Report for proposed expansion of the Belfast Silica mine

eMakhazeni Local Municipality, Nkangala District Municipality, Mpumalanga Province

Farm: Remainder of Portion 1 Klipfontein 385 JS

Fourie, H. Dr heidicindy@yahoo.com

Palaeontological Desktop Impact Assessment: Protocol for finds

Commissioned by: Clean Stream Environmental Services

P.O. Box 647, Witbank, 1035

013 697 5021

2014/11/11

Ref: MP 30/5/1/2/3/2/1/388 EM

B. Executive summary

Outline of the development project: Clean Stream Environmental Services has appointed Dr H. Fourie, a palaeontologist, to undertake a Desktop Paleontological Impact Assessment: Protocol for finds of –

Belfast Silica Mine (Pty) Ltd proposes the feasibility of the expansion of the Belfast Silica mine on the Remainder of Portion 1 Klipfontein 385 JS, eMakhazeni Local Municipality, Nkangala District Municipality, Mpumalanga Province. The development may entail the expansion of the silica quarry. Belfast Silica Mine (Pty) Ltd has been mining silica since 1988 on the remainder of portion 1 of the farm Klipfontein 385 JS. The owner wants to extend the mine to the existing silica resource that occurs inside the defined mining area. At present there are two existing quarries.

This project includes one Alternative.
Alternative 1: A roughly 19.19 ha rectangular property situated 8 km north west of Belfast and Siyathuthuka. It is located on a gravel road which connects with the R 33 to Stoffberg. The proposed extension area would involve 31.82 ha located on the same farm, a total of 51.05 ha.

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 aremarkably 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.

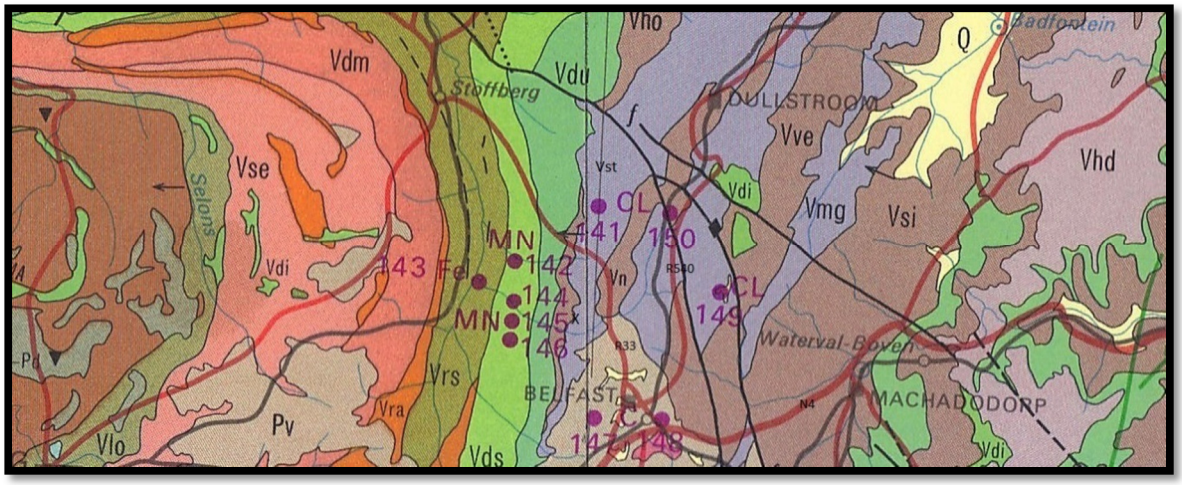
For this study, resources such as geological maps, scientific literature, institutional fossil collections, satellite images, aerial maps and topographical maps were used. It provides an assessment of the observed or inferred palaeontological heritage within the study area, with recommendations (if any) 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 the Geological Map of South Africa, 1:100 000 (Visser 1984).



Legend to Map and short explanation

Vho - (brown) Houtenbek Formation, Pretoria Group of the Transvaal Supergroup. Hornfels, quartzite and limestone.
Vst – (purple) Steenkampsberg Formation, Pretoria Group of the Transvaal Supergroup. Quartzite.
Vn – (brown) Nederhorst Formation, Pretoria Group of the Transvaal Supergroup. Hornfels, quartzite and arkose.
…… - Lineament (possible dyke).
---f-- - Fault.
X- Belfast Silica Mine (next to MN145 on map above).

