Proposed rehabilitation of the Skoenmakers River and bridge restoration

Blue Crane Route Local Municipality, Cacadu District Municipality, Eastern Cape Province

Farm: Volkers Rivier, Fonteins Plaats, Geelhoutboom, Kruis Rivier, Palmietfontein

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Palaeontological Impact Assessment: Desktop study

Facilitated by: SRK Consulting

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2015/08/31

Ref: DEA14/12/16/3/3/1/1361 and 1362,1363,1364,1365,1366,1367,1368,1369,1370

B. Executive summary

Outline of the development project: SRK Consulting has facilitated the appointed of Dr H. Fourie, a palaeontologist, to undertake a Paleontological Impact Assessment (PIA), Desktop study of the suitability of the proposed rehabilitation of the Skoenmakers River and bridge restoration on the Farms Portions 3 and 7 Volkers Rivier 244, Portions 4 and 6 Fonteins Plaats 246, Portion 0 Geelhoutboom 247, Portions 4, 5, 6, 8 and 9 Kruis Rivier 248, and Portions 1 and 3 Palmietfontein 407 in the Blue Crane Route Local Municipality, Cacadu District Municipality, in the Eastern Cape Province.

The applicant, Department of Water and Sanitation, proposes to rehabilitate and restore 10 bridges / crossings on the Skoenmakers River.

The Project includes ten river crossings and four Alternatives (see Section D).

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.

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.

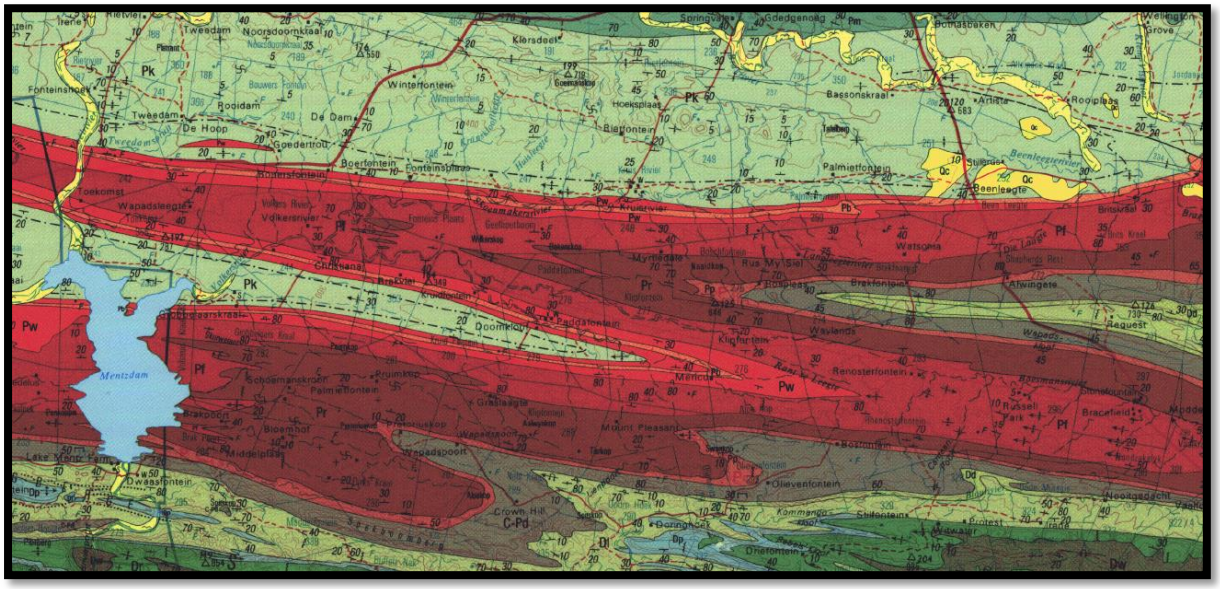
A Palaeontological Impact Assessment is generally warranted where rock units of LOW to VERY HIGH palaeontological sensitivity are concerned, levels of bedrock exposure within the study area are adequate; large scale projects with high potential heritage impact are planned; and where the distribution 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, 3324 Geological Map of Port Elizabeth (Toerien, 1991).

Figure 1: The geology of the development area.



