Magogudi Tyre Storage Facilities Olyvenhoutsdrift

Dawid Kruiper Local Municipality, Gordonia District Municipality, Northern Cape Province

Farm: Plot 1298 Olyvenhouts Drift Settlement

Fourie, H. Dr heidicindy@yahoo.com

012 322 7632/012 942 0110 x 1057

Palaeontological Impact Assessment: Desktop Study

Facilitated by: Exigo Sustainability (Pty) Ltd

Postnet Suite 74, Private Bag X07, Arcadia, 0007

Tel: 012 751 2160

2019/06/13

Ref: Pending

B. Executive summary

Outline of the development project: Exigo Sustainability (Pty) Ltd has facilitated the appointment of Dr H. Fourie, a palaeontologist, to undertake a Palaeontological Impact Assessment (PIA), Desktop Study of the Magogudi Tyre Storage Facilities Olyvenhoutsdrift on the Farm Olyvenhoutsdrift Settlement Plot 1298, Dawid Kruiper Local Municipality, in the Gordonia District Municipality, Northern Cape Province.

The applicant, Magogudi Construction Projects proposes to temporary store tyres, then cut/shred, bale and transport to a recycling facility.

The Project includes one Alternative (see Figure 1):
Alternative 1: A roughly rectangular area marked in black bordering on the N14 National Road to the west, the Orange River to the east and the town of Upington to the north. The approximate size of the site is 4-5 hectares.

Legal requirements:-

The **National Heritage Resources Act (Act No. 25 of 1999) (NHRA)** requires that all heritage resources, that is, all places or objects of aesthetic, architectural, historical, scientific, social, spiritual, linguistic or technological value or significance are protected. The Republic of South Africa (RSA) has a remarkably rich fossil record that stretches back in time for some 3.5 billion years and must be protected for its scientific value. Fossil heritage of national and international significance is found within all provinces of the RSA. South Africa's unique and non-renewable palaeontological heritage is protected in terms of the National Heritage Resources Act. According to this act, palaeontological resources may not be excavated, damaged, destroyed or otherwise impacted by any development without prior assessment and without a permit from the relevant heritage resources authority.

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

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

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

A Palaeontological Impact Assessment is generally warranted where rock units of **LOW to VERY HIGH** palaeontological sensitivity are concerned, levels of bedrock exposure within the study area are adequate; large scale projects with high potential heritage impact are planned; and where the distribution and nature of fossil remains in the proposed area is unknown. The specialist will inform whether further monitoring and mitigation are necessary.

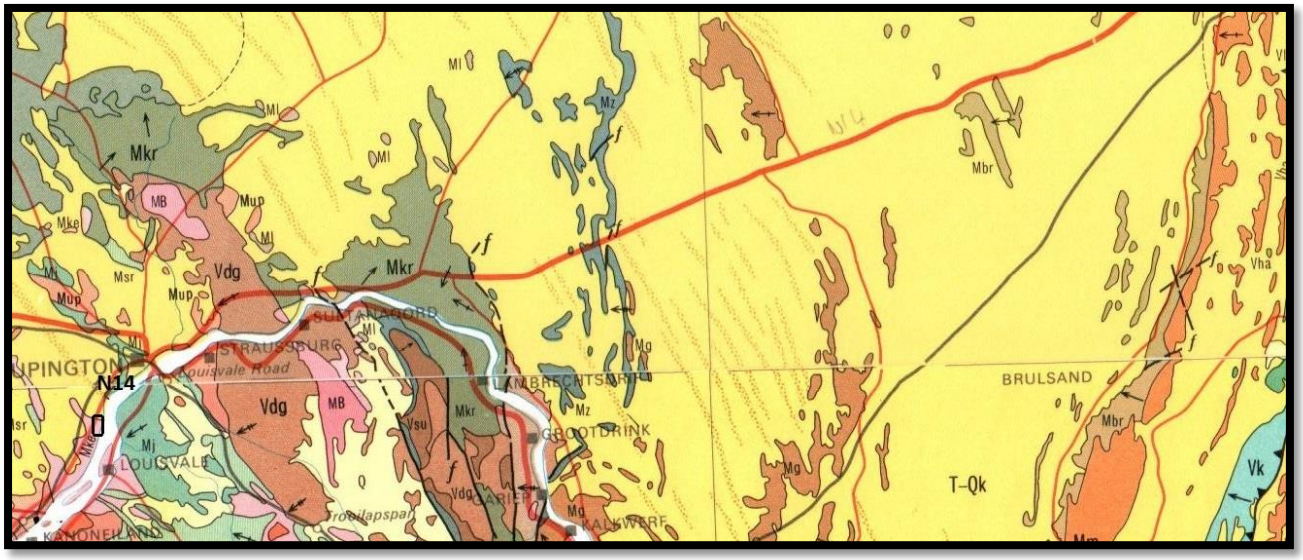
Types and ranges of heritage resources as outlined in Section 3 of the National Heritage Resources Act (Act No.25 of 1999):
(i) (i) objects recovered from the soil or waters of South Africa, including archaeological and palaeontological objects and material, meteorites and rare geological specimens.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

