Final Rehabilitation and Closure of the Inactive Hoornbosch Prospect Shaft

Lephalale Local Municipality, Waterberg District Municipality, Limpopo Province

Farm: Hoornbosch 439-LQ

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Palaeontological Impact Assessment: Phase 1 Field Study

Commissioned by: Golder Associates

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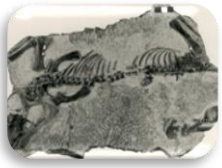
Ref: Pending

2019/01/14



B. Executive summary

Outline of the development project: Golder Associates has facilitated the appointment of Dr H. Fourie, a palaeontologist, to undertake a Paleontological Impact Assessment (PIA), Phase 1 Field Study of the Proposed Final Rehabilitation and Closure of the Inactive Hoornbosch Prospect Shaft. The site is located on the Farm Hoornbosch 439-LQ approximately 10 km north of Lephalale in the Waterberg District Municipality, Lephalale Local Municipality within the Limpopo Province.

The Mokolo River is situated approximately 2 km east of the site and Sandloop River approximately 500 m to the south. The site is to be decommissioned and rehabilitated.

The Project includes one Alternative (Figure 1):
None as the site is in existence. It is a roughly rectangular area located north of Lephalale on the western side of the R510 Road. The approximate size is 32.5 ha.

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.

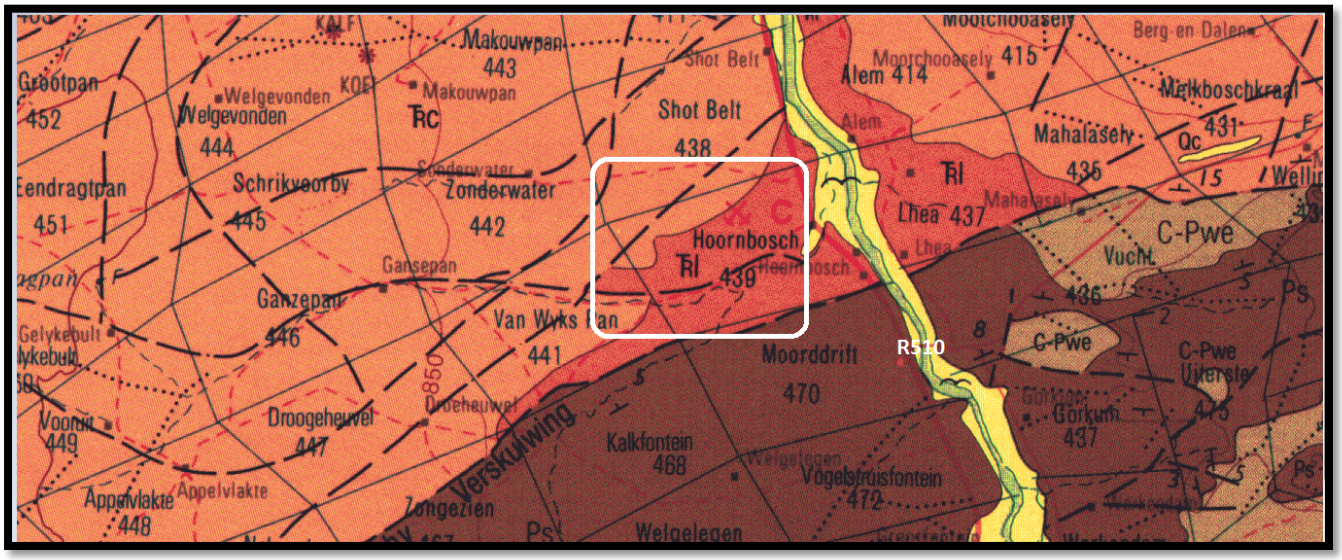
Types and ranges of heritage resources as outlined in Section 3 of the National Heritage Resources Act (Act No.25 of 1999):
(i) (i) objects recovered from the soil or waters of South Africa, including archaeological and palaeontological objects and material, meteorites and rare geological specimens.
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 rehabilitation project 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, South Africa and Geological Map of Ellisras 2326, 1:250 000 (Brandl 1993).

Figure 3: The geology of the development area.



Legend to map and short explanation.
M – (yellow) Alluvium. Quaternary.
TRc – (light orange) Fine-grained cream-coloured sandstone. Clarens Formation, Stormberg Group, Karoo Supergroup. Triassic.
PTl – (orange) Red mudstone and siltstone. Lisbon Formation, Ecca Group, Karoo Supergroup.
Ps – (brown) Sandstone, gritstone, mudstone, coal. Swartrant Formation, Ecca Group, Karoo Supergroup. Permian.
--f-- - Daarby Fault.
…… – (black) Lineament (Landsat, aeromagnetic).
------ - Concealed geological boundary.
□ – Outlining farm where mine rehabilitation will take place.