Mining activities:
MN - Gabbro
CL – Flint Refractory Clay
C – Coal
Fe – Iron

Summary of findings: The desktop palaeontological impact assessment was undertaken during November 2014 and the following is reported:
The formations present are mainly the Transvaal Supergroup (Vho, Vst, Vn). The development will take place on the Steenkampsberg Formation, Pretoria Group, Transvaal Supergroup on the remainder of portion 1 of the farm Klipfontein 385 JS.

The Transvaal Supergroup is Vaalian in age (2600 – 2100 Ma). The Transvaal Supergroup comprises of clastic, volcanic and chemical sedimentary rocks. Quartzitic sandstones, mudstones and shale together with a prominent volcanic unit, minor conglomerate, chemical and volcanic members are present in the Pretoria Group. The Pretoria Group is known for stromatolitic fossils in some of the other formations. It is usually not more than 500 m thick and is well developed with an age of 2224 ± 21 Ma old.

The Steenkampsberg Formation (Vst/Vsq) which is the predominant formation in the development area is overlain by the Nederhorst Formation (Vn) (hornfels, quartzite, arkose) which is between 470-255 m in thickness. The total thickness of the Steenkampsberg Formation quartzites is between 470-630 m and the underlying Houtenbek Formation is 140-255 m thick (Sheet information, Visser 1984). All three these formations are only present regionally in the eastern section of the Transvaal basin (Kent 1980, Snyman 1996). The Steenkampsberg Formation is overlain by the Houtenbek Formation (Vho/Vh) (hornfels, quartzite, limestone) in the development area. This is followed by the Dullstroom Formation. A total thickness of 76 m is measured for the Steenkampsberg Formation in this region. The succession strikes north and dips at 12 – 18˚ to the west. Diabase sills intrude here.

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 MODERATE for the Pretoria Group and LOW for the Steenkampsberg Formation (Vst/Vsq) (NID CaseID 6466).

Recommendation: The impact of the development on fossil heritage is MODERATE and LOW and therefore mitigation or conservation measures are not necessary for this development. A Phase 1 Palaeontological Assessment is not recommended. The topsoil, subsoil, overburden, inter-burden and bedrock do not need to be surveyed for fossiliferous outcrops, but care must be taken during the digging not to dig into underlying Pretoria Group formations such as Time Ball Hill. Care should be taken not to intrude on the limestones of the Houtenbek Formation. Protocol for finds is attached due to the LOW sensitivity (Appendix 2). It is noted that only the quartzite will be mined.

This project includes one Alternative:
Alternative 1: A roughly 19.19 ha rectangular property situated 8 km north west of Belfast and Siyathuthuka. It is located on a gravel road which connects with the R 33 to Stoffberg. The proposed extension area would involve 31.82 ha located on the same farm, a total of 51.05 ha.

Stakeholders: Developer – Belfast Silica Mine (Pty) Ltd., Mr C. Wessels, P.O. Box 1014, Belfast, 1100. Tel 012 346 2546.
Environmental – Clean Stream Environmental Services, P.O. Box 647, Witbank, 1035. Tel 013 697 5021.
Landowner – Four Rivers Trading 179 (Pty) Ltd (Contact person: Mr C. Wessels).

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D. Background information on the project

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

Outline of development

Belfast Silica Mine (Pty) Ltd proposes the feasibility of the expansion of the Belfast Silica mine on the Remainder of Portion 1 Klipfontein 385 JS, eMakhazeni Local Municipality, Nkangala District Municipality, Mpumalanga Province. The development may entail the expansion of the silica quarry. Belfast Silica Mine (Pty) Ltd has been mining silica since 1988 on the remainder of portion 1 of the farm Klipfontein 385 JS. The owner wants to extend the mine to the existing silica resource that occurs inside the defined mining area. At present there are two existing quarries.

The silica found in the quartzite is used in the metallurgical industry as flux and as building material (sand, rock). A crushing and screening plant is used to produce the required products. The material is stockpiled. An opencast quarrying method is used involving drilling and blasting. The current mine plan will extend into the proposed extension area as indicated on Figure 2.2a instead of mining deeper. This will increase the Life of Mine to 40 years (Scope Report).

All of the infrastructure needed is already present such as the crushing and screening plant; loading plant; sand drying plant; workshop area; diesel tank and paraffin tank; Eskom transformer; office; change house and ablution facility; explosive

magazine; guard house; gravel access road; and product stockpiles. Water, electricity, sewage and waste disposal, and roads are present (Scope Report).

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Topographic Map (Provided by Clean Stream Environmental Services).

