PALAEONTOLOGICAL ASSESSMENT FOR THE PROPOSED MINING RIGHT ON TENBOSCH FARM NO. 162 JU ALL PORTIONS (EXCLUDING PORTION 46, 74&90), VYEBOOM FARM NO. 414 JU, ALL PORTIONS (EXCLUDING PORTION 1) TURFBULT 593 JU ALL PORTIONS, TECKLENBURG'S RANCH 548 JU ALL PORTIONS, WITHIN THE BARBERTON MAGISTERIAL DISTRICT IN MPUMALANGA PROVINCE

Prepared for

Manzolwandle Investments (Pty) Ltd

Prepared by

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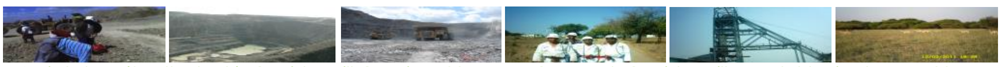
Palaeontology: The branch of science concerned with fossil animals and plants.

Final Report (14-06-2019)



EXECUTIVE SUMMARY

Singo Consulting (Pty) Ltd was appointed by Manzolwandle Investments (Pty) Ltd to undertake a Palaeontological Impact Assessment, assessing the potential palaeontological impact of the proposed mining right activities on the Tenbosch Farm no. 162 JU All portions (excluding portion 46, 74 & 90), Vyeboom Farm no. 414 JU, All Portions (excluding portion 1) Turfbult 593 JU All Portions, Tecklenburg's Ranch 548 JU All Portions, within the Barberton Magisterial district in Mpumalanga Province.

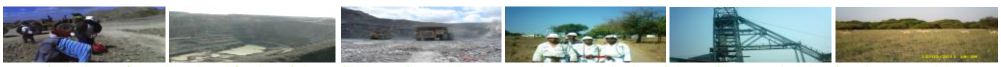
This palaeontology report forms part of the Environmental Impact Assessment (EIA) and complies with the requirements of the South African Heritage Resource Act No 25 of 1999. According to the National Heritage Resources Act (Act No 25 of 1999, section 38), a palaeontological impact assessment is required to detect the presence of fossil material within the proposed development footprint and to assess the overall impact of the proposed operation associated with the proposed project on the palaeontological resources that may occur within the project area. This report further provide recommendation as to how impacts might be mitigated to reduce or when possible, avoid them.

The development site of the proposed mining right project area is entirely underlain by sedimentary successions of the Vryheid and Volkrust formations of the Ecca Group of the Karoo Supergroup. The Vryheid formation is famous and generally known to contain a rich assemblage of plant fossils and the mining of coal where possible. From previous coal studies, coal of the Vryheid formation consists of fossil plant material. This Vryheid Formation has also trace fossil assemblages of the non-marine Mermia Ichnofacies and is dominated by the ichnogenera Umfolozia (arthropod trackways) and Undichna (fish swimming trails), palaeoniscoid fish, small eocarid crustaceans, insects, trace fossils (king crab track ways. shark coprolites?), palynomorphs (organic-walled spores and pollens), petrified wood (mainly of primitive gymnosperms, silicified or calcified) and sparse vascular plant remains (Glossopteris leaves, lycopods etc). The unique mesosaurid reptile, Mesosaurus may also be present in the development site.

When a thorough field survey was being conducted, few trace fossils were found within coal layers. A moderate palaeontological sensitivity is allocated to this proposed project area. This is because of the localised occurrence of the fossil traces found.

Recommendations:
Singo Consulting (Pty) Ltd recommends that:

✓ If any drilling to be conducted will intersect the Vryheid Formation as is known to be rich in fossils, then, the second phase of paleontological studies on actual core should be considered.



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- ✓ If excavation goes to the depth that will expose the fresh bedrock, the possibility of finding fossils is high and any fossils observed must be reported and rescued by a qualified palaeontologist. All recorded fossils must be rescued according to SAHRA specifications.
- ✓ As it stands, Singo Consulting (Pty) Ltd recommends that, no further mitigation for Palaeontological Heritage is needed until operation commence or drilling.

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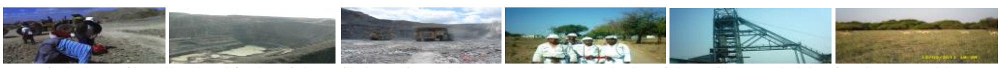


1. INTRODUCTION

Singo Consulting (Pty) Ltd was appointed to undertake a Palaeontological Impact Assessment, assessing the potential palaeontological impact of the proposed Mining Right. The purpose of this Palaeontological Impact Assessment is to identify and assess potential palaeontological heritage from both exposed and drilled rock samples on the site of the proposed development. This is to further assess the impact the development may have on this resource, and to make recommendations as to how the calculated impacts might be mitigated.

1.1. Legal Requirements

This report forms part of the Environmental Impact Assessment for the proposed Mining Right at Barberton Magisterial District, in Mpumalanga Province and complies with the requirements for the South African National Heritage Resource Act No 25 of 1999. In accordance with Section 38 (Heritage Resources Management), a Palaeontological Impact Assessment is required to assess any potential impacts to palaeontological heritage within the development.

Categories of heritage resources recognised as part of the National Estate in Section 3 of the Heritage Resources Act, and which therefore fall under its protection, include:

- ✓ Geological sites of scientific or cultural importance;
- ✓ Objects recovered from the soil or waters of South Africa, including archaeological and palaeontological objects and material, meteorites and rare geological specimens; and
- ✓ Objects with the potential to yield information that will contribute to an understanding of South Africa's natural or cultural heritage.

1.2. AIMS OF THE STUDY

A paleontological investigation is usually the last opportunity to record the fossil heritage within the proposed project. This record is a very important and used to understand past histories and forms an important part of South Africa's National Estate.

With the use of "SAHRA APM Guidelines: Minimum Standards for the Archaeological & Palaeontological Components of Impact Assessment Reports" the aims of the palaeontological impact assessment were attempt to:

- ✓ Identify exposed and subsurface rock formations that are paleontologically significant;
- ✓ Assess the level of palaeontological significance of these formations;

- ✓ Comment on the impact of the development on these exposed and/or potential fossil resources and
- ✓ Make recommendations as to how the developer should conserve or mitigate damage to these resources.

1.3. Objective

The objective of this study is to conduct a Palaeontological Impact Assessment, which forms part of the Heritage Impact Assessment (HIA) and the EIA Report, to determine the impact of the development on potential palaeontological material at the site.

1.4. Paleontological Sensitivity Classification

The likely impact of the proposed development on this local fossil heritage was determined using the palaeontological sensitivity of the rock units of the proposed area, the nature and scale of the development itself, most notably the minimal extent of fresh bedrock excavation envisaged. The different sensitivity classes used are explained in Table 1 below.

Table 1: Paleontological sensitivity analysis outcome classification

Sensitivity	Description
Low Sensitivity	Areas where there is likely to be a negligible impact on the fossil heritage. This category is reserved largely for areas underlain by igneous rocks. However, development in fossil bearing strata with shallow excavations or with deep soils or weathered bedrock can also form part of this category.
Moderate Sensitivity	Areas where fossil bearing rock units are present but fossil finds are localised or within thin or scattered sub-units. Pending the nature and scale of the proposed development the chances of finding fossils are moderate. The developer should be made aware of the potential for finding fossils. If fossil material is later discovered it must be appropriately protected and the discovery reported to the appropriate Heritage Authority so that any appropriate mitigation by a palaeontological specialist can be considered and implemented, at the developer's expense.
High Sensitivity	Areas where fossil bearing rock units are present with a very high possibility of finding fossils of a specific assemblage zone. Fossils will most probably be present in outcrops and exposed bedrock. The chances of finding fossils during excavations by a professional palaeontologist are high. Palaeontological mitigation measures need to be incorporated into the Environmental Management Plan. The mitigation should involve the comprehensive recording and collection of surface and embedded fossils along and close to the development footprint by a professional palaeontologist.

According to the DMR requirements, when rock units of moderate to high palaeontological sensitivity are present within the proposed project, palaeontological mitigation measures should be incorporated into the Environmental Management Plan.

1.5. Assumptions and Limitations

The accuracy and reliability of desktop Palaeontology Impact Assessments are normally limited by the following restrictions:

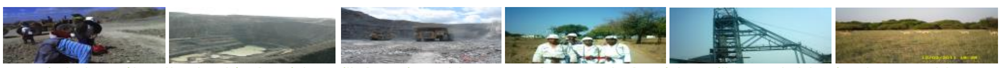
- ✓ The accuracy of geological maps where information may be based solely on aerial photographs and small areas of significant geology have been ignored. The sheet explanations for geological maps are inadequate and little to no attention is paid to palaeontological material.
- ✓ The accuracy of geological maps where information may be based solely on aerial photographs and small areas of significant geology have been ignored. The sheet explanations for geological maps are inadequate and little to no attention is paid to palaeontological material.
- ✓ A lot of Farms in South Africa are private-owned and mostly inaccessible. This causes fragmentation and scattering of data that is being collected. Sampled boreholes are from one farm, other farms' palaeontological and geological information is interred.

For reasons such as lack of palaeontologists in South Africa, vast land within the country remains a myth paleontologically. Looking at other fossil data collected from different areas of the country of similar assemblage zones normally provides an insight on the possible occurrence of the fossil in an unexplored area. Desktop studies therefore usually assume the presence of unexposed fossil heritage within study areas of similar geological formations. Where considerable exposures of bedrocks or potentially fossiliferous superficial sediments are present in the study area, the reliability of a Palaeontological Impact Assessment may be significantly improved through field-survey by a professional palaeontologist.

