Natal East Prospecting Program

Nkandla District Municipality, Kranskop - and Msinga Local Municipality, Kwazulu Natal Province.

Farm: Klip River 4665-GT, Tugela Location 4674-GT and Reserve No. 19 15839-GU

Fourie, H. Dr heidicindy@yahoo.com

012 322 7632/012 492 0110 x 1057

Palaeontological Impact Assessment: Phase 1 Field Study

Facilitated by: J. Pelser Archaeological Consulting cc

833B St Bernard Street, Garstfontein,

0081

083 459 3091

Ref: KZN 30/5/1/1/2/10854PR

2019/06/22

B. Executive summary

Outline of the development project: Shango Solutions has facilitated the appointment of Dr H. Fourie, a palaeontologist, to undertake a Palaeontological Impact Assessment (PIA), Phase 1 Field Study of the suitability of the Natal East Prospecting Program on the Farms Klip River 4665-GT, Tugela Location 4674-GT and Reserve No. 19 15839-GU, Nkandla District Municipality, Kranskop - and Msinga Local Municipalities within the Kwazulu Natal Province.

The applicant, WRE Base Metals (Pty) Ltd intends to conduct prospecting without bulk sampling.

The Project includes one Alternative (Figure 1):
Alternative 1: The site is situated south of the town of Dundee, 30 km northeast of Estcourt, north of the town of Greytown, and with the R33 Road to the west. The size of the site is approximately is 34 474.53 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.

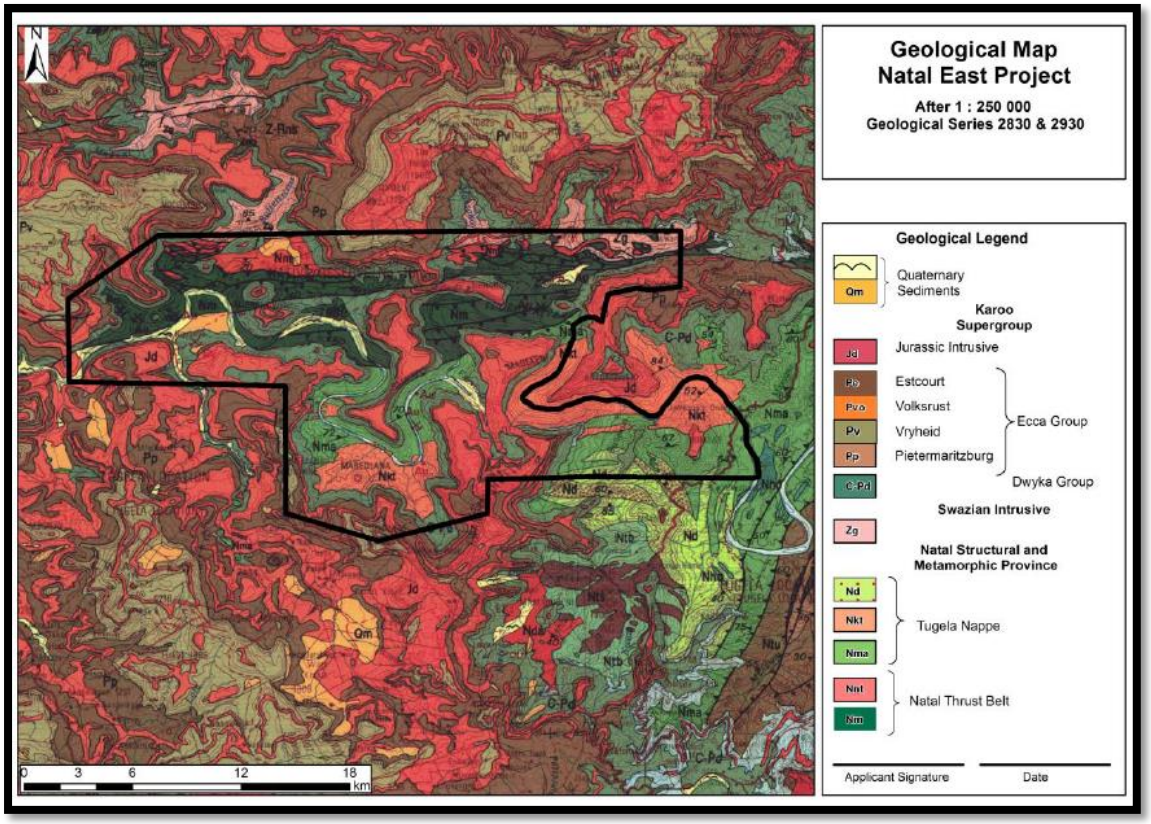
Types and ranges of heritage resources as outlined in Section 3 of the National Heritage Resources Act (Act No.25 of 1999):
(i) (i) objects recovered from the soil or waters of South Africa, including archaeological and palaeontological objects and material, meteorites and rare geological specimens.
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 aims to provide comment and recommendations on the potential impacts that the proposed development project / mining could have on the fossil heritage of the area and to state if any mitigation or conservation measures are necessary.

Outline of the geology and the palaeontology:
The geology was obtained from map 1:100 000, Geology of the Republic of South Africa (Visser 1984) and 1:250 000, 2830 Dundee (Wolmarans and Linstrőm 1988).

Figure 4: The geology of the development area (PWP 2019).



Legend to map and short explanation.
M – Alluvium (light yellow).
Qm – Basal boulder bed, yellow-brown sandy clay (darker yellow). Masotcheni Formation. Quaternary.
Jd – Dolerite (pink). Jurassic.
Pe – Dark blue-grey shale, carbonaceous in places; fine-to coarse-grained sandstone (green). Estcourt Formation, Ecca Group, Karoo Supergroup.
Pvo – Dark-grey shale (orange). Volksrust Formation, Ecca Group, Karoo Supergroup.
Pp – Dark-grey shale (brown). Pietermaritzburg Formation, Ecca Group, Karoo Supergroup.
Pv – Medium-to coarse-grained sandstone, grey micaceous shale; coal (light green). Vryheid Formation, Ecca Group, Karoo Supergroup. Permian.
C-Pd – Tillite; minor shale, varved shale and sandstone (grey). Dwyka Group, Karoo Supergroup.
Nd – Diorite, biotite – hornblende gneiss; migmatite (lime green). Mkondeni Diorite Formation, Tugela Nappe.
Nkt – Tonalite (darker orange). Kotangweni Tonalite, Tugela Nappe.

Nma – Amphibolite (green). Manyane Formation, Tugela Group, Tugela Nappe.
Nnt – Arcosic grit, conglomerate, breccia, mudstone, shale, limestone, ferruginous dolomitic limestone (red). Ntingwe Group, Natal Thrust Belt.
Nm – Hornblende gneiss, schists, quartzite, amphibolite, phyllite, mylonite (dark green). Mfongosi Group, Natal Thrust Belt.
Zg – Granite (light pink). Swazian Intrusive.
…… – (blue) Lineament (Landsat, aeromagnetic).
------ - Concealed geological boundary.
⊥72 – Strike and dip of bed.
-^- -^- - Concealed or inferred thrust fault.
-^-^-^- - Thrust fault.
□ – Proposed development (blocked in green).

Mining Activities:
Au - Gold.

Summary of findings (**1d**): The Phase 1 PIA Field Study was undertaken in June 2019 in the winter in mild and dry conditions and the following is reported:

One formation (Figure 4) in the study area is of quaternary age, the Masotcheni Formation (Qm) which represents local colluvial deposits of Cenozoic age. Over areas totalling fully 40% of Southern Africa the 'hard rocks', from the oldest to the Quaternary, are concealed by normally unconformable deposits – principally sand, gravel, sandstone, and limestone. Inland deposits are much more extensive than marine deposits and are terrestrial and usually unfossiliferous. Some of these deposits date back well into the Tertiary, whereas others are still accumulating. Owing to the all-to-often lack of fossils and of rocks suitable for radiometric or palaeomagnetic dating, no clear-cut dividing line between the Tertiary and Quaternary successions could be established (Kent 1980). The alluvium sands were deposited by a river system and reworked by wind action (Snyman 1996).

