Report on the proposed construction of a poultry abattoir

Amersfoort, Dr Pixley Ka Isaka Seme Local Municipality, Gert Sibande District Municipality, Mpumalanga Province

Farm: Portion 19 Amersfoort Townlands 57HS

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Palaeontological Impact Assessment: Phase 1 Field study

Commissioned by: Aurecon (Pty) Ltd

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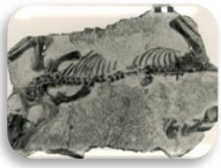
013 752 7055

2014/12/12

MDEDET Ref: 17/2/3GS-217



B. Executive summary

Outline of the development project: Aurecon Environmental Specialist (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 new construction of a poultry abattoir located on Portion 19 of the farm Amersfoort Townlands 57 HS, in Amersfoort, Dr Pixley Ka Isaka Seme Local Municipality, Gert Sibande District Municipality, Mpumalanga Province.

The Department of Agriculture, Rural Development and Land Administration proposes the development of an abattoir to the south of Ezamokuhle Township. It is planned to have a slaughter capacity of 150 000 broilers per week. The broilers will be delivered daily by truck. The physical size of the abattoir would be approximately 80m x 40m. It will be split into a dirty and clean section.

The Project includes two location Alternatives (see map):
Alternative 1: The 5 Ha site is located next to a waste disposal dump to the south of Ezamokuhle Township and to the west of Amersfoort town. Portion 19 is located next to the road to the Township and opposite the silos and Simon Street. The development footprint will cover an area of 5000m². It is as far as possible from the wetland area.
Alternative 2: No go, as there is a cemetery approximately 800m to the south, there is a waste disposal site, the area slopes towards a watercourse, and there are houses/residential areas nearby.

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.

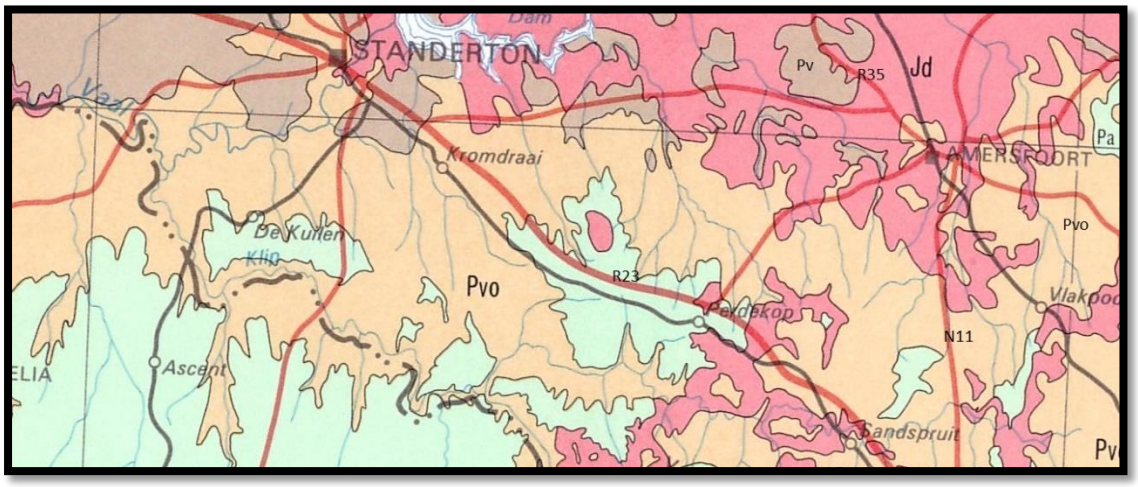
For this study, resources such as geological maps, scientific literature, institutional fossil collections, satellite images, aerial maps and topographical maps were used. It provides an assessment of the observed or inferred palaeontological heritage within the study area, with recommendations (if any)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



Legend to Map and short explanation.
Pvo – (light orange) Shale. Volksrust Formation, Ecca Group, Karoo Supergroup. Permian.
Pv – (brown) Sandstone, shaly sandstone, grit, shale, conglomerate and coal. Vryheid Formation, Ecca Group, Karoo Supergroup. Permian.
Jd – (pink) Dolerite. Karoo Dolerite Suite. Jurassic.

