Grootpan and Kromklip 88kV

Van Dyks Drift, Steve Tshwete Local Municipality, Mpumalanga Province

Goedehoop 46 IS portion 3 (remaining extent) and portion 6; Geluk 26 IS portion 7; Koornfontein 27 IS portion 3; Komati Power Station 56 IS Remainder in the Steve Tshwete Local Municipality in the Mpumalanga Province.

Kromfontein 30 IS; Steenkoolspruit 18 IS; Van Dyksdrift 19 IS in the eMahlahleni Local Municipality in the Mpumalanga Province

Fourie, H. Dr heidicindy@yahoo.com

012 0000040/012 993 3110

Palaeontological Impact Assessment: Phase 1 Field study

Commissioned by: Texture Environmental Consultants

P.O. Box 36593, Menlo Park, Pretoria, 0102

082 568 6344

2015/02/01

B. Executive summary

Outline of the development project: Texture Environmental Consultants has appointed Dr H. Fourie, a palaeontologist, to undertake a Paleontological Impact Assessment, Phase 1 Field study of the suitability of the proposed new construction of Grootpan and Kromklip 88kV Project on the farms Goedehoop 46 IS portion 3 (remaining extent) and portion 6; Geluk 26 IS portion 7; Koornfontein 27 IS portion 3; Komati Power Station 56 IS Remainder in the Steve Tshwete Local Municipality in the Mpumalanga Province and on Kromfontein 30 IS; Steenkoolspruit 18 IS; Van Dyksdrift 19 IS in the eMahlahleni Local Municipality in the Mpumalanga Province.

Xtrata plans to do open cast mining where the 2x88kV Kromklip Tee-Van Dyks Coll Tee Mink lines are located, as a result the mine requested Eskom to remove these lines. The 2x88kV Kromklip Tee-Van Dyks Coll Tee Mink lines supply the 88kV substations, traction stations and switching stations below. With the removal of the Kromklip Tee-Van Dyks Coll Tee Mink lines an alternative source of supply is needed for the 88kV network. The proposed scope of work to build the Haasfontein 88kV switching station will provide an alternative source for the 88kV network:

- Van Dyks Coll Tee switching station
- Van Dyks Coll substation
- Bezuidenhoutsrus Traction station
- Van Dyks Drift Traction Tee switching station
- Van Dyks Drift Traction station

The Project includes several Section and Options (see map):
1: Construct the Haasfontein 88kV switching station with 3x88kV feeder bays
2: On the existing Kudu-Halfgewonnen South 88kV Mink line, create a LILO configuration.
3: Build an 88kV line from the LILO configuration on the Kudu-Halfgewonnen South to the Haasfontein 88kV switching station.
4: Build a second 88kV chickadee line from the LILO configuration to the Haasfontein 88kV switching station.
5: Build an 88kV chickadee line from the Komati MTS 88kV feeder bay to the Kudu-Halfgewonnen South 88kV line (bypass Kudu 132/88kV TRF).
6: Dismantle the 9.5km 2x88kV lines from Kromklip Tee to Van Dyks Coll Tee station.
7: Build an 88kV line from the Haasfontein 88kV switching station to the Geluk-Van Dyks Drift Traction Tee line.
8: Build an 88kV double-circuit line to reconnect a section of the dismantled 2x 88kV Kromklip Tee to Van Dyks Coll Tee lines.

The **National Heritage Resources Act 25 of 1999** 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.

This report prescribes to the Heritage Impact Assessment of Section 38 of the National Heritage Resources Act 25 of 1999.

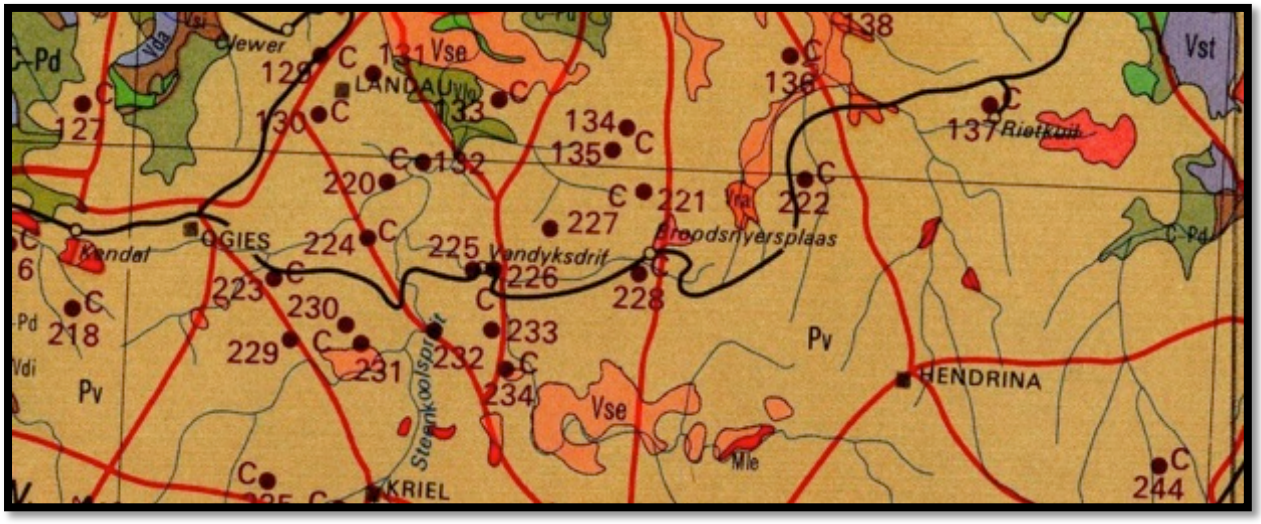
For this study, resources such as geological maps, scientific literature, institutional fossil collections, satellite images, aerial maps and topographical maps were used. It provides an assessment of the observed or inferred palaeontological heritage within the study area, with recommendations (if any) 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, 1999 (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.
Section 38, 1(b) requires the details of the construction of a bridge or similar structure exceeding 50m in length.

