

Biesjesfontein 218 Prospecting Project

Dikgatlong Local Municipality, Frances Baard District Municipality, Northern Cape Province.

Farm: Biesjesfontein 218

Fourie, H. Dr heidicindy@yahoo.com

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Palaeontological Impact Assessment: Desktop Study

Commissioned by: Exigo Sustainability (Pty) Ltd

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0007

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Ref: Pending

2019/04/30



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 suitability of the Proposed Biesjesfontein 218 Prospecting Project on the Farm Biesjesfontein in Dikgatlong Local Municipality, Frances Baard District Municipality within the Northern Cape Province.

The applicant Renaissance Resources, proposes to prospect for diamonds by drilling.

The Project includes one Alternative (Figure 1):

Alternative 1: A roughly rectangular area outlined in black northwest of the Vaal River, to the east of the R 370 Road, and to the west of the town of Delportshoop. The size of the site is approximately 15.8 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.

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);

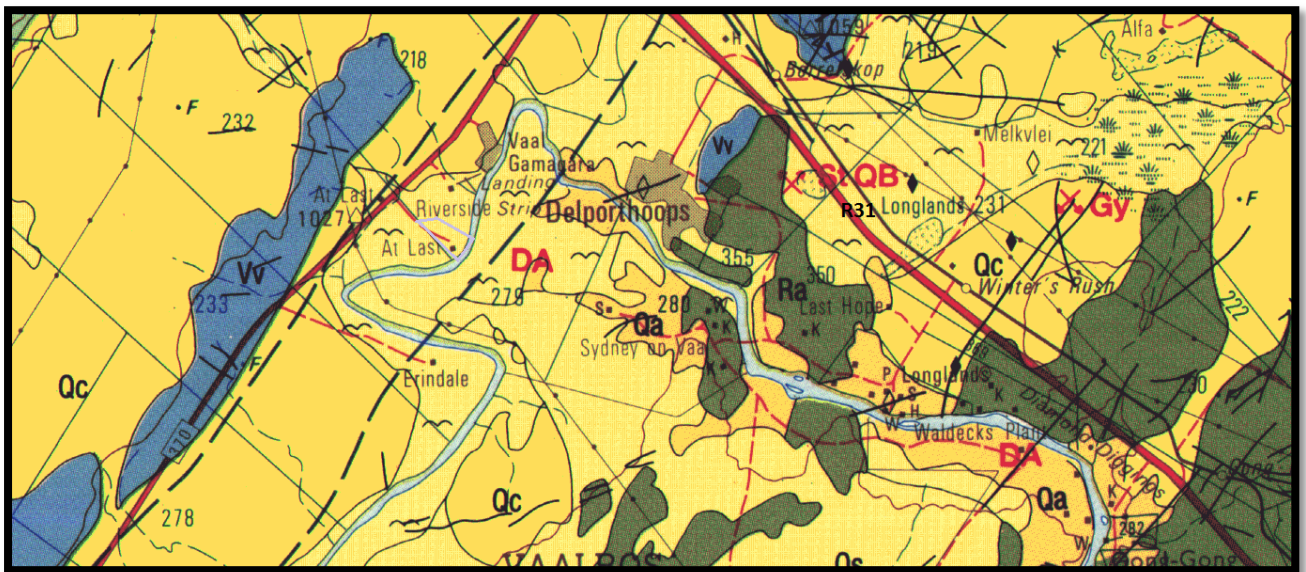
(d) the re-zoning of a site exceeding 10 000 m² in extent; (e) or any other category of development provided for in regulations by SAHRA or a PHRA authority.

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, 2824 Kimberley (Bosch and Visser 1994).

Figure 3: The geology of the development area.



Legend to map and short explanation.

