Proposed Improvement of the National Route R 37 Section 2 from Modikwa Mine to Burgersfort

Fetakgomo – Tubatse Local Municipality, Sekhukune District Municipality, Limpopo Province

Farm: Road reserve

Fourie, H. Dr heidicindy@yahoo.com

012 322 7632/012 993 3110

Palaeontological Impact Assessment: Desktop Study

Facilitated by: Chameleon Environmental Consultants

P.O. Box 11788, Silver Lakes, Pretoria, 0054

Tel: 082 571 6920

2018/03/19

Ref: DEA 14/12/16/3/3/1/1873

B. Executive summary

Outline of the development project: Chameleon Environmental Consultants has facilitated the appointment of Dr H. Fourie, a palaeontologist, to undertake a Paleontological Impact Assessment (PIA), Desktop Study of the suitability of the Proposed Improvement of the National Route R37 Section 2 from Modikwa Mine to Burgersfort (25.87 km) in the Fetakgomo -Tubatse Local Municipality, Sekukuhne District Municipality within the Limpopo Province.

The applicant, SANRAL SOC. Limited proposes to upgrade the R37 between km 117.0 and km 142.87 from Modikwa Mine to Burgersfort.

The Project includes one Alternative (see google.earth image):
Alternative 1: A section of the R37 road marked in red. The existing two lanes from km 117.0 and km 142.87 will be overlaid with a 30 mm asphalt overlay on 150 mm G1 material. Size of area is 25.87 km.

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.

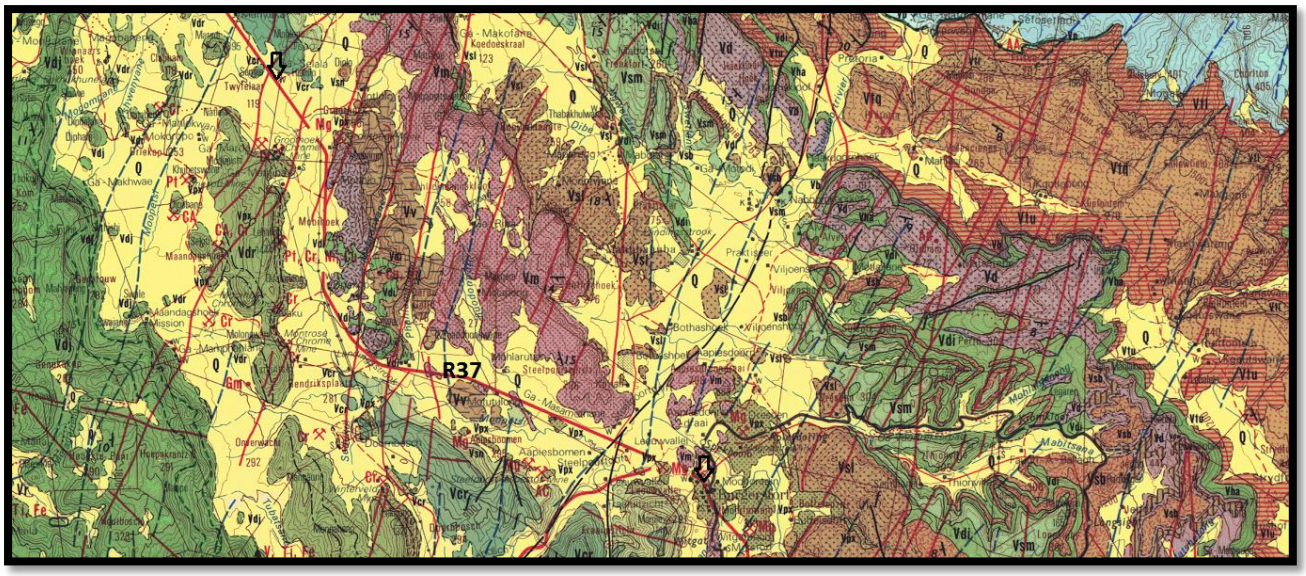
Types and ranges of heritage resources as outlined in Section 3 of the National Heritage Resources Act (Act No.25 of 1999):
(i) (i) objects recovered from the soil or waters of South Africa, including archaeological and palaeontological objects and material, meteorites and rare geological specimens.

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 in extent; (e) or any other category of development provided for in regulations by SAHRA or a PHRA authority.

This report 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 1:250 000 Map of Pilgrim's Rest, 2430 (Walraven 1986).

Figure 3: The geology of the development area.



Legend to Map and short explanation.
Q – Superficial deposits including alluvium and scree (yellow). Quaternary.
Vdr – Medium to coarse grained norite and anorthosite, medium to coarse grained pyroxenite (seagreen). Dwars River Subsuite, Rustenburg Layered Suite, Bushveld Complex. Vaalian.
Vsn – Fine to medium-grained norite; pyroxenite (green). Shelter Norite Formation, Rustenburg Layered Suite, Bushveld Complex.
Vpx – Medium to coarse-grained pyroxenite (green [::]). Rustenburg Layered suite, Bushveld Complex.
Vdi – Green, fine to medium-grained diabase (light green).
Vl – Medium-grained feldspathic quartzite, thin conglomerate layers and gritty lenses (dark purple). Lakenvlei Formation, Pretoria Group, Transvaal Supergroup.
Vv – Fine-grained hornfels with subordinate layers of carbonate and calc-silicate rocks; layers of siltstone and sandstone (brown). Vermont Formation, Pretoria Group, Transvaal Supergroup.
Vm – Pure white coarse-grained quartzite with non-continues shaly layers (purple). Magaliesberg Formation, Pretoria Group, Transvaal Supergroup.

