Ngululu Resources opencast coal mine

Nkangala District Municipality, Mpumalanga Province

Farm: Portion 26, 46 and 47 Droogenfontein 242 IR.

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Palaeontological Impact Assessment: Phase 1 Field study

Commissioned by: Shangoni Management Services

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EIA Ref 17/2/3N-312

MP30/5/1/1/2/10076MR

B. Executive summary

Outline of the development project: Shangoni Management Services Pty (Ltd) has appointed Dr H. Fourie, a palaeontologist, to undertake a Paleontological Impact Assessment, Phase 1 field study of the suitability of the proposed development of an opencast coal mine and associated infrastructure to be located on portions 26, 46 and 47 on the farm Droogenfontein 242 IR, Nkangala District Municipality, Mpumalanga Province.

Ngululu Resources proposes an opencast coal mine with an estimated life of mine of 20 years. The proposed site with corresponding farm portions is approximately 15km south-west of Delmas Town in the Victor Kanye Local Municipality as part of the Nkangala District Municipality.

Currently there are no mining activities taking place on the proposed site. Ngululu Resources holds the prospecting rights on portions 26, 46 and 47 of the farm Droogenfontein 242 IR. Surface rights of these portions do not belong to Ngululu Resources. Three minable seams are present on portion 26. This coal will be used for domestic power generation and as low volatile pseudo anthracite.

The Project includes one Alternative (see map):
Alternative 1: Three portions of land, portions 46 and 47 are situated adjacent to the R555, south of the Sundale agricultural holdings. Portion 26 is situated approximately 2km to the south of the R555 towards Aston Lake.

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.

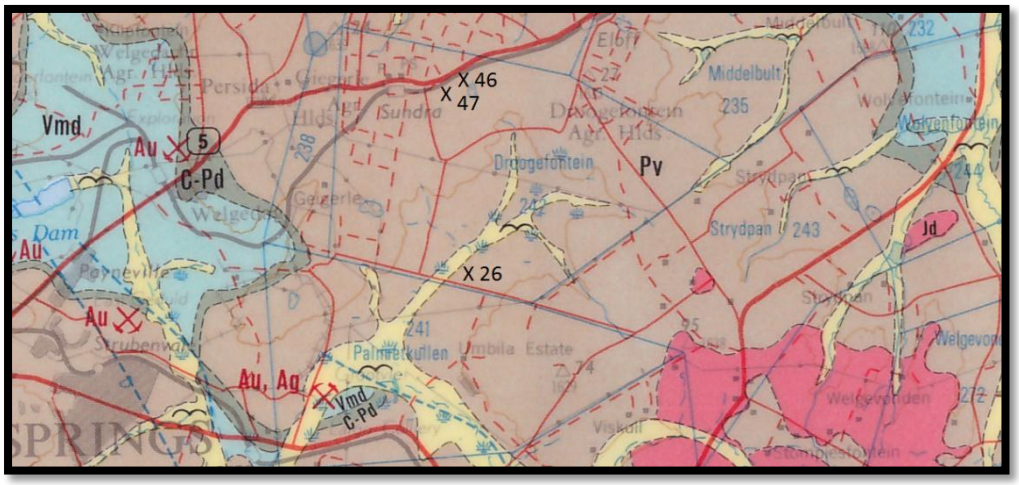
For this study, resources such as geological maps, scientific literature, institutional fossil collections, satellite images, aerial maps and topographical maps were used. It provides an assessment of the observed or inferred palaeontological heritage within the study area, with recommendations (if any)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

Outline of the geology and the palaeontology:
The geology was obtained from maps 1:100 000, South Africa (Visser 1984) and East Rand 2628 (Keyser, Botha and Groenewald 1986).



Legend to Map and short explanation.
Pv – (light brown) Sandstone, shaly sandstone, grit, shale, conglomerate and coal, Vryheid Formation, Ecca Group, Karoo Supergroup.
Jd – (pink) Dolerite, Karoo Dolerite Suite, Karoo Supergroup.
Vmd – (blue) Dolemite, chert, Malamani Subgroup, Chunniespoort Group, Transvaal Supergroup.
ΛΛ – (yellow) Alluvium, Quaternary/Tertiary.
X – Portions 26, 46 and 47.

