Environmental Impact Assessment Report and Environmental Management Programme Report for Listed Activities Associated with a Mining Right Amendment on Portion 61 & 62 of the Farm Cyferfontein 457-KR

Modimolle Local Municipality, Waterberg District Municipality, Limpopo Province.

Farm: Portion 61 and 62 of the Farm Cyferfontein 457-KR

Fourie, H. Dr heidicindy@yahoo.com

012 322 7632/079 940 6048

Palaeontological Impact Assessment: Phase 1: Field Study

Commissioned by: BECS Services

358 Serene Street,

Garsfontein, Pretoria,

0081

072 191 6074

Ref: DMR LP30//5/1/2/3/2/1/71

2020/09/06

Fossil plant – Irrigation Formation

B. Executive summary (this Section must be in the EMPr)

Outline of the development project: BECS Services has facilitated the appointment of Dr H. Fourie, a palaeontologist, to undertake a Palaeontological Impact Assessment (PIA), Phase 1: Field Study of the Environmental Impact Assessment Report and Environmental Management Programme Report for Listed Activities Associated with a Mining Right Amendment on Portion 61 & 62 of the Farm Cyferfontein 457-KR, on Portion 61 and 62 of the Farm Cyferfontein 457-KR in the Modimolle Local Municipality, Waterberg District Municipality, Limpopo Province.

The applicant, Imerys Refractory Minerals SouthAfrica (Pty) Ltd Cyferfontein Mine plans to mine a quarry for clay.

The Project includes one Alternative (Figure 2):
Alternative 1: The site is blocked in yellow with the N1 National Road to the west and the R33 Road to the north. The existing clay mine is to the north.
The area is approximately 107 hectares.

Legal requirements:-

The **National Heritage Resources Act (Act No. 25 of 1999) (NHRA)** requires that all heritage resources, that is, all places or objects of aesthetic, architectural, historical, scientific, social, spiritual, linguistic or technological value or significance are protected. The Republic of South Africa (RSA) has a remarkably rich fossil record that stretches back in time for some 3.5 billion years and must be protected for its scientific value. Fossil heritage of national and international significance is found within all provinces of the RSA. South Africa's unique and non-renewable palaeontological heritage is protected in terms of the National Heritage Resources Act. According to this act, palaeontological resources may not be excavated, damaged, destroyed or otherwise impacted by any development without prior assessment and without a permit from the relevant heritage resources authority.

The main aim of the assessment process is to document resources in the development area and identify both the negative and positive impacts that the development brings to the receiving environment. The PIA therefore identifies palaeontological resources in the area to be developed and makes recommendations for protection or mitigation of these resources.

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

A Palaeontological Impact Assessment is generally warranted where rock units of **LOW to VERY HIGH** palaeontological sensitivity are concerned, levels of bedrock exposure within the study area are adequate; large scale projects with high potential heritage impact are planned; and where the distribution and nature of fossil remains in the proposed area is unknown. The specialist will inform whether further monitoring and mitigation are necessary.

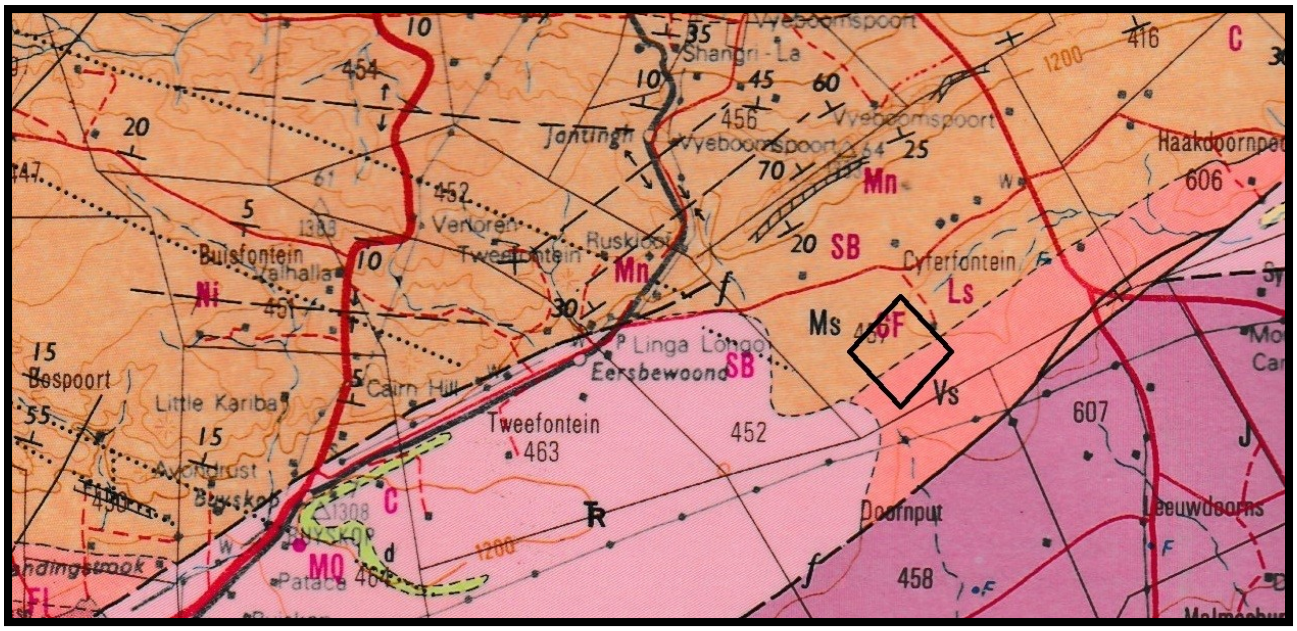
Types and ranges of heritage resources as outlined in Section 3 of the National Heritage Resources Act (Act No.25 of 1999):
(i) (i) objects recovered from the soil or waters of South Africa, including archaeological and palaeontological objects and material, meteorites and rare geological specimens.
This report adheres to the guidelines of Section 38 (1) of the National Heritage Resources Act (Act No. 25 of 1999).

Subject to the provisions of subsections (7), (8) and (9), any person who intends to undertake a development categorised as (a) the construction of a road, wall, power line, pipeline, canal or other similar form of linear development or barrier exceeding 300 m in length; (b) the construction of a bridge or similar structure exceeding 50 m in length; (c) any development or other activity which will change the character of a site (see Section 38); (d) the re-zoning of a site exceeding 10 000 m² in extent; (e) or any other category of development provided for in regulations by SAHRA or a PHRA authority.

This report (**1c)** aims to provide comment and recommendations on the potential impacts that the proposed development project / mining (if applicable) could have on the fossil heritage of the area and to state if any mitigation or conservation measures are necessary.

<u>Outline of the geology and the palaeontology</u>:
The geology was obtained from map 1:100 000, Geology of the Republic of South Africa (Visser 1984) and 1:250 000, 2428 Nylstroom (du Plessis 1978).