Legend to Map and short explanation.
Qc – Calcrete (yellow). Quaternary.
Pk – Mudstone, subordinate sandstone, occasional thin cherty beds (light green). Koonap Formation, Adelaide Subgroup, Karoo Supergroup.
Pw – Sandstone, shale, mudstone (light red). Waterford Formation, Ecca Group, Karoo Supergroup.
Pb – Shale (orange). Britskraal Formation, Ecca Group, Karoo Supergroup.
Pf – Rhythmite, subordinate shale and sandstone (red). Fort Brown Formation, Ecca Group, Karoo Supergroup.
Pr – Sandstone, shale (brown). Ripon Formation, Ecca Group, Karoo Supergroup.
…… – (black) Lineament (Possible dyke).
--f— Fault.
⊥ - strike and dip.

Mining Activities:
None.

Summary of findings: The Desktop Palaeontological Impact Assessment was undertaken in August in the winter in dry and cold conditions and the following is reported:

Formations present are part of the Karoo Supergroup. The Karoo Supergroup is renowned for its fossil wealth (Kent, 1980; Visser, 1989) (Figure 1). 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 (Kent, 1980; Snyman, 1996).

The Adelaide Subgroup consists of greenish grey, and greyish-red mudstones and sandstones and is overlain by the Tarkastad Subgroup. The Koonap Formation (Pk), Adelaide Subgroup, Beaufort Group is approximately 1300 m thick (Kent, 1980).

The Waterford Formation (Pw) overlies the Fort Brown shale and where present constitutes the uppermost formation of the Ecca Group. It reaches a maximum thickness of about 800 m and is characterised by a relative abundance of grey sandstone and the presence of dark blue-grey shale (Kent, 1980; Snyman, 1996). It weathers yellow-brown (Visser, 1989). The Fort Brown (Pf) is middle-Ecca and reaches a maximum thickness of 1,500 m. Blue shale is interlayered with sandstone (Kent, 1980; Visser, 1989). The Ripon Formation (Pr) is lower-Ecca and is 1000 m in thickness (Visser, 1989).

On the farms Kruis Rivier 248 and Palmietfontein 250 and 407, the river is present on the rocks of the Adelaide Subgroup. Over the farms Volkers Rivier 244, Fonteins Plaats 246 and Geelhoutboom 247 the river is present on the Ecca Group

rocks. So, there is some concern with the development due to the presence of the Karoo Supergroup. The depth of the Formations should be verified with geological cores. The topsoil, subsoil and overburden must be surveyed for fossils and Mitigation is needed for the fossiliferous layer.

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 can generally be LOW to VERY HIGH, and here locally **VERY HIGH** for the Adelaide Subgroup and **MODERATE** for the Ecca Group (SG 2.2 SAHRA APMHOB, 2012).

Recommendation:
The impact of the development on fossil heritage is **VERY HIGH and MODERATE** and therefore a field survey or further mitigation or conservation measures may be necessary for this development (according to SAHRA protocol). A Phase 1 Palaeontological Impact Assessment: Field study may be recommended. The overburden and inter-burden consisting of Karoo rocks must be surveyed for fossiliferous outcrops (mudstone, shale). 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. Protocol is attached (Appendix 1) (See Section E).

During the study it was found that the site is directly underlain by siltstone, sandstone, and mudstone of the Karoo Supergroup.

The Project includes ten river crossings and four Alternatives (see Section D).

Concerns/threats:

1. Threats are earth moving equipment/machinery (front end loaders, excavators, graders, dozers) during construction, the sealing-in or destruction of the fossils by development, vehicle traffic and human disturbance.
2. Mitigation may be needed (see Section H).
3. No consultation with parties was necessary.

Stakeholders: Developer – Department of Water and Sanitation, Southern Operations and Walmer.
Environmental – SRK Consulting, P.O. Box 35290, Menlopark, Pretoria, 0102, Tel: 012 361 9821.
Landowner – Several private landowners.

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

The applicant, Department of Water and Sanitation, proposes to rehabilitate and restore 12 bridges on the Skoenmakers River including structures such as gabion baskets and concrete embankments. This river is being used as a transfer route for water by the Orange-Fish-Sundays River Interbasin Transfer Scheme. It receives water from the Gariep dam via a gravity tunnel and discharges into the Darlington dam. Development of the Orange-Fish-Sundays River Interbasin Transfer Scheme in the 1970's to early 1980's made access for farmers to their lands hazardous. To overcome inaccessibility to Middlewater and farmlands, 10 River crossings were constructed.