---f--- – (black) Fault.
……. – Lineament.
⊥15 - Dip and strike of layer.
↓ – Approximate position of proposed upgrade.

Mining Activities

Cr - Chrome	Cu – Copper	Mg – Magnesite
Ni – Nickel	Pt – Platinum group of minerals.	

Summary of findings: The Palaeontological Impact Assessment: Desktop Study was undertaken in March 2018 in the summer in dry and hot conditions (Appendix 6 of Act, 1(d)), and the following is reported:

The development is taking place on the Quaternary alluvium and scree, Bushveld Complex and Transvaal Supergroup rocks are present near the development. For archaeological sites, please refer to Heritage Impact Assessment.

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 unfossiliferous. 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).

Fossils in South Africa mainly occur in rocks of sedimentary nature and not in rocks from igneous or metamorphic nature. Therefore, the palaeontological sensitivity can generally be LOW to VERY HIGH, and here locally **MODERATE** for the Quaternary (SG 2.2 SAHRA APMHOB, 2012) (Groenewald and Groenewald 2014).

Recommendation:
The impact of the development on fossil heritage is **MODERATE** and therefore a desktop study was necessary for this development (according to SAHRA protocol). A Phase 1 Palaeontological Impact Assessment must be done if fossils are found.

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

Rock Unit	Significance/vulnerability	Recommended Action
Quaternary	Moderate	Desktop study is required

The Quaternary Alluvium is present here in the development area. Groenewald & Groenewald (2014) rates this Group as having a moderate palaeontological significance due to the possibility of mammalian fossil remains of Cenozoic aged terrestrial organisms that have been recorded from the sedimentary rocks. These fossils are important indicators of palaeo-environmental conditions. Therefore a **MODERATE** status is allocated. A small section of the R 37 upgrade near Burgersfort is close to the Vermont Formation (Vv), this Formation has a **HIGH** palaeontological sensitivity, caution is recommended (see geological map).

The Project includes one Alternative (see google.earth image):
Alternative 1: A section of the R37 road marked in red. The existing two lanes from km 117.0 and km 142.87 will be overlaid with a 30 mm asphalt overlay on 150 mm G1 material. Size of area is 25.87 km.

Concerns/threats to be added to the EMPr (1g,1ni,1nii,1o,1p):

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

The recommendations are:

1. Mitigation is needed if fossils are found, permission needed from SAHRA.
2. No consultation with parties was necessary.
3. The development may go ahead with caution, but the ECO must survey for fossils before or after blasting or excavating in line with the legally binding Environmental Management Programme (EMPr) this must be updated to include the involvement of a palaeontologist/ archaeozoologist when necessary.
4. The EMPr already covers the conservation of heritage and palaeontological artefacts that may be exposed during construction activities. The protocol is to immediately cease all construction activities if a fossil is unearthed and contact SAHRA for further investigation. It is recommended that the EMPr be updated to include the involvement (pre-construction training of ECO) of a palaeontologist / archaeozoologist during the digging and excavation phase of the development and ECO to visit site bi-weekly during construction.

Stakeholders:

Developer – The South African National Roads Agency SOC. Limited, 38 Ida Street, Menlo Park, Pretoria, 0040.
Environmental – Chameleon Environmental Consultants, P.O. Box 11788, Silver Lakes, 0054, Tel. 082 571 6920.
Landowner – SANRAL, Private Bag x17, Lynwood Ridge, 0040.

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 (GN R38282 of 4 December 2014) of the Environmental Impact Assessment Regulations (see Appendix 1).