Summary of findings: The Phase 1 Palaeontological Impact Assessment field study was undertaken during April and May 2014 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 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.

The three portions of Droogefontein 242IR were visited and there are no visible rocky outcrops of the Vryheid Formation on the surface as the overburden is substantial and most of the land are utilised by human inhabitation. Portion 26 is used for agriculture and there is a maize crop present. The Droogefontein Project area is located on the western edge of the Central Witbank Coalfield in the Vischkuil sub-basin. On Droogefontein the coal is possibly predominantly bituminous to anthracite in rank. The topsoil layer is approximately 5-8m thick and is followed by the clay layer of approximately 0.35-0.40m in thickness. Geological borehole logs show layers of siltstone, sandstone, mudstone and coal. The wetland on portion 26 is covered with alluvium.

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, and here locally VERY HIGH for the Vryheid Formation.

Recommendation:
The Phase 1 Palaeontological Impact Assessment Field study of the suitability of the proposed development recommend a Phase 2 Palaeontological Impact Assessment, Mitigation.

The Project includes one Alternative (see map):

Alternative 1: Three portions of land, portions 46 and 47 are situated adjacent to the R555, south of the Sundale agricultural holdings. Portion 26 is situated approximately 2km to the south of the R555 towards Aston Lake.

Droogefontein is directly underlain by rocks of the Vryheid Formation and is presently utilised for smallholdings (portions 46, 47) and agriculture (portion 26). Recent structures and graves are present. It is located on a gentle eastern facing slope. The development of an opencast mine includes several projects. The installation of water pipelines, a fire water reticulation system, clean and dirty water channels, dams, drains, septic tank, and the sewage water pipeline. Channels will need to be dug for the pollution control dam, substation, workshop and office complex foundations. Bulk diesel and oil storage tanks will be erected and roads will be scraped. Although portions 46 and 47 of Droogefontein are not envisaged to be utilised during the mining project, these portions were also included in the investigation since it forms part of the mining right application.

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

Concerns/threats:

1. The land size may not be adequate.
2. Insufficient planning information provided by developer.
3. Insufficient lay-out plans for all structures.
4. Threats are earth moving equipment/machinery during mining, the sealing-in or destruction of the fossils by development, vehicle traffic and human disturbance.

Stakeholders: Developer – Ngululu Resources, PO Box 76347, Highveld X11, 0169, 012 663 2257.
Environmental – Shangoni Management Services Pty (Ltd), Block C8, 472 Botterklapper Street, Die Wilgers, 012 807 7036.
Landowner – Portion 26 – S.M. van Dyk; Portion 46 - M. Vereker; Portion 47- O. Bezuidenhout.

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).

Outline of development

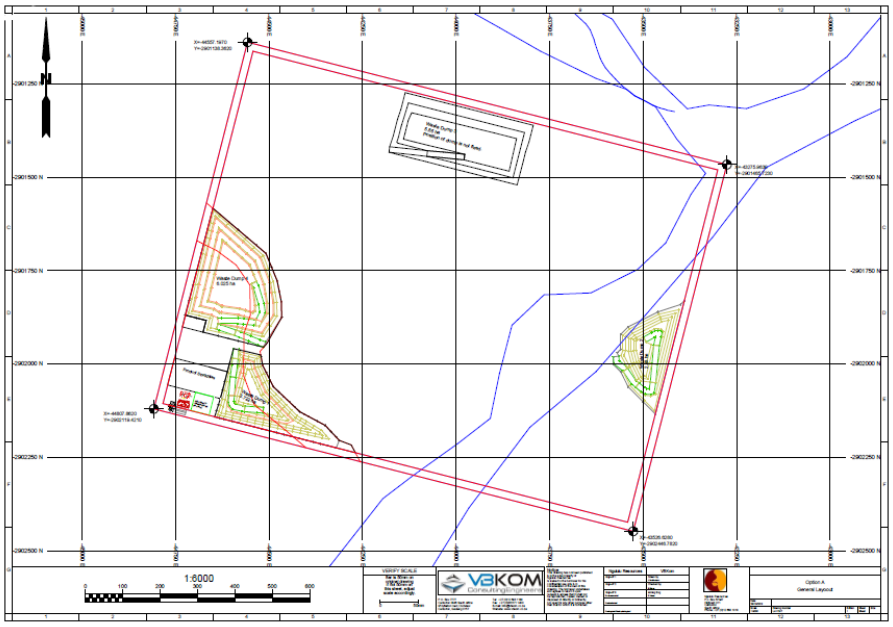
This report discusses the suitability of the proposed new development of an opencast coal mine and associated infrastructure to be located on portions 26, 46 and 47 on the farm Droogenfontein 242 IR, Nkangala District Municipality, Mpumalanga Province near Sundra.