Several formations are present in the Karoo Supergroup (Figure 4). The Karoo Supergroup is renowned for its fossil wealth. Overlying the Volksrust Formation in the Estcourt- Mooi River area is a mappable unit called the Estcourt Formation which are about 400 m thick (Kent 1980). Very little is written on the Volksrust Formation (Pvo). It rests conformably on the Vryheid Formation. Fossils consist of fish scales and wood. This formation reaches thicknesses of 170-270 m (Visser 1989).

The Vryheid Formation (Pe,Pv), Ecca Group is rich in plant fossils such as the *Glossopteris* flora represented by stumps, leaves, pollen and fructifications (Appendix 1). This formation is early to mid-Permian (Palaeozoic) in age and consists of sandstone, shaly sandstone, grit, conglomerate, coal and shale. Coal seams are present in the Vryheid Formation within the sandstone and shale layers with the fossils mainly present in the grey shale which is interlayered between the coal seams (Kent 1980, Visser 1989). Borehole logs in the coalfields show the following layers; soil, shale and sandstone, shale and sandstone interbedded, sandstone, coal, conglomerate reworked diamictite, Dwyka Tillite, and the Pre-Karoo Basement. The Pietermaritzburg Formation attains a thickness of over 400 m (Kent 1980).

Visser *et al.* (1990) proposed two subdivisions for the Dwyka Group in the main Karoo basin, the southern Elandsvlei and northern Mbizane Formations. In the far north, the Tshidzi and Wellington Formations also form part of the Dwyka Group. The Dwyka Group is underlain by the Witteberg Group, Bokkeveld or Table Mountain

Groups, Natal Group and various Proterozoic and Archaean units. Ranges in age from Late Carboniferous to Early Permian and the group as a whole becomes younger towards the north and east. A thickness of 100-600 m is obtained (Visser *et al.* 1990).

Older in age are the formations of the Tugela Nappe and the Natal Thrust Belt (Figure 4). The Natal Metamorphic and Structural Province is 900-1 194 Ma and was subdivided into the Ntingwe, Mfongozi, Tugela, and Mapumulo Groups. The Ntingwe Group is only 1 to 5 km wide and about 40 km in length. It comprises the Makasana, Manzawayo, and Dlolwana Formations (Kent 1980, Snyman 1996).

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 Karoo Supergroup strata the palaeontological sensitivity can generally be **LOW to VERY HIGH**, and here locally **VERY HIGH** for the Estcourt and Vryheid Formations, **MODERATE** for the Masotcheni, Volksrust (**HIGH**), Pietermaritzburg and Dwyka Formations (**LOW**) and **LOW** for the Tugela Nappe and Natal Thrust Belt (**INSIGNIFICANT**) (Groenewald 2012). The Groenewald (2012) Palaeotechnical report differs from the SG 2.2 SAHRA APMHOB, 2012 (here bracketed), but as fossils may occur as impressions of arthropod remains and *Hyolithes princeps* in the rocks of the Ntingwe Group (Kent 1980), Natal Thrust Belt a **LOW** status is allocated. Groenewald did not have a category **HIGH.**

Large areas of the coastal plain of Kwazulu-Natal is covered in a blanket of alluvial sand and no significant fossils have been described from these sediments (Groenewald 2012).

The Estcourt Formation contains evidence of an abundance of marine and probably estuarine invertebrates that left trace fossils in the rock record (Groenewald 2012). The Estcourt Formation contains evidence of an abundance of marine and probably estuarine invertebrates that left trace fossils in the rock record (Groenewald 2012). The Volksrust Formation contains a monotonous sequence of grey shale is present and fossils are significant, but very rarely recorded. Fossils include rare temnospondyl amphibian remains, invertebrates, minor coals with plant remains, petrified wood, and low-diversity marine to non-marine trace fossil assemblages (Groenewald and Groenewald 2014). The Vryheid Formation (Pe,Pv), Ecca Group is rich in plant fossils such as the *Glossopteris* flora represented by stumps, leaves, pollen and fructifications (Appendix 1). Fossils are generally absent from the Pietermaritzburg Formation although trace fossils have been recorded from the upper layers (Groenewald 2012).

Boulders containing fossil archaeocyathids (cone-shaped filter-feeding organisms related to sponges) have been discovered in the southern outcrops of the Dwyka Group, but not in South Africa. Trace fossils are relatively abundant in the shales occurring near the top of the Dwyka Group, these traces were produced by fish and various arthropods. Plants occurring are lycopods, moss, pre-*Glossopteris* flora, pollen, spores and wood. Microfossils include foraminifers, sponge spicules, and radiolarians, coprolites, bivalves, brachiopods and nautiloids also occur (MacRae 1999, Visser *et al.* 1990). Plant fossils have been described from outcrops of the Dwyka Group in Limpopo Province, with special reference in the Springbok Flats region (Groenewald and Groenewald 2014).

<u>Recommendation</u>:
The potential impact of the development on fossil heritage is **VERY HIGH** to **LOW** therefore a field survey or further mitigation or conservation measures were necessary for this development (according to SAHRA protocol). A Phase 2 PIA and or mitigation are only recommended if the Phase 1: Field study finds fossils (macro) or if fossils are recovered during drilling or excavating.

During the survey, it was found that the prospecting will be take place over several geological formations such as the Ecca Group, Dwyka Group, Tugela Nappe and Natal Thrust Belt. The area is covered by overburden, vegetation, houses, natural grassland and other land uses include roads and crops and the Tugela River. The development may benefit the community and economy. Fossils were not found during the walk through and drive through.

The Project includes one Alternative (Figure 1):
Alternative 1: The site is situated south of the town of Dundee, 30 km northeast of Estcourt, north of the town of Greytown, and with the R33 Road to the west. The size of the site is approximately is 34 474.53 hectares.

The project area covers only one Alternative and 10 Trenches (T1-T10).

Concerns/threats (**1g,1ni,1nii,1o,1p**) 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, mining activities, prospecting, 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:

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 with caution, but the ECO together with the mine geologist must survey for fossils before and or after blasting 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 (pre-construction training of ECO) during the digging and excavation phase of the development either for training or a site visit once a month during construction.

Stakeholders: Applicant – WRE Base Metals (Pty) Ltd, P.O. Box 2591, Cresta, Johannesburg, 2118. Tel: 011 431 1191.
Environmental – Shango Solutions. Tel: 011 678 9731.
Landowner – Inganyama Trust.

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 (GN R326 of 7 April 2017) 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, 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.