Outline of development

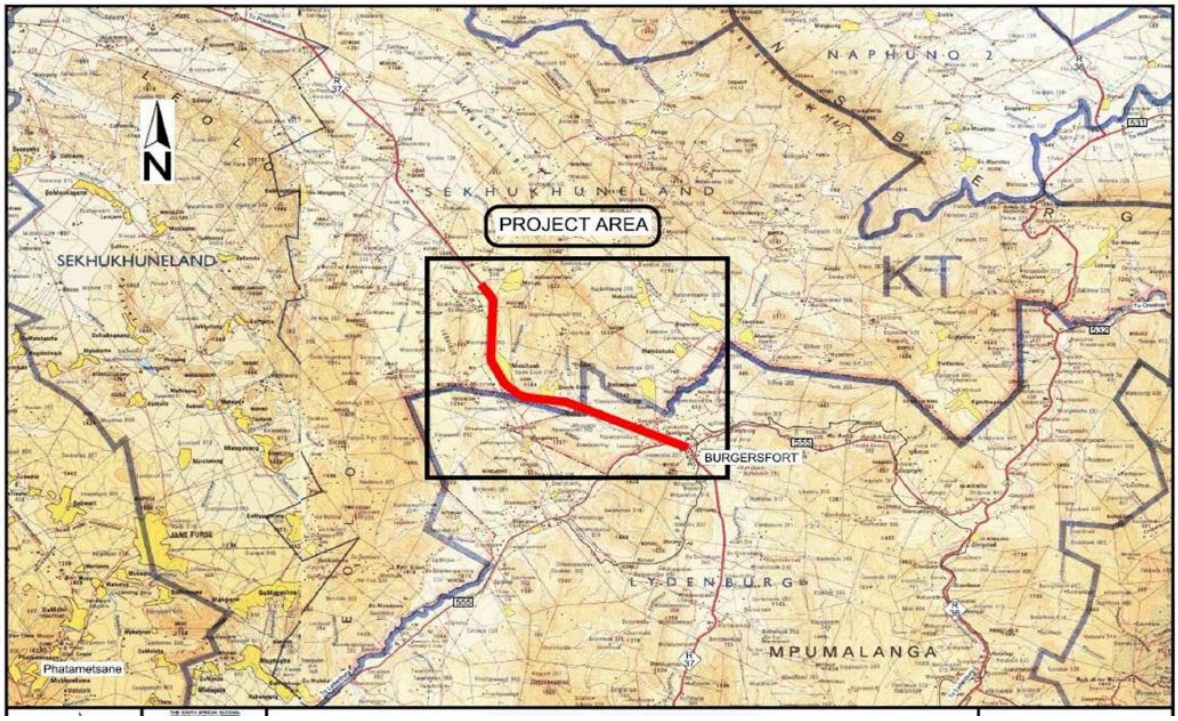
This report discusses and aims to provide the developer with information regarding the location of palaeontological material that will be impacted by the development. In the pre-construction phase it is necessary for the developer to apply for the relevant permit from the South African Heritage Resources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

The applicant, SANRAL SOC. Limited proposes to upgrade the R37 between km 117.0 and km 142.87 from Modikwa Mine to Burgersfort.

The road is in very poor condition and requires an upgrade. Should the road not be upgraded, the traffic on the R37 could experience increasingly unsafe driving conditions. The road pavement is already in a very poor condition and the vertical and horizontal alignments of the road need to be upgraded to ensure the safety of the traveling public. This will also accommodate the predicted increase in traffic volume and avoid high driver frustration.

The current high volumes of heavy vehicle traffic between Polokwane and Burgersfort is a major safety and capacity concern. The volume of heavy vehicles is expected to increase significantly over the next 20 years. Traffic volumes and design principles determine that the road needs to be upgraded to ensure the safety of the travelling public. If this is not done, it is anticipated that accidents on this road will increase in future.

Figure 1: Topographic map showing location (Chameleon).



The following infrastructure is anticipated:

1. Storm water drains and sub-surface drains,
2. Widen the road at appropriate locations to 11.8 m on both sides from 7.4 m,

3. Improve capacity of intersections,
4. Adding two lanes from km 117.00 to km 142.87 (4 lanes undivided),
5. Widening the bridge over Steelpoort River within the current road reserve,
6. Replacing 133 culverts.

The Project includes one Alternative (see google.earth image):
Alternative 1: A section of the R37 road marked in red. The existing two lanes from km 117.0 and km 142.87 will be overlaid with a 30 mm asphalt overlay on 150 mm G1 material. Size of area is 25.87 km.

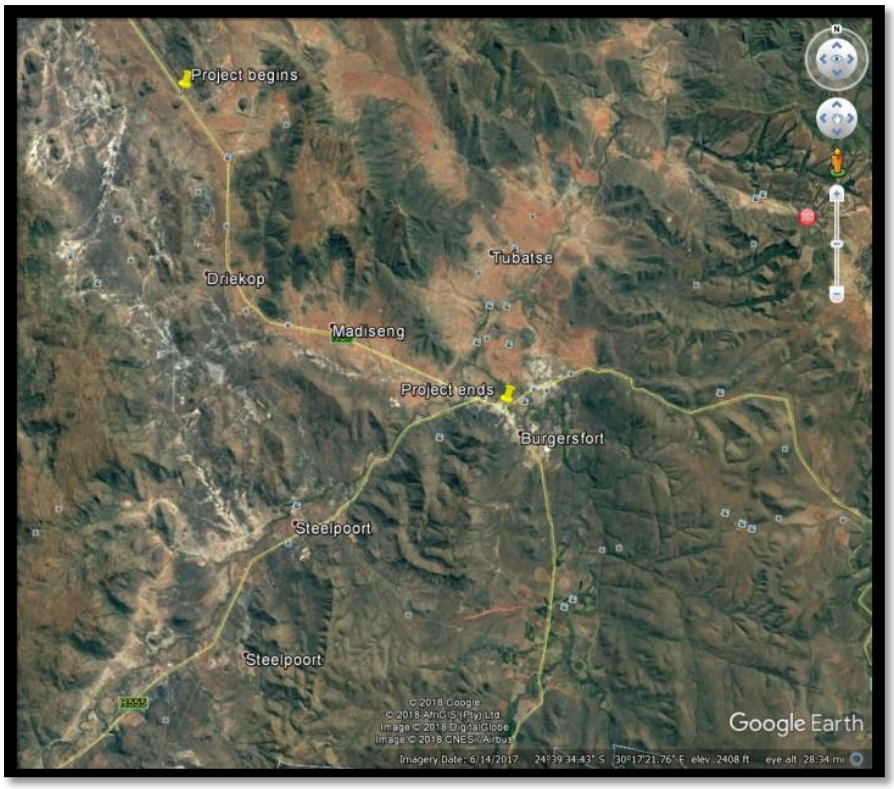
Rezoning/ and or subdivision of land: No, existing road reserve will be used.
Name of Developer and Consultant: SANRAL and Chameleon Environmental Consultants.
Terms of reference: Dr H. Fourie is a palaeontologist commissioned to do a palaeontological impact assessment to ascertain if any palaeontological sensitive material is present in the development area. This study will advise on the impact on fossil heritage mitigation or conservation necessary, if any.
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. For the past twelve years she carried out field work in the Eastern Cape, Limpopo, Mpumalanga, Gauteng and Free State Provinces. Dr Fourie has been employed at the Ditsong: National Museum of Natural History in Pretoria (formerly Transvaal Museum) for 23 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.