Ngululu Resources proposes an opencast coal mine with an estimated life of mine of 20 years. The proposed site with corresponding farm portions is approximately 15km south-west of Delmas Town in the Victor Kanye Local Municipality as part of the Nkangala District Municipality. Mining in the Witbank Coalfield started in 1889 and several defunct and active mines are present in the Delmas area. The area is typical of the Vischkuil basin with inconsistently developed coal seams.

Currently there are no mining activities taking place on the proposed site. Ngululu Resources holds the prospecting rights on portions 26, 46 and 47 of the farm Droogenfontein 242 IR. Surface rights of these portions do not belong to Ngululu Resources.

The whole of portion 26 will be exploited through an opencast boxcut to gain access to the seams. The first three months will be dedicated to stripping and storing of topsoil and the establishment of stormwater diversion channels to ensure compliance. It is envisaged that all waste rock and overburden shall be used to backfill the open pit. The mine will not be washing and screening the coal. Ngululu will be developing the mine in three Phases, Phase 1 will be mining in the southern section with the waste dump to the west, Phase 2 will rehabilitate Phase 1 and move on to the next section in a northerly direction, the waste dump will remain, and Phase 3 will rehabilitate the mine and the waste dump.

The Project includes one Alternative (see map):
Alternative 1: Three portions of land, portions 46 and 47 are situated adjacent to the R555, south of the Sundale agricultural holdings. Portion 26 is situated approximately 2km to the south of the R555 towards Aston Lake.



Site plan-layout (courtesy of Shangoni) – to show the positions of the waste rock dumps (marked 1 to 4 anti-clockwise starting in the left hand corner).

The following infrastructure is anticipated:-

1. Change-house.
2. Pollution control dam (Co-disposal of mine residue and dewatered slurry).
3. The workshop(s).
4. Administrative offices and Security offices for access control.

5. Substation.
6. Crusher.
7. Waste rock dump.
8. Coal stockyard.
9. Weighbridge (Haul/Access and service roads).
10. Septic tank system.
11. Bulk diesel and oil storage facilities.

The construction may entail several projects. The installation of water pipelines, fire water reticulation system, clean and dirty water channels, dams, drains, septic tank, and the sewage water pipeline. Channels will need to be dug for the pollution control dam, substation, weighbridge, workshop and office complex foundations. Bulk diesel and oil storage tanks will be erected and roads will be scraped.

Change-house, Workshop and associated Administrative and Security building Complex
The workshop complex may consist of refuelling bays, workshops, offices and parking bays. The administrative block will have to have change rooms, ablution facilities, meeting rooms, and lunch/rest rooms for staff and workers. Septic tanks and soak ways will be required. Parking bays may be provided, a brake test ramp, a dust suppression water tank will be required. A silt trap will carry dirty water to a discard facility. Potable water will have to be used. It is here that the trucks will be maintained. A weighbridge may be present here.

Pollution control dam (Co-disposal of mine residue and dewatered slurry)
For the collection of run-off water into a storm water drainage system.

Haul/Access and service roads
The combined mine material and fuel may be hauled from the open cast mine to adjacent mines. An additional haul road will be required to join the existing routes to the workshop and administration building complex. The mine may need a conveyor system or overland haul roads.