Mining Activities:
C – Coal. Presently has no influence on the project.

Summary of findings (1d): The Phase 1 PIA Field Study was undertaken towards the end of September 2018 in the summer in very hot and dry conditions and the following is reported:

The development will be situated on the Lisbon Formation close to Lephalale.

The Karoo Supergroup is renowned for its fossil wealth. It is marked as Undifferentiated strata of the Karoo Supergroup, but correlates with the Vryheid Formation (Pe,Pv), Ecca Group and the Grootgeluk Formation which is rich in plant fossils such as the *Glossopteris* flora represented by stumps, leaves, pollen and fructifications (Appendix 1). This formation is early to mid-Permian (Palaeozoic) in age and consists of sandstone, shaly sandstone, grit, conglomerate, coal and shale. Coal seams are present in the Grootegeluk Formation within the sandstone and shale layers of the horsts and grabens. Fossils are mainly present in the grey shale which is interlayered between the coal seams (Kent 1980, Visser 1989). Borehole logs in the coalfields show the following layers; soil, shale and sandstone, shale and sandstone interbedded, sandstone, coal, conglomerate reworked diamictite, Dwyka Tillite, and the Pre-Karoo Basement.

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 Lisbon Formation (SG 2.2 SAHRA APMHOB, 2012).

Recommendation:
The potential impact of the rehabilitation project on fossil heritage is **VERY HIGH** and therefore a field survey or further mitigation or conservation measures were necessary for this development (according to SAHRA protocol). A Phase 2 PIA and or mitigation are recommended as the Phase 1: Field study found fossils (plant remains).

- During the survey, it was found that the site is directly underlain by shale and sandstone of the Lisbon Formation and that coal is present.
- The project site is largely disturbed due to remnant mining infrastructure and demolition waste, as well as remnant mine waste, including discard dumps, slimes paddocks, and large areas of coal veneer.
- The survey was done in summer towards the end of September 2018, conditions were very hot and dry and presently the area is covered by vegetation, natural grassland and other land uses include a road.
- The development will take place on the Lisbon Formation known for its plant fossils. Fossil plants were found on the discard dumps. The development will benefit the farmer.

The Project includes one Alternative (Figure 1):
None as the site is in existence. It is a roughly rectangular area located north of Lephalale on the western side of the R510 Road. The approximate size is 32 ha.

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 activities, 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 is needed (Appendix 2) as fossils were found. It is only the discard dumps that yielded fossils and that needs to be collected from the surface and a little below.

2. No consultation with parties was necessary. The Environmental Control Officer must familiarise him- or herself with the Lisbon Formation and its fossils and obtain training.
3. **The rehabilitation may go ahead, but the ECO must survey for fossils during rehabilitation in line with the legally binding Environmental Management Programme (EMPr) this must be updated to include the involvement of a palaeontologist 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 rehabilitation activities if a fossil is unearthed, 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 as necessary and to provide ECO training before project commencement and that this report to be issued to the ECO whom must monitor the rehabilitation of the discard heaps.

Stakeholders: Developer – Exxaro Resource Limited, Grootegeluk Coal Mine, P.O. Box 178, 0555.
Environmental – Golder Associates, P.O. Box 6001, Halfway House, 1685, Tel. 011 254 4970.
Landowner – Not known.

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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 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.

It is understood that mining/prospecting at Hoornbosch was undertaken by Iscor in the late 1970's / early 1980's. The site needs rehabilitation and closure to ensure a safe, stable and non-contaminating state.

The site has several abandoned structures such as:

