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DEPARTMENT OF PUBLIC WORKS

LESOTHO BORDER ROAD ENVIRONMENTAL SCOPING REPORT

PALAEONTOLOGICAL IMPACT ASSESSMENT: PHASE 1 REPORT

REVISION 01
REPORT NO: SAS 215207

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RECORD OF REVISIONS

REV. NO.	STATUS	DESCRIPTION OF REVISION	REV. DATE
00	Draft	Issued for approval	18/09/2015
01	Final	Public review of as part of the Scoping Report phase	29/02/2016
	Final	Issue for approval by authorities	

ENVIRONMENTAL IMPACT ASSESSMENT FOR THE LESOTHO BORDER ROAD INFRASTRUCTURE PROJECT

LIST OF REPORTS

REPORT TITLE	**REPORT NUMBER**
Scoping (Screening) Report	P14165/R3214
Environmental Impact Assessment Report	
Environmental Management Programme	
Water Use Licence Application Supporting Documents	
Environmental Management Programme for Borrow Areas	
Alien Vegetation Control Plan	SAS 215205
SUPPORTING REPORTS (SCOPING LEVEL)	
Floral Impact Assessment	SAS 214261_Flora
Faunal Impact Assessment	SAS 214261_Fauna
Wetland Impact Assessment	SAS 214261_Wet
Aquatic Ecology Impact Assessment	SAS 214261_Aqua
Land and Soil Capability Impact Assessment	SAS 215206
Heritage Impact Assessment	2015/JvS/003
Palaeontological Impact Assessment	SAS 215207

DECLARATION OF INDEPENDENCE

I, Dr. H Fourie, as the authorised heritage consultant hereby confirm my independence as a specialist and declare that I do not have any interest, be it business, financial, personal or other, in any proposed activity, application or appeal in respect of which I was appointed as the palaeontological impact assessment specialists in terms of the National Environmental Management Act, 1998 (Act No. 107 of 1998) and the National Heritage Resources Act (Act No. 25 of 1999), other than fair remuneration for worked performed, specifically in connection with the Palaeontological Impact Assessment: Phase 1 Report for the Lesotho / Free State Border Road Infrastructure Project Environmental Impact Assessment. I further declare that I am confident in the results of the studies undertaken and conclusions drawn as a result of it – as is described in my attached report.

Signed: 

Date: 29/02/2016

EXECUTIVE SUMMARY

Scientific Aquatic Services has facilitated the appointment of Dr H. Fourie, a palaeontologist, to undertake a Palaeontological Impact Assessment (PIA), Phase 1 Field study of the suitability of the proposed Lesotho Border Project over 224 farm portions; 4 towns, namely Fouriesburg, Ficksburg, Hobhouse and Wepener; 5 Local Municipalities, namely Dihlabeng, Setsoto, Mantsopa, Naledi and Mokohare; and 2 District Municipalities, namely Thabo Mofutsanyana and Xhariep, in the Free State Province. The applicant, Department of Public Works, proposes to develop the Lesotho Border road.

The scope of the study was to ascertain if any palaeontological sensitive material is present in the development area. This study will advise on the impact on fossil heritage mitigation or conservation necessary, if any.

The following conclusions were drawn during the desktop study:

During the survey it was found that the site is directly underlain by siltstone, sandstone, and mudstone of the Karoo Supergroup and is presently utilised, either as a patrol road of for various other uses. Recent structures are present such as bridges, as well as the Lesotho informal settlements and fences nearby. The site is located on a sloping topography with rocky outcrops (bedrock). The development of the road includes several projects that will need channels and trenches (storm water) to be dug and removal of overburden. Large sections of the road are present on sandstone.

The survey was done in both winter and summer, conditions were dry, cold and hot and the area is covered by overburden, vegetation and grassland. Due to time constraints, the survey did not find any fossils, but they are present as the construction of the road will take place on the Karoo Supergroup Formations more specifically the Stormberg Group (Molteno, Elliot, Clarens) and the Beaufort Group (Tarkastad Subgroup) known for its wealth of fossils. Both access roads and bridges may need upgrading. There is only one route option with a very high possible impact on palaeontological resources. The mitigation process should take place after vegetation clearance, but before grading the road.

The following conclusions were drawn following the baseline Phase 1 palaeontological assessment:

Formations present are part of the Karoo Supergroup. The Karoo Supergroup is renowned for its fossil wealth (Kent 1980, Visser 1989). Large areas of the southern African continent are covered by the Karoo Supergroup. An estimated age is 150 – 180 Ma. and a maximum thickness of 7000 m is reached in the south. Three formations overlie the Beaufort Group, they are the Molteno, Elliot and Clarens Formations. At the top is the Drakensberg Basalt Formation with its pillow lavas, pyroclasts, and basalts. (Kent 1980, Snyman 1996).

The Tarkastad Subgroup of the Beaufort Group consists of a lower predominantly arenaceous Katberg Sandstone Formation and a predominantly upper argillaceous Burgersdorp Formation (Kent 1980, Cole *et al*. 2004). It is Early Triassic in age. Fossils are abundant. Reptile, mammal-like reptile, trace fossils, dinosaurs, the earliest known tortoise in Gondwana, small, early mammals, and wood, are plentiful in the Molteno Formation (Snyman 1996, Visser 1998, Norman and Whitfield 2006). The Clarens Formation has a maximum thickness of 250 m in the south and consists of pink and yellow sandstone which is fine and never coarse. Cave and cliff formation is common. Fossils are scarce, but dinosaurs are found with the fish *Semionotus capensis* (Snyman 1996, Visser 1998, Norman and Whitfield 2006).

Criteria used (Fossil Heritage Layer Browser/SAHRA):

Rock Unit	Significance/vulnerability	Recommended Action
Tarkastad Subgroup	Very High	Field assessment and protocol for finds is required
Molteno Formation	Very High	Field assessment and protocol for finds is required

Elliot Formation	Very High	Field assessment and protocol for finds is required
Clarens Formation	High	Desktop study is required and based on the outcome of the desktop study, a field assessment is likely
Drakensberg Basalt	Low	No palaeontological studies are required however a protocol for finds is required

Perceived impact on these aspects of the ecology include, but are not limited to the following:

Consideration will be given during the impact assessment to impacts that the construction of the proposed linear development and associated border fence will have on the palaeontological resources.

Perceived impact on these aspects include, but are not limited to the following:

- Site clearance by use of earth moving equipment/machinery (front end loaders, excavators, graders, dozers) during construction within the Karoo Supergroup geological formations, especially the Tarkastad Subgroup, Molteno and Elliot Formations;
- The sealing-in or destruction of fossils during the realignment, construction and upgrade of the proposed linear development. Vehicle traffic and human disturbance could also lead to this impact

Key mitigation measures to consider during the scoping phase include:

- The impact of the development on fossil heritage is very high and high and therefore a field survey or further mitigation or conservation measures may be necessary for this development (according to SAHRA protocol). A Phase 2 Palaeontological Impact Assessment and or mitigation may be recommended. A Phase 2 Palaeontological Impact Assessment: Mitigation will include:

- Recommendations for the future of the site.
- Description of work done (including number of people and their responsibilities.
- A written assessment of the work done, fossils excavated, not removed or collected and observed.
- Conclusion reached regarding the fossil material.
- A detailed site plan.
- Possible declaration as a heritage site or Site Management Plan.

- The overburden and inter-burden consisting of Karoo rocks must be surveyed for fossiliferous outcrops (mudstone, shale). Special care must be taken during the digging, drilling, blasting and excavating of foundations, trenches, channels and footings and removal of overburden not to intrude fossiliferous layers.

During the EIA phase, the following plan of study will be followed:

This study aims to provide comment and recommendations on the potential impacts that the proposed development could have on the fossil heritage of the area and to state if any mitigation or conservation measures are necessary.

There is no objection to the development, but it was necessary to request a Phase 1 Palaeontological Impact Assessment: Field study to determine whether the development will affect fossiliferous outcrops as the palaeontological sensitivity is very high and high. A Phase 2 Palaeontological Mitigation may be required as the Phase 1 Palaeontological Assessment identified a fossiliferous formation (Karoo Supergroup).

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ACRONYMS AND ABBREVIATIONS

DAFF	Department of Agriculture Forestry and Fisheries
DM	District Municipality
DPW	National Department of Public Works
EIA	Environmental Impact Assessment
EMPr	Environmental Management Programme
GPS	Global Positioning System
NHRA	National Heritage Resources Act
NEMA	National Environmental Management Act
PHRA	Provincial Heritage Resource Authority
PIA	Palaeontological Impact Assessment
RSA	Republic of South Africa
SAHRA	South African Heritage Resources Agency
SANDF	South African National Defence Force

LIST OF UNITS

km	Kilometre
km/h	Kilometre per hour
m	Metre
m^2	Square metre
m^3	Cubic metre
m^3/s	Cubic metre per second

1 INTRODUCTION

1.1 BACKGROUND

The borderline between Lesotho and the Free State Province of South Africa is the international border for which both countries are responsible. The South African National Defence Force (SANDF) and Department of Agriculture Forestry and Fisheries (DAFF) respectively, have been entrusted with the guarding and protection of the border to ensure that diseases such as foot and mouth disease do not spread to South Africa.

According to a settlement agreement between National Departments, Free State Provincial Departments and Free State Agriculture, the National Department of Public Works (DPW) is responsible for the border fences and the border patrol road between South Africa and Lesotho. The patrol road has fallen into disrepair and cannot be effectively used for its intended purpose. Although the road has been in existence and used for several decades, the state has not secured rights to the land or the use thereof for the purpose. The road itself covers a distance of approximately 520 km, traversing approximately 262 properties.

The road is needed to enable the effective patrol of the border between South Africa and Lesotho by the SANDF and for use by the DAFF, to manage and control the possible trans-border spreading of animal disease, through managing and maintaining the border fence, amongst others.

To address the above need, the Defence Force as a client of the DPW, initiated a project that entails the preparation of a comprehensive site audit and obtaining of the required environmental authorizations that will form the basis for the redesign and re-construction of the road and to secure the required and defined servitude (Right of Way) in favour of the state for the road reserve. Therefore, the main objective of this project is to determine and establish the site for the road and to obtain “site clearance” for the road.

Environmental authorisation is required for the infrastructure components of the project. The purpose of the Environmental Impact Assessment (EIA) is to assess the components of the project that are listed activities by the National Environmental Management Act (NEMA) and the National Heritage Resources Act (Act No. 25 of 1999) and is intended for submission to the South African Heritage Resources Agency (SAHRA). The EIA process will provide the information that the environmental authorities require to decide whether the project should be authorised or not, and if so then under what conditions.