2. PROPOSED DEVELOPMENT DESCRIPTION

Manzolwandle Investments (Pty) Ltd is applying for a Mining Right for the mining of coal on Farm Tenbosch 162 JU excluding portion 46, 74 and 90; Farm Vyeboom 414 JU excluding portion 01; Farm Tecklenburg's Ranch 548 JU and Turfbult 593 JU within the Jurisdiction of Nkomazi Local Municipality of the Ehlanzeni District Municipality in Mpumalanga Province.

The proposed mining area is approximately 17 975 Ha in extent and the mineable material occurs at an average depth of 30 metres. Mining will make use of blasting by means of explosives in order to loosen the hard rock. The loosened material will be loaded and hauled out of the excavation and coal mined loaded onto a mobile crusher plant in the mining area. The overburden will then be stockpiled and transported to clients using trucks and trailers.
The Proposed Mining Activity will start as a surface mine, then it will be upgraded into underground mine. There are several infrastructure requirements such as roads, rail, electricity and water need and that will be



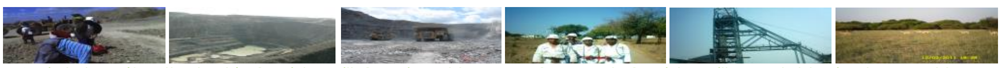
affected by the proposed activity. The public roads to be affected by the proposed mining are (1) the N4 from the Lembobo Border to Nelspruit (2) Olifant Drive from the N4 to Marloth Park (3) Coopersal Road from the proposed farms to the N4 and (4) R571 which connects Olifant Drive to the Komatipoort Town.

Besides the infrastructure mentioned above, there are other infrastructures to be used.
The following are the facilities and infrastructure that will be used:

- ✓ Contractor's Yard with septic/chemical ablution facilities;
- ✓ Offices;
- ✓ Weighbridge, workshop and stores (with septic/chemical ablution facilities);
- ✓ Rail Siding;
- ✓ Diesel facilities and a hardstand;
- ✓ Power and Water;
- ✓ Boxcut;
- ✓ Stockpiles (topsoil, overburden, subsoil/softs, ROM);
- ✓ Surface water management measures (storm water diversion berms and trenches, pollution control dams, tailings dam etc.);
- ✓ Crushing, screening & wash facility; and
- ✓ Disposal dump.

3. Geographical Location of the Site

Manzolwandle Investments (Pty) Ltd proposes to undertake coal mining in Farm Tenbosch 162 JU excluding portion 46, 74 and 90; Farm Vyeboom 414 JU excluding portion 01; Farm Tecklenburg's Ranch 548 JU and Turfbult 593 JU within the Jurisdiction of Nkomazi Local Municipality of the Ehlanzeni District Municipality in Mpumalanga Province. The proposed site is approximately 17975 hectares in extent and located at approximately 4 km west of Komatipoort, 10 km west of Lebombo border control, approximately 31 km from Malelane, using the N4 road to Mozambique, and approximately 93 km east of Nelspruit. The proposed site is located on the south of the Kruger National Park, and is enclosed by the Crocodile River on the north and Komati River on the South



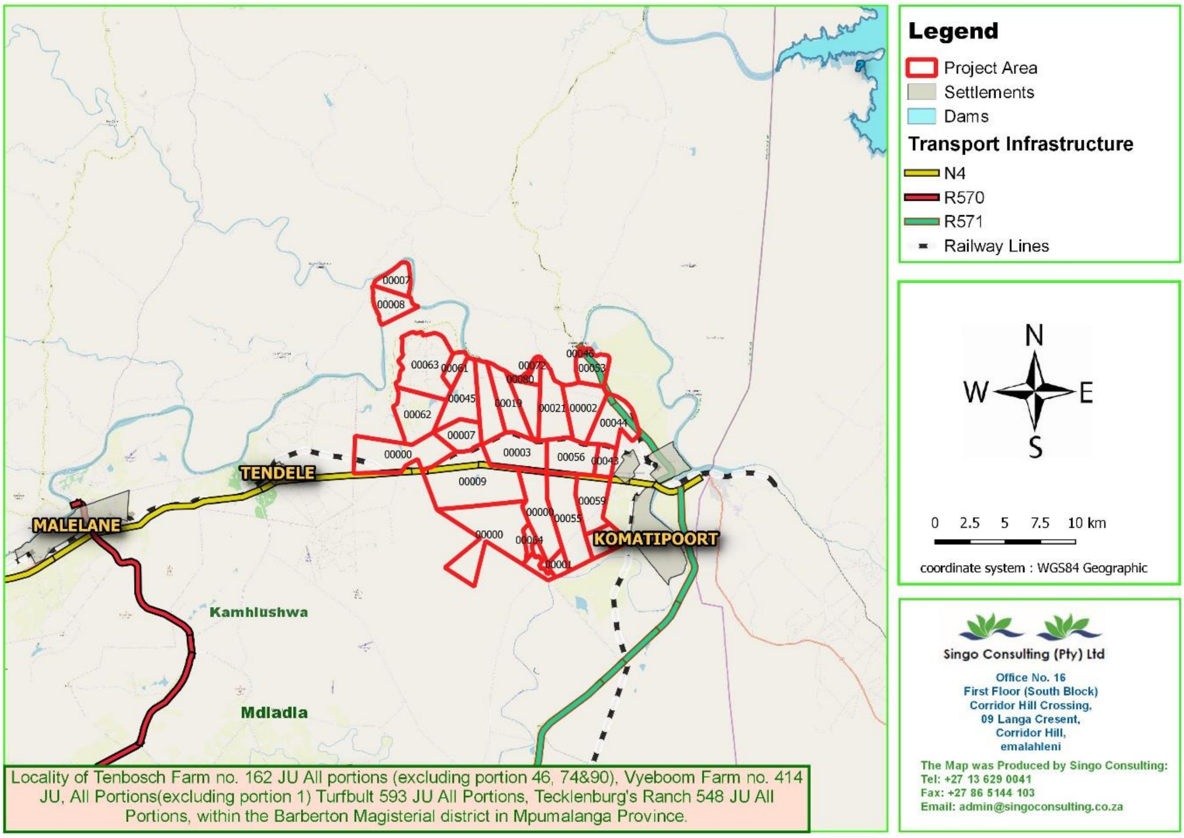


Figure 1: Location map showing the Proposed Mine Area, shown in red.

4. GEOLOGY

4.1. General Geology

The main Karoo Supergroup basin covers over 50% of South Africa's surface and consists of five groups, based on age, which show a change of depositional environment in time. These groups are: the Dwyka (glacial), Ecca (shallow marine and coastal plain), Beaufort (non-marine fluvial), Stormberg (aeolian) and the volcanic Lebombo or Drakensberg groups (Johnson et al., 2006).

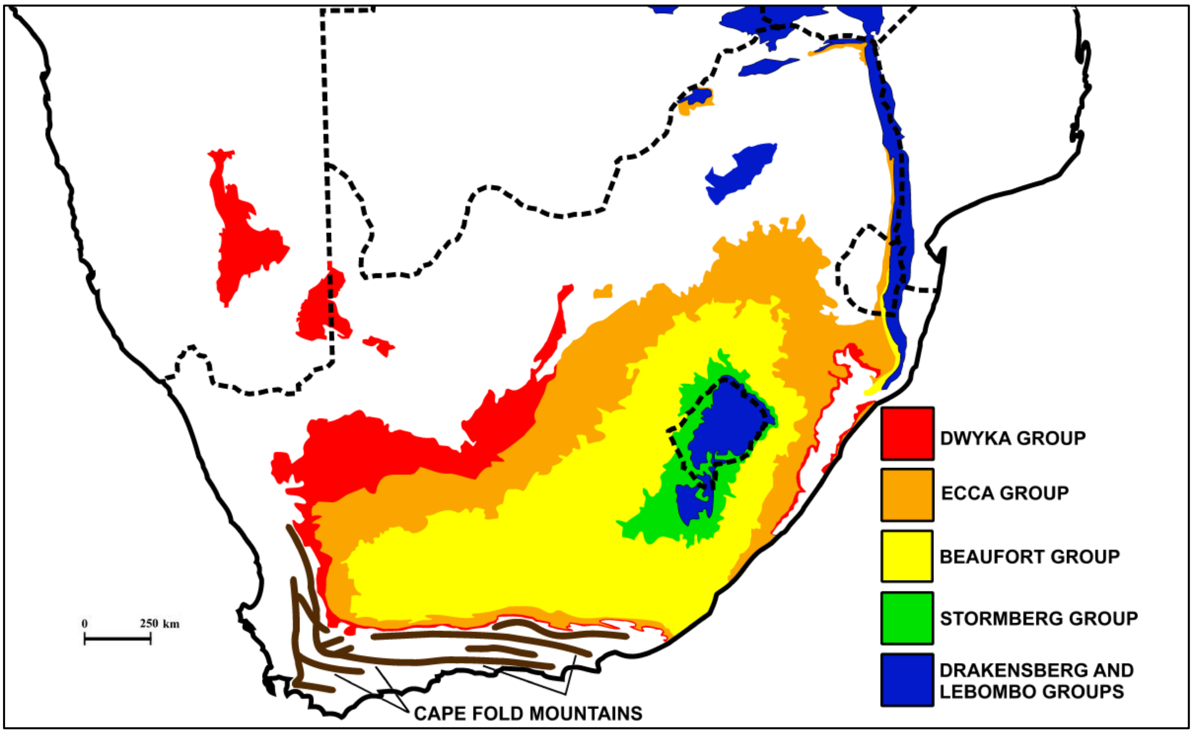


Figure 2. Geological map of the known preserved Karoo Basin in South Africa and adjacent areas (adapted from Catuneanu et al., 2002).