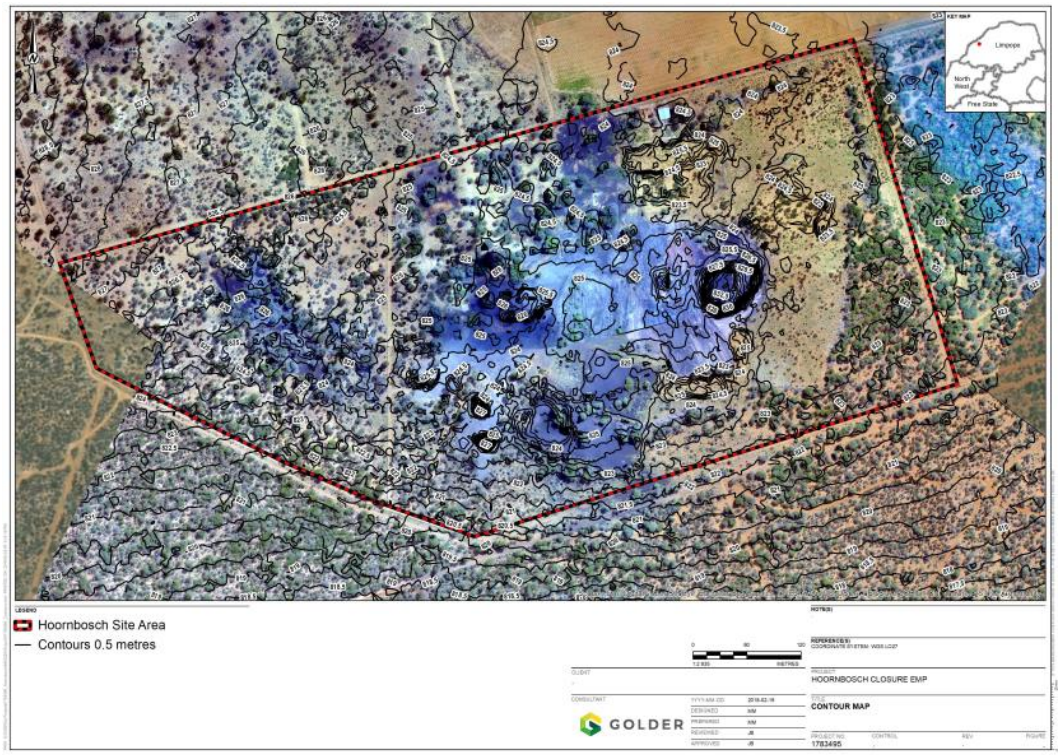
1. Vertical shaft (about 8 m in diameter) with associated headgear,
2. Remnants of the winding equipment associated with the above headgear,
3. Numerous remnant concrete floors, slabs, bases and footings,
4. Brick structures,
5. Remnant equipment, pipes, cabling, steel plates, etc.
6. Building rubble, tyres, etc.,
7. Boreholes.

Remnant mining residue includes:

8. Discard dump,
9. Three fines paddocks,
10. Extensive areas of coal veneers.

This report will concentrate on the latter.

Figure 1: Topographic map to show location (Golder).



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None as the site is in existence. It is a roughly rectangular area located north of Lephalale on the western side of the R510 Road. The approximate size is 32 ha.

Rezoning/ and or subdivision of land: No will remain Agriculture.
Name of developer and consultant: Exxaro Resource Limited, Grootegeluk Coal Mine and Golder Associates.

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 23 years.
Legislative requirements: South African Heritage Resources Agency (SAHRA) for issue of permits if necessary. National Heritage Resources Act (Act No. 25 of 1999). An electronic copy of this report must be supplied to SAHRA.

E. Description of property or affected environment
Location and depth:
The Proposed Final Rehabilitation and Closure of the Inactive Hoornbosch Prospect Shaft is situated on the Farm Hoornbosch 439-LQ near Lephalale in the Waterberg District Municipality, Lephalale Local Municipality within the Limpopo Province.

The depth is determined by the rehabilitation processes.

A typical profile includes soil and clay, sandstone and siltstone, shale, coal upper seam, coal seam, sandstone, no 1 seam, shale and dolomite at the bottom. Here in Lephalale, the entire coal sequence attains a thickness of up to 70 m.

Figure 2: Google.earth image to show proposed infrastructure (Golder).

The site is underlain by the Lisbon Formation, Karoo Supergroup.

F. Description of the Geological Setting

Description of the rock units:

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

The southern part of the Karoo basin is 3000 m thick, but the northern part of the basin is much thinner. The animals present during Beaufort times flourished on the floodplanes, lakes and marshes. Sandstone is deposited in times of flooding in the river channels and the mudstones were deposited on the floodplains in the shallow lakes (Snyman 1996).

The Ecca Group is early to mid-Permian (545-250 Ma) in age. Sediments of the Ecca group are lacustrine and marine to fluvio-deltaic (Snyman 1996). The Ecca group is known for its coal (mainly the Vryheid Formation) (five coal seams) and uranium. Coalfields formed due to the accumulation of plant material in shallow and large swampy deltas (see Appendix 1). The Ecca Group conformably overlies the Dwyka Group and is conformably overlain by the Beaufort Group, Karoo Supergroup. 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 seams also being present in the north-east (Kent 1980, Johnson 2009).

Map 1: Geology of the Karoo Supergroup (Faure *et al.*1996).