Figure 3: The geology of the development area.



Legend to map and short explanation.
d – Diabase (green). Vaalian to post Mockolian.
TR –Fine-grained red to cream sandstone (pink). Clarens Formation, Karoo Supergroup. Triassic.
Ms – Medium to coarse-grained sandstone; pebble-sandstone; tuffaceous graywacke; siltstone, shale and conglomerate (brown). Swaershoek Formation, Nylstroom Subgroup, Waterberg Group. Mokolian.
Vs – Volcanic rocks, sandstone,quartzite (amber). Schrikkloof Formation, Rooiberg Group, Transvaal Supergroup. Vaalian.
…… – (black) Lineament (Landsat, aeromagnetic).
------ - Concealed geological boundary.
---f--- - Fault.
⊥20 – Strike and dip of bed.
◊ – Proposed development (in black).

The Waterberg Group of rocks today occurs in several separate regions: in the Limpopo and Mpumalanga Provinces. These separate patches probably originally formed a single sheet of sedimentary rocks that since

became fragmented as a result of erosion. A deep red iron oxide is responsible for the colouration. As the rocks are chemically resistant and very hard, they produce spectacular cliffs and mountainous topography (McCarthy and Rubidge 2005). Snyman (1996) places the age as 1 800 Ma till 1 700 Ma (Mokolian). A threefold subdivision is recognised, the Nylstroom, Matlabas and Kransberg Subgroups. It overlies the Loskop Formation. The succession in the early Waterberg basin (the Nylstroom protobasin and Alma trough) comprises the Swaershoek sandstone and Alma graywacke Formations. The Swaershoek Formation (Ms) extends over the entire Nylstroom syncline and the northern slopes of the Swaershoekberge and the Hoekberge. It overlies the Rooiberg Group of the Transvaal Supergroup (Kent 1980). This formation forms the base of the Waterberg Group with a maximum thickness of 2500 m (Visser 1989).

The Rooiberg Group is a 2500-6000m thick succession of feldspathic quartzites, arkoses and shales, with interbedded volcanics and felsites. It consists of two formations, the lower Damwal (Vdr) and the upper Selons River (Vs), restricted in its distribution to the central part of the basin (Kent 1980, Snyman 1996). It (Selons River) was further subdivided into the lower Doornkloof Felsite Member and an upper Klipnek Felsite Member (Kent 1980, Visser 1989) and west of Warmbath (Bela Bela) it is again subdivided into two units, the Kwaggasnek Formation and the Schrikkloof Formation (Vs). A layer of amygdaloidal rhyolite is present close to the top of the Kwaggasnek Formation. It rests on the Smelterskop sediments at Rooiberg and is intruded by Nebo granite. The Schrikkloof Formation in the Nylstroom area is conformably overlain by sediments from the Waterberg Group in an ash-flow sheet. Together with the Kwaggasnek Formation it reaches thicknesses of 6000 m as is equivalent to the Selonsrivier Formation.This group has an estimated age of 2,150 Ma (Visser 1989).

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

Trace fossils may be present in the Waterberg Group (see Section G). Nixon *et al.* (1988) described the black shales south-west of Potchefstroom as consisting of overlapping laminated basal mounds which are stromatolitic as well as spheroidal possible planktonic fossil algae. These can range in size from 3.5 - 17 mm in height and up to 10 mm in diameter and can be present in the development area.

Fossils have not been recorded from the Schrikkloof Formation.

Summary of findings (**1d**): The Palaeontological Impact Assessment Phase 1: Field Study was undertaken in August 2020 in the spring in hot and dry conditions (**1c)** during the official Level 2 covid-19 lockdown, and the following is reported:

The project includes one Alternative (Figure 2) with the same **LOW** impact, it is the contact zone between the Swaershoek and Schrikkloof Formations that are mined.
Alternative 1: The site is blocked in yellow with the N1 National Road to the west and the R33 Road to the north. The existing clay mine is to the north.
The area is approximately 107 hectares.

Field Observation: The property is currently used for game and cattle farming and the vegetation is lush with mature trees and tall grass. Outcrops and fossils were not found.

Recommendation:

The potential impact of the development on fossil heritage is **LOW,** but the Clarens Formation with a **HIGH** sensitivity is to the south-west and therefore a field survey was conducted for this development (according to SAHRA protocol). If chance fossils are found during construction a Phase 2: Mitigation are recommended (stromatolites). Fossils have been recorded from the Clarens Formation (Section G).

Concerns/threats (**1g**) to be added to the EMPr:

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

The recommendations are (**1ni, 1niA,1nii)**:

1. Mitigation may be needed (Appendix 2) if fossils are found.
2. No consultation with parties was necessary. The Environmental Control Officer must familiarise him- or herself with the formation present and its fossils.
3. The development may go ahead, but the ECO together with the mine geologist must survey for fossils before and or after clearing, blasting, drilling or excavating.
4. The EMPr already covers the conservation of heritage and palaeontological material that may be exposed during construction activities. For a chance find, the protocol is to immediately cease all construction activities, construct a 30 m no-go barrier, and contact SAHRA for further investigation. It is recommended that the EMPr be updated to include the involvement of a palaeontologist for pre-construction training of the ECO.

Stakeholders: Developer – Imerys Refractory Minerals South Africa (Pty) Ltd, Cyferfontein Mine.
Environmental – BECS Services, 358 Serene Road, Garsfontein, Pretoria, 0081.
Landowner – Morula Tona Boerdery CC, Mr Ikey Jooste.

C. Table of Contents

D. Background information on the project

Report

This report is part of the environmental impact assessment process under the National Environmental Management Act, as amended (Act No. 107 of 1998) (NEMA) and includes Appendix 6 (May 2019) of the Environmental Impact Assessment Regulations (see Appendix 3). It is also in compliance with The Minimum Standards for Palaeontological Components of Heritage Impact Assessment Reports (**2**), SAHRA, APMHOB, Guidelines 2012, Pp 1-15.

