Proposed Shangoni Gate Development within the Kruger National Park

Mopane and Vhembe District Municipalities, Limpopo Province

Farm: Kruger National Park North 449 MT

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Palaeontological Impact Assessment: Phase 1 Field Study

Facilitated by: Envirolution Consulting

P.O. Box 1898, Sunninghill, Johannesburg, 2157

Tel: 0861 44 44 99

2017/05/13

Ref: Pending

B. Executive summary

Outline of the development project: Envirolution Consulting has facilitated the appointment of Dr H. Fourie, a palaeontologist, to undertake a Paleontological Impact Assessment (PIA), Phase 1 Field Study of the suitability of the Proposed Development of the Shangoni Gate within the Kruger National Park on the Farm Kruger National Park North 449 MT, with related infrastructure within the Mopani and Vhembe District Municipalities in the Limpopo Province.

The applicant, SANPARKS, proposes to develop a road, a picnic spot, a tented camp, bridges, a new gate and reception area near Shingwedzi Rest Camp in the northern part of the Kruger National Park. The SAHRA Interim Comment CaseID 10675 requires a field based PIA for the riverbed area with a moderate sensitivity.

The Project includes several Alternatives (see google.earth image):

1. Shangoni visitor's entrance gate, 2 Alternatives and a Preferred Alternative.
2. Reception facility, 1 Alternative and a Preferred Alternative.
3. New tarred access road and its associated bridge crossings.
4. Picnic site, 2 Alternatives.
5. Tented camps, 1 Alternative and a Preferred Alternative.
6. Camping sites, 1 Alternative and a Preferred Alternative.

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.

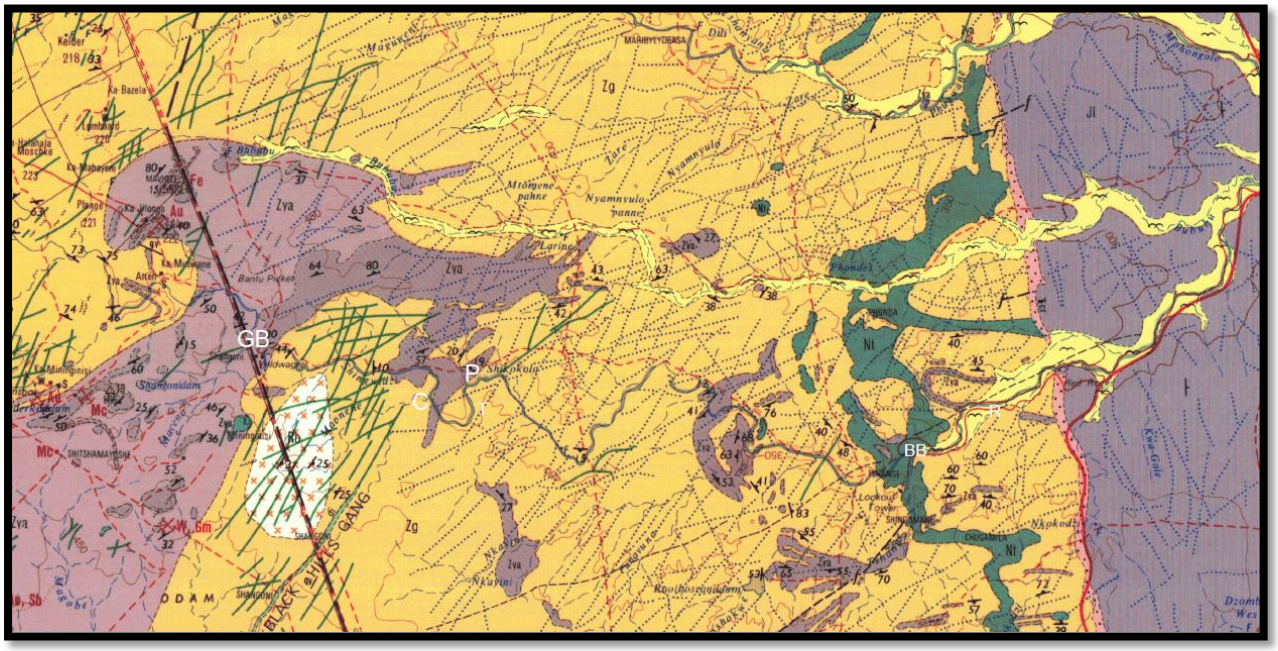
Types and ranges of heritage resources as outlined in Section 3 of the National Heritage Resources Act (Act No.25 of 1999):
(i) (i) objects recovered from the soil or waters of South Africa, including archaeological and palaeontological objects and material, meteorites and rare geological specimens.
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 the 1:250 000 (2330) Geological Map of Tzaneen (Brandl1985).

Figure 2: The geology of the development area.