As part of this environmental assessment and authorisation process Dr H Fourie have been contracted by Scientific Aquatic Services to undertake a Palaeontological Impact Assessment (PIA): Phase 1, for the proposed development of:

- Realignment, reconstruction and upgrading of the service road
- Repair and Reconstruction of the border fence
- Utilisation of natural resources for the construction of the roadway from new and existing borrow pits
- Locations of construction camps
- Repair and reconstruction of bridges and small water crossings
- Repair and maintenance of access roads and fences.

Reference will be made to the specific developments accordingly (hereinafter collectively referred to as the “linear development”) and the specific aspects referred to as follows:

- the proposed quarries,
- the proposed access roads
- the proposed servitude;
- the proposed road; and
- the proposed fence system.

1.2 PURPOSE OF THIS REPORT

This report discusses and aims to provide the developer with information regarding the location of palaeontological material that will be impacted by the development. In the pre-construction phase, it is necessary for the developer to apply for the relevant permit from SAHRA.

1.3 DETAILS AND EXPERTISE OF THE SPECIALIST

Dr Fourie obtained a Ph.D from the Bernard Price Institute for Palaeontological Research (now ESI), University of the Witwatersrand. Her undergraduate degree is in Geology and Zoology. She specialises in vertebrate morphology and function concentrating on the Therapsid Therocephalia. For the past nine years she carried out field work in the Eastern Cape, Limpopo, Gauteng and Free State Provinces. Dr Fourie has been employed at the Ditsong: National Museum of Natural History in Pretoria (formerly Transvaal Museum) for 21 years.

1.4 STRUCTURE OF THIS REPORT

This specialist study is undertaken in compliance with Regulation 23(5) of GN 982. **Table 1** indicates how the requirements of Regulation 23(5) of GN 982 (Appendix 6) have been fulfilled in this report.

Table 1: Report content requirements in terms of Regulation 23(5) of GN 982 (Appendix 6)

Regulatory Requirements in terms of Regulation 323(5) of GN 982	Section of Report
(a) The person who prepared the report; and the expertise of that person to carry out the specialist study or specialised process	1.3
(b) a declaration that the person is independent	Page iv
(c) an indication of the scope of, and the purpose for which, the report was prepared	3.1
(d) the date and season of the site investigation and the relevance of the season to the outcome of the assessment	6.2
(e) a description of the methodology adopted in preparing the report or carrying out the specialised process	6
(f) the specific identified sensitivity of the site related to the activity and its associated structures and infrastructures	8.2
(g) and identification of any areas to be avoided, including buffers	8.2
(h) a map superimposing the activity including the associated structures and infrastructure on the environmental sensitivities of the site including areas to be avoided, including buffers	Figure 14
(i) a description of any assumptions made and any uncertainties or gaps in knowledge	4

Regulatory Requirements in terms of Regulation 323(5) of GN 982	Section of Report
(j) a description of the findings and potential implications of such findings on the impact of the proposed activity, including identified alternatives, on the environment	9
(k) any mitigation measures for inclusion in the Environmental Management Programme (EMPr)	9
(l) any conditions for conclusion in the environmental authorisation	5.1, Appendix 1
(m) any monitoring requirements for inclusion in the EMPr or environmental authorisation	To be defined in EIA phase investigation
(n) a reasoned opinion – (i) as to whether the proposed activity or portions thereof should be authorised; and (ii) if the opinion is that the proposed activity or portions thereof should be authorised, any avoidance, management and mitigation measures that should be included in the EMPr, and where applicable, the closure plan	To be defined in EIA phase investigation
(o) a description of any consultation process that was undertaken during the course of preparing the specialist report	Not applicable at this stage
(p) a summary and copies of any comments received during any consultation process and where applicable all responses thereto	To be defined in EIA phase investigation
(q) any other information requested by the competent authority	Not applicable at this stage

2 PROJECT BACKGROUND SUMMARY

2.1 LOCALITY

The extent of the border road stretches from remote areas to the south of the small town of Clarens in the northern parts of the Free State to the confluence of the Caledon and the Orange Rivers in remote areas to the east of the small town of Zastron in the southern parts of the Free State Province, and follows a course along the Caledon River past the towns of Fouriesburg, Ficksburg, Hobhouse and Wepener, covering a distance of approximately 520 km (**Figure 1**). The proposed linear development traverses two District Municipalities (DMs) namely the Thabo Mofutsanyana DM and the Xhariep DM.

The proposed linear development is situated within the jurisdiction of the following local municipalities:

- Dihlabeng Local Municipality;
- Setsoto Local Municipality;
- Mantsopa Local Municipality;
- Naledi Local Municipality; and
- Mokohare Local Municipality.

The proposed linear development also passes through six South African border posts, namely, the Caledonspoort Border Post, the Ficksburg Bridge Border Post, the Peka Bridge Border Post, the Maseru Bridge Border Post, the Van Rooyens Gate Border Post and the Makhaleng Bridge Border Post.

The proposed linear development traverses approximately 262 farm portions. Access to the border road during the construction and operational phases will take place by means of access roads affecting approximately 30 farm portions and a minimum of 262 right of way servitudes that will have to be secured and registered against the Title Deeds of the properties.

2.2 MAIN PROJECT COMPONENTS

The project forms a large integrated project with several components. The proposed infrastructure includes:

- **The repair, reconstruction and realignment of the service road;**

The proposed road will have a width of 4 m to ensure sufficient passing space for vehicle travelling in opposite directions at regular intervals. The road reserve with a width of 30 m will also be registered as a servitude for the road. The proposed 4 m wide road must carry military traffic to a design speed of 50 km/hr and various pavement design options are available such as a gravel wearing courses and where steep inclines occur where erosion is problematic, alternatives such as concrete pavement, concrete block pavement, concrete strips and grass blocks are being considered as part of the design.

- **The repair, reconstruction and construction of new bridges and small water crossings;**

Flow and connectivity of water in water resources are required and essential to maintain the function of the systems being crossed. Pavement methods will vary, depending on the availability of rock materials. Appropriately sized culverts will be placed at low points to ensure that the road crossing does not impede the flow of water in the systems. Small, full width concrete drifts will be constructed across minor streams. A minor stream is defined for purposes of this project as streams with a design flood volume of $Q<5$ m^3/s for the 1:5-year recurrence flood. Concrete culverts and clear span bridges will be constructed across major crossings. The drainage design will dictate the appropriate measures to be employed.

- **Alignment and construction of the border fence;**

Two fences will be constructed on both sides of the proposed road and where the road deviates from the Caledon River, a third fence, namely the outer fence along the river, will be constructed. Access to the river through gates will be given to the farm owners where applicable. It is proposed that a 1 km Clear View Fences be used at each Border Post affected by the linear development, on either side of the port of entry. However, the prior excludes Maseru Border Post, requiring a Clear View Fence of more than 1km on either side of entry.

- **Utilisation of natural resources for the construction of the roadway from new and existing borrow pits**;

The construction of the road will require suitable construction material, *inter alia*, to be sourced from identified well located and accessible (licensed) borrow pits.

- **Construction camps; and**

Construction camps will be positioned on land close to the proposed linear development. Materials and equipment used during the construction of the proposed linear development

will be temporarily stored in these areas, and rehabilitated once the construction of the proposed linear development has been completed. Exact locations of the construction camps will be determined later in the EIA phase.

- **Access roads.**
- Access routes will be used to gain access from the main roads to the proposed road (border road). Access routes will be upgraded, if they are in a poor condition. If there is not an access route and a route is required, this will be treated the same way as the proposed road i.e. a new road will be constructed across the path of least impact. This will be further investigated in more detail during the EIA phase.

2.3 ALTERNATIVES

The following project level alternatives will be assessed:

- Alternatives for the road alignment
- Road design alternatives; and
- The no project option.

For the construction camps, borrow pits and the service road, the specialist will identify any sensitive areas and deviations to avoid these will be proposed in consultation with the technical team.

Figure 1: Locality map of the study area.

3 TERMS OF REFERENCE

3.1 SCOPE OF THE STUDY

The purpose of this scoping report is to provide background desktop information and to discuss relevant findings and important areas. The scope of work for this assessment consisted of:

- Conducting desktop investigations of the area, in which literature, reports, databases and maps were studies, where available; and
- Site assessments of the proposed linear development.

Specific outcomes required from the report in terms of the palaeontological impact assessment include the flowing:

- To ascertain if any palaeontological sensitive material is present in the development area;
- Advise on the perceived impact on fossil heritage mitigation or conservation necessary, if any; and
- To present the plan of study for the EIA phase.

4 ASSUMPTIONS AND LIMITATIONS

The accuracy and reliability of the report may be limited by the following constraints:

- No subsurface investigation (i.e. excavations or sampling) were undertaken, since a permit from SAHRA is required for such activities.
- Most development areas have never been surveyed by a palaeontologist or geophysicist.
- Variable accuracy of geological maps and associated information: For large areas of terrain these maps are largely based on aerial photographs and some ground-thruthing.
- Inadequate sheet explanations for geological maps, with little or no attention paid to palaeontological issues in many cases, including poor locality information.
- Long sections of the existing road are densely vegetated by exotic tree growth, limiting visibility.
- The extensive relevant palaeontological “grey literature” - in the form of unpublished university theses, impact studies and other reports.
- Lack of rocky outcrops.
- Insufficient data from developer and exact lay-out plan for all structures.

5 LEGISLATION AND GUIDELINES CONSIDERED

5.1 NATIONAL HERITAGE RESOURCES ACT (ACT NO. 25 OF 1999)

The various categories of heritage resources recognised as part of the National Estate in Section 3 of the National Heritage Resources Act (NHRA) include, among others:

- geological sites of scientific or cultural importance;
- palaeontological sites;
- palaeontological objects and material, meteorites and rare geological specimens.

According to Section 35 of the National Heritage Resources Act, dealing with archaeology, palaeontology and meteorites:

(1) The protection of archaeological and palaeontological sites and material and meteorites is the responsibility of a provincial heritage resources authority.

(2) All archaeological objects, palaeontological material and meteorites are the property of the State.

(3) Any person who discovers archaeological or palaeontological objects or material or a meteorite in the course of development or agricultural activity must immediately report the find to the responsible heritage resources authority, or to the nearest local authority offices or museum, which must immediately notify such heritage resources authority.

