PROPOSED DEVELOPMENT AT SAMANCOR ECM LANNEX SECTION, MPUMALANGA

PALAEONTOLOGICAL IMPACT STUDY

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For:

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1. Executive Summary

The area that will be impacted by this development is primarily underlain by Vaalian aged (2.65 – 2.05 Ga) sedimentary rocks of the Transvaal Supergroup that may contain fossilised bacteria and bacterial mats. Diabase intrusions and Bushveld Igneous Complex rocks also occurred in the study area. Due to contact thermal metamorphosis caused by the diabase and Bushveld Igneous Complex intrusions the chances of finding intact fossils of bacterial mats in these sedimentary rocks are very small.

There is a slight probability of finding mammal, bird or reptile bones, mollusc shells and ostrich egg fragments in the alluvium, soils and gravels constituting the Quaternary to Recent deposits. The ECO should take responsibility of monitoring the excavations, especially in the alluvium, sands, gravels and soils constituting the Quarternary deposits where there is a small chance of finding fossils or sub-fossils. If a significant find is made the procedure stipulated under Procedure for Chance Palaeontological Finds (p.17-18) should be followed which includes the safeguarding of the exposed fossils and the contacting of a palaeontologist for further advice.

The palaeontological impact significance of the study area is considered to be low and no further palaeontological studies are recommended for the study area, except in the unlikely case of a significant discovery during construction.

2. Introduction

The Heritage Act of South Africa stipulates that fossils and fossil sites may not be altered or destroyed. The purpose of this document is to detail the probability of finding fossils in the study area that may be impacted by the proposed development.

The palaeontological heritage of South Africa is unsurpassed and can only be described in superlatives. The South African palaeontological record gives us insight in inter alia the origin of life, photosynthesis, dinosaurs, mammals and humans. Fossils are also used to identify rock strata and determine the geological context of the subregion with other continents and played a crucial role in the discovery of Gondwanaland and the formulation of the theory of plate tectonics. Fossils are also used to study evolutionary relationships, sedimentary processes and palaeoenvironments.

South Africa has the longest record of palaeontological endeavour in Africa. South Africa was even one of the first countries in the world in which museums displayed fossils and palaeontologists studied earth history. South African palaeontological institutions and their vast fossil collections are world-renowned and befittingly the South African Heritage Act is one of the most sophisticated and best considered in the world.

Fossils and palaeontological sites are protected by law in South Africa. Construction and mining in fossiliferous areas may be mitigated in exceptional cases but there is a protocol to be followed.

This is a Palaeontological Impact Assessment which was prepared in line with Regulation 28 of the National Environmental Management Act (No. 107 of 1998) Regulations on Environmental Impact Assessment. This involved a site visit and an overview of the literature on the palaeontology and associated geology of the area.

3. Terms of reference for the report

According to the South African Heritage Resources Act (Act 25 of 1999) (Republic of South Africa, 1999), certain clauses are relevant to palaeontological aspects for a terrain suitability assessment.

- **Subsection 35(4)** No person may, without a permit issued by the responsible heritage resources authority-
- (a) destroy, damage, excavate, alter, deface or otherwise disturb any archaeological or palaeontological site or any meteorite;
- (b) destroy, damage, excavate, remove from its original position, collect or own any archaeological or palaeontological material or object or any meteorite;
- (c) trade in, sell for private gain, export or attempt to export from the republic any category of archaeological or palaeontological material or object, or any meteorite; or
- (d) bring onto or use at an archaeological or palaeontological site any excavation equipment or any equipment which assist with the detection or recovery of metals or archaeological material or objects, or use such equipment for the recovery of meteorites.
- **Subsection 35(5)** When the responsible heritage resources authority has reasonable cause to believe that any activity or development which will destroy, damage or alter any archaeological or palaeontological site is under way, and where no application for a permit has been submitted and no heritage resources management procedures in terms of section 38 has been followed, it may-
- (a) serve on the owner or occupier of the site or on the person undertaking such development an order for the development to cease immediately for such period as is specified in the order;
- (b) carry out an investigation for the purpose of obtaining information on whether or not an archaeological or palaeontological site exists and whether mitigation is necessary;
- (c) if mitigation is deemed by the heritage resources authority to be necessary, assist the person on whom the order has been served under paragraph (a) to apply for a permit as required in subsection (4); and
- (d) recover the costs of such investigation form the owner or occupier of the land on which it is believed an archaeological or palaeontological site is located or from the person proposing to undertake the development if no application for a permit is received within two weeks of the order being served.