Legend to Map and short explanation.
m- Alluvium, sand scree (yellow), Quaternary.
Jl – Basalt, limbirgite, rhyolite (purple), Letaba Basalt, Lebombo Group, Karoo Supergroup, Jurassic.
T-Rc – Fine-grained, mottled red and white, argillaceous sandstone (pink [::]), Red Rocks Member, Clarens Formation, Karoo Supergroup, Trias.
Nt – Olivine gabbro (green), Timbavati Gabbro, Namibian.
Rb – Porphyritic biotite granite (white [xx]), Shamiriri Formation, Randium.
Zya – Ultramafic schist; amphibolite; iron-formation; acid metalava; quartzitic schist; granitetiferous schist; quartzite; dolomite; metaquartzite; calc-silicate rocks and granulite (lilac), Giyani Group, Swazium.
Zg – Grey biotite, gneiss and migmatite with anatectic mobilisates (dark yellow), Goudsplaatsgneiss, Murchison Group, Swazium.
---f--- – (black) Fault.
⊥ 30 - Strike and dip of lineation.
….. – Linear structure (Landsat and aeromagnetic)
G – Gate, Reception Area, B – Bridge, C – Camping Site, P – Picnic Site, T- Tented Camp, R - Road – Approximate position of preferred developments (in white on the Figure).

Mining Activities
None.

Summary of findings: The Palaeontological Impact Assessment: Phase 1: Field Study was undertaken in April and May 2017 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 Letaba Basalt, Goudsplaatsgneiss, Timbavati Gabbro, Giyani Group, Shamiriri Formation, and Clarens Formation. It has an undulating topography. Only the Red Rocks Member and the Quaternary sands are potentially fossiliferous. The site is covered with lush vegetation (trees, grass). Big game is present.

The Red Rock Member present is part of the Karoo Supergroup. The Karoo Supergroup is renowned for its fossil wealth (Kent 1980, Visser 1989). Large areas of the southern African continent are covered by the Karoo Supergroup. 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. At the top is the Drakensberg Basalt Formation with its pillow lavas, pyroclasts, and basalts. (Kent 1980, Snyman 1996), here the Lebombo Group.

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).

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 sedimentary rocks the palaeontological sensitivity can generally be LOW to VERY HIGH, and here locally **HIGH** for the Clarens Formation and **MODERATE** for the Quaternary (SG 2.2 SAHRA APMHOB, 2012).

Recommendation:
The impact of the development on fossil heritage is **HIGH** and therefore a field survey or further mitigation or conservation measures were necessary for this development (according to SAHRA protocol). A Phase 1 Palaeontological Impact Assessment and or mitigation were done. The walk through did not locate any fossils.

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

Rock Unit	Significance/vulnerability	Recommended Action
Clarens Formation	High	Desktop study is required and based on the outcome of the desktop study, a field assessment is likely
Quaternary	Moderate	Desktop study is required

The Project includes several Alternatives (see google.earth image):

1. Shangoni visitor's entrance gate, 2 Alternatives and a Preferred Alternative.
2. Reception facility, 1 Alternative and a Preferred Alternative.
3. New tarred access road and its associated bridge crossings.
4. Picnic site, 2 Alternatives.
5. Tented camps, 1 Alternative and a Preferred Alternative.
6. Camping sites, 1 Alternative and a Preferred Alternative.

Concerns/threats (1g,1ni,1nii,1o,1p):

1. Threats are earth moving equipment/machinery (front end loaders, excavators, graders, dozers) during construction, digging of foundations, the sealing-in, disturbance, damage or destruction of the fossils by development, vehicle traffic, and human disturbance.
2. The overburden and inter-burden must always be surveyed for fossils during construction. Special care must be taken during the digging, drilling, blasting and excavating of foundations, trenches, channels and footings and removal of overburden during construction not to intrude fossiliferous layers.
3. Mitigation may be needed if a fossil is found, in this case, the area must be fenced off (Appendix 3).

4. No consultation with parties was necessary.
5. Alternatives are feasible, Preferred Alternatives are supported.
6. The development may go ahead with caution, if a fossil is found, all construction must stop, and SAHRA must be notified. The Environmental Control Officer must familiarise him- or herself with the Clarens Formation fossils.
7. The walk through did not find fossils as the area is covered with lush vegetation.

Stakeholders: Developer – SANPARKS, Skukuza, Kruger National Park and/or 643 Leyds Street, Muckleneuk, Pretoria, 0002.
Environmental – Envirolution Consulting, P.O. Box 1898, Sunninghill, 2157, Tel. 0861 44 44 99.
Landowner – SANPARKS, Skukuza, Kruger National Park and/or 643 Leyds Street, Muckleneuk, Pretoria, 0002.

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 2).