(4) No person may, without a permit issued by the responsible heritage resources authority—

(a) destroy, damage, excavate, alter, deface or otherwise disturb any archaeological or palaeontological site or any meteorite;

(b) destroy, damage, excavate, remove from its original position, collect or own any archaeological or palaeontological material or object or any meteorite;

(c) trade in, sell for private gain, export or attempt to export from the Republic any category of archaeological or palaeontological material or object, or any meteorite; or

(d) bring onto or use at an archaeological or palaeontological site any excavation equipment or any equipment which assist in the detection or recovery of metals or archaeological and palaeontological material or objects, or use such equipment for the recovery of meteorites.

(5) When the responsible heritage resources authority has reasonable cause to believe that any activity or development which will destroy, damage or alter any archaeological or palaeontological site is under way, and where no application for a permit has been submitted and no heritage resources management procedure in terms of section 38 has been followed, it may—

(a) serve on the owner or occupier of the site or on the person undertaking such development an order for the development to cease immediately for such period as is specified in the order;

(b) carry out an investigation for the purpose of obtaining information on whether or not an archaeological or palaeontological site exists and whether mitigation is necessary

(c) if mitigation is deemed by the heritage resources authority to be necessary, assist the person on whom the order has been served under paragraph *(a)* to apply for a permit as required in subsection (4); and

(d) recover the costs of such investigation from the owner or occupier of the land on which it is believed an archaeological or palaeontological site is located or from the person proposing to undertake the development if no application for a permit is received within two weeks of the order being served.

Types and ranges of heritage resources as outlined in Section 3 of the National Heritage Resources Act (Act No.25 of 1999):

(i) objects recovered from the soil or waters of South Africa, including archaeological and palaeontological objects and material, meteorites and rare geological specimens.

This report adheres to the guidelines of Section 38 (1) of the National Heritage Resources Act (Act No. 25 of 1999).

Subject to the provisions of subsections (7), (8) and (9), any person who intends to undertake a development categorised as

(a) the construction of a road, wall, power line, pipeline, canal or other similar form of linear development or barrier exceeding 300 m in length;
(b) the construction of a bridge or similar structure exceeding 50 m in length;
(c) any development or other activity which will change the character of a site (see Section 38);
(d) the re-zoning of a site exceeding 10 000 m² in extent; (e) or any other category of development provided for in regulations by SAHRA or a Provincial Heritage Resource Authority (PHRA).

The NHRA requires that all heritage resources, that is, all places or objects of aesthetic, architectural, historical, scientific, social, spiritual, linguistic or technological value or significance, are protected. The Republic of South Africa (RSA) has a remarkably rich fossil record that stretches back in time for some 3.5 billion years and must be protected for its scientific value. Fossil heritage of national and international significance is found within all provinces of the RSA. South Africa's unique and non-renewable palaeontological heritage is protected in terms of the National Heritage Resources Act. According to this act, palaeontological resources may not be excavated, damaged, destroyed or otherwise impacted by any development without prior assessment and without a permit from the relevant heritage resources authority.

6 METHODOLOGY

6.1 PRELIMINARY INVESTIGATION

The main aim of the assessment process is to document resources in the development area and identify both the negative and positive impacts that the development brings to the receiving environment. The PIA therefore identifies palaeontological resources in the area to be developed and makes recommendations for protection or mitigation of these resources.

> *"palaeontological" means any fossilised remains or fossil trace of animals or plants which lived in the geological past, other than fossil fuels or fossiliferous rock intended for industrial use, and any site which contains such fossilised remains or traces.*

For this study, resources such as geological maps, scientific literature, institutional fossil collections, satellite images, aerial maps and topographical maps were used. It provides an assessment of the observed or inferred palaeontological heritage within the study area, with recommendations (if any) for further specialist palaeontological input where this is considered necessary.

6.2 FIELD SURVEY AND DOCUMENTATION

A Palaeontological Impact Assessment is generally warranted where rock units of low to very high palaeontological sensitivity are concerned, levels of bedrock exposure within the study area are adequate; large scale projects with high potential heritage impact are planned; and where the distribution and nature of fossil remains in the proposed area is unknown. The specialist will inform whether further monitoring and mitigation are necessary.

The palaeontological impact assessment field study was undertaken over the period of the 10th to the 14th of August 2015 and from the 12th till the 19th of November 2015. The walk through of the affected portion was done and photographs (in 7.1 mega pixels) were taken of the site with a digital Canon camera (PowerShot A470). A Global Positioning System (GPS) (Garmin eTrex 10) is used to record fossiliferous finds if the area is not covered with topsoil, subsoil, overburden, vegetation, grassland, trees and waste. The walk through did identify the Karoo Supergroup.

7 DESCRIPTION OF THE AFFECTED ENVIRONMENT

7.1 BACKGROUND TO PALAEONTOLOGY OF THE AREA

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

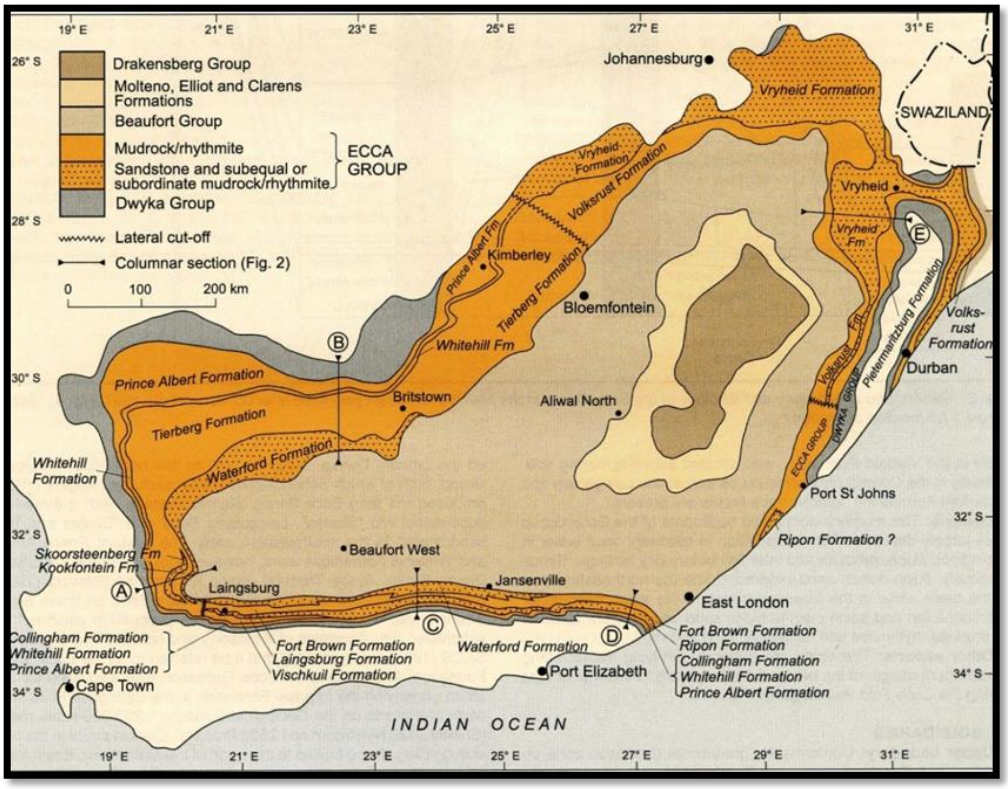

Figure 2: Extent of the Karoo Supergroup (Johnson 2009).

The rocks of the Karoo Supergroup are internationally acclaimed for their richness and diversity of fossils. The rocks of the Beaufort Group of South Africa cover approximately one-third of the land surface and have yielded an abundance of well-preserved therapsids and other tetrapods which have been used to subdivide this Group into eight faunal Assemblage Zones.

The geological history of the Free State Province spans a total of 3600 million years, including some of the major events that lead to the deposition of a wealth of economically

important sequences of rocks. The oldest rocks are associated with the basement granites of the Vredefort Dome. Cyanobacteria have been described from the conglomerates of the Witwatersrand Supergroup, stromatolites from the Ventersdorp Supergroup, petrified wood, trace fossils, fish, insects, tetrapods, invertebrates, and plants from the Permian Ecca, and the main coal producing Vryheid Formation (Groenewald and Groenewald 2014).

Fossils of *Lystrosaurus, Thrinaxodon, Moschorhinus, Galesaurus* and the small amphibian *Lydekkerina* are frequently preserved as articulated skeletons within well-defined blue-grey or red-brown calcareous nodules present in the *Lystrosaurus* Assemblage Zone (**Figure 3**). *Procolophon* has been recorded from burrow casts. The *Cynognathus* Assemblage Zone is characterised by the presence of *Cynognathus, Diademodon* and *Kannemeyeria.* Fossil fishes, invertebrates, plants and trace fossils may also occur in both biozones (Rubidge 1995).

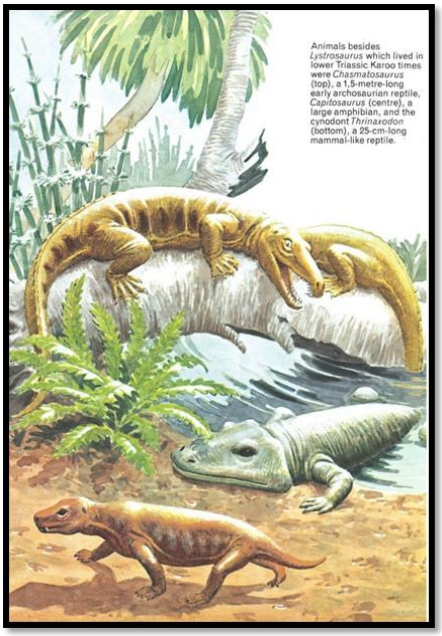

Figure 3: Typical Karoo scene during the *Lystrosaurus* Assemblage Zone times (Cluver 1978).

Lystrosaurus is a dicynodont (mammal-like reptile) (**Figure 4**) with a distinctive, down-turned snout, lending the skull its characteristic shape. It is one of three genera that survived the End-Permian extinction event. *Cynognathus* was a large, bear sized, carnivorous conodont (Cole *et al.* 2004).