The continual change in the hydrological regime of this once ephemeral stream to a much bigger perennial river led to dramatic changes to both the physical structure and riparian vegetation structure of the river system. This has resulted in:

- Erosion of the river embankment.
- Excessive siltation causing unnatural islands to form within the river bed.
- Blockage of water extraction Weirs and pump stations.
- Excessive invasive vegetation causing blockage of the water course.
- Damage to infrastructure such as road crossings, water extraction weirs and equipment to regulate flood water.

This continual change has led to the deterioration of the 10 river crossings. This project entails restoring and/or upgrading the crossings.

Ten river crossings are planned;

River Crossing 1: Located on the DWS servitude and will be upgraded by removing the structures that were part of the existing bridge and constructing a suspended bridge. The foot print of River Crossing 1 will be expanded as the height of the crossing will be raised and the length increased.

River Crossing 2: Located along the DWS servitude, is going to be upgraded by removing existing structures and replacing them with portal culverts adequately sized to accommodate the hydraulic capacity, both current and future. The foot print of River Crossing 2 will be widened.

River Crossing 3: Located along the DWS servitude, is going to be upgraded by removing existing structures and replacing them with portal culverts adequately sized to accommodate the hydraulic capacity, both current and future. The foot print of River Crossing 3 will be widened

River Crossing 4: Located on the DWS servitude, is going to be expanded with 2 additional culverts and the reinstatement of the washed away embankment including approach slabs. The foot print of River Crossing 4 will be extended.

River Crossing 5: This bridge is going to be repaired and maintained. Approach slabs will also be constructed on either side of each bridge crossing. Bull noses will be constructed in order to prevent debris getting trapped in the water way. This will expand on the footprint of the crossing.

River Crossing 6: Located along the DWS servitude, is going to be upgraded by removing existing structures and replacing them with portal culverts adequately sized to accommodate the hydraulic capacity, both current and future. The foot print of River Crossing 6 will be widened.

River Crossing 7: Located along the DWS servitude, is going to be upgraded by removing existing structures and replacing them with portal culverts adequately sized to accommodate the hydraulic capacity, both current and future. The foot print of River Crossing 7 will be widened.

River Crossing 8: Located along the DWS servitude, is going to be upgraded by removing existing structures and replacing them with portal culverts adequately sized to accommodate the hydraulic capacity, both current and future. The foot print of River Crossing 8 will be widened.

River Crossing 9: Located along the DWS servitude, is going to be upgraded by removing existing structures and replacing them with portal culverts adequately sized to accommodate the hydraulic capacity, both current and future. The foot print of River Crossing 9 will be widened

River Crossing 10: Located along the DWS servitude, is going to be upgraded by removing existing structures and replacing them with portal culverts adequately sized to accommodate the hydraulic capacity, both current and future. The foot print of River Crossing 10 will be widened.

The Project includes 4 Alternatives:

Alternative 1
Monolithic, single span, concrete bridges are considered to replace the existing culvert structures. These type of structures are however both costly and time-consuming to construct. This is mainly due to the span needing to be in excess of about 50 meters making the structure impractical to construct. Since the low-flow period of the river is only a month, with high flow volumes the rest of the time, this option would not be viable. The existing and future traffic loads to these bridges would also not warrant the cost involved with a single span bridge structures.
Alternative 2
Due to the short available construction period and in order to allow for proper hydraulic capacity, it was proposed to construct suspended steel structures over the entire river width at each of the crossings. These would replace the existing structures and as a result of the nature of these structures, it can be constructed adjacent to the river and moved into position during full flow of the river. These type of structures are however extremely costly. With the current and expected volume of traffic over the said river crossings, this option would not be economically viable.
Alternative 3
Clean out and repair the existing structures, upgrade the existing erosion protection and remove silt upstream from the structures. This option does however not consider the hydraulic capacity of the existing structures, as well as future increase in the transfer (base flow) of water. Although this will be the most cost-effective solution, the existing problems experienced at the structures will not be addressed and re-occurrence of the current conditions will again have to be addressed in near future.
Alternative 4
Remove the existing structures and replace it with portal culverts adequately sized to accommodate the hydraulic capacity, both current and future. These pre-cast structures can be placed directly after removal of the existing structures which would lead to some time saving on the construction programme. The construction can also take place in phases which would allow for the bridges being constructed over a longer period by introducing temporary river diversion methods.