- Qs – Red and grey aeolian dune sand (yellow). Quaternary.
- M – Alluvium and scree (yellow). Quaternary.
- Qc – Calcrete, calcified pandune and surface limestone (dark yellow). Quaternary.
- Jd – Dolerite (pink). Jurassic.
- Vv – Siltstone, shale, quartzite, gritstone, conglomerate (blue). Vryburg Formation, Transvaal Supergroup. Vaalian.
- Ra – Andesite, in places amygdaloidal and/or porphyritic; quartzite and conglomerate lens near bottom (green). Allanridge Formation, Platberg Group, Ventersdorp Supergroup. Radium.
- – (black) Lineament (Landsat, aeromagnetic).
- - Concealed geological boundary.
- ⊥12 – Strike and dip of bed.
- ◆ - Kimberlite pipe.
- – Proposed Prospecting (in lilac).

Summary of findings (1d): The Desktop Study was undertaken in April 2019 in autumn in warm and dry conditions and the following is reported. As this is a desktop study the season has no influence on the outcome.

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).

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

The Quaternary Formation may contain fossils. Very wide range of possible fossil remains, though these are often sparse, such as: mammalian bones and teeth, tortoise remains, ostrich eggshells, non-marine mollusc shells, ostracods, diatoms, and other micro fossil groups, trace fossils (e.g. calcretised termitaria, rhizoliths, burrows, vertebrate tracks), freshwater stromatolites, plant material such as peats, foliage, wood, pollens, within calc tufa. Stromatolite structures range from a centimetre to several tens of metres in size.

Recommendation:

The potential impact of the development on fossil heritage is **HIGH**, therefore a field survey or further mitigation or conservation measures are necessary if fossils are found (according to SAHRA protocol). A Phase 2 PIA and or mitigation are only recommended if fossils are found during construction (1d).

The development will benefit the community, industries and businesses.

The Project includes one Alternative (Figure 1):

Alternative 1: A roughly rectangular area outlined in black northwest of the Vaal River, to the east of the R 370 Road, and to the west of the town of Delportshoop. The size of the site is approximately 15.8 hectares.

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

1. Threats are earth moving equipment/machinery (for example haul trucks, front end loaders, excavators, graders, dozers) during construction, the sealing-in or destruction of the fossils by development, vehicle traffic, mining, prospecting, and human disturbance.
2. Special care must be taken during the digging, drilling, blasting and excavating of foundations, trenches, channels and footings and removal of overburden as a site visit may have missed a fossiliferous outcrop. An appropriate Protocol and Management plan is attached for the Environmental Control Officer (Appendix 2).

The recommendations are:

1. Mitigation may be needed (Appendix 2) if fossils are found.
2. No consultation with parties was necessary. The Environmental Control Officer must familiarise him- or - herself with the formation present and its fossils and obtain training pre-construction (one day).
3. The development may go ahead.
4. The EMPr already covers the conservation of heritage and palaeontological material that may be exposed during construction activities. For a chance fossil find, the protocol is to immediately cease all construction activities, construct a 30 m barrier, and contact SAHRA for further investigation. It is

recommended that the EMPr be updated to include the involvement of a palaeontologist (pre-construction training of ECO) and ECO must visit site after blasting and excavating.

Stakeholders: Developer – Renaissance Resources, P.O. Box 51288, Waterfront, Cape Town, 8002.

Environmental – Exigo Sustainability (Pty) Ltd. Postnet Suite 74, Private Bag x07, Arcadia 0007, 012 751 2160.

Landowner – N/a

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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 R326 of 7 April 2017) of the Environmental Impact Assessment Regulations (see Appendix 3). It is in compliance with The Minimum Standards for Palaeontological Components of Heritage Impact Assessment Reports, Guidelines 2012.

Outline of development

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

The applicant Renaissance Resources proposes to prospect by drilling holes in order to look for diamonds.