Fossil localities such as Dewetsdorp and Rouxville near the Lesotho Border Road have yielded rich fossil finds such as *Procolophon trigoniceps, Lystrosaurus* and *Proterosuchus vanhoepeni* in the *Lystrosaurus* Assemblage Zone. Bokpoort in the Wepener district is the focus of a study on the end-Permian mass extinction event. In the *Cynognathus* Assemblage Zone, Aliwal North and Rouxville, *Mesosuchus browni, Melinodon simus, Cynognathus, Diademodon tetragonus* and *Kannemeyeria simocephalus* fossils are found (Kitching 1977). Fossils in the *Lystrosaurus* Assemblage Zone can be spaced quite close together with as little as 3 m in between finds as seen in the Groot Brak River dongas near Middelburg (personal observation).

Figure 4: Skull of *Lystrosaurus* (H. Fourie).

The Molteno Formation is Late Triassic in age and has an abundance of gymnosperms, insects such as cockroaches, beetles, hemiptera and dragonflies. Plant fossils dominate the fossil assemblage of the Molteno Formation. Insects, *Dicroidium*

, Spenobaieria and *Heidiphyllum* are abundant (Cole *et al.* 2004). Dinosaur tracks are also present. The diminishing synapsid populations were being superseded by dinosaurs such as the long-necked *Antetonitis* and *Aardonyx* of the early Elliot Formation times. In a unique find in the Golden Gate Highlands National Park, the upper Elliot Formation has yielded the oldest known *Massospondylus* dinosaur eggs in the world (Groenewald and Groenewald 2014). Amphibians, non-dinosaurian archosaurs, theropod dinosaurs, dinosaur eggs, therapsids, mammaliaformes, crocodilomorphs, and chelonia make up the fauna of the Elliot and Clarens Formations (Chinsamy-Turan 2012, Groenewald 1986). Most recently, the fossil bones of a plant-eating dinosaur (Highland Giant) have been discovered near the Lesotho border in Clarens and a new species of *Eucnemesaurus* in Aliwal North from the lower Elliot Formation. The Late Triassic to Early Jurassic Elliot and Clarens formations of Lesotho has yielded richly-diverse vertebrate track assemblages.

Fossils in South Africa mainly occur in rocks of sedimentary nature and not in rocks from igneous or metamorphic nature. Therefore, if there is the presence of Karoo Supergroup strata the palaeontological sensitivity is generally low to very high, but here locally very high for the Tarkastad Subgroup, the Molteno and Elliot Formations and high for the Clarens Formation, and low for the Drakensberg Basalts.

Description of the rock units:

Large areas of the southern African continent are covered by the Karoo Supergroup (**Figures 2, 6, and 7**). It covers older geological formations with an almost horizontal blanket. Several basins are present with the main basin in the central part of south Africa and several smaller basins towards Lebombo, Springbok Flats and Soutpansberg. An estimated age is 150 – 180 Ma. And a maximum thickness of 7000 m is reached in the south. Three

formations overlie the Beaufort Group, they are the Molteno, Elliot and Clarens Formations. The Elliot Formation is also known as the Red Beds and the old Cave Sandstone is known as the Clarens Formation. At the top is the Drakensberg Basalt Formation with its pillow lavas, pyroclasts, etc. (Kent 1980, Snyman 1996).

The Tarkastad Subgroup of the Beaufort Group consists of a lower predominantly arenaceous Katberg Sandstone Formation and a predominantly upper argillaceous Burgersdorp Formation (Cole *et al*. 2004, Kent 1980). It is Early Triassic in age. This Subgroup is absent in the west. A maximum thickness of 900 m can be measured for the Katberg sandstone. Red, bluish and green mudstone, siltstone and fine- to medium-grained sandstone lenses are characteristic of the Burgersdorp Formation. This Subgroup marks the boundary of the Plaeozoic and the Mesozoic (Snyman 1996, Visser 1998). Fossil mammal-like reptiles are present (Norman and Whitfield 2006).

The rocks of the Beaufort Group were deposited by large, northward-flowing, meandering rivers in which sand accumulated, flanked by extensive floodplains where periodic floods deposited mud. Following the end-Permian mass extinction, the meandering rivers were replaced by multi-channelled, braided river systems that deposited sand rather than the silts and muds of the earlier meandering rivers. The sandstone-dominated strata deposited by these braided rivers, known as the Katberg Formation, can be as much as 1000 m thick. As time passed, the high-energy, braided rivers of the Katberg Formation reverted to a meandering form, possibly reflecting recovery of the vegetation. These sedimentary deposits are the Burgersdorp Formation (McCarthy and Rubidge 2005).

A short period of uplift and erosion followed. This was short-lived, however, and sedimentation was renewed, forming the rocks of the Stormberg Group on top of the slightly eroded rocks. The rocks of the Stormberg Group reflect a gradual change to increasingly more arid conditions. The Molteno Formation rocks were deposited mainly by large braided rivers. A change in climate is reflected in the floodplain sediments of the Elliot Formation. In addition to meandering river deposits, salt-pan deposits are found, containing fossilised lungfish, as well as fossilised, thick, arid-zone soil layers. Warming and aridity increased towards the end of the deposition of the Elliot Formation. By the time of deposition of the rocks of the upper Clarens Formation, true desert conditions prevailed, with the development of an extensive sand sea (McCarthy and Rubidge 2005).

Further to the lithostratigraphy, the Beaufort Group is divided into biostratigraphic units. The *Lystrosaurus* Assemblage Zone includes the Katberg Formation and the lower third of the Burgersdorp Formation and is characterised by the abundance of *Lystrosaurus* in association with *Procolophon.* Overlying this biozone is the uppermost *Cynognathus* Assemblage Zone characterised by *Cynognathus, Diademodon* and *Kannemeyeria* and occupying the upper two-thirds of the Burgersdorp Formation (Rubidge 1995).

The Molteno Formation consists of a collection of quartzitic sandstones and grey shale, also present are basal conglomerate, pebbles, and siltstone. Plant and insect fossils are common with coal beds. This formation is relatively thin, as thin as 100 – 700 m. The cool climate led to a lush plant growth with *Dicroidium* ferns (**Figure 5**), arthopoda, mollusca, wood in the sandstone, and fresh water fish (Norman and Whitfield 2006, Snyman 1996, Visser 1998).

Figure 5: Example of a Molteno plant fossil, TM3289 (H. Fourie) (Scale = 3cm).

The Elliot Formation overlies the Molteno Formation and has a maximum thickness of 500 m. It consists of siltstone, mudstone and sandstone. Oxygenation of the iron coloured the sediments red during and after deposition. Reptile, mammal-like reptile, trace fossils, dinosaurs, the earliest known tortoise in Gondwana, small, early mammals, and wood, are plentiful (Norman and Whitfield 2006, Snyman 1996, Visser 1998).

The Clarens Formation has a maximum thickness of 250 m in the south. Pink and yellow sandstone is fine and never coarse. Cave and cliff formation is common. Fossils are scarce, but dinosaurs are found with the fish *Semionotus capensis* (Norman and Whitfield 2006, Snyman 1996, Visser 1998).

Around 190 Ma years ago the first basalt magma created the Drakensberg Basalt Formation through shield vulcanos. The resultant Drakensberg covers an area of 140 000 km² peaking at nearly 3500 m above sea level. The lava is dark grey to black, but weathers chocolate brown with abundant whitish amygdales. It is early Jurassic in age and here locally known as the Maluti (Norman and Whitfield 2006, Snyman 1996, Visser 1998).

Dolerite dykes (Jd) occur throughout the Karoo Supergroup. Structural geological features such as dykes and faults can have a measurable influence on ground water flow and mass transport.

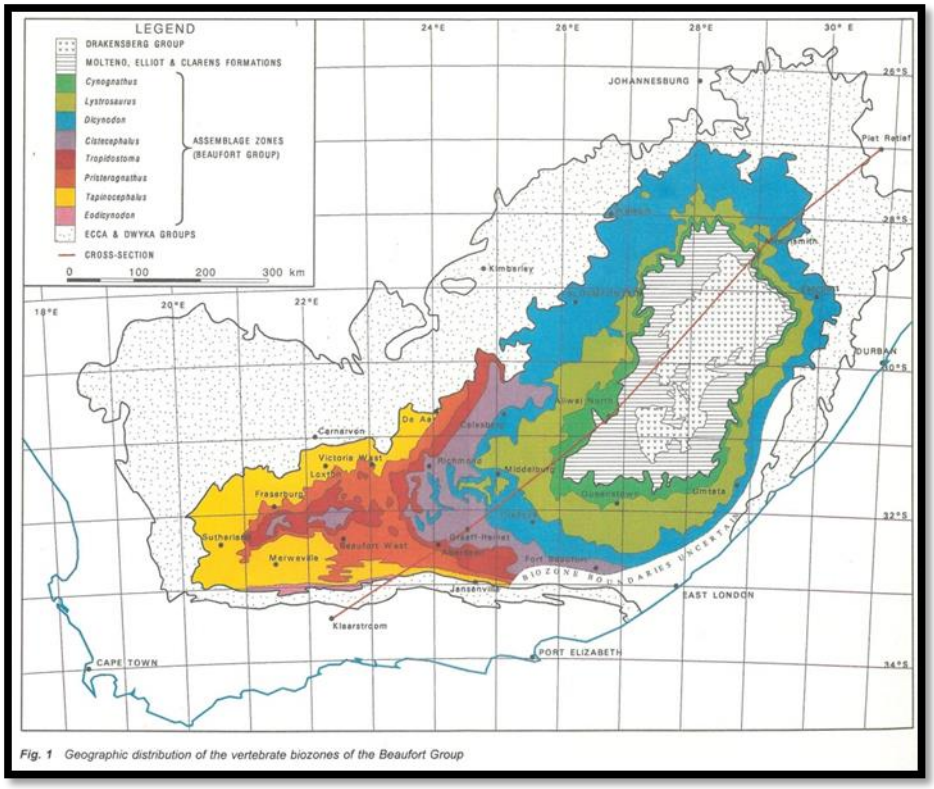

Figure 6: Geographic distribution of the vertebrate bio-zones of the Beaufort Group.

