphonomy. This can only be done during mining or excavations. In order for this to happen, in case of coal mining operations, the process will have to be closely scrutinised by a professional palaeontologist / palaeobotanist to ensure that only the coal layers are mined and the interlayers (siltstone and mudstone) are surveyed for fossils or representative sampling of fossils are taking place.

The palaeontological impact assessment process presents an opportunity for identification, access and possibly salvage of fossils and add to the few good plant localities. Mitigation can provide valuable onsite research that can benefit both the community and the palaeontological fraternity.

A Phase 2 study is very often the last opportunity we will ever have to record the fossil heritage within the development area. Fossils excavated will be stored at a National Repository.

A Phase 2 Palaeontological Impact Assessment: Mitigation will include (SAHRA) -

1. Recommendations for the future of the site.
2. Description and purpose of work done (including number of people and their responsibilities).
3. A written assessment of the work done, fossils excavated, not removed or collected and observed.
4. Conclusion reached regarding the fossil material.
5. A detailed site plan and map.
6. Possible declaration as a heritage site or Site Management Plan.
7. Stakeholders.
8. Detailed report including the Desktop and Phase 1 study information.
9. Annual interim or progress Phase 2 permit reports as well as the final report.
10. Methodology used.

Mitigation involves planning the protection of significant fossil sites, rock units or other palaeontological resources and/or excavation, 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 a Phase 2 may be implemented.

The Mitigation is done in order to rescue representative fossil material from the study area to allow and record the nature of each locality and establish its age before it is destroyed and to make samples accessible for future research. It also interprets the evidence recovered to allow for education of the public and promotion of palaeontological heritage.

Should further fossil material be discovered during the course of the development (*e. g.* during bedrock excavations), this must be safeguarded, where feasible *in situ,* and reported to a palaeontologist or to the Heritage Resources authority. In situations where the area is considered palaeontologically sensitive (*e. g.* Karoo Supergroup Formations, ancient marine deposits in the interior or along the coast) the palaeontologist might need to monitor all newly excavated bedrock. The developer needs to give the palaeontologist sufficient time to assess and document the finds and, if necessary, to rescue a representative sample.

When a Phase 2 palaeontological impact study is recommended, permission for the development to proceed can be given only once the heritage resources authority has received and approved a Phase 2 report and is satisfied that (a) the palaeontological resources under threat have been adequately recorded and sampled, and (b) adequate development on fossil heritage, including, where necessary, *in situ* conservation of heritage of high significance. Careful planning, including early consultation with a palaeontologist and heritage management authorities, can minimise the impact of palaeontological surveys on development projects by selecting options that cause the least amount of inconvenience and delay.

Three types of permits are available; Mitigation, Destruction and Interpretation. The specialist will apply for the permit at the beginning of the process (SAHRA 2012).

The Palaeontological Society of South Africa (PSSA) does not have guidelines on excavating or collecting, but the following is suggested:

1. The developer needs to clearly stake or peg-out (survey) the areas affected by the mining/ construction/ development operations and dig representative trenches and if possible supply geological borehole data. When the route is better defined, it is recommended that a specialist undertake a 'walk through' of the entire road as well as construction areas, including camps and access roads, prior to the start of any construction activities, this may be done in sections.
2. When clearing vegetation, topsoil, subsoil or overburden, hard rock (outcrop) is found, the contractor needs to stop all work.
3. A Palaeobotanist / palaeontologist (contact SAHRIS for list) must then inspect the affected areas and trenches for fossiliferous outcrops / layers. The contractor / developer may be asked to move structures, and put the development on hold.
4. If the palaeontologist / palaeobotanist is satisfied that no fossils will be destroyed or have removed the fossils, development and removing of the topsoil can continue.
5. After this process the same palaeontologist / palaeobotanist will have to inspect and offer advice through the Phase 2 Mitigation Process. Bedrock excavations for footings may expose, damage or destroy previously buried fossil material and must be inspected.
6. When permission for the development is granted, the next layer can be removed, if this is part of a fossiliferous layer, then with the removal of each layer of sediment, the palaeontologist / palaeobotanist must do an investigation (a minimum of once every week).
7. At this stage the palaeontologist / palaeobotanist in consultation with the developer / mining company must ensure that a further working protocol and schedule is in place. Onsite training should take place, followed by an annual visit by the palaeontologist / palaeobotanist.

The South African Heritage Resources Agency has the following documents in place:
Guidelines to Palaeontological Permitting policy.
Minimum Standards: Palaeontological Component of Heritage Impact Assessment reports.
Guidelines for Field Reports.
Palaeotechnical Reports (Eastern Cape, North West, Northern Cape, Mpumalanga, Gauteng, Western Cape, Free State, KwaZulu Natal, and Limpopo)

Appendix 4: Table 2: Listing points in Appendix 6 of the Act and position in Report (bold in text).

Section in Report	Point in Act	Requirement
B	1(c)	Scope and purpose of report
B	1(d)	Duration, date and season
B	1(g)	Areas to be avoided
D	1(ai)	Specialist who prepared report
D	1(aii)	Expertise of the specialist
F Figure 3	1(h)	Map
F	1(ni)	Authorisation
F	1(nii)	Avoidance, management, mitigation and closure plan
G Table 1	1(cA)	Quality and age of base data
G Table 2	1(cB)	Existing and cumulative impacts
G	1(f)	Details or activities of assessment
G	1(j)	Description of findings
H	1(e)	Description of methodology
H	1(i)	Assumptions
J	1(o)	Consultation

J	1(p)	Copies of comments during consultation
J	1(q)	Information requested by authority
Declaration	1(b)	Independent declaration
Appendix 3	1(k)	Mitigation included in EMPr
Appendix 3	1(l)	Conditions included in EMPr
Appendix 3	1(m)	Monitoring included in EMPr
D	1q, 2	Protocol or minimum standard

Appendix 5: Impact Statement

The development footprint is situated mostly on the Quaternary with a **MODERATE** palaeontological sensitivity. The **nature of the impact is the destruction of Fossil Heritage.** Loss of fossil heritage will have a negative impact (-1). The extent of the impact only extends in the region of the development activity footprint and may include transport routes (2). The expected duration of the impact is assessed as potentially permanent (5). The intensity/magnitude of the impact is high as it is destructive (4). The probability of the impact occurring will be definite and will occur regardless of preventative measures (5). The impact is irreversible (5).

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 irreversible. With Mitigation the impact will be High and the cumulative impact is High (3). Impacts on palaeontological heritage during the construction and preconstruction phase could potentially occur and is regarded as having a high possibility. The significance of the impact occurring will be as below: S= C x P

C= (E+D+M+R) x N ÷4
C = -4
S = C x P = -16 High Degree of confidence Low
Priority = CI+LR = 3+3=6; PF = 1.5
FS = PF x S = 1.5x(-16) = (-24) High negative

Mitigation measures:

- The Impact on geology as a whole is High and cannot be mitigated, comparing managed versus unmanaged scenarios is meaningless.
- For a chance find, the protocol is to immediately cease all construction activities, construct a 30 m no-go barrier, and contact SAHRA for further investigation. Construction workers must be informed that this is a no-go area.
- A representative sample must be put aside for inspection. This sample can be sent to a recognised palaeontological repository for curation and safe keeping after the permit was obtained.

All phases of the development will have the same impact.