Substation and Power lines
Power will need to be reticulated at 6,6kV by means of buried cable or a 22kV overhead line is to be fed from the existing Eskom overhead line. Three phase electricity is needed for mining activities.

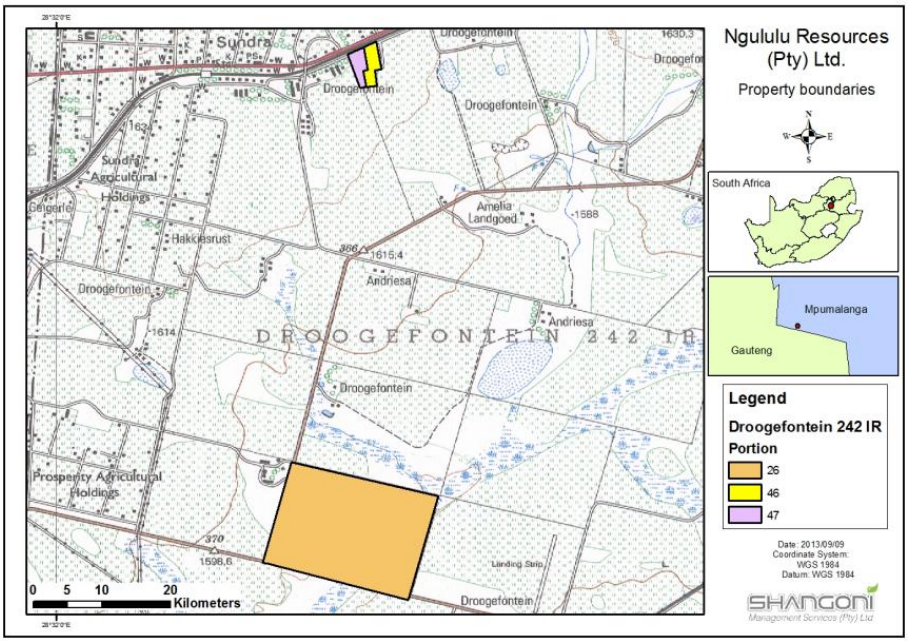
Crusher, Waste rock dump, Coal stockyard
The first three months will be dedicated to vegetation clearance, stripping and storing of topsoil. The waste dump will be located in the southwest corner of portion 26.

Rezoning/ and or subdivision of land: Yes, from Agriculture to Mining.
Name of developer and consultant: Ngululu Resources and Shangoni Management Services.
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 19 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:

Ngululu plans to develop an opencast coal mine and associated infrastructure to be located on portions 26, 46 and 47 on the farm Droogenfontein 242 IR, Nkangala District Municipality, Mpumalanga Province. The closest towns are Delmas and Springs.

Topographic map to show location of portions (provided by Shangoni). Also see Appedix 1.



Google-earth map below to show locations of portions 46, 47 and 26 of Droogefontein.