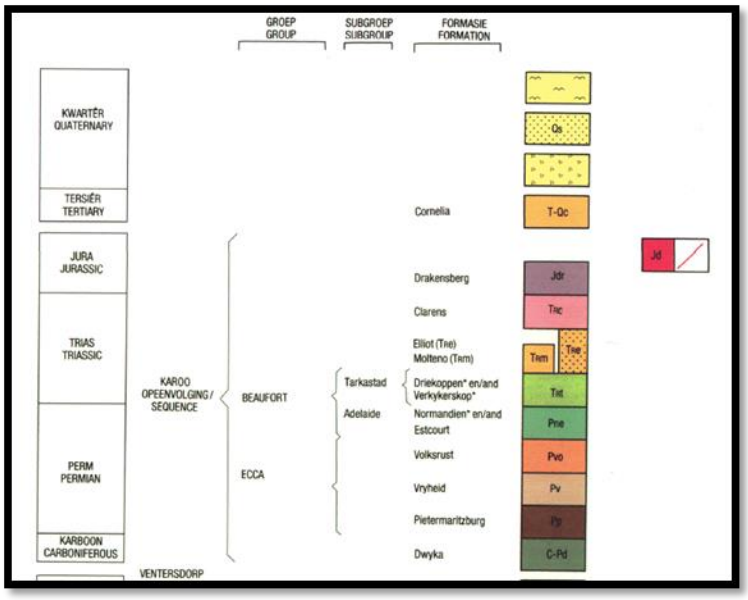

Figure 7: Lithostratigraphic column of the Karoo Supergroup (Muntingh 1992).

8 PALAEONTOLOGICAL PHASE 1 ASSESSMENT RESULTS

During the survey it was found that the site is directly underlain by siltstone, sandstone, and mudstone of the Karoo Supergroup and is presently utilised. The geology was obtained from map 1:100 000, Geology of the Republic of South Africa (Visser 1984).

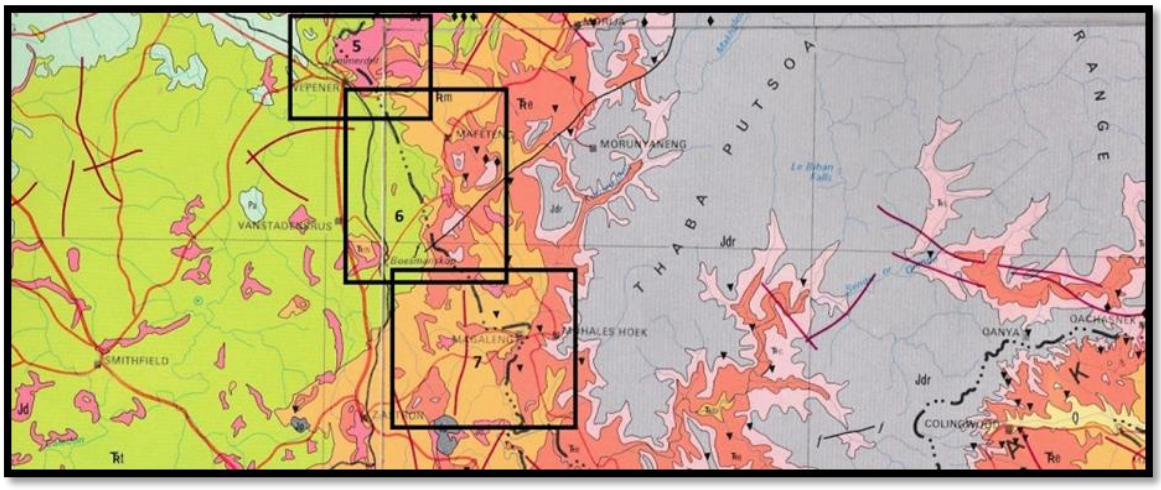

Figure 8: The geology of the development area – southern section.

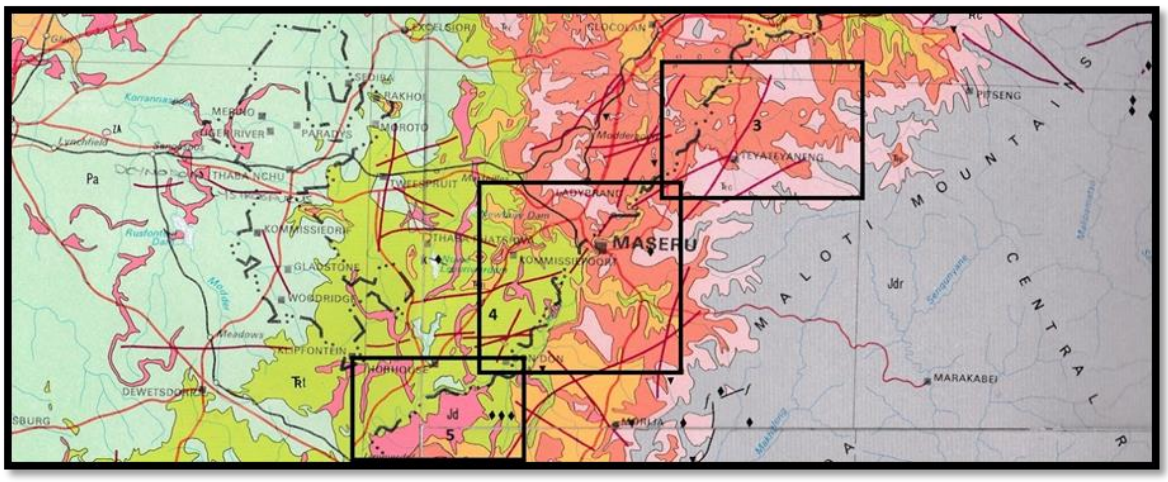

Figure 9: Geology of the middle section.

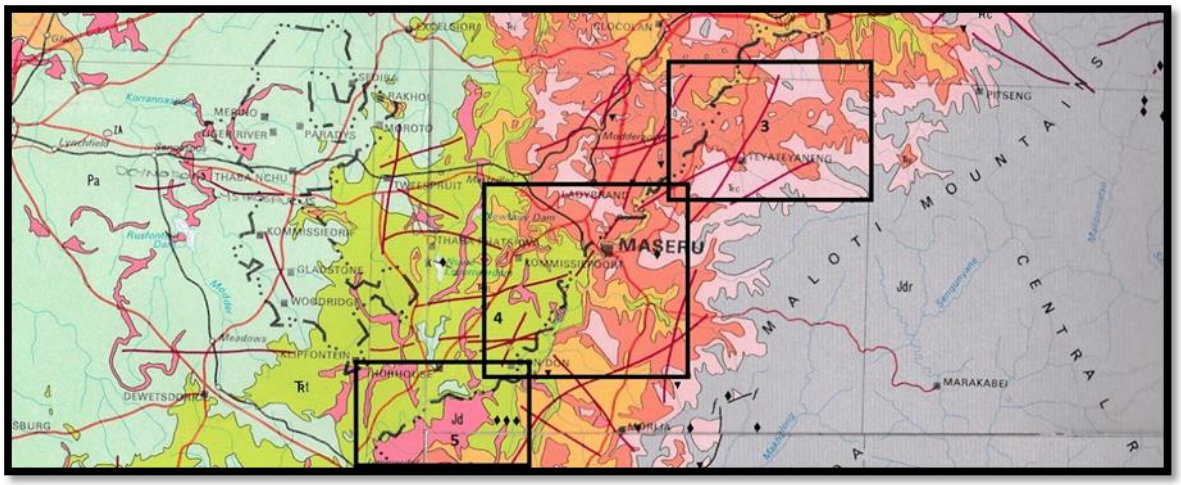

Figure 10: Geology of the northern section.

Legend to Map and short explanation.
Jdr – (purple) Basalt. Drakensberg Group, Karoo Supergroup.
Kc – (pink) Sandstone, siltstone. Clarens Formation, Stormberg Group, Karoo Supergroup.
Ke – (orange) Mudstone, sandstone. Elliot Formation, Stormberg Group, Karoo Supergroup.
Km – (light orange) Sandstone, mudstone, shale. Molteno Formation, Stormberg Group, Karoo Supergroup.
Kt – (green) Mudstone, sandstone. Tarkastad Subgroup, Beaufort Group, Karoo Supergroup.
Jd – Karoo Dolerite suite (dark pink).
…… – (black) Lineament (Possible dyke).
--f— Fault.

Formations present are part of the Karoo Supergroup. The Karoo Supergroup is renowned for its fossil wealth (Kent 1980, Visser 1989). Large areas of the southern African continent are covered by the Karoo Supergroup. An estimated age is 150 – 180 Ma. and a maximum thickness of 7000 m is reached in the south. Three formations overlie the Beaufort Group, they are the Molteno, Elliot and Clarens Formations. At the top is the Drakensberg Basalt Formation with its pillow lavas, pyroclasts, and basalts. (Kent 1980, Snyman 1996).

The Tarkastad Subgroup of the Beaufort Group consists of a lower predominantly arenaceous Katberg Sandstone Formation and a predominantly upper argillaceous Burgersdorp Formation (Kent 1980, Cole *et al*. 2004). It is Early Triassic in age. Fossils are abundant. Reptile, mammal-like reptile, trace fossils, dinosaurs, the earliest known tortoise in Gondwana, small, early mammals, and wood, are plentiful in the Molteno Formation (Snyman 1996, Visser 1998, Norman and Whitfield 2006). The Clarens Formation has a maximum thickness of 250 m in the south and consists of pink and yellow sandstone which is fine and never coarse. Cave and cliff formation is common. Fossils are scarce, but dinosaurs are found with the fish *Semionotus capensis* (Snyman 1996, Visser 1998, Norman and Whitfield 2006).

Fossils in South Africa mainly occur in rocks of sedimentary nature and not in rocks from igneous or metamorphic nature. Therefore, if there is the presence of Karoo Supergroup strata the palaeontological sensitivity can generally be low to very high, and here locally very high for the Elliot Formation, Molteno Formation and Tarkastad Subgroup, and high for the Clarens Formation (SG 2.2 SAHRA APMHOB, 2012).

8.1 FIELD OBSERVATIONS

Recent structures are present such as bridges, as well as the Lesotho informal settlements and fences nearby. The site is located on a sloping topography. The development of the road includes several projects that will need foundations, footings, channels and trenches to be dug.

The road and its shoulder are currently not well maintained, but covered with grassland, topsoil and overburden. Sandstone outcrops (**Figure 11**) are present (Southern section, near Zastron). This type of outcrop will need mitigation as it is right on the shoulder of the road.

Figure 11: The presence of Sandstone outcrops between Wepener and Zastron.

Both the Molteno and Elliot Formations are present between Wepener and Zastron and the Tarkastad Subgroup is present within the Wepener area (**Figure 12**).

Figure 12: View to show embankment with Elliot Formation and sloping topography near Ladybrand.