It is proposed to comment and recommend on the impact of the development on fossil heritage, and if mitigation or conservation is 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 2628 East Rand (Keyser *et al.* 1986).



Legend to Map and short explanation.
Pv – (brown) Sandstone, shaly sandstone, grit, shale, conglomerate and coal. Vryheid Formation, Ecca Group, Karoo Supergroup. Permian.

Summary of findings: The Phase 1 Palaeontological Impact Assessment Field study was undertaken during January 2015 and the following is reported:

Formations present are part of the Karoo Supergroup. The Karoo Supergroup is renowned for its fossil wealth. The Vryheid Formation (Pe,Pv), Ecca Group is rich in plant fossils such as the *Glossopteris* flora represented by stumps, leaves, pollen and fructifications. 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 Vryheid Formation within the sandstone and shale layers. Fossils are mainly present in the grey shale which is interlayered between the coal seams. 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 Vryheid Formation (SG 2.2 SAHRA APMHOB 2012).

Recommendation:
The Project includes several Section and Options (see map):
Section 1: Construct the Haasfontein 88kV switching station with 3x88kV feeder bays
Section 2: On the existing Kudu-Halfgewonnen South 88kV Mink line, create a LILO configuration.
Section 3: Build an 88kV line from the LILO configuration on the Kudu-Halfgewonnen South to the Haasfontein 88kV switching station.
Section 3: Build a second 88kV chickadee line from the LILO configuration to the Haasfontein 88kV switching station.
Section 4: Build an 88kV chickadee line from the Komati MTS 88kV feeder bay to the Kudu-Halfgewonnen South 88kV line (bypass Kudu 132/88kV TRF).
Section 5: Dismantle the 9.5km 2x88kV lines from Kromklip Tee to Van Dyks Coll Tee station.
Section 6: Build an 88kV line from the Haasfontein 88kV switching station to the Geluk-Van Dyks Drift Traction Tee line.

During the survey it was found that the farms are directly underlain by dolerite, the shale, shaly sandstone, grit, conglomerate and sandstone of the Vryheid Formation and is presently used for agriculture. Recent structures are mostly absent. It is located on a gentle facing slope. The development of the 88kV lines includes several projects that will need foundations, footings, channels and trenches to be dug. Infrastructure include - access road.

The impact of the development on fossil heritage is VERY HIGH and therefore a field survey or further mitigation or conservation measures may be necessary for this development (according to SAHRA protocol). A Phase 2 Palaeontological Impact Assessment and or mitigation may be recommended. The overburden and inter-burden consisting of Ecca rocks must be surveyed for fossiliferous outcrops (shale). Special care must be taken during the digging, drilling, blasting and excavating of foundations, trenches, channels and footings and removal of overburden. Protocol is attached (Appendix 2).

Concerns/threats:

1. Threats are earth moving equipment/machinery (front end loaders, excavators, graders, dozers) during construction, the sealing-in or destruction of the fossils by development, vehicle traffic and human disturbance.
2. Mitigation is needed (Appendix 2).

Stakeholders: Developer – ESKOM.
Environmental – Texture Environmental Consultants, P.O. Box 36593, Pretoria, 0102, 082 568 6344.
Landowner – 5 Private landowners.

C. Table of Contents

D. Background information on the project

Report

This report is part of the environmental impact assessment process under the NEMA (National Environmental Management Act 107 of 1998) [as amended].

Outline of development

This report discusses and aims to provide the developer with information regarding the location of palaeontological material that will be impacted by the development. In the pre-construction phase it is necessary for the developer to apply for the relevant permit from the South African Heritage Resources Agency (SAHRA).