Subject to the provisions of subsections (7), (8) and (9), any person who intends to undertake a development categorised as (a) the construction of a road, wall, power line, pipeline, canal or other similar form of linear development or barrier exceeding 300 m in length; (b) the construction of a bridge or similar structure exceeding 50 m in length; (c) any development or other activity which will change the character of a site (see Section 38); (d) the re-zoning of a site exceeding 10 000 m² 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).

Figure 3: The geology of the development area.



Legend to Map and short explanation.
T-Qk – Sand, limestone (yellow). Kalahari Group.
T-Qk/C-Pd – Tillite, sandstone, mudstone, shale (grey) Dwyka Group, Karoo Super Group.
Mke – Granite (pink). Suite Keimoes.
Mj – Amphibolite, calc-silicate rocks (green). Korannaland Super Group.
---f--- – (black) Fault.
……. – Lineament.
□ – Approximate position of storage facility.

Mining Activities
None

Summary of findings: The Palaeontological Impact Assessment: Desktop Study was undertaken in May 2019 in the winter in mild and dry conditions (Appendix 6 of Act, **1(d))**, and the following is reported. As this is a desktop study the season has no influence on the outcome:

The development is taking place on the Suite Keimoes rocks with the Kalahari Group (T-Qk) present nearby.

The Kalahari deposits extend in age down to at least the Late and probably the Early Tertiary (65 million years ago). Fossils are scarce, and are of terrestrial plants and animals with close affinity to living forms. Included in the Kalahari Group are the Quaternary alluvium, terrace gravels, surface limestone, silcrete, and aeolian sand. Four major types of sands have been delineated (Kent 1980). The alluvium sands were deposited by a river system and reworked by wind action (Snyman 1996). A thick cover of Kalahari reddish sand blankets most outcrops and is dominated by the typical Kalahari thornveld (Norman and Whitfield 2006). The Kalahari Group is underlain by the Uitenhage and Zululand Groups (McCarthy and Rubidge 2005).

The Keimoes Suite is situated along a north-north-westerly line through Keimoes along the margin of the Namaqualand Metamorphic Complex. This Suite is divided into three main units. The Upington Granitoid and basic and ultrabasic bodies consists of grey gneiss and biotite-hornblende in a sill-like sheet; the Unfoliated granitoids consists of the Elandslaagte Muscovite Granite, the Brakbos Biotite Granite, the Eindgoed Granite, and the Lat River Biotite Granite amongst others; and the Charnockite-magerite-anorthosite consists of the Friersdale Charnockite as the three main units. An age of 1 372 Ma – 1 200 Ma is proposed (Kent 1980).

Palaeontology - 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 **HIGH** for the Kalahari Group and **INSIGNIFICANT to ZERO** for the Suite Keimoes (SG 2.2 SAHRA APMHOB, 2012) (Groenewald and Groenewald 2014).

The more recent Phanerozoic deposits (Cenozoic) are of importance in the study of life during the last 300 million years. Large areas in the western part of the Province are underlain by Cenozoic (Tertiary, Quaternary) deposits of the Kalahari Group. The Keimoes Suite is devoid of fossils.

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

Rock Unit	Significance/vulnerability	Recommended Action
Kalahari Group	High	Desktop study is required and based on the outcome of the desktop study, a field assessment is likely
Keimoes Suite	Insignificant to Zero	No action is required

The Kalahari Group is present close to the development area. Groenewald & Groenewald (2014) rates this Group as having a high palaeontological significance due to the significant 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 **HIGH** status is allocated.