South Africa’s unique and non-renewable palaeontological heritage is protected in terms of the NHRA. According to this act, heritage 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.

As areas are developed and landscapes are modified, heritage resources, including palaeontological resources, are threatened. As such, both the environmental and heritage legislation require that development activities must be preceded by an assessment of the impact undertaken by qualified professionals. Palaeontological Impact Assessments (PIAs) are specialist reports that form part of the wider heritage component of:

- Heritage Impact Assessments (HIAs) called for in terms of Section 38 of the National Heritage Resources Act, Act No. 25, 1999 by a heritage resources authority.
- Environmental Impact Assessment process as required in terms of other legislation listed in s. 38(8) of NHRA;
- Environmental Management Plans (EMPs) required by the Department of Mineral Resources.

HIAs are intended to ensure that all heritage resources are protected, and where it is not possible to preserve them in situ, appropriate mitigation measures are applied. An HIA is a comprehensive study that comprises a palaeontological, archaeological, built environment, living heritage, etc specialist studies. Palaeontologists must acknowledge this and ensure that they collaborate with other heritage practitioners. Where palaeontologists are engaged for the entire HIA, they must refer heritage components for which they do not have expertise on to appropriate specialists. Where they are engaged specifically for the palaeontology, they must draw the attention of environmental consultants and developers to the need for assessment of other aspects of heritage. In this sense, Palaeontological Impact Assessments that are part of Heritage Impact Assessments are similar to specialist reports that form part of the EIA reports. The standards and procedures discussed here are therefore meant to guide the conduct of PIAs and specialists undertaking such studies must adhere to them. The process of assessment for the palaeontological (PIA) specialist components of heritage impact assessments, involves:

Scoping stage in line with regulation 28 of the National Environmental Management Act (No. 107 of 1998) Regulations on Environmental Impact Assessment. This involves an **initial assessment** where the specialist evaluates the scope of the project (based, for example, on NID/BIDs) and advises on the form and extent of the assessment process. At this stage the palaeontologist may also decide to compile a **Letter of Recommendation for Exemption from further Palaeontological Studies**. This letter will state that there is little or no likelihood that any significant fossil resources will be impacted by the development. This letter should present a reasoned case for exemption, supported by consultation of the relevant geological maps and key literature.

A **Palaeontological Desktop Study** – the palaeontologist will investigate available resources (geological maps, scientific literature, previous impact assessment reports, institutional fossil collections, satellite images or aerial photos

, etc) to inform an assessment of fossil heritage and/or exposure of potentially fossiliferous rocks within the study area. A Desktop studies will conclude whether a further field assessment is warranted or not. Where further studies are required, the desktop study would normally be an integral part of a field assessment of relevant palaeontological resources.

A **Phase 1 Palaeontological Impact Assessment** is generally warranted where rock units of 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 project area is unknown. In the recommendations of Phase 1, the specialist will inform whether further monitoring and mitigation are necessary. The Phase 1 should identify the rock units and significant fossil heritage resources present, or by inference likely to be present, within the study area, assess the palaeontological significance of these rock units, fossil sites or other fossil heritage, comment on the impact of the development on palaeontological heritage resources and make recommendations for their mitigation or conservation, or for any further specialist studies that are required in order to adequately assess the nature, distribution and conservation value of palaeontological resources within the study area.

A **Phase 2 Palaeontological Mitigation** involves planning the protection of significant fossil sites, rock units or other palaeontological resources and/or the 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 Phase 2 may be implemented.

A **‘Phase 3’ Palaeontological Site Conservation and Management Plan** may be required in cases where the site is so important that development will not be allowed, or where development is to co-exist with the resource. Developers may be required to enhance the value of the sites retained on their properties with appropriate interpretive material or displays as a way of promoting access of such resources to the public.

The assessment reports will be assessed by the relevant heritage resources authority, and depending on which piece of legislation triggered the study, a response will be given in the form of a Review Comment or Record of Decision (ROD). In the case of PIAs that are part of EIAs or EMPs, the heritage resources authority will issue a comment or a record of decision that may be forwarded to the consultant or developer, relevant government department or heritage practitioner and where feasible to all three.