Summary of findings: The Phase 1 Palaeontological Impact Assessment Field study was undertaken during November 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 (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.

The Volkrust Formation consists of a 150-250 m of shale (Kent 1980). This formation is only present in the northern basin as fine shale and siltstone (Snyman 1996). Both the Vryheid and Volksrust Formations overlie the Pietermaritzburg Formation (Johnson 2009). The age is early to mid-Permian. Fossils that may occur are fish scales, fossil wood and the bivalve *Megadesmus.*

The area is underlain by dolerite, shale and mudstone of the Volksrust Formation and most of the development will take place on a smaller inlier of shale. The sandstone of the Vryheid Formation is also exposed (Smit and White 2014).

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 and HIGH for the Volksrust Formation (SG 2.2 SAHRA APMHOB 2012).

Recommendation:
The Project includes two location Alternatives (see map):
Alternative 1: The 5 Ha site is located next to a waste disposal dump to the south of Ezamokuhle Township and to the west of Amersfoort town. Portion 19 is located next to the road to the Township and opposite the silos and Simon Street. The development footprint will cover an area of 5000m². It is as far as possible from the wetland area.

Alternative 2: No go, as there is a cemetery approximately 800m to the south, there is a waste disposal site, the area slopes towards a watercourse, and there are houses/residential areas nearby.

During the survey it was found that the farm Amersfoort Townsland is directly underlain by dolerite, the shale and mudstone of the Volksrust Formation and the sandstone of the Vryheid Formation and is presently underutilised. Recent structures are not present, but a waste disposal (rubbish) dump is. It is located on a gentle facing slope. The development of the plant includes several projects that will need foundations, footings, channels and trenches to be dug. Infrastructure includes - access road and building.

The impact of the development on fossil heritage is VERY HIGH and 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. 'Most of the development site is located within a small inlier of shale' (Smit and White 2014). It is recommended that the footprint of the abattoir is moved to the solid sandstone and that the shale is avoided. If the shale cannot be avoided then Mitigation is needed (Appendix 2).

Stakeholders: Developer – Department of Agriculture, Rural Development and Land Administration. Private Bag X11219, Nelspruit, 1200.
Environmental – Aurecon (Pty) Ltd. P.O. Box 3135, Nelspruit, 1200, 013 752 7055.
Landowner – Municipality.

C. Table of Contents

D. Background information on the project

Report

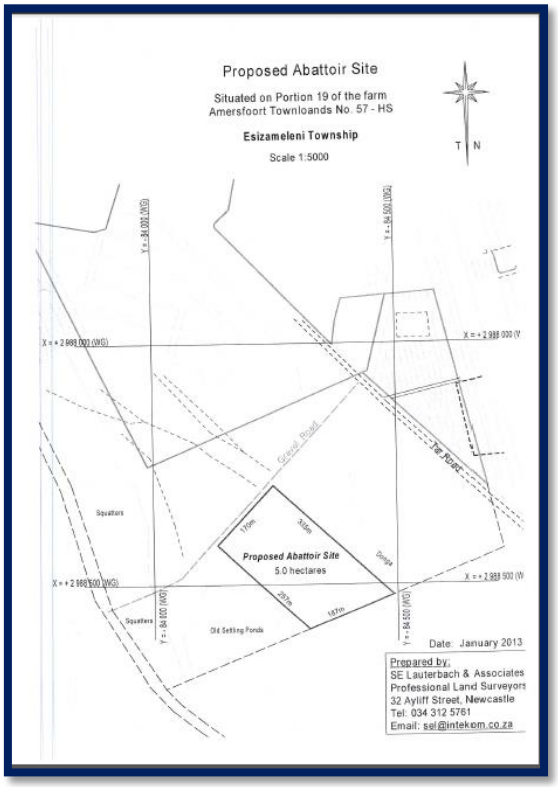
This report is part of the environmental impact assessment process under the NEMA (National Environmental Management Act 107 of 1998) [as amended].