Recommendation:
The impact of the development on fossil heritage is **HIGH** and therefore a field survey or further Phase 2: mitigation or conservation measures will be necessary for this development (according to SAHRA protocol) if a fossil is found.

The Project includes one Alternative (see Figure 1):
Alternative 1: A roughly rectangular area marked in black bordering on the N14 National Road to the west, the Orange River to the east and the town of Upington to the north. The approximate size of the site is 4-5 hectares.

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 material that may be exposed during construction activities. The protocol is to immediately cease all construction activities if a fossil is unearthed, construct a 30 m no-go barrier and contact SAHRA for further investigation. It is recommended that the EMPr be updated to include the involvement (pre-construction training of ECO) of a palaeontologist/archaeozoologist during the digging and excavation phase of the development and ECO to visit site after blasting and excavating and keep a photographic record.

Stakeholders: Developer – Magogudi Construction Projects, 11 Kreupelhout Avenue, Weltevreden Park, Roodepoort, 1724.
Environmental – Exigo Sustainability (Pty) Ltd, Postnet Suite 74, Private Bag X07, Arcadia, 0007, Tel: 012 751 2160.
Landowner – N/a.

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).

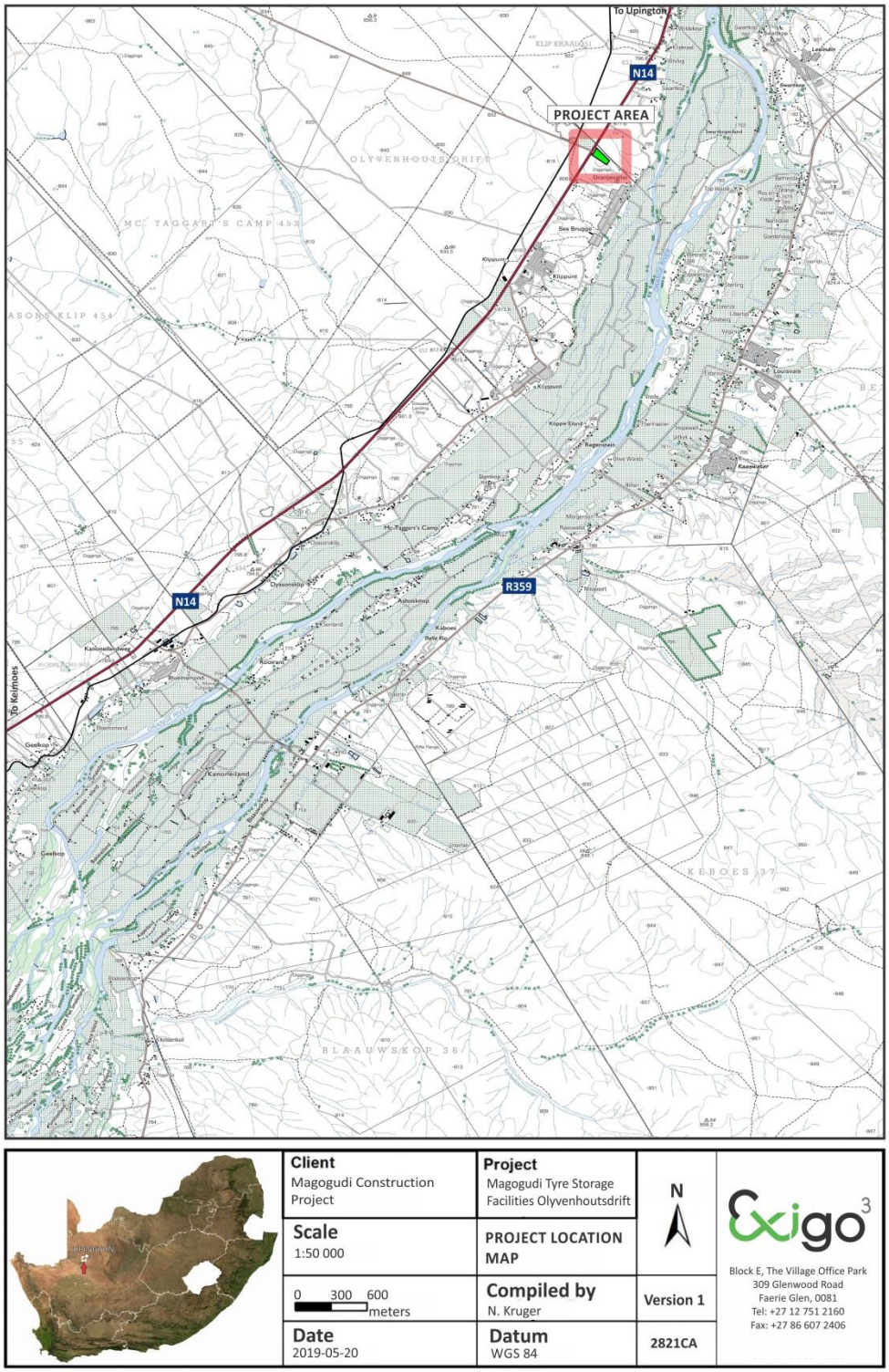
Outline of development

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 Magogudi Construction Projects, propose to temporary store tyres, which will then be cut/shred, baled into small packages (5-7 tonnes) and transported to recycling facility. Trucks / bakkies will deliver old tyres to the storage facility, ten deliveries per day will be received. No effluent / emissions are expected.