4. Details of study area and the type of assessment:

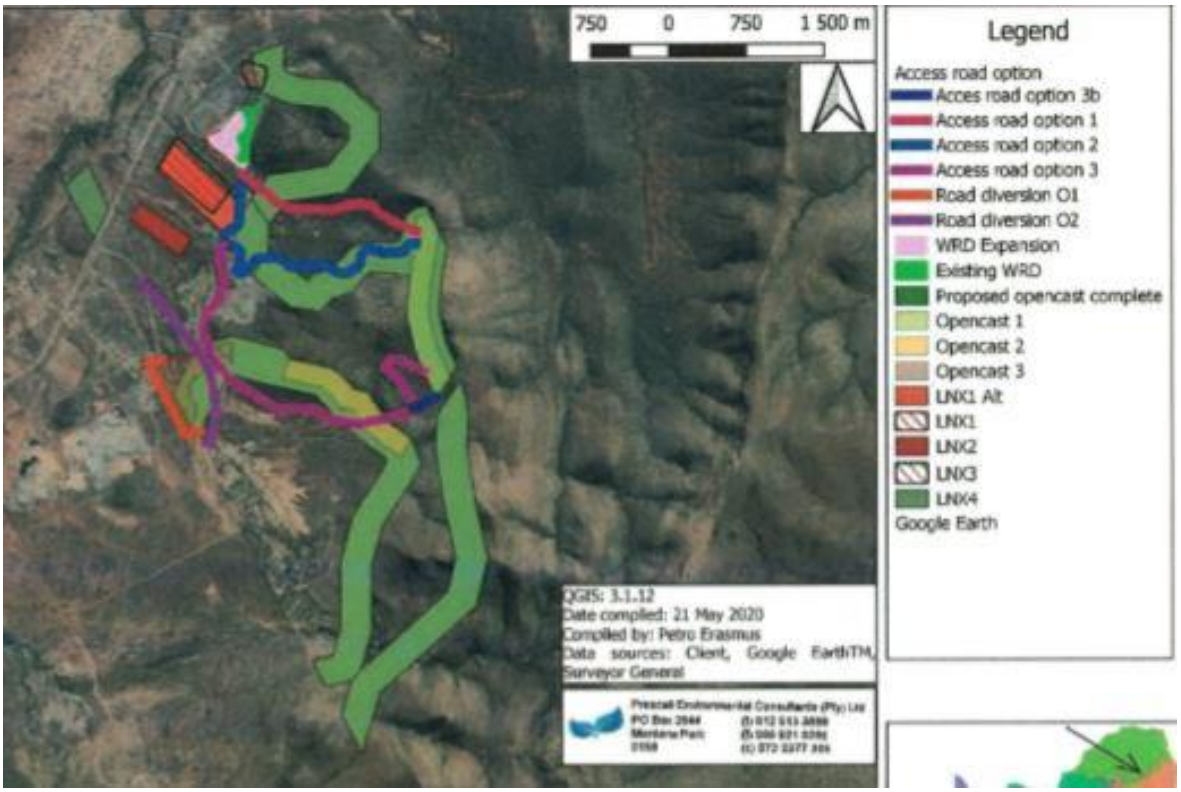
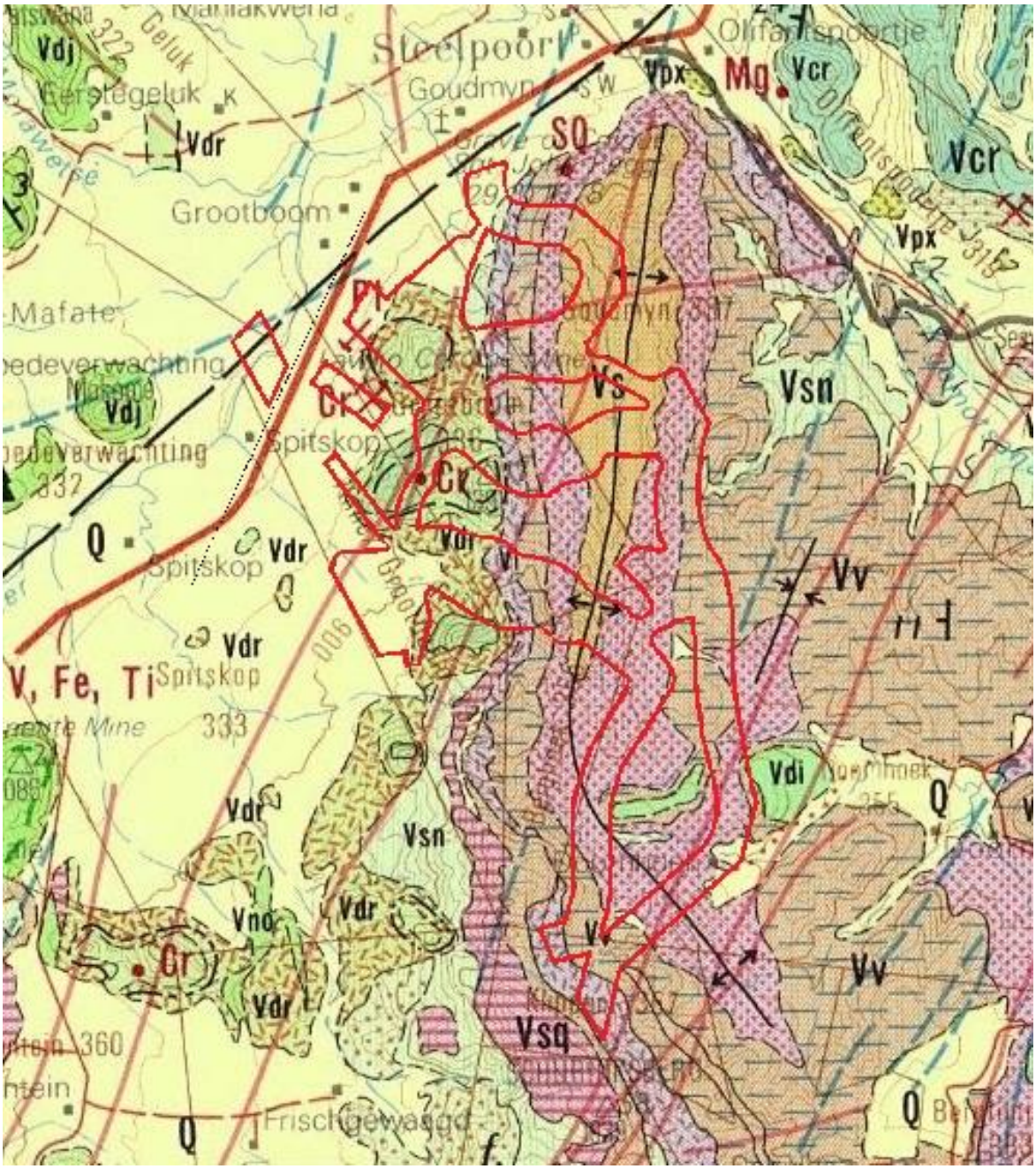