In general, the coal deposits in South Africa are hosted by the Karoo Supergroup, which was deposited in the Gondwana basin that covered parts of Africa, Antarctica, South America and Australia. The basal Stratigraphy of the Karoo Supergroup comprises the Dwyka Group which is a Late Carboniferous to Early Permian (~320 Ma) sequence of glacial and periglacial sediments including diamictite, till moraine, conglomerate, sandstone, mudstone and varved shale.

This is overlain by the Ecca Group which is an Early to Late Permian (~260 Ma) sequence comprising sandstone, siltstone, mudstone and significant coal seams deposited in a terrestrial basin on a gently subsiding shelf platform. In the surrounding Witbank Coalfield areas, the Ecca Group is overlain by the Beaufort Group, which is Early Triassic (~260 to 210 Ma), comprising multi-coloured mudstone and sandstone with only minor coal accumulation, and was deposited in a fluvial environment. The Molteno Formation rests unconformably on the Beaufort Group and comprises Late Triassic (~210 Ma) coarse, immature sandstone with minor argillaceous layers derived from braided streams. This in turn is overlain by the Elliot Formation consisting of red mudstone and sandstone and the Clarens Formation comprising Aeolian sandstone. At the top of the Karoo Supergroup stratigraphy is the Drakensburg Group, which comprises Early to Middle Jurassic (~180 Ma) flood basalts.

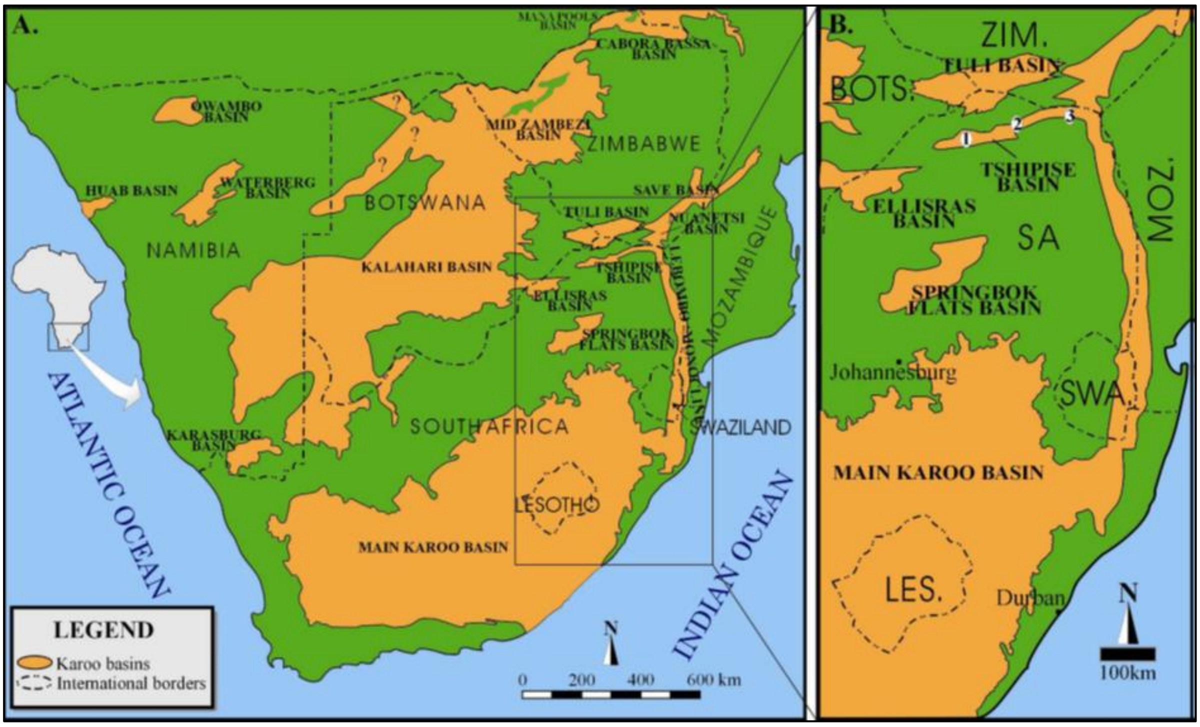


Figure 3.A: A map of Southern Africa with the Karoo basins (After: Snyman, 1998).

4.2. Regional Geology

The distribution of geological formations of project area includes rocks from a wide variety of lithological units ranging in age from Swazian to Resent. Included in these are the biotite-trondhjemite gneiss and migmatite of the Swazian basement complex, rocks of the Barberton Sequence and intrusions of Timbavati Gabbro and Dolerite dykes.

4.2.1. Barberton sequence

The rock formations of this area are among the oldest on earth and are collectively grouped as the Barberton Sequence, and exceed a total thickness of 16 km. This group consists as a succession of volcanic layers, overlaid by sedimentary rocks. The oldest rocks of the Barberton Sequence are the ultra-basic to basic igneous rocks of the Onverwacht Group. This includes ultra-basic high-Magnesium lavas, periodic komatite, intermediate to basaltic metamorphic rock, intermediate to acid volcanic rocks and a large variety of pyroclastic rocks.

A succession of rocks, mainly pelitic, follows on the Onverwacht Group and is collectively known as the Fig Tree Group. A striking layer of Chert and striped iron-containing Chert, the Ulundi layer, is found about halfway in the Fig Tree

Group. The top formation in this group consists of pyroclastic rock, mainly tuff and agglomerate. The beginning of the Fig Tree Group is recognized by the exposure of shale interlayered with Chert, a hard, extremely compact, semivitreous cryptocristalline rock.

4.2.2. Granite and gneiss of the Swazian quaternary

The geology of the area is biotite-tonalite. Tonalite exhibits a wide range in texture varying from non-exfoliated to lightly exfoliated, medium grained granite to gneiss and migmatite. The rocks are light grey when fresh but weather to a light brown colour. In the veld a low relief and relatively high degree of weathering characterize the rocks. Abrupt changes between textural variants and the presence of pegmatite veins are characteristic of this formation. Biotite is the only mafic mineral in gneiss that otherwise consists of plagioclase, quartz and potassium (K) feldspars.

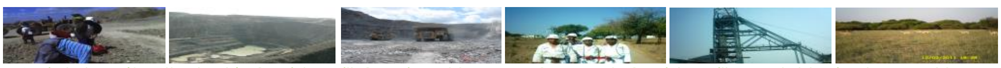
4.2.3. Tonalitic granite and gneiss

These rocks are elliptic and found to terminate the layered effect of the surrounding rock formation rather abruptly. The granite gneiss formations are usually lower than the surrounding rock formations. Many dykes traverse the granite gneiss formation and are found to protrude above this formation due to the difference in resistance to weathering. Although the tonalite exhibits a central massive structure, a strongly exfoliated edge is found parallel to the point of contact with the surrounding rock formations. Tonalites consist of plagioclase and quartz with subservient biotite and hornblende. Tonalites are characterized by a relative homogeneity and restricted variation in chemical composition.

4.2.4. Nelspruit suit

The Nelspruit Suite consists of granite, porphyritic and magmatic granite. The granite is a grey to white biotite granite characterized by its colour and grain size that varies from medium to coarse grained. Magmatic and gneiss-like variants of this granite are found along east to west dykes running through Marloth Park and Lionspruit Game Reserve.

Characteristic of the Nelspruit Suite is the general presence of coarse-grained pegmatite. Pegmatite being an igneous rock, with interlocking crystals, resembles granite in composition. The granite forms a coarse topography in contrast to the biotite gneiss and migmatite. The Nelspruit Suite consists of granite containing potassium feldspars, plagioclase, quartz, biotite and other minerals. Although the central granite area is mafic with no exfoliation, it may be found where contact is made with the surrounding rock formations. This exfoliation is accentuated by the parallel orientation of feldspar crystals.



4.2.5. Intrusive rock formations

Many dykes and plate formations are found as intrusions in the Swazian granite and gneiss. This includes plate formations of diabase and peridotite forming characteristic topographical features. Red, clay soils and plateaus with round boulders are usually found on these formations.

These plate formations and dykes of peridotite consisting of olivine, dioptic augite and other minerals intrude through olivine gabbro (plagioclase, olivine hypersthene and augite) to diabase (plagioclase, augite transposed to amphibole, biotite and chlorite). Porphyritic quartz, diorite and quartz-diorite dykes are also present.

4.2.6. Timbavati gabbro

The Timbavati Gabbro formation is characterized by its concave shape with a slope of 20° to 30°. The Timbavati Gabbro consists of plagioclase (labradorite to bytownite), pyroxene (both hypersthene and augite) and olivine. Biotite and chlorite can displace the pyroxene and serpentinise the olivine. Other minerals are quartz, potassium feldspars, biotite and oxide minerals. Biotite gneiss near gabbro may change its colour to red. Hybridisation of gabbro due to assimilation of granite material is also found to be a distinct character of this Timbavati gabbro.