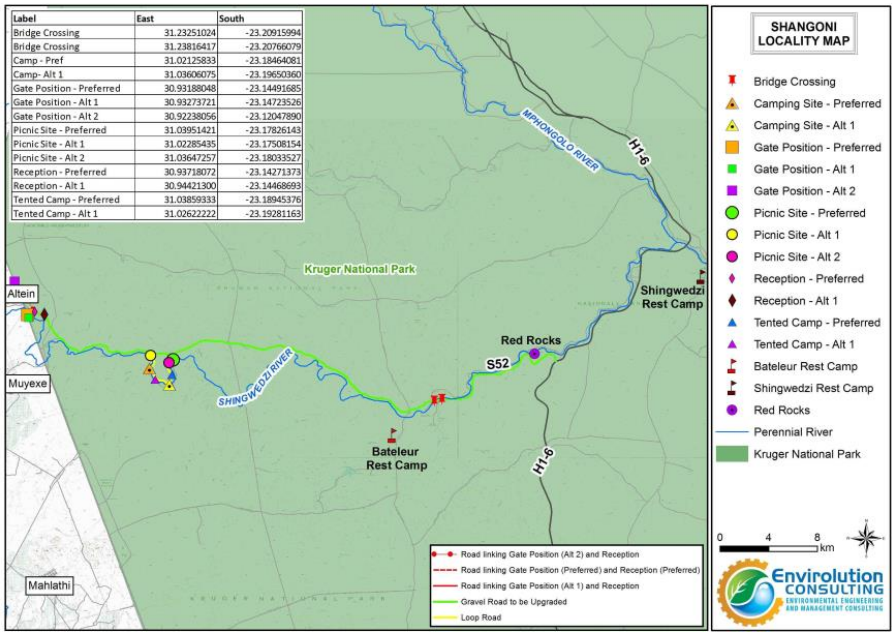
Outline of development

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 or construction phase it may be necessary for the developer to apply for the relevant permit from the South African Heritage Resources Agency (SAHRA / PHRA).

The applicant, SANPARKS, proposes the Shangoni Gate Development. This development will consist of the Shangoni visitor's entrance gate; a reception facility; and a new surfaced road of approximately 50.6 km in length with a road reserve wider than 13,5 m; and three high level bridges where the road crosses the Shingwedzi River and the Tshanga tributary. The development also includes a picnic site; camping site and tented rest camp.

This forms part of the vision of the Park to create benefits to neighbouring communities. The area to be developed does not presently attract many tourists because it lacks essential tourism facilities and attractions. There is a vision for enjoyment of self-drive activities through reduced crowding at view points and congestion on the roads. It should create an appreciation of peace and tranquillity or 'sense of place'.

Figure 1: Map showing layout of the development (Envirolution Consulting).



The following infrastructure is anticipated:

1. Shangoni visitor's entrance gate, 2 Alternatives and a Preferred Alternative (waiting lane),
2. Reception facility, 1 Alternative and a Preferred Alternative (offices, guard house, shop, toilets, parking, education centre),
3. New tarred access road and its associated bridge crossings,
4. Picnic site, 2 Alternatives (umbrellas, braai area, kitchen, parking, ablution),
5. Tented camps, 1 Alternative and a Preferred Alternative (12, short dirt road, staff accommodation, ablution, kitchen),
6. Camping sites, 1 Alternative and a Preferred Alternative (20, fencing, staff accommodation, ablution, kitchen),
7. Sewerage services, septic tanks and a reed bed,
8. Water supply, from existing boreholes,
9. Parking areas,
10. Solid waste services,
11. Power supply, possibly solar or a Hybrid Solar System,
12. Fences, and
13. Bridge crossings.

The Project includes several Alternatives (see google.earth image):

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3. New tarred access road and its associated bridge crossings.
4. Picnic site, 2 Alternatives.
5. Tented camps, 1 Alternative and a Preferred Alternative.
6. Camping sites, 1 Alternative and a Preferred Alternative.

Rezoning/ and or subdivision of land: No.
Name of Developer and Environmental Consultant: SANPARKS and Envirolution Consulting.
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 ten 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 22 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 Development of the Shangoni Gate with related infrastructure, will be situated within the Kruger National Park on the Farm Kruger National Park North 449 MT, within the Mopani and Vhembe District Municipalities in the Limpopo Province.

The development will provide a much needed entrance gate; reception area; picnic spot; camping site; and an upgraded road and bridge crossings. These upgrades will alleviate congestion in other areas. The new upgraded and existing roads roughly follow the Shingwedzi River.

The road from Punda Maria is on flattish savanna country (though there are rocky outcrops) brightened by the perennial green of mopane bush. The Shingwedzi Rest Camp is close to the Tropic of Capricorn (Duggan 1983). The road will start from the Shangoni Gate Entrance and cross over the Shingwedzi River for the first time by means of a high level single lane bridge to join the same alignment as that of the existing gravel road.

Depth is determined by the related infrastructure.

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The bulk of the site is underlain by the archaic granites, a small slither of Clarens Formation is present between the Letaba Basalts and the Goudplaatsgneiss, with the quaternary sediments present in and around the riverbed.

F. Description of the Geological Setting
Description of the rock units:
The Kruger National Park is underlain mainly by several varieties of Basement granite-gneiss, as well as minor greenstone remnants, and several younger gabbroic and syenite intrusions. In the far north, Soutpansberg and Karoo sediments occur, and sediments and volcanics of the Karoo Supergroup make up the entire eastern strip (Norman and Whitfield 2006).