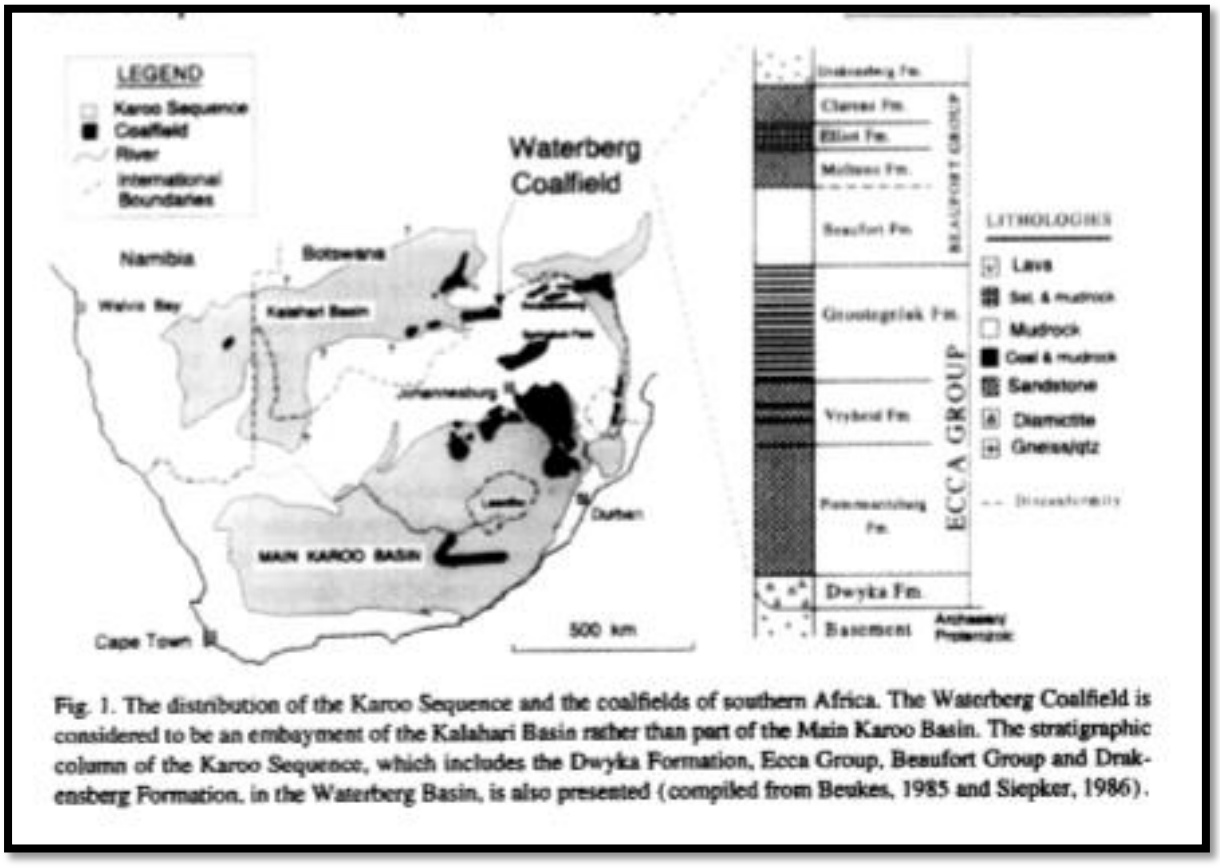
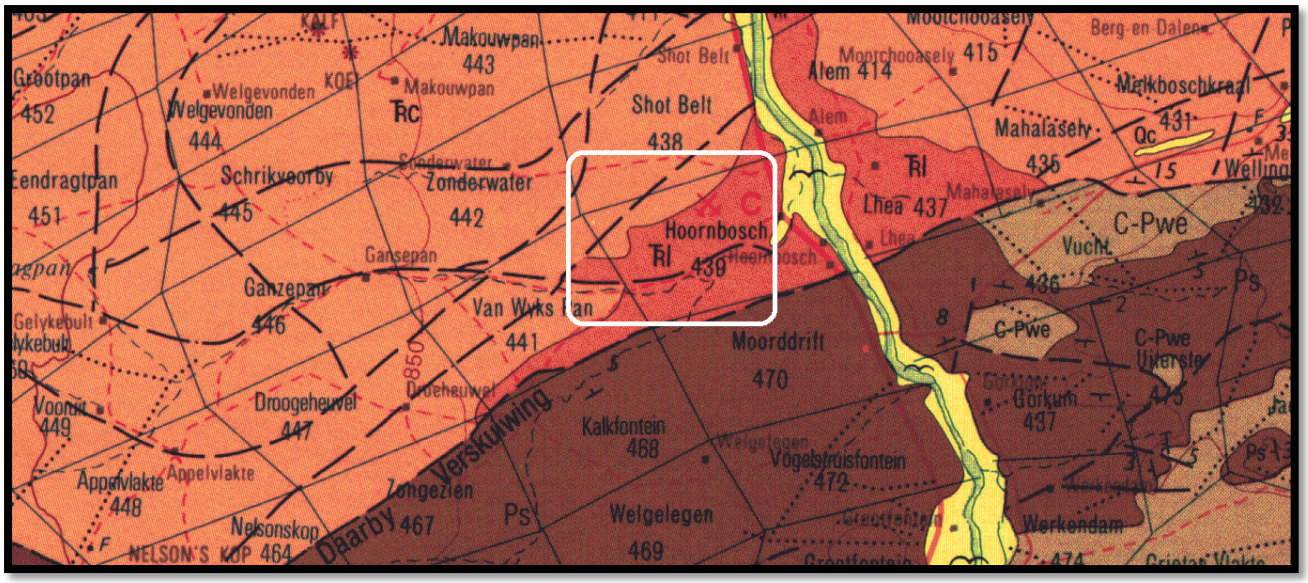