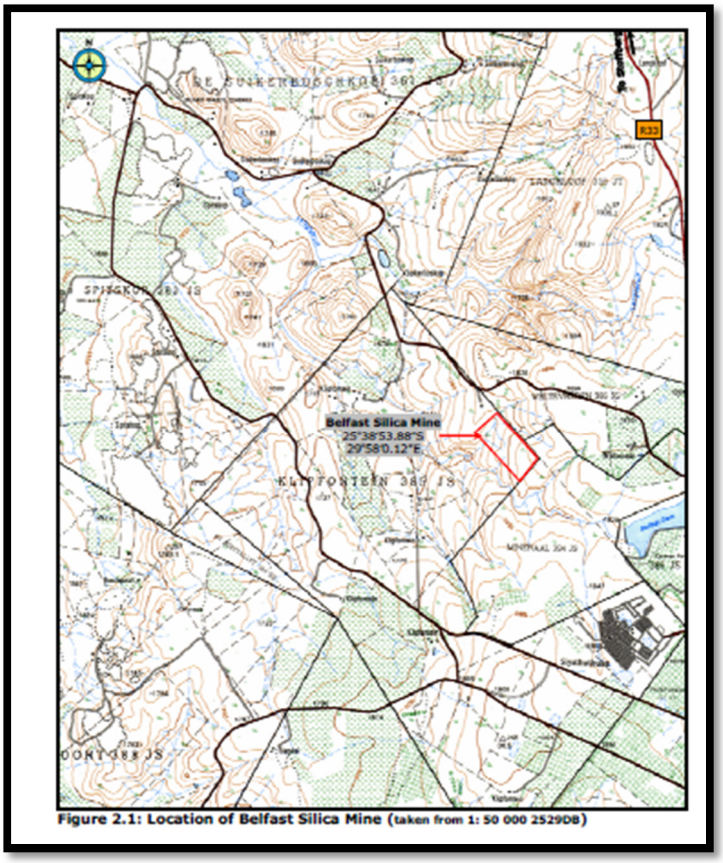


Figure 2.1: Location of Belfast Silica Mine (taken from 1: 50 000 2529DB)

Proposed extension plan (Provided by Clean Stream Environmental Services).