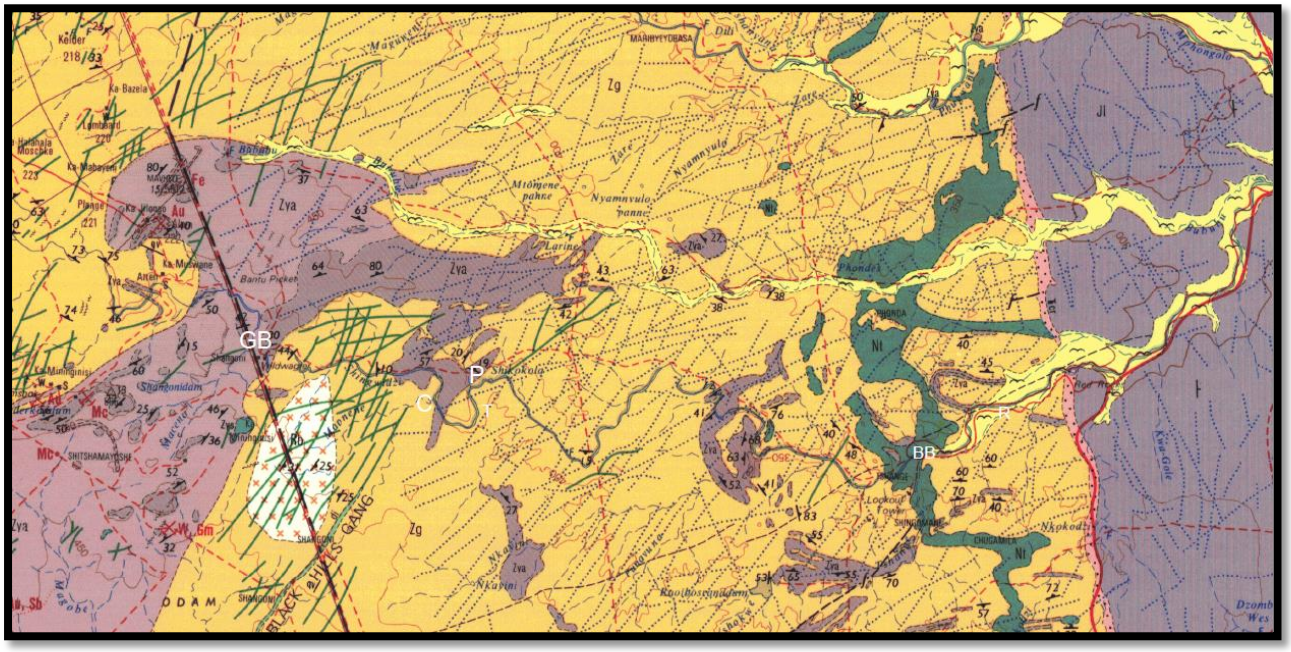
The Red Rocks Member present is part of the Karoo Supergroup. The Karoo Supergroup is renowned for its fossil wealth (Kent 1980, Visser 1989). Large areas of the southern African continent are covered by the Karoo Supergroup. An estimated age is 150 – 180 Ma. and a maximum thickness of 7000 m is reached in the south. Three formations overlie the Beaufort Group, they are the Molteno, Elliot and Clarens Formations. At the top is the Drakensberg Basalt Formation with its pillow lavas, pyroclasts, and basalts. (Kent 1980, Snyman 1996).

A short period of uplift and erosion followed after the deposition of the Beaufort Group. This was short-lived, however, and sedimentation was renewed, forming the rocks of the Stormberg Group on top of the slightly eroded rocks. The rocks of the Stormberg Group reflect a gradual change to increasingly more arid conditions. The bottom Molteno Formation rocks were deposited mainly by large braided rivers. A change in climate is reflected in the floodplain sediments of the middle Elliot Formation. In addition to meandering river deposits, salt-pan deposits are found, containing fossilised lungfish, as well as fossilised, thick, arid-zone soil layers. Warming and aridity increased towards the end of the deposition of the Elliot

Formation. By the time of deposition of the rocks of the upper Clarens Formation, true desert conditions prevailed, with the development of an extensive sand sea (McCarthy and Rubidge 2005).

The Clarens Formation has a maximum thickness of 250 m in the south. Pink and yellow sandstone is fine and never coarse. Cave and cliff formation is common. Fossils are scarce, but dinosaurs are found with the fish *Semionotus capensis* (Norman and Whitfield 2006, Snyman 1996, Visser 1998). Here in the Kruger National Park the Clarens Formation is represented by the Red Rocks Member that shows diagnostic calcareous concretions ranging in diameter from around 1-10 cm. They're unusual in sometimes having fine crystals of calcite in the centre. The grey to mauve sandstone is very fine-grained and devoid of any visible bedding (Norman 2013).

Figure 2: The geology of the development area (Brandl 1985).



Legend to Map and short explanation.

m- Alluvium, sand scree (yellow), Quaternary.

Jl – Basalt, limbirgite, rhyolite (purple), Letaba Basalt, Lebombo Group, Karoo Supergroup, Jurassic.

T-Rc – Fine-grained, mottled red and white, argillaceous sandstone (pink [::]), Red Rocks Member, Clarens Formation, Karoo Supergroup, Trias.

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Zya – Ultramafic schist; amphibolite; iron-formation; acid metalava; quartzitic schist; granitetiferous schist; quartzite; dolomite; metaquartzite; calc-silicate rocks and granulite (lilac), Giyani Group, Swazium.