Fig. 1. The distribution of the Karoo Sequence and the coalfields of southern Africa. The Waterberg Coalfield is considered to be an embayment of the Kalahari Basin rather than part of the Main Karoo Basin. The stratigraphic column of the Karoo Sequence, which includes the Dwyka Formation, Ecca Group, Beaufort Group and Drakensberg Formation, in the Waterberg Basin, is also presented (compiled from Beukes, 1985 and Siepker, 1986).

Figure 3: Excerpt of 1:250 000 Geological Map 2326 Ellisras (Brandl 1993).



Legend to map and short explanation.

M – (yellow) Alluvium

TRc – (light orange) Fine-grained cream-coloured sandstone. Clarens Formation, Stormberg Group, Karoo Supergroup. Triassic.

PTl – (orange) Red mudstone and siltstone. Lisbon Formation, Ecca Group, Karoo Supergroup.

Ps – (brown) Sandstone, gritstone, mudstone, coal. Swartrant Formation, Ecca Group, Karoo Supergroup. Permian.

--f-- - Daarby Fault.

…… – (black) Lineament (Landsat, aeromagnetic).

------ - Concealed geological boundary.

□ – outlining farm where mine rehabilitation will take place.

Coal has always been the main energy source in industrial South Africa. It is in Mpumalanga, south of the N4, that most of the coal-fired power stations are found. Eskom is by far the biggest electricity generator in Africa. Thick layers of coal just below the surface are suited to open-cast mining and where the overlying sediments are too thick, shallow underground mining. In 2003, coal was South Africa's third most valuable mineral commodity and is also used by Sasol for fuel- and chemicals-from-coal (Norman and Whitfield 2006). Grodner and Cairncross (2003) proposed a 3-D model of the Witbank Coalfield to allow easy evaluation of the sedimentary rocks, both through space and time. Through this, one can interpret the environmental conditions present at the time of deposition of the sediments. This can improve mine planning and mining techniques. The Vryheid Formation is underlain by the Dwyka Group and is gradually overlain by mudstones (and shale) and sandstones of the Volksrust Formation. The typical colours for the Vryheid Formation are grey and yellow for the sediments and black for the coal seam. The thickness of the grey shale can vary and this is interlayered with the also variable yellow sandstone and coal seams.