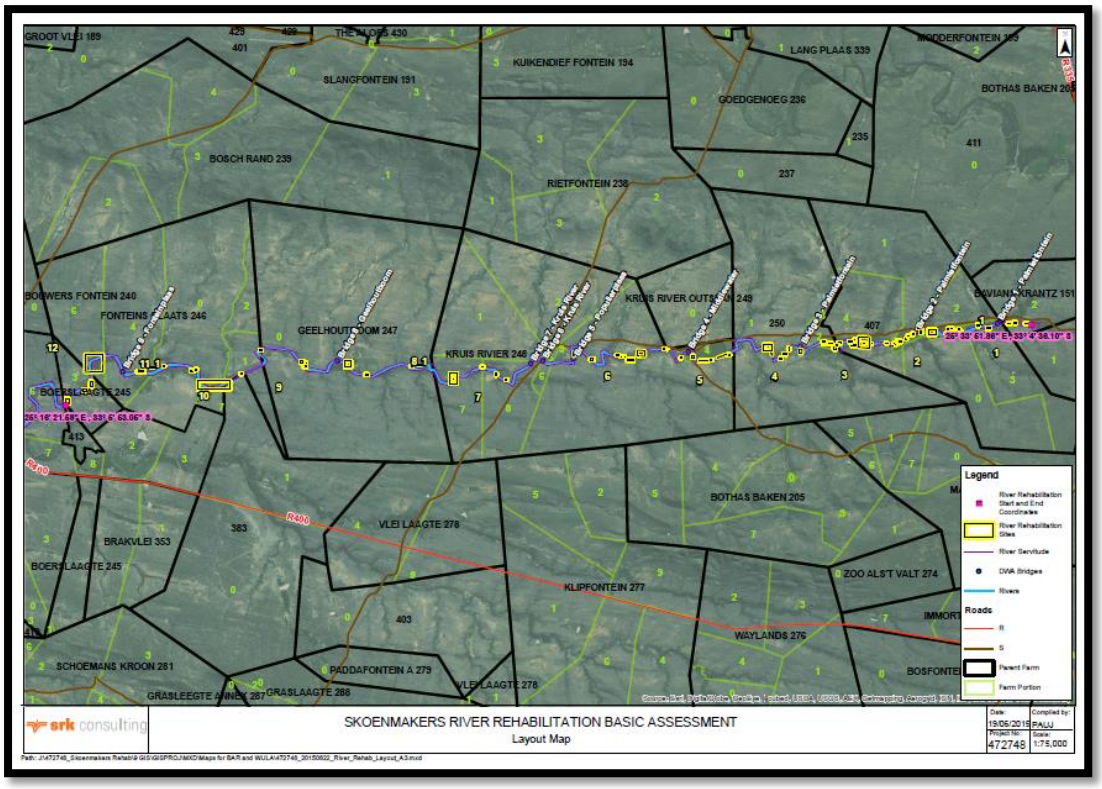
Rezoning/ and or subdivision of land: No.
Name of developer and consultant: The Department of Water and Sanitation, Southern Operations, Walmer and SRK Consulting.
Terms of reference: Dr H. Fourie is a palaeontologist commissioned to do a palaeontological impact assessment: field study to ascertain if any palaeontological sensitive material is present in the development area. This study will advise on the impact on fossil heritage mitigation or conservation necessary, if any.
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 nine years she carried out field work in the Eastern Cape, Limpopo, Gauteng and Free State Provinces. Dr Fourie has been employed at the Ditsong: National Museum of Natural History in Pretoria (formerly Transvaal Museum) for 21 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 rehabilitation of the Skoenmakers River and bridge restoration is on Portions 3 and 7 Volkers Rivier 244, Portions 4 and 6 Fonteins Plaats 246, Portion 0 Geelhoutboom 247, Portions 4, 5, 6, 8 and 9 Kruis Rivier 248, and Portions 1 and 3 Palmietfontein 407 in the Blue Crane Route Local Municipality, Cacadu District Municipality, in the Eastern Cape Province.