Xtrata plans to do open cast mining where the 2x88kV Kromklip Tee-Van Dyks Coll Tee Mink lines are located, as a result the mine requested Eskom to remove these lines. The 2x88kV Kromklip Tee-Van Dyks Coll Tee Mink lines supply the 88kV substations, traction stations and switching stations below. With the removal of the Kromklip Tee-Van Dyks Coll Tee Mink lines an alternative source of supply is needed for the 88kV network. The proposed scope of work to build the Haasfontein 88kV switching station will provide an alternative source for the 88kV network:

- Van Dyks Coll Tee switching station
- Van Dyks Coll substation
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- Van Dyks Drift Traction Tee switching station
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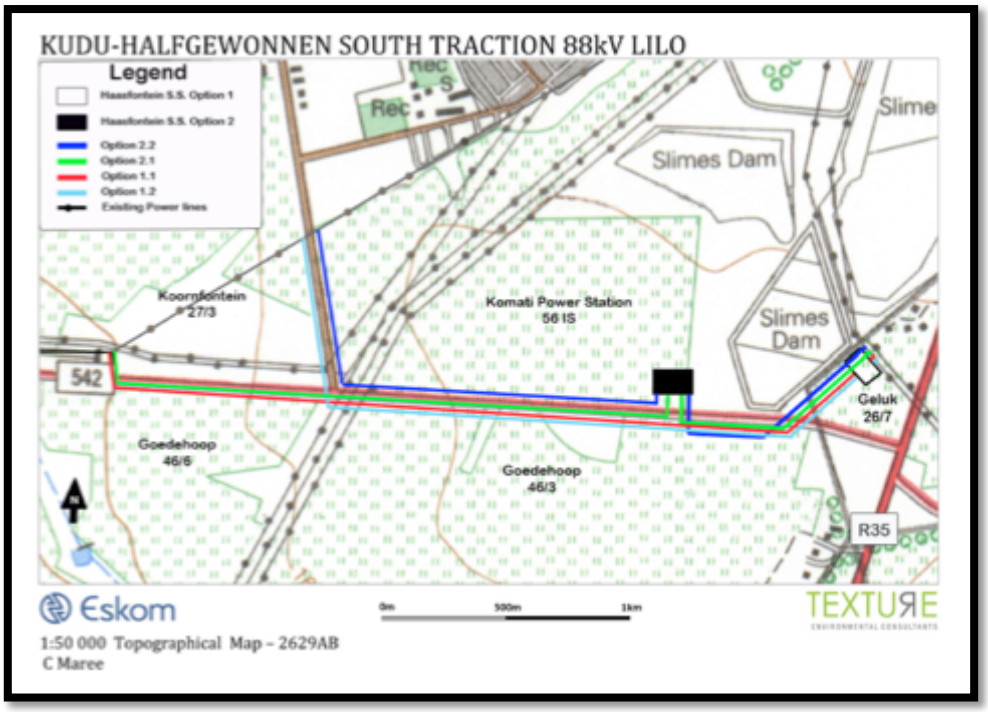
Site plan (provided by Texture Environmental Consultants.



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The following infrastructure is anticipated:-

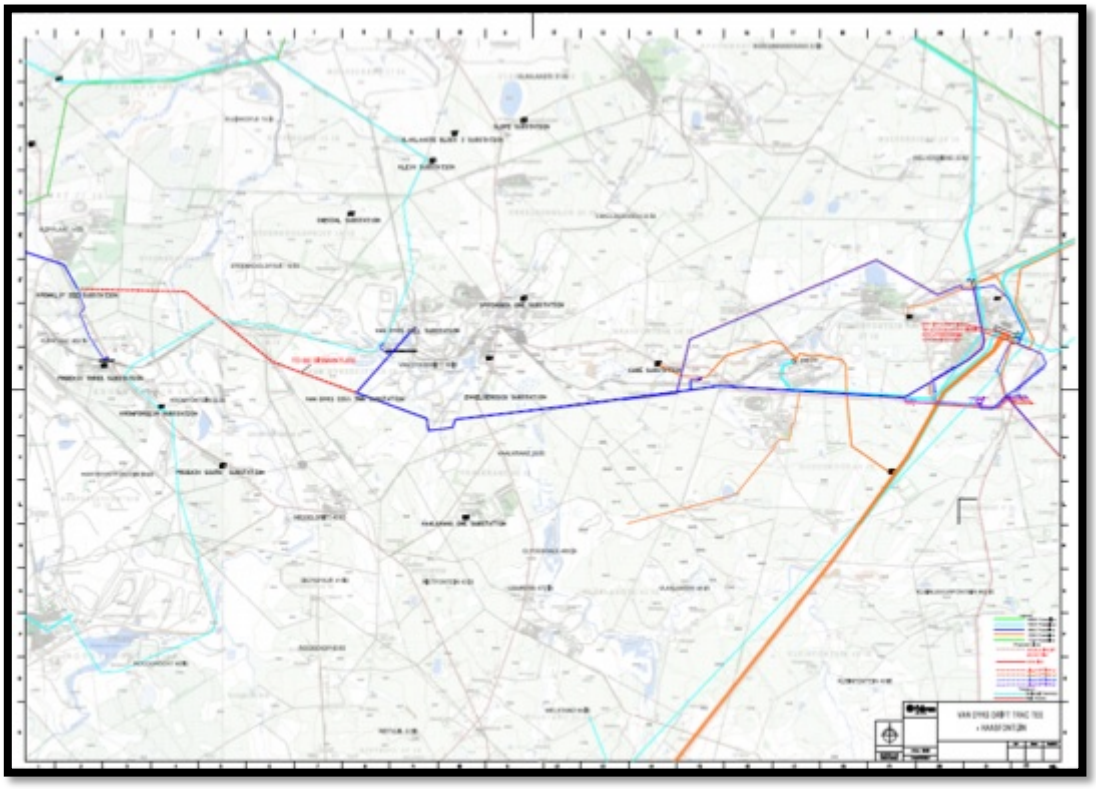
1. Pylons and switching station.
2. Access roads.