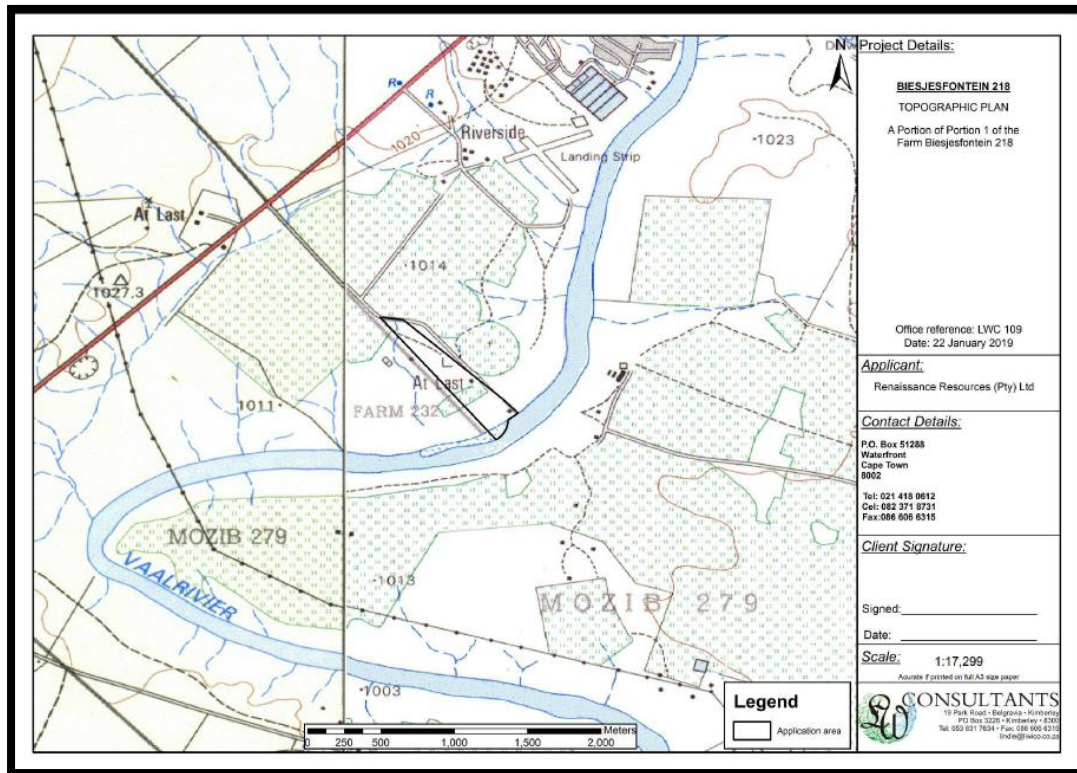
Local benefits of the proposed development include benefits to the local economy through possible job creation and local supplier procurement during the construction phase as well as during the operational phase of the development.

Related infrastructure:

1. Roads (already present),
2. Temporary buildings,

3. Security fence.

Figure 1: Topographic location (Exigo)



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Alternative 1: A roughly rectangular area outlined in black northwest of the Vaal River, to the east of the R 370 Road, and to the west of the town of Delportshoop. The size of the site is approximately 15.8 hectares.

Rezoning/ and or subdivision of land: No.

Name of developer and consultant: Renaissance Resources and Exigo Sustainability (Pty) Ltd.

Terms of reference: Dr H. Fourie is a palaeontologist commissioned to do a palaeontological impact assessment: field study to ascertain if any palaeontological sensitive material is present in the development area. This study will advise on the impact on fossil heritage mitigation or conservation necessary, if any.

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 13 years she carried out field work in the Eastern Cape, Western Cape, Northern Cape, North West, Free State, Gauteng, Limpopo and Mpumalanga 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.