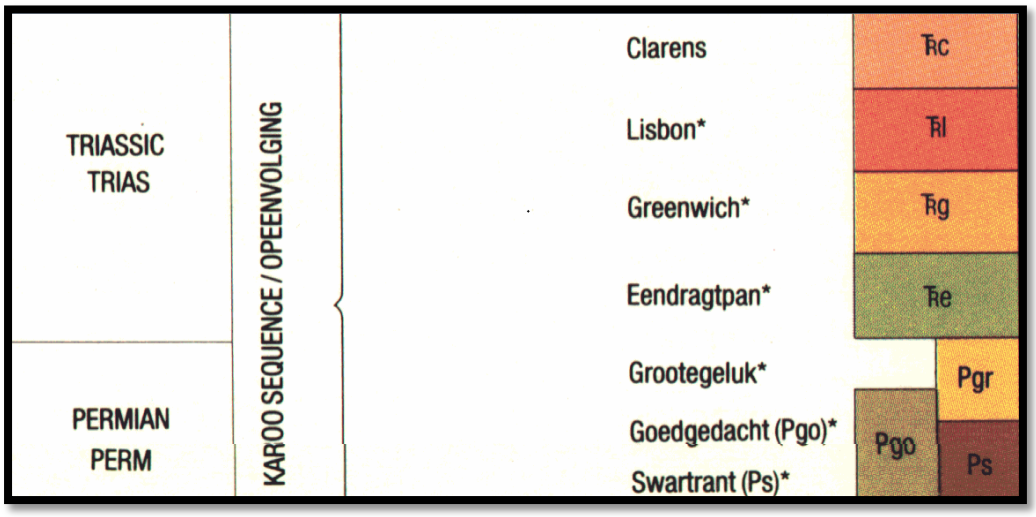
The Waterberg (Ellisras) coalfield is situated north-west of the Karoo basin. A series of horsts and grabens allow shallow coal to be mined. In this area, the Vryheid Formation together with the Volksrust Formation is named the Grootegeluk Formation (Cairncross 2001). Yellow and red shale with brown mudstone, white grit, conglomerate, coal rich shale, 4 coal seams, and dark grey to black shale are present. *Glossopteris* is abundant as for the Vryheid Formation (Visser 1989). The Grootegeluk Formation in the Waterberg Coalfield is about 70 m thick and consists of relatively thin coal beds interbedded with numerous mudstone and carbonaceous mudstone layers. It

is considered to be an embayment of the much larger Kalahari Basin with the coal layers numbered 5-11. Palynological evidence is present in the form of spores from mosses, ferns, alae and fungi (Faure *et al.*1996).

Ecca rocks are stable and lend themselves well to developments. It is only unstable in or directly above mining activities (Snyman 1996). Dolerite dykes do 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.

The entire coal sequence attains thicknesses of up to 115 m. (Cairncross 2001). A typical profile includes soil and clay, sandstone and siltstone, shale, 2 upper seam, shale, 2 seam, sandstone, no 1 seam, shale and dolomite at the bottom. Diabase or dolerite dykes are also present in the area. The thickness of the grey shale can vary and this is interlayered with the also variable yellow sandstone and coal seams.

Figure 4: Lithostratigraphy of study area (Brandl 1993).



Field Observations

The walk through was done towards the end of September 2018, conditions were very hot and dry. Photographs below show the remnants of historic mining activities and a flat topography. A variety of soil types (overburden and topsoil) were present. During the walk-through fossil plants were discovered on the discard dump / heaps.

Figure 5: View of the area to the southeast.

Figure 6: View to the southern fence.

Figure 7: View to the fence on the western boundary of the property.

Figure 8: Typical discard dump, there are 9 on the property, all yielding fossils. The waypoint is 23˚ 34' 40.49" S, 27˚ 42' 26.93 E.

Figure 9: Another discard dump.

There is some concern with the proposed rehabilitation project due to the presence of plant fossils. All the Alternatives will be situated on the Lisbon Formation. The depth of the Formation can be verified with geological cores. The topsoil, subsoil and overburden must be surveyed for fossils with mitigation where fossils are present.

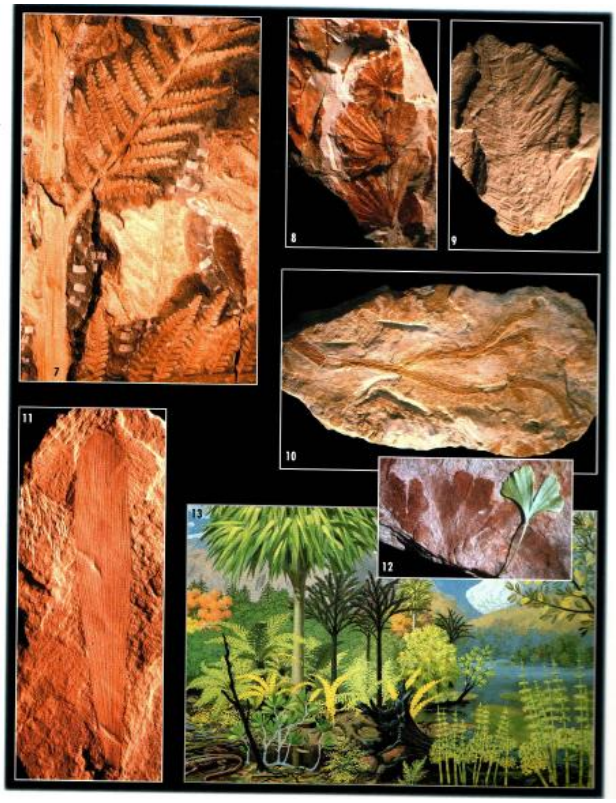
The project includes one Alternative (Figure 1)
None as the site is in existence. It is a roughly rectangular area located north of Lephalale on the western side of the R510 Road. The approximate size is 32 ha.