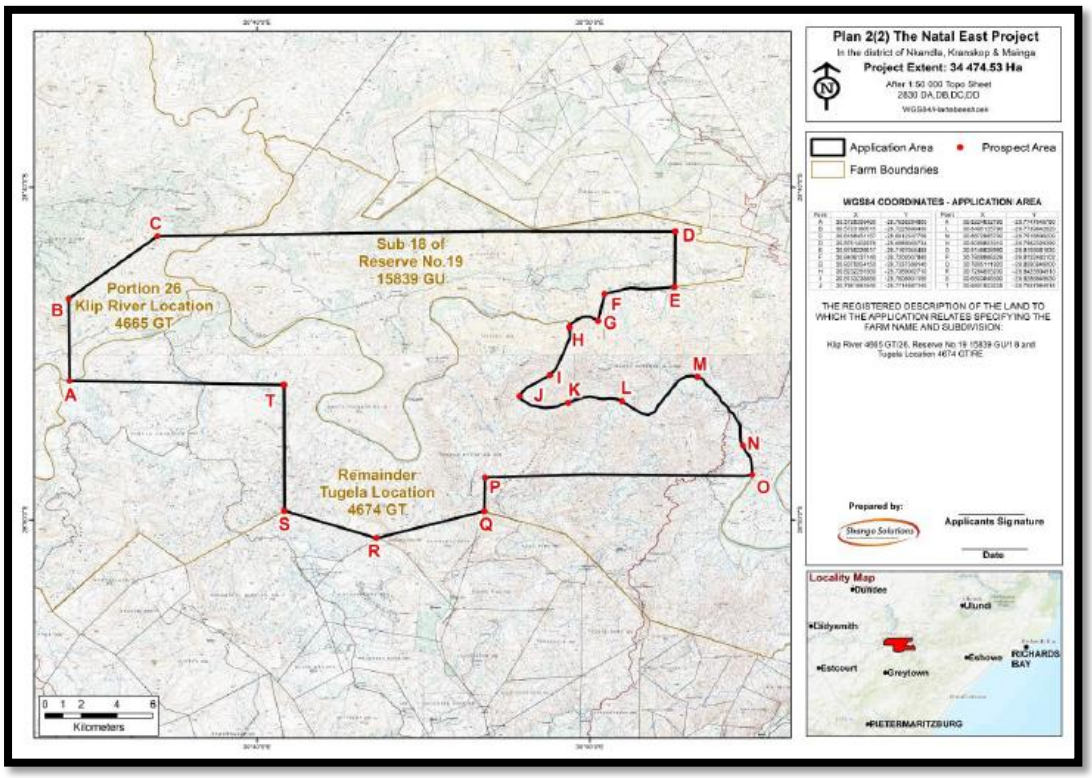
The applicant, WRE Base Metals (Pty) Ltd intends to conduct prospecting without bulk sampling (Figure 1). It seems that trenches will be dug (25x2x2m) instead of drilling.

Local benefits of the proposed development include benefits to the local economy through possible job creation and local supplier procurement during the construction phase as well as during the operational phase of the development.

Related infrastructure:

1. Unknown.

Figure 1: Development lay-out (PWP 2019)



The Project includes one Alternative (Figure 1):
Alternative 1: The site is situated south of the town of Dundee, 30 km northeast of Estcourt, north of the town of Greytown, and with the R33 Road to the west. The size of the site is approximately is 34 474.53 hectares.

Rezoning/ and or subdivision of land: No.
Name of developer and consultant: WRE Base Metals (Pty) Ltd and J. Pelser Archaeological Consulting cc.
Terms of reference: Dr H. Fourie is a palaeontologist commissioned to do a palaeontological impact assessment: field study to ascertain if any palaeontological sensitive material is present in the development area. This study will advise on the impact on fossil heritage mitigation or conservation necessary, if any.
Dr Fourie obtained a Ph.D from the Bernard Price Institute for Palaeontological Research (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. Dr Fourie is currently employed by Ditsong: National Museum of Natural History as Curator of the plant, invertebrate, reptile, fish, dinosaur and Therapsid collections. For the past 13 years she carried out field work in the Eastern Cape, Western Cape, Free State, Gauteng, Limpopo and Mpumalanga Provinces. Dr Fourie has been employed at the Ditsong: National Museum of Natural History in Pretoria (formerly Transvaal Museum) for 24 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 Natal East Prospecting Program will be located on the Farms Klip River 4665-GT, Tugela Location 4674-GT and Reserve No. 19 15839-GU, Nkandla District Municipality, Kranskop - and Msinga Local Municipalities within the Kwazulu Natal Province (Figure 2).

Depth is determined by the related infrastructure to be developed, and the thickness of the formation in the development area, such as foundations, footings and channels. 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. Geological maps do not provide depth or superficial cover, it only provides mappable surface outcrops.

Figure 2: Location map.

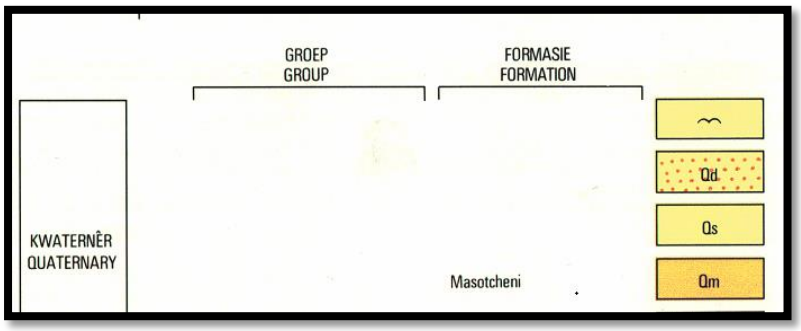
The Project includes one Alternative (Figure 1):
Alternative 1: The site is situated south of the town of Dundee, 30 km northeast of Estcourt, north of the town of Greytown, and with the R33 Road to the west. The size of the site is approximately is 34 474.53 hectares.

F. Description of the Geological Setting

Description of the rock units:

Over areas totalling fully 40% of Southern Africa the 'hard rocks', from the oldest to the Quaternary (Figure 3), are concealed by normally unconformable deposits – principally sand, gravel, sandstone, and limestone. Inland deposits are much more extensive than marine deposits and are terrestrial and usually unfossiliferous. Some of these deposits date back well into the Tertiary, whereas others are still accumulating. Owing to the all-to-often lack of fossils and of rocks suitable for radiometric or palaeomagnetic dating, no clear-cut dividing line between the Tertiary and Quaternary successions could be established (Kent 1980). The alluvium sands were deposited by a river system and reworked by wind action (Snyman 1996).

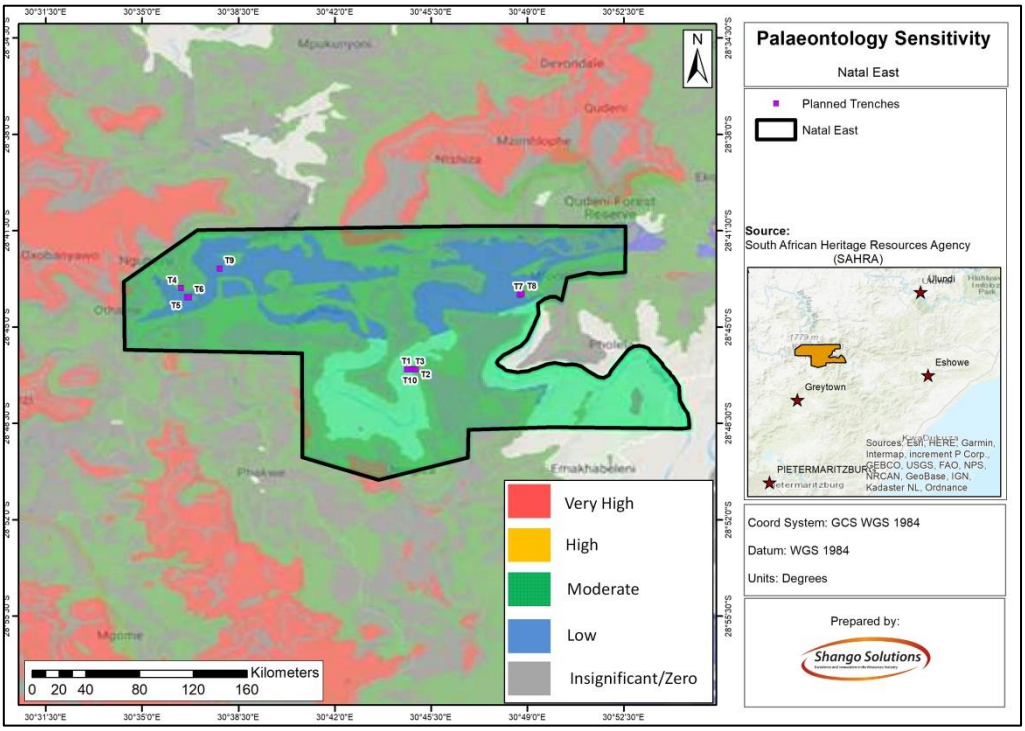
Figure 3: Lithology of the recent deposits.