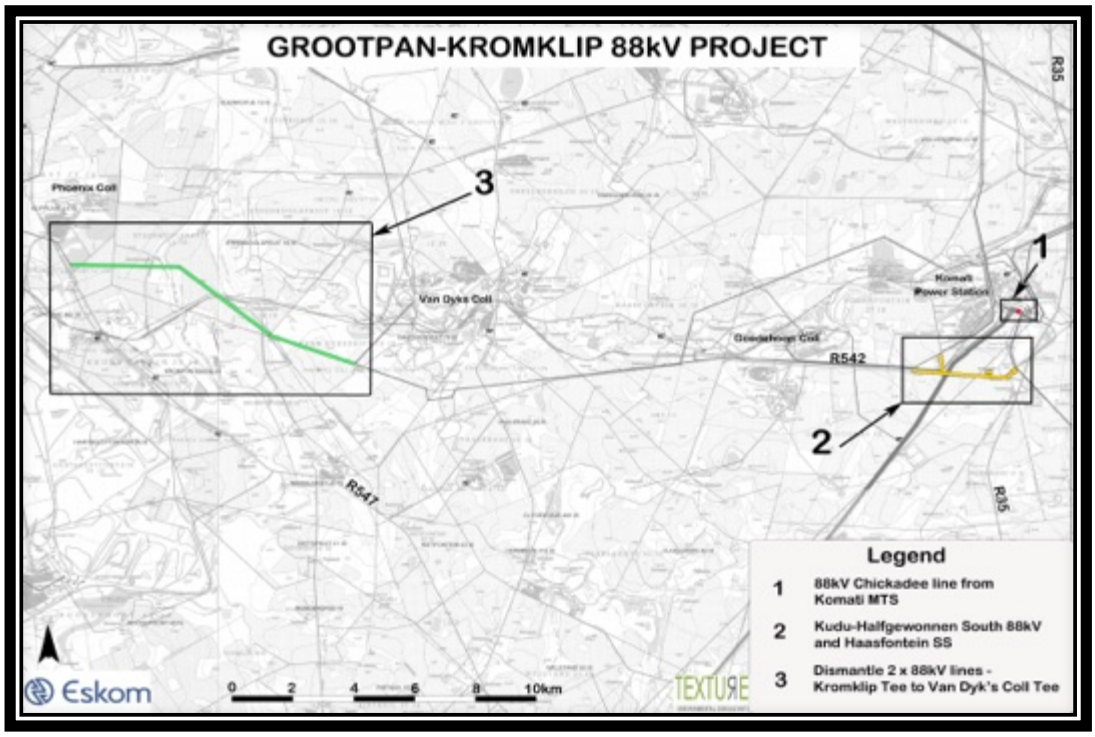
Rezoning/ and or subdivision of land: None.
Name of developer and consultant: Eskom and Texture Environmental Consultants.
Terms of reference: Dr H. Fourie is a palaeontologist commissioned to do a palaeontological impact assessment: field study to ascertain if any palaeontological sensitive material 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, University of the Witwatersrand. Her undergraduate degree is in Geology and Zoology. She specialises in vertebrate morphology and function concentrating on the Therapsid Therocephalia. For the past nine years she carried out field work in the Eastern Cape. Dr Fourie has been employed at the Ditsong: National Museum of Natural History in Pretoria (formerly Transvaal Museum) for 20 years.
Legislative requirements: South African Heritage Resources Agency (SAHRA) for issue of permits if necessary. National Heritage Resources Act no: 25 of 1999. An electronic copy of this report must be supplied to SAHRA.

E. Description of property or affected environment
Location:

The new switching station, LILO configuration, Chickadee lines and Tee line will be constructed on portion 3 (remaining extent) and portion 6 Goedehoop 46IS, Portion 0 (remaining extent) Geluk 26IS, Portion 3 (remaining extent) and portion 21 Koornfontein 27IS, Steve Tshwete Local Municipality, Mpumalanga Province.

Topographic map (Texture Environmental Consultants) showing location.





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The bulk of the site is underlain by the flat-lying Vryheid Formation of the Ecca Group, Karoo Supergroup sediments covered by corn fields, grassland, shrubs and bushes.

F. Description of the Geological Setting

Description of the rock units:

Large areas of the southern African continent are covered by the Karoo Supergroup. 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) (5 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).

The Vryheid Formation is named after the type area of Vryheid-Volksrust. In the north-eastern part of the basin the Vryheid Formation thins and eventually wedges out towards the south, southwest and west with increasing distance from its source area to the east and northeast (Johnson 2009). The Vryheid Formation consists essentially of sandstone, shale, and subordinate coal beds, and has a maximum total thickness of 500 m. It forms part of the Middle Ecca (Kent 1980). This formation has the largest coal reserves in South Africa. The prodelta sediments are characterised by trace and plants fossils (Snyman 1996).

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 gradually overlain by mudstones (and shale) and sandstones of the Volksrust Formation.