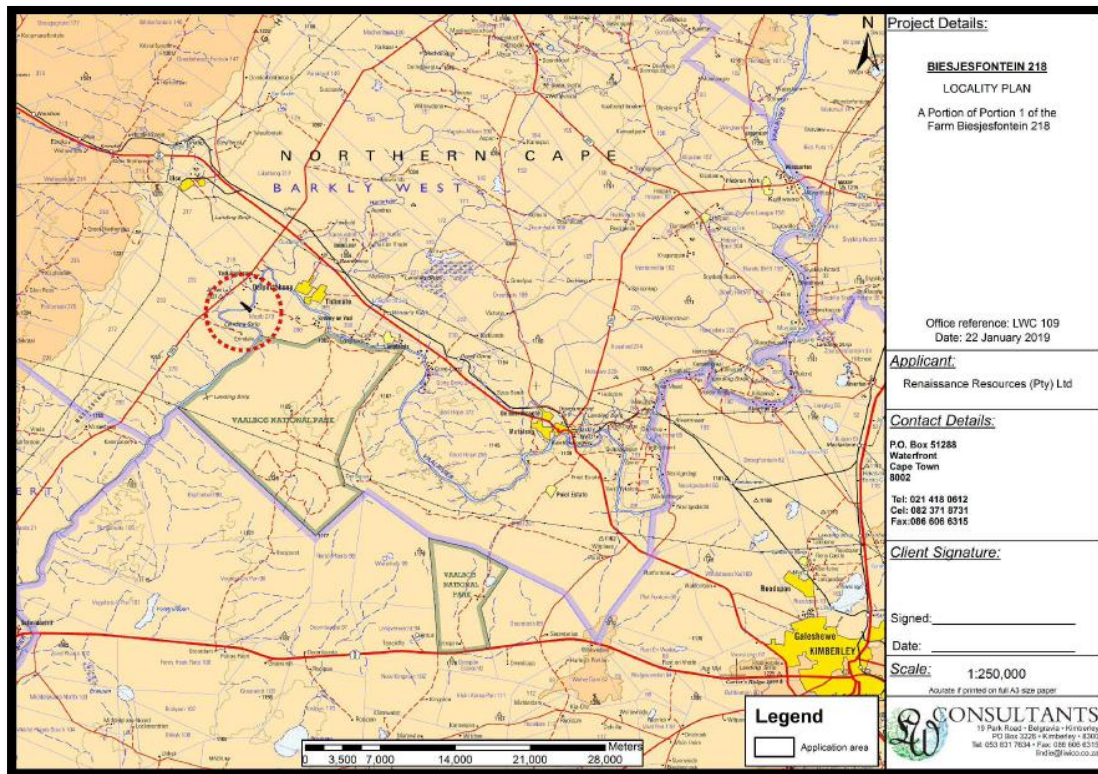
E. Description of property or affected environment

Location and depth:

The proposed Biesjesfontein 218 Prospecting Project will be situated on Biesjesfontein 218 in Dikgatlong Local Municipality, Frances Baard District Municipality within the Northern Cape Province.

Depth is determined by the infrastructure to be developed and the thickness of the formation in the development area, in this instance the boreholes.

Figure 2: Location map of proposed infrastructure (Exigo).



The Project includes one Alternative (Figure 1):

Alternative 1: A roughly rectangular area outlined in black northwest of the Vaal River, to the east of the R 370 Road, and to the west of the town of Delportshoop. The size of the site is approximately 15.8 hectares.

The site is underlain by the Quaternary Formation.

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).

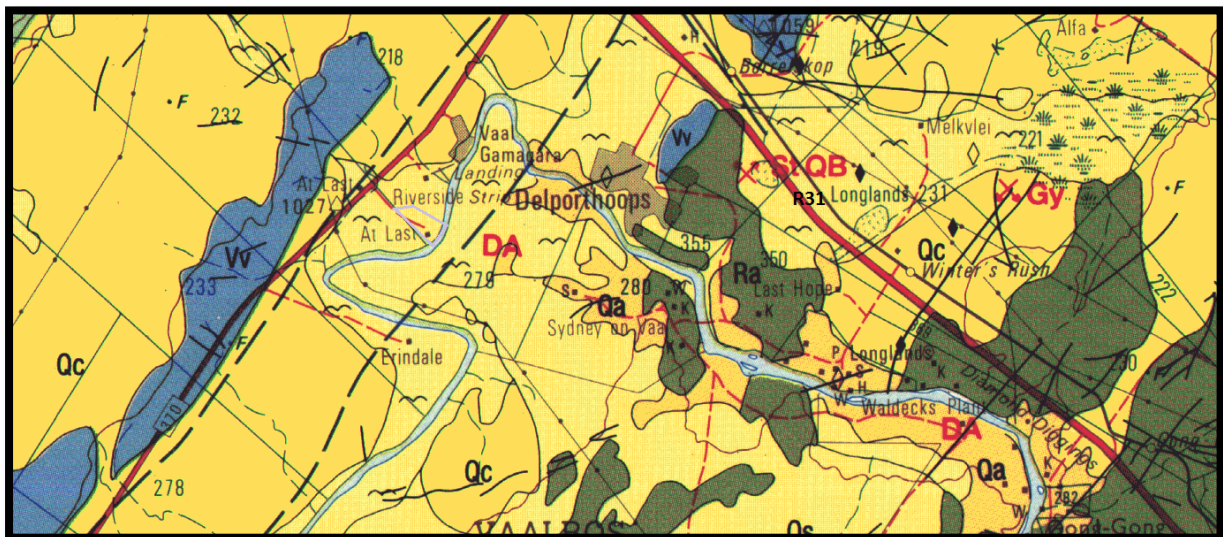
The Griqualand West Basin, Transvaal Supergroup consists mainly of sediments of chemical origin together with lavas and subordinate clastic sediments. The basal unit, the Vryburg Formation lies unconformably on the granite and rocks of the Ventersdorp Supergroup. It is followed by the Campbell Group which consists of the Schmidtsdrif Formation and the upper Ghaap Plateau Formation. There are also two formations in the Griquatown Group, namely, the Asbestos Hills and Koegas Formations. The Gamagara Formation follows and is located on the Maremane Anticline, it is overlain by the Makganyene Formation. The Cox Group consists of the