E. Description of property or affected environment
Location and depth:
The Proposed Improvement of the National Route R37 Section 2 from Modikwa Mine to Burgersfort (25.87 km) will be situated in the Fetakgomo-Tubatse Local Municipality, Sekukuhne District Municipality within the Limpopo Province.

Depth is determined by the related infrastructure such as the road. 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.

The Project includes one Alternative (see google.earth image):
Alternative 1: A section of the R37 road marked in red. The existing two lanes from km 117.0 and km 142.87 will be overlaid with a 30 mm asphalt overlay on 150 mm G1 material. Size of area is 25.87 km.

Figure 2: Google.earth image showing location (Chameleon).



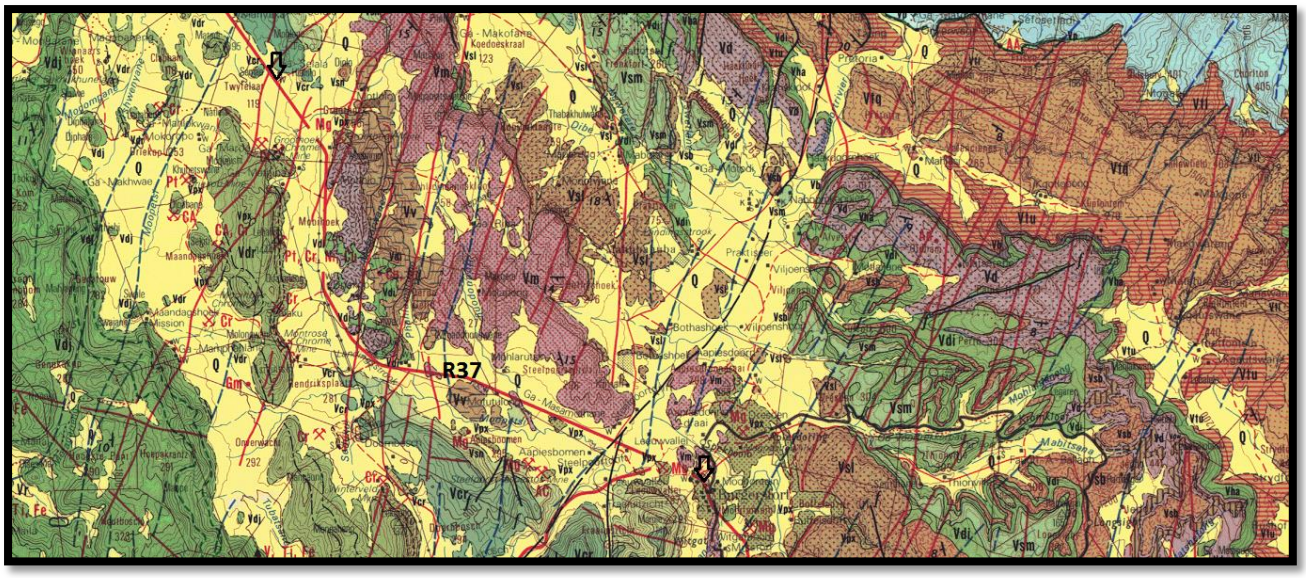
The site is underlain by the Quaternary sands.

F. Description of the Geological Setting

Description of the rock units:

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 unfossiliferous. 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).