The depth of structures is determined by the foundations and footings.

Figure 2: Google.earth image showing location of Landfill site (SRK Consulting).



The bulk of the site is underlain by the Karoo Supergroup Formations covered by vegetation, grassland and sandstone outcrops.

F. Description of the Geological Setting
Description of the rock units:
Large areas of the southern African continent are covered by the Karoo Supergroup (Figure 1, Map 1). It is Phanerozoic in age and covers older geological formations with an almost horizontal blanket. Several basins are present with the main basin in the central part of South Africa and several smaller basins towards Lebombo, Springbok Flats and Soutpansberg. An estimated age is 150 – 180 Ma. And a maximum thickness of 7000 m is reached in the south. Three formations overlie the Beaufort Group, they are the Molteno, Elliot and Clarens Formations. The Elliot Formation is also known as the Red Beds and the old Cave Sandstone is known as the Clarens Formation. At the top is the Drakensberg Basalt Formation with its pillow lavas, pyroclasts, etc. (Kent, 1980; Snyman, 1996).

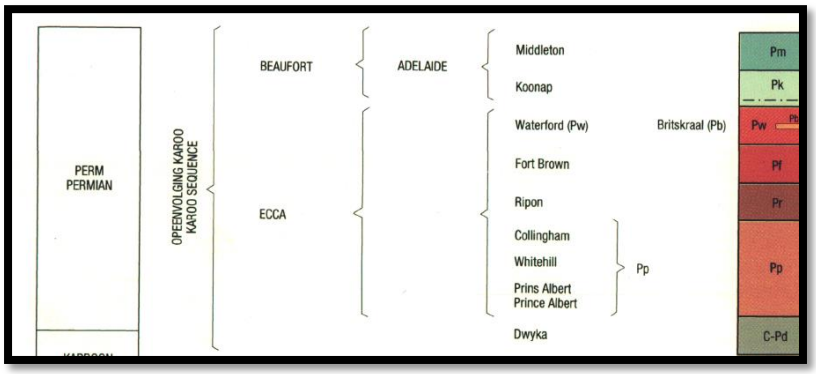
The Ecca Group forms part of the Karoo Supergroup. It conformably overlies the Dwyka Group and is conformably overlain by the Beaufort Group. It consists essentially of mudrock (shale), but sandstone-rich units occur towards the margins of the present main Karoo basin in the south, west and north-east, with coal seems also being present in the north-east (Kent, 1980; Johnson, 2009). Sediments of the Ecca Group are lacustrine and marine to fluvio-deltaic (Snyman, 1996). The age of the Ecca Group is Palaeozoic, early to mid-Permian, approximately 545-250 Ma. The Ecca Group is known for its coal (mainly the Vryheid Formation) and uranium. This Group also outcrops on the Springbok Flats. The shale is always dark grey and plant fossils are common (Visser, 1989).

The Adelaide Subgroup consists of greenish grey, and greyish-red mudstones and sandstones and is overlain by the Tarkastad Subgroup. The Koonap Formation (Pk), Adelaide Subgroup, Beaufort Group is approximately 1300 m thick (Kent, 1980).

The Waterford Formation (Pw) overlies the Fort Brown shale and where present constitutes the uppermost formation of the Ecca Group. It reaches a maximum thickness of about 800 m and is characterised by a relative abundance of grey sandstone and the presence of dark blue-grey shale (Kent, 1980; Snyman, 1996). It weathers yellow-brown (Visser, 1989). The Fort Brown (Pf) is middle-Ecca and reaches a maximum thickness of 1,500 m. Blue shale is interlayered with sandstone (Kent, 1980; Visser, 1989). The Ripon Formation (Pr) is lower-Ecca and is 1000 m in thickness (Visser, 1989). The strata are usually flat-lying except along the southern margin of the basin where they were folded and faulted during the Cape Fold Belt orogeny (Johnson, 2009).