Outline of development

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

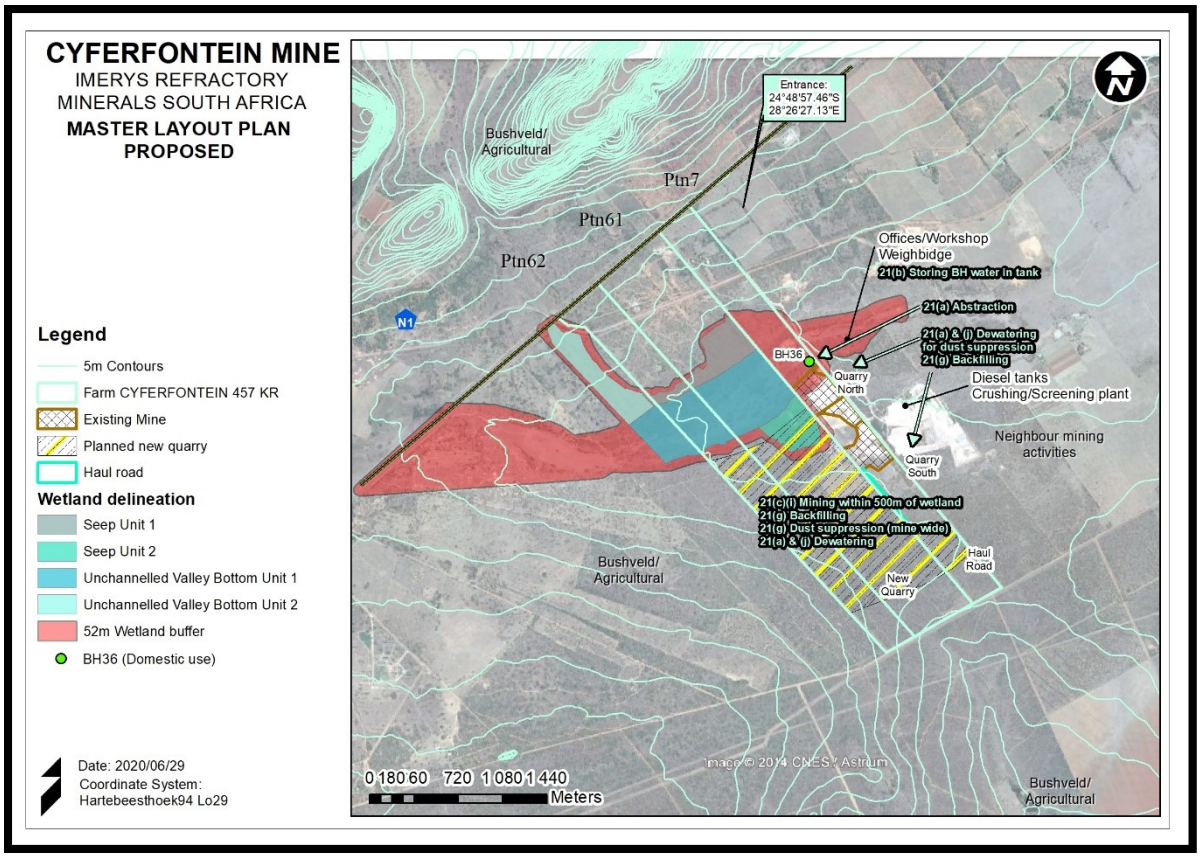
The applicant, Imerys Refractory Minerals South Africa (Pty) Ltd proposes to mine for clay. It will be an open quarry with rehabilitation in an ongoing basis using roll-over mining. The topsoil is stockpiled, to be reused during rehabilitation. There is no blasting as the material excavated is soft enough for free digging. It is the contact zone between the Swaershoek and Schrikkloof Formations that are mined.

The following related infrastructure will be present (**1f**):

- Road,
- Quarry.

Local benefits of the proposed development include benefits to the local economy through possible job creation, local inhabitants, and local supplier procurement during the mining phase as well as during the mine closure phase of the development.

Figure 1: Topographic map (BECS Services).



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The area is approximately 107 hectares.

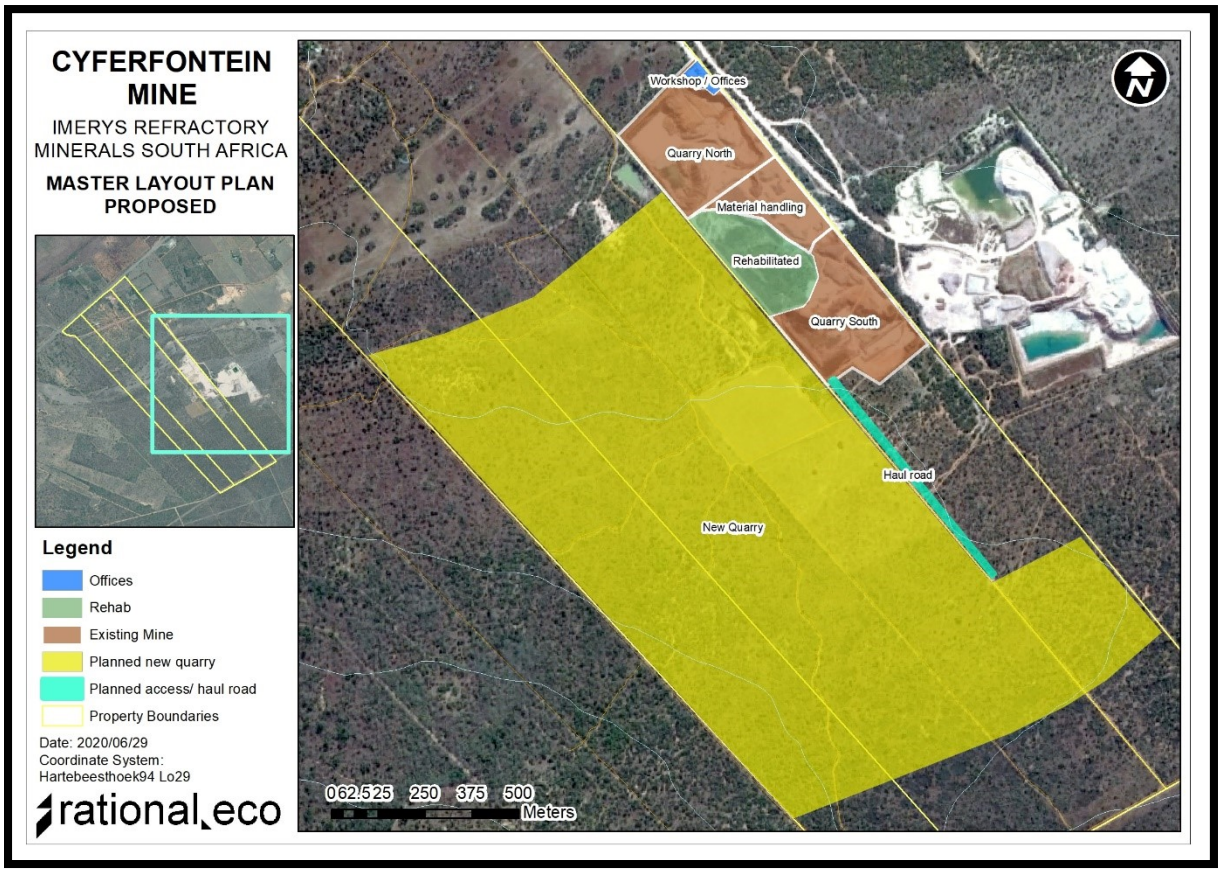
Rezoning/ and or subdivision of land: No.
Name of developer and consultant: Imerys Refractory Minerals South Africa (Pty) Ltd, Cyferfontein Mine and BECS Services.
Terms of reference: Dr H. Fourie is a palaeontologist commissioned to do a palaeontological impact assessment: field study to ascertain if 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.
Curriculum vitae – short (**1aii, 1aii**): Dr Fourie obtained a Ph.D from the Bernard Price Institute for Palaeontological Research (now ESI), University of the Witwatersrand. Her undergraduate degree is in Geology and Zoology. She specialises in vertebrate morphology and function concentrating on the Therapsid Therocephalia. She is currently employed by Ditsong: National Museum of Natural History as Curator of the fossil plant, invertebrate, amphibian, fish, reptile, dinosaur and Therapsid collections. For the past 13 years she carried out field work in the Eastern Cape, Western Cape, North West, Northern Cape, Free State, Gauteng, Limpopo, Kwazulu Natal, and Mpumalanga Provinces. Dr Fourie has been employed at the Ditsong: National Museum of Natural History in Pretoria (formerly Transvaal Museum) for 26 years.
Legislative requirements: South African Heritage Resources Agency (SAHRA) for issue of permits if necessary. National Heritage Resources Act (Act No. 25 of 1999). An electronic copy of this report must be supplied to SAHRA.