Figure 3: Geology of the area (Walraven 1986)



Q – Superficial deposits including alluvium and scree (yellow). Quaternary.
Vdr – Medium to coarse grained norite and anorthosite, medium to coarse grained pyroxenite (seagreen). Dwars River Subsuite, Rustenburg Layered Suite, Bushveld Complex. Vaalian.
Vsn – Fine to medium-grained norite; pyroxenite (green). Shelter Norite Formation, Rustenburg Layered Suite, Bushveld Complex.
Vpx – Medium to coarse-grained pyroxenite (green [::]). Rustenburg Layered suite, Bushveld Complex.
Vdi – Green, fine to medium-grained diabase (light green).
Vl – Medium-grained feldspathic quartzite, thin conglomerate layers and gritty lenses (dark purple). Lakenvlei Formation, Pretoria Group, Transvaal Supergroup.
Vv – Fine-grained hornfels with subordinate layers of carbonate and calc-silicate rocks; layers of siltstone and sandstone (brown). Vermont Formation, Pretoria Group, Transvaal Supergroup.
Vm – Pure white coarse-grained quartzite with non-continues shaly layers (purple). Magaliesberg Formation, Pretoria Group, Transvaal Supergroup.
---f--- – (black) Fault.
……. – Lineament.
↓ – Approximate position of upgrade.

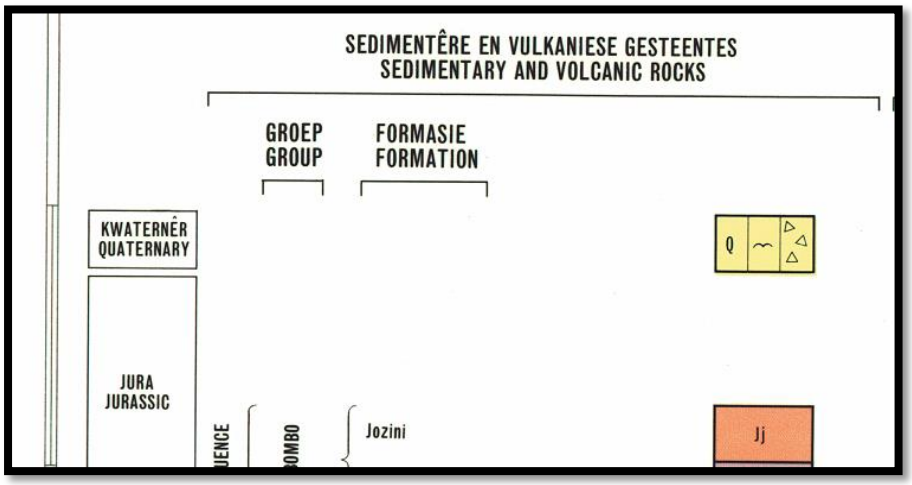
The Transvaal Supergroup fills an east-west elongated basin in the south-central part of the old Transvaal (now North – West, Gauteng and Mpumalanga) as far south as Potchefstroom. It is Vaalian in age, approximately 2600 Ma to 2100 Ma. A maximum thickness of the Transvaal Supergroup reaches 2000 m in the north-eastern section. The east-west elongated basin is filled with clastic, volcanic and chemical sedimentary rocks. Three groups based on lithological differences have been established: they are the Rooiberg, Pretoria and Chuniespoort Groups as well as other smaller groups (Kent 1980, Snyman 1996). It is the Bushveld Complex that is responsible for the tilting of the Transvaal sediments and the heat of its intrusion having created andalusite crystals (Norman and Whitfield 2006). This Supergroup is underlain by the Ventersdorp, Witwatersrand and Pongola Supergroups, and the Dominion Group. Three prominent ridges are present from the oldest to the youngest, the Time Ball Hill, Daspoort and Magaliesberg Formations (Norman and Whitfield 2006). The Vermont Formation is fairly thick between 450 – 800 m and the overlaying Lakenvlei Formation attains thicknesses of 160 – 300 m. (Visser 1989).

A small section of the R 37 upgrade near Burgersfort is close to the Vermont Formation, this Formation has a **HIGH** palaeontological sensitivity, caution is recommended (see geological map).

The Rustenburg Layered Suite of the Bushveld Complex is also present. It is Vaalian in age (2,100 – 1,920 Ma) and consists of an igneous intrusion with anorthosite, hybrid gabbro, gabbro, diabase, epidiorite, pyroxenite, and norite rocks. The Bushveld Complex is a massive body of igneous origin and it is intrusive in the Transvaal Supergroup. Both mafic and ultramafic rocks are present in the Rustenburg Layered Suite. The site is covered in 'Bushveld' vegetation and the weathering product is known as 'black turf' (Kent, 1980; Visser, 1989). There is a presence of mining past and present.