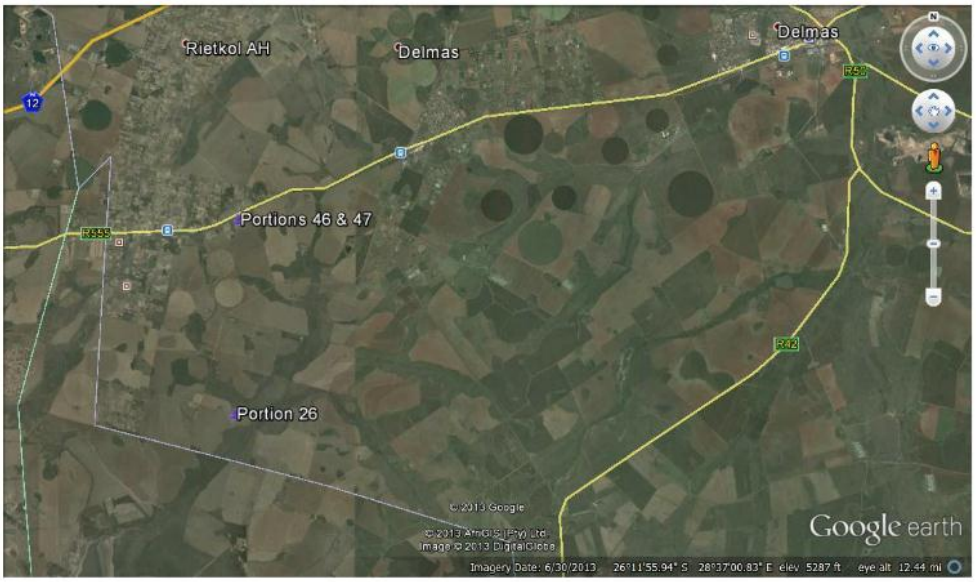


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Figure 4: Closer view of Portion 26. Note the ploughed fields and wetland section (Google Earth 2013 – Image date 2013/06/30).

Figure courtesy of Pelser (2013 HIA).

The bulk of the site is on the flat-lying Vryheid Formation of the Ecca Group, Karoo Supergroup sediments. The sites are covered by trees, weeds, bushes, a wetland, agriculture, building structures, graves and other associated structures.

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 (Johnson 2009) (Kent 1980).

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 this part of 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).

The Droogefontein Project area is located on the western edge of the Central Witbank Coalfield in the Vischkuil sub-basin. The Witbank Coalfield is a basin-like feature that extends from Brakpan in the west to Belfast in the east. Five seams are developed in the Witbank Coalfield numbered from No. 1 at the base to No. 5 at the top with the number 2 seam providing most of the coal mined to date in the Witbank Coalfield. On Droogefontein the coal is possibly predominantly bituminous to anthracite in rank. The topsoil layer is approximately 5-8m deep and is followed by the clay layer of approximately 0.35-0.40m in thickness. Geological borehole logs show layers of siltstone, sandstone, mudstone and coal (Scholtz 2013).

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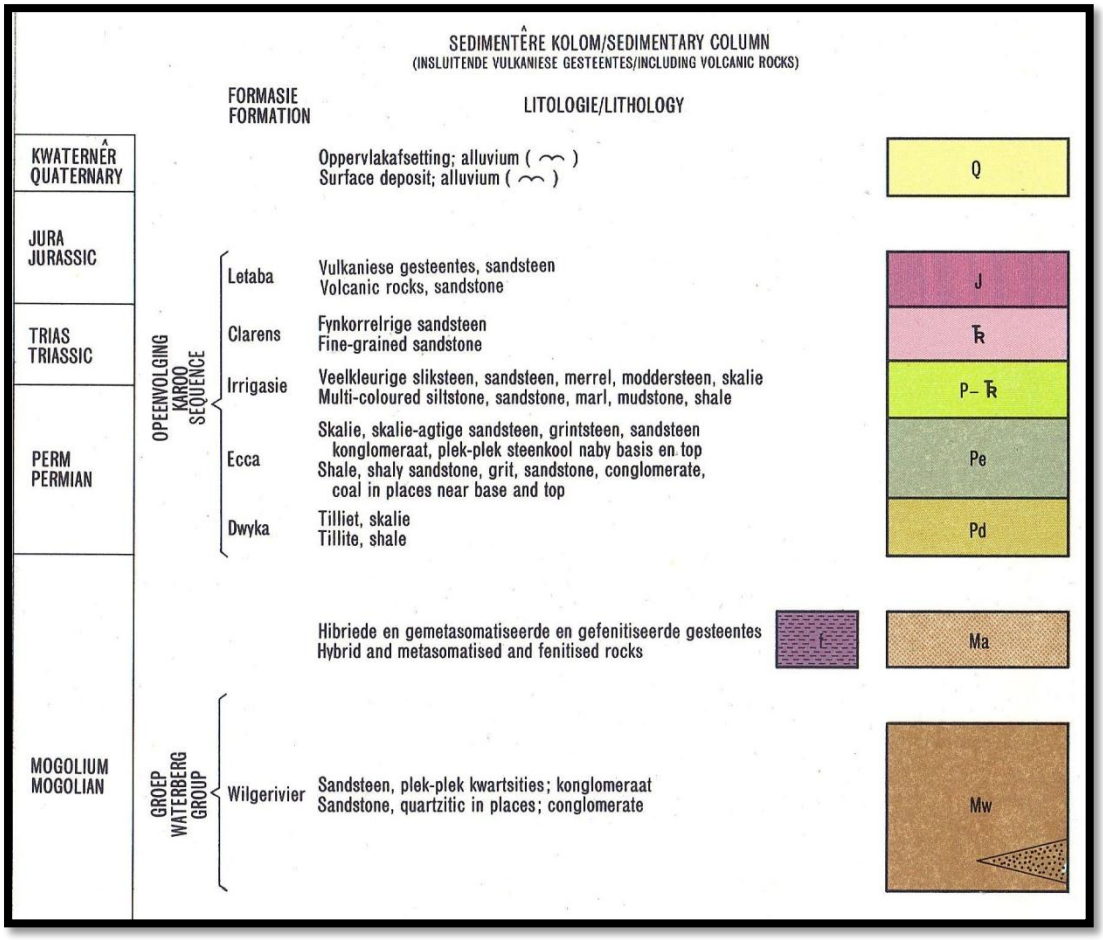
Lithostratigraphic column to show the Ecca Group within the Karoo Supergroup (Walrafen 1978).