E. Description of property or affected environment
Location and depth:

The proposed Environmental Impact Assessment Report and Environmental Management Programme Report for Listed Activities Associated with a Mining Right Amendment on Portion 61 & 62 of the Farm Cyferfontein 457-KR, will be situated on Portion 61 and 62 of the Farm Cyferfontein 457-KR in the Modimolle Local Municipality, Waterberg District Municipality, Limpopo Province.

Depth is determined by the related infrastructure to be developed and the thickness of the formation in the development area as well as depth of the foundations, footings and channels to be developed. Details of the location and distribution of all significant fossil sites or key fossiliferous rock units are often difficult to determine due to thick topsoil, subsoil, overburden and alluvium. Depth of the overburden may vary a lot. Geological maps do not provide depth or superficial cover, it only provides mappable surface outcrops. The depth can be verified with test pit results or drill cores and is determined by the depth of the quarry. The clay layers are 2 m below surface and gradually increases in depth towards the west and south with a total depth at 25 m to 30 m.

Figure 2: Location map (BECS Services).



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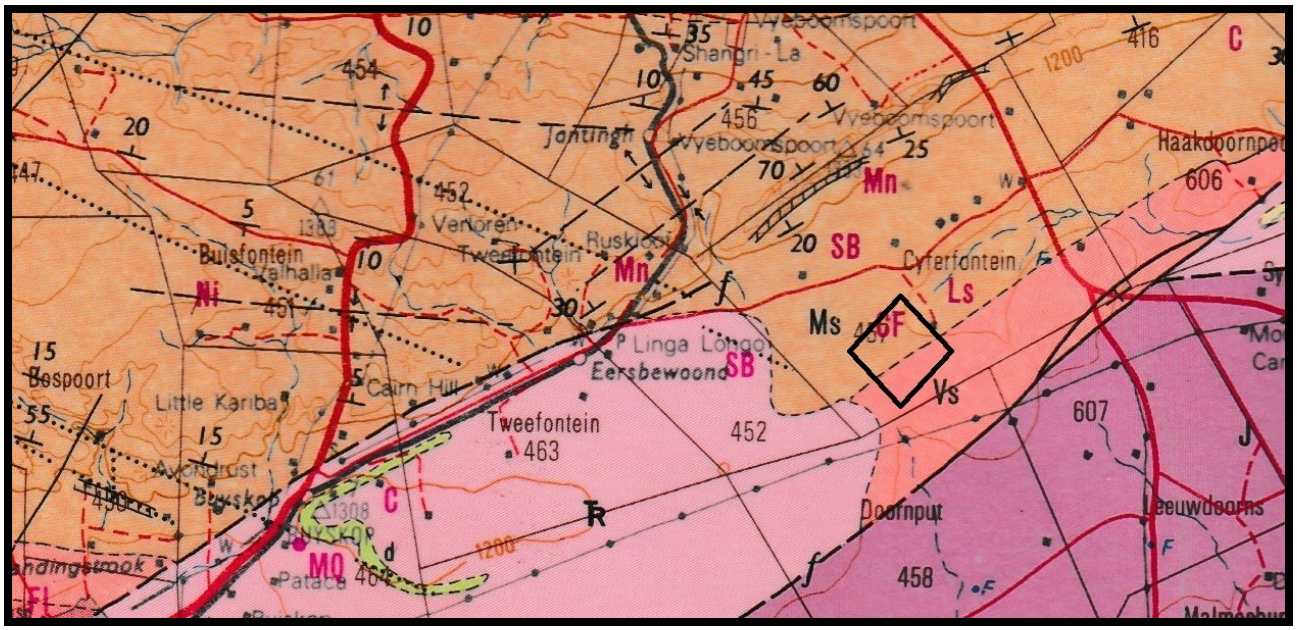
F. Description of the Geological Setting

<u>Description of the rock units:</u>

Figure 3: Excerpt of 1:250 000 Geological Map 2428 Nylstroom (du Plessis 1978) (**1h**).



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<u>Mining Activities on Figure above</u>:

CF – Plastic Fire-clay	Ls – Limestone and dolomite
Mn – Manganese	SB – Building sand

The mining past and present has an influence on the development as this is a mining project.

Geological formations present in the area are: Waterberg Group, Rooiberg Group and the Clarens Formation.

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

The Clarens Formation has a maximum thickness of 250 m in the south. Pink and yellow sandstone is fine and never coarse. Cave and cliff formation are common. Fossils are scarce, but dinosaurs are found with the fish *Semionotus capensis* (Norman and Whitfield 2006, Snyman 1996, Visser 1998).

The Waterberg Group of rocks today occurs in several separate regions: in the Limpopo and Mpumalanga Provinces. These separate patches probably originally formed a single sheet of sedimentary rocks that since became fragmented as a result of erosion. A deep red iron oxide is responsible for the colouration. As the rocks are chemically resistant and very hard, they produce spectacular cliffs and mountainous topography (McCarthy and Rubidge 2005). The Waterberg Group (Kent 1980) is known for its reddish sandstone with conglomerates present between Pretoria and Middelburg, it is older than the coal and younger than the Magaliesberg Quartzite Formation. In the Cullinan-Middelburg base only one formation has been recognised, the unconformable Wilgerivier Formation. Trace fossils are found in the Waterberg Group. Snyman (1996) places the age as 1 800 Ma till 1 700 Ma (Mokolian).

A threefold subdivision is recognised, the Nylstroom, Matlabas and Kransberg Subgroups. It overlies the Loskop Formation. The succession in the early Waterberg basin (the Nylstroom protobasin and Alma trough) comprises the Swaershoek sandstone and Alma graywacke Formations. The Swaershoek Formation extends over the entire Nylstroom syncline and the northern slopes of the Swaershoekberge and the Hoekberge. It overlies the Rooiberg Group of the Transvaal Supergroup (Kent 1980). This formation forms the base of the Waterberg Group with a maximum thickness of 2500 m (Visser 1989). Kranskop, just east of the N1 National Road and just after the Kranskop Toll Plaza, shows the reddish-weathering sandstones and subordinate of the Waterberg Group (Norman and Whitfield 2006).