4.2.7. Karoo dolerite

Karoo dolerite is a well-known feature which occurred after the deposition of the Karoo Supergroup. Basic dyke formation of the late Karoo magmatic period is found throughout the area. Due to their relatively high resistance to weathering and erosion, the dolerite dykes appear more dominant in areas.

The dolerite dykes are generally fine grained, dark grey to black in colour with massive structure. These dykes consist of plagioclase (labradorite to bytownite) with augite and other minerals. Intrusions of dolerite dykes are due to weaknesses in the older rock formations and have a north-south orientation.

4.3. Local Geology

4.3.1. Beaufort group

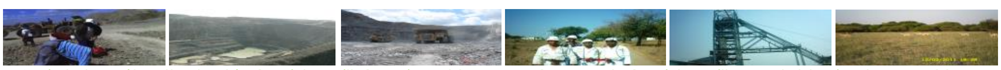
Most of the continental deposits of the Karoo Supergroup are grouped in the aerially extensive Beaufort Group. This formed from sedimentation from the fast-risisng Cape Fold Belt sediments which was at the time, producing a much greater volume of sediments. The sediments prograde diachronously northward in rivers that flowed across the floor of the former brackish to freshwater basin down a 500km long piedmont flank into a westward sloping axis of sediment transport (Johnson et al, 1997).

Further explained is that, after about 15 million years of deposition, the piedmont wedge reached an estimated thickness of about 6km at the south part of the Karoo Basin. The Beaufort Group thins northwards due to the youngling of the Ecca and Beaufort boundary and the deeper erosion of the Beaufort strata that happened before the deposition of the Late Triassic Molteno Formation. The mud and sand in the Beaufort Group are commonly red due to the well-drained, highly oxidized fluvial slope on which they were deposited; as well as due to the onset of warm and seasonal global temperature increase. As Johnson et al. (1996) explained; red and greenish mudrocks are common in the upper Beaufort Group, reflecting an increase in sub-aerial exposure under oxidizing conditions. Bamford (2004) also explained that the Beaufort Group deposits indicate river systems down grading to braided rivers and meandering streams as the regional climate dried up and basins filled with sediments from the Cape-Fold Belt.

The Beaufort Group is exposed almost over the entire Karoo basin and is intruded by dolerite sills and dykes. The dolerite intrusions vary from being olivine rich through tholeiitic to granophyres. When considering the minerals within the rocks, dolerites are also noted by differences in colours (Karpeta and Johnson, 1979), with sills showing grading through olivine, hyperite into gabbro. The proportion of dolerite to country rock is seen to vary in the formations. This could be attributed to the fact that some areas experienced much of magmatic activity than the other areas. The sediments on the contact of dolerite intrusions have been indurated or recrystallised, which led to the formation of hornfels.

The Beaufort Group is subdivided into the Adelaide Subgroup and the Tarkastad Subgroup. The lower Adelaide Subgroup consists of the Balfour Formation with the Palingkloof, Elandsberg, Barberskrans, Daggaboersnek and the Oudeberg Members, the Koonap Formation and the Middleton Formation. As Viser (1995) explained, the lower Beaufort Group consists of dark grey, green and red mudstone alternating with fine grained sandstone, with the base of the group consisting of an upward coarsening deltaic sequence, whereas stacked upward-fining fluvial cycles and flood plain mudrocks, with thin crevasse splay sandstones, commonly present in the rest of the succession. The Tarkastad Subgroup which forms the upper part of the Beaufort Group, consists of the Katberg and Burgersdorp Formations that are restricted to the southern margins of the Karoo Basin from south of Queenstown to north of Aliwal North (Rubidge, 1995).

According to Bamford (2004), the Balfour Formation is a fining upward sequence of greengrey sandstones with bands of darker mudstones,deposited when braided rivers graded upwards into meandering stream systems. However, according to Smith (1995), the major coarsening upward cycle begins in the Balfour Formation and ends at the top of the Katberg Formation. The Koonap Formation consists of greenish silty-mudstones and sandstones in a fining upward sequence deposited when a high energy braided river system graded into a lower energy meandering river system (Bamford, 2004). The Middleton Formation has dark red and green grey mudstones interbedded with sandstones in an overall fining upward sequence. The upper member of the Balfour Formation is characterized by red and maroon mudrocks as



opposed to the dark grey and greenish grey mudrocks of the underlying strata. The predominantly argillaceous unit gradually coarsens upwards into the arenaceous Katberg Sandstone Formation which is composed of fine to medium grained pinkish grey sandstone with subordinate greenish grey mudstone (Smith, 1995).

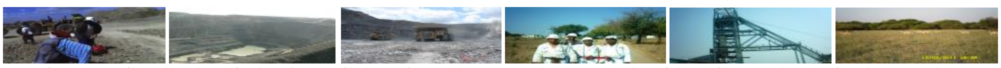
In the Early Triassic times, there was a tectonic rejuvenation of source area that led to steeper gradients and a sharp increase in the supply of coarser grained detritus. Therefore, alluvial fans developed in areas adjacent to the source terrain and river channels became braided, depositing only sands that formed the Katberg Sandstone, mud and silt was carried down further into the distal parts of the flood plain to form the Burgersdorp Formation. As tectonic changes occurred, climatic conditions were also changing, and it was these climatic changes that influenced stream types. For instance, between the late Permian and early Triassic Periods, there was a change to warmer climatic conditions after having had glaciations of the early to middle Permian.

The lowest Beaufort Group sediments were deposited in warm temperate to humid conditions, but later deposition occurred in increasingly arid conditions. Hence the Tarkastad Subgroup corresponds to the Early Triassic Lystrosaurus and Cynognathus tetrapod zones (Rubidge, 1984).

According to Bamford (2004), the Katberg Formation is thick and laterally extensive and has light olive grey, coarse grained sandstone with transverse and longitudinal macro-forms containing horizontal and trough cross bedding. The tabular sheet sandstones of the Katberg Formation are vertically superimposed and separated by erosion surfaces lined with intraformational mud pebble conglomerates (Smith, 1995).

4.3.2. Ecca Group

The proposed Mining Project Area falls within the Ecca Group of the Karoo Supergroup. The Ecca Group, which is of Permian in age, comprises a total of 16 formations, reflecting the lateral facies changes that characterizes this succession. Of these 16 formations, two are of great interest in this study because they occur within the project area. These are mainly the Volkrust and Vryheid formations.



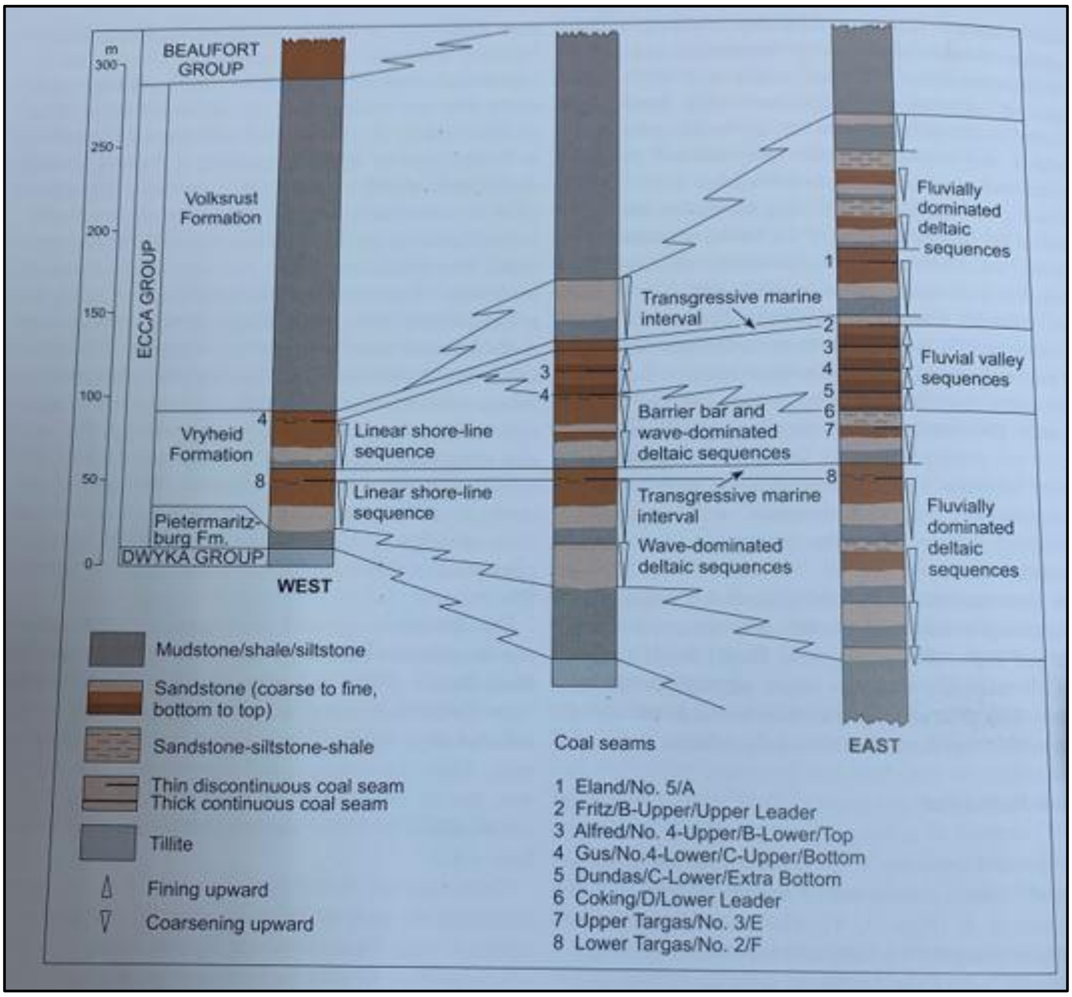


Figure 4: Schematic west-east section though the Ecca Group in the Northeastern part of the Main Karoo Basin (after Van Vuuren, 1983).