lower Ongeluk Formation and the upper Voëlwater Formation. It attains a maximum thickness of 4500 m (Kent 1980, Snyman 1996).

The Vryburg Formation constitutes the lowermost formation of the Griqualand West basin / Supergroup. It unconformably overlies pre-Griqualand West rocks, and is conformably overlain by the Schmidtsdrif Formation. An age of 2300 ± 50 Ma was obtained. It consists essentially of quartzitic sandstone, mudrock and siltstone, with andesitic/basaltic lava present in places. This formation is not thicker than 900 m and often covered with Karoo Supergroup and Kalahari Group sediments. It is correlated with the Black Reef Series in the Transvaal Supergroup (Smit, *et al.* 1991). Smit *et al.* (1991) recognised five members, the Kalkput Quartzite, Geelbeksdam, Rosendal, Waterloo and Oeola.

A volcanic event that started 2,714 million years ago is responsible for the Klipriviersberg Group of the Ventersdorp Supergroup, further eruptions of basalt and rhyolite formed the Platberg Group (McCarthy and Rubidge 2005). The Ventersdorp Supergroup consists mainly of andesitic lava, tuff and agglomerate. The Klipriviersberg Group and the Platberg Group are Randian in age, where the Rietgat Formation is Vaalian in age (Sheet information 2626 Wes Rand). The Ventersdorp Supergroup sits disconformably on the Witwatersrand Supergroup and is made up of the lower Klipriviersberg Group, the middle Platberg Group, and two formations (Bothaville and Allanridge). Together it can reach a maximum thickness of 4,260 m in some areas. The Klipriviersberg Group comprises the Edenville, Westonarea, Alberton and Orkney Formations. Several formations make up the Platberg Group, the Kameeldoorns, Makwassie, Rietgat, Bothaville and Allanridge (Kent 1980). It is described as an elliptical basin named after the town of Ventersdorp. Sediments accumulated in fault-bounded troughs or grabens and gold can be present (Norman and Whitfield 2006).

Figure 3: Excerpt of 1:250 000 Geological Map 2824 Kimberley (Bosch and Visser 1994).



Legend to map and short explanation.

Qs – Red and grey aeolian dune sand (yellow). Quaternary.

M – Alluvium and scree (yellow). Quaternary.

Qc – Calcrete, calcified pandune and surface limestone (dark yellow). Quaternary.

Jd – Dolerite (pink). Jurassic.

Vv – Siltstone, shale, quartzite, gritstone, conglomerate (blue). Vryburg Formation, Transvaal Supergroup. Vaalian.