The Transvaal Supergroup fills an east-west elongated basin in the south-central part of the old Transvaal (now North – West, Gauteng and Mpumalanga) as far south as Potchefstroom. It is Vaalian in age, approximately 2600 Ma to 2100 Ma. A maximum thickness of the Transvaal Supergroup reaches 2000 m in the north-eastern section. The east-west elongated basin is filled with clastic, volcanic and chemical sedimentary rocks. Three groups based on lithological differences have been established: they are the Rooiberg, Pretoria and Chuniespoort Groups as well as other smaller groups (Kent 1980, Snyman 1996). It is the Bushveld Complex that is responsible for the tilting of the Transvaal sediments and the heat of its intrusion having created andalusite crystals (Norman and Whitfield 2006). This Supergroup is underlain by the Ventersdorp, Witwatersrand and Pongola Supergroups, and the Dominion Group. Three prominent ridges are present from the oldest to the youngest, the Time Ball Hill, Daspoort and Magaliesberg Formations (Norman and Whitfield 2006).

The Rooiberg Group is a 2500-6000m thick succession of feldspathic quartzites, arkoses and shales, with interbedded volcanics and felsites. It consists of two formations, the lower Damwal (Vdr) and the upper Selons River (Vs), restricted in its distribution to the central part of the basin (Kent 1980, Snyman 1996). The Selons River Formation has either a sandstone or a quartzite at its base and mainly consists of red rhyolite. It (Selons River) was further subdivided into the lower Doornkloof Felsite Member and an upper Klipnek Felsite Member (Kent 1980, Visser 1989) and west of Warmbath (Bela Bela) it is again subdivided into two units, the Kwaggasnek Formation and the Schrikkloof Formation. A layer of amygdaloidal rhyolite is present close to the top of the Kwaggasnek Formation. It rests on the Smelterskop sediments at Rooiberg and is intruded by Nebo granite. The Schrikkloof Formation in the Nylstroom area is conformably overlain by sediments from the Waterberg Group in an ash-flow sheet. Together with the Kwaggasnek Formation it reaches thicknesses of 6000 m as is equivalent to the Selonsrivier Formation. This group has an estimated age of 2,150 Ma (Visser 1989).

Figure 4: Lithostratigraphy (du Plessis 1978).

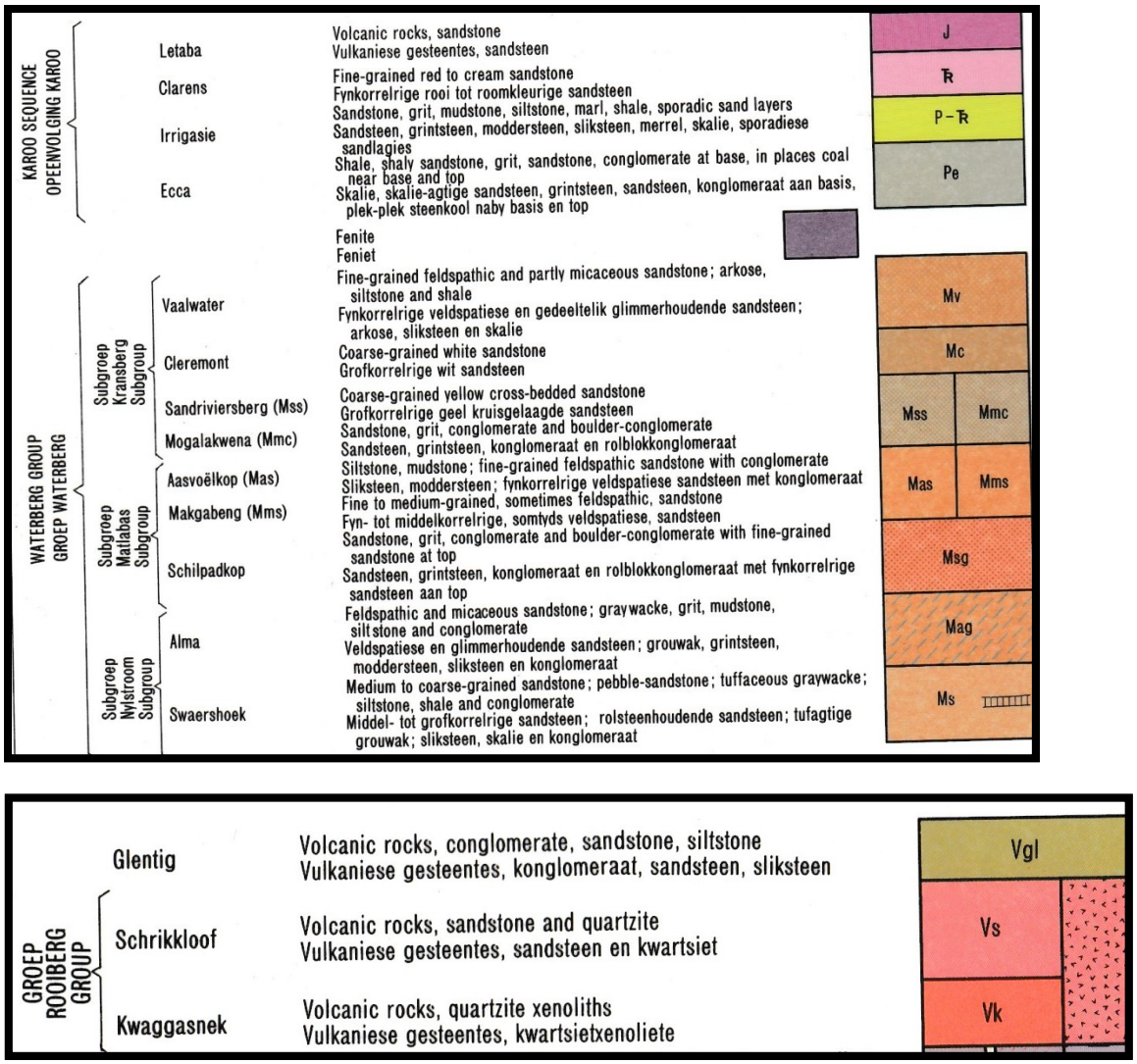
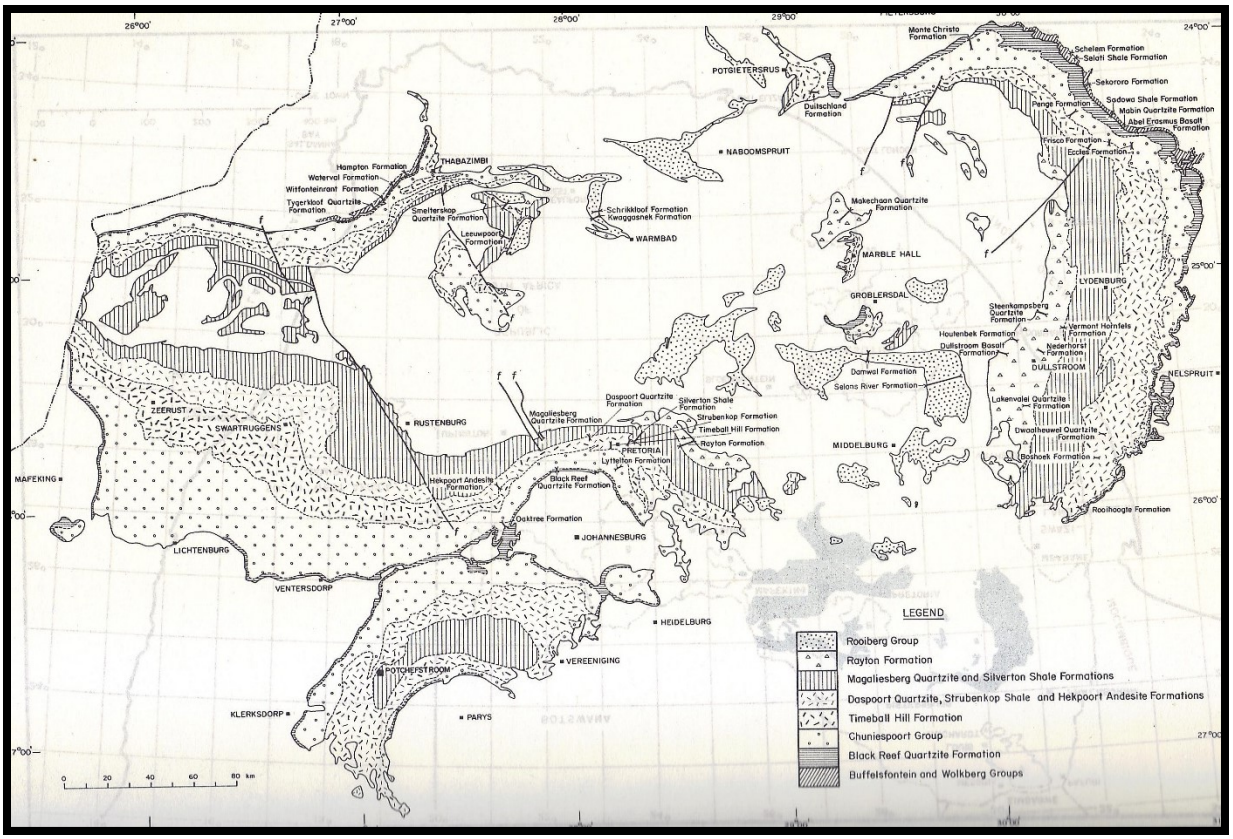