Local benefits of the proposed development include benefits to the local economy through possible job creation and local supplier procurement during the construction phase as well as during the operational phase of the development.

Figure 1: Topographic map showing location (Exigo).



The following infrastructure is anticipated:

1. Access roads for big trucks,
2. Pre-processing areas and offices,
3. Parking spaces,
4. Electricity and water points, and
5. Fence with access gate.

The Project includes one Alternative (see Figure 1):

Alternative 1: A roughly rectangular area marked in black bordering on the N14 National Road to the west, the Orange River to the east and the town of Upington to the north. The approximate size of the site is 4-5 hectares.

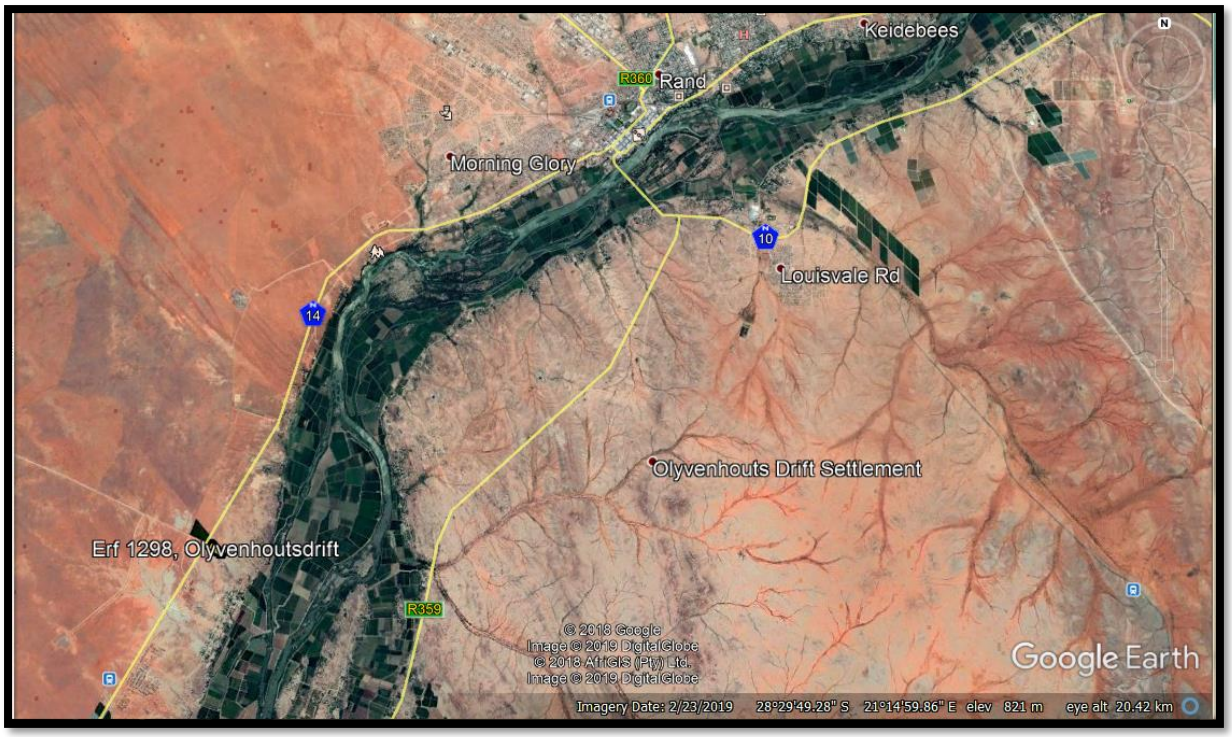
Rezoning/ and or subdivision of land: No.
Name of Developer and Consultant: Magogudi Construction Projects and Exigo Sustainability (Pty) Ltd.
Terms of reference: Dr H. Fourie is a palaeontologist commissioned to do a palaeontological impact assessment to ascertain if any palaeontological sensitive material 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. She is presently employed by Ditsong: Natiolnal Museum of Natural History as Curator of the invertebrate, plant, fish, reptile, dinosaur, and therapsid collections. For the past 13 years she carried out field work in the Eastern Cape, Limpopo, Mpumalanga, Gauteng, Free State and Kwazulu Natal Provinces. Dr Fourie has been employed at the Ditsong: National Museum of Natural History in Pretoria (formerly Transvaal Museum) for 24 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 Magogudi Tyre Storage Facilities Olyvenhoutsdrift will be situated on Plot 1298 Olyvenhouts Drift Settlement in the Dawid Kruiper Local Municipality, Gordonia District Municipality, Northern Cape Province.