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 Ecca Group may contain fossils of diverse non-marine trace, *Glossopteris* flora, mesosaurid reptiles, palaeoniscid fish, marine invertebrates, insects, and crustaceans (Johnson 2009). *Glossopteris* trees rapidly colonised the large deltas along the northern margin of the Karoo Sea. Dead vegetation accumulated faster than it could decay, and thick accumulations of peat formed, which were ultimately converted to coal. It is only in the northern part of the Karoo Basin that the glossopterids and cordaitales, ferns, clubmosses and horsetails thrived (McCarthy and Rubidge 2005). Palynological evidence is present in the form of spores from mosses, ferns, alae and fungi in the Grootegeluk Formation (Faure *et al.*1996).

Figure 10: Examples of fossil flora (MacRae 1999).



The *Glossopteris* flora is thought to have been the major contributor to the coal beds of the Ecca. These are found in Karoo-age rocks across Africa, South America, Antarctica, Australia and India. This was one of the early clues to the theory of a former unified Gondwana landmass (Norman and Whitfield 2006).

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

SPRINGBOKFLATS ELLISRAS	Clarens (TR; TRc; Jc)		Aeolian sandstones, minor ephermeral stream deposits	Dinosaur remains and trackways can be expected	Very poor levels of surface exposure (most data obtained from borehole cores)
TULI TSHIPISE	Clarens (TR; TRc; Jc) (Probably Upper Elliot and Clarens)	Tshipise (Jt)	Cream-coloured aeolian sandstone, playa lake deposits ("Cave Sandstone") Clarens Formation of Main Karoo Basin	Aeolianites contain petrified logs, trace fossils of insects (including controversial fossil termitaria), dinosaur trackways (possibly *Massospondylus, Syntarsus / Coelophysis*).	Fault-bound basins within Limpopo Belt. Stratigraphic context of dinosaur fossils often unclear in the literature. Note revised stratigraphy and correlations with Main Karoo Basin proposed in recent papers on Tuli Basin by E. Bordy (UCT): Upper Unit P-Trkb in part Red Rocks Member (Elliot Fm)
		Red Rocks (Jr)	Pale red argillaceous sandstone with calcareous concretions (fluvial / sabkha setting). White silcrete at top of succession, beneath Tshipise Member Probably Upper Elliot of Main Karoo Basin	Skeletal remains of dinosaurs (*Massospondylus*), possible dinosaur eggshells, dinosaur and other tracks, trace fossils of insects and root casts	
ELLISRAS	Lisbon (TRl; l)		Red mudrocks with calcareous concretions, minor sandstones	Trace fossils (*"Cruziana"*, *"Skolithos"*, extensive bioturbation, possible fossil termitaria, rhizoliths) Large sauropodomorph dinosaurs (possibly *"Euskelesaurus"* and / or *Massospondylus*)	Early records of dinosaur remains from 1920s

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 Lisbon Formation.

Table 2: Taken from The Palaeotechnical Report (Groenewald and Groenewald 2014).

ELLISRAS	Grootegeluk (Pg; Pgr)		Cycles of thick coals, carbonaceous mudrocks	Glossopterid coal flora abundant associated with thick coal seams	Also known as Waterberg Coalfield Important coal reserves for future mining – high impacts may be anticipated. Pg Ecca Group
	Goedgedacht (Pg; Pgo)		Mudstones, sandstones, coals of proglacial alluvial fans, braided streams	Glossopterid coal flora	
	Swartrant (Pg; Psw)		Deltaic sandstones, mudrocks, with coals, glacio-lacustrine, fluvial and swamp sediments	Glossopterid coal flora	

Databases and collections: Ditsong: National Museum of Natural History. Evolutionary Studies Institute, University of the Witwatersrand (ESI).
Impact: **VERY HIGH** for the Lisbon Formation. There are significant fossil resources that may be impacted by the development (shale).

H. Description of the Methodology (1e)

The palaeontological impact assessment field study was undertaken towards the end of September 2018 (27/09/2018). The walk through of the affected portion was done and photographs (in 20 mega pixels) were taken of the site with a digital Canon camera (PowerShot SX620HS). A Global Positioning System (GPS) can be used (Garmin eTrex 10) to record outcrops if not covered with topsoil, subsoil, overburden, and vegetation. The walk through did identify the Lisbon Formation. A literature survey is included.