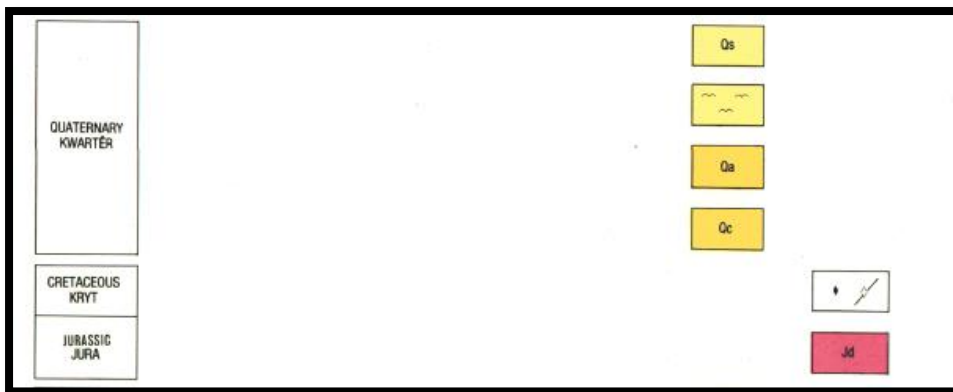
Ra – Andesite, in places amygdaloidal and/or porphyritic; quartzite and conglomerate lens near bottom (green). Allanridge Formation, Platberg Group, Ventersdorp Supergroup. Randium.

- – (black) Lineament (Landsat, aeromagnetic).
- - Concealed geological boundary.
- ⊥12 – Strike and dip of bed.
- ◆ - Kimberlite pipe.
- – Proposed Prospecting.

Mining Activities:

- DA – Diamond
- Gy - Gypsum
- QB – Building sand
- St – Stone aggregate

Figure 4: Lithostratigraphy (Bosch and Visser 1994).



The project includes one Alternative (Figure 1)

Alternative 1: A roughly rectangular area outlined in black northwest of the Vaal River, to the east of the R 370 Road, and to the west of the town of Delportshoop. The size of the site is approximately 15.8 hectares.

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).

The Cenozoic Era, in which we are presently living, is popularly known as the ‘Age of the Mammals’. These fossils are preserved on the river gravel terraces (Cornelia), cave systems (Makapan), coastal plains (Langebaanweg), and basins. The Cenozoic Era of South Africa has been subdivided into six African Land Mammal Ages, namely, Recent, Florisian, Cornelian, Makapanian, Langebaanian, and Namibian (MacRae 1999).

Significant fossil finds in the Free State are recorded from Cenozoic aged superficial deposits at specific localities such as Florisbad, Cornelia and others. The fossils recorded include bones and teeth of mammals, reptiles, fish, freshwater molluscs, petrified wood, trace fossils, rhizoliths and diatom floras (Groenewald and Groenewald 2014).

Very wide range of possible fossil remains, though these are often sparse, such as: mammalian bones and teeth, tortoise remains, ostrich eggshells, non-marine mollusc shells, ostracods, diatoms, and other micro fossil groups, trace fossils (e.g. calcretised termitaria, rhizoliths, burrows, vertebrate tracks), freshwater stromatolites, plant material such as peats, foliage, wood, pollens, within calc tufa. Stromatolite structures range from a centimetre to

several tens of metres in size. They are the result of algal growth in shallow water, indicating a very rich growth that would have caused an enrichment in the amount of oxygen in the atmosphere (Groenewald and Groenewald 2014).