Depth is determined by the related infrastructure such as the foundations to be developed and the thickness of the formation in the development area. Details of the location and distribution of all significant fossil sites or key fossiliferous rock units are often difficult to determine due to thick topsoil, subsoil, overburden and alluvium. Depth of the overburden may vary a lot. Geological maps do not provide depth or superficial cover, it only provides mappable surface outcrops. The Kalahari Group reaches thicknesses of 280 m.

The Project includes one Alternative (see Figure 1):
Alternative 1: A roughly rectangular area marked in black bordering on the N14 National Road to the west, the Orange River to the east and the town of Upington to the north. The approximate size of the site is 4-5 hectares.

Figure 2: Location map of development area (Exigo).



The site is underlain by the Kalahari Group rocks and the tyre storage facility will be on the rocks of the Keimoes Suite.

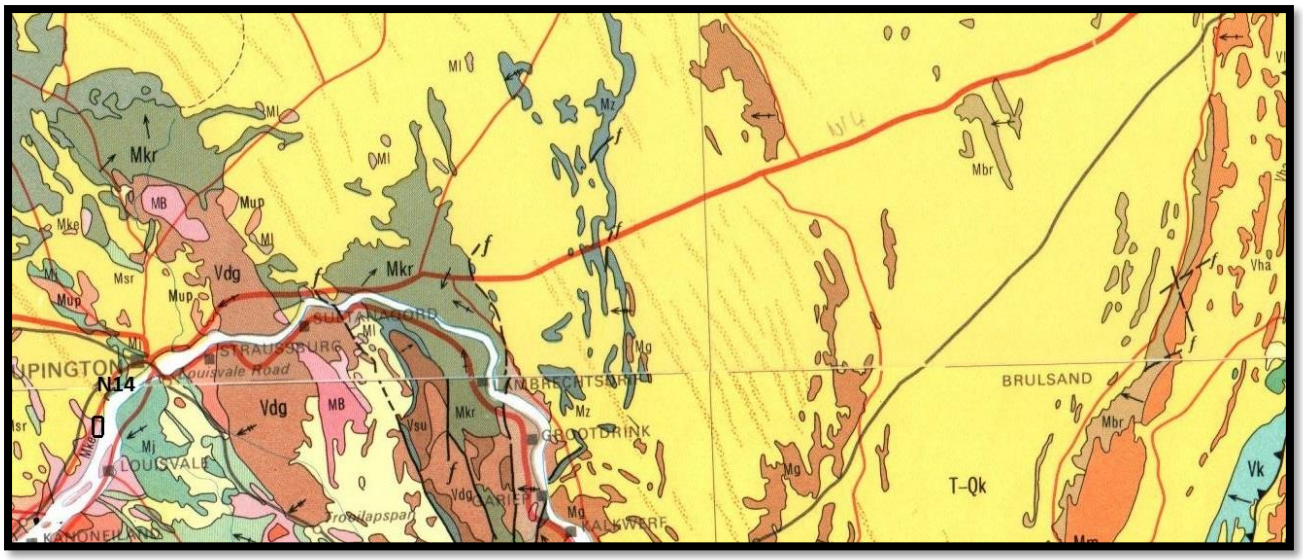
F. Description of the Geological Setting

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).