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).

The Department of Agriculture, Rural Development and Land Administration proposes the development of an abattoir to the south of Ezamokuhle Township (450m). It is planned to have a slaughter capacity of 150 000 broilers per week. The broilers will be delivered daily by truck. The physical size of the abattoir would be approximately 80m x 40m. It will be split into a dirty and clean section (Smit and White 2014).

Proposed abattoir site (provided by Aurecon).



Within the dirty section, poultry is stunned, slaughtered, decapitated and feathers are removed. Feathers and blood are then collected in drums in order to be transported to a protein rendering plant. Carcasses then proceed into the clean section where they are chilled and either cut into portions or left as a whole bird for packaging, weighing and subsequently bulk packed for dispatch. Amersfoort Highveld Clay grassland covers the site and the Skulpspruit is nearby. The area slopes from the north-west to the south-east (Smit and White 2014).

Since the demand for poultry within South Africa is high and the excess demand is presently covered by the import market, it will be advantageous for the government to establish poultry abattoirs which will cater to increased chicken farming. These developments will support government policies aimed at reducing poverty and encouraging employment (Smit and White 2014).

The Project includes two location Alternatives (see map):
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Alternative 2: No go, as there is a cemetery approximately 800m to the south, there is a waste disposal site, the area slopes towards a watercourse, and there are houses/residential areas nearby.

The following infrastructure is anticipated:-

1. Access road and parking.
2. Abattoir and associated infrastructure.

Construction may also include several other needs such as the installation of water pipelines and power lines. Channels and trenches will need to be dug for the abattoir foundations and roads will be scraped.

Rezoning/ and or subdivision of land: None.
Name of developer and consultant: Department of Agriculture, Rural Development and Land Administration and Aurecon (Pty) Ltd.
Terms of reference: Dr H. Fourie is a palaeontologist commissioned to do a palaeontological impact assessment: field study to ascertain if any palaeontological sensitive material is present in the development area. This study will advise on the impact on fossil heritage mitigation or conservation necessary, if any.
Dr Fourie obtained a Ph.D from the Bernard Price Institute for Palaeontological Research, 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:
A new construction of a poultry abattoir located on Portion 19 of the farm Amersfoort Townlands 57 HS, in Amersfoort, Dr Pixley Ka Isaka Seme Local Municipality, Gert Sibande District Municipality, Mpumalanga Province.

Google.earth map (Aurecon) showing location of Portion 19 and proximity to Ezamokuhle.

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Alternative 2: No go, as there is a cemetery approximately 800m to the south, there is a waste disposal site, the area slopes towards a watercourse, and there are houses/residential areas nearby.

The bulk of the site is underlain by the flat-lying Vryheid Formation of the Ecca Group, Karoo Supergroup sediments covered by grassland, shrubs and bushes. The Volksrust Formation is present as outcrops on the surface.

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).

Legend to Map and short explanation, 2728 Frankfort 1:250 000 (Muntingh 1992).

Pvo (Orange) Bluish-grey or dark grey mudstone and shale, subordinate siltstone. Volksrust Formation, Ecca Group, Karoo Supergroup.

Pv (brown) Sandstone, dark grey mudstone and shale, coal beds in places. Vryheid Formation, Ecca Group, Karoo Supergroup.

Jd – Dolerite.

Amersfoort is present in the top right hand corner of the map.

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.

The Volkrust Formation consists of a 170-270 m of soft blue shale. This formation stretches from the eastern perimeter of the basin around the northern edge of the basin ending on the western Tierberg Formation. It rest conformably on the Vryheid Formation. Fossils are rare, but fish scales and fossil wood have been reported (Kent 1980). This formation is only present in the northern basin as fine shale and siltstone (Snyman 1996). Both the Vryheid and Volksrust Formations overlie the Pietermaritzburg Formation (Johnson 2009).