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 (Figure 4). 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 Beaufort Group is underlain by the Ecca Group which is underlain by the Dwyka Group.

The southern part of the Karoo basin is 3000 m thick, but the northern part of the basin is much thinner. The animals present during Beaufort times flourished on the floodplanes, lakes and marshes. Sandstone is deposited in times of flooding in the river channels and the mudstones were deposited on the floodplains in the shallow lakes (Snyman 1996). The Ecca Group is early to mid-Permian (545-250 Ma) in age. Sediments of the Ecca group are lacustrine and marine to fluvio-deltaic (Snyman 1996). The Ecca group is known for its coal (mainly the Vryheid Formation) (five coal seams) and uranium. Coalfields formed due to the accumulation of plant material in shallow and large swampy deltas (see Appendix 1). The Ecca Group conformably overlies the Dwyka Group and is conformably overlain by the Beaufort Group, Karoo Supergroup. It consists essentially of mudrock (shale), but sandstone-rich units occur towards the margins of the present main Karoo basin in the south, west and north-east, with coal seams also being present in the north-east (Kent 1980, Johnson 2009).

Figure 4: Excerpt of 1:250 000 Geological Map indicating paleo sensitivity (Shango Solutions 2019).

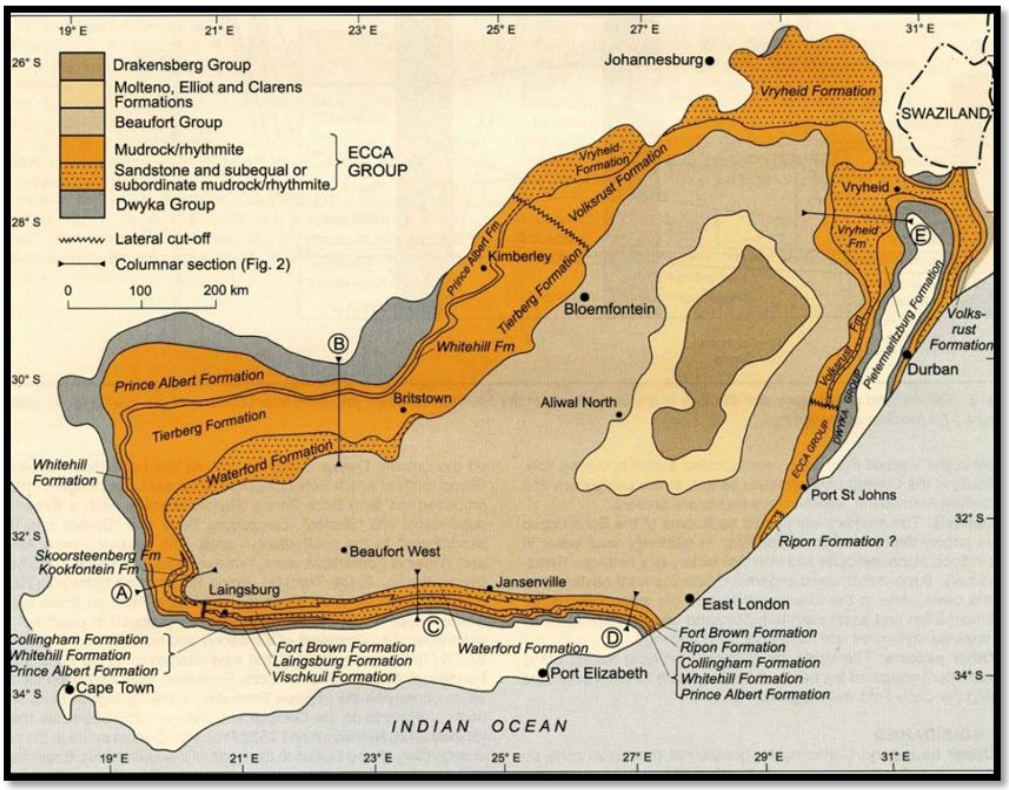


Legend to map and short explanation.
M – Alluvium (light yellow).
Qm – Basal boulder bed, yellow-brown sandy clay (darker yellow). Masotcheni Formation. Quaternary.
Jd – Dolerite (pink). Jurassic.
Pe – Dark blue-grey shale, carbonaceous in places; fine-to coarse-grained sandstone (green). Estcourt Formation, Ecca Group, Karoo Supergroup.
Pvo – Dark-grey shale (orange). Volksrust Formation, Ecca Group, Karoo Supergroup.
Pp – Dark-grey shale (brown). Pietermaritzburg Formation, Ecca Group, Karoo Supergroup.
Pv – Medium-to coarse-grained sandstone, grey micaceous shale; coal (light green). Vryheid Formation, Ecca Group, Karoo Supergroup. Permian.
C-Pd – Tillite; minor shale, varved shale and sandstone (grey). Dwyka Group, Karoo Supergroup.
Nd – Diorite, biotite – hornblende gneiss; migmatite (lime green). Mkondeni Diorite Formation, Tugela Nappe.
Nkt – Tonalite (darker orange). Kotangweni Tonalite, Tugela Nappe.
Nma – Amphibolite (green). Manyane Formation, Tugela Group, Tugela Nappe.
Nnt – Arcosic grit, conglomerate, breccia, mudstone, shale, limestone, ferruginous dolomitic limestone (red). Ntingwe Group, Natal Thrust Belt.
Nm – Hornblende gneiss, schists, quartzite, amphibolite, phyllite, mylonite (dark green). Mfongosi Group, Natal Thrust Belt.
Zg – Granite (light pink). Swazian Intrusive.
…… – (blue) Lineament (Landsat, aeromagnetic).
------ - Concealed geological boundary.
⊥72 – Strike and dip of bed.
-^- -^- - Concealed or inferred thrust fault.
-^-^-^- - Thrust fault.
□ – Proposed prospecting (blocked in black).

Overlying the Volksrust Formation in the Estcourt- Mooi River area is a mappable unit called the Estcourt Formation which is about 400 m thick (Kent 1980). Very little is written on the Volksrust Formation. It rests conformably on the Vryheid Formation. Fossils consist of fish scales and wood. This formation reaches thicknesses of 170-270 m (Visser 1989). A monotonous sequence of grey shale is present and fossils are significant, but very rarely recorded. Fossils include rare temnospondyl amphibian remains, invertebrates, minor coals with plant remains, petrified wood, and low-diversity marine to non-marine trace fossil assemblages (Groenewald and Groenewald 2014). Kent (1980) described the Volksrust Formation as the 150-270 m of shale which overlies the Vryheid Formation. The deposition of this formation coincides with that of the Fort Brown and Waterford Formations in the south (Snyman 1996). It occurs from the south of Kwazulu-Natal into the Free State and is concordant (Visser 1989).

The Vryheid Formation is named after the type area of Vryheid-Volksrust. In the north-eastern part of the basin the Vryheid Formation thins and eventually wedges out towards the south, southwest and west with increasing distance from its source area to the east and northeast (Johnson 2009). The Vryheid Formation consists essentially of sandstone, shale, and subordinate coal beds, and has a maximum total thickness of 500 m. It forms part of the Middle Ecca (Kent 1980). This formation has the largest coal reserves in South Africa. The pro-delta sediments are characterised by trace and plants fossils (Snyman 1996).