Dolerite intrusions are 183 million years old (early Jurassic, Mesozoic) characterised by boulder-strewn hills and red soil (Norman and Whitfield 2006). Dolerite forms through the process of cooling and consolidation of warm, molten magma at a slow rate to form large crystals. It is thus an igneous rock without quartzite, olivine and feldspar. Dolerites are commonly seen as characteristic flat-topped hills. Intrusions are generally horizontal, evenly inclined or undulating sheets with a well-marked transgressive tendency, dykes are common. These dykes and sills are more resistant to erosion than the host sedimentary rock, and consequently often form caps to flat-topped hills (McCarthy and Rubidge 2005).

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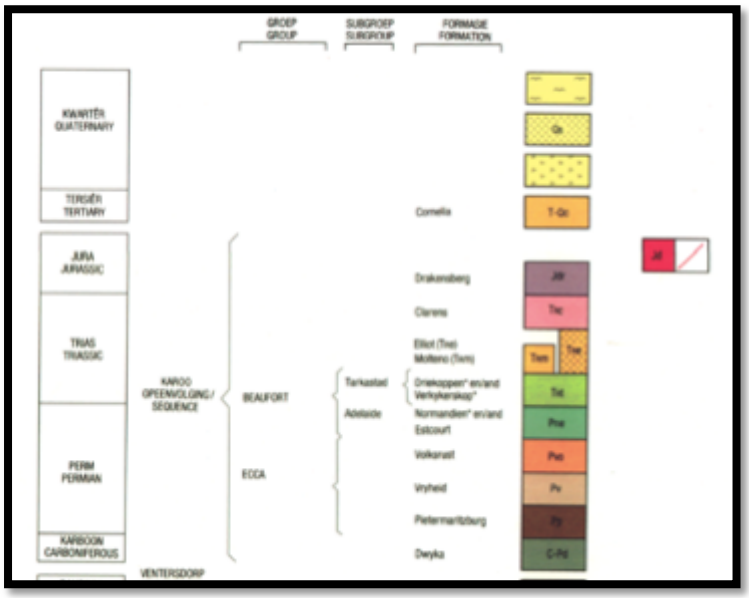
Lithostratigraphic column to show the Ecca Group within the Karoo Supergroup (Muntingh 1992).



Ecca rocks are stable and lend themselves well to developments. It is only unstable in or directly above mining activities (Snyman 1996). The site itself is situated on the flat-lying Vryheid Formation, Ecca Group, Karoo Supergroup. 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 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 walk through was done in December and at the end of January, conditions were wet in December. Photographs below show the gentle sloping topography. Rocky outcrops are absent.

The photograph below shows the view towards the Komati Power station. This photograph was taken with the first site visit during December, it was a very wet rainy day. The cornfield is just visible as low plants. During the second site visit in January the mealies were fully grown and it makes it difficult to see outcrops. The second visit was on a warm Summer day with rain only in the last part of the site visit. Usually when a field like this has been planted, outcrops are absent as farmers need deep soil.

The photograph below shows the view towards the south. The farm dwellings can be seen as well as the wetland in the bottom of the photograph. This is also south of the R542.

An example soil samples from a borehole, probably 1 m apart, of the Vryheid Formation geology. Grey shale to the far right and the yellow represents the sandstone (Witbank Coalfields).

Photograph above shows an example of baked shale formed during the process when the dolerite/diabase intrudes through the Vryheid Formation (Witbank Coalfields). As the site is underlain by dolerite, this type of shale may be present.

The photograph below is of the surface with scattered rocks that indicates the presence of the Vryheid Formation, no outcrops were found.

Photograph below are in a gulley showing a bank of grit and mudstone.

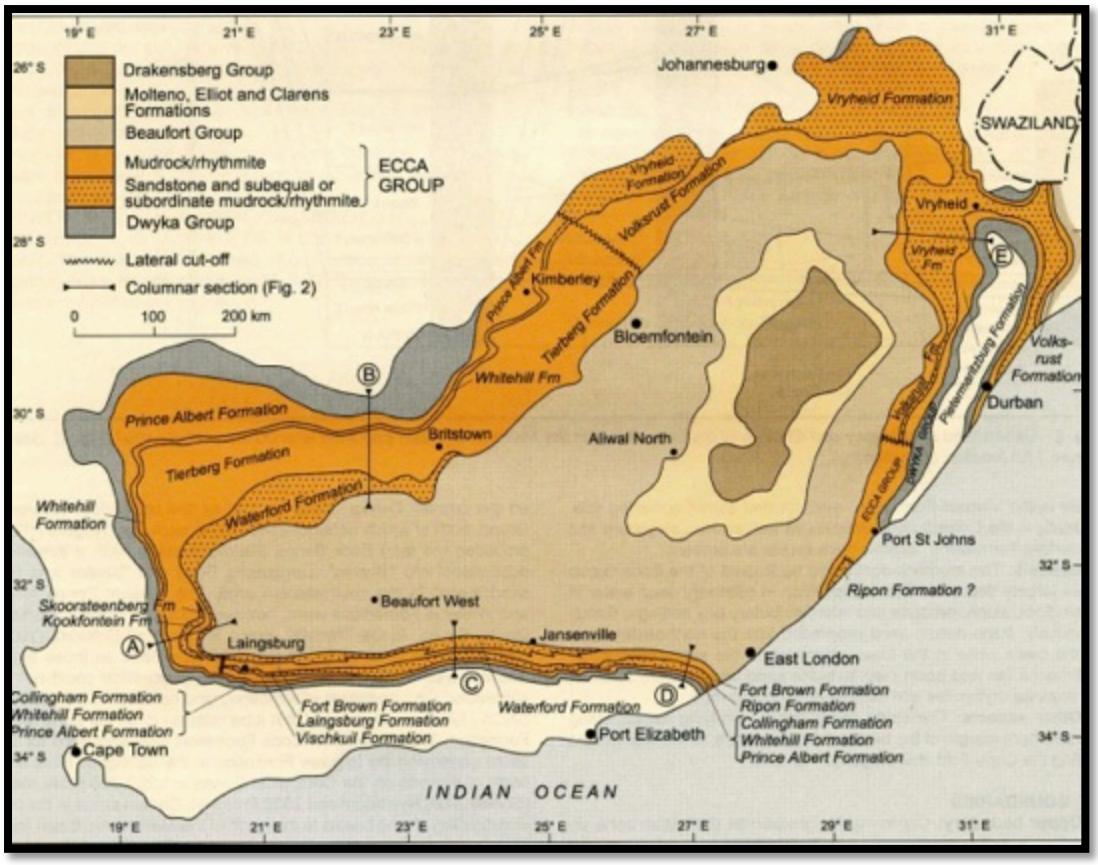
Photograph below is of a typical Vryheid formation landscape with the mine in the bacground. This area is present where the line will be dismantled.