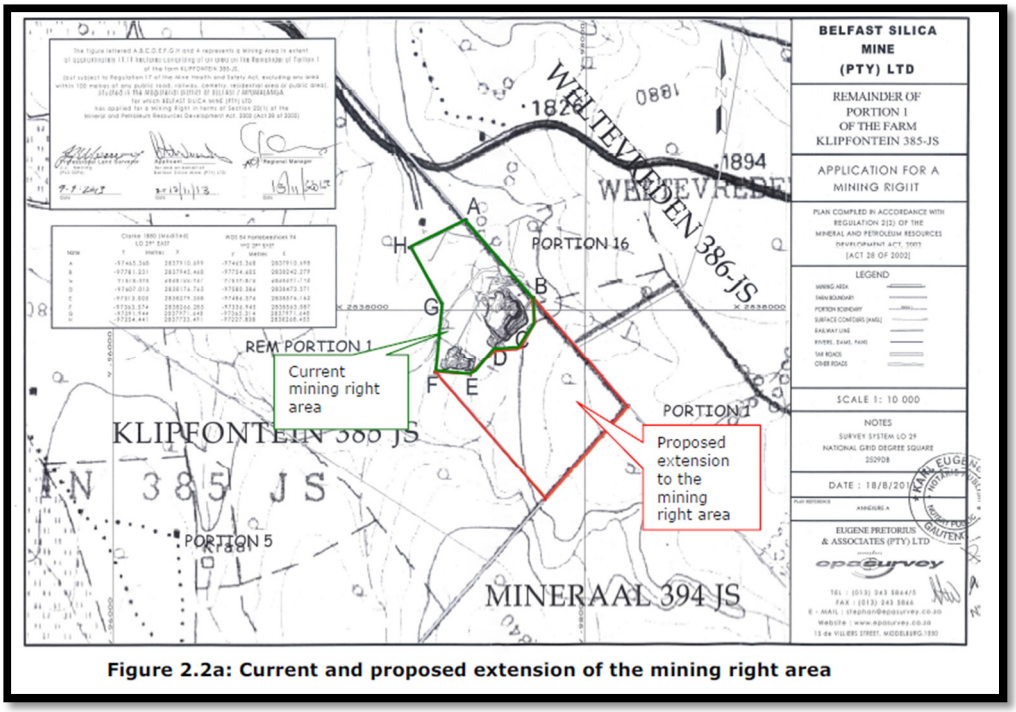
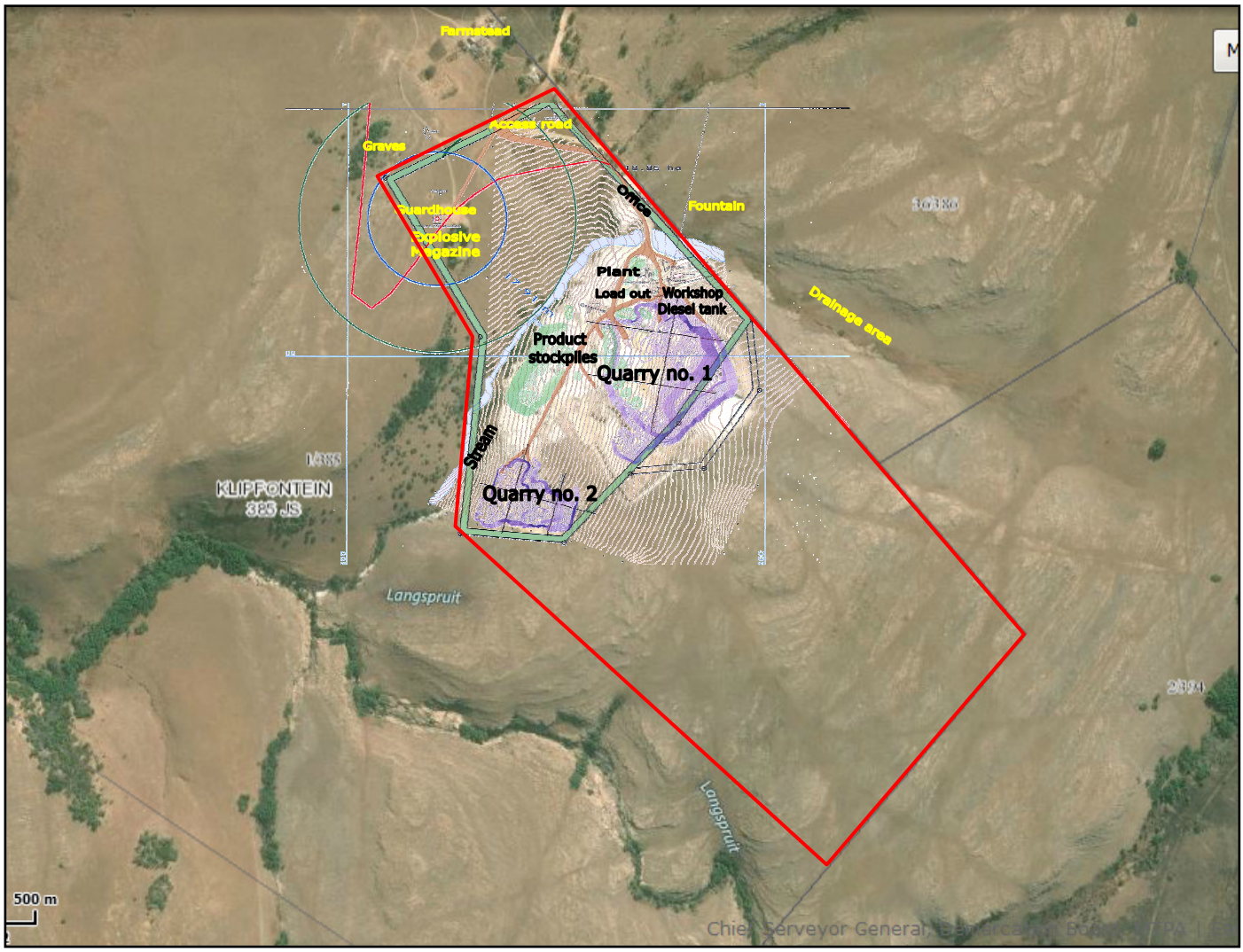


Figure 2.2a: Current and proposed extension of the mining right area

Rezoning/ and or subdivision of land: Already a mine.
Name of developer and consultant: Belfast Silica Mine (Pty) Ltd and Clean Stream Environmental Services.
Terms of reference: Dr H. Fourie is a palaeontologist commissioned to do a desktop palaeontological impact assessment 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 Province and Mpumalanga Province. 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/PHRA.