Zg – Grey biotite, gneiss and migmatite with anatectic mobilisates (dark yellow), Goudsplaatsgneiss, Murchison Group, Swazium.

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Over areas totalling fully 40% of Southern Africa the 'hard rocks', from the oldest to the Quaternary (m), 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 Letaba Basalt (Jl) Formation forms part of the Lebombo Group, Karoo Supergroup with the Jozini and Movene Formations. It usually lays conformably on the Clarens Formation. A thickness of 3 600 m is reached and it is Middle Jurassic in age. It spans from northern Kwazulu-Natal north till it reaches the Limpopo River. The Goudsplaatsgneiss (Zg) forms the floor for the Bandelierskop Complex and the Murchison Group. The Shamiriri Granite (Rb) is intrusive in the Giyani Group and the Goudplaatsgneiss. It is Randium in age. The Timbavati gabbro (Nt) is present west of the Shingwedzi camp and outcrops as far as Komatipoort in the south. It is mostly in a sill or plate form. An age of 1 454 ± 59 my places it in the Namibium. The Giyani Group (Zya) forms a range of low hills and ranges (domes) known as the Sutherland Range in the Klein Letabavallei northeast of Tzaneen. These greenstones rarely form outcrops. It is also intrusive in the goudplaatsgneiss and is Swazian in age (Kent 1980, Snyman 1996, Visser 1989).

Field Observation.

This property is large, quite overgrown with lush vegetation and has an undulating topography. The presence of game is a challenge.

The new gate and reception areas will be situated on the Giyani Group lavas, this area is not crucial to the palaeontological heritage of the area as these lavas are devoid of fossils. The preferred options are supported. The bridge will be a high level single lane bridge.

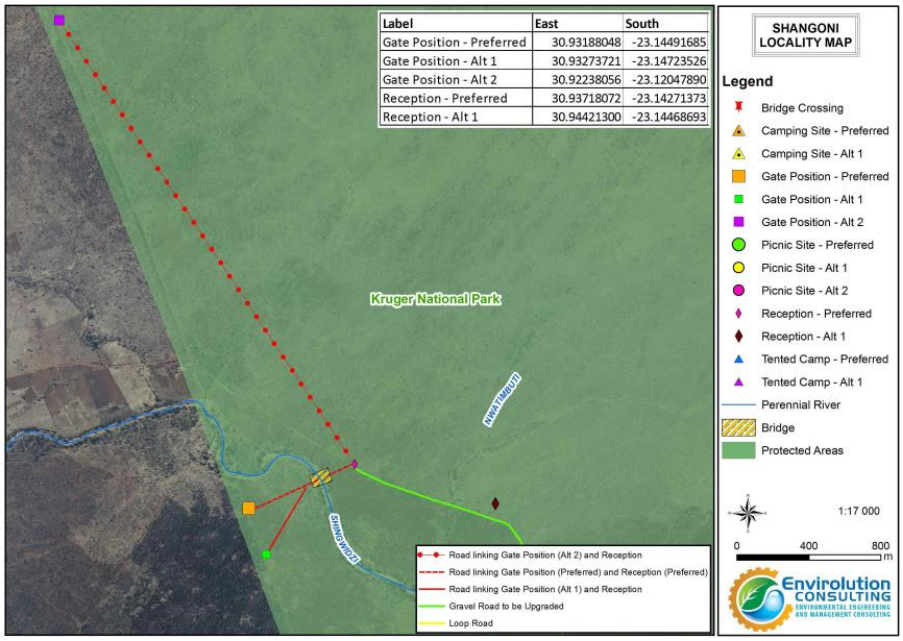
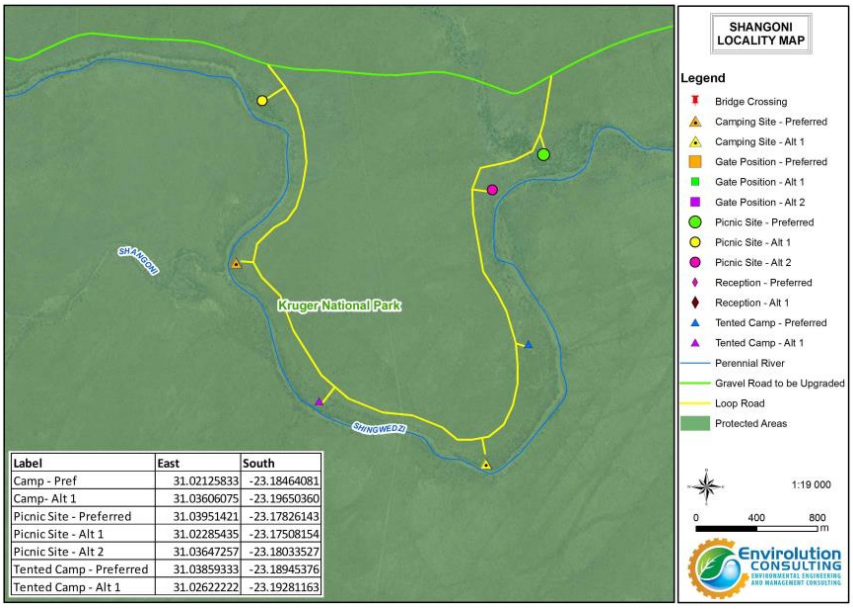


Figure 3: Figure to show location of new Shangoni Gate and Reception area.