There is some concern with the property due to the presence of Vryheid Formation, but if the pylons are not planted deeper than 2m then the Vryheid Fomation may be avoided. This can be verified with geological cores. The topsoil, subsoil and overburden must be surveyed for fossils and Mitigation is needed for the shale layer.

It is recommended to wait for the response from SAHRA on the Phase 1 Field study (this report), and if mitigation is recommended then the SAHRA protocol must be followed. Alternatives will not be feasible (Smit and White 2014) as all proposed development portions and surrounding areas are on the Vryheid Formation.

G. Background to Palaeontology of the area

Summary: When rock units of moderate to very high palaeontological sensitivity are present within the development footprint, a desk top and or field scoping (survey) study by a professional palaeontologist is usually warranted. The main purpose of a field scoping (survey) study would be to identify any areas within the development footprint where specialist palaeontological mitigation during the construction phase may be required (SG 2.2 SAHRA AMPHOB 2012).



Map from Johnson (2009) to show extent of the Ecca Group, more specifically the Vryheid Formation and the Volksrust Formation.

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) (Appendix 1).

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).

Photograph H. Fourie: Fossil courtesy of Prof. Bamford, The Evolutionary Studies Institute. A Horsetail fern stem.

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 Vryheid Formation.

Criteria used (Fossil Heritage Layer Browser/SAHRA):

Rock Unit	Significance/vulnerability	Recommended Action
Vryheid Formation (Pv) (Pe)	VERY HIGH	Field assessment and protocol for finds is required
Karoo Dolerite Suite (do/Jd)	Insignificant or Zero	No action required

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

H. Description of the Methodology

The palaeontological impact assessment field study was undertaken at the end of January 2015. The walk through of the affected portion was done and photographs (in 7.1 mega pixels) were taken of the site with a digital Canon camera (PowerShot A470). It was not necessary to use a Global Positioning System (GPS) (Garmin eTrex 10) to record fossiliferous finds as the area is covered with topsoil, subsoil and overburden, grassland, shrubs and bushes. The walk through did locate the Vryheid Formation, but not the underlying shale. A literature survey is included.

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

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

A Phase 2 Palaeontological Impact Assessment: Mitigation will include:

1. Recommendations for the future of the site.
2. Description of work done (including number of people and their responsibilities.
3. A written assessment of the work done, fossils excavated, not removed or collected and observed.
4. Conclusion reached regarding the fossil material.

5. A detailed site plan.
6. Possible declaration as a heritage site or Site Management Plan.

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

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

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

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

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

I. Description of significant fossil occurrences

All Karoo Supergroup geological formations are ranked as LOW to VERY HIGH, and here the impact is potentially VERY HIGH for the Vryheid 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 also occur 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 be determined due to thick topsoil, subsoil, overburden and alluvium. Depth of the overburden may vary a lot. The vast coal mining industry 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 (front end loaders, excavators, graders, dozers) during construction, the sealing-in or destruction of fossils by development, vehicle traffic, and human disturbance. See Description of the Geological Setting (F) above.

J. Recommendation

a. There is no objection (see Recommendation B) to the development, but it was necessary to request a Phase 1 Palaeontological Impact Assessment: Field study to determine whether the development will affect fossiliferous outcrops as the palaeontological sensitivity is VERY HIGH. A Phase 2 Palaeontological Mitigation may be required as the Phase 1 Palaeontological Assessment found a fossiliferous outcrop (Vryheid Formations). Protocol is attached (Appendix 2).
b. This project may benefit the economy, the growth of the community and social development in general.
c. Preferred choice: All options are viable, but the impact on the palaeontological heritage is VERY HIGH for the Vryheid Formation. The thin inlier of shale is problematic. Care must be taken during the digging of foundations and removing topsoil, subsoil and overburden (see Executive Summary).
d. The following should be conserved: if any palaeontological material is exposed during digging, excavating, drilling or blasting SAHRA must be notified. All construction activities must be stopped and a palaeontologist should be called in to determine proper mitigation measures.