Further to the lithostratigraphy, the Beaufort Group is divided into biostratigraphic units. In this particular region, the biozone boundaries are unclear, but the *Tapinocephalus* and *Pristerognathus* Assemblage Zones within the Koonap Formation are present and is characterised by the abundance of Therapsid fossils (Rubidge, 1995).

Figure 3: Lithostratigraphic column of the Karoo Supergroup (Toerien, 1991).



Dolerite dykes (Jd) occur throughout the Karoo Supergroup. Structural geological features such as dykes and faults can have a measurable influence on ground water flow and mass transport.

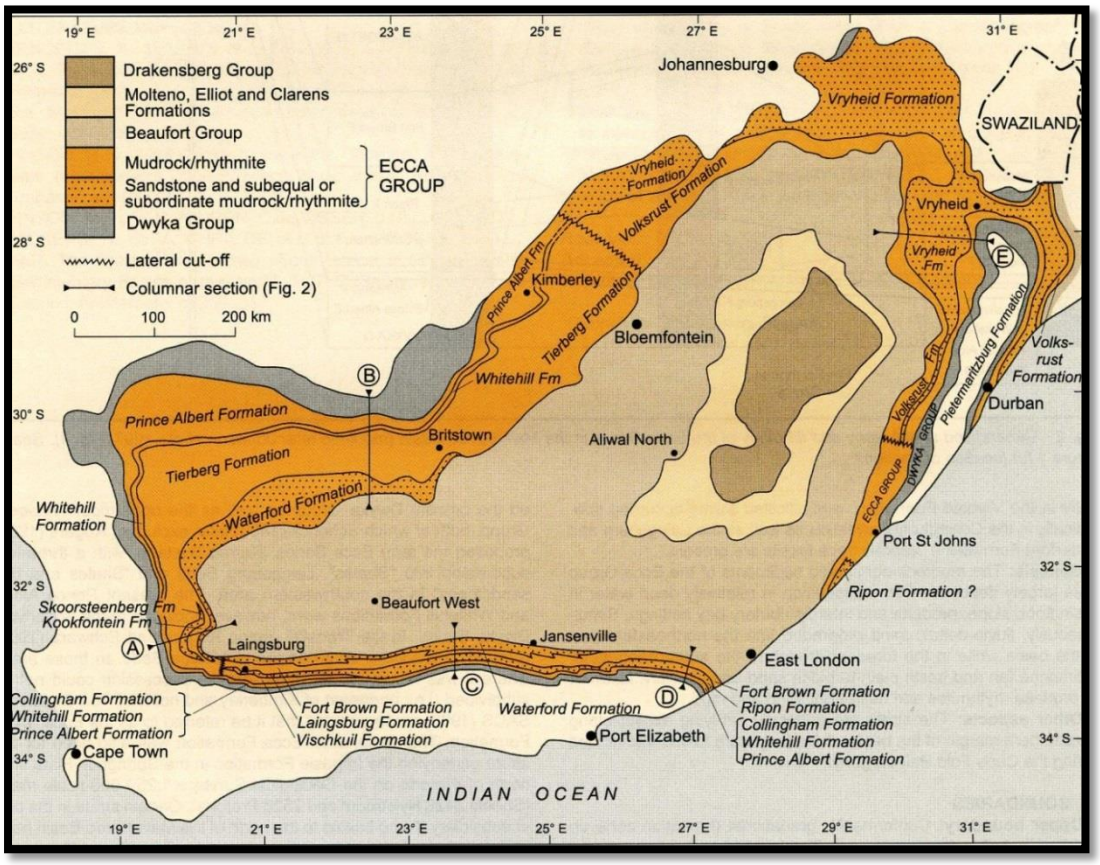
On the farms Kruis Rivier 248 and Palmietfontein 250 and 407, the river is present on the rocks of the Adelaide Subgroup. Over the farms Volkers Rivier 244, Fonteins Plaats 246 and Geelhoutboom 247 the river is present on the Ecca Group rocks. So, there is some concern with the development due to the presence of the Karoo Supergroup. The depth of the Formations should be verified with geological cores. The topsoil, subsoil and overburden must be surveyed for fossils and Mitigation is needed for the fossiliferous layer.

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 the SAHRA protocol must be followed. Alternatives will not be feasible as all proposed development portions and surrounding areas are on the Karoo Supergroup.

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).