Figure 5: Map of Transvaal Supergroup showing location of the Rooiberg Group (Kent 1980).



Vaalian to post-Mokolian diabase (di) intrusions occur throughout the area in the form of plates, sills and dykes. These plates are common in the Transvaal Supergroup and when present in the Pretoria Group they are referred to as the Transvaal diabase (Kent 1980, Visser 1989). The diabase sills of Bushveld age (Norman and Whitfield 2006) is typically fine-grained, green-grey with plagioclase and pyroxenes (Visser 1989).

Field Observation: The property is currently used for game and cattle farming and the vegetation is lush with mature trees and tall grass. Outcrops and fossils were not found.

Figure 6: View in north-western corner.

Figure 7: Quarry present against eastern fence.

Figure 8: Area where cattle are kept.

Figure 9: South section.

Figure 10: Towards the middle in the west.

G. Background to Palaeontology of the area (1j)

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).

Amphibians, non-dinosaurian archosaurs, theropod dinosaurs, dinosaur eggs, therapsids, mammaliaformes, crocodilomorphs, and chelonia make up the fauna of the Elliot and Clarens Formations (Chinsamy-Turan 2012, Groenewald 1986). Most recently, the fossil bones of a plant-eating dinosaur (Highland Giant) have been discovered near the Lesotho border in Clarens. Aeolonites, belonging to the Jurassic aged Clarens and Tshipise Formations contain petrified logs, trace fossils of insects and dinosaur trackways (possibly *Massospondylus, Syntarsus / Coelophysis*) (Groenewald and Groenewald 2014).

Near Hammanskraal and Temba where the old smoke stacks are, is the abandoned refractory fire-clay mine which mined the weathered shale of the Ecca Group (Norman and Whitfield 2006). The geological map indicates this as the Irrigasie Formation (P-TR) and this abandoned mine has yielded some beautiful plant fossils of *Glossopteris* flora (see photo on Title page).

Trace fossils may be present in the Waterberg Group (see Table below). Nixon *et al.* (1988) described the black shales south-west of Potchefstroom as consisting of overlapping laminated basal mounds which are stromatolitic as well as spheroidal possible planktonic fossil algae. These can range in size from 3.5 - 17 mm in height and up to 10 mm in diameter and can be present in the development area.

Chemical sediments such as fine-grained limestone and dolomite is made up of deposits of organically derived carbonate shells, particles or precipitate. Dolomite is magnesium-rich limestone formed from algal beds and stromatolites. These Early Proterozoic Transvaal stromatolitic dolomites formed and released free oxygen at around 2900 – 2400 Ma. These are accepted to be the fossil remnants of the simplest single-celled organisms. They occur as finely layered, concentric, mound-like structures formed by microscopic algal organisms (Norman and Whitfield 2006). Chert may contain fossils such as echinoids or sponges if nodular, although not common and is rated unlikely. Similar stromatolites may occur.

Figure 11: Stromatolite in dolomite (Photograph E. Butler).

Fossils have not been recorded from the Schrikkloof Formation.