Map 1: Karoo Supergroup distribution and lithostratigraphy (Johnson 2009).



Coal has always been the main energy source in industrial South Africa. It is in Mpumalanga, south of the N4, that most of the coal-fired power stations are found. Eskom is by far the biggest electricity generator in Africa. Thick layers of coal just below the surface are suited to open-cast mining and where the overlying sediments are too thick, shallow underground mining. In 2003, coal was South Africa's third most valuable mineral commodity and is also used by Sasol for fuel- and chemicals-from-coal (Norman and Whitfield 2006). Grodner and Cairncross (2003) proposed a 3-D model of the Witbank Coalfield to allow easy evaluation of the sedimentary rocks, both through space and time. Through this, one can interpret the environmental conditions present at the time of deposition of the sediments. This can improve mine planning and mining techniques. The Vryheid Formation is underlain by the Dwyka Group (Map 1) and is gradually overlain by mudstones (and shale) and sandstones of the Volksrust Formation. The typical colours for the Vryheid Formation are grey and yellow for the sediments and black for the coal seam. The thickness of the grey shale can vary and this is interlayered with the also variable yellow sandstone and coal seams.

At the bottom overlying the Dwyka Group is the Pietermaritzburg Formation. It attains a thickness from 170 to of over 400 m thick (Kent 1980, Visser 1989).

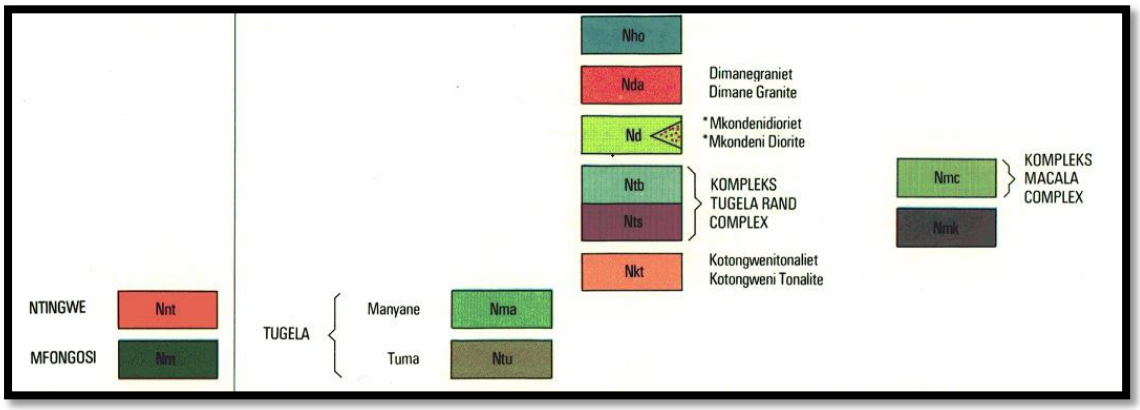
Ecca rocks are stable and lend themselves well to developments. It is only unstable in or directly above mining activities (Snyman 1996). The site itself is partly situated on the flat-lying Vryheid Formation, Ecca Group, Karoo Supergroup. Dolerite dykes occur throughout the Karoo Supergroup. Structural geological features such as dykes and faults can have a measurable influence on ground water flow and mass transport.

Visser *et al.* (1990) proposed two subdivisions for the Dwyka Group in the main Karoo basin, the southern Elandsvlei and northern Mbizane Formations. In the far north, the Tshidzi and Wellington Formations also form part of the Dwyka Group. The Dwyka Group is underlain by the Witteberg Group, Bokkeveld or Table Mountain Groups, Natal Group and various Proterozoic and Archaean units. Ranges in age from Late Carboniferous to Early Permian and the group as a whole becomes younger towards the north and east. A thickness of 100-600 m

is obtained. The Dwyka Group is underlain by the Witteberg Group, Bokkeveld or Table Mountain Groups, Natal Group and various Proterozoic and Archaean units. Ranges in age from Late Carboniferous to Early Permian and the group as a whole becomes younger towards the north and east. A thickness of 100-600 m is obtained (Visser *et al.* 1990).

The geological foundation of Kwazulu-Natal (Figure 4) is represented by the Kaapvaal Craton and the Natal Metamorphic Province, the ancient foundations of Kwazulu-Natal (Groenewald 2012). The Natal Metamorphic and Structural Province is 900-1 194 Ma and was subdivided into the Ntingwe, Mfongozi, Tugela, and Mapumulo Groups (Figure 5). The Ntingwe Group is only 1 to 5 km wide and about 40 km in length. It comprises the Makasana, Manzawayo, and Dlolwana Formations (Kent 1980, Snyman 1996). These are the floor rocks across which rivers flowed that accumulated the pebbles, sand, and the mud that would make the Natal Group. It's the building blocks of the Valley of a Thousand Hills (Norman and Whitfield 2006).The term nappe is given to the upper folded slab of a thrust fault, the result of a type of reverse fault, along which one slab of folded rocks slides over another (McCarthy and Rubidge 2005).

Figure 5: Lithology of the Natal Thrust Belt and the Tugela Nappe.
Natal Thrust Belt Tugela Nappe



Field Observations

This property is large, roads are not present and it was not possible to get to the location of the trenches. It is too vast to try and get to trench areas by foot. The areas where the Very High and High palaeontological sensitivity are present are not accessible. The site visit was done in June 2019, conditions mild and dry. Photographs below show the undulating topography. A variety of soil types (overburden and topsoil) will be present. There is a concern that trenches will be dug (25x2x2m), no drilling (Figure 6-9).

The thrust faulted metamorphic rocks of the Mfongozi (Nm) and Tugela Groups (Nma) of the Natal Metamorphic Province will be explored for the base metals (cobalt, copper, nickel, zinc, tungsten) and also iron ore, manganese and gold (PWP 2019). Ten trenches are planned, T4, T5, T6, and T9 are situated on the Mfongosi Formation (Nm) (Au has been mined), T1, T2, T3, and T 10 are situated on the Manyane Formation (Nma) (Au has been mined), and T7 and T8 are situated on the Mfongosi Formation (Nm) (Au has been mined). These layers are overlain by the Dwyka and Ecca Groups with the Dwyka Group close by as outcrops, but it's presence as outcrops could not be confirmed.

Figure 6: View of property where trenches T4, T5, T6, and T9 will be dug.

Figure 7: View of river and quaternary deposits.

Figure 8: View of Ecca Group rocks on northern border of property.

Figure 9: View of project area in the distance (hill) area and road.

The project includes one Alternative (Figure 1)

Alternative 1: The site is situated south of the town of Dundee, 30 km northeast of Estcourt, north of the town of Greytown, and with the R33 Road to the west. The size of the site is approximately is 34 474.53 hectares.

G. Background to Palaeontology of the area

Summary: When rock units of moderate to very high palaeontological sensitivity are present within the development footprint, a desk top and or field scoping (survey) study by a professional palaeontologist is usually warranted. The main purpose of a field scoping (survey) study would be to identify any areas within the development footprint where specialist palaeontological mitigation during the construction phase may be required (SG 2.2 SAHRA AMPHOB, 2012).