Figure 4: First river crossing after entering at the new Shangoni Gate.

The newly proposed picnic site, camp site and tented camp site will be situated on the Giyani Group and Goudplaatsgneiss sediments. This area was not investigated due to the presence of igneous sediments. A loop road will be tarred and provide access to the picnic site, tented camp, and camping sites. It will be approximately 8 km in length and will have a width of 6 m.



Label	East	South
Camp - Pref	31.02125833	-23.18464081
Camp- Alt 1	31.03606075	-23.19650360
Picnic Site - Preferred	31.03951421	-23.17826143
Picnic Site - Alt 1	31.02285435	-23.17508154
Picnic Site - Alt 2	31.03647257	-23.18033527
Tented Camp - Preferred	31.03859333	-23.18945376
Tented Camp - Alt 1	31.02622222	-23.19281163

Figure 5: Map to illustrate newly proposed Camping Site, Picnic Site and Tented Camp. The loop road here will be tarred.

Figure 6: View of area where the proposed picnic site, camp site and tented camp will be. It is overgrown.

Figure 7: Photograph of igneous rocks on the Ranger section of the S52.

The entire road S52 was travelled and rocky outcrops on the shoulder of the road were recorded. Both bridge crossings were photographed, lavas and quaternary sediments are present. The road will start at Shangoni Gate Entrance and provide access to the proposed tourism facilities, it will be tarred. The first bridge crossing is a high level single lane bridge, from here the upgrade will be the existing gravel Shangoni Rangers' road for approximately 35 km before it links into the existing

S52 public gravel road, it ends at the juncture with the H1-6 tourist road. The entire road will have a width of 6 m. It will also cross many smaller drainage lines by means of low level bridges and crossings. A road reserve of 13.5 m will be present on the newly tarred 50.6 km road.

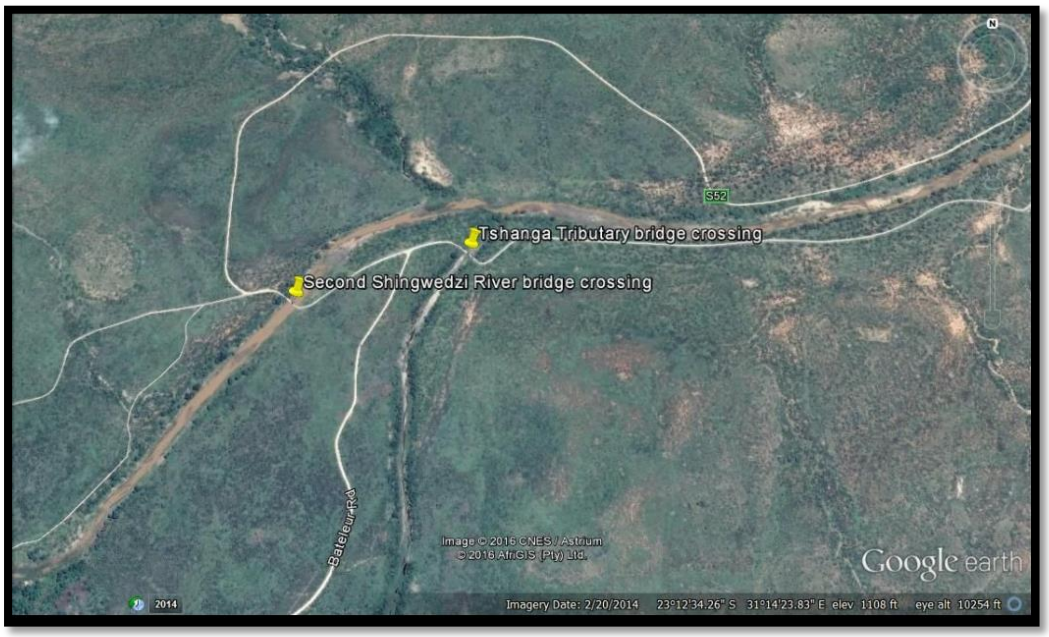


Figure 8: Google.earth view of bridge crossings. The second crossing over the Shingwedzi River will be in a new area.

Figure 9: Figure to show sandbank present at both river crossings.

Figure 10: View towards river crossing at the Tshanga Tributary low water bridge crossing.

Figure 11: View towards river crossing at the Shingwedzi River, this will be a new bridge crossing.