Figure 1: Google Earth photo indicating the study area

The proposed development will take place in the mountainous region of northern Mpumalanga and southern Limpopo southwest of the Drakensberg Escarpment (see Fig. 1) south of Steelpoort. The area is renowned for its mining activities along the eastern rim of the Bushveld Igneous Complex.

The site was visited and the relevant literature and geological maps for the study area in which the development is proposed to take place, have been studied for a Palaeontological Impact Study.

5. Geological setting of the study area



The study area is indicated by the red lines.

Figure 2: Geology of the study area and surroundings. Adapted from the 2430 Pilgrim's Rest 1:250 000 Geology Map (Geological Survey, 1986)

GEOLOGICAL LEGEND

	Lithology	Stratigraphy		Age
Q	Surface deposit including alluvium, sand, soil, gravel, scree			Quaternary
Vdj	Coarse-grained gabbro and anorthosite	Dsjate Subsuite	Rustenburg Layered Suite of the Bushveld Igneous Complex	Vaalian 2.65–2.05 Ga
Vdr	Medium to coarse-grained norite and anorthosite (upper part), Medium to coarse-grained pyfoxenite (lower part)	Dwars River Subsuite		
Vcr	Medium to fine-grained pyroxenite and feldspathic pyroxenite.	Croydon Subsuite		
Vsn	Fine to medium-grained norite, pyroxenite in places.	Shelter Norite		
Vno	Fine-grained norite			
Vpx	Medium to coarse-grained pyroxenite			
Vdi	Green fine to medium-grained diabase.	Diabase intrusion		
Vsq	Fine to medium-grained quartzite with purple sandstone and shale with quartz clasts and thin conglomerate layers.	Steenkamps-berg Format.		
Vl	Medium-grained feldspathic quartzite, thin conglomerate layers and gritty lenses.	Lakenvalei Formation	Pretoria Group of the Transvaal Supergroup	
Vv	Fine-grained hornfels with subordinate layers of carbonate and calc-silicate rocks; layers of siltstone and mudstone.	Vermont Formation		
Vs	Undifferentiated layers of shale, mudstone, limestone, tuff, agglomerate, dolomite, lava	Silverton Formation		

The study area is underlain by the Pretoria Group of the Transvaal Supergroup and rocks of the Rustenburg Suite of the Bushveld Igneous Complex (see Fig. 2).

The Pretoria Group rocks that dominate the eastern part of the study area consist mostly of mudrocks alternating with quartzitic sandstones, interbedded basaltic-andesitic lavas, and subordinate conglomerates, diamictites and carbonate rocks all of which have been submitted to thermal metamorphism (Eriksson *et al*., 2009; Cawthorn *et al*., 2009).

The western part of the study area is dominated by the igneous rocks of the Bushveld Igneous Complex and diabase, which intruded into the older Transvaal Supergroup approximately 2.1 Ga ago. The Bushveld Igneous Complex is represented in the study area by norite and pyroxenite (Cawthorn *et al*., 2009).

The sedimentary rock formations of the area underwent folding and thermal metamorphism due to the emplacement of the Bushveld Igneous Complex and diabase intrusions. Low-lying areas are covered by layers of Quaternary to Recent alluvium (Partridge *et al*., 2009).

6. Site visit

The site was visited 11-12 July 2020. No fossils or fossiliferous rocks were found. The sedimentary rocks in the study area have been thermally metamorphosised due to thermal metamorphosis following the placement of the Bushveld Igneous Complex.

Figure 3: View of the mountainous area where the Pretoria Group outcrops (facing East from 24°48'57.98"S 30°10'43.96"E)