The Kalahari deposits extend in age down to at least the Late and probably the Early Tertiary (65 million years ago). Fossils are scarce, and are of terrestrial plants and animals with close affinity to living forms. Included in the Kalahari Group are the Quaternary alluvium, terrace gravels, surface limestone, silcrete, and aeolian sand. Four major types of sands have been delineated (Kent 1980, Visser 1989). The alluvium sands were deposited by a river system and reworked by wind action (Snyman 1996). A thick cover of Kalahari reddish sand blankets most outcrops and is dominated by the typical Kalahari thornveld (Norman and Whitfield 2006). The Kalahari Group is underlain by the Uitenhage and Zululand Groups (McCarthy and Rubidge 2005).

Figure 3: Geology of the area



Legend to Map.
T-Qk – Sand, limestone (yellow). Kalahari Group.
T-QK/C-Pd – Tillite, sandstone, mudstone, shale (grey) Dwyka Group, Karoo Supergroup.
Mke – Granite (pink). Suite Keimoes.
Mj – Amphibolite, calc-silicate rocks (green). Korannaland Supergroup.
---f--- – (black) Fault.
……. – Lineament.
□ – Approximate position of tyre storage facility.

The Keimoes Suite is situated along a north-north-westerly line through Keimoes along the margin of the Namaqualand Metamorphic Complex. This Suite is divided into three main units. The Upington Granitoid and basic and ultrabasic bodies consists of grey gneiss and biotite-hornblende in a sill-like sheet; the Unfoliated granitoids consists of the Elandslaagte Muscovite Granite, the Brakbos Biotite Granite, the Eindgoed Granite, and the Lat River Biotite Granite amongst others; and the Charnockite-magerite-anorthosite consists of the Friersdale Charnockite, as the three main units. An age of 1 372 Ma – 1 200 Ma is proposed (Kent 1980). Visser (1989) adds the Vaalputs (Gneiss) Granite and the Cnydas Subsuite with an age of 1 076 ± 20 Ma.

Snyman (1996) lumps the Marydale and Kaaien Groups, Korannaland Supergroup, Bushmanland Group, Okiep Group, and the Orange River Group and later intrusive units such as the Keimoes suite into the Namaqualand Metamorphic Complex. The Korannaland Supergroup comprises the pre-granitic rocks in the western Korannaland. Eight formations are present, namely, the Goede Hoop Formation, Biesje Poort Formation, Kokerberg Formation, Rautenbach se Kop Formation, Kenhardt Formation, Toeslaan Formation, Jannelspan Formation, and the Eierdoppe Formation. This Super Group is situated along the eastern margin of the Namaqua Mobile Belt and is intruded by various granitoids of the Keimoes Suite. Age is estimated as 1 200 – 1 500 Ma (Kent 1980).

The dedicated 800 km-long railway line from the mines at Sishen to Saldanha Bay passes next to Upington. Upington is built on a river terrace some 15 m above the Orange River flood plain (Norman and Whitfield 2006).

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. Significant fossil remains of Cenozoic aged terrestrial organisms have been recorded from the sedimentary rocks of the Kalahari Group. These fossils are rarely found and are allocated a **HIGH** palaeontological sensitivity as they are important indicators of palaeo-environmental conditions (Groenewald and Groenewald 2014).

Figure 9: Example of a Stromatolite (Photograph: E. Butler).

The more recent Phanerozoic deposits (Cenozoic) are of importance in the study of life during the last 300 million years. Large areas in the western part of the Province are underlain by Cenozoic (Tertiary, Quaternary) deposits of the Kalahari Group.

Table 1: Taken from Palaeotechnical Report (Almond and Pether 2009).

14. KALAHARI GROUP **(K-Q)**	Fluvial gravels, sands, lacustrine and pan mudrocks, evaporites, aeolian sands, pedocretes (especially calcrete) Late Cretaceous to Recent <90 Ma → 0 Ma	Palynomorphs, root casts (rhizomorphs) and burrows (eg termitaria), rare vertebrate remains (mammals, fish, ostrich egg shell *etc*), diatom-rich limestones, freshwater stromatolites, freshwater and terrestrial shells (gastropods, bivalves), ostracods, charophytes	Fossils mainly associated with ancient pans, lakes and river systems Palaeontology poorly studied
4. NAMAQUA METAMORPHIC PROVINCE **large number of subunits** **(M*….)**	Igneous and metamorphic rocks (including high grade metasediments) Early to Mid Proterozoic (Mokolian) *c.* 2-1 Ga	NO FOSSILS RECORDED	

Legend:
Blue – Low palaeontological sensitivity.
Black – Incignificant to Zero palaeontological sensitivity.