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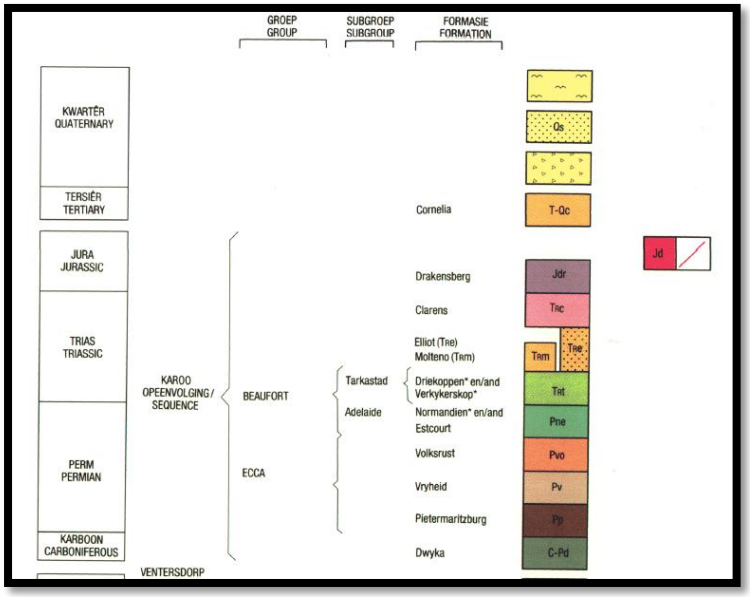
Lithostratigraphic column to show the Ecca Group within the Karoo Supergroup (Muntingh 1992).



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 at the end of November, conditions were wet. The study area shows one portion, portion 19 which is roughly rectangular. A fair amount of levelling will be needed for infrastructure. The stream is flowing at present.

The photographs show the gentle sloping topography. Rocky outcrops can be seen and the sandstone bank belonging to the Vryheid Formation is very prominent.

The photograph below shows the view towards the Township and the waste disposal area (rubbish dump). The yellow bank in the background is the Vryheid Formation sandstone. The greyish soil is the result of the weathering bluish-grey mudstone and shale.

The photograph below shows the view towards the wetland. The silos are to the left (south) of the photograph.

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 sandstones.

Both photographs below are in a gulley showing a bank of sandstone and siltstones.

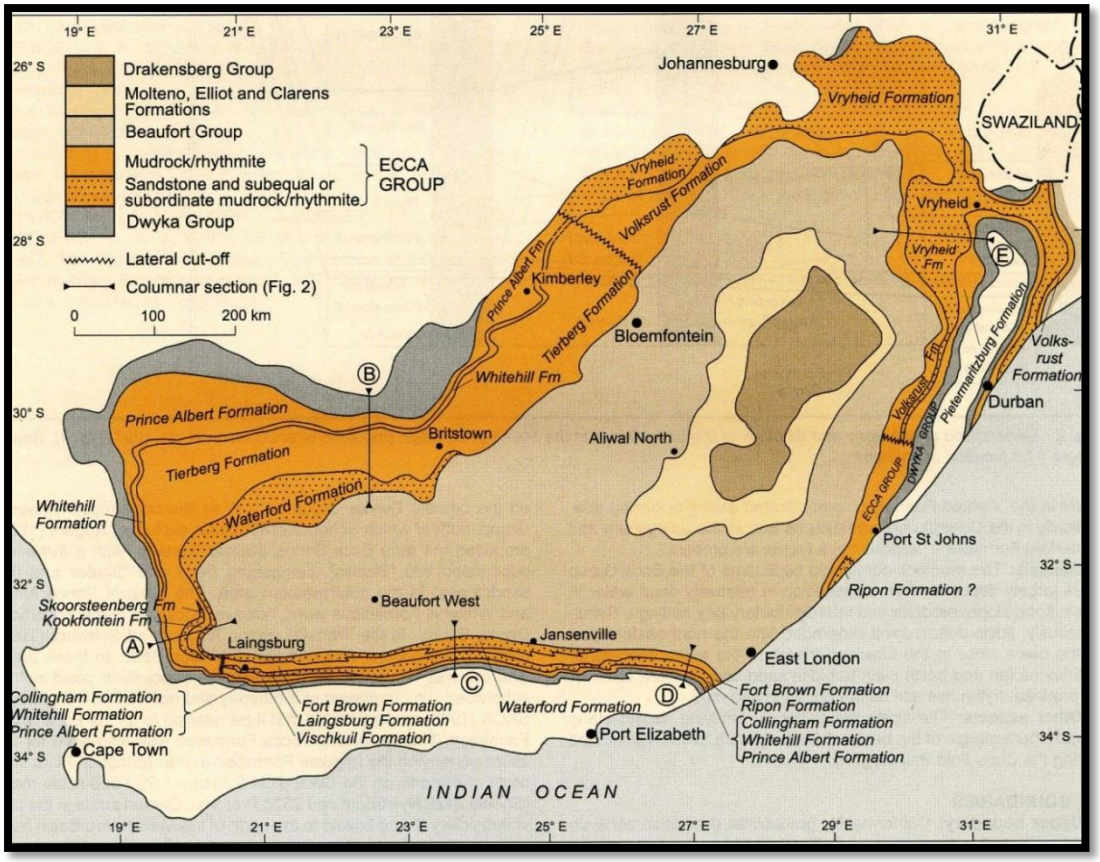
Photograph below is of a typical Vryheid formation lithostratigraphy. It shows the grit overlying the solid bank of yellow sandstone. This donga is at a lower level than the rest of the site.