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

SPRINGBOKFLATS ELLISRAS	Clarens (TR; TRc; Jc)			Aeolian sandstones, minor ephermeral stream deposits	Dinosaur remains and trackways can be expected	Very poor levels of surface exposure (most data obtained from borehole cores)
Kransberg (kr1)		Vaalwater (Mv; vw) Cleremont (Mc; c) Sandriviersberg Mogalakwena (Msm)		Continental "red beds" - predominantly braided stream deposits (sandstones, conglomerates with minor mudrocks), Also beach, tidal flat, lacustrine, aeolian and possible marine shelf sediments Musekwa Member also refered to as Musekwa Formation. 400m thick volcanic assemblage Early to Mid Proterozoic (Mokolian) c. 2 to 1.7 Ga	Earliest known terrestrial cyanobacterial mats recorded from playa lake deposits of the Makgabeng Fm (Waterberg Group) (1.8 Ga) on the Makgabeng Plateau, Waterberg	Early Proterozoic "red beds" provide evidence for the development of an oxygenated atmosphere after c. 2Ga Glentig Formation was previously included within the uppermost Pretoria Group (1: 1 million map) but is now regarded as a proto-Waterberg / Soutpansberg unit.
Matlabas		Aasvo lkop (Mam; as) Makgabeng (mk) Skilpadkop (sk) Setlaole (Mss)				
Nylstroom		Alma (Ma; al) Swaershoek (Msw; sw)				
		Glentig (Vgl)				

Selons River(Vs; Vse) (now renamed subdivided into Kwaggasnek (Vkw; Vkn), Schrikkloof (Vzf) and Rinkhalskop (Vrh)) Smelterskop (Vsm1; Vsm2; Vsm3; Vsm4; Vsm5; Vsm6)		Volcanics plus minor, thin but extensive horizons of metamorphosed sediments (quartzites, sandstones, mudrocks, cherts), mainly of fluvial origin. Volcanics are related to intrusives of the underlying Bushveld Magmatic Province 2.06 Ga	Fossils within minor sedimentary units unlikely because of fluvial depositional setting and subsequent metamorphism..	Possible evidence for a catastrophic event at the base of Rooiberg Group (basin floor collapse, slumping, volcanism) Selons River and Kwaggasnek units previously included within upper Pretoria Group by some geologists
Damwal (Vdr)				

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 **LOW** for the Swaershoek and Schrikkloof Formations.

Table 2: Criteria used (Fossil Heritage Layer Browser/SAHRA) (**1cB**).

Rock Unit	Significance/vulnerability	Recommended Action
Clarens	High	Desktop Study and Field Assessment likely
Swaershoek Formation	Low	Desktop Study
Schrikkloof Formation	Low	Desktop Study

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

BLUE	Low Palaeontological sensitivity/vulnerability. Low possibility that fossils that are described in the literature will be visible to the naked eye or be recognized as fossils by untrained persons. Fossils of for example small domal Stromatolites as well as micro-bacteria are associated with these rock units. Fossils of micro-bacteria are extremely important for our understanding of the development of Life, but are only visible under large magnification. Recording of the fossils will contribute significantly to the present knowledge and understanding of the development of Life in the region. Where geological units are allocated a blue colour of significance, and the geological unit is surrounded by highly significant geological units (red or orange coloured units), a palaeontologist must be appointed to do a desktop survey and to make professional recommendations on the impact of development on significant palaeontological finds that might occur in the unit that is allocated a blue colour. An example of this scenario will be where the scale of mapping on the 1:250 000 scale maps excludes small outcrops of highly significant sedimentary rock units occurring in dolerite sill outcrops. Collection of a representative sample of potential fossiliferous material recommended.

The project includes one Alternative (Figure 2) with a **LOW** impact, it is the contact zone between the Swaershoek and Schrikkloof Formations that are mined.

H. Description of the Methodology (1e)

The palaeontological impact assessment field study was undertaken in August 2020 during the official covid-19 Level 2 lockdown. A Phase 1: Field Study includes a walk through and drive through of the affected portion and photographs (in 20 mega pixels) taken of the site with a digital camera (Canon PowerShot SX620HS). It may be necessary to use a Global Positioning System (GPS) (Garmin eTrex 10) to record outcrops if not covered with topsoil, subsoil, overburden, and vegetation. A literature survey is included and the study relied on literature, geological maps, google.maps, and google.earth images.

SAHRA Document 7/6/9/2/1 requires track records/logs from archaeologists not palaeontologists as palaeontologists concentrate on outcrops which may be recorded on a GPS. Isolated occurrences of rocks usually do not constitute an outcrop. Fossils can occur in dongas, as nodules, in fresh rock exposures, and in riverbeds. Finding fossils require the experience and technical knowledge of the professional palaeontologist, but that does not mean that an amateur can't find fossils. The geology of the region is used to predict what type of fossil and zone will be found in any particular region. An archaeozoologist can be called upon to survey for more recent fossils in the Quaternary and Tertiary deposits, if present.

Assumptions and Limitations (**1e**):-
The accuracy and reliability of the report may be limited by the following constraints:

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

A Phase 1 Palaeontological Impact Assessment: Field Study will include:

1. Recommendations for the future of the site.
2. Background information on the project.
3. Description of the property of affected environment with details of the study area.
4. Description of the geological setting and field observations.
5. Background to palaeontology of the area.
6. Heritage rating.
7. Stating of significance (Heritage Value).

A Phase 2 Palaeontological Impact Assessment: Mitigation will include:

1. Recommendations for the future of the site.
2. Description of work done (including number of people and their responsibilities).
3. A written assessment of the work done, fossils excavated, not removed or collected and observed.
4. Conclusion reached regarding the fossil material.
5. A detailed site plan.
6. Possible declaration as a heritage site or Site Management Plan.

The National Heritage Resources Act No. 25 of 1999 further prescribes -

> Act No. 25 of 1999. National Heritage Resources Act, 1999.
> The National Estate as: 3 (2) (f) archaeological and palaeontological sites, (i)(1) objects recovered from the soil or waters of South Africa, including archaeological and palaeontological objects and material, meteorites and rare geological specimens,
> Heritage assessment criteria and grading used: (a) Grade 1: Heritage resources with qualities so exceptional that they are of special national significance;
> (b) Grade 2: Heritage resources which, although forming part of the national estate, can be considered to have special qualities which make them significant within the context of a province or a region; and
> (c) Grade 3: Other heritage resources worthy of conservation.

SAHRA is responsible for the identification and management of Grade 1 heritage resources.
Provincial Heritage Resources Authority (PHRA) identifies and manages Grade 2 heritage resources.
Local authorities identify and manage Grade 3 heritage resources.

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

Archaeology, palaeontology and meteorites: Section 35.
(2) Subject to the provisions of subsection (8) (a), all archaeological objects, palaeontological material and meteorites are the property of the State.
(3) Any person who discovers archaeological or palaeontological objects or material or a meteorite in the course of development or agricultural activity must immediately report the find to the responsible heritage resources authority, or to the nearest local authority offices or museum, which must immediately notify such heritage resources authority.

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

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

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

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

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

I. Description of significant fossil occurrences

One of the formations in the development area may contain fossils. Nixon *et al.* (1988) described the black shales south-west of Potchefstroom as consisting of overlapping laminated basal mounds which are stromatolitic

as well as spheroidal possible planktonic fossil algae. These can range in size from 3.5 - 17 mm in height and up to 10 mm in diameter and can be present in the development area.

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 threats to the National Palaeontological Heritage are:- earth moving equipment/machinery (for example haul trucks, front end loaders, excavators, graders, dozers) during construction, prospecting, mining activities, the sealing-in or destruction of fossils by development, vehicle traffic, and human disturbance. See Description of the Geological Setting (F) above.