7. Palaeontological potential of the study area

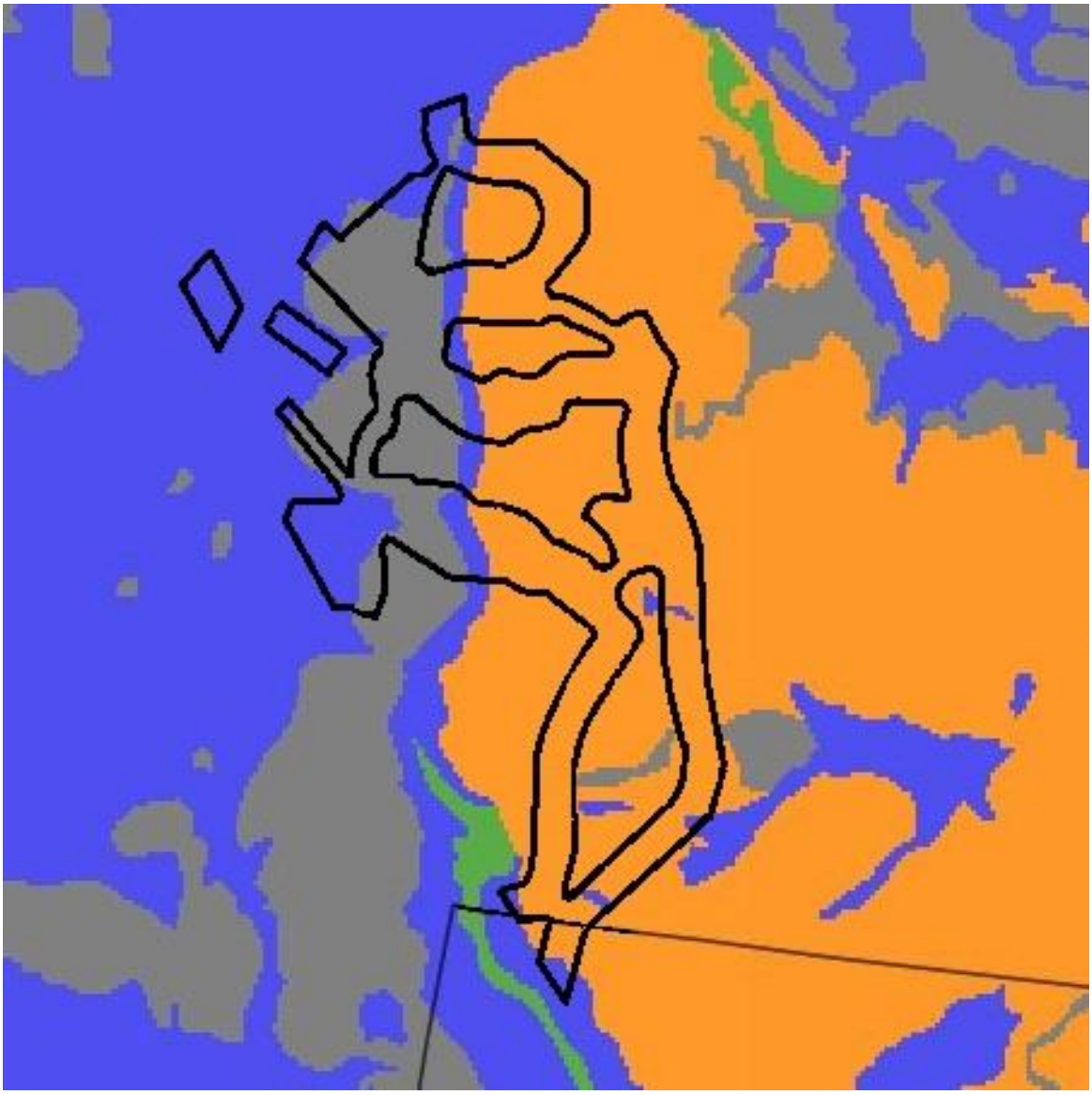


Figure 4: Palaeosensitivity map of the study area and surroundings (SAHRA, 2020)

Colour	Palaeontological Significance	Action
ORANGE	HIGH	Desktop study is required and based on the outcome of the desktop study, a field assessment is likely.
GREEN	MODERATE	Desktop study is required.
BLUE	LOW	No palaeontological studies are required however a protocol for finds is required.
GREY	INSIGNIFICANT / ZERO	No palaeontological studies are required.

The proposed development will occur in areas which are considered by the South African Heritage Resources Agency (SAHRA) to range from having a High, Moderate, Low to Insignificant Palaeontological Sensitivity (see Fig. 4). The eastern part of the area earmarked for development is underlain by the Pretoria Group rocks that are considered to have a High Palaeontological Sensitivity. The western part of the study area is underlain by rocks of the Rustenburg Layered Suite of the Bushveld Igneous Complex that are considered to be of No Palaeontological Significance. The igneous rocks of the Rustenburg Suite are overlain towards the west by Quaternary aged sediments that are considered to have a Low Palaeontological Significance (see Fig. 4).

The Transvaal Supergroup was set down from approximately 2.7 to 2.5 billion years ago and consists of layers of sedimentary and volcanic rocks (Tankard *et al*., 1982; Eriksson *et al*., 2009). The Transvaal Supergroup rocks include quartzite, mudstone, shale, siltstone, conglomerate, limestone, diamictite, tuff and andesite suggesting a range of depositional sources ranging from alluvial fans, floodplains, deltas to coastal and deep basinal environments (Eriksson *et al*, 2009).

The Silverton Formation constitutes the oldest geological unit in the study area. The fine-layered mudstones and shales are separated by the fine-grained tuff, agglomerate and lava in places. This suggests that these sediments settled down deep underwater from suspension but also at times by means of gravity flow and during storms on an offshore shelf along the eastern margins of the Kaapvaal Craton (Eriksson *et al*., 2009).

It has been suggested that the organic carbon found in the shales of the Silverton Formation has been formed due to microbial activity (Eriksson *et al*., 1989). Although no domal stromatolites, like those found in the north-eastern part of the Tansvaal Basin were found in the study area (Bekker *et al*., 2008), Walraven (1989) suggests that the thin carbonate horizons in this formation could have been formed by stromatolites.