There is some concern with the property (portion 19) on which the Department of Agriculture wants to construct an abattoir. The area has a small inlier of shale present, if the footprint of the building can be moved due to the large extent of the site and foundations are not deeper than 600mm it may be possible to avoid building on the shale. If the shale covers the entire site then 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 and HIGH for the Volksrust 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
Volksrust Formation (Pvo)	HIGH	Desktop study is required and based on the outcome of the desktop study, a field assessment is likely.
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 and HIGH for the Volksrust 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 November 2014. 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 Volksrust and Vryheid Formations, 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.

Bivalves (Volksrust Formation) are part of the phylum Mollusca and as such are relatives of animals as diverse as slugs and snails (gastropods), plated chitons, elongate scaphopods, the squids, cuttlefish, octopuses, as well as the nautiloids and the extinct ammonoids and belemnites. Molluscs are essentially marine animals, although bivalves and gastropods do occupy fresh water niches. Bivalves first appear in the early Ordovician, and became very successful since the beginning of the Triassic. Shell form and dentition are important in the classification of fossil bivalves (Moody 1983) (Appendix 1).

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 of the new abattoir and associated infrastructure, 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 and HIGH. A Phase 2 Palaeontological Mitigation may be required as the Phase 1 Palaeontological Assessment found a fossiliferous outcrop (Volksrust and 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: Location Alternative one, 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 Scoping Document (BAR) provided by Aurecon (Pty) Ltd.
c. Areas that would involve mitigation and may need a permit from the South African Heritage Resources Agency are discussed.
d. The following should be conserved: if any palaeontological material is exposed during digging, excavating, drilling or blasting, SAHRA must be notified. All development activities must be stopped and a palaeontologist should be called in to determine proper mitigation measures. Especially 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.

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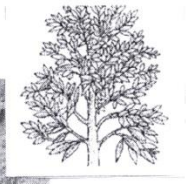
Heidi Fourie
2014/12/12

Appendix 1: Examples of Vryheid Formation fossils.

Ecca Group

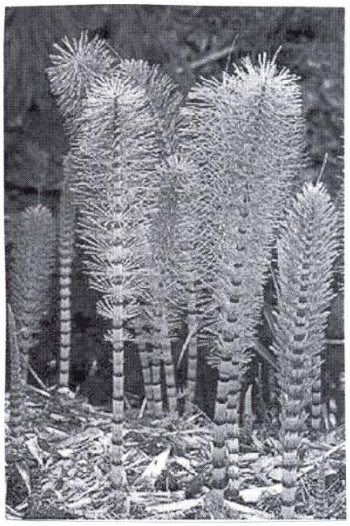
Vryheid Formation

Glossopteris



Ferns

Horsetails



Clubmosses

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

Example of fossil bivalves.

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.