Dolerite of the Karoo Supergroup is present with the Tarkastad Subgroup between Hobhouse and Wepener, the Tarkastad Subgroup, the Molteno, Elliot and Clarens Formations are present in Ladybrand, and the Elliot and Molteno Formations are present between Ficksburg and Ladybrand. The Tarkastad Subgroup, and the Molteno and Elliot Formations are present in the Northern section of the route, close to Fouriesburg. The section between Fouriesburg and Clarens has additionally the Clarens Formation as well as the Drakensberg Basalt.

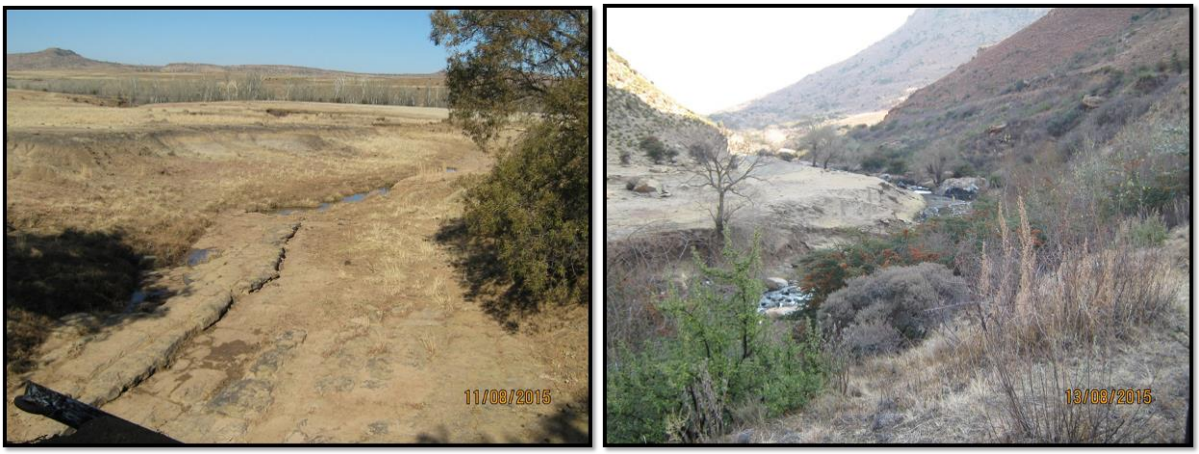

Figure 13: Left: View of site showing the Molteno Formation outcrop in a side stream (between Hobhouse and Wepener). Border with woody area in background. Right: View towards Lesotho close between Clarens and Fouriesburg.

The geological formations consist mainly of flat-lying sandstones, shales and subsidiary siltstones and mudstones. The survey did not find any fossils. Most of the site is directly underlain by stratigraphic units belonging to the upper part of the Karoo Supergroup. It may be possible that the grading of the road will intrude into the fossiliferous sandstone, mudstone, siltstone or shale. A complete walk through was not possible due to time

constraints, it would take up to 29 months to do an in depth survey of the area. It is also assumed that access roads will have to be upgraded to get machinery and workers on site. Bridges also need upgrading and as none of them exceed 50 m in length they fall within the scope of this report.

There is some concern with the property due to the presence of the Karoo Supergroup. The depth of the Formation can be verified with geological cores. The outcrops, topsoil, subsoil and overburden must be surveyed for fossils and Mitigation is needed for the fossiliferous layers. Bedrock exposure is very good and most of the road surface is on sandstone. Mining, urban settlements, a cemetery, poplar plantations, the river, fences, and steep cliffs are also present next to the road.

It is recommended to wait for the response from SAHRA on the Phase 1 Field study (this report), and if mitigation is recommended then SAHRA protocol must be followed. Alternatives will not be feasible as all proposed development portions and surrounding areas are on the Karoo Supergroup

8.2 SENSITIVITY

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

Rock Unit	Significance/vulnerability	Recommended Action
Tarkastad Subgroup	Very High	Field assessment and protocol for finds is required
Molteno Formation	Very High	Field assessment and protocol for finds is required
Elliot Formation	Very High	Field assessment and protocol for finds is required
Clarens Formation	High	Desktop study is required and based on the outcome of the desktop study, a field assessment is likely
Drakensberg Basalt	Low	No palaeontological studies are required however a protocol for finds is required

Impact: very high for the Tarkastad Subgroup, Molteno and Elliot Formations, high for the Clarens Formation and low for the Drakensberg Basalt Formation. There are significant fossil resources that may be impacted by the development (mudstone, shale) and if destroyed are no longer available for scientific research or other public good.

8.2.1 INVENTORY OF IDENTIFIED PALAEONTOLOGICAL SITES

The following figure and table presents areas identified during the site assessment that could have a high impact on palaeontological resources.

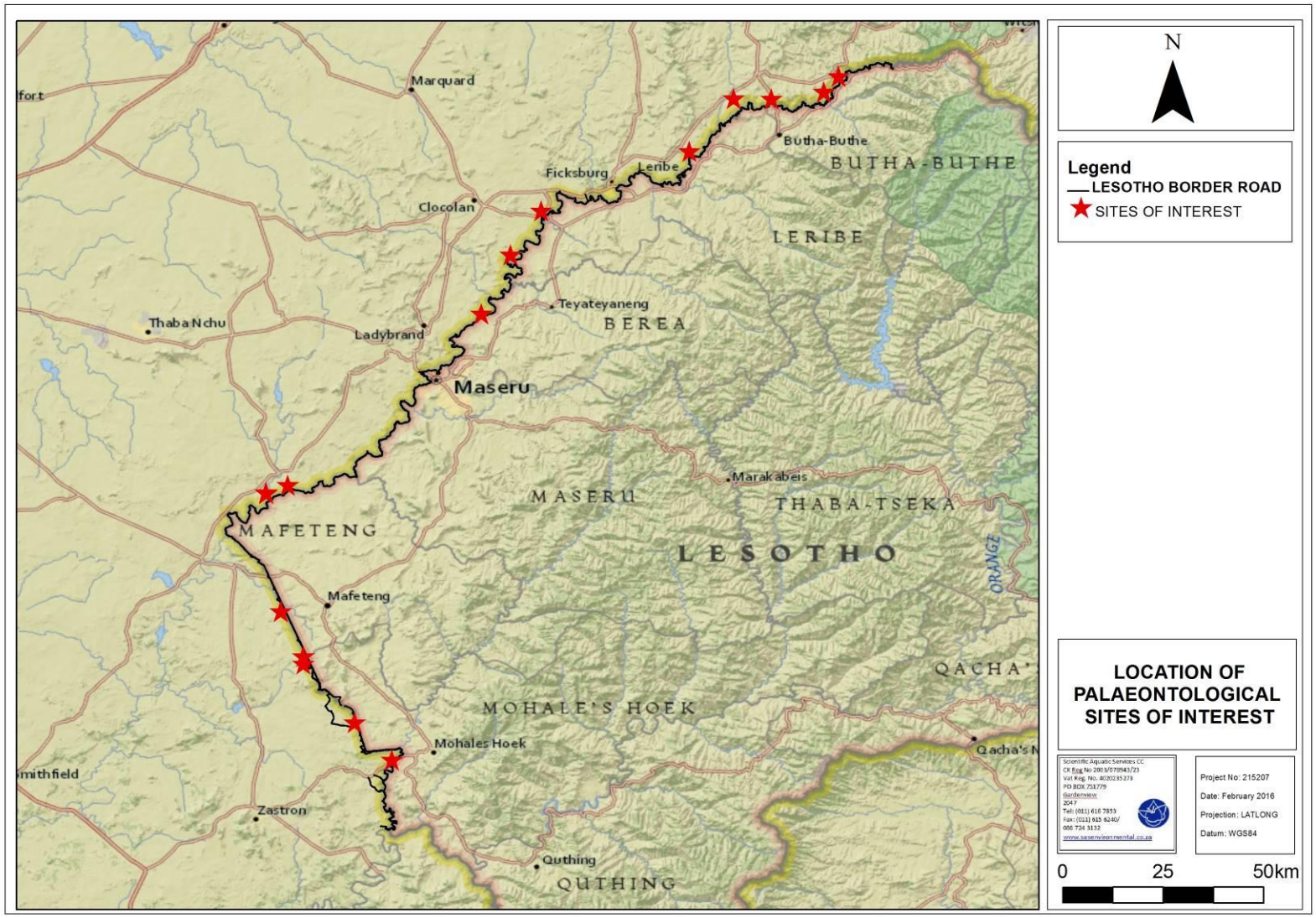

Figure 14: The location of identified Palaeontological sites along the proposed linear development.

Table 3: Sites identified during the site assessment with potential impact ratings.

Site	Photograph	Location and Description
1		S 30˚10' 2.22" E 27˚ 23' 4.67" 1419 m Old Zastron District Sandstone outcrop next to road. Geology: Molteno and Elliot Formations. Potential impact: Very High. The Elliot Formation is on the Triassic-Jurassic boundary and can provide insight into a mass extinction event.
2		S 30˚ 05' 0.67" E 27˚ 18' 3.19" 1518 m Klaarwater basecamp. Road mostly sandstone sand. Zastron. Geology: Molteno and Elliot Formations. Potential impact: Very High. The Elliot Formation also provides evidence for early dinosaur diversification on Gondwana.
3		S 29˚ 57' 5.47" E 27˚ 11' 8.00" 1660 m Road very gravelly with scattered dolerite and sandstone flakes. This section is to the south of the Makhaleng Bridge border post. Zastron. Geology: Molteno and Elliot Formations. Potential impact: Very High.

Site	Photograph	Location and Description
4		S 29˚ 56' 7.22" E 27˚ 11' 8.99" 1619 m The road continues south over the hill. zastron. Geology: Molteno and Elliot Formations. Potential impact: Very High. The Molteno Formation provides information on Triassic biota.
5		S 29˚ 50' 2.13" E 27˚ 08' 8.27" 1504 m This section of road is on sandstone. It is a straight section with a well maintained fence next to it. Seville. South of Wepener. Old Wepener District. Geology: Tarkastad Subgroup, Molteno and Elliot Formations. Potential impact: Very High. The Tarkastad Subgroup provides information on the Late Permian Mass Extinction Event.
6		S 29˚ 50' 2.13" E 27˚ 08' 8.27" 1504 m Wepener. Geology: Tarkastad Subgroup, Molteno and Elliot Formations. 6 km from border road. Potential impact: Very High. Sandstone thickness will vary and may contain fossils – Burgersdorp Formation. Red mudstones – Burgersdorp Formation (*Cynognathus* Assemblage Zone).