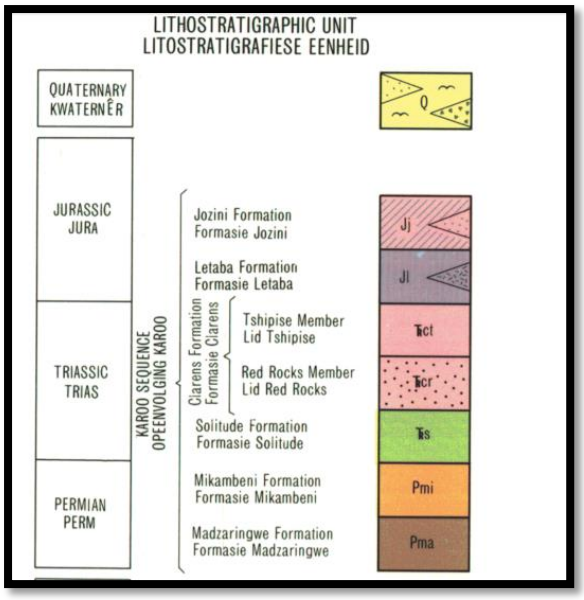
Figure 12: View at Red Rocks (*Ribye-ra Khubyane*) showing the calcrete on the surface, the subsoil below and the Clarens sandstone on the opposite bank. The road does not encroach on the river or river bank, it is situated to the south as can be seen on the lay-out plan.

Figure 13: It is only a small section of the road to be upgraded that will be present on the Quaternary and the Clarens sandstone. This section stretches for a short distance from the connection with the Mopani-Shingwedzi road H1-6 to the First River Crossing bridge. A large part of the upgrade will take place on the calcrete section.

The Project includes several Alternatives (see google.earth image):

1. Shangoni visitor's entrance gate, 2 Alternatives and a Preferred Alternative.
2. Reception facility, 1 Alternative and a Preferred Alternative.
3. New tarred access road and its associated bridge crossings.
4. Picnic site, 2 Alternatives.
5. Tented camps, 1 Alternative and a Preferred Alternative.
6. Camping sites, 1 Alternative and a Preferred Alternative.

Figure 14: Lithostratigraphic column of the geology of the site (Brandl 1985).



It is recommended to wait for the response from SAHRA on the (this report) Phase 1: Field study. Alternatives may be feasible, but were not suggested by the developer.

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).

Amphibians, non-dinosaurian archosaurs, theropod dinosaurs, dinosaur eggs, therapsids, mammaliaformes, crocodilomorphs, and chelonia make up the fauna of the Elliot and Clarens Formations (Chinsamy-Turan 2012, Groenewald 1986). Most recently, the fossil bones of a plant-eating dinosaur (Highland Giant) have been discovered near the Lesotho border in Clarens and a new species of *Eucnemesaurus* in Aliwal North from the lower Elliot Formation. Aeolonites, belonging to the Jurassic aged Clarens and Tshipise Formations contain petrified logs, trace fossils of insects and dinosaur trackways (possibly *Massospondylus, Syntarsus / Coelophysis*) (Groenewald and Groenewald 2014).

Several Quaternary formations have yielded mammal fossils such as the Florisbad, Aliwal North, Amanzi, Taung, Calc-tufa and the Cornelia Formations. There are many cave deposits namely Kromdraai, Makapansgat, Sterkfontein and the Swartkrans Formations that have yielded the famous hominin fossils (Kent, 1980).

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

Subgroup/ sequence	Group	Formation	Fossil Heritage	Comment
Quaternary	-	-	Mammalian, tortoise, ostrich eggshell, molluscs, microfossils, plant fossils	-
Karoo	Drakensberg	Clarens	Dinosaur remains and trackways can be	Very poor levels of

Supergroup			expected.	surface exposure.

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 sedimentary rock strata the palaeontological sensitivity is generally LOW to VERY HIGH, but here locally **HIGH** for the Clarens Formation, Ecca Group, Karoo Supergroup and **MODERATE** for the Quaternary.

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

Rock Unit	Significance/vulnerability	Recommended Action
Quaternary	Moderate	Desktop study is required
Clarens Formation	High	Desktop study is required and based on the outcome of the desktop study, a field assessment is likely.

Databases and collections: Ditsong: National Museum of Natural History.
Impact: **HIGH** for the Clarens Formation, Karoo Supergroup and **MODERATE** for the Quaternary. There are significant 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 field study was undertaken in April and May of 2017. A literature survey is included and the study relied on literature, geological maps, google.maps and google.earth images. The walk through of the affected portion was done and photographs (in 20 mega pixels) were taken of the site with a digital Canon camera (Power Shot SX620HS). It was not necessary to use a Global Positioning System (GPS) (Garmin eTrex 10) to records outcrops where not covered with topsoil, subsoil, overburden, and vegetation.

A walk through was done by stopping every kilometre of the S52 road, getting out of the vehicle, record the geology and look for fossils.

Assumptions and Limitations (Appendix 6 of Act 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. 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.

During the Triassic the mammals had advanced and the archosaurs now came into their own. These were crocodile-like. *Coelophysis* was one of the first dinosaurs. Other creatures present were nothosaurs, the first plesiosaurs and ichthyosaurs, and pterosaurs.