Although there are no reports of fossil discoveries from the study area, this formation contains fossils of microbial mats which have been described from fossil localities towards the west of the study area (Parizot *et al*., 2005; Bosch & Eriksson, 2008). These microbial mats are responsible for sediment binding which includes the preservation of ripple marks where they were covered by these mats. There are also wrinkle structures in these sediments and trace fossils which consist of sinuous cracks between ripple marks named *Manchuriophycus* (see Fig. 5) (Bosch & Eriksson, 2008) and rolled-up mat fragments in the sediments (see Fig, 6) (Eriksson *et al*., 2007). These very thin layers of carbon-rich material are the presumed remains of microbial mats which were formed by photosynthesizing bacterial colonies, similar or related to those which formed stromatolite domes.

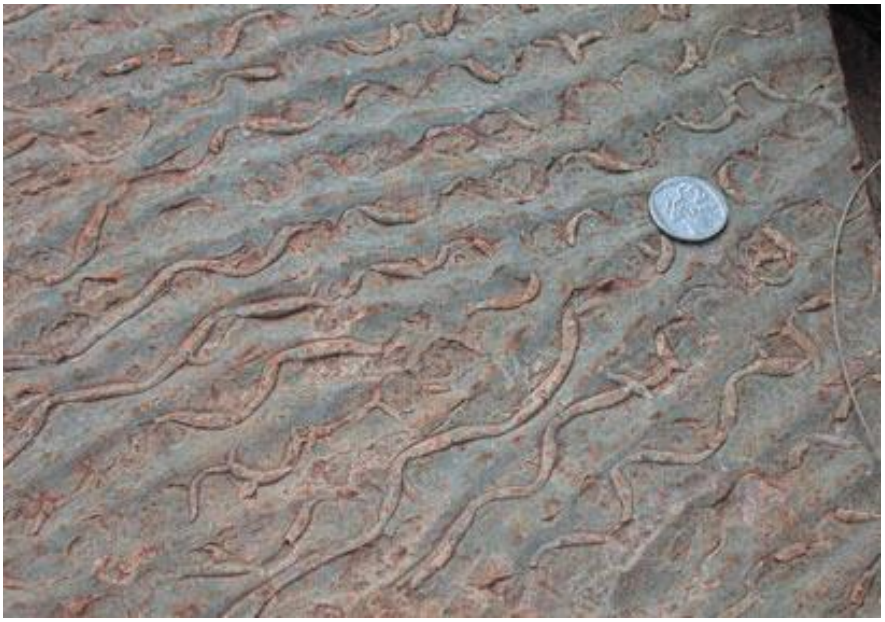


Figure 5: *Manchuriophyscus* (Bosch & Eriksson (2008). Picture by Pieter Bosch)
Source: https://www.researchgate.net/publication/304076637_Synaeresis_Crack_Polygons/figures?lo=1

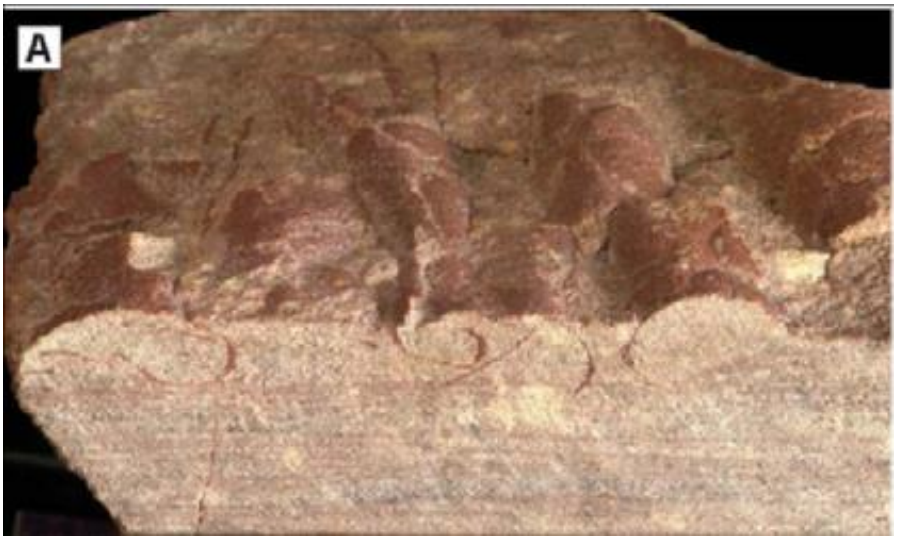


Figure 6: Rolled-up mat fragments (Source: Eriksson *et al*., 2007).
Source: https://www.researchgate.net/publication/259343767_Mat-destruction_features/figures?lo=1)