Site	Photograph	Location and Description
7		Wilgedraai basecamp. North of Wepener. Very sandy road surface. Wepener. Geology: Tarkastad Subgroup, Molteno and Elliot Formations. Potential impact: Very High.
8		S 29˚ 33' 5.16" E 27˚ 09' 5.19" 1444 m Kroonbult near Hobhouse. This section of road is to the north. Lots of agates on road surface. Below surface is a hard bank of sandstone. Block 5. Old Wepener District. Geology: Tarkastad Subgroup and Karoo Dolerite. Potential impact: Very High, but Zero for the Dolerite.
9		S 29˚ 34' 3.55" E 27˚ 06' 8.33" 1438 m Near Hobhouse. Sandstone bank in side stream of river. Geology: Tarkastad Subgroup and Karoo Dolerite. Potential impact: Very High, but Zero for the Dolerite.

Site	Photograph	Location and Description
10		S 29˚ 34' 8.85" E 27˚ 06' 9.76" 1446 m Section north of Hobhouse. Tarkastad Subgroup is present below road. Palingkloof Member. Dolerite on road surface. Old Hobhouse and Ladybrand Districts. Geology: Tarkastad Subgroup, the Molteno, Elliot and Clarens Formations. Potential impact: Very High, but High for the Clarens Formation.
11		S 29˚ 10' 1.39" E 27˚ 35' 5.96" 1499 m Waverley. North of Ladybrand. Old Ladybrand District. Geology: Molteno and Elliot Formations. Potential impact: Very High.
12		S 29˚ 02' 4.22" E 27˚ 39' 0.74" 1518 m Caledonia close to Clocolan. Road on sandstone. Old Ficksburg and Clocolan Districts. Geology: Tarkastad Subgroup, Molteno and Elliot Formations. Potential impact: Very High.

Site	Photograph	Location and Description
13		S 28˚ 56' 9.73" E 27˚ 43' 6.97" 1529 m Road just south of Peka Bridge Border Post. Ficksburg Geology: Tarkastad Subgroup, Molteno and Elliot Formations. Potential impact: Very High.
14		S 28˚ 48' 8.87" E 28˚ 03' 3.80" 1580 m Francois. Ficksburg. Geology: Tarkastad Subgroup, Molteno and Elliot Formations. Potential impact: Very High.
15		S 28˚ 48' 8.87" E 28˚ 03' 3.80" 1580 m Road surface over sandstone bank. Francois. Kommandonek. North of Ficksburg. Geology: Tarkastad Subgroup, Molteno and Elliot Formations. Potential impact: Very High.
16		S 28˚ 41' 7.11" E 28˚ 14' 3.89" 1624 m Camelrock on the Caledonspoort Border Post. Road on steep hill. Sandstone surface. Old Fouriesburg District. Geology: Molteno, Elliot and Clarens Formations, Drakensberg Basalts. Potential Impact: Very High, but

Site	Photograph	Location and Description
		High for the Clarens and Zero for the Drakensberg.
17		S 28˚ 41' 3.11" E 28˚ 09' 0.55" 1588 m This section of road is north of the Bethlehem Sand & Klip mine. Old Fouriesburg District. Geology: Molteno, Elliot and Clarens Formations, Drakensberg Basalts. Potential Impact: Very High, but High for the Clarens and Zero for the Drakensberg
18		S 28˚ 40' 9.72" E 28˚ 21' 7.75" 1645 m Near Fouriesburg and Surrender Hill. Glen Lyon. Geology: Molteno, Elliot and Clarens Formations, Drakensberg Basalts. Potential Impact: Very High, but High for the Clarens and Zero for the Drakensberg
19		S 28˚ 38' 5.29" E 28˚ 23' 7.92" 1691 m Clarens Road S 1356. Geology: Molteno, Elliot and Clarens Formations, Drakensberg Basalts. Potential Impact: Very High, but High for the Clarens and Zero for the Drakensberg

9 DESCRIPTION OF PERCEIVED IMPACTS ASSOCIATED WITH THE INFRASTRUCTURE

Consideration will be given during the impact assessment to impacts that the construction of the proposed linear development and associated border fence will have on the palaeontological resources.

Perceived impact on these aspects include, but are not limited to the following:

- Site clearance by use of earth moving equipment/machinery (front end loaders, excavators, graders, dozers) during construction within the Karoo Supergroup geological formations, especially the Tarkastad Subgroup, Molteno and Elliot Formations;
- the sealing-in or destruction of fossils during the realignment, construction and upgrade of the proposed linear development. Vehicle traffic and human disturbance could also lead to this impact.

Key mitigation measures to consider during the scoping phase include:

- The impact of the development on fossil heritage is very high and high and therefore a field survey or further mitigation or conservation measures may be necessary for this development (according to SAHRA protocol). A Phase 2 Palaeontological Impact Assessment and or mitigation may be recommended. A Phase 2 Palaeontological Impact Assessment: Mitigation will include:
  - Recommendations for the future of the site.
  - Description of work done (including number of people and their responsibilities.
  - A written assessment of the work done, fossils excavated, not removed or collected and observed.
  - Conclusion reached regarding the fossil material.
  - A detailed site plan.
  - Possible declaration as a heritage site or Site Management Plan.
- The overburden and inter-burden consisting of Karoo rocks must be surveyed for fossiliferous outcrops (mudstone, shale). Special care must be taken during the digging, drilling, blasting and excavating of foundations, trenches, channels and footings and removal of overburden not to intrude fossiliferous layers. Protocol is attached (Appendix 1).

10 CONCLUSION

During the survey it was found that the site is directly underlain by siltstone, sandstone, and mudstone of the Karoo Supergroup and is presently utilised, either as a patrol road of for various other uses. Recent structures are present such as bridges, as well as the Lesotho informal settlements and fences nearby. The site is located on a sloping topography with rocky outcrops (bedrock). The development of the road includes several projects that will need channels and trenches (storm water) to be dug and removal of overburden. Large sections of the road are present on sandstone.

The survey was done in both winter and summer, conditions were dry, cold and hot and the area is covered by overburden, vegetation and grassland. Due to time constraints, the

survey did not find any fossils, but they are present as the construction of the road will take place on the Karoo Supergroup Formations more specifically the Stormberg Group (Molteno, Elliot, Clarens) and the Beaufort Group (Tarkastad Subgroup) known for its wealth of fossils. Both access roads and bridges may need upgrading. There is only one route option with a very high possible impact on palaeontological resources. The mitigation process should take place after vegetation clearance, but before grading the road.

11 PLAN OF STUDY FOR THE EIA PHASE

11.1 METHOD OF IMPACT ASSESSMENT

This study aims to provide comment and recommendations on the potential impacts that the proposed development could have on the fossil heritage of the area and to state if any mitigation or conservation measures are necessary (see Appendix 1).

In order for the Environmental Assessment Practitioner (EAP) to allow for sufficient consideration of all environmental impacts, impacts are assessed using a common, defensible method of assessing significance that will enable comparisons to be made between risks/impacts and will enable authorities, stakeholders and the client to understand the process and rationale upon which risks/impacts have been assessed. The method to be used for assessing risks/impacts is outlined in the sections below.

The first stage of the risk/impact assessment is the identification of environmental activities, aspects and impacts. This is supported by the identification of receptors and resources, which allows for an understanding of the impact pathway and an assessment of the sensitivity to change. The definitions used in the impact assessment are presented below.

- An **activity** is a distinct process or task undertaken by an organisation for which a responsibility can be assigned. Activities also include facilities or infrastructure that is possessed by an organisation.
- An **environmental aspect** is an 'element of an organizations activities, products and services which can interact with the environment'[1]. The interaction of an aspect with the environment may result in an impact.
- **Environmental risks/impacts** are the consequences of these aspects on environmental resources or receptors of particular value or sensitivity, for example, disturbance due to noise and health effects due to poorer air quality. In the case where the impact is on human health or wellbeing, this should be stated. Similarly, where the receptor is not anthropogenic, then it should, where possible, be stipulated what the receptor is.
- **Receptors** can comprise, but are not limited to, people or human-made systems, such as local residents, communities and social infrastructure, as well as components of the biophysical environment such as wetlands, flora and riverine systems.
- **Resources** include components of the biophysical environment.
- **Frequency of activity** refers to how often the proposed activity will take place.

[1] The definition has been aligned with that used in the ISO 14001 Standard.

- **Frequency of impact** refers to the frequency with which a stressor (aspect) will impact on the receptor.
- **Severity** refers to the degree of change to the receptor status in terms of the reversibility of the impact; sensitivity of receptor to stressor; duration of impact (increasing or decreasing with time); controversy potential and precedent setting; threat to environmental and health standards.
- **Spatial extent** refers to the geographical scale of the impact.
- **Duration** refers to the length of time over which the stressor will cause a change in the resource or receptor.

The significance of the impact is then assessed by rating each variable numerically according to the defined criteria. Refer to the **Table 5**. The purpose of the rating is to develop a clear understanding of influences and processes associated with each impact. The severity, spatial scope and duration of the impact together comprise the consequence of the impact and when summed can obtain a maximum value of 15. The frequency of the activity and the frequency of the impact together comprise the likelihood of the impact occurring and can obtain a maximum value of 10. The values for likelihood and consequence of the impact are then read off a significance rating matrix and are used to determine whether mitigation is necessary[2].

The assessment of significance is undertaken twice. Initially, significance is based on only natural and existing mitigation measures (including built-in engineering designs). The subsequent assessment takes into account the recommended management measures required to mitigate the impacts. Measures such as demolishing infrastructure, and reinstatement and rehabilitation of land, are considered post-mitigation.

The model outcome of the impacts was then assessed in terms of impact certainty and consideration of available information. The Precautionary Principle is applied in line with South Africa's National Environmental Management Act (No. 108 of 1997) in instances of uncertainty or lack of information, by increasing assigned ratings or adjusting final model outcomes. In certain instances, where a variable or outcome requires rational adjustment due to model limitations, the model outcomes have been adjusted.