Sampling and collecting:
Wherefore a permit is needed from the South African Heritage Resources Agency (SAHRA).

a. Objections: Cautious. See heritage value and recommendation.
b. Conditions of development: See Recommendation.
c. Areas that may need a permit: Yes.
d. Permits for mitigation: Needed from SAHRA/PHRA prior to Mitigation.

K. Conclusions

a. All the land involved in the development was assessed and none of the property is unsuitable for development (see Recommendation B).
b. All information needed for the Phase 1 Palaeontological Impact Assessment and Field scope was provided by the Consultant. All technical information was taken from the BID provided by Texture Environmental Consultants.
c. Areas that would involve mitigation and may need a permit from the South African Heritage Resources Agency are discussed.
d. The following should be conserved: if any palaeontological material is exposed during digging, excavating, drilling or blasting, SAHRA must be notified. All development activities must be stopped and a palaeontologist should be called in to determine proper mitigation measures. Especially shallow caves.
e. Condition in which development may proceed: It is further suggested that a Section 37(2) agreement of the Occupational, Health and Safety Act 85 of 1993 is signed with the relevant contractors to protect the environment and adjacent areas as well as for safety and security reasons.

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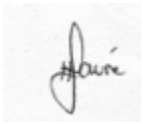
Declaration

I, Heidi Fourie, declare that I am an independent consultant and have no business, financial, personal or other interest in the proposed development project for which I was appointed to do a palaeontological assessment. There are no circumstances that compromise the objectivity of me performing such work.

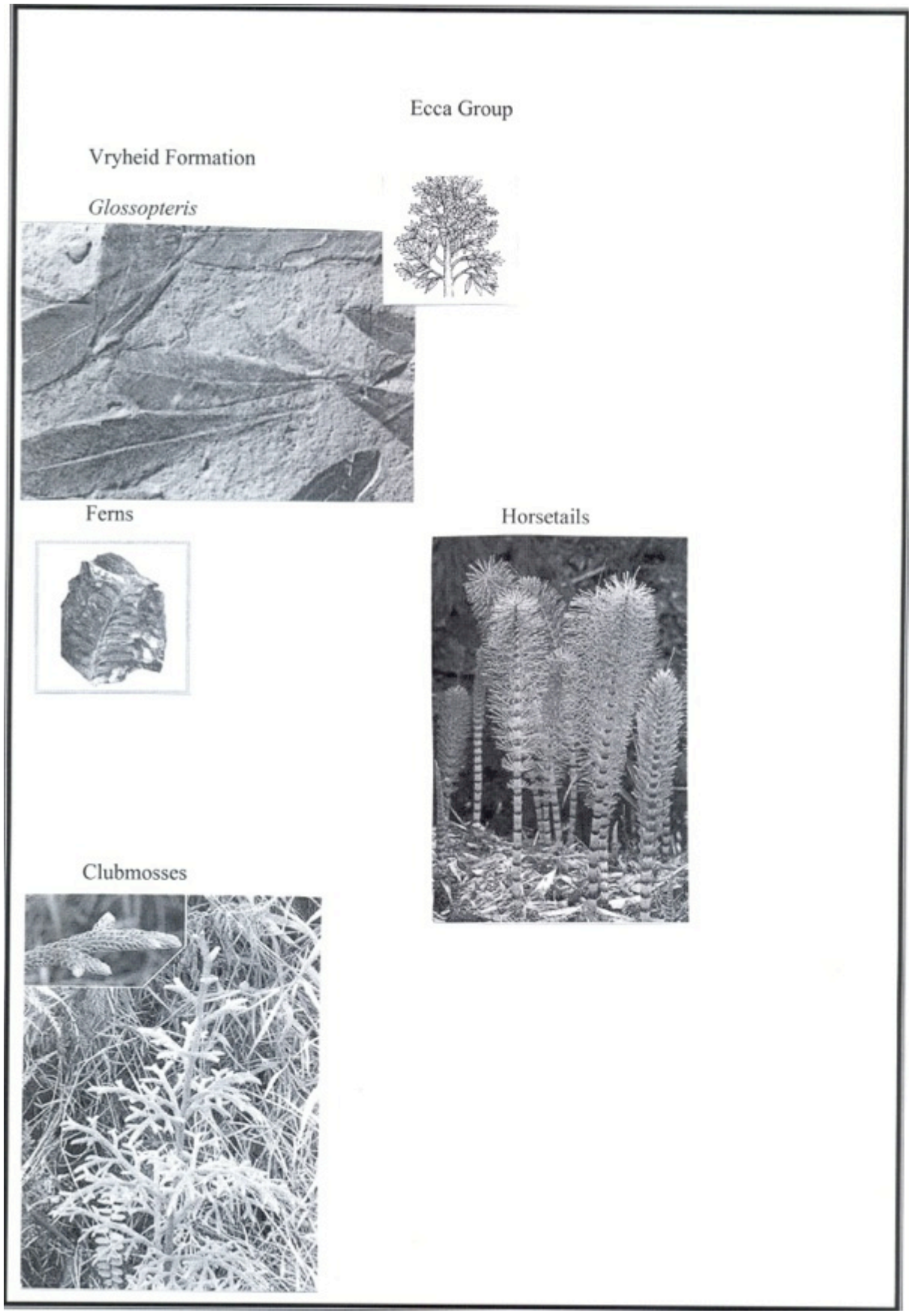
Heidi Fourie accepts no liability, and the client, by receiving this document, indemnifies Heidi Fourie against all actions, claims, demands, losses, liabilities, costs, damages and expenses arising from or in connection with services rendered, directly or indirectly by the use of the information contained in this document.