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. The overburden and inter-burden was closely inspected for fossiliferous outcrops. 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 photograph below shows portion 47. A farmhouse and associated structures are present here with a small pond and vegetable garden. The thick overburden can be seen in the embankment of the pond. This portion will not be mined.

The photograph below shows the location of portion 46. A farmhouse and associated structures are present. This portion will not be mined. Both portions 46 and 47 are surrounded by maize fields.

The workshop, office block, haul roads, pollution control dam, substation, crusher, weighbridge, septic tank, bulk diesel and oil storage facility and associated structures will be constructed in the present maize field and wetland on portion 26.

The overburden in this area is thick due to agriculture. Alluvium is present in the wetland. Several roads will be required of which one road has already been scraped (below) and prepared. The other access roads will have to be scraped.

A wetland is present on portion 26 and next to it are the graves.

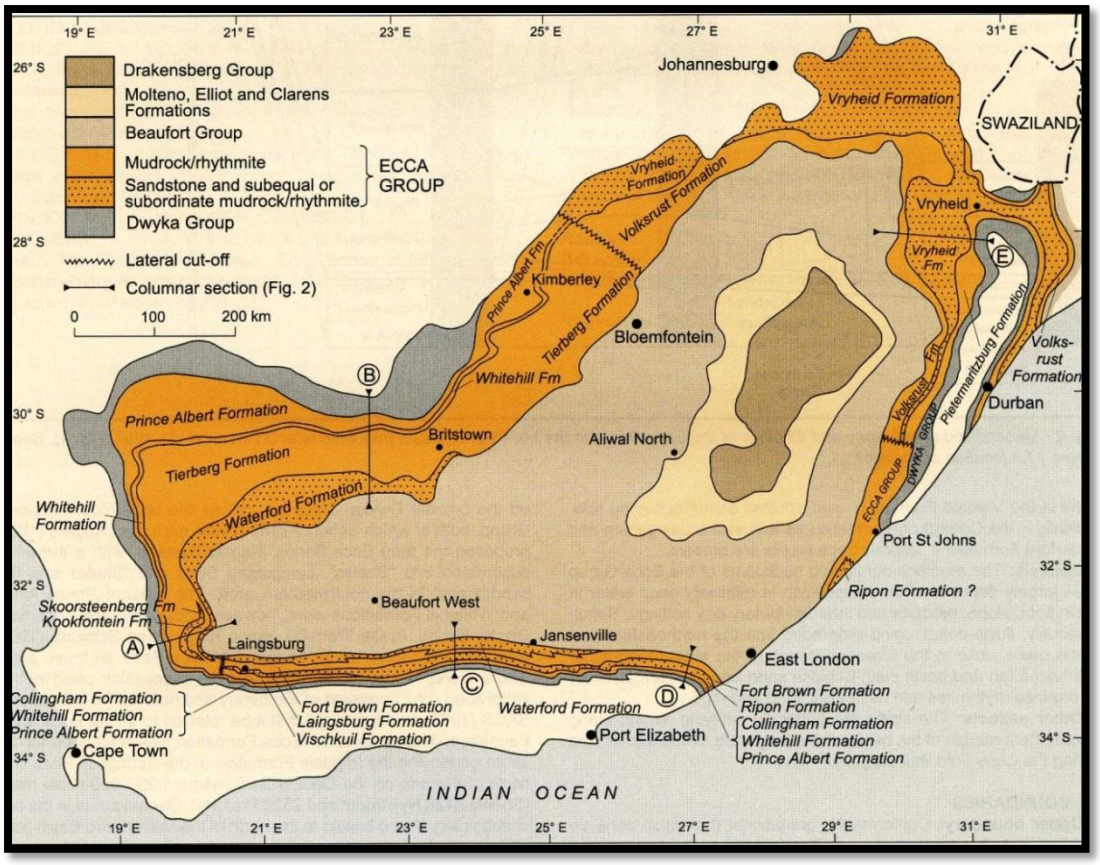
The photograph above shows some of the shale on the surface of the road. This area is present on the road next to portion 26 and gives an indication of what is underneath the overburden. The mine will be present where the maize field is located.