There are several discard dumps present on the property, these are fossiliferous. Document SAHRA 7/6/9/2/1 only requires track records/logs from archaeologists not palaeontologists as palaeontologists concentrate and survey the area for outcrops which may be recorded on a GPS. Isolated occurrences of rocks usually do not constitute an outcrop. Fossils will mostly 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 present in any particular region. Archaeozoologists concentrate and identify more recent fossil finds and must be consulted for any Plio-Pleistocene finds.

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. 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 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)

All Karoo Supergroup geological formations are ranked as LOW to VERY HIGH, and here the impact is potentially **VERY HIGH** for the Lisbon Formation, Ecca Group. 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. The pollen of the Greenside Colliery also on the Vryheid formation was the focus of a Ph.D study. It is often difficult to spot the greyish fossils as they are the same colour as the grey shale in which they are present as these coalified compressions have been weathered to leave surface replicas on the enclosing shale matrix. A locality close to

Ermelo, also Vryheid Formation, has yielded *Scutum, Glossopteris* leaves, *Neoggerathiopsis* leaves, the lycopod *Cyclodendron leslii,* and various seeds and scale leaves (Prevec 2011).

Fossils likely to be found are mostly plants (Appendix 1) such as '*Glossopteris* flora' of the Vryheid Formation. The aquatic reptile *Mesosaurus* and fossil fish may also occur with marine invertebrates, arthropods and insects. Trace fossils can also be present. The marine bivalve *Megadesmus* is found in the upper part of the Volksrust Formation near Newcastle (Johnson 2009).

During storms a great variety of leaves, fructifications and twigs accumulated and because they were sandwiched between thin films of mud, they were preserved to bear record of the wealth and the density of the vegetation around the pools. They make it possible to reconstruct the plant life in these areas and wherever they are found, they constitute most valuable palaeobotanical records (Plumstead 1963) and can be used in palaeoenvironmental reconstructions.

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 vast coal mining industry (Vryheid Formation) provides palaeontologists with fantastic access to coal-associated plant fossils, while simultaneously resulting in the destruction of important National Palaeontological Heritage.

The threats are:- earth moving equipment/machinery (for example haul trucks, front end loaders, excavators, graders, dozers) during the proposed rehabilitation project, the sealing-in or destruction of fossils by development, vehicle traffic, mining activities, 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 rehabilitation, but it was necessary to request a Phase 1 Palaeontological Impact Assessment: Field study to determine whether the proposed rehabilitation project will affect fossiliferous outcrops as the palaeontological sensitivity is **VERY HIGH**. A Phase 2 Palaeontological Mitigation is now required as the Phase 1 Palaeontological Assessment identified a fossiliferous formation or surface fossils or if fossils are found during construction or mining. The Protocol for Finds and Management Plan is attached (Appendix 2) for the ECO, the development may go ahead after the Phase 2: Mitigation.
b. This project will benefit the environment, economy, and social development of the community.
c. Preferred choice: Any Alternatives will have the same impact. The impact on the palaeontological heritage is **VERY HIGH.** Care must be taken during 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.

<u>Sampling and collecting (1m,1k)</u>:
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,** for the shale layer as fossils were found.
d. Permits for mitigation: **Needed from SAHRA/PHRA**.

K. Conclusions

a. All the land involved in the development was assessed and none of the property is unsuitable for the proposed rehabilitation project (see Recommendation B).
b. All information needed for the Phase 1 Palaeontological Impact Assessment and Field scope was provided by the Consultant. All technical information was provided by Golder Associates.
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.
e. Condition in which development may proceed: It is further suggested that a Section 37(2) agreement of the Occupational, Health and Safety Act 85 of 1993 is signed with the relevant contractors to protect the environment and adjacent areas as well as for safety and security reasons.

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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 Phase 1 PIA 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.

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Heidi Fourie
2019/01/14

Appendix 1: **Figure 11:** Example of a plant fossil found on site. *Glossopteris* leaves.

Appendix 2: **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. When a fossil is found, the area must be fenced-off and the construction workers must be informed that this is a no-go area. Therefore, the EMPr must be updated to include the involvement of a palaeontologist during the digging and excavation (ground breaking) phase of the development.

The EMPr already covers the conservation of heritage and palaeontological artefacts that may be exposed during construction activities. It is recommended that the EMPr be updated to include the involvement (training) 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 Grootte Geluk Formation, these are present in the grey shale (or any other fossiliferous layer ranked as VERY HIGH or HIGH) or invertebrates from e.g 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 and construct a 30 m barrier.
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 2	1(k)	Protocol for finds
	1(m)	"
	1(q)	"

Table 4: Listing points in Appendix 6 of the Act and position in Report.