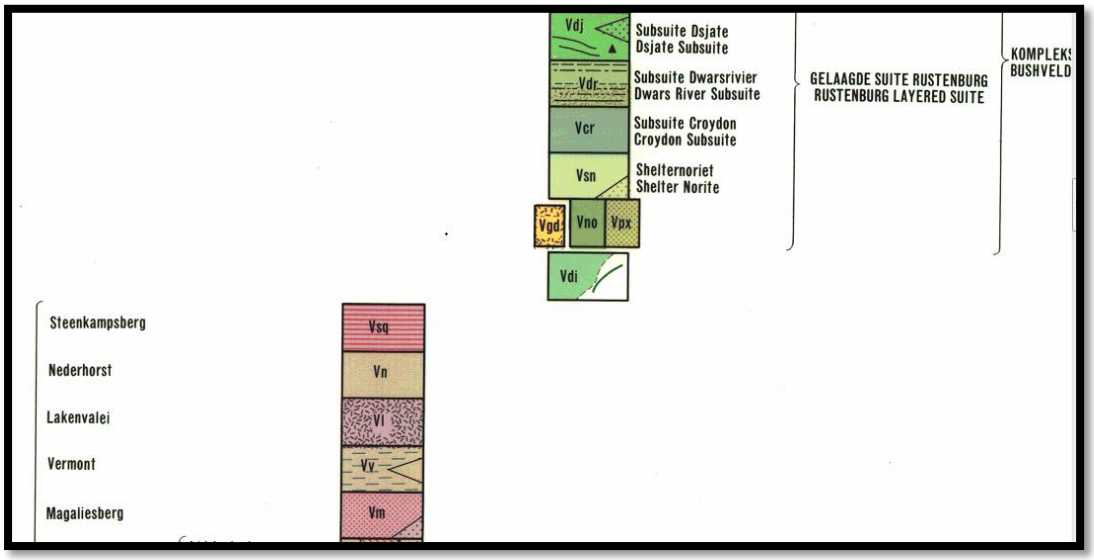
The Bushveld Complex extends over 440 km east-west, from Burgersfort to Nietverdiend; and for nearly 350 km north-south from Villa Nora to Bethal. The Layered Suite, the source of an immense wealth of platinum, chrome and vanadium, comprises six quite distinct zones. It is here that iron ore and the Merensky Reef are found. Magnesite mines provide magnesium carbonate for making heat-resistant bricks (Norman and Whitfield 2006).

Figure 4: Geological Legend of area (Walraven 986)



The geological history of the Limpopo Province spans a total of 3600 million years, including some of the major events that lead to the deposition of a wealth of economically important sequences of rocks. Although most of the Archaean and Proterozoic aged rocks are much more known for their mineral wealth, rather than their palaeontological importance, the more recent Phanerozoic deposits are of importance in the study of the evolution of life during the last 300 million years (Groenewald and Groenewald 2014).

Figure 5: Geological Legend of Bushveld Complex and Transvaal Supergroup (Walraven 1986)



The Project includes one Alternative (see google.earth image):
Alternative 1: A section of the R37 road marked in red. The existing two lanes from km 117.0 and km 142.87 will be overlaid with a 30 mm asphalt overlay on 150 mm G1 material. Size of area is 25.87 km.

It is recommended to wait for the response from SAHRA on the Desktop Study (this report), and if a Phase 1: Field study is recommended then SAHRA protocol must be followed. Alternatives will not be feasible.

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).

'Algal microfossils' have been reported from shales and are probably of diagenetic origin (Eriksson 1999). Stromatolites are significant indicators of palaeoenvironments and provide evidence of algal growth between 2640 and 2432 million years ago (Groenewald and Groenewald 2014).

Figure 6: Example of a Stromatolite (Photograph: E. Butler).

Significant fossils finds in the Limpopo Province are recorded from Cenozoic cave breccia associated with the karst topography in areas underlain by dolomite of the Transvaal Supergroup. These rock formations, such as Makapansgat, are invariably associated with underground deposits and are not mapped on the geological maps. The study of the development of early man will be of very high significance (Groenewald and Groenewald 2014).

Table 1: Taken from Palaeotechnical Report (Groenewald and Groenewald 2014).

Subgroup/ sequence	Group	Formation	Fossil Heritage	Comment
Quaternary	-	-	Mammalian bones and teeth. Tortoise remains. Ostrich eggshell. Invertebrates. Micro fossils. Trace fossils. Plant remains.	Sparse.

Transvaal SG	Pretoria	Vermont	Stromatolites.	May also contain micro-Fossils
		Magaliesberg	Microbial mat structures (dessicated mats sometimes resemble trace fossils).	Micro-fossils

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 Karoo Supergroup strata the palaeontological sensitivity is generally LOW to VERY HIGH, but here locally **MODERATE** for the Quaternary.

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

Rock Unit	Significance/vulnerability	Recommended Action
Quaternary (Q)	Moderate	Desktop study is required

The Quaternary Alluvium is present here in the development area. Groenewald & Groenewald (2014) rates this Group as having a moderate palaeontological significance due to the possibility of mammalian fossil remains of Cenozoic aged terrestrial organisms that have been recorded from the sedimentary rocks. These fossils are important indicators of palaeo-environmental conditions. Therefore a **MODERATE** status is allocated.

Databases and collections: Ditsong: National Museum of Natural History.
Impact: **MODERATE** for the Quaternary sands. There are fossil resources that may be impacted by the development and if destroyed are no longer available for scientific research or other public good.

H. Description of the Methodology (1e)

The palaeontological impact assessment Desktop Study was undertaken in March 2018. A literature survey is included and the study relied on literature, geological maps, google.maps and google.earth images.

Assumptions and Limitations (Appendix 6 of Act 1(i):-
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. Insufficient data from developer and exact lay-out plan for all structures.

A Phase 1 Palaeontological Impact Assessment: Field Study will include:

1. Recommendations for the future of the site.
2. Background information on the project.
3. Description of the property of affected environment with details of the study area.
4. Description of the geological setting and field observations.
5. Background to palaeontology of the area.
6. Field Rating.
7. Stating of Significance (Heritage Value).