J. Recommendation (1o,1p, 1q)

a. There is no objection (see Recommendation B) to the development, 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 **LOW** with an area with a **HIGH** sensitivity to the south-west, but if a chance fossil is found A Phase 2: Palaeontological Assessment Mitigation or conservation or if surface fossils are found during clearing, construction excavations, drilling and blasting. The Protocol for Chance Finds and Management Plan is attached (Appendix 2) for the ECO.
b. This project will benefit the environment, economy, and social development of the community.
c. Preferred choice: Only one Alternative is presented (see Executive Summary).
d. The following should be conserved: if any palaeontological material is exposed during clearing, 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.
e. Consultation with parties was not necessary.

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

a. Objections: Cautious. See heritage value and recommendation.
b. Conditions of development: See Recommendation.
c. Areas that may need a permit: Only if a fossil is unearthed.
d. Permits for mitigation: **SAHRA/PHRA**.

K. Conclusions

a. All the land involved in the development was assessed and none of the property is unsuitable for development (see Recommendation B).
b. All information needed for the Phase 1 Palaeontological Impact Assessment and Field scope was provided by the Consultant. All technical information was provided by BECS Services.
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, a 30 m no-go barrier constructed and a palaeontologist should be called in to determine proper mitigation measures, especially for shallow caves (quaternary / dolomite).
e. Condition in which development may proceed: It is further suggested that a Section 37(2) agreement of the Occupational, Health and Safety Act 85 of 1993 is signed with the relevant

contractors to protect the environment (fossils) and adjacent areas as well as for safety and security reasons.

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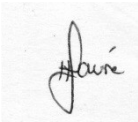
Declaration (disclaimer) 1(b)

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

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

It may be possible that the PIA Phase 1: Field Study may have missed palaeontological resources in the project area as outcrops are not always present or visible due to vegetation while others may lie below the overburden of earth and may only be present once development commences.

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



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Heidi Fourie
2020/09/06

Appendix 1 (**1k,1l,1m**): **Protocol for Chance Finds and Management plan**

This section covers the recommended protocol for a Phase 2 Mitigation process as well as for reports where the Palaeontological Sensitivity is **LOW**; this process guides the palaeontologist / palaeobotanist on site and should not be attempted by the layman / developer. As part of the Environmental Authorisation conditions, an Environmental Control Officer (ECO) will be appointed to oversee the construction activities in line with the legally binding Environmental Management Programme (EMPr) so that when a fossil is unearthed they can notify the relevant department and specialist to further investigate. Therefore, the EMPr must be updated to include the involvement of a palaeontologist during the digging and excavation (ground breaking) phase of the development.

The EMPr already covers the conservation of heritage and palaeontological material that may be exposed during construction activities.

- The protocol is to immediately cease all construction activities if a fossil is unearthed and contact SAHRA for further investigation.
- The area must be fenced-off with a 30 m barrier and the construction workers must be informed that this is a no-go area.
- If fossils were found, they must be placed in a safe area for further investigation.
- The ECO should familiarise him- or herself with the fossiliferous formations and its fossils.
- A site visit is recommended after drilling, excavations and blasting and the keeping of a photographic record. A regular monitoring presence over the period during which excavations are made, by a palaeontologist, is generally not practical, but can be done during ground breaking.
- The Evolutionary Studies Institute, University of the Witwatersrand has good examples of Ecca Group Fossils.
- The developer must survey the areas affected by the development and indicate on plan where the construction / development / mining (if applicable) 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 (if present). 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 fossil localities. Mitigation can provide valuable onsite research that can benefit both the community and the palaeontological fraternity.

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

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

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

5. A detailed site plan and map.
6. Possible declaration as a heritage site or Site Management Plan.
7. Stakeholders.
8. Detailed report including the Desktop and Phase 1 study information.
9. Annual interim or progress Phase 2 permit reports as well as the final report.
10. Methodology used.

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

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

1. The developer needs to clearly stake or peg-out (survey) the areas affected by the mining (if applicable)/ construction/ development operations and dig representative trenches and if possible supply geological borehole data.
2. When clearing topsoil, subsoil or overburden and hard rock (outcrop) is found, the contractor / developer needs to stop all work.
3. 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.
4. 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.
5. 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.
6. When permission for the development is granted, the next layer can be removed, if this is part of a fossiliferous layer, then with the removal of each layer of sediment, the palaeontologist / palaeobotanist must do an investigation (a minimum of once a week).
7. At this stage the palaeontologist / palaeobotanist in consultation with the developer / mining company must ensure that a further working protocol and schedule is in place. Onsite training should take place, followed by an annual visit by the palaeontologist / palaeobotanist.

Fossil excavation if necessary during Phase 2:

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

SAHRA Documents:

Guidelines to Palaeontological Permitting Policy.
Minimum Standards: Palaeontological Component of Heritage Impact Assessment reports.
Guidelines for Field Reports.
Palaeotechnical Reports for all the Provinces.

Appendix 2: Table of Appendix 6 requirements.

Section in Report	Point in Act	Requirement
B	1(c)	Scope and purpose of report
B	1(d)	Duration, date and season
B	1(g)	Areas to be avoided
D	1(ai)	Specialist who prepared report
D	1(aii)	Expertise of the specialist
F Figure 3	1(h)	Map
B	1(ni)(niA)	Authorisation
B	1(nii)	Avoidance, management, mitigation and closure plan
G Table 1	1(cA)	Quality and age of base data
G Table 2	1(cB)	Existing and cumulative impacts
D	1(f)	Details or activities of assessment
G	1(j)	Description of findings
H	1(e)	Description of methodology
H	1(i)	Assumptions
J	1(o)	Consultation
J	1(p)	Copies of comments during consultation
J	1(q)	Information requested by authority
Declaration	1(b)	Independent declaration
Appendix 2	1(k)	Mitigation included in EMPr
Appendix 2	1(l)	Conditions included in EMPr
Appendix 2	1(m)	Monitoring included in EMPr
D	2	Protocol or minimum standard

Appendix 3: **Impact Summary**

The development footprint is situated on the contact between the Swaershoek and Schrikkloof Formations which is present northeast of Pretoria and is approximately 1,200 m thick. It consists of medium to coarse-grained sandstone; pebble-sandstone; tuffaceous graywacke; siltstone, shale and conglomerate (Swaershoek) and volcanic rocks, sandstone, and quartzite (Schrikkloof) (Visser 1989) with a low palaeontological sensitivity. The Nature of the impact is the destruction of Fossil Heritage. Loss of fossil heritage will have a negative impact. The probability of the impact occurring will be probable. The expected duration of the impact is assessed as potentially permanent. Only the site will be affected. In the absence of mitigation procedures (should fossil material be present within the affected area) the damage or destruction of any palaeontological materials will be permanent and irreversible. With Mitigation the impact will be low and the cumulative impact is low. Impacts on palaeontological heritage during the premining phase could potentially occur but are regarded as having a minor possibility. The duration of the impact is permanent. The significance of the impact occurring will be moderate/medium.