4.3.2.1. Vryheid Formation

Thickness of the Vryheid Formations generally thins towards the north, west and South from a maximum of 500m. However, the marked variations in thickness can be witnessed in the northern and northwestern margins of the basin where the formation rests directly on the uneven pre-Karoo topography. Vryheid formation is characterized by different lithofacies which are mainly arranged in an upward-coarsening cycles, which are essentially of deltaic in origin. According to Johnson et. al, 2006, the base of an idealised coarsening-upward deltaic cycle in the eastern part of the formation consists of dark-grey, muddy siltstone resulting from shelf suspension deposition in anoxic water of moderate depth.

Prodelta sediments are represented by alternations of bioturbated, immature sandstones, dark siltstones and mudstones of a centimetre to decimetre scale.

The Vryheid Formation can be subdivided into a lower fluvial-dominated deltaic interval, a middle fluvial interval and an upper fluvial-dominated deltaic interval in the eats (Tavener-Smith et al., 1988a). These subdivisions correspond approximately to the "lower sandstones", "coal zone" and "upper sandstone" of Blignaut and Furter (1940).

4.3.2.2. Volkrust Formation

The Volkrust Formation is a predominantly argillaceous unit which interfingers with the overlying Beaufort Group and the Underlying Vryheid formation. In terms of its associated lithologies, this formation consists of grey to black silty shale with thin, usually bioturbated, siltstone or sandstone lenses and beds, particularly towards its upper and lower contacts.

Basically, in terms of lithologies, the Vryheid and Volkrust Formations are related and much similar. It is said so mostly because they both contain bioturbations, other fossil traces and coal seams.

Geological map below shows Farm Tecklenburg's Rach 548, which is the drilled farm. From this farm, 9 boreholes were drilled, and their cores were logged. Geological assessments confirm that the lithologies within this farm are that from the Ecca group of the Karoo Supergroup. Also, its coal, shale and sandstones interbedded with shale and coal have trace fossils.

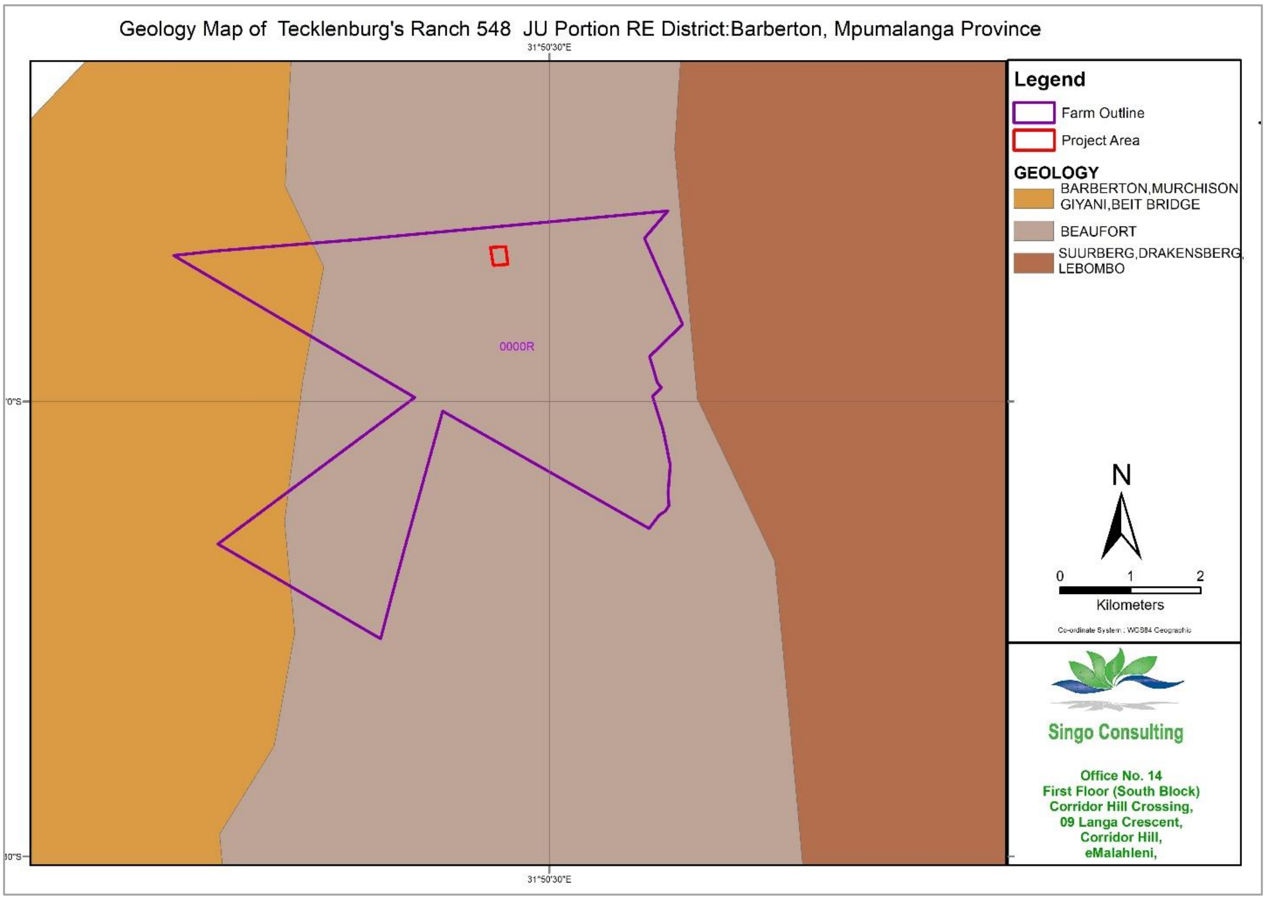


Figure 5: Geological map of the drilled section of the project area.

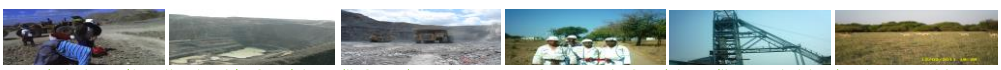
4.4. Coal Seam Geology

As it has been mentioned previously, coal and its associated lithologies are the hosts to fossil traces. Within the Karoo Supergroup,The project area lies within the Kangwane Coalfield. The Kangwane Coalfield has mostly been described as a 33 km wide, 72 km long, north-south trending extent of coal-bearing rocks situated in the eastern part of the Mpumalanga Province. In terms of its geography, Kangwane Coalfield unfurls form near Komatipoort (where the project area is located) in the north, to the Mananga border Post at the Swaziland border in the South. Its total extent has been approximated to be 210, 000 hectares.

In the Kangwane Coalfield, the Karoo Supergroup succession consist of, from bottom to top, the Dwyka Group, and the Vryheid and Volkrust formations of the Ecca Group. Rarely, and locally, the Beaufort and Stormberg Groups may occur. This succession is capped by the Lebombo Group volcanics. Basically, these volcanics are a temporal equivalent of the Drakensberg Group in the MKB. From previous studies within the area, it is said that the exploitable coal seams are hosted in the fine- to course—grained sandstones and subordinate mudstones and the siltstones of the Vryheid Formation. Orientation wise, these strata strikes primarily north-northeast, south-southwest and dip to the east at a dip angle of 5-15°, with a gentler southerly dip (2°).

4.4.1. Coal Seams

In the Kangwane Coalfield, Seam nomenclature has not been systemized or standardized. During various drilling programmes, up to 14 coal seams were delineated and found to be hosted in the Vryheid and Volkrust Formation equivalents.