Map 1: Extent of the Karoo Supergroup (Johnson 2009).

The aquatic reptile *Mesosaurus* from the Whitehill Formation and fish remains are the only vertebrate fossils known from the Ecca Group. The arthropod *Notocaris* is also common in the Whitehill Formation, with silicified stems occurring sporadically in the Collingham Formation as well as the Laingsburg and Waterford Formations. Various trace fossils are present (Johnson, 2009).

Fossils present in the *Tapinocephalus* Assemblage Zone are the Pisces (e.g. *Atherstonia*), Amphibia (e.g. *Rhinesuchus*), Reptilia (e.g. *Bradysaurus*), Synapsida (e.g. *Tapinocephalus, Elliotsmithia, Diictodon, Gorgonops, Glanosuchus*) as well as Mollusca (e.g. *Palaeomutela*), plant fossils (e.g. Glossopteris) and trace fossils (e.g. *Undichnus*). The *Pristerognathus* Assemblage Zone is characterised by the presence of Pisces (e.g. *Namaichthys*), Amphibia (e.g. *Rhinesuchus*), Reptilia (e.g. *Broomia*), Synapsida (e.g. *Elliotsmithia, Jonkeria, Emydops, Galesuchus, Lycosuchus*), Mollusca (e.g. *Palaeomutela*), plant fossils (e.g. *Dadoxylon*) and trace fossils (e.g. Therapsid footprints) (Rubidge, 1995).

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 **VERY HIGH** for the Adelaide Subgroup and **MODERATE** for the Ecca Group.

Criteria used (Fossil Heritage Layer Browser/SAHRA):

Rock Unit	Significance/vulnerability	Recommended Action
Adelaide Subgroup	Very High	Field assessment and protocol for finds is required
Ecca Group	Moderate	Desktop study is required

Databases and collections: Ditsong: National Museum of Natural History. Evolutionary Studies Institute, University of the Witwatersrand (ESI).

Impact: **VERY HIGH** for the Adelaide Subgroup and **MODERATE** for the Ecca Group. There may be significant fossil resources that may be impacted by the development (mudstone, shale).

H. Description of the Methodology

The palaeontological impact assessment desktop study was undertaken in August 2015. A Global Positioning System (GPS) (Garmin eTrex 10) is used to record fossiliferous finds if the area is not covered with topsoil, subsoil, overburden, vegetation, grassland and trees.

Assumptions and Limitations:-

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 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.

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

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

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

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

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

I. Description of significant fossil occurrences

All Karoo Supergroup geological formations are ranked as LOW to VERY HIGH, and here the impact is potentially **VERY HIGH** for Adelaide Subgroup and **MODERATE** for the Ecca Group.

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 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

a. There is no objection (see Recommendation B) to the development, but it may be 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 **VERY HIGH and MODERATE**. A Phase 2 Palaeontological Mitigation may be required if the Phase 1 Palaeontological Assessment identified a fossiliferous formation (Karoo Supergroup). Protocol is attached (Appendix 1).

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 **VERY HIGH and MODERATE.** The presence of Karoo Formations is problematic. Care must be taken during the digging of foundations and removing topsoil, subsoil and overburden (see Executive Summary).

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:

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: **May be needed from SAHRA/PHRA prior to Mitigation**.

K. Conclusions

a. All the land involved in the development was assessed and none of the property is unsuitable for development (see Recommendation B).
b. All information needed for the Desktop study was provided by the Consultant. All technical information was provided by SRK Consulting.
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. 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.

L. Bibliography

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Declaration

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.

Heidi Fourie accepts no liability, and the client, by receiving this document, indemnifies Heidi Fourie 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.

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
2015/08/31

Appendix 1: **Protocol for finds**

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

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.

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

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

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

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

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

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

1. The developer needs to clearly stake or peg-out (survey) the areas affected by the mining/ construction/ development operations and dig representative trenches and if possible supply geological borehole data.
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 every two weeks).
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. 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 does have the following documents in place:
Guidelines to Palaeontological Permiting policy.
Minimum Standards: Palaeontological Component of Heritage Impact Assessment reports.
Guidelines for Field Reports.

Appendix 2:

Table 1: 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 2	1(k)	Protocol for finds
	1(m)	"
	1(q)	"