[2] Some risks/impacts that have low significance will however still require mitigation

Table 4: Criteria for assessing significance of impacts

LIKELIHOOD DESCRIPTORS

Probability of impact	**RATING**
Highly unlikely	1
Possible	2
Likely	3
Highly likely	4
Definite	5
Sensitivity of receiving environment	**RATING**
Ecology not sensitive/important	1
Ecology with limited sensitivity/importance	2
Ecology moderately sensitive/ /important	3
Ecology highly sensitive /important	4
Ecology critically sensitive /important	5

CONSEQUENCE DESCRIPTORS

Severity of impact	**RATING**
Insignificant / ecosystem structure and function unchanged	1
Small / ecosystem structure and function largely unchanged	2
Significant / ecosystem structure and function moderately altered	3
Great / harmful/ ecosystem structure and function Largely altered	4
Disastrous / ecosystem structure and function seriously to critically altered	5
Spatial scope of impact	**RATING**
Activity specific/ < 5 ha impacted / Linear features affected < 100m	1
Development specific/ within the site boundary / < 100ha impacted / Linear features affected < 100m	2
Local area/ within 1 km of the site boundary / < 5000ha impacted / Linear features affected < 1000m	3
Regional within 5 km of the site boundary / < 2000ha impacted / Linear features affected < 3000m	4
Entire habitat unit / Entire system/ > 2000ha impacted / Linear features affected > 3000m	5
Duration of impact	**RATING**
One day to one month	1
One month to one year	2
One year to five years	3
Life of operation or less than 20 years	4
Permanent	5

Table 5: Significance rating matrix

LIKELIHOOD (Frequency of activity + Frequency of impact)	CONSEQUENCE (Severity + Spatial Scope + Duration)														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30
	3	6	9	12	15	18	21	24	27	30	33	36	39	42	45
	4	8	12	16	20	24	28	32	36	40	44	48	52	56	60
	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75
	6	12	18	24	30	36	42	48	54	60	66	72	78	84	90
	7	14	21	28	35	42	49	56	63	70	77	84	91	98	105
	8	16	24	32	40	48	56	64	72	80	88	96	104	112	120
	9	18	27	36	45	54	63	72	81	90	99	108	117	126	135
	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150

Table 6: Positive/Negative Mitigation Ratings

Significance Rating	Value	Negative Impact management recommendation	Positive Impact management recommendation
Very High	126 - 150	Consider the viability of the project. Very strict measures to be implemented to mitigate impacts according to the impact mitigation hierarchy if the project is to proceed.	Actively promote the project
High	101 - 125	Consider alternatives in terms of project execution and location. Ensure designs take environmental sensitivities into account and Ensure management and housekeeping is maintained and attention to impact minimisation is paid according to the impact mitigation hierarchy.	Promote the project and monitor ecological performance
Medium High	76 – 100	Consider alternatives in terms of project execution and Ensure management and housekeeping is maintained and attention to impact minimisation is paid according to the impact mitigation hierarchy.	Implement measures to enhance the ecologically positive aspects of the project while managing any negative impacts
Medium Low	51 - 75	Ensure management and housekeeping is maintained and attention to impact minimisation is paid.	Implement measures to enhance the ecologically positive aspects of the project while actively managing any negative impacts
Low	26 - 50	Promote the project and ensure management and housekeeping is maintained.	Monitor ecological performance and pay extensive attention to minimising potential negative environmental impacts
Low Very	1 - 25	Promote the project.	Actively seek measures to implement impact minimisation according to the impact mitigation hierarchy and identify positive ecological aspects to be promoted

The following points are considered when undertaking the assessment:

- Risks and impacts were analysed in the context of the *project's area of influence* encompassing:
  - Primary project site and related facilities that the client and its contractors develops or controls;

- Areas potentially impacted by cumulative impacts for further planned development of the project, any existing project or condition and other project-related developments; and
- Areas potentially affected by impacts from unplanned but predictable developments caused by the project that may occur later or at a different location.

- Risks/Impacts were assessed for all stages of the project cycle including:
  - Pre-construction
  - Construction and;
  - Operation.
- Latent impacts will be assessed;
- Cumulative impacts on the local resources will be considered;
- If applicable, transboundary or global effects were assessed;
- Individuals or groups who may be differentially or disproportionately affected by the project because of their *disadvantaged* or *vulnerable* status were assessed.
- Particular attention was paid to describing any residual impacts that will occur after rehabilitation.

An impact assessment following the above methodology will be undertaken where the anticipated impacts on the ecological environment arising from the project will be assessed. The significance of each impact will be determined for each phase of the project life cycle. Following the assessment of impacts, mitigatory measures will be developed which will aim to lessen or negate the significance of the identified impacts. Possible impacts which have been conceptually identified are listed below:

- Encroachment of infrastructure or construction or operational waste materials into sensitive areas could occur and would affect the habitat integrity of these areas.
- Ineffective rehabilitation of riparian habitat areas could cause siltation and changes in the hydrological functioning of these areas.
- Vehicles may impact upon sensitive areas during construction, operation and rehabilitation, resulting in a loss of habitat.
- Ineffective removal of alien invader species and exposed areas could lead to re-establishment of invasive species, impacting on floral community rehabilitation efforts.
- Ineffective rehabilitation and monitoring of disturbed areas could lead to loss of species diversity.

Please note that the above list is not exhaustive, and during the detailed impact assessment phase additional impacts may be identified.

11.1.1 MITIGATION MEASURE DEVELOPMENT

The following points present the key concepts considered in the development of mitigation measures for the construction and operation of the proposed linear development.

- *Mitigation* and *performance improvement measures* and actions that address the risks and impacts[3] are identified and described in as much detail as possible. Mitigating measures are investigated according to the impact minimisation hierarchy as follows:
  - Avoidance or prevention of impact;

[3] Mitigation measures should address both positive and negative impacts

- Minimisation of impact;
- Rehabilitation; and
- Offsetting.

➢ Measures and actions to address negative impacts will favour avoidance and prevention over minimisation, mitigation or compensation.

Desired outcomes are defined, and have been developed in such a way as to be *measurable events with performance indicators, targets and acceptable criteria* that can be tracked over *defined periods*, wherever possible.

REFERENCES

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

CHINSAMY-TURAN, A. (ed) 2012. *Forerunners of Mammals.* Indiana University Press, Bloomington and Indiapolis. Pp 1-330.

CLUVER, M.A. 1978. *Fossil Reptiles of the South African Karoo.* South African Museum, Cape Town, Pp 1-54.

COLE, D.I., NEVELING, J., HATTINGH, J., CHEVALLIER, L.P., REDDERING, J.S.V. and BENDER, P.A. 2004. Geology of the Middelburg Area. Council for Geoscience, South Africa, Explanation Sheet 3124, 1:250 000. Pp 1-43.

KENT, L. E., 1980. Part 1: Lithostratigraphy of the Republic of South Africa, South West Africa/Namibia and the Republics of Bophuthatswana, Transkei and Venda. SACS, Council for Geosciences, *Stratigraphy of South Africa. 1980. South African Committee for Stratigraphy.* Handbook 8, Part 1, pp 690.

KEYSER, N., BOTHA, G.A., BOTHA, G.A. and GROENEWALD, G.H. 1986. Geological Map 2628 East Rand, 1:250 000. South African Committee for Stratigraphy, Council for Geoscience, Pretoria.

JOHNSON, M.R. 2009. Ecca Group. Karoo Supergroup. Catalogue of South African Lithostratigraphic Units. SACS, **10:** 5-7.

MCCARTHY, T and RUBIDGE, B. 2005. *The Story of Earth Life: A southern African perspective on a 4.6-billion-year journey.* Struik. Pp 333.

MUNTINGH, D.J. (ed) 1992. Geological Map 2728 Frankfort, 1:250 000, South African Committee for Stratigraphy, Council for Geoscience, Pretoria.

NORMAN, N. 2013. *Geology off the beaten track: exploring South Africa's hidden treasures.* De Beers, Struik, Pp 1-256.

NORMAN, N. and WHITFIELD, G., 2006. *Geological Journeys.* De Beers, Struik, Pp 1-320.

RUBIDGE, B. S. (ed.), 1995. Biostratigraphy of the Beaufort Group (Karoo Supergroup). South African Committee for Biostratigraphy, Biostratigraphic Series No. 1, 46pp. Council for Geoscience, Pretoria.

SG 2.2 SAHRA APMHOB Guidelines, 2012. Minimum standards for palaeontological components of Heritage Impact Assessment Reports, Pp 1-15.

SNYMAN, C. P., 1996. *Geologie vir Suid-Afrika*. Departement Geologie, Universiteit van Pretoria, Pretoria, Volume 1, Pp. 513.

VAN DER WALT, M., DAY, M., RUBIDGE, B. S., COOPER, A. K. & NETTERBERG, I., 2010. Utilising GIS technology to create a biozone map for the Beaufort Group (Karoo Supergroup) of South Africa. *Palaeontologia Africana,* **45:** 1-5.

VISSER, D.J.L. (ed) 1984. Geological Map of South Africa 1:100 000. South African Committee for Stratigraphy. Council for Geoscience, Pretoria.

VISSER, D.J.L. (ed) 1989. *Toeligting: Geologiese kaart (1:100 000). Die Geologie van die Republieke van Suid Afrika, Transkei, Bophuthatswana, Venda, Ciskei en die Koningkryke van Lesotho en Swaziland*. South African Committee for Stratigraphy. Council for Geoscience, Pretoria.

APPENDIX 1:

This section covers the recommended protocol for a Phase 2 Mitigation process as well as for reports where the Palaeontological Sensitivity is LOW; this process guides the palaeontologist / palaeobotanist on site and should not be attempted by the layman / developer.

The developer must survey the areas affected by the development and indicate on plan where the construction / development / mining will take place. Trenches have to be dug to ascertain how deep the sediments are above the bedrock (can be a few hundred metres). This will give an indication of the depth of the topsoil, subsoil, and overburden, if need be trenches should be dug deeper to expose the interburden.

Mitigation will involve recording, rescue and judicious sampling of the fossil material present in the layers sandwiched between the geological / coal layers. It must include information on number of taxa, fossil abundance, preservational style, and taphonomy. This can only be done during mining or excavations. In order for this to happen, in case of coal mining operations, the process will have to be closely scrutinised by a professional palaeontologist / palaeobotanist to ensure that only the coal layers are mined and the interlayers (siltstone and mudstone) are surveyed for fossils or representative sampling of fossils are taking place.

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

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

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

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

Mitigation involves planning the protection of significant fossil sites, rock units or other palaeontological resources and/or excavation, recording and sampling of fossil heritage that might be lost during development, together with pertinent geological data. The mitigation may take place before and / or during the construction phase of development. The specialist will require a Phase 2 mitigation permit from the relevant Heritage Resources Authority before a Phase 2 may be implