PALAEONTOLOGICAL IMPACT ASSESSMENT REPORT

THE PROPOSED UTILISATION OF BORROW PITS ON ROADS:

DR08024, DR08147, DR08153 & DR08156 - Qaukeni/Inqguza Hill Local Municipality,
DR08029 - Port St Johns Local Municipality
DR08120 & DR08123 – Mibizana Local Municipality
DR08131 – Mhlontio Local Municipality
DR08173 – Nyandeni Local Municipality
DR08273, DR08275, DR08281 & DR18033 – King Sabata Dalindyedo Local Municipality

OLIVER TAMBO DISTRICT MUNICIPALITY
Eastern Cape Province South Africa

Department of Road and Public Works
Eastern Cape Provincial Government

Consultant:
Biotechnology & Environmental Specialist Consultancy cc
PO Box 8241, Nahoon, 5210, East London, South Africa
9 Douglas Road, Vincent, 5247, East London, South Africa
Office Tel: +27 43 726 4242
Office Fax: +27 43 726 3199
Office Email: info@besc.co.za

26 October 2011

Metsi Metseng Geological & Environmental Services

Suite 91
Private Bag X62
Bethlehem 9700
info@mmges.co.za
Fax 086 743 6864
+27 82 070 0735
+27 82 829 4978
www.mmges.co.za
VAT 4260183498
Reg 1999/30444/23

EXECUTIVE SUMMARY

The Department of Roads and Public Works of the Eastern Cape Province identified 28 borrow pits in order to obtain construction materials as part of a lager project to upgrade/re-surface a total of 13 roads located throughout the Oliver Tambo District Municipality. Biotechnology & Environmental Specialist Consultancy (BESC) commissioned this Palaeontological Impact Assessment as part of the Heritage Impact Assessment. The purpose of the Palaeontological Impact Assessment is to identify exposed and potential palaeontological heritage on the site of the proposed development, to assess the impact the development may have on this resource, and to make recommendations as to how this impact might be mitigated.

The proposed project is planned to utilise road building material from the new and existing borrow pits to upgrade the following sections of roads: i) DR08024, DR08147, DR08153 & DR08156 at Qaukeni/Inqguza Hill Local Municipality, ii) DR08029 at Port St Johns Local Municipality, iii) DR08120 & DR08123 at Mibizana Local Municipality, iv) DR08131 at Mhlontio Local Municipality v) DR08173 at Nyandeni Local Municipality and vi) DR08273, DR08275, DR08281 & DR18033 at King Sabata Dalindyedo Local Municipality

A basic assessment of the topography and geology of the area was made by using appropriate geological (1:250 000) maps in conjunction with Google Earth. A review of the literature on the geological formations exposed at surface in the development site and the fossils that have been associated with these geological strata was undertaken. A site field investigation was conducted on 20 – 22 October 2011, with the aim to document any exposed fossil material and to assess the palaeontological potential of the region in terms of the type and extent of rock outcrop in the area.

The study area is underlain by rocks ranging in age from the Devonian (Natal Group) to Permian and Triassic Adelaide and Tarkastad Subgroups of the Beaufort Group of the Karoo Supergroup. Dolerite intrusions of the Jurassic era are present over the entire study area. Alluvial deposits of the Quaternary era occur predominantly in the lower lying valley floors. The underlying sequences of the Natal Group, overlain by the Dwyka Formation and the Ecca Group have low fossil occurrence if any. The upper Beaufort Group is known for fossil occurrence in the biostratigraphic subdivision of the group.

The field investigation confirms that the borrow pit sites are dominated by rolling hill topography. The results of the field invitation were that the borrow pits associated with the (i) undifferentiated mudrock, carbonaceous shales, fine-grained graywackes and alternating dark-grey shales of the Ecca Group were deeply weathered and fossils were restricted to poorly defined trace fossils, (ii). lenticular sandstones and massive mudstones of the Adelaide Subgroup were restricted to deeply excavated quarries, with fossils of *Glossopteris* abundantly present, (ii) bluish-grey and reddish-grey mudstone in the Katberg Formation of the Tarkastad Subgroup revealed interesting burrow casts and although no body fossils were discovered during the field investigations, the possibility of finding fossils during future excavation operations is very high, (iii) predominantly red mudstone in the Burgersdorp Formation of the Tarkastad Subgroup did not reveal any body fossils and trace fossils were restricted to some poorly defined burrow casts, well defined root structures were however recorded and (iv) igneous rock of the Karoo Dolerite does not contain fossils

Borrow pits within the Ecca Group has a medium palaeontological sensitivity rating. The borrow pits within the Adelaide Subgroup as well as the Katberg and Burgersdorp Formations of the Tarkastad Subgroup have a high palaeontological sensitivity rating. The significance rating can be summarised as follows:

SIGNIFICANCE RATING							
Rock Unit	Temporal Scale	Spatial Scale	Degree of confidence	Impact severity		Overall Significance	
				With mitigation	Without mitigation	With mitigation	Without mitigation
Ecca Group	permanent	international	possible	beneficial	severe	beneficial	Negative
Adelaide Subgroup	permanent	international	possible	beneficial	very severe	beneficial	High negative
Katberg Formation	permanent	international	possible	beneficial	very severe	beneficial	High negative
Burgersdorp Formation	permanent	international	possible	beneficial	very severe	beneficial	High negative

Through adequate monitoring and mitigation measures during excavations, the high impact severity can be lowered to beneficial. The exposure and subsequent reporting of fossils (that would otherwise have remained undiscovered) will be a beneficial palaeontological impact.

It is recommended: (i) That a collection and rescue permit be obtained from SAHRA prior construction. (ii) That all earth-moving activities within the borrow pits with potential impact on the Ecca Group, Adelaide Subgroup as well as the Katberg and Burgersdorp Formations of the Tarkastad Subgroup be monitored by a palaeontologist. (iii) That a monitoring report be submitted to SAHRA after the completion of the earth works phase. (iv) That the resident ECO be trained by a professional palaeontologist in the recognition of fossil material. If fossil material is later discovered it must be appropriately protected and the discovery reported to a palaeontologist for the removal thereof.

Road and borrow pit specific mitigation recommendation is summarised as follows:

Road No	B/Pit No	Mitigation Measures
DR08024	024_BP01N	Igneous/metamorphic rocks or Quaternary alluvial deposits underlie these zones, with no potential for fossils.
DR08024	024_BP02N	Igneous/metamorphic rocks or Quaternary alluvial deposits underlie these zones, with no potential for fossils.
DR08024	024_BP02N	Igneous/metamorphic rocks or Quaternary alluvial deposits underlie these zones, with no potential for fossils.
DR08029	029_BP01N	All earth-moving activities are to be monitored by a palaeontologist. A monitoring report should be submitted to SAHRA after completion of the earth-moving activity. The resident ECO must be trained by a professional palaeontologist in the recognition of fossils. If fossil material is later discovered it must be appropriately protected and the discovery reported to a palaeontologist for the removal thereof as per SAHRA legislation
DR08029	029_BP02N	Igneous/metamorphic rocks or Quaternary alluvial deposits underlie these zones, with no potential for fossils.
DR08029	029_BP03N	Igneous/metamorphic rocks or Quaternary alluvial deposits underlie these zones, with no potential for fossils.
DR08029	029_BP04N	All earth-moving activities are to be monitored by a palaeontologist. A monitoring report should be submitted to SAHRA after completion of the earth-moving activity. The resident ECO must be trained by a professional palaeontologist in the recognition of fossils. If fossil material is later discovered it must be appropriately protected and the discovery reported to a palaeontologist for the removal thereof as per SAHRA legislation
DR08029	029_BP05N	A permit for the collection and rescue of fossils must be obtained from SAHRA prior the construction phase. All earthworks activities are to be monitored by a resident palaeontologist. A monitoring report should be submitted to SAHRA after completion of the earth-moving activity
DR08120	120_BP01N	All earth-moving activities are to be monitored by a palaeontologist. A monitoring report should be submitted to SAHRA after completion of the earth-moving activity. The resident ECO must be trained by a professional palaeontologist in the recognition of fossils. If fossil material is later discovered it must be appropriately protected and the discovery reported to a palaeontologist for the removal thereof as per SAHRA legislation

Road No	B/Pit No	Mitigation Measures
DR08120	120_BP02N	All earth-moving activities are to be monitored by a palaeontologist. A monitoring report should be submitted to SAHRA after completion of the earth-moving activity. The resident ECO must be trained by a professional palaeontologist in the recognition of fossils. If fossil material is later discovered it must be appropriately protected and the discovery reported to a palaeontologist for the removal thereof as per SAHRA legislation
DR08123	123_BP01N	All earth-moving activities are to be monitored by a palaeontologist. A monitoring report should be submitted to SAHRA after completion of the earth-moving activity. The resident ECO must be trained by a professional palaeontologist in the recognition of fossils. If fossil material is later discovered it must be appropriately protected and the discovery reported to a palaeontologist for the removal thereof as per SAHRA legislation
DR08131	131_BP01N	Igneous/metamorphic rocks or Quaternary alluvial deposits underlie these zones, with no potential for fossils.
DR08147	147_BP01	Igneous/metamorphic rocks or Quaternary alluvial deposits underlie these zones, with no potential for fossils.
DR08147	147_BP02	Igneous/metamorphic rocks or Quaternary alluvial deposits underlie these zones, with no potential for fossils.
DR08153	153_BP01N	All earth-moving activities are to be monitored by a palaeontologist. A monitoring report should be submitted to SAHRA after completion of the earth-moving activity. The resident ECO must be trained by a professional palaeontologist in the recognition of fossils. If fossil material is later discovered it must be appropriately protected and the discovery reported to a palaeontologist for the removal thereof as per SAHRA legislation
DR08156	156_BP01N	All earth-moving activities are to be monitored by a palaeontologist. A monitoring report should be submitted to SAHRA after completion of the earth-moving activity. The resident ECO must be trained by a professional palaeontologist in the recognition of fossils. If fossil material is later discovered it must be appropriately protected and the discovery reported to a palaeontologist for the removal thereof as per SAHRA legislation
DR08173	173_BP01	Igneous/metamorphic rocks or Quaternary alluvial deposits underlie these zones, with no potential for fossils.
DR08173	173_BP02	Igneous/metamorphic rocks or Quaternary alluvial deposits underlie these zones, with no potential for fossils.
DR08273	273_BP01N	All earth-moving activities are to be monitored by a palaeontologist. A monitoring report should be submitted to SAHRA after completion of the earth-moving activity. The resident ECO must be trained by a professional palaeontologist in the recognition of fossils. If fossil material is later discovered it must be appropriately protected and the discovery reported to a palaeontologist for the removal thereof as per SAHRA legislation
DR08273	273_BP02N	All earth-moving activities are to be monitored by a palaeontologist. A monitoring report should be submitted to SAHRA after completion of the earth-moving activity. The resident ECO must be trained by a professional palaeontologist in the recognition of fossils. If fossil material is later discovered it must be appropriately protected and the discovery reported to a palaeontologist for the removal thereof as per SAHRA legislation
DR08273	273_BP03N	A permit for the collection and rescue of fossils must be obtained from SAHRA prior the construction phase. All earthworks activities are to be monitored by a resident palaeontologist. A monitoring report should be submitted to SAHRA after completion of the earth-moving activity
DR08273	273_BP04N	Igneous/metamorphic rocks or Quaternary alluvial deposits underlie these zones, with no potential for fossils.
DR08275	275_BP01N	A permit for the collection and rescue of fossils must be obtained from SAHRA prior the construction phase. All earthworks activities are to be monitored by a resident palaeontologist. A monitoring report should be submitted to SAHRA after completion of the earth-moving activity
DR08281	281_BP01	All earth-moving activities are to be monitored by a palaeontologist. A monitoring report should be submitted to SAHRA after completion of the earth-moving activity. The resident ECO must be trained by a professional palaeontologist in the recognition of fossils. If fossil material is later discovered it must be appropriately protected and the discovery reported to a palaeontologist for the removal thereof as per SAHRA legislation
DR08281	281_BP02	All earth-moving activities are to be monitored by a palaeontologist. A monitoring report should be submitted to SAHRA after completion of the earth-moving activity. The resident ECO must be trained by a professional palaeontologist in the recognition of fossils. If fossil material is later discovered it must be appropriately protected and the discovery reported to a palaeontologist for the removal thereof as per SAHRA legislation

Road No	B/Pit No	Mitigation Measures
DR18033	18033_BP01N	All earth-moving activities are to be monitored by a palaeontologist. A monitoring report should be submitted to SAHRA after completion of the earth-moving activity. The resident ECO must be trained by a professional palaeontologist in the recognition of fossils. If fossil material is later discovered it must be appropriately protected and the discovery reported to a palaeontologist for the removal thereof as per SAHRA legislation
DR18033	18033_BP02N	A permit for the collection and rescue of fossils must be obtained from SAHRA prior the construction phase. All earthworks activities are to be monitored by a resident palaeontologist. A monitoring report should be submitted to SAHRA after completion of the earth-moving activity
DR18033	18033_BP03N	A permit for the collection and rescue of fossils must be obtained from SAHRA prior the construction phase. All earthworks activities are to be monitored by a resident palaeontologist. A monitoring report should be submitted to SAHRA after completion of the earth-moving activity

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1. INTRODUCTION

The Department of Roads and Public Works of the Eastern Cape Province identified 28 borrow pits in order to obtain construction materials as part of a lager project to upgrade/re-surface a total of 13 roads located throughout the Oliver Tambo District Municipality. Biotechnology & Environmental Specialist Consultancy (BESC) commissioned this Palaeontological Impact Assessment as part of the Heritage Impact Assessment. The purpose of the Palaeontological Impact Assessment is to identify exposed and potential palaeontological heritage on the site of the proposed development, to assess the impact the development may have on this resource, and to make recommendations as to how this impact might be mitigated.

1.1. Legal Requirements

This report forms part of the preparation of an Environmental Management Plan as defined and required by Regulations in terms of the Minerals and Petroleum Resources Development Act 28 of 2002 for the permitting of borrow pits. The report also complies with the requirements of the South African National Heritage Resource Act No 25 of 1999. In accordance with Section 38 (Heritage Resources Management), a Heritage Impact Assessment (HIA) is required to assess any potential impacts to palaeontological heritage within the footprint of the identified 28 borrow pits.

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;
- objects with the potential to yield information that will contribute to an understanding of South Africa's natural or cultural heritage.

2. PROPOSED DEVELOPMENT DESCRIPTION

The Eastern Cape Province's Department of Roads and Public Works identified 28 borrow pits in order to obtain construction materials as part of a lager project to upgrade/re-surface a total of 13 roads located throughout the Oliver Tambo District Municipality.

The roads and borrow pits identified is summarised in Table 2.1. For the location of the borrow pits see Figure 2.1.

Table 2.1 Roads and borrow-pits in the Oliver Tambo District Municipality

Rd No	B/Pit No	Longitude	Latitude	Area	Municipality
DR08024	024_BP01N	29°45'27.9" E	31°20'21.9" S	Lusikisiki	Qaukeni/Inqguza Hill LM
DR08024	024_BP02N	29°47'12.3" E	31°19'29.9" S	Lusikisiki	Qaukeni/Inqguza Hill LM
DR08024	024_BP02N	29°45'16.4"E	31°20'01.5" S	Lusikisiki	Qaukeni/Inqguza Hill LM
DR08029	029_BP01N	29°16'19.9" E	31°43'22.0" S	Port St Johns	Port St Johns LM
DR08029	029_BP02N	29°18'11.2" E	31°45'10.1" S	Port St Johns	Port St Johns LM
DR08029	029_BP03N	29°18'13.8" E	31°45'18.3" S	Port St Johns	Port St Johns LM
DR08029	029_BP04N	29°21'39.1" E	31°44'02.8" S	Port St Johns	Port St Johns LM
DR08029	029_BP05N	29°21'54.1" E	31°42'59.6" S	Port St Johns	Port St Johns LM
DR08120	120_BP01N	29°49'33.9" E	30°54'28.1" S	Bizana	Mbizana LM

Rd No	B/Pit No	Longitude	Latitude	Area	Municipality
DR08120	120_BP02N	29°49'34.7" E	30°54'10.5" S	Bizana	Mbizana LM
DR08123	123_BP01N	29°40'12.2" E	30°58'32.8" S	Bizana	Mbizana LM
DR08131	131_BP01N	28°45'25.6" E	30°58'24.3" S	Qumbu	Mhlontlo LM
DR08147	147_BP01	29°46'01.9" E	31°20'23.6" S	Lusikisiki	Qaukeni/Inqguza Hill LM
DR08147	147_BP02	29°47'40.5" E	31°20'56.7" S	Lusikisiki	Qaukeni/Inqguza Hill LM
DR08153	153_BP01N	29°30'7.5" E	31°20'21.8" S	Lusikisiki	Qaukeni/Inqguza Hill LM
DR08156	156_BP01N	29°23'8.8" E	31°19'22.5" S	Lusikisiki	Qaukeni/Inqguza Hill LM
DR08173	173_BP01	28°58'51.4" E	31°24'27.2" S	Libode	Nyandeni LM
DR08173	173_BP02	28°59'04.9" E	31°22'51.7" S	Libode	Nyandeni LM
DR08273	273_BP01N	28°26'23.4" E	31°46'39.1" S	Clarkebury	KSD LM
DR08273	273_BP02N	28°24'20.8" E	31°48'07.6" S	Clarkebury	KSD LM
DR08273	273_BP03N	28°17'38.6" E	31°48'20.0" S	Clarkebury	Engcobo LM
DR08273	273_BP04N	28°16'16.2" E	31°47'06.7" S	Clarkebury	Engcobo LM
DR08275	275_BP01N	28°27'14.1" E	31°53'2.2" S	Clarkebury	KSD LM
DR08281	281_BP01	28°39'08.6" E	31°44'05.3" S	Payne	KSD LM
DR08281	281_BP02	28°31'08.4" E	31°44'18.9" S	Payne	KSD LM
DR18033	18033_BP01N	28°47'50.1" E	32°03'14.7" S	Elliotdale	Mbashe LM
DR18033	18033_BP02N	28°39'53.8" E	31°58'46.6" S	Elliotdale	KSD LM
DR18033	18033_BP03N	28°52'23.9" E	32°11'43.0" S	Elliotdale	Mbashe LM

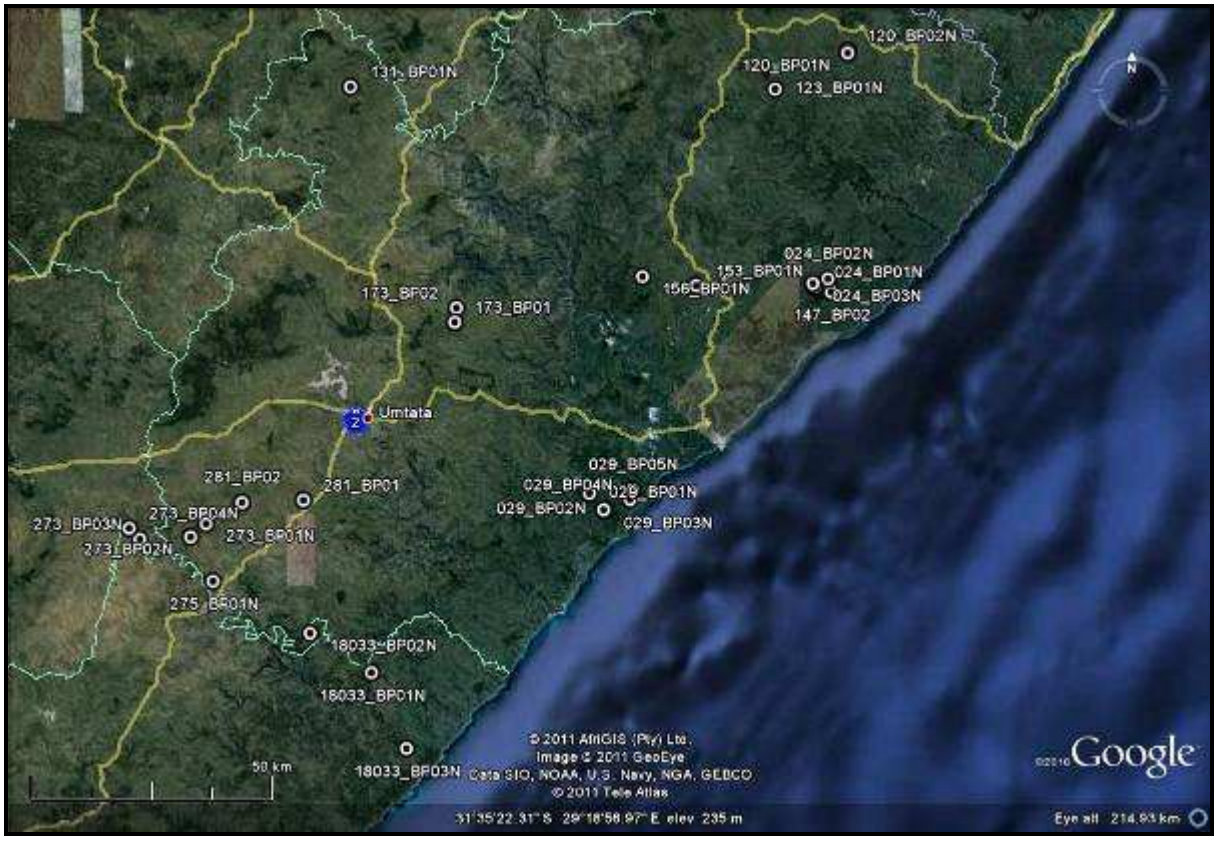

Figure 2.1 Location of the Oliver Tambo District Municipality identified borrow pits

3. AIMS AND METHODS

After discussions with BESC a request for a Phase 1 Palaeontological Impact Assessment (PIA) was received. Following the *"SAHRA APM Guidelines: Minimum Standards for the Archaeological & Palaeontological Components of Impact Assessment Reports"* the aims of the PIA were:

- identifying exposed and subsurface rock formations that are considered to be palaeontologically significant;
- assessing the level of palaeontological significance of these formations;
- conducting fieldwork to assess the immediate risk to exposed fossils as well as to document and sample these localities;
- commenting on the impact of the development on these exposed and/or potential fossil resources;
- making recommendations as to how the developer should conserve or mitigate damage to these resources.

A basic assessment of the topography and geology of the area was made by using appropriate geological (1:250 000) maps in conjunction with Google Earth. The only limitation on this methodology is the scale of mapping, which restricts comparison of the geology to the 1:250 000 scale. This restriction only applies in areas where major changes in the geological character of the area occur over very short distances or on the geological transformation zones.

A review of the literature on the geological formations exposed at surface in the development site and the fossils that have been associated with these geological strata was undertaken.

A field investigation of the site was conducted on 20-22 October 2011 by Dr G Groenewald, Mrs S Groenewald and Mr T Hugo who are experienced fieldworkers. The aims of the fieldwork were to document any exposed fossil material and to assess the palaeontological potential of the region in terms of the type and extent of rock outcrop in the area.

4. GEOLOGICAL BACKGROUND OF THE AREA

The study area is underlain rocks ranging in age from the Devonian (Natal Group) to Permian and Triassic Adelaide and Tarkastad Subgroups of the Beaufort Group of the Karoo Supergroup. Dolerite intrusions of the Jurassic era are present over the entire study area. Alluvial deposits of the Quaternary era occur predominantly in the lower lying valley floors.

The entire sequence consists of the Natal Group, overlain by the Dwyka Formation, the Ecca Group, Beaufort Group, Alluvium deposits and intrusive Karoo dolerite. The various borrow pits' geology identified and verified is summarised in Table 4.1 and illustrated in figures 4.1 – 4.3 (Geological Maps: 3028 Kokstad, 3128 Umtata and 3228 Kei Month)

Table 4.1 The geology of the various borrow pits

Rd Nr	B/Pit No	Geology	Area	Figure
DR08024	024_BP01N	Natal Group	Lusikisiki	4.3
DR08024	024_BP02N	Natal Group	Lusikisiki	4.3
DR08024	024_BP02N	Natal Group	Lusikisiki	4.3
DR08147	147_BP01	Natal Group	Lusikisiki	4.3
DR08147	147_BP02	Natal Group	Lusikisiki	4.3
DR08120	120_BP01N	Ecca Group	Bizana	4.1

Rd Nr	B/Pit No	Geology	Area	Figure
DR08120	120_BP02N	Ecca Group	Bizana	4.1
DR08123	123_BP01N	Ecca Group	Bizana	4.1
DR18033	18033_BP03N	Ecca Group	Elliotdale	4.2
DR18033	18033_BP01N	Adelaide Subgroup	Elliotdale	4.2
DR18033	18033_BP02N	Adelaide Subgroup	Elliotdale	4.2
DR08029	029_BP01N	Adelaide Subgroup	Port St Johns	4.3
DR08029	029_BP04N	Adelaide Subgroup	Port St Johns	4.3
DR08029	029_BP05N	Adelaide Subgroup	Port St Johns	4.3
DR08153	153_BP01N	Adelaide Subgroup	Lusikisiki	4.3
DR08156	156_BP01N	Adelaide Subgroup	Lusikisiki	4.3
DR08173	173_BP02	Adelaide decomposed dolerite	Libode	4.2
DR08275	275_BP01N	Tarka Stad's Katberg Formation	Clarkebury	4.2
DR08281	281_BP01	Tarka Stad's Katberg Formation	Payne	4.2
DR08281	281_BP02	Tarka Stad's Katberg Formation	Payne	4.2
DR08173	173_BP01	Tarka Stad decomposed dolerite	Libode	4.2
DR08273	273_BP01N	Tarka Stad's Burgersdorp Formation	Clarkebury	4.2
DR08273	273_BP02N	Tarka Stad's Burgersdorp Formation	Clarkebury	4.2
DR08273	273_BP03N	Tarka Stad's Burgersdorp Formation	Clarkebury	4.2
DR08029	029_BP02N	Decomposed dolerite	Port St Johns	4.3
DR08029	029_BP03N	Decomposed dolerite	Port St Johns	4.3
DR08131	131_BP01N	Decomposed Dolerite	Qumbu	4.1
DR08273	273_BP04N	Decomposed dolerite	Clarkebury	4.2

The borrow pits' geological units identified can be summarised as follows:

4.1. The Natal Group

The Natal Group of rocks consists of reddish-grey conglomerates, cross-bedded siliceous quartzose and feldspathic sandstone and mudstones. Although difficult to confirm, the age of the Natal Group is tentatively placed in the Ordovician epoch (Marshall 2006, in Johnson et al, 2006).

4.2. Dwyka Formation

The Dwyka Formation is a Late Carboniferous to Early Permian glacial deposit that unconformably overlies the Natal Group and is represented by a sequence of coarse but homogenous diamictites and subordinate mudstones and sandstones. Thin lenses of finely laminated bluish-grey to yellowish-grey shale are interbedded with diamictites.

4.3. The Ecca Group

The Ecca Group is a succession of shale and subordinate sandstone, conformably overlying the Dwyka tillites. In the study area the Ecca Group consists of undifferentiated mudrock, carbonaceous shales, fine-grained graywackes and alternating dark-grey shales. Due to extensive faulting and deep weathering the Ecca Group rocks have not been studied in detail.

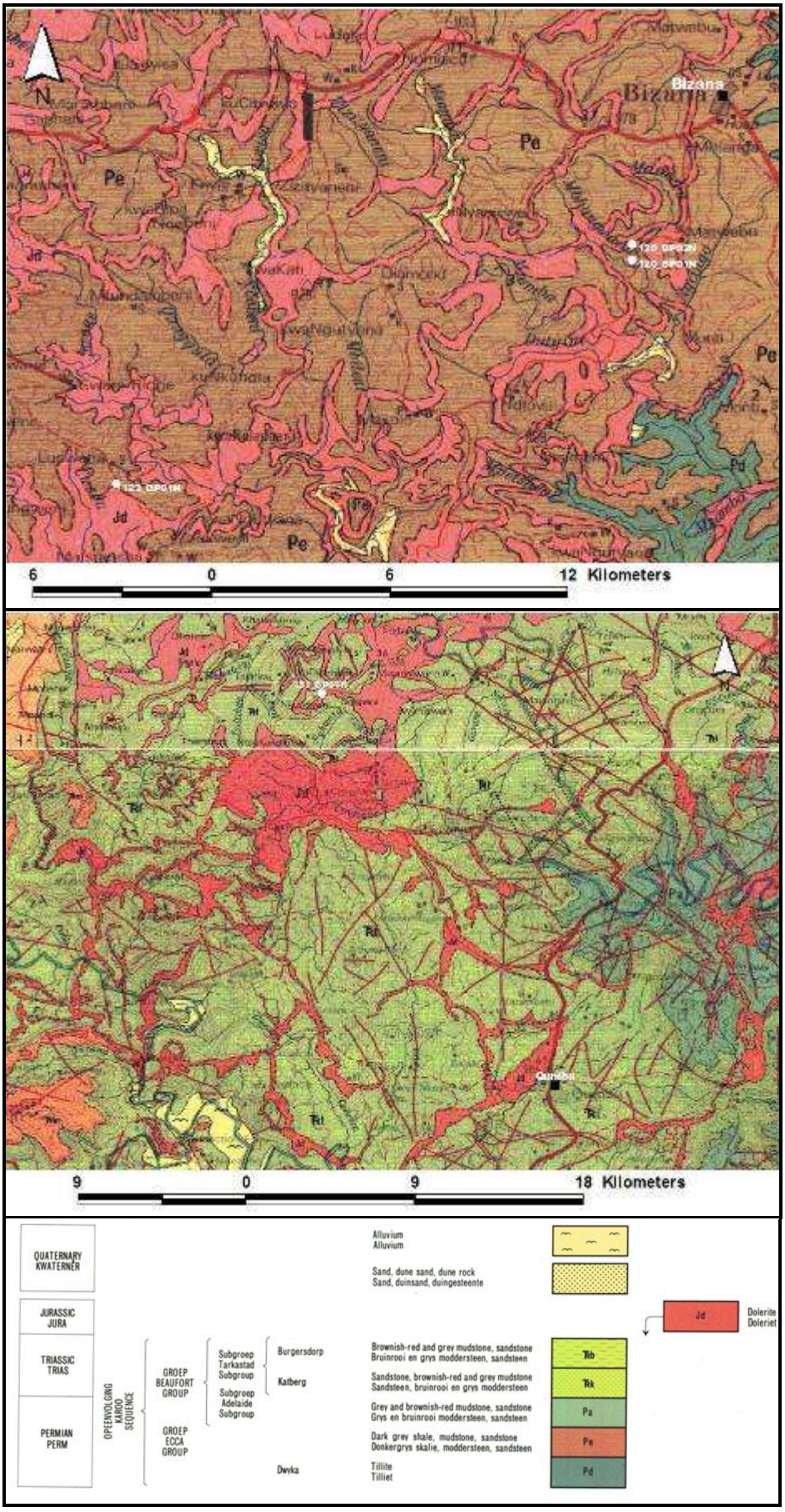

Figure 4.1 The geology of borrow pits: 120 BP 01&02N, 123 BP 01N and 131 BP 01N

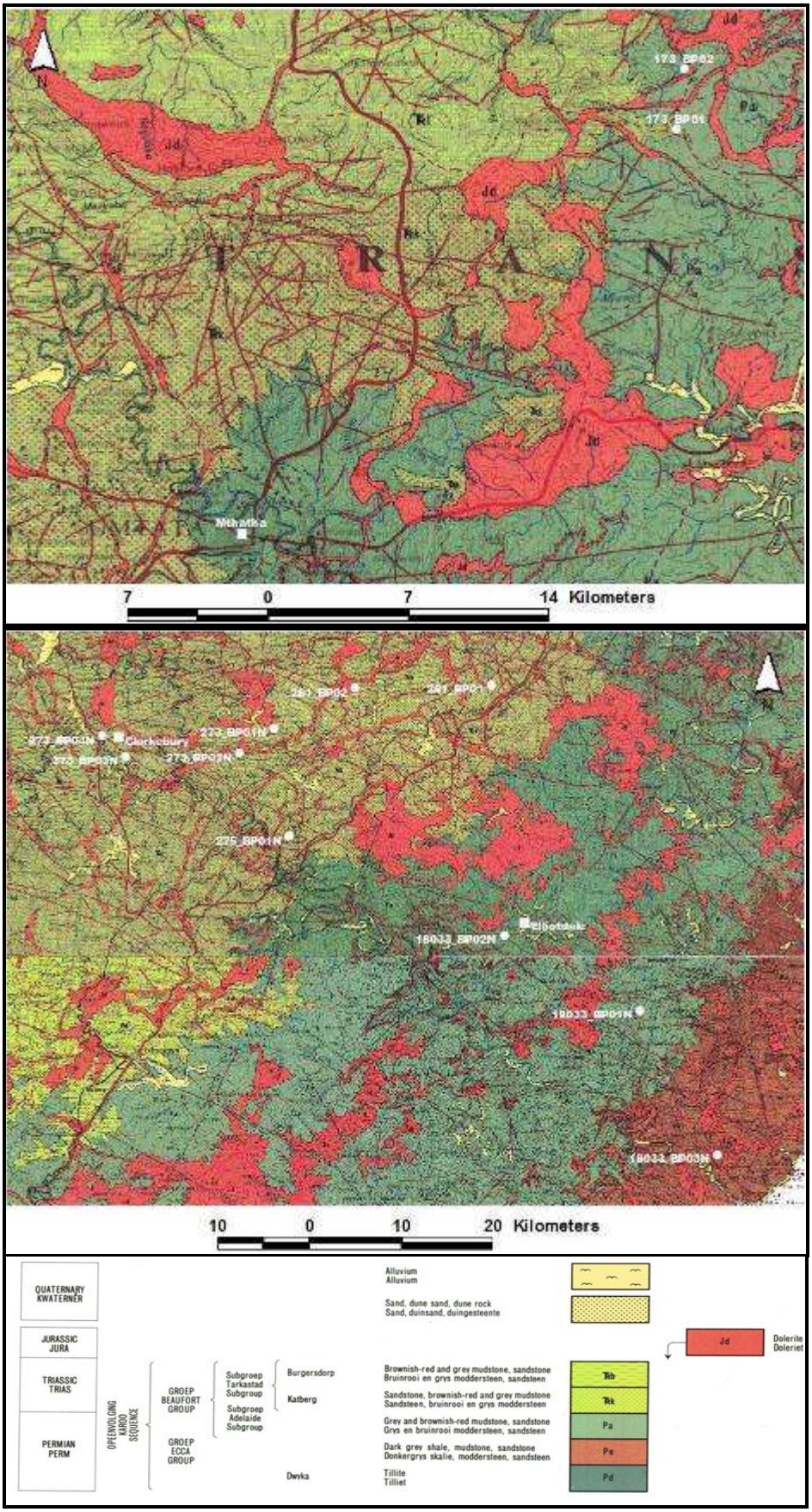

Figure 4.2 **The geology of borrow pits: 173 BP 01&02, 273 BP 01-04N, 275 BP 01N, 281 BP 01&02, 18033 BP 01-03N**

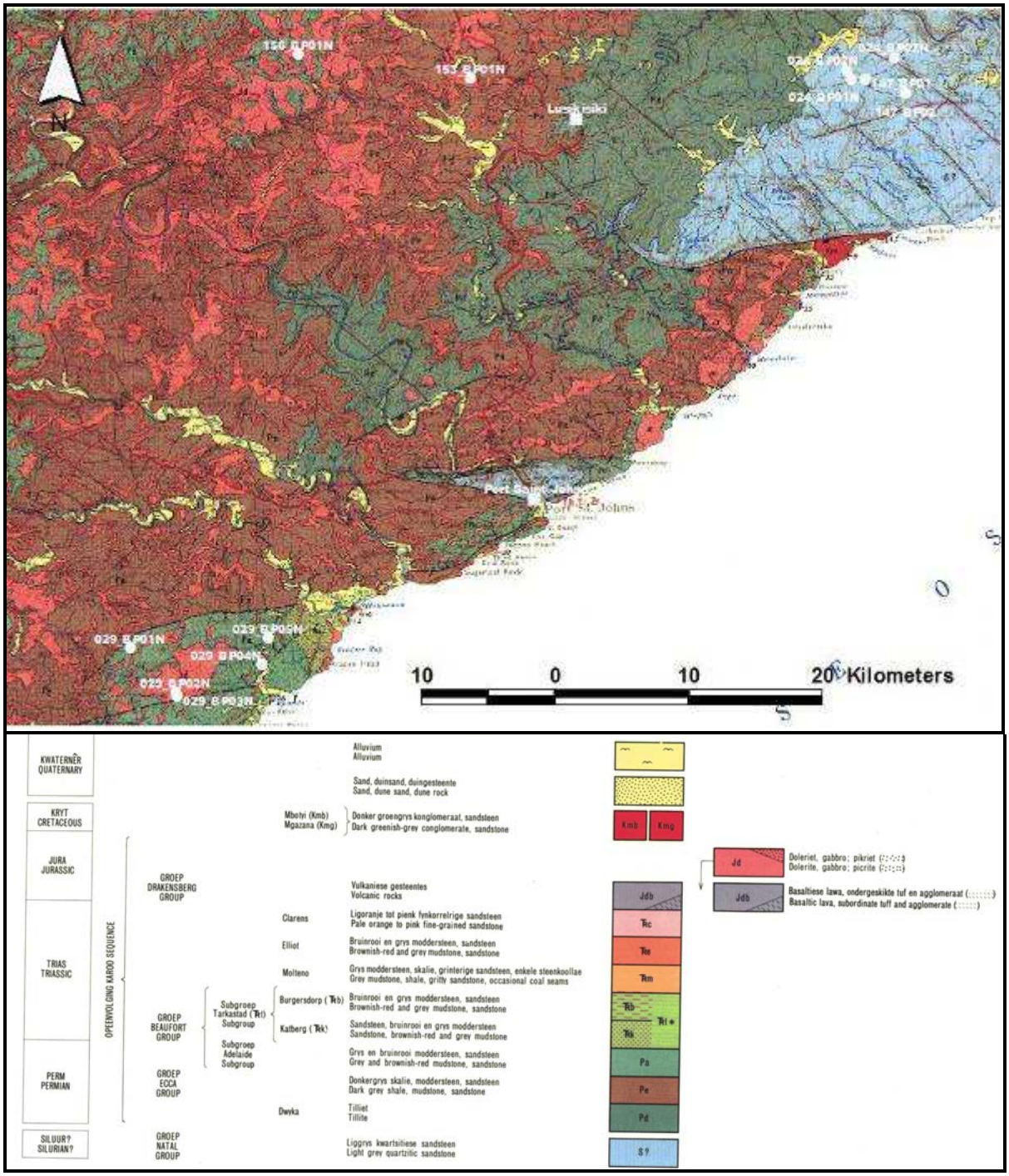

Figure 4.3 Geology of borrow pits: 024 BP 01-03N, 029 BP 01-05N, 147 BP 01&02, 153 BP 01N and 156 BP 01N

4.4. The Beaufort Group

The Beaufort Group in made up of the lower Adelaide and upper Tarkastad Subgroups

4.4.1. The Adelaide Subgroup

From oldest to youngest, the Adelaide Subgroup west of 28°E is represented by the Koonaap, Middleton and Balfour Formations respectively, but they are difficult to separate due to poor exposures in the study area. Upward fining cycles, lenticular sandstones and massive mudstones point to a fluviatile mode of deposition for the origin of the Adelaide Subgroup.

4.4.2. The Tarkastad Subgroup

The Tarkastad Subgroup is made up of the lower arenaceous Katberg Formation and the upper argillaceous Burgersdorp Formation. Based on the characteristic presence of upward-fining cycles, lenticular sandstones, massive mudstones and non-marine vertebrate remains, the depositional history of the Tarkastad Subgroup is also interpreted as a fluviatile environment.

4.4.2.1. The Katberg Formation

The Katberg Formation consists of relatively extensive beds of yellowish-grey to light greenish-grey sandstones and bluish-grey and reddish-grey mudstones (Groenewald, 1996).

4.4.2.2. Burgersdorp Formation

The Burgersdorp Formation consists of a secession of predominantly red mudstone and interbedded yellow-grey to light greenish-grey sandstone. The depositional environment is interpreted to be predominantly fluvial with extensive lacustrine deposits associated with this sequence (Groenewald, 1996; Johnson et al 2006).

4.5. Karoo Dolerite

Karoo Dolerite intrusions are present over the entire study area. Due to its resistance to weathering, it underlies most of the higher topography in the region.

4.6. Recent Alluvial Deposits

Small pockets of alluvial deposits are present over the entire study area. These deposits are however limited to the river banks on the valley floors.

5. PALAEONTOLOGICAL BACKGROUND OF THE AREA

The underlying sequences of the Natal Group, overlain by the Dwyka Formation and the Ecca Group have low fossil occurrence if any. The upper Beaufort Group is known for fossil occurrence in the biostratigraphic subdivision of the group.

5.1. The Natal Group

No fossils are expected in the Natal Group.

5.2. The Dwyka Formation

No fossils have been described from this Formation in the study area.

5.3. The Ecca Group

The Ecca Group rocks are in general deeply weathered and fossils are restricted to poorly defined trace fossils.

5.4. Beaufort Group

The value of vertebrate fossils in rocks of the Beaufort Group lies in its use as distinguishable biostratigraphic criteria to refine further subdivision of the group. The biozones employed are based on the vertebrate fossil remains that are so abundant in these rocks.

Excavations for the burrow pits, as well as the roads and other infrastructure, may provide an opportunity to inspect fresh unweathered rock of this assemblage zone in the study area.

5.4.1. AdelaideSubgroup

The Adelaide Subgroup is not subdivided in the study area and outcrops are extremely poorly defined due to deep weathering. The potential for fossils from the *Eodicynodon, Tapinocephalus, Pristerognathus, Tropidostoma , Cistecephalus* and *Dicynodon* Assemblage Zones is moderate to high (Rubidge et al, 1995; Johnson et al, 2006). Plant fossils that can be expected from these rocks include examples of *Glossopteris* assemblages and examples of other genera include *Cyclodendron, Phyllotheca* and *Noeggerathiopsis*. Invertebrate fossils are restricted to trace fossils, including casts of some vertebrate burrows (Groenewald, 1996)

5.4.2. Tarkastad Subgroup

5.4.2.1. Katberg Formation

The Triassic Katberg Formation overlies the Adelaide Subgroup and contains important international biostratigraphic information. The Katberg Formation represent a time period that includes the Middle Permian to Middle Triassic and contain fossil remains of animals that transcends from reptiles to mammals. The Katberg Formation correlates with the middle and upper part of the *Lystrosaurus* Assemblage Zone, containing fossils of both vertebrates and invertebrates of the Triassic era.

The Katberg Formation also contains some unique well-preserved vertebrate burrows (Groenewald, 1991) that are associated with the *Lystrosaurus* and *Procolophon* fauna that dominates this stratigraphic unit.

5.4.2.2. Burgersdorp Formation

The Burgersdorp Formation is associated with the *Cynognathus* Assemblage Zone which is known as a productive fossil bearing zone in the Karoo Supergroup (Rubidge et al 1995: Groenewald 1996; Johnson et al, 2006).

5.5. Karoo Dolerite

Due to the igneous character of this rock type it does not contain fossils.

5.6. Recent Alluvial Deposits

Due to its alluvial character of this geology it does not contain fossils.

6. RESULTS OF THE FIELD INVESTIGATION

The development area is dominated by rolling hill topography with poor outcrops of all the rock formations. The results of the field investigations in the various geological units are as follows:

6.1. Natal Group

No fossils are expected from the Natal Group and due to time and budget constraints burrow pits falling on this geological group were not visited during the field investigation.

6.2. Ecca Group

Outcrops of the Ecca Group are restricted to deeply excavated quarries and fossils are restricted to trace fossils

6.3. Beaufort Group

6.3.1. Adelaide Subgroup

Outcrops of the Adelaide Subgroup are restricted to deeply excavated quarries in the study area. Fossils of *Glossopteris* are abundantly present in outcrops of the Adelaide Subgroup

6.3.2. Tarkastad Subgroup

Quarries excavated into mud rock of the Tarkastad Subgroup are well defined and good examples of trace fossils, including casts of vertebrate burrows, are present in these outcrops.

6.3.2.1. Katberg Formation

Borrow pits associated with the Katberg Formation mudstone revealed interesting burrow casts and although no body fossils were discovered during the field investigations, the possibility of finding fossils during future excavation operations is very high.

The upper boundary of the Katberg Formation conformably grades into the Burgersdorp Formation, a predominantly red mudstone unit.

6.3.2.2. Burgersdorp Formation

Borrow pits associated with the Burgersdorp Formation did not reveal any body fossils and trace fossils are restricted to some poorly defined burrow casts. Well defined root structures were however recorded during the field investigation.

6.4. Karoo Dolerite

Karoo Dolerite is an igneous rock and does not contain fossils

The results of the field investigation are summarised according to the various roads in Table 6.1

Rd Nr	B/Pit No	Geol.	Site Photo	Fossil Photo(s) if any
DR08024	024_BP01N	S?	Not visited	
DR08024	024_BP02N	S?	Not visited	
DR08024	024_BP02N	S?	Not visited	
DR08029	029_BP01N	Pa		
DR08029	029_BP02N	Jd		

Rd Nr	B/Pit No	Geol.	Site Photo	Fossil Photo(s) if any
DR08029	029_BP03N	Jd		
DR08029	029_BP04N	Pa		
DR08029	029_BP05N	Pa		 *Glossopteris* Leaves
DR08120	120_BP01N	Pe		
DR08120	120_BP02N	Pe		
DR08123	123_BP01N	Pe		

Rd Nr	B/Pit No	Geol.	Site Photo	Fossil Photo(s) if any
DR08131	131_BP01N	Jd	Not visited	
DR08147	147_BP01	S?	Not visited	
DR08147	147_BP02	S?	Not visited	
DR08153	153_BP01N	Pa		
DR08156	156_BP01N	Pa		
DR08173	173_BP01	Jd		
DR08173	173_BP02	Jd		
DR08273	273_BP01N	Trb		

Rd Nr	B/Pit No	Geol.	Site Photo	Fossil Photo(s) if any
DR08273	273_BP02N	Trb		
DR08273	273_BP03N	Trb		 Fossils of Rhizomes
DR08273	273_BP04N	Jd		
DR08275	275_BP01N	Trk		 Fossilised burrow casts
DR08281	281_BP01	Trk		

Rd Nr	B/Pit No	Geol.	Site Photo	Fossil Photo(s) if any
DR08281	281_BP02	Trk		
DR18033	18033_BP01N	Pa		
DR18033	18033_BP02N	Pa		 *Glossopteris* Leaves
DR18033	18033_BP03N	Pe		 Trace fossils

7. PALAEONTOLOGICAL SIGNIFICANCE AND RATING

The predicted palaeontological impact of the development is based on the initial mapping assessment and literature reviews, as well as information gathered during the field investigation.

The palaeontological significance and rating is summarised in Table 7.1 and 7.2. For the methodology and definitions of impact rating and significance see Appendix A (CES 2011).

There is a possibility that fossils could be encountered during excavation in to the Ecca and Beaufort Group geology and these fossils would be of international significance. If effective mitigation is in place at the time of exposure, and the fossils are successfully excavated for study, this would represent a beneficial palaeontological impact.

Table 7.1 Palaeontological Significance of Geological Units of the Borrow pis

Geological Unit	Rock Type and Age	Fossil Heritage	Vertebrate Biozone	Palaeontological Sensitivity
Natal Group	Feldspathic sandstone and mudstone conglomerates; ORDOVICIAN/ SILURIAN	Poor; no diagnostic fossils	None	Nil
Ecca Group	Marine shales and sandstones; PERMIAN	*Mesosaurid* reptiles, crustaceans, palaeoniscoid fish, rare ichnofossils plants, sponge spicules, insect wings		Medium sensitivity
Adelaide Subgroup	Fluvial and lacustrine mudstones and sandstones. LATE PERMIAN	Vertebrate fossils of all the main assemblage zones can be expected. Plant fossils such as *Glossopteris* assemblages and other genera including *Cyclodendron, Phyllotheca* and *Noeggerathiopsis.* Invertebrate fossils are restricted to trace fossils, including casts of some vertebrate burrows	*Eodicynodon, Tapinocephalus, Pristerognathus, Tropidostoma , Cistecephalus, Dicynodon* and *Lystrosaurus* Assemblage Zones	High sensitivity
Katberg Formation	Medium to Coarse-Grained Sandstone EARLY TRIASSIC	Vertebrate fossils including amphibians, *Captorhinids, Eosuchids, Dicynodonts, Therocephalians, Cynodonts* and trace fossils.	*Lystrosaurus* Assemblage Zone	High sensitivity
Burgersdorp Formation	Fluvial and lacustrine mudstones and sandstones. EARLY TRIASSIC	Vertebrate fossils also include amphibians	*Cynognathus* Assemblage Zone	High sensitivity
Drakensberg Group	Dolerite Dykes & Sills (Igneous Intrusions)	None	None	Nil

Unfortunately within these rock units there is no way of assessing the likelihood of encountering fossils during excavation. As evidenced in other similar areas with exposures, fossils were apparently absent or very scarce over large areas, but locally dense accumulations were found.

Therefore, fossils within the borrow pit sites could be characterised as rare but highly significant. The damage and/or loss of these fossils due to inadequate mitigation would be a highly negative palaeontological impact. The exposure and subsequent reporting of fossils (that would otherwise have remained undiscovered) to a qualified palaeontologist for excavation will be a beneficial palaeontological impact.

Table 7.2 Significance Rating Table as Per CES Template

Rock Unit	Temporal Scale (duration of impact)	Spatial Scale (area in which impact will have an effect)	Degree of confidence (confidence with which one has predicted the significance of an impact)	Impact severity (severity of negative impacts, or how beneficial positive impacts would be)		Overall Significance (The combination of all the other criteria as an overall significance)	
				With mitigation	Without mitigation	With mitigation	Without mitigation
Ecca Group	permanent	international	possible	beneficial	severe	beneficial	Negative
Adelaide Subgroup	permanent	international	possible	beneficial	very severe	beneficial	High negative
Katberg Formation	permanent	international	possible	beneficial	very severe	beneficial	High negative
Burgersdorp Formation	permanent	international	possible	beneficial	very severe	beneficial	High negative

8. PALAEONTOLOGICAL IMPACT AND MITIGATION

The predicted palaeontological impact of the development is based on the initial mapping assessment and literature reviews as well as information gathered during the field investigation. The field investigation confirms that most of the area is underlain by the Natal, Ecca and Beaufort Groups with Dolerite intrusions.

The Ecca and Beaufort Groups are interbedded mudstones and sandstones that do have potential to yield fossils. The excavation within the Ecca and Beaufort Groups' bedrock will have the potential to uncover the mud rock and sandstone. Therefore monitoring and mitigation in terms of the palaeontological heritage are required.

Due to the igneous character of Dolerite it does not contain fossils and any excavations into dolerite do not require monitoring or mitigation in terms of palaeontological heritage.

The following colour coding method is used to classify a development area's palaeontological impact as illustrated in Figure 8.1 and 8.2:

- Red colouration indicates a very high possibility of finding fossils of a specific assemblage zone. Fossils will most probably be present in all outcrops on the site/route and the chances of finding fossils during the construction phase are very high.
- Orange colouration indicates a possibility of finding fossils of a specific assemblage zone either in outcrops or in bedrock on the site/route.
- Green colouration indicates that there is no possibility of finding fossils in that section of the site/route development.

The proposed development of borrow pits involves the excavation of bedrock material. These excavations have the potential to impact directly on fossil heritage if the mudstone of the Ecca and Beaufort Groups are exposed.

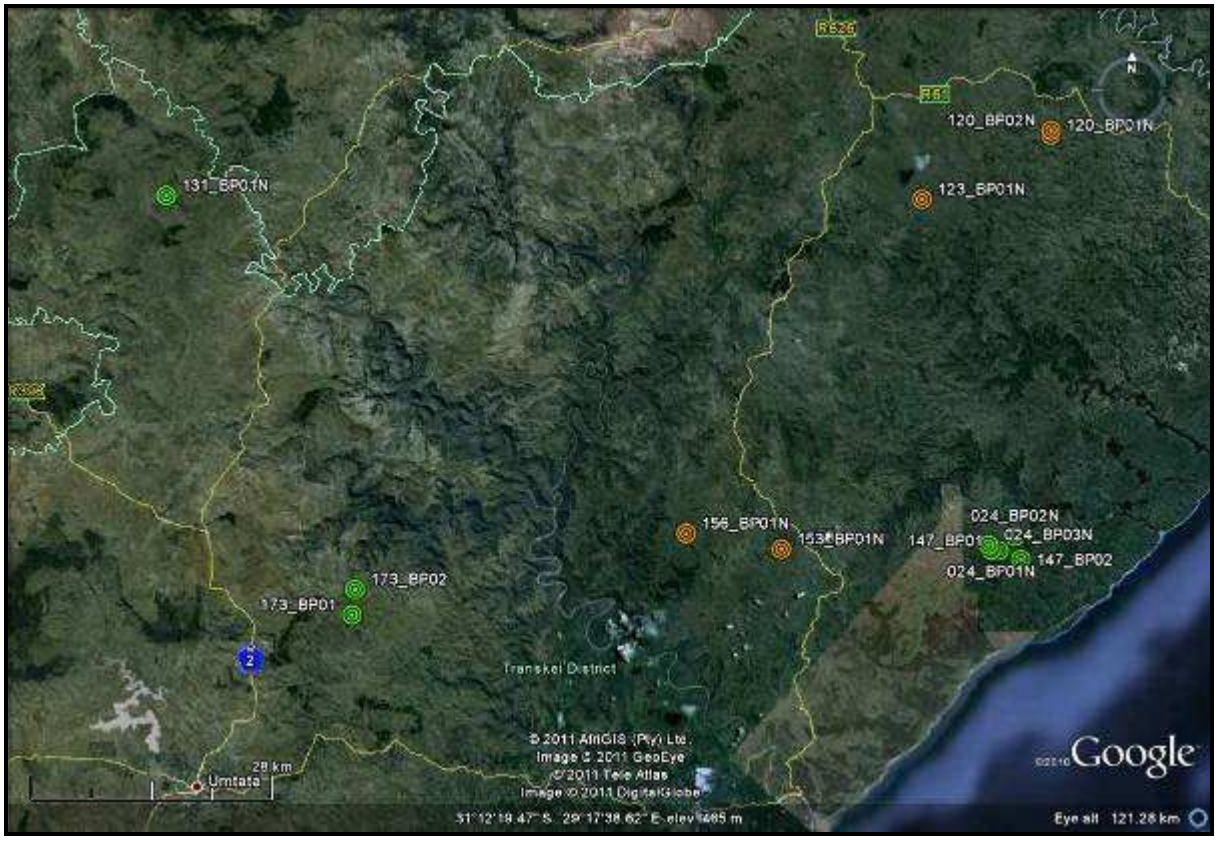

Figure 8.1 Palaeontological impact on the proposed borrow pits North of Umtata

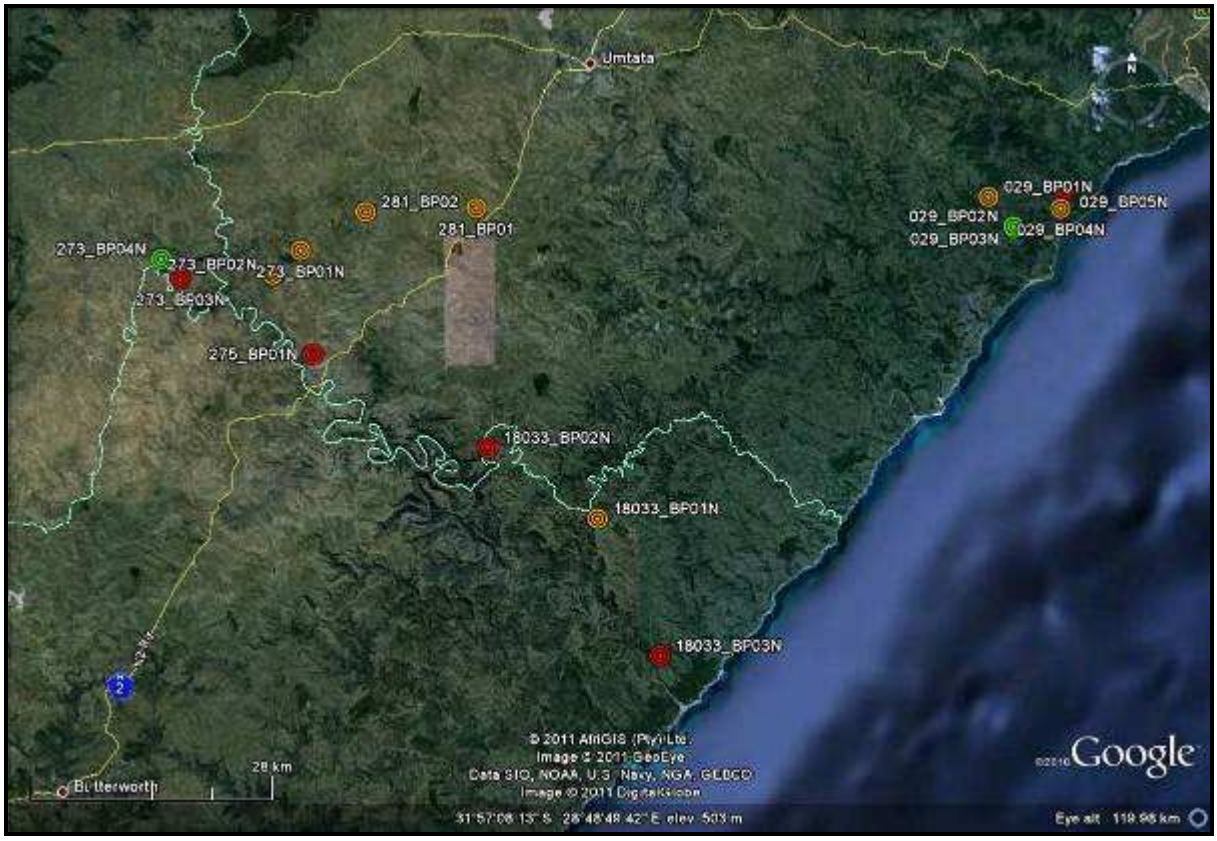

Figure 8.2 Palaeontological impact on the proposed borrow pits South of Umtata

From Figure 8.1 and 8.2 the following mitigation measures are recommended:

Table 8.1 Site Specific Mitigation Measures

Colour Coding (Figures. 8.1 & 8.2)	Mitigation Recommended
Green Sites	Igneous/metamorphic rocks or Quaternary alluvial deposits underlie these zones, with no potential for fossils.
Orange Sites	All earth-moving activities are to be monitored by a palaeontologist. A monitoring report should be submitted to SAHRA after completion of the earth-moving activity. The resident ECO must be trained by a professional palaeontologist in the recognition of fossils. If fossil material is later discovered it must be appropriately protected and the discovery reported to a palaeontologist for the removal thereof as per SAHRA legislation
Red Sites	A permit for the collection and rescue of fossils must be obtained from SAHRA prior the construction phase. All earthworks activities are to be monitored by a resident palaeontologist. A monitoring report should be submitted to SAHRA after completion of the earth-moving activity.

9. CONCLUSION

The areas around the borrow pits are dominated by rolling hill topography. The underlying Ecca and Beaufort Groups are interbedded mudstones and sandstones. There is a high potential to uncover fossil material in these underlying mudstones during excavations.

The borrow pits in the Ecca Group have a medium palaeontological sensitivity rating. The borrow pits within the Beaufort Group, i.e. the Adelaide Subgroup and the Katberg and Burgersdorp Formations of the Tarkastad Subgroup have a high palaeontological sensitivity rating.

Through adequate monitoring and mitigation measures during excavations of the Ecca and Beaufort Groups the medium to high impact severity can be lowered to beneficial. The exposure and subsequent reporting of fossils (that would otherwise have remained undiscovered) will have a beneficial palaeontological impact.

It is generally recommended that:

- A permit for the collection and rescue of fossils from the Ecca and Beaufort Groups must be obtained from SAHRA prior the construction phase.
- All earth-moving activities with potential impact on the Ecca and Beaufort Groups are to be monitored by a palaeontologist. A monitoring report should be submitted to SAHRA after completion of the earth-moving activity.
- The resident ECO must also be trained by a professional palaeontologist in the recognition of fossil material. If fossil material is later discovered it must be appropriately protected and the discovery reported to a palaeontologist for the removal thereof as per SAHRA legislation.
- The borrow pit specific recommendations is summarised in Table 9.1

Table 9.1 Borrow pit specific recommendations

Road No	B/Pit No	Longitude	Latitude	Geology	Municipality	Mitigation Measures
DR08024	024_BP01N	29°45'27.9" E	31°20'21.9" S	Natal Group	Inqguza Hill LM	Igneous/metamorphic rocks or Quaternary alluvial deposits underlie these zones, with no potential for fossils.
DR08024	024_BP02N	29°47'12.3" E	31°19'29.9" S	Natal Group	Inqguza Hill LM	Igneous/metamorphic rocks or Quaternary alluvial deposits underlie these zones, with no potential for fossils.
DR08024	024_BP02N	29°45'16.4"E	31°20'01.5" S	Natal Group	Inqguza Hill LM	Igneous/metamorphic rocks or Quaternary alluvial deposits underlie these zones, with no potential for fossils.
DR08029	029_BP01N	29°16'19.9" E	31°43'22.0" S	Adelaide	Port St Johns LM	All earth-moving activities are to be monitored by a palaeontologist. A monitoring report should be submitted to SAHRA after completion of the earth-moving activity. The resident ECO must be trained by a professional palaeontologist in the recognition of fossils. If fossil material is later discovered it must be appropriately protected and the discovery reported to a palaeontologist for the removal thereof as per SAHRA legislation
DR08029	029_BP02N	29°18'11.2" E	31°45'10.1" S	Dolerite	Port St Johns LM	Igneous/metamorphic rocks or Quaternary alluvial deposits underlie these zones, with no potential for fossils.
DR08029	029_BP03N	29°18'13.8" E	31°45'18.3" S	Dolerite	Port St Johns LM	Igneous/metamorphic rocks or Quaternary alluvial deposits underlie these zones, with no potential for fossils.
DR08029	029_BP04N	29°21'39.1" E	31°44'02.8" S	Adelaide	Port St Johns LM	All earth-moving activities are to be monitored by a palaeontologist. A monitoring report should be submitted to SAHRA after completion of the earth-moving activity. The resident ECO must be trained by a professional palaeontologist in the recognition of fossils. If fossil material is later discovered it must be appropriately protected and the discovery reported to a palaeontologist for the removal thereof as per SAHRA legislation
DR08029	029_BP05N	29°21'54.1" E	31°42'59.6" S	Adelaide	Port St Johns LM	A permit for the collection and rescue of fossils must be obtained from SAHRA prior the construction phase. All earthworks activities are to be monitored by a resident palaeontologist. A monitoring report should be submitted to SAHRA after completion of the earth-moving activity
DR08120	120_BP01N	29°49'33.9" E	30°54'28.1" S	Ecca	Mbizana LM	All earth-moving activities are to be monitored by a palaeontologist. A monitoring report should be submitted to SAHRA after completion of the earth-moving activity. The resident ECO must be trained by a professional palaeontologist in the recognition of fossils. If fossil material is later discovered it must be appropriately protected and the discovery reported to a palaeontologist for the removal thereof as per SAHRA legislation
DR08120	120_BP02N	29°49'34.7" E	30°54'10.5" S	Ecca	Mbizana LM	All earth-moving activities are to be monitored by a palaeontologist. A monitoring report should be submitted to SAHRA after completion of the earth-moving activity. The resident ECO must be trained by a professional palaeontologist in the recognition of fossils. If fossil material is later discovered it must be appropriately protected and the discovery reported to a palaeontologist for the removal thereof as per SAHRA legislation

Road No	B/Pit No	Longitude	Latitude	Geology	Municipality	Mitigation Measures
DR08123	123_BP01N	29°40'12.2" E	30°58'32.8" S	Ecca	Mbizana LM	All earth-moving activities are to be monitored by a palaeontologist. A monitoring report should be submitted to SAHRA after completion of the earth-moving activity. The resident ECO must be trained by a professional palaeontologist in the recognition of fossils. If fossil material is later discovered it must be appropriately protected and the discovery reported to a palaeontologist for the removal thereof as per SAHRA legislation
DR08131	131_BP01N	28°45'25.6" E	30°58'24.3" S	Dolerite	Mhlontlo LM	Igneous/metamorphic rocks or Quaternary alluvial deposits underlie these zones, with no potential for fossils.
DR08147	147_BP01	29°46'01.9" E	31°20'23.6" S	Natal Group	Inqguza Hill LM	Igneous/metamorphic rocks or Quaternary alluvial deposits underlie these zones, with no potential for fossils.
DR08147	147_BP02	29°47'40.5" E	31°20'56.7" S	Natal Group	Inqguza Hill LM	Igneous/metamorphic rocks or Quaternary alluvial deposits underlie these zones, with no potential for fossils.
DR08153	153_BP01N	29°30'7.5" E	31°20'21.8" S	Adelaide	Inqguza Hill LM	All earth-moving activities are to be monitored by a palaeontologist. A monitoring report should be submitted to SAHRA after completion of the earth-moving activity. The resident ECO must be trained by a professional palaeontologist in the recognition of fossils. If fossil material is later discovered it must be appropriately protected and the discovery reported to a palaeontologist for the removal thereof as per SAHRA legislation
DR08156	156_BP01N	29°23'8.8" E	31°19'22.5" S	Adelaide	Inqguza Hill LM	All earth-moving activities are to be monitored by a palaeontologist. A monitoring report should be submitted to SAHRA after completion of the earth-moving activity. The resident ECO must be trained by a professional palaeontologist in the recognition of fossils. If fossil material is later discovered it must be appropriately protected and the discovery reported to a palaeontologist for the removal thereof as per SAHRA legislation
DR08173	173_BP01	28°58'51.4" E	31°24'27.2" S	Dolerite	Nyandeni LM	Igneous/metamorphic rocks or Quaternary alluvial deposits underlie these zones, with no potential for fossils.
DR08173	173_BP02	28°59'04.9" E	31°22'51.7" S	Dolerite	Nyandeni LM	Igneous/metamorphic rocks or Quaternary alluvial deposits underlie these zones, with no potential for fossils.
DR08273	273_BP01N	28°26'23.4" E	31°46'39.1" S	Burgersdorp	KSD LM	All earth-moving activities are to be monitored by a palaeontologist. A monitoring report should be submitted to SAHRA after completion of the earth-moving activity. The resident ECO must be trained by a professional palaeontologist in the recognition of fossils. If fossil material is later discovered it must be appropriately protected and the discovery reported to a palaeontologist for the removal thereof as per SAHRA legislation
DR08273	273_BP02N	28°24'20.8" E	31°48'07.6" S	Burgersdorp	KSD LM	All earth-moving activities are to be monitored by a palaeontologist. A monitoring report should be submitted to SAHRA after completion of the earth-moving activity. The resident ECO must be trained by a professional palaeontologist in the recognition of fossils. If fossil material is later discovered it must be appropriately protected and the discovery reported to a palaeontologist for the removal thereof as per SAHRA legislation

Road No	B/Pit No	Longitude	Latitude	Geology	Municipality	Mitigation Measures
DR08273	273_BP03N	28°17'38.6" E	31°48'20.0" S	Burgersdorp	Engcobo LM	A permit for the collection and rescue of fossils must be obtained from SAHRA prior the construction phase. All earthworks activities are to be monitored by a resident palaeontologist. A monitoring report should be submitted to SAHRA after completion of the earth-moving activity
DR08273	273_BP04N	28°16'16.2" E	31°47'06.7" S	Dolerite	Engcobo LM	Igneous/metamorphic rocks or Quaternary alluvial deposits underlie these zones, with no potential for fossils.
DR08275	275_BP01N	28°27'14.1" E	31°53'2.2" S	Katberg	KSD LM	A permit for the collection and rescue of fossils must be obtained from SAHRA prior the construction phase. All earthworks activities are to be monitored by a resident palaeontologist. A monitoring report should be submitted to SAHRA after completion of the earth-moving activity
DR08281	281_BP01	28°39'08.6" E	31°44'05.3" S	Katberg	KSD LM	All earth-moving activities are to be monitored by a palaeontologist. A monitoring report should be submitted to SAHRA after completion of the earth-moving activity. The resident ECO must be trained by a professional palaeontologist in the recognition of fossils. If fossil material is later discovered it must be appropriately protected and the discovery reported to a palaeontologist for the removal thereof as per SAHRA legislation
DR08281	281_BP02	28°31'08.4" E	31°44'18.9" S	Katberg	KSD LM	All earth-moving activities are to be monitored by a palaeontologist. A monitoring report should be submitted to SAHRA after completion of the earth-moving activity. The resident ECO must be trained by a professional palaeontologist in the recognition of fossils. If fossil material is later discovered it must be appropriately protected and the discovery reported to a palaeontologist for the removal thereof as per SAHRA legislation
DR18033	18033_BP01N	28°47'50.1" E	32°03'14.7" S	Adelaide	Mbashe LM	All earth-moving activities are to be monitored by a palaeontologist. A monitoring report should be submitted to SAHRA after completion of the earth-moving activity. The resident ECO must be trained by a professional palaeontologist in the recognition of fossils. If fossil material is later discovered it must be appropriately protected and the discovery reported to a palaeontologist for the removal thereof as per SAHRA legislation
DR18033	18033_BP02N	28°39'53.8" E	31°58'46.6" S	Adelaide	KSD LM	A permit for the collection and rescue of fossils must be obtained from SAHRA prior the construction phase. All earthworks activities are to be monitored by a resident palaeontologist. A monitoring report should be submitted to SAHRA after completion of the earth-moving activity
DR18033	18033_BP03N	28°52'23.9" E	32°11'43.0" S	Ecca	Mbashe LM	A permit for the collection and rescue of fossils must be obtained from SAHRA prior the construction phase. All earthworks activities are to be monitored by a resident palaeontologist. A monitoring report should be submitted to SAHRA after completion of the earth-moving activity

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11. QUALIFICATIONS AND EXPERIENCE OF THE AUTHOR

Dr Gideon Groenewald has a PhD in Geology from the Nelson Mandela Metropolitan University (1996) and the National Diploma in Nature Conservation from the University of South Africa (1990). He specialises in research on South African Permian and Triassic sedimentology and macrofossils with an interest in biostratigraphy, and palaeoecological aspects. He has extensive experience in the locating of fossil material in the Karoo Supergroup and has more than 20 years of experience in locating, collecting and curating fossils, including exploration field trips in search of new localities in the southern, western, eastern and north-eastern parts of the country. His publication record includes multiple articles in internationally recognized journals. Dr Groenewald is accredited by the Palaeontological Society of Southern Africa (society member for 25 years).

Declaration of Independence

I, Gideon Groenewald, declare that I am an independent specialist consultant 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 my performing such work.

Dr Gideon Groenewald
Geologist

12. APPENDIX A - METHODOLOGY FOR ASSESSING THE SIGNIFICANCE OF IMPACTS

Although specialists will be given relatively free rein on how they conduct their research and obtain information, they will be required to provide their reports to the EAP in a specific layout and structure, so that a uniform specialist report volume can be produced.

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 a number of 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 a particular affected system (for ecological impacts) or a particular 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 9-1: 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 predicted 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 9-2: The severity rating scale

Impact severity (The severity of negative impacts, or how beneficial positive impacts would be on a particular 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

Overall Significance (The combination of all the above criteria as an overall significance)	
VERY HIGH NEGATIVE	**VERY BENEFICIAL**
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.	
HIGH NEGATIVE	**BENEFICIAL**
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.	
MODERATE NEGATIVE	**SOME BENEFITS**
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.	
LOW NEGATIVE	**FEW BENEFITS**
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.	
NO SIGNIFICANCE	
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 particular 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 particular development on people's psychological perspective of the environment.	