The biggest concern with this project it that the property (portion 26) which Ngululu Resources wants to develop for mining is small. At present it is used for maize production and is highly profitable. The overburden is thick in places and care should be taken if foundations for buildings and associated structures are dug. Lots of invader trees and plants are present on portions 46 and 47. The whole of portion 26 will be affected by the coal handling and processing plant, pollution control dam, roads, buildings, crusher, waste rock dump, coal stockyard, weighbridge, and residue with slurry, such structures will need several trenches, foundations and footings to be dug which may enter the more solid Vryheid Formation.

It is recommended to wait for the response from SAHRA and if mitigation is recommended then the SAHRA protocol must be followed. Alternatives will not be feasible as all proposed development portions and surrounding areas are on the Vryheid Formation. The wetland may be a sensitive no-go area from an ecological perspective, but not the focus of this report.

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.

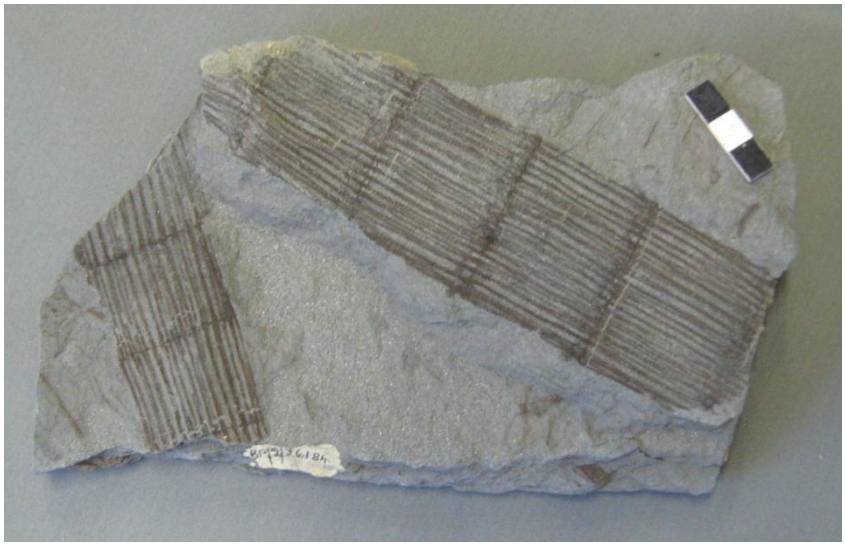


Map from Johnson (2009) to show extent of the Ecca Group, more specifically the Vryheid Formation.

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).

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

The author of this report has done two Phase 1 Palaeontological Impact Assessment Field studies, one in the Molteno Formation, Stormberg Group for the Dorper wind energy development and one investigation of a new discard dump at the Greenside Colliery on the Vryheid Formation, Ecca Group, Karoo Supergroup.