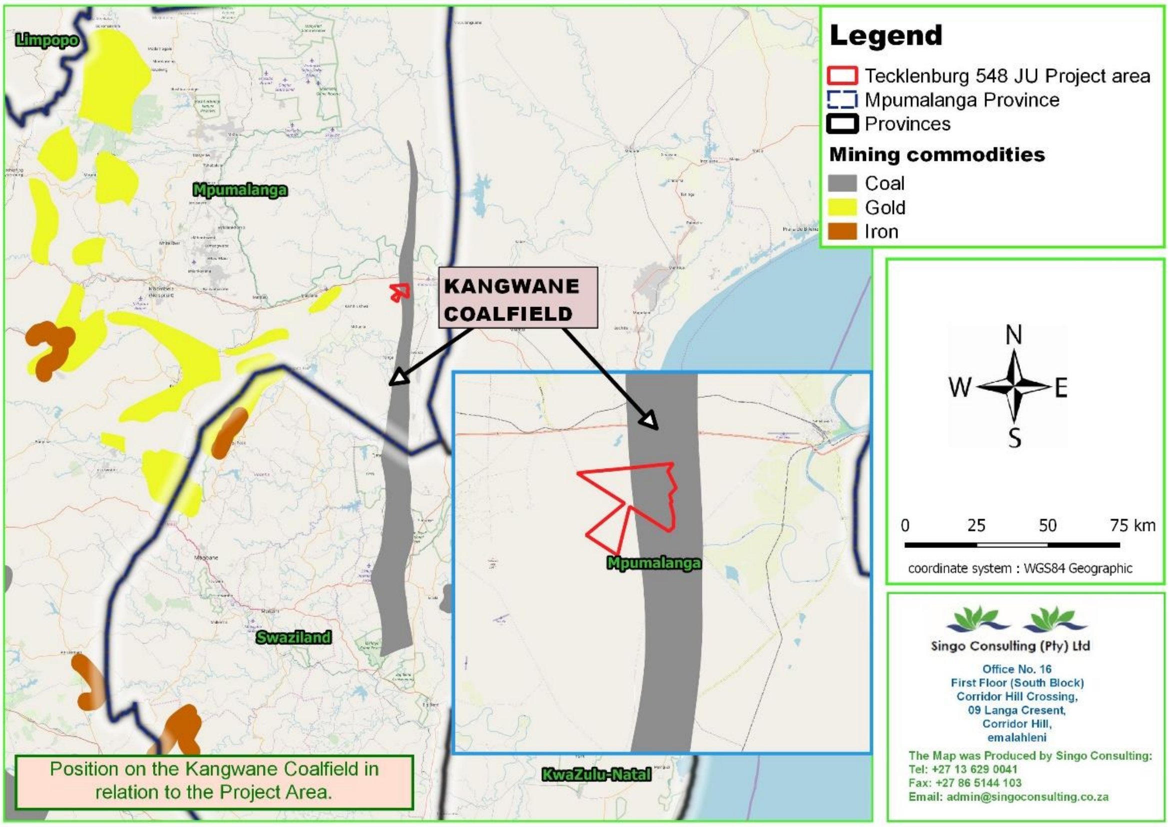
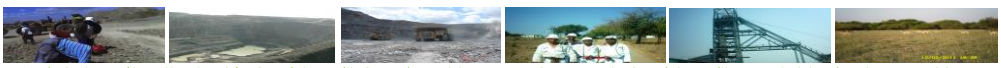


Figure 6: The thinning behaviour of the Kangwane Coalfield towards far north.

A very distinct and obvious behaviour of the Kangwane Coalfield, that has been picked by several authors its thinning towards far north. In the Northern part of the coalfield, the coal seams are found concentrated over narrow zone and woth subordinate partings, however, which tend to thicken South-and eastwards. This behaviour can easily be seen on the figure above.

Though there are up to 14 coal seams which have been delineated, however, there are generally only four to five discrete coal seams present within the whole Coalfield. Usually, they are relatively thin, but may reach mineable widths in places. They are labelled from bottom to top, figure below.



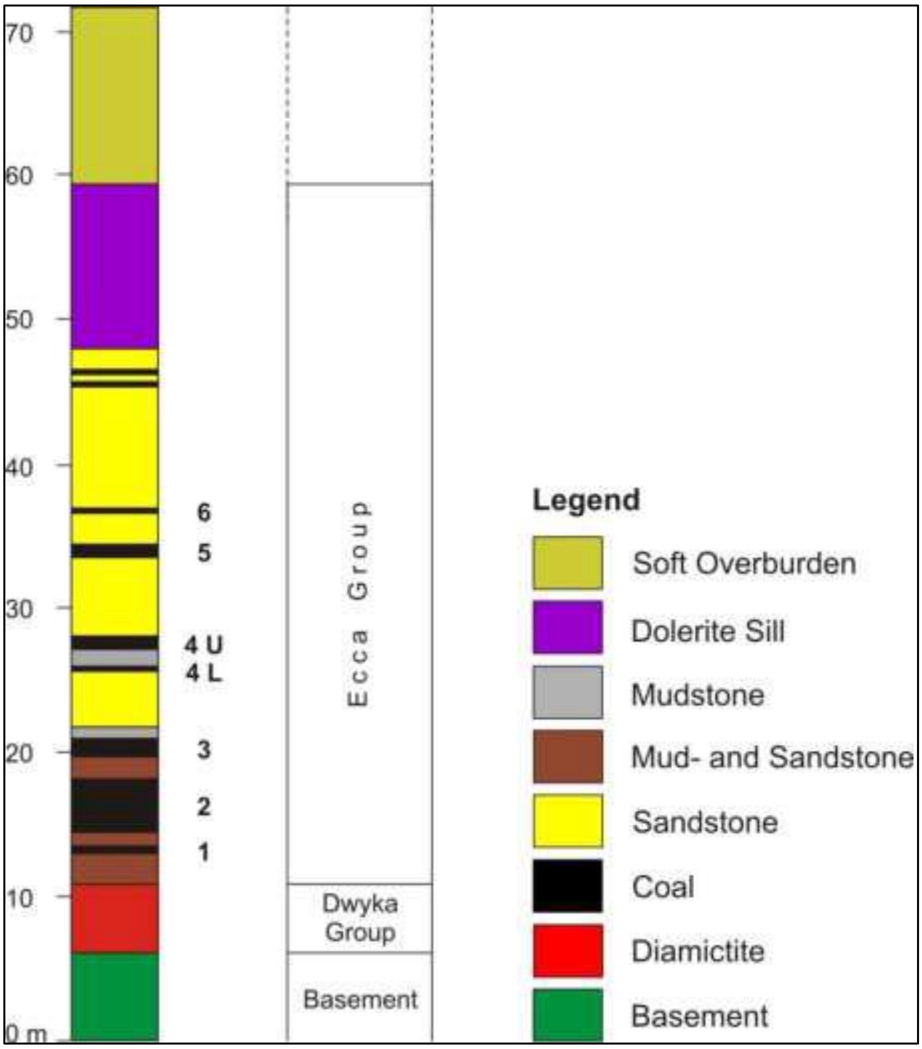


Figure 7: The figure depicts the lithostratigraphic column of the Kangwane Coalfield.

(a) The No.1 Seam

The No.1 Seam is best known from the northern Nkomati Anthracite block and occurs at the bottom of the sedimentary succession. It lies unconformably on either basement granites or Dwyka Group lithologies where present. According to Snyman (1998), at the Nkomati mine, the No.1 seam is restricted to the Nkomati anthracite Matadeni resource area, and this is where it averages approximately 1.1m thickness. It is also said that it may be up to 10 m thick in other places.

(b) The No.2 Seam

Hancox 2014 outlines that the No. 2 Seam at Nkomati mine may be split into No.2 Lower (No. 2 L) and No. 2 Upper (No. 2 U) seam. This is shown on the figure above, which is displaying the actual lithostratigraphy of the Kangwane Coalfield. The No. 2 L is regarded as the main Seam and it is the most prominent coal seam ranging from 2.0-8.7 m of thickness. The No. 2U Seam is described as one which lies approximately ten metres higher in the succession than the No. 2 L seam, with the partying formed by a dark grey mudstone to siltstone. In the Madadeni area, its thickness averages 2.4 m, but it is said to be more erratic on the Mangweni area where it reaches over 6 m, but averages only 0.9 m. It is also more frequently disrupted and devolatilised by the overlying dolerite sill.

(C) The No. 3 Seam

This Seam occurs approximately ten metres above the No. 2U seam. The partying between these two seams is formed by medium- to coarse-grained sandstone, or interbedded sandstone and mudstone unit. The immediate floor to the No. 3 Seam may therefore be either medium-grained sandstone or dark grey carbonaceous siltstone. The seam itself is only present in restricted areas, and where developed consists of a 1 m thick seam of bright coal. The immediate roof to the No. 3 Seam is

normally formed by medium- to coarse-grained sandstone, which fines upwards into dark grey mixed sandstone and siltstone, and dark grey carbonaceous mudstone. Where present the No. 4 Seam is usually less than 1 m in thickness and is normally too thin to be considered economic. In the ZYL Kangwane southern block area their No. 4 Seam is divided into a No. 4 Lower (No. 4 L) that averages 1.43 m in thickness, and a No. 4 Upper (No. 4 U) Seam that averages 1.2 m thickness.

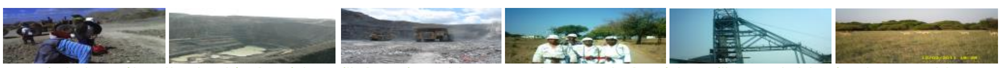
Aston (2011) provides a different nomenclature for the Vryheid Formation hosted coal seams in Sentula's Nkomati mine area, referring to them as the 3 Seam (Lower or No. 1 Seam), 5/6 Seam (Middle or No. 2 Seam), 7 Seam (Upper or No. 3 Seam) and 9 Seam (Top or No. 4 Seam). He further notes that they occur over a total thickness of ±70 m of sandstone and that regionally the up to 8 m thick Lower Seam, and the Middle Seam are the most prominent, while the Upper and Top seams are sporadic and excluded from resource calculations. In the northern sector, approximately 300-400 m above the No. 1 Seam, an additional set of thin (rarely greater than 2 m in thickness) set of coal seams occur, which are hosted in a mudstone dominated succession that is the Volksrust Formation equivalent. Ashton (2011) refers to these as the 2/4, 6 and 8 seams.

5. PALAEONTOLOGY OF THE AREA

5.1. Karoo Supergroup

5.1.1. Ecca Group -Vryheid Formation (PV).

The Vryheid Formation is well-known for the occurrence of coal beds that resulted from the accumulation of plant material over long periods of time. According to Bamford (2011), Plant fossils described from the Vryheid Formation are; *Azaniodendron fertile, Cyclodendron leslii, Sphenophyllum hammanskraalensis, Annularia sp., Raniganjia sp., Asterotheca spp., Liknopetalon enigmata, Glossopteris > 20 species, Hirsutum 4 spp., Scutum 4*



spp., Ottokaria 3 spp., Estcourtia sp., Arberia 4 spp., Lidgetonnia sp., Noeggerathiopsis sp. and Podocarpidites sp.