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



Heidi Fourie
2015/02/09

Appendix 1: Examples of Vryheid Formation fossils.



Example of a plant fossil (courtesy of the ESI). *Glossopteris* leave.

Appendix 2: **Protocol for finds**

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

The developer must survey the areas affected by the development and indicate on plan where the construction / development / mining will take place. Trenches have to be dug to ascertain how deep the sediments are above the bedrock (can be a few hundred metres). This will give an indication of the depth of the topsoil, subsoil, and overburden, if need be trenches should be dug deeper to expose the interburden.

Mitigation will involve recording, rescue and judicious sampling of the fossil material present in the layers sandwiched between the geological / coal layers. It must include information on number of taxa, fossil abundance, preservational style, and taphonomy. This can only be done during mining or excavations. In order for this to happen, in case of coal mining operations, the process will have to be closely scrutinised by a professional palaeontologist / palaeobotanist to ensure that only the coal layers are mined and the interlayers (siltstone and mudstone) are surveyed for fossils or representative sampling of fossils are taking place.

The palaeontological impact assessment process presents an opportunity for identification, access and possibly salvage of fossils and add to the few good plant localities. Mitigation can provide valuable onsite research that can benefit both the community and the palaeontological fraternity.

A Phase 2 study is very often the last opportunity we will ever have to record the fossil heritage within the development area. Fossils excavated will be stored at a National Repository.

A Phase 2 Palaeontological Impact Assessment: Mitigation will include (SAHRA) -

1. Recommendations for the future of the site.
2. Description and purpose of work done (including number of people and their responsibilities).

3. A written assessment of the work done, fossils excavated, not removed or collected and observed.
4. Conclusion reached regarding the fossil material.
5. A detailed site plan and map.
6. Possible declaration as a heritage site or Site Management Plan.
7. Stakeholders.
8. Detailed report including the Desktop and Phase 1 study information.
9. Annual interim or progress Phase 2 permit reports as well as the final report.
10. Methodology used.

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

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

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

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

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

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

1. The developer needs to clearly stake or peg-out (survey) the areas affected by the mining/ construction/ development operations and dig representative trenches and if possible supply geological borehole data.
2. Fossils likely to occur are for example the fossil plants from the Vryheid Formation, these are present in the grey shale (or any other fossiliferous layer ranked as VERY HIGH or HIGH) or invertebrates from the Volksrust Formation (or any other fossiliferous layer).
3. When clearing topsoil, subsoil or overburden and hard rock (outcrop) is found, the contractor needs to stop all work.
4. A Palaeobotanist / palaeontologist (contact SAHRIS for list) must then inspect the affected areas and trenches for fossiliferous outcrops / layers. The contractor / developer may be asked to move structures, and put the development on hold.
5. If the palaeontologist / palaeobotanist is satisfied that no fossils will be destroyed or have removed the fossils, development and removing of the topsoil can continue.
6. After this process the same palaeontologist / palaeobotanist will have to inspect and offer advice through the Phase 2 Mitigation Process. Bedrock excavations for footings may expose, damage or destroy previously buried fossil material and must be inspected.

7. When permission for the development is granted, the next layer can be removed, if this is part of a fossiliferous layer, then with the removal of each layer of sediment, the palaeontologist / palaeobotanist must do an investigation (a minimum of once every two weeks).
8. At this stage the palaeontologist / palaeobotanist in consultation with the developer / mining company must ensure that a further working protocol and schedule is in place. Onsite training should take place, followed by an annual visit by the palaeontologist / palaeobotanist.

Fossil excavation if necessary during Phase 2:

1. Photography of fossil / fossil layer and surrounding strata.
2. Once a fossil has been identified as such, the task of extraction begins.
3. It usually entails the taking of a GPS reading and recording lithostratigraphic, biostratigraphic, date, collector and locality information.
4. Using Paraloid (B-72) as an adhesive and protective glue, parts of the fossil can be kept together (not necessarily applicable to plant fossils).
5. Slowly chipping away of matrix surrounding the fossil using a geological pick, brushes and chisels.
6. Once the full extent of the fossil / fossils are visible, it can be covered with a plaster jacket (not necessarily applicable to plant fossils).
7. Chipping away sides to loosen underside.
8. Splitting of the rock containing palaeobotanical material should reveal any fossils sandwiched between the layers.

SAHRA does have the following documents in place:
Guidelines to Palaeontological Permiting policy.
Minimum Standards: Palaeontological Component of Heritage Impact Assessment reports.
Guidelines for Field Reports.