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, and it is not necessary to request a Phase 2 Palaeontological Impact Assessment: Mitigation to determine whether the development will affect fossiliferous outcrops. The palaeontological sensitivity is **HIGH** so caution is recommended. A Phase 2 Palaeontological Mitigation will be required if a fossil is found during construction (for example a stromatolite). Fossils were not found during the walk through.
b. This project may benefit the economy, the growth of the community, tourism, and social development in general.
c. Preferred choice: All the Preferred options are supported. The impact on the palaeontological heritage is **HIGH.** 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.
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.

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, if a fossil is found (Section G).
d. Permits for mitigation: Needed from SAHRA/PHRA.

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 Field Study was provided by the Environmental Consultant. All technical information was provided by Envirolution Consulting.
c. Areas that would involve mitigation and may need a permit from the South African Heritage Resources Agency are discussed (see Recommendation B).
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. Especially 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.

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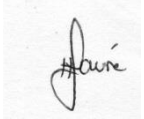
Gratitude
A special thanks to the staff of Shingwedzi Camp and Batileur Bush Camp and to the ranger Norman for his expertise and keeping me safe.

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.



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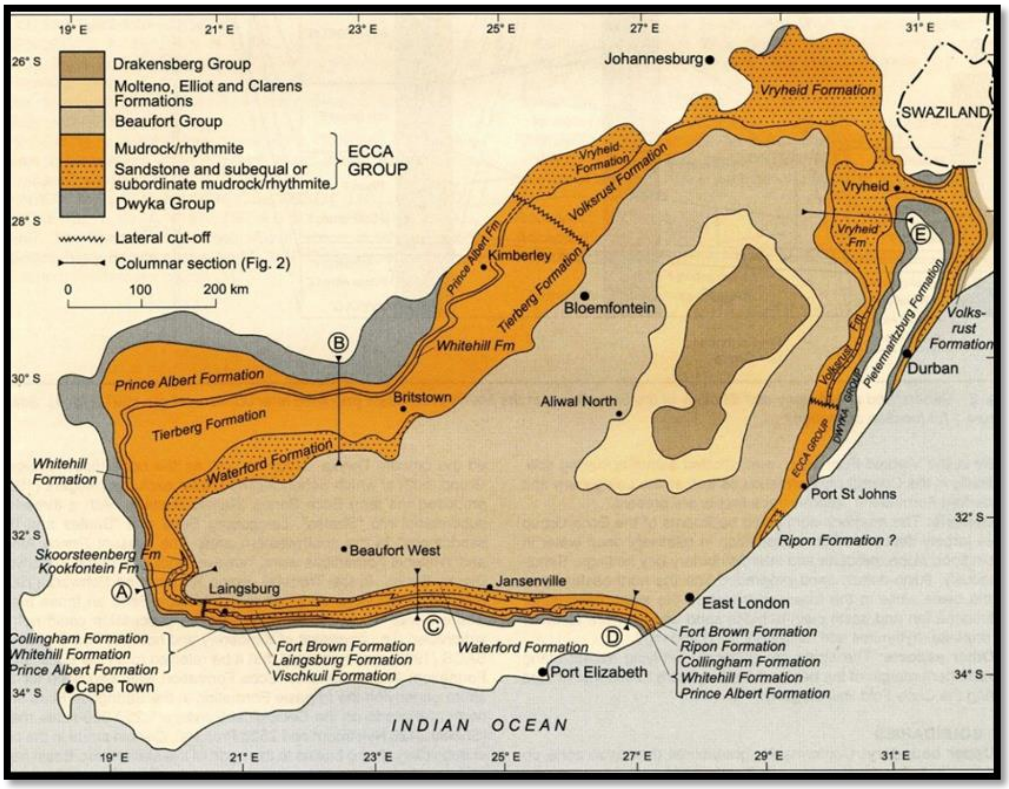
Heidi Fourie
2017/05/13

Appendix 1: Geology of the Karoo Supergroup (Johnson 2009).



Appendix 2:

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 3: Protocol for finds and Management Plan.

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 / ECO on site and should not be attempted by the layman / developer. The developer needs to employ an Environmental Control Officer (ECO) to oversee the construction activities so that when a fossil is unearthed they can notify the relevant department and specialist to further investigate. This ECO should familiarise him- or herself with the applicable formations and its fossils. Miners or construction

workers should be informed that fenced-off areas are no-go areas. 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; see Report, or any other fossiliferous layer ranked as **VERY HIGH or HIGH**.
3. When clearing topsoil, subsoil or overburden and hard rock (outcrop) is found, the contractor needs to stop all work. The area needs to be fenced off.
4. A Palaeobotanist / palaeontologist (contact SAHRIS for list) / ECO 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 / ECO 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 / ECO must do an investigation (a minimum of once a week).
8. At this stage the palaeontologist / palaeobotanist / ECO 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. Using 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 are 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 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 for all the Provinces.

Appendix 3: Table with Road Upgrade photographs.

	
Red Rocks Member, towards Shangoni Gate 4 km from Mopanie junction.	View of shoulder of S52 at the 5 km mark.

	
One of the many low level water river crossings over smaller drainage lines.	View of shoulder of road at the 10 km mark. The road reserve will be 13.5 m.
	
Area at Shangoni Gate where new bridge crossing over the Shingwedzi river will be.	Area at the Shingwedzi river where new bridge and reception area will be located.