The Quaternary Formation may contain fossils. A very wide range of possible fossil remains, though these are often sparse, such as: mammalian bones and teeth, tortoise remains, ostrich eggshells, non-marine mollusc shells, ostracods, diatoms, and other micro fossil groups, trace fossils (e.g. calcretised termitaria, rhizoliths, burrows, vertebrate tracks), freshwater stromatolites, plant material such as peats, foliage, wood, pollens, within calc tufa. Stromatolite structures range from a centimetre to several tens of metres in size. Large areas of the coastal plain of Kwazulu-Natal are covered in a blanket of alluvial sand and no significant fossils have been described from these sediments (Groenewald 2012).

The Ecca Group may contain fossils of diverse non-marine trace, *Glossopteris* flora, mesosaurid reptiles, palaeoniscid fish, marine invertebrates, insects, and crustaceans (Johnson 2009). *Glossopteris* trees rapidly colonised the large deltas along the northern margin of the Karoo Sea. Dead vegetation accumulated faster than it could decay, and thick accumulations of peat formed, which were ultimately converted to coal. It is only in the northern part of the Karoo Basin that the glossopterids and cordaitales, ferns, clubmosses and horsetails thrived (McCarthy and Rubidge 2005). The Glossopteris flora is thought to have been the major contributor to the coal beds of the Ecca. These are found in Karoo-age rocks across Africa, South America, Antarctica, Australia and India. This was one of the early clues to the theory of a former unified Gondwana landmass (Norman and Whitfield 2006).

The Estcourt Formation contains evidence of an abundance of marine and probably estuarine invertebrates that left trace fossils in the rock record (Groenewald 2012). The Volksrust Formation consists of a monotonous sequence of grey shale and fossils are significant, but very rarely recorded. Fossils include rare temnospondyl amphibian remains, invertebrates, minor coals with plant remains, fish scales, petrified wood, and low-diversity marine to non-marine trace fossil assemblages (Groenewald and Groenewald 2014). The Vryheid Formation (Pe,Pv), Ecca Group is rich in plant fossils such as the *Glossopteris* flora (Appendix 1) represented by stumps, leaves, pollen and fructifications (Appendix 1). Fossils are generally absent from the Pietermaritzburg Formation although trace fossils have been recorded from the upper layers (Groenewald 2012).

Boulders containing fossil archaeocyathids (cone-shaped filter-feeding organisms related to sponges) have been discovered in the southern outcrops of the Dwyka Group, but not in South Africa. Trace fossils are relatively abundant in the shales occurring near the top of the Dwyka Group, these traces were produced by fish and various arthropods. Plants occurring are lycopods, moss, pre-*Glossopteris* flora, pollen, spores and wood. Microfossils include foraminifers, sponge spicules, and radiolarians, coprolites, bivalves, brachiopods and nautiloids also occur (MacRae 1999, Visser *et al.* 1990). Plant fossils have been described from outcrops of the Dwyka Group in Limpopo Province, with special reference in the Springbok Flats region. Outcrops are however rare in the Mpumalanga Province and any recording of fossils will be highly significant (Groenewald and Groenewald 2014).

Impressions of arthropod remains and *Hyolithes princeps* are present in the rocks of the Ntingwe Group (Kent 1980).

Table 1: Taken form The Palaeotechnical Report (Groenewald 2012).

Group	Subgroup	Formation	Member	Lithology	Fossil Record
		m m m m m		Recent alluvial sediments	None
		Qs		Dune sand from extensive reworking of the Kosi Bay Formation on the Northern Natal coastal plain that resulted from marine regressionand dry periods when dune formation was wide spread. Yellowish red grey and white dune sands with local pockets of calcareous clays	Local peat deposits up to 4m thick
		Δ Δ Δ Δ Δ		Debris	None
		Masocheni (Qm)		Thin sedimentary deposit on hillsides and in valley floor, on floodplains of rivers	Fossil plant roots preserved as silcrete around original roots
		Estcourt (Pe / Pes)	Emakwazini (Pem)	Deltaic Coarse-grained sandstone and shale	Trace Fossils, including areas in the Estcourt Area, plant fossils of *Glossopteris*
Ecca		Volksrust (Pvo)		Dark Grey Shale	Trace Fossils
		Vryheid (Pv)		Light grey coarse- to fine-grained sandstone and siltstone. Dark coloured siltstone due to presence of carbon enrichment and coal beds	Abundant plant fossils of *Glossopteris* and other plants. Trace fossils. The reptile *Mesosaurus* has been found in the southern part of the Karoo Basin
		Pietermaritzburg (Pp)		Dark Grey Shale	Trace Fossils
		Dwyka (C-Pd / Pd)		Tillite, diamictite	None recorded in KwaZulu-Natal to date. the basin

Supergroup or Sequence	Group	Subgroup	Formation	Member	Lithology	Fossil Record
Natal Structural and metamorfic province	Mapumulo		Nmz, Nmk, Ns, Ne, Nmn, Nml, Nmg, Nmc, Nmi, Nh, Nma, Nly, No, Nss, Nsm, Ni, Nb, Na, Ns, Ncg, Nhg, Ngg, Ng, Nn, Nm, Nmh, Nl, Nt, Nmu, Nmp, Nq, Nh, Nbi, Nmg, Nsg, Nmg, Nsg, Nw, Nta, Ndg, Nnt		Various formations of intrusive and metamorphic rocks, comprising mainly of granite, gneises and amphibolite	None
	Matigulu					
	Tugela					
	Ntingwe					
	Mfongosi					
			Intrusive Rocks (M)		Intrusive rocks consisting of Granite and Gneiss	None

Fossils in South Africa mainly occur in rocks of sedimentary nature and not in rocks from igneous or metamorphic nature. Therefore, if there is the presence of Karoo Supergroup strata the palaeontological sensitivity is generally LOW to VERY HIGH, but here locally **VERY HIGH to LOW**.

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

Rock Unit	Significance/vulnerability	Recommended Action
Estcourt, Vryheid Formations	Very High	Field assessment and protocol for finds is required
Masotcheni, Volksrust, Pietermaritzburg, Dwyka	Moderate	Desktop study is required and based on the outcome, a field assessment is likely
Tugela Nappe	Low	Desktop study is required
Natal Thrust Belt	Low	Desktop study is required

Databases and collections: Ditsong: National Museum of Natural History. Evolutionary Studies Institute, University of the Witwatersrand (ESI).
Impact: **VERY HIGH** to **LOW**. There are significant fossil resources that may be impacted by the development (shale) and here locally **VERY HIGH** for the Estcourt and Vryheid Formations, **MODERATE** for the Masotcheni, Volksrust (**HIGH**), Pietermaritzburg and Dwyka Formations (**LOW**) and **LOW** for the Tugela Nappe and Natal Thrust Belt (**INSIGNIFICANT**) (Groenewald 2012). The Groenewald (2012) Palaeotechnical report differs from the SG 2.2 SAHRA APMHOB, 2012 (here bracketed), but as fossils may occur as impressions of arthropod remains and *Hyolithes princeps* in the rocks of the Ntingwe Group (Kent 1980), Natal Thrust Belt a **LOW** status is allocated. Groenewald did not have a category **HIGH.**

H. Description of the Methodology (1e)

The palaeontological impact assessment field study was undertaken in June 2019. The walk through and drive through of the affected portion were done and photographs (in 20 mega pixels) were taken of the site with a digital Canon camera (PowerShot SX620HS). It was not 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. The walk through and drive through did identify the Ecca Group north of the project.

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. Archaeozoologists can be called upon to survey for more recent fossils in the Quaternary and Tertiary deposits.