Rocks of the Bushveld Igneous Complex and diabase intrusions are exposed at several places in the study area (see Fig. 2). **It is expected that these igneous intrusions would have destroyed the fossils in the adjacent Transvaal Supergroup rocks during contact thermal metamorphosis** (Cawthorn *et al*., 2009). **The rocks of the Transvaal Supergroup which would normally have a High Palaeontological Sensitivity have lost this characteristic in the study area and could be considered to be non-fossiliferous.**

Alluvium, scree, sand, gravel and soil dating from the Late Cenozoic to Recent cover the Transvaal Supergroup, diabase and Bushveld Igneous rocks in places in the study area (see Fig. 4). The alluvium consists mostly of mud, sand and gravel that have been eroded from the surrounding landscape and were deposited on the flats between the mountain ranges and in the valley bottoms. Although no fossils or sub-fossils been reported from the Quaternary sediments in this region, there is always the possibility that something may be discovered. In spite of these Quaternary fossiliferous deposits being extremely rare there are well documented cases of remains of tortoises, snail shells, ostrich eggs, termitaria, bones etc. that have been discovered elsewhere (Macrae, 1999; Partridge *et a*l., 2009).

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8. Conclusion and recommendations:

The area is underlain by Vaalian aged (2.65 – 2.05 Ga) sedimentary rocks of the Pretoria Group of the Transvaal Supergroup and the igneous rocks of the Rustenburg Layered Suite of the Bushveld Igneous Complex. The sedimentary rocks of the Pretoria Group have undergone thermal metamorphosis by igneous intrusions and the emplacement of the Bushveld Igneous Complex. **Due to the very low probability of fossils occurring in the study area it is recommended that the project should be exempt from further palaeontological studies.**

In the unlikely event that fossils are found in the soil cover in the study area the ECO should take the following steps:

PROCEDURE FOR CHANCE PALAEONTOLOGICAL FINDS

Extracted and adapted from the National Heritage Resources Act, 1999 Regulations Reg No. 6820, GN: 548.

The following procedure must be considered in the event that previously unknown fossils or fossil sites are exposed or found during the life of the project:

1. Surface excavations should continuously be monitored by the ECO and any fossil material be unearthed the excavation must be halted.

2. If fossiliferous material has been disturbed during the excavation process it should be put aside to prevent it from being destroyed.

3. The ECO then has to take a GPS reading of the site and take digital pictures of the fossil material and the site from which it came.

4. The ECO then should contact a palaeontologist and supply the palaeontologist with the information (locality and pictures) so that the palaeontologist can assess the importance of the find and make recommendations.

5. If the palaeontologist is convinced that this is a major find an inspection of the site must be scheduled as soon as possible in order to minimise delays to the development.

From the photographs and/or the site visit the palaeontologist will make one of the following recommendations:

a. The material is of no value so development can proceed, or:

b. Fossil material is of some interest and a representative sample should be collected and put aside for further study and to be incorporated into a recognised

fossil repository after a permit was obtained from SAHRA for the removal of the fossils, after which the development may proceed, or:

c. The fossils are scientifically important and the palaeontologist must obtain a SAHRA permit to excavate the fossils and take them to a recognised fossil repository, after which the development may proceed.

7. If any fossils are found then a schedule of monitoring will be set up between the developer and palaeontologist in case of further discoveries.

9. Declaration of Independence:

I. Jacobus Francois Durand declare that I am an independent consultant and have no business, financial, personal or other interest in the proposed development, application or appeal in respect of which I was appointed other than fair remuneration for work performed in connection with the activity, application or appeal. There are no circumstances that compromise the objectivity of my performing such work.

Palaeontological specialist:
Dr JF Durand (Sci. Nat.)
BSc Botany & Zoology (RAU), BSc Zoology (WITS), Museology Dipl. (UP), Higher Education Diploma (RAU), PhD Palaeontology (WITS)