According to Bamford (2011) "Little data have been published on these potentially fossiliferous deposits. Around the coalmines there is most likely to be good material and yet in other areas the exposures may be too poor to be of interest. When they do occur, fossil plants are usually abundant and it would not be feasible to preserve and maintain all the sites, however, in the interests of heritage and science, such sites should be well recorded, sampled and the fossils kept in a suitable institution.

Although no vertebrate fossils have been recorded from the Vryheid Formation, invertebrate trace fossils have been described in some detail by Mason and Christie (1985). It should be noted, however, that the aquatic reptile, *Mesosaurus*, which is the earliest known reptile from the Karoo Basin, as well as fish (*Palaeoniscus capensis*), have been recorded in equivalent-aged strata in the Whitehill Formation in the southern part of the basin (MacRae, 1999; Modesto, 2006). Indications are that the Whitehill Formation in the main basin might be correlated with the mid-Vryheid Formation. If this assumption proves correct, there is a possibility that Mesosaurus could be found in the Vryheid Formation.

The late Carboniferous to early Jurassic Karoo Supergroup of South Africa includes economically important coal deposits within the Vryheid Formation of the Mpumalanga area. The Karoo sediments are almost entirely lacking in body fossils but ichnofossils (trace fossils) are locally abundant. Modern sedimentological and ichnofaunal studies suggest that the north-eastern part of the Karoo basin was marine. In KwaZulu-Natal a shallow basin margin accommodated a prograding fluviodeltaic complex forming a broad sandy platform on which coal-bearing sediments were deposited. Ichnofossils include U-burrows (formerly *Corophioides*) which are assigned to ichnogenus *Diplocraterion* (Mason and Christie, 1985).

A High Palaeontological Sensitivity is allocated to the areas underlain by the Vryheid Formation.
Due to the igneous character (high temperature formation) of the rocks no fossils will be anticipated. A Very Low Palaeontological Sensitivity is allocated to the sections underlain by these units.

6. METHODOLOGY

6.1. Desktop/Scope Study

Preceding the undertaken field investigations, a preliminary assessment (desktop study) of the topography and geology of the study area was made using appropriate 1:250 000 geological maps in conjunction with Google Earth. Potential fossiliferous rock units (groups, formations etc.) were identified within the study area and the known fossil heritage within each rock unit was acquired from the published scientific literature and previous palaeontological impact studies.

6.2. Fieldwork

The aim of the fieldwork was to document any exposed fossil material and to assess the palaeontological potential of the project in terms of the type and extent of rock outcrop in the area. During this stage, several field-survey were conducted on foot within the proposed prospecting area. Field assessments were done throughout all farms, however only Farm Tecklenburg's Rach 548 the drilled farm. From this farm, 9 boreholes were drilled, and their cores were logged. Thorough rock descriptions were done and as well the assessment on the overall landscape of the area.

7. FIELD ASSESSMENTS

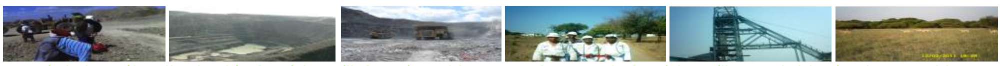
Steep slopes and mountainous areas are to be found in the western part and along the eastern boundary of the municipality (Nkomazi). The Kaalrug Mountain range is to be found to the west, forming part of the Barberton Mountain lands and the Lebombo Mountain range is located along the eastern boundary. The Lebombo Plains, located between the Komati River and the Lebombo Mountains to the east, are characterized by flat to undulating landscapes.

The central part between the Komati River and the mountainous western areas where the project area is located is flat, however, steeper slopes occur to the south towards Swaziland border.

Photo ID	GPS (Cape) Coordinates	Brief Description	Images taken
SC1	-092115 2934800 1700	Reddish soils (fire breaks) on Vryheid Formation – No outcrops at were found at this point. Outcrops are restricted by the blanket that the dolerite has made. No fossils observed along the farm fence.	

SC2	-091869 2934796 1690	Grassland and shrubs of the project area.	 
		Coal sample with a plant fossil.	
SC3	-092051 2934829 1700	Dolerite intrusion into wet or inhomogeneously lithified sediments, resulting in the formation of localized peperite and associated fluidized sediment.	

SC4	-092052 2934829 1700	Sandstone with lenses of coal and mudstone. This is a representation of changing depositional energy. Sandstone being deposited in a high fluvial energy with mud and coal being deposited during lower fluvial energy. Bioturbations were observed. This is the reworking of soils and sediments by animals or plants. These include burrowing, ingestion and defecation of sediment grains. No fossil seen.	
SC5	-092115 2934800 1700	Access roads into the project area.	



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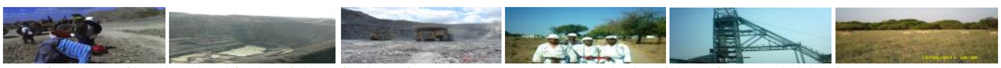
8. Findings and Recommendations

Results of the field investigation were used to predict the potential occurrence of buried fossil heritage within the proposed mining area. In this case, investigations were sorely conducted through a thorough study of rock samples from drilled core logs and outcrop assessments within Farm Tecklenburg 548 JU. For the other farms, it was inferred that fossil traces could occur within using lithological successions, especially the Volkrust and Vryheid formations which are known to be continuous and hosts of fossils.
There were plant fossils and bioturbations observed from borehole 09. Fossils were found within coal layers while bioturbations were observed mostly on sandstone and shale layers. After identifying potentially fossiliferous rock units; ascertaining the fossil heritage from the literature and evaluating the nature and scale of the development itself, Palaeontological sensitivity can be assigned. The palaeontological sensitivity can be described as moderate due to the localised occurrence of the fossil traces found.

The project area falls within the Vryheid Formation. Vryheid Formation is world renown for the occurrence of coal beds and various plant fossils, and it has been generally assigned a high palaeontological sensitivity. However, during field observations and as seen from the data above, no essential fossils were found. Only leaf fossils found within coal layers and bioturbations. These kinds of fossils are not regarded as important and are not to stop mining activities from commencing.

Should fossil remains be discovered during any phase of the proposed mining project, this applies whether found on the surface or exposed during excavations, it should be reported to the ECO responsible of the project. Such discoveries ought to be protected (preferably *in situ*) and the ECO should alert SAHRA (South African Heritage Research Agency) so that appropriate mitigation (*e.g.* recording, sampling or collection) can be taken by a professional palaeontologist.

It is therefore considered that the proposed prospecting and planned mining right activities on the Tenbosch Farm no. 162 JU All portions (excluding portion 46, 74&90), Vyeboom Farm no. 414 JU, All Portions(excluding portion 1) Turfbult 593 JU All Portions, Tecklenburg's Ranch 548 JU All Portions is deemed appropriate and feasible and will not lead to any ruinous impacts on the palaeontological resources of the area. As such, the proposed prospecting and operation of the mine may be authorised. This is so because the whole extent of the proposed project area is not considered sensitive in terms of palaeontological resources.



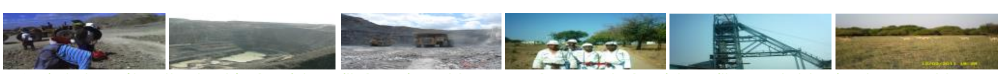
9. CONCLUSION

The development site for the proposed Mining Right in Mpumalanga Province is underlain by Randian aged, intrusive rocks and granites, Permian aged sandstone of the Vryheid Formation and Jurassic aged dolerite.

Areas underlain by Pre-Karoo rocks and dolerite are allocated a Low Palaeontological Sensitivity. It must be noted that plant fossils were not present in all the traversed area, indicating low sensitivity. However, if the mining depth goes down to sediments then the second phase of this kind of study should be considered.

Due to the lack of sedimentary rocks outcrops and the fact that observed fossil traces are limited to coal layers, a Medium Palaeontological Sensitivity is allocated to the project.

IMPORTANT: If fossils are however, observed during excavations, the management of the project must be notified. Subsequently, the palaeontologist must be informed, and the fossils recovered according to SAHRA specifications. Quarterly assessment of the fossil on high walls and crushed material should be considered.



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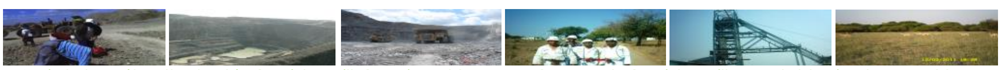

11. QUALIFICATIONS AND EXPERIENCE OF THE AUTHOR AND AUDITOR

NK Singo (thereafter refer as **Singo Consulting (Pty) Ltd**) is a PhD candidate in Geology from the University of Johannesburg and MSc graduate from the University of South Africa. BSc (Hons) Mining and Environmental Geology graduate from the University of Venda. He has extensive experience of Karoo geology more especially coalfields.

R Mufamadi holds an honours degree in Geology from the University of the Witwatersrand. She is a qualified geologist and researcher who has been acknowledged several times by means of awards and certification by several organizations such as the University of the Witwatersrand. From her experience, Rudzani has worked in the fields of GIS, Data management and Geo-Environmental consultancy.