Assumptions and Limitations (**1i**):-
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 (1f)

All Karoo Supergroup geological formations are ranked as LOW to VERY HIGH, and here the impact is potentially **VERY HIGH** and **HIGH** for the Ecca Group. Rocks of Permian age in South Africa are particularly rich in fossil plants (Rayner and Coventry 1985). The fossils are present in the grey shale interlayered with the coal seams. The fossils are not very rare and occur also in other parts of the Karoo stratigraphy. The pollen of the Greenside Colliery also on the Vryheid formation was the focus of a Ph.D study. It is often difficult to spot the greyish fossils as they are the same colour as the grey shale in which they are present as these coalified compressions have been weathered to leave surface replicas on the enclosing shale matrix. A locality close to Ermelo, also Vryheid Formation, has yielded *Scutum, Glossopteris* leaves, *Neoggerathiopsis* leaves, the lycopod *Cyclodendron leslii,* and various seeds and scale leaves (Prevec 2011).

Fossils likely to be found are mostly plants (Appendix 1) such as '*Glossopteris* flora' of the Ecca Group. The aquatic reptile *Mesosaurus* and fossil fish may also occur with marine invertebrates, arthropods and insects. Trace fossils can also be present. The marine bivalve *Megadesmus* is found in the upper part of the Volksrust Formation near Newcastle (Johnson 2009).

During storms a great variety of leaves, fructifications and twigs accumulated and because they were sandwiched between thin films of mud, they were preserved to bear record of the wealth and the density of the vegetation around the pools. They make it possible to reconstruct the plant life in these areas and wherever they are found, they constitute most valuable palaeobotanical records (Plumstead 1963) and can be used in palaeoenvironmental reconstructions. The Estcourt Formation is singular worldwide in that it yields an excellently preserved, well-studied flora and insect fauna (MacRae 1999).

Details of the location and distribution of all significant fossil sites or key fossiliferous rock units are often difficult to be determined due to thick topsoil, subsoil, overburden and alluvium. Depth of the overburden may vary a lot. The vast coal mining industry (Vryheid Formation) provides palaeontologists with fantastic access to coal-associated plant fossils, while simultaneously resulting in the destruction of important National Palaeontological Heritage.

The threats are:- earth moving equipment/machinery (for example haul trucks, front end loaders, excavators, graders, dozers) during construction, 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 (1j,1l)

a. There is no objection (see Recommendation B) to the development, but it was necessary to request a Phase 1 Palaeontological Impact Assessment: Field study to determine whether the development will affect fossiliferous outcrops as the palaeontological sensitivity is **VERY HIGH to MODERATE**. A Phase 2 Palaeontological Mitigation is only required if the Phase 1 Palaeontological Assessment identified a fossiliferous formation or surface fossils or if fossils are found during construction. The Protocol for 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 (see Executive Summary).

d. The following should be conserved: if any palaeontological material is exposed during digging, excavating, drilling or blasting SAHRA must be notified. All construction activities must be stopped, a 30 m no-go barrier constructed and a palaeontologist should be called in to determine proper mitigation measures.

Sampling and collecting (**1m,1k**):

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. Some technical information was provided by Shango Solutions.
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 for shallow caves.
e. Condition in which development may proceed: It is further suggested that a Section 37(2) agreement of the Occupational, Health and Safety Act 85 of 1993 is signed with the relevant contractors to protect the environment and adjacent areas as well as for safety and security reasons.

L. Bibliography

ALMOND, J., PETHER, J, and GROENEWALD, G. 2013. South African National Fossil Sensitivity Map. SAHRA and Council for Geosciences.

DE ZANCHE, V. and MIETTO, P. 1977. *The World of Fossils.* Sampson Low Guides, Berkshire, Printed in Italy, Pp 256.

GRODNER, M. and CAIRNCROSS, B. 2003. A regional scale 3-D model of the Witbank Coalfield, Northern Karoo Basin, South Africa. *South African Journal of Geology,* **106(4):** 249-264.

GROENEWALD, G 2012. SAHRA Palaeotechnical Report. AMAFA Palaeontological Heritage of Kwazulu-Natal Province, Pp 29.

JOHNSON, M.R. 2009. Ecca Group. Karoo Supergroup. Catalogue of South African Lithostratigraphic Units. SACS, **10:** 5-7.
KENT, L. E., 1980. Part 1: Lithostratigraphy of the Republic of South Africa, South West Africa/Namibia and the Republics of Bophuthatswana, Transkei and Venda. SACS, Council for Geosciences, *Stratigraphy of South Africa. 1980. South African Committee for Stratigraphy.* Handbook 8, Part 1, pp 690.
KEYSER, N., BOTHA, G.A. and GROENEWALD, G.H. 1986. 1:250 000 Geological Map of the East Rand, 2628. South African Committee for Stratigraphy, Council for Geoscience, Pretoria.
MACRAE, C. 1999.*Life Etched in Stone: Fossils of South Africa.* Geological Society of south Africa, Johannesburg. Pp 305.
MARSHALL, C.G.A 2005. Natal Group, [Natal Group], [*Ordovician].* Catalogue of South African Lithostratigraphic Units, **8:** 25-27.
MCCARTHY, T and RUBIDGE, B. 2005. *The Story of Earth Life: A southern African perspective on a 4.6-billion-year journey.* Struik. Pp 333.
NIXON, N., ERIKSSON, P.G., JACOBS, R. and SNYMAN, C.P. 1988. Early Proterozoic micro-algal structures in carbonaceous shales of the Pretoria Group, south-west of Potchefstroom. *South African Journal of Science,* **84:** 592-595.
NORMAN, N. and WHITFIELD, G., 2006. *Geological Journeys.* De Beers, Struik, P 1-320.
PLUMSTEAD, E.P. 1963. The influence of plants and environment on the developing animal life of Karoo times. *South African Journal of Science,* **59(5):** 147-152.
PREVEC, R. 2011. A structural re-interpretation and revision of the type material of the glossopterid ovuliferous fructification *Scutum* from South Africa. *Palaeontologia africana,* **46:** 1-19.
RAYNER, R.J. and COVENTRY, M.K. 1985. A *Glossopteris* flora from the Permian of South Africa. *South African Journal of Science,* **81:** 21-32.
RUBIDGE, B. S. (ed.), 1995. Biostratigraphy of the Beaufort Group (Karoo Supergroup). South African Committee for Biostratigraphy, Biostratigraphic Series No. 1, 46pp. Council for Geoscience, Pretoria.
SG 2.2 SAHRA APMHOB Guidelines, 2012. Minimum standards for palaeontological components of Heritage Impact Assessment Reports, Pp 1-15.
SNYMAN, C. P., 1996. *Geologie vir Suid-Afrika*. Departement Geologie, Universiteit van Pretoria, Pretoria, Volume 1, Pp. 513.
VAN DER WALT, M., DAY, M., RUBIDGE, B. S., COOPER, A. K. & NETTERBERG, I., 2010. Utilising GIS technology to create a biozone map for the Beaufort Group (Karoo Supergroup) of South Africa. *Palaeontologia Africana,* **45:** 1-5.
VISSER, D.J.L. 1984 (ed). Geological Map of South Africa 1:100 000. South African Committee for Stratigraphy. Council for Geoscience, Pretoria.
VISSER, D.J.L. 1989 (ed). *Toeligting: Geologiese kaart (1:100 000). Die Geologie van die Republieke van Suid Afrika, Transkei, Bophuthatswana, Venda, Ciskei en die Koningkryke van Lesotho en Swaziland*. South African Committee for Stratigraphy. Council for Geoscience, Pretoria.
WALRAVEN, F. 1978. 1: 250 000 Geological Map 2528 of Pretoria. South African Committee for Stratigraphy, Council for Geoscience, Pretoria.

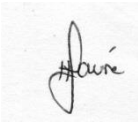
Declaration (disclaimer) 1(b)

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 Phase 1 PIA 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.



_____

Heidi Fourie
2019/06/22

Appendix 1: Examples of Vryheid Formation fossils (MacRae 1999).