| | | | |
|---|--|---|---|
| <p>19. OTHER CAENOZOIC FLUVIAL, LACUSTRINE & TERRESTRIAL DEPOSITS OF INTERIOR</p> <p>(Most too small to be indicated on 1: 250 000 geological maps)</p> <p>eg Kwaggaskop, Dasdap, Vaalputs, Arries Drift, Windsorton, Rietputs, Riverton Fms</p> | <p>Fluvial, pan, lake and terrestrial sediments, including diatomite (diatom deposits), pedocretes, spring tufa / travertine, cave deposits, peats, colluvium</p> <p>Late Cretaceous /Palaeocene to Holocene</p> | <p>Bones and teeth of wide range of mammals, including mammals (eg teeth & bones of mastodont proboscideans, rhinos, bovinds, horses, micromammals), reptiles (crocodiles, tortoises), ostrich egg shells, fish, freshwater and terrestrial molluscs (unionid bivalves, gastropods), crabs, trace fossils (eg termitaria, horizontal invertebrate burrows, stone artefacts), petrified wood, leaves, rhizoliths, diatom floras, peats and palynomorphs.</p> <p>Calcareous tufas at edge of Ghaap Escarpment might be highly fossiliferous (cf Taung in NW Province – abundant Makapanian Mammal Age vertebrate remains, including australopithecines)</p> | <p>Scattered records, many poorly studied and of uncertain age</p> <p>Reflect ancient drainage systems of subcontinental interior (eg Geelvloer – Koa River Valley system, Palaeo-Orange and Vaal systems)</p> <p>Include fossil equivalents of famous Arriesdrift Mid Miocene fauna from S. Namibia (eg at Bosluispan, Proto-Orange Terrace Gravels of lower Orange River)</p> <p>Fossils threatened by alluvial diamond mining (Vaal & Mid to Lower Orange River gravels)</p> <p>Orange River Man (100-50 Ka, <i>H. heidelbergensis</i>)</p> <p>See archaeological literature for fossil & subfossil remains from archaeological sites (eg Wonderwerk Cave nr Kuruman, Kathu Pan near Sishen)</p> |
|---|--|---|---|

Table 1: Taken from The Palaeotechnical Report (Groenewald and Groenewald 2014).
Purple – High 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 sedimentary strata the palaeontological sensitivity is generally LOW to VERY HIGH, but here locally HIGH for the Quaternary Formation.

| Rock Unit | Significance/vulnerability | Recommended Action |
|-----------|----------------------------|---|
| m | High | Desktop study and field assessment is likely |
| Qs | High | Desktop study and field assessment is likely |
| Qc | High | Desktop survey and field assessment is likely |

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

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

Impact: **HIGH** for the Quaternary Formation (m), Qc and Qs Formations. There are significant fossil resources that may be impacted by the development.

H. Description of the Methodology (1e)

The palaeontological impact assessment desktop study was undertaken in April 2019. A field assessment would include a walkthrough of the affected portion and photographs (in 20 mega pixels) taken of the site with a digital Canon camera (PowerShot SX620HS). It may be necessary to use a Global Positioning System (GPS) (Garmin eTrex 10) to record outcrops if not covered with topsoil, subsoil, overburden, and vegetation. A literature survey is included and the study relied on literature, geological maps, google.maps, and google.earth images.

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

fossil and zone will be found in any particular region. An archaeozoologist can be called upon to assess more recent quaternary and tertiary deposits.

Assumptions and Limitations (1i):-

The accuracy and reliability of the report may be limited by the following constraints:

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

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. Heritage 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.

The National Estate as: 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 used: (a) Grade 1: Heritage resources with qualities so exceptional that they are of special national significance;

(b) Grade 2: Heritage resources which, although forming part of the national estate, can be considered to have special qualities which make them significant within the context of a province or a region; and

(c) Grade 3: Other heritage resources worthy of conservation.

SAHRA is responsible for the identification and management of Grade 1 heritage resources.

Provincial Heritage Resources Authority (PHRA) identifies and manages Grade 2 heritage resources.

Local authorities identify and manage Grade 3 heritage resources.

No person may damage, deface, excavate, alter, remove from its original position, subdivide or change the planning status of a provincially protected place or object without a permit issued by a heritage resources authority or local authority responsible for the provincial protection.

Archaeology, palaeontology and meteorites: Section 35.

(2) Subject to the provisions of subsection (8) (a), all archaeological objects, palaeontological material and meteorites are the property of the State.

(3) Any person who discovers archaeological or palaeontological objects or material or a meteorite in the course of development or agricultural activity must immediately report the find to the responsible heritage resources authority, or to the nearest local authority offices or museum, which must immediately notify such heritage resources authority.