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 11: 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 111: 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 11 heritage resources.
Local authorities identify and manage Grade 111 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.

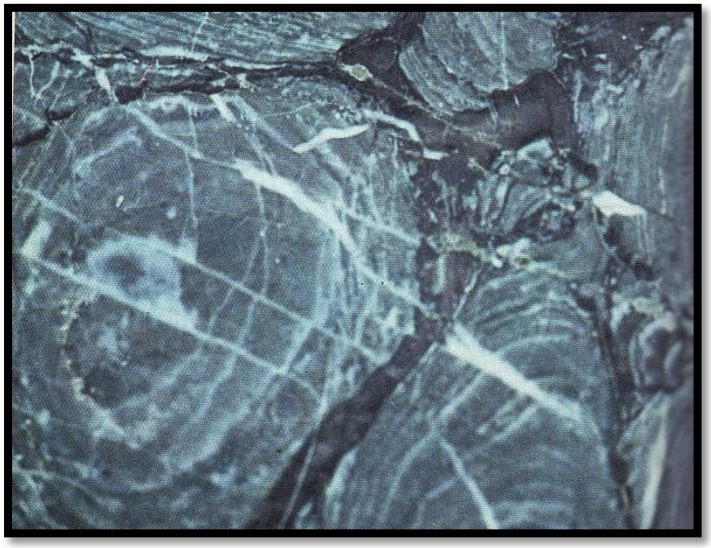
Three types of permits are available; Mitigation, Destruction and Interpretation. The specialist will apply for the permit at the beginning of the process (SAHRA 2012).

I. Description of significant fossil occurrences (1f)

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.

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 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 (Groenewald and Groenewald 2014).

Figure 7: Thin section of a stromatolite (De Zanche and Mietto 1977).



At Makapansgat fossils such as the vitally important australopithecines were entomb very quickly (Norman 2013). This cave provides three - perhaps four – million years of history, the breccia is packed with fossil bones. There are two caves of importance, namely the Limeworks Cave and the Cave of Hearths. The Cave of Hearths have yielded *Homo habilis,* then *Homo erectus* and finally *Homo sapiens* at 500 AD (Norman and Whitfield 2006).

The threats are:- 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 is not 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 **MODERATE**. A Phase 1 Palaeontological Field Study may be required if a fossiliferous formation (for example breccia) or fossils are found.

b. This project may benefit the economy, the growth of the community and social development in general.

c. Preferred choice: The impact on the palaeontological heritage is **MODEARTE** for the Quaternary. Care must be taken during the grading of roads, digging of foundations and removing topsoil, subsoil and overburden (see Executive Summary) or blasting of bedrock. A small section of the R 37 upgrade near Burgersfort is close to the Vermont Formation, this Formation has a **HIGH** palaeontological sensitivity, caution is recommended (see geological map).

d. The following should be conserved: if any palaeontological material is exposed during digging, excavating, drilling or blasting SAHRA must be notified. All construction activities must be stopped and a palaeontologist should be called in to determine proper mitigation measures. A palaeontologist / archaeozoologist should visit the site once a month during digging and excavation.

Sampling and collecting (1m,1k):

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.
d. Permits for mitigation: Needed from SAHRA/PHRA if fossils are found.

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 PIA Study was provided by the Consultant. All technical information was provided by Chameleon Environmental Consultants.
c. Areas that would involve mitigation and may need a permit from the South African Heritage Resources Agency are discussed.
d. The following should be conserved: if any palaeontological material is exposed during digging, excavating, drilling or blasting, SAHRA must be notified. All development activities must be stopped and a palaeontologist should be called in to determine proper mitigation measures, for example, shallow caves.
e. 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 and adjacent areas as well as for safety and security reasons.

L. Bibliography

ALMOND, J., PETHER, J, and GROENEWALD, G. 2013. South African National Fossil Sensitivity Map. SAHRA and Council for Geosciences.

BOWLES, M., DE BRUIN, D., DE KOCK, G., DIXON, R.D., FIELD, M., HAMMERBECK, E.C.I., HERZBERG, W., KEYSER, A.W., MACRAE, C.S., VILJOEN, M.J., WINTERBACH, D.J. and WORST, B. 1992. Some superlatives of geology in southern Africa. Presented by The Geological Society of South Africa on occasion of the 29th International Geological Congress, Kyoto, Japan. Pp 20.