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

H. Description of the Methodology

The palaeontological impact assessment field study was undertaken during May 2014. The walk through of the affected portions was done and photographs were taken of the sites with a digital Canon camera. It was not necessary to use a Global Positioning System (GPS) to record fossiliferous finds as the area is covered with thick topsoil and some alluvium in the wetland. The author is using the data from the Geohydrological Investigation (Scholtz 2013) and the Heritage Impact Assessment (Pelser 2013) for additional information.

Assumptions and Limitations:-
The accuracy and reliability of the report is 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 mine 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 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 (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 could not be determined due to the thick overburden and alluvium. Depth of the overburden may vary a lot.

The threats are:- earth moving equipment/machinery during mining, 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 of the new opencast mine and associated structures, but it was necessary to request a Phase 1 Palaeontological Impact Assessment to determine whether the development will affect fossiliferous outcrops as the palaeontological sensitivity is VERY HIGH. A Phase 2 Palaeontological Mitigation will be required as the Phase 1 Palaeontological Assessment found fossiliferous outcrops (grey shale).
b. This project may benefit the economy, the growth of the community and social development in general.
c. Preferred choice: Alternative one, but the impact on the palaeontological heritage is VERY HIGH for the Vryheid Formation. Care must be taken during the digging of foundations and removing 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 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 Scoping Documents provided by Shangoni.
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.

HFourie

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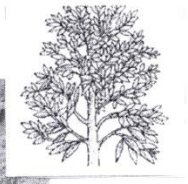
Heidi Fourie
2014/05/15

Appendix 1:

Ecca Group

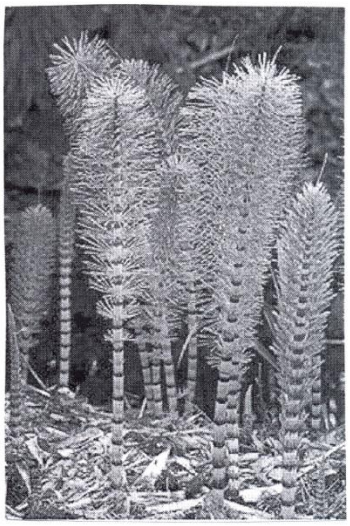
Vryheid Formation

Glossopteris



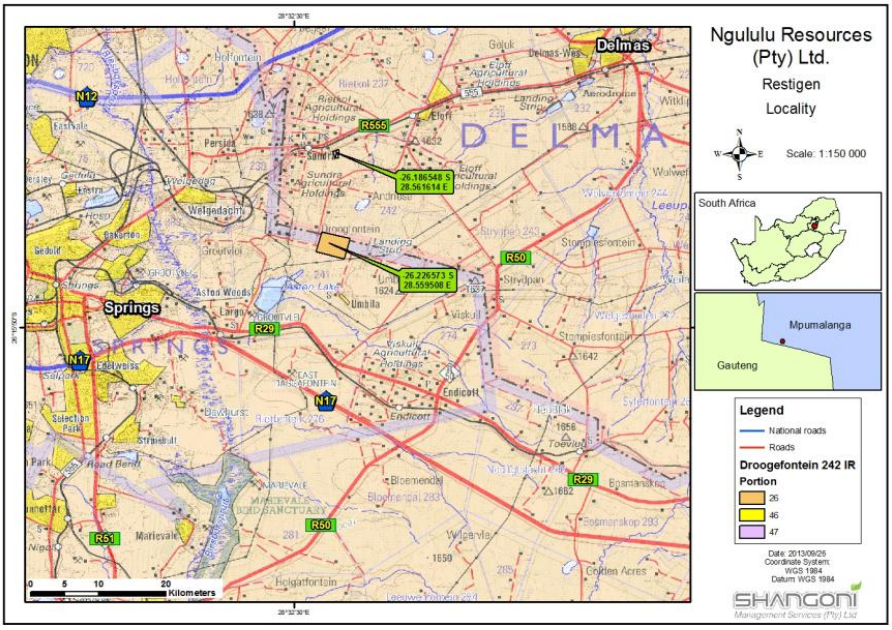
Ferns

Horsetails



Clubmosses

Location map of portions 46, 47 and 26 (courtesy of Shangoni).



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