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 **HIGH** for the Kalahari Group.

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

Rock Unit	Significance/vulnerability	Recommended Action
Kalahari Group	High	Desktop study is required and based on the outcome of the desktop study, a field assessment is likely
Keimoes Suite	Insignificant to Zero	No action required

The Kalahari Group is present here in the development area. Groenewald & Groenewald 2014 rates this Group as having a high palaeontological significance due to the significant 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 **HIGH** status is allocated.

Databases and collections: Ditsong: National Museum of Natural History.
Impact: **HIGH** for the Kalahari Group and **INSIGNIFICANT to ZERO** for the Keimoes Suite. 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: Desktop Study was undertaken in May 2019. During the Phase 1: Field Study a walkthrough of the affected portion will be done and photographs (in 20 mega pixels) taken of the site with a digital Canon camera (PowerShot SX620HS). A Global Positioning System (GPS (Garmin eTrex 10) can be used to record the outcrops. A literature survey is included and the study relied on literature, geological maps, google.maps and google.earth images. No fossils were found.

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. Inaccessibility of site.
7. 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.

Stromatolites are likely to be present. These 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).

18. KALAHARI GROUP **Wessels (Tw), Budin (Tb), Eden (Te), Mokalanen (T-Qm), Obobogorop, Gordonia (Qg) and Lonely Formations**	Fluvial gravels, sands, lacustrine and pan mudrocks, diatomites and diatomaceous limestones, evaporites, consolidated to unconsolidated aeolian sands, pedocretes (especially calcrete) Late Cretaceous to Recent <90 Ma → 0 Ma	Palynomorphs, root casts (rhizomorphs / rhizoliths) and burrows (*eg* termitaria), rare vertebrate remains (mammals, fish, ostrich egg shell *etc*), diatoms, freshwater stromatolites, freshwater and terrestrial shells (gastropods, bivalves), ostracods, charophytes	Fossils mainly associated with ancient pans, lakes and river systems Palaeontology poorly studied. Basal Late Cretaceous gravels and lacustrine clays probably fossiliferous (bones, teeth, petrified wood, palynomorphs?) but v. rarely exposed.

Figure 9: Thin section of a stromatolite (De Zanche and Mietto 1977).

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 may be necessary to request a Phase 2 Palaeontological Impact Assessment: Field study if the development affects fossiliferous outcrops as the palaeontological sensitivity is **HIGH**. A Phase 2 Palaeontological Mitigation is required if a fossil is unearthed during blasting or excavating.

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 **HIGH** for the Kalahari Group. 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. 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, a 30 m no-go barrier constructed and a palaeontologist should be called in to determine proper mitigation measures. 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 after blasting and excavating and keep a photopgraphic record.

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 Palaeontological Impact Assessment was provided by the Consultant. All technical information was provided by Exigo Sustainability (Pty) Ltd.
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 (fossils) and adjacent areas as well as for safety and security reasons.

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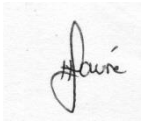
Declaration (Disclaimer) (1b)

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 Desktop Study may have missed palaeontological resources in the project area as the presence of outcrops are not known or visible due to vegetation while others may lie below the overburden of earth 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
2019/06/13

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	Concerns/threats
	1(n)ii	Concerns/threats
	1(o)	Concerns/threats
	1(p)	Concerns/threats
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)	Recommendation
	1(m)	Sampling and collecting
	1(k)	Sampling and collecting
Declaration	1(b)	Declaration
Appendix 1	1(k)	Protocol for finds
	1(m)	Protocol for finds
	1(q)	Protocol for finds

Appendix 2: Management Plan and Protocol for Chance 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. 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. 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. 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. It is recommended that the EMPr be updated to include the involvement (training/site visit) of a palaeontologist / archaeozoologist during the digging and excavation phase of the development. The ECO should familiarise him- or herself with the Ecca Group formations and its fossils. The Evolutionary Studies Institute, University of the Witwatersrand has good examples of Ecca Group 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.