DE ZANCHE, V. and MIETTO, P. 1977. *The World of Fossils.* Sampson Low Guides, Berkshire, Printed in Italy, Pp 256.
GROENEWALD, G. and GROENEWALD, D. 2014. SAHRA Palaeotechnical Report: Palaeontological Heritage of the Limpopo Province. South African Heritage Resources Agency, Pp 1-22.
KENT, L. E., 1980. Part 1: Lithostratigraphy of the Republic of South Africa, South West Africa/Namibia and the Republics of Bophuthatswana, Transkei and Venda. SACS, Council for Geosciences, *Stratigraphy of South Africa. 1980. South African Committee for Stratigraphy.* Handbook 8, Part 1, Pp 690.
MCCARTHY, T and RUBIDGE, B. 2005. *The Story of Earth Life: A southern African perspective on a 4.6-billion-year journey.* Struik. Pp 333.
NORMAN, N. 2013. *Geology off the beaten track: exploring South Africa's hidden treasures.* De Beers, Struik, Pp 1-256.
NORMAN, N. and WHITFIELD, G., 2006. *Geological Journeys.* De Beers, Struik, Pp 1-320.
SG 2.2 SAHRA APMHOB Guidelines, 2012. Minimum standards for palaeontological components of Heritage Impact Assessment Reports, Pp 1-15.
SNYMAN, C. P., 1996. *Geologie vir Suid-Afrika*. Departement Geologie, Universiteit van Pretoria, Pretoria, Volume 1, Pp. 513.
VAN DER WALT, M., DAY, M., RUBIDGE, B. S., COOPER, A. K. & NETTERBERG, I., 2010. Utilising GIS technology to create a biozone map for the Beaufort Group (Karoo Supergroup) of South Africa. *Palaeontologia Africana,* **45:** 1-5.
VISSER, D.J.L. (ed) 1984. Geological Map of South Africa 1:100 000. South African Committee for Stratigraphy. Council for Geoscience, Pretoria.
VISSER, D.J.L. (ed) 1989. *Toeligting: Geologiese kaart (1:100 000). Die Geologie van die Republieke van Suid Afrika, Transkei, Bophuthatswana, Venda, Ciskei en die Koningkryke van Lesotho en Swaziland*. South African Committee for Stratigraphy. Council for Geoscience, Pretoria, Pp 494.
WALRAVEN, F. 1986. Geological Map of Pilgrim's Rest 1:250 000 (2430). South African Committee for Stratigraphy, Council of Geoscience, Pretoria.

Declaration (Disclaimer) (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 field study may have missed palaeontological resources in the Project Area as the presence of outcrops are not known and may only be found 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.

Heidi Fourie

2018/03/19

Appendix 1:

Table 3: Listing points in Appendix 6 of the Act and position in Report.

Section	Point in Act	Heading
B	1(c)	Outline of development project
	1(d)	Summary of findings
	1(g)	Concerns/threats:
	1(n)i	"
	1(n)ii	"
	1(o)	"
	1(p)	"
D	1(h)	Figures
	1(a)i	Terms of reference
H	1(e)	Description of Methodology
	1(i)	Assumptions and Limitations
I	1(f)	Heritage value
J	1(j)	Recommendation
	1(l)	"
	1(m)	Sampling and collecting
	1(k)	"
Declaration	1(b)	Declaration
Appendix 1	1(k)	Protocol for finds
	1(m)	"
	1(q)	"

Appendix 2: Management Plan and Protocol for Finds.

This section covers the recommended protocol for a Phase 1 Field Study and 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 construction activities in line with the legally binding Environmental Management Programme (EMPr) so that when a fossil is unearthed they can notify the relevant department and specialist to further investigate. When a fossil is found the area must be fenced-off and the construction workers must be informed that this is a no-go area. Therefore the EMPr must be updated to include the involvement of a palaeontologist during the digging and excavation (ground breaking) phase of the development.

The EMPr already covers the conservation of heritage and palaeontological artefacts that may be exposed during construction activities. The protocol is to immediately cease all construction activities if a fossil is unearthed and contact SAHRA for further investigation. It is recommended that the EMPr be updated to include the involvement (training/site visit) of a palaeontologist / archaeozoologist to provide pre-contruction training of the ECO. The ECO should familiarise him- or herself with the formations and its fossils in the development area. The Evolutionary Studies Institute, University of the Witwatersrand has good examples of fossils.

The developer must survey the areas affected by the development and indicate on plan where the construction / development / mining will take place. Trenches 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 of 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.

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.
2. Fossils likely to occur are for example the fossil plants from the Vryheid Formation, these are present in the grey shale (or any other fossiliferous layer ranked as VERY HIGH or HIGH) or invertebrates from the Volksrust Formation (or any other fossiliferous layer).
3. When clearing topsoil, subsoil or overburden and hard rock (outcrop) is found, the contractor needs to stop all work.
4. 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.
5. 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.
6. 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.

7. 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 a week).
8. 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.

Fossil excavation if necessary during Phase 2:

1. Photography of fossil / fossil layer and surrounding strata.
2. Once a fossil has been identified as such, the task of extraction begins.
3. It usually entails the taking of a GPS reading and recording lithostratigraphic, biostratigraphic, date, collector and locality information.
4. Use Paraloid (B-72) as an adhesive and protective glue, parts of the fossil can be kept together (not necessarily applicable to plant fossils).
5. Slowly chipping away of matrix surrounding the fossil using a geological pick, brushes and chisels.
6. Once the full extent of the fossil / fossils is visible, it can be covered with a plaster jacket (not necessarily applicable to plant fossils).
7. Chipping away sides to loosen underside.
8. Splitting of the rock containing palaeobotanical material should reveal any fossils sandwiched between the layers.

SAHRA Documents:
Guidelines to Palaeontological Permitting Policy.
Minimum Standards: Palaeontological Component of Heritage Impact Assessment reports.
Guidelines for Field Reports.
Palaeotechnical Reports for all the Provinces.