E. Description of property or affected environment
Location and depth:
Belfast Silica Mine (Pty) Ltd proposes the feasibility of the expansion of the Belfast Silica mine on the Remainder of Portion 1 Klipfontein 385 JS, eMakhazeni Local Municipality, Nkangala District Municipality, Mpumalanga Province. The development may entail the expansion of the silica quarry. Belfast Silica Mine (Pty) Ltd has been mining silica since 1988 on the remainder of portion 1 of the farm Klipfontein 385 JS. The depth of structures / buildings is determined by the foundations, footings and channels. In this instance no buildings or structures will be erected.

Google.earth Map (provided by Clean Stream Environmental Services).



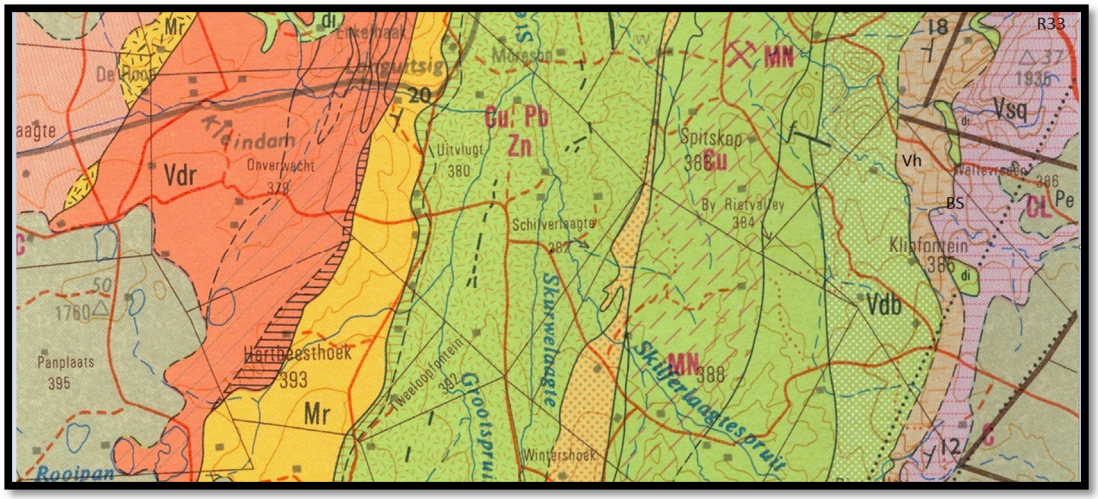
F. Description of the Geological Setting

Description of the rock units:

The development is taking place in an area covered by mostly the Transvaal Supergroup sediments (Appendix 1).

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. An 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, Chuniespoort, and Pretoria Groups as well as other smaller groups (Kent 1980). 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).

The Pretoria Group (Appendix 1) consists predominantly of quartzitic sandstones, mudstones and shale together with a prominent volcanic unit, minor conglomerate, chemical, and volcanic members. It comprises the, Time Ball Hill, Silverton and Magaliesberg Formations as well as several smaller Formations and overlies the Chuniespoort Group. Both the shale and quartzite of the Pretoria Group are utilised in the building industry. The Time Ball Hill shale formation is known to contain 'algal microfossils' diagenetic in origin. Stromatolites as they are known are preserved in the subordinate carbonate rocks in the Pretoria Group (Eriksson 1999, Kent 1980). This Supergroup is underlain by the Ventersdorp, Witwatersrand and Pongola Supergroups, and the Dominion Group.



Legend to Map and short explanation (Walraven 1978)
Vh – (brown) Houtenbek Formation, Pretoria Group of the Transvaal Supergroup. Hornfels, quartzite, chert and limestone.
Vst – (purple) Steenkampsberg Formation, Pretoria Group of the Transvaal Supergroup. Quartzite and subordinate shale.
…… - Lineament (possible dyke).
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BS - Belfast Silica Mine.

The Steenkampsberg Formation which is the predominant formation in the development area is overlain by the Nederhorst Formation which is between 470-255 m in thickness. The total thickness of the Steenkampsberg Formation is between 470-630 m and the underlying Houtenbek Formation is 140-255 m thick (Sheet information, Visser 1984). All three these formations are only present regionally in the eastern section of the Transvaal basin (Kent 1980, Snyman 1996).

The Steenkampsberg Formation is overlain by the Houtenbek Formation in the development area. This is followed by the Dullstroom Formation (Vdb) (green). A total thickness of 76 m is measured for the Steenkampsberg Formation in this region. The succession strikes north and dips at 12 – 18˚ to the west. Diabase sills intrude here. The Lower Zone of the Bushveld Complex occurs on the most western part of the original farm Klipfontein 385 JS, and further to the west. Overburden or topsoil is virtually non-existent. Three faults are visible in the existing quarries. The quartzite is fine-grained, white to light greyish in colour or light yellowish and fine to medium-grained. The calculated thickness for the Houtenbek Formation is 0 to 50 m (Niesing and Lingenfelder 2003).

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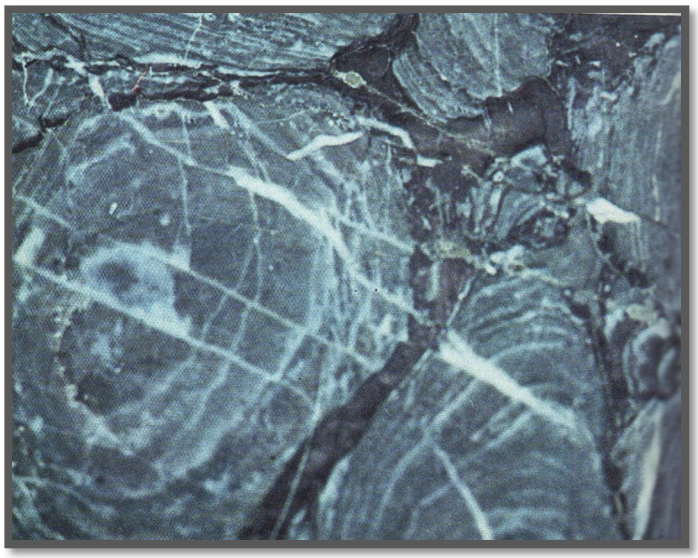
G. Background to Palaeontology of the area
Summary: When rock units of moderate to high palaeontological sensitivity are present within the development footprint, a desktop and or field scoping (survey) study by a professional palaeontologist is usually warranted. The main purpose of a field scoping (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).

Chemical sediments of the Pretoria Group 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 2900-2400Ma. Stromatolites are common in the Malmani dolomites, accepted to be the fossil remnants of the simplest single-celled organisms. They are finely layered, concentric, mound-like structures formed by microscopic algal organisms (Norman and Whitfield 2006). Algal microfossils reported from the Timeball Hill Formation shales are probably of diagenetic origin (Eriksson 1999).

Stromatolites in thin section (De Zanche and Mietto 1977).



There are no fossils recorded for the Steenkampsberg Formation as for the formations in the description above which are not present on the development site. It is noted that the Houtenbek Formation has a limestone and chert component.

Criteria used (Fossil Heritage Layer Browser/SAHRA):

Rock unit	Significance/vulnerability	Recommended action
Steenkampsberg Formation	Low	No palaeontological studies are required, however a protocol for finds is required.
Pretoria Group	Moderate	Desktop study is required

Databases and collections: Ditsong: National Museum of Natural History.
Impact: MODERATE and LOW. There may be significant fossil resources (MODERATE) that may be impacted by the development.

H. Description of the Methodology

The desktop palaeontological impact assessment scope was undertaken during November 2014.
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. A site visit was not conducted.
7. Insufficient data from developer and exact lay-out plan for all structures.

I. Description of significant fossil occurrences (Heritage value)

All Karoo Supergroup geological formations are ranked LOW to VERY HIGH, but here the impact is potentially MODERATE for the Pretoria Group and LOW for the Steenkampsberg Formation.

J. Recommendation

a. There is no objection to the development, and it is not necessary to request a Phase 1 Palaeontological Impact Assessment to determine whether the development will affect fossiliferous outcrops as the palaeontological sensitivity is MODERATE and LOW. A Phase 2 Palaeontological Mitigation will only be required if the Phase 1 Palaeontological Assessment finds fossiliferous outcrops. A Protocol for finds is attached (Appendix 2) due to the LOW palaeontological sensitivity.

b. This project will benefit the economy, the growth of the community and social development in general.
c. Preferred choice: Alternative 1 as the palaeontological sensitivity is MODERATE and LOW. Protocol for finds is attached and significant fossil resources may be impacted by the mine (Appendix 2). It is noted that only the silica (quartzite) will be mined.
d. The following should be conserved: if any palaeontological material is exposed during digging, excavating, drilling, or blasting SAHRA/PRHA 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 may be needed from the South African Heritage Resources Agency (SAHRA).

a. Objections: None.
b. Conditions of development: See Recommendation.
c. Areas that may need a permit: None.
d. Permits for mitigation - needed from SAHRA / PHRA: None.

K. Conclusions

a. All the land involved in the development was assessed and none of the property is unsuitable for development.
b. All information needed for the Desktop Palaeontological Impact Assessment scope was provided by Clean Stream Environmental 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 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 the Mine Health and Safety Act, 1996 (Act 26 of 1996) is adhered to for safety and security reasons.

L. Bibliography

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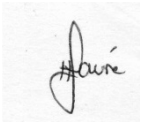
WALRAVEN, F. 1978. Geological Map of Pretoria 2528, 1:250 000. South African Committee for Stratigraphy. Council for Geoscience.

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 scope. There are no circumstances that compromise the objectivity of me performing such work.

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

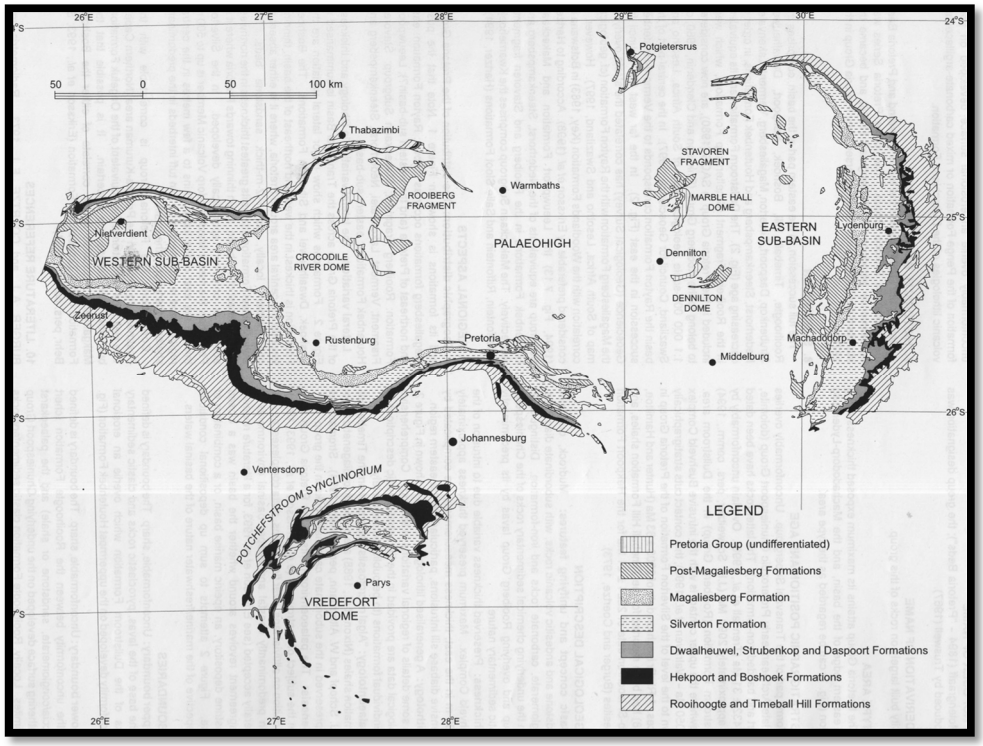
This report may not be altered in any way and any parts drawn from this report must make reference to this report.



Heidi Fourie
2014/11/11

Appendix 1:

Map of the Transvaal Supergroup (Eriksson 1999)



Lithostratigraphic column of the Pretoria Group (Eriksson 1999)