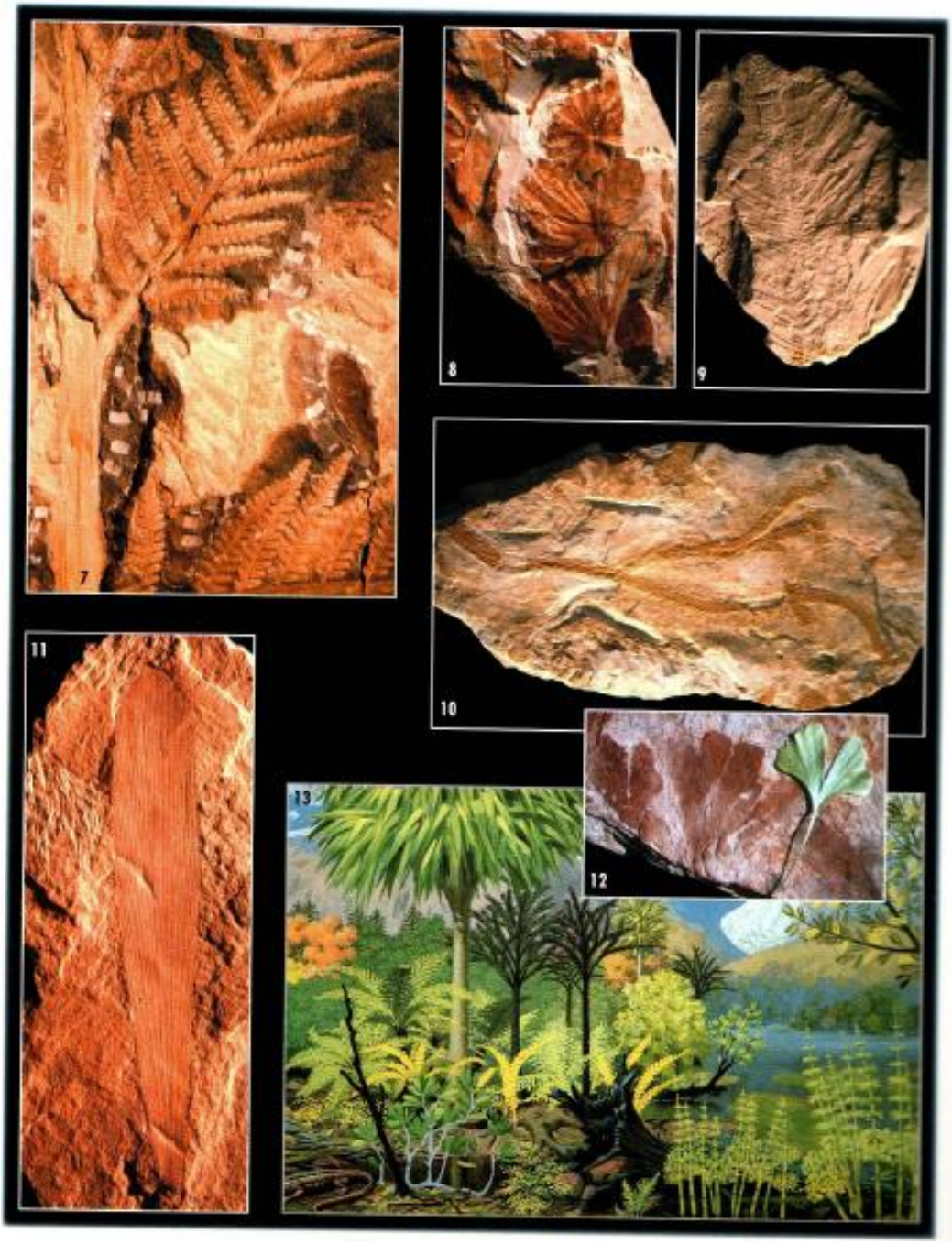


Figure 11: Example of a plant fossil (courtesy of the ESI). *Glossopteris* leave.

Appendix 2 (1k,1m,1q): **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. When a fossil is found, the area must be fenced-off and the construction workers must be informed that this is a no-go area. 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 artefacts 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 ECO should familiarise him- or herself with the fossiliferous formations and its fossils. A bi-weekly site visit is recommended and the keeping of a photographic record. 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 will take place. Trenches have to be dug to ascertain how deep the sediments are above the bedrock (can be a few hundred metres). This will give an indication of the depth of the topsoil, subsoil, and overburden, if need be trenches should be dug deeper to expose the interburden.

Mitigation will involve recording, rescue and judicious sampling of the fossil material present in the layers sandwiched between the geological / coal layers. It must include information on number of taxa, fossil

abundance, preservational style, and taphonomy. This can only be done during mining or excavations. In order for this to happen, in case of coal mining operations, the process will have to be closely scrutinised by a professional palaeontologist / palaeobotanist to ensure that only the coal layers are mined and the interlayers (siltstone and mudstone) are surveyed for fossils or representative sampling of fossils are taking place.

The palaeontological impact assessment process presents an opportunity for identification, access and possibly salvage of fossils and add to the few good plant localities. Mitigation can provide valuable onsite research that can benefit both the community and the palaeontological fraternity.

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

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

1. Recommendations for the future of the site.
2. Description and purpose of work done (including number of people and their responsibilities).
3. A written assessment of the work done, fossils excavated, not removed or collected and observed.
4. Conclusion reached regarding the fossil material.
5. A detailed site plan and map.
6. Possible declaration as a heritage site or Site Management Plan.
7. Stakeholders.
8. Detailed report including the Desktop and Phase 1 study information.
9. Annual interim or progress Phase 2 permit reports as well as the final report.
10. Methodology used.

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

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

1. The developer needs to clearly stake or peg-out (survey) the areas affected by the mining/ construction/ development operations and dig representative trenches and if possible supply geological borehole data.
2. Fossils likely to occur are for example the fossil plants from the Vryheid Formation, these are present in the grey shale (or any other fossiliferous layer ranked as VERY HIGH or HIGH) or invertebrates from the Volksrust Formation (or any other fossiliferous layer).
3. When clearing topsoil, subsoil or overburden and hard rock (outcrop) is found, the contractor needs to stop all work.
4. A Palaeobotanist / palaeontologist (contact SAHRIS for list) must then inspect the affected areas and trenches for fossiliferous outcrops / layers. The contractor / developer may be asked to move structures, and put the development on hold.
5. If the palaeontologist / palaeobotanist is satisfied that no fossils will be destroyed or have removed the fossils, development and removing of the topsoil can continue.
6. After this process the same palaeontologist / palaeobotanist will have to inspect and offer advice through the Phase 2 Mitigation Process. Bedrock excavations for footings may expose, damage or destroy previously buried fossil material and must be inspected.
7. When permission for the development is granted, the next layer can be removed, if this is part of a fossiliferous layer, then with the removal of each layer of sediment, the palaeontologist / palaeobotanist must do an investigation (a minimum of once a week).

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. 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 3: Table of Appendix 6 requirements.

Section	Point in Act	Heading
B	1(c)	Outline of development project
	1(d)	Summary of findings
	1(g)	Concerns/threats
	1(n)i	Concerns/threats
	1(n)ii	Concerns/threats
	1(o)	Concerns/threats
	1(p)	Concerns/threats
D	1(h)	Figures
	1(a)i	Terms of reference
H	1(e)	Description of Methodology
	1(i)	Assumptions and Limitations
I	1(f)	Heritage value
J	1(j)	Recommendation
	1(l)	Recommendation
	1(m)	Sampling and collecting
	1(k)	Sampling and collecting
Declaration	1(b)	Declaration
Appendix	1(k)	Protocol for finds
	1(m)	Protocol for finds
	1(q)	Protocol for finds