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

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

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

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

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

I. Description of significant fossil occurrences (1f)

All geological formations are ranked as LOW to VERY HIGH, and here the impact is potentially **HIGH** for the Quaternary Formations. Rocks of Permian age in South Africa are particularly rich in fossil plants (Rayner and Coventry 1985). The fossils are present in the grey shale interlayered with the coal seams. The fossils are not very rare and occur also in other parts of the Karoo stratigraphy.

Very wide range of possible fossil remains, though these are often sparse, such as: mammalian bones and teeth, tortoise remains, ostrich eggshells, non-marine mollusc shells, ostracods, diatoms, and other micro fossil groups,

trace fossils (e.g. calcretised termitaria, rhizoliths, burrows, vertebrate tracks), freshwater stromatolites, plant material such as peats, foliage, wood, pollens, within calc tufa. Stromatolite structures range from a centimetre to several tens of metres in size. They are the result of algal growth in shallow water, indicating a very rich growth that would have caused an enrichment in the amount of oxygen in the atmosphere (Groenewald and Groenewald 2014).

The threats are:- earth moving equipment/machinery (for example haul trucks, front end loaders, excavators, graders, dozers) during construction, activities, 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, but it may be necessary to request a Phase 1 Palaeontological Impact Assessment: Field study if a fossil is found as the palaeontological sensitivity is **HIGH** and at the same time A Phase 2 Palaeontological Mitigation which is generally required if the Phase 1 Palaeontological Assessment identified a fossiliferous formation or surface fossils or if fossils are found during construction. The Protocol for a Chance Find and Management Plan is attached (Appendix 2) for the ECO.
- b. This project will benefit the environment, economy, and social development of the community.
- c. Preferred choice: The impact on the palaeontological heritage is a **HIGH** sensitivity (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, a 30 m no-go barrier constructed, 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: Only if a fossil is unearthed.
- d. Permits for mitigation: **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 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, especially for 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) 1(b)

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.

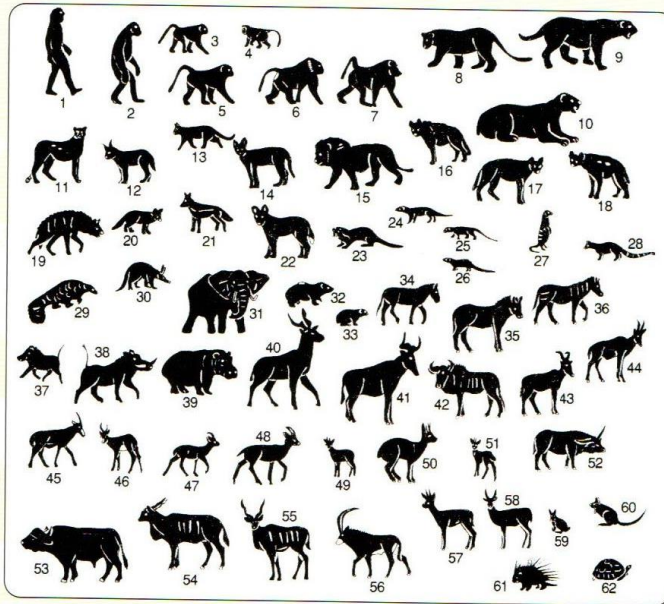
It may be possible that the Desktop Study may have missed palaeontological resources in the project area as outcrops are not always present or visible due to vegetation while others may lie below the overburden of earth and may only be present once development commences.

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

A handwritten signature in black ink, appearing to read 'Fourie', is centered within a light gray rectangular box.

Heidi Fourie
2019/04/30

Appendix 1: Examples of Quaternary Formation fossils.



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

Courtesy of Dr C.K. Brain.
Museum of Natural History, Pretoria

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

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



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

Appendix 2 (1k,1m,1q): Protocol for Chance 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 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 material that may be exposed during construction/development activities. The protocol is to immediately cease all 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. The ECO should familiarise him- or herself with the fossiliferous formations and its fossils. A weekly site visit is recommended and the keeping of a photographic record when feasible. 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.

Appendix 3: Table of Appendix 6 requirements.

| 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(k) | Protocol for finds |
| | 1(m) | “ |
| | 1(q) | “ |