FORMATIONS		WESTERN AREA	CENTRAL AREA	EASTERN AREA	SOUTHERN AREA	Inferred palaeoenvironments
Houtenbek	Mudrock (tuffaceous in places), sandstone, limestone	Rayton/Woodlands Formation in far west (mudrock, sandstone) ⩽ 200 m	Rayton Formation (mudrock, sandstone, minor andesite and dolomite) ~ 1 200 m	150 – 200 m	Absent	Fan, fan-delta, delta, shallow lacustrine
Steenkampsberg	Sandstone			450 – 600 m		
Nederhorst	Sandstone (arkosic in places) Mudrock (tuffaceous in places)			200 – 800 m		
Lakenvalei	Sandstone			200 – 350 m		
Vermont	Mudrock (tuffaceous in places)			500 – 700 m		
Magaliesberg	Sandstone with mudrock lenses and interbeds	150 – 430 m, significant mudrock, sandstones thicken westwards and eastwards	260 – 340 m, subordinate mudrocks thicken westwards	~225 – 550 m, subordinate mudrock	⩽ 340 m, mostly eroded	Regressive sandy shoreline, braid-delta, high-energy tidal flat
Silverton	carbonate rocks Lydenburg Shale Member (commonly tuffaceous) Machadodorp Volcanic Member (pyroclastic rocks, basalt) Boven Shale Member	~500 – 1 328 m, reworked tuffs common, thins westwards, uppermost carbonates ~117 – 167 m thick, Machadodorp Member absent, basal shale generally thin	~450 – 850 m, Machadodorp Member 1 – 2 m thick, upper shales thin	~1040 – 2230 m, lower shales generally thin, Machadodorp Member ~57 – 517 m thick	⩽ 1 365 m, Machadodorp Member thin (⩽ 6 m), mostly eroded	Relatively deep water, transgressive epeiric sea; volcanic activity, mainly in the east
Daspoort	Sandstone, mudrock	~65 – 120 m, sandstone pebbly in far west	~40 – 100 m, pebbly sandstone common	~10 – 120 m, sandstone pebbly, thicker in north, ironstones in northeast	~45 – 80 m, sandstone pebbly	Distal fan, fluvial braidplain, braid-delta; transgressive epeiric sea in the east
Strubenkop	Mudrock, subordinate sandstone	~50 – 360 m, minor sandstone	~100 – 150 m, significant sandstone, minor tuff	~30 – 145 m, thickens to north and south	~80 – 185 m, thickens southwards	Transgressive lacustrine
Dwaalheuwel	Sandstone, conglomerate, subordinate mudrock	~15 – 70 m, basal conglomerate in north	⩽ 3 – 4 m, lenticular, absent in places	~40 – 110m, minor conglomerates in north	Absent	Alluvial fan, fan-delta
Hekpoort	Basaltic andesite, pyroclastic rocks	~190 – 890 m, thins northwards	~340 – 630 m, air-fall and reworked pyroclastics relatively common	~90 – 500 m, thins northwards, pyroclastics common	~430 – 1 140 m, significant tuffs (200 – 300 m thick), thickens southwards	Volcanic
Boshoek	Sandstone, conglomerate, diamictite	~35 – 70 m, significant conglomerates	⩽ 2 m, mostly absent	~20 – 80 m, large channels	~30 – 60 m, localised diamictite	Alluvial fan, slump deposits
Timeball Hill	Upper mudrock unit Diamictite/conglomerate/arkose lens	Mudrock 200 – 430 m, thickens westwards	Mudrock 130 – 350 m, thick lens of diamictite/ conglomerate	Mudrock ~225 – 750 m, thickens northwards, thick arkose/diamictite lenses in north and northeast	Mudrock ~130 – 300 m	Relatively deep lacustrine (with suspension sedimentation and turbidity currents), distal fluvio-deltaic, basal volcanism in south and southwest
	Klapperkop Quartzite Member	Quartzite ~90 – 620 m, thickens westwards	Quartzite ~40 m	Quartzite ~70 – 230 m, thins southwards	Quartzite ~40 – 100 m, thins southwards	
	Lower mudrock unit	Mudrock 160 – 460 m, thickens westwards	Mudrock ~220 – 350 m	Mudrock ~300 – 580 m, thins to south, thin tuff bed	Mudrock ~80 – 540 m, thickens southwards	
	Bushy Bend Lava Member	Minor basal lavas			Bushy Bend Member ⩽ 90 m	
Rooihoogte	Polo Ground Sandstone Member Mudrock, subordinate carbonate rocks Bevets Conglomerate/Breccia Member	~17 – 232 m, basal conglomerate thick in north, shale thick in south	~10 – 50 m, breccia and conglomerate lenticular, Polo Ground Member thin	⩽ ~2 – 140 m, thickest in Dennilton and Marble Hall fragments	~14 – 150 m, thick breccia	Karst-fill, alluvial fan, lacustrine
Chuniespoort Group	Iron-formation, dolomite	Palaeokarst topography				

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 then 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 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 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 (in case of coal mines) and the interlayers (siltstone and mudstone) are surveyed for fossils or representative sampling of fossils are taking place.

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 (if the Vryheid Formation is absent, then skip this point).
3. When clearing topsoil, subsoil or overburden and hard rock (outcrop) is found, the contractor needs to stop all work.
4. A Palaeontologist / Palaeobotanist (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 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 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 will 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.