12. DECLARATION OF INDEPENDENCE

We (Ndinannyi Kenneth Singo and Rudzani Mufamadi), declare that we are independent consultants and have no financial, personal or other interest in the proposed development, nor the developers or any of their subsidiaries, apart from fair remuneration for work performed in the delivery of palaeontological heritage assessment services. There are no circumstances that compromise the objectivity of ours in performing such work.

Ndinannyi Kenneth Singo
Geologist

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Rudzani Mufamadi

Geologist

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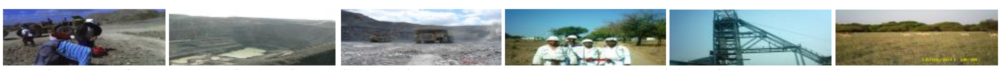

APPENDIX 1 - METHODOLOGY FOR ASSESSING THE SIGNIFICANCE OF IMPACTS

To ensure a direct comparison between various specialist studies, a standard rating scale has been defined and will be used to assess and quantify the identified impacts. This is necessary since impacts have several parameters that need to be assessed. Four factors need to be considered when assessing the significance of impacts, namely:

1. Relationship of the impact to **temporal** scales - the temporal scale defines the significance of the impact at various time scales, as an indication of the duration of the impact.
2. Relationship of the impact to **spatial** scales - the spatial scale defines the physical extent of the impact.
3. The severity of the impact - the **severity/beneficial** scale is used in order to scientifically evaluate how severe negative impacts would be, or how beneficial positive impacts would be on affected system (for ecological impacts) or affected party.
   The severity of impacts can be evaluated with and without mitigation in order to demonstrate how serious the impact is when nothing is done about it. The word ‘mitigation’ means not just ‘compensation’, but also the ideas of containment and remedy. For beneficial impacts, optimization means anything that can enhance the benefits. However, mitigation or optimization must be practical, technically feasible and economically viable.

4. The **likelihood** of the impact occurs - the likelihood of impacts taking place as a result of project actions differs between potential impacts. There is no doubt that some impacts would occur (e.g. loss of vegetation), but other impacts are not as likely to occur (e.g. vehicle accident), and may or may not result from the proposed development. Although some impacts may have a severe effect, the likelihood of them occurring may affect their overall significance.

The ***environmental significance*** scale is an attempt to evaluate the importance of a particular impact. This evaluation needs to be undertaken in the relevant context, as an impact can either be ecological or social, or both. The evaluation of the significance of an impact relies heavily on the values of the person making the judgment. For this reason, impacts of especially a social nature need to reflect the values of the affected society.
Negative impacts that are ranked as being of “**VERY HIGH**” and “**HIGH**” significance will be investigated further to determine how the impact can be minimised or what alternative activities or mitigation measures can be implemented. These impacts may also assist decision makers i.e. lots of **HIGH** negative impacts may bring about a negative decision.

For impacts identified as having a negative impact of “**MODERATE**” significance, it is standard practice to investigate alternate activities and/or mitigation measures. The most effective and practical mitigations measures will then be proposed.

For impacts ranked as "**LOW**" significance, no investigations or alternatives will be considered. Possible management measures will be investigated to ensure that the impacts remain of low significance.

Table 1: Criterion used to rate the significance of an impact

Significance Rating Table	
Temporal Scale (The duration of the impact)	
Short term	Less than 5 years (Many construction phase impacts are of a short duration)
Medium term	Between 5 and 20 years
Long term	Between 20 and 40 years (From a human perspective almost permanent).
Permanent	Over 40 years or resulting in a permanent and lasting change that will always be there
Spatial Scale (The area in which any impact will have an affect)	
Individual	Impacts affect an individual.
Localised	Impacts affect a small area, often only a portion of the project area.
Project Level	Impacts affect the entire project area.
Surrounding Areas	Impacts that affect the area surrounding the development
Municipal	Impacts affect either the Local Municipality, or any towns within them.
Regional	Impacts affect the wider district municipality or the province as a whole.
National	Impacts affect the entire country.
International/Global	Impacts affect other countries or have a global influence.
Will definitely occur	Impacts will definitely occur.
Degree of Confidence or Certainty (The confidence to predict the significance of an impact)	
Definite	More than 90% sure of a particular fact. Should have substantial supportive data.
Probable	Over 70% sure of a particular fact, or of the likelihood of that impact occurring.
Possible	Only over 40% sure of a particular fact or of the likelihood of an impact occurring.
Unsure	Less than 40% sure of a particular fact or of the likelihood of an impact occurring.

Table 2: The severity rating scale

Impact severity (The severity of negative impacts, or how beneficial positive impacts would be on an affected system or party)	
Very severe	**Very beneficial**
An irreversible and permanent change to the affected system (s) or party (ies) which cannot be mitigated. For example, the permanent loss of land.	A permanent and very substantial benefit to the affected system(s) or party (ies), with no real alternative to achieving this benefit. For example, the vast improvement of sewage effluent quality.
Severe	**Beneficial**
Long term impacts on the affected system(s) or party (ies) that could be mitigated. However, this mitigation would be difficult, expensive or time consuming, or some combination of these. For example, the clearing of forest vegetation.	A long term impact and substantial benefit to the affected system(s) or party (ies). Alternative ways of achieving this benefit would be difficult, expensive or time consuming, or some combination of these. For example, an increase in the local economy.
Moderately severe	**Moderately beneficial**
Medium to long term impacts on the affected system(s) or party (ies), which could be mitigated. For example, constructing the sewage treatment facility where there was vegetation with a low conservation value.	A medium to long term impact of real benefit to the affected system(s) or party (ies). Other ways of optimising the beneficial effects are equally difficult, expensive and time consuming (or some combination of these), as achieving them in this way. For example, a 'slight' improvement in sewage effluent quality.
Slight	**Slightly beneficial**
Medium- or short-term impacts on the affected system(s) or party (ies). Mitigation is very easy, cheap, less time consuming or not necessary. For example, a temporary fluctuation in the water table due to water abstraction.	A short to medium term impact and negligible benefit to the affected system (s) or party (ies). Other ways of optimising the beneficial effects are easier, cheaper and quicker, or some combination of these.
No effect	**Don't know/Can't know**
The system(s) or party (ies) is not affected by the proposed development.	In certain cases, it may not be possible to determine the severity of an impact

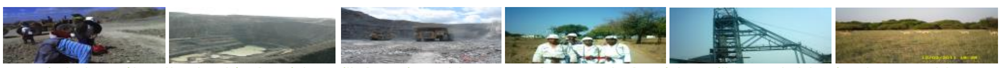

Table 3: Overall significance appraisal

<table>
<tr><td colspan="2">Overall Significance (The combination of all the above criteria as an overall significance)</td></tr>
<tr><td>VERY HIGH NEGATIVE</td><td>VERY BENEFICIAL</td></tr>
<tr><td colspan="2">These impacts would be considered by society as constituting a major and usually permanent change to the (natural and/or social) environment, and usually result in severe or very severe effects, or beneficial or very beneficial effects.
Example: The loss of a species would be viewed by informed society as being of VERY HIGH significance.
Example: The establishment of a large amount of infrastructure in a rural area, which previously had very few services, would be regarded by the affected parties as resulting in benefits with VERY HIGH significance.</td></tr>
<tr><td>HIGH NEGATIVE</td><td>BENEFICIAL</td></tr>
<tr><td colspan="2">These impacts will usually result in long term effects on the social and/or natural environment. Impacts rated as HIGH will need to be considered by society as constituting an important and usually long-term change to the (natural and/or social) environment. Society would probably view these impacts in a serious light.
Example: The loss of a diverse vegetation type, which is fairly common elsewhere, would have a significance rating of HIGH over the long term, as the area could be rehabilitated.
Example: The change to soil conditions will impact the natural system, and the impact on affected parties (such as people growing crops in the soil) would be HIGH.</td></tr>
<tr><td>MODERATE NEGATIVE</td><td>SOME BENEFITS</td></tr>
<tr><td colspan="2">These impacts will usually result in medium to long term effects on the social and/or natural environment. Impacts rated as MODERATE will need to be considered by society as constituting a fairly important and usually medium term change to the (natural and/or social) environment. These impacts are real but not substantial.
Example: The loss of a sparse, open vegetation type of low diversity may be regarded as MODERATELY significant.</td></tr>
<tr><td>LOW NEGATIVE</td><td>FEW BENEFITS</td></tr>
<tr><td colspan="2">These impacts will usually result in medium to short term effects on the social and/or natural environment. Impacts rated as LOW will need to be considered by the public and/or the specialist as constituting a fairly unimportant and usually short-term change to the (natural and/or social) environment. These impacts are not substantial and are likely to have little real effect.
Example: The temporary change in the water table of a wetland habitat, as these systems is adapted to fluctuating water levels.
Example: The increased earning potential of people employed as a result of a development would only result in benefits of LOW significance to people who live some distance away.</td></tr>
<tr><td colspan="2">NO SIGNIFICANCE</td></tr>
</table>

There are no primary or secondary effects at all that are important to scientists or the public. **Example:** A change to the geology of a formation may be regarded as severe from a geological perspective but is of NO significance in the overall context.
DON'T KNOW
In certain cases, it may not be possible to determine the significance of an impact. For example, the significance of the primary or secondary impacts on the social or natural environment given the available information. **Example:** The effect of a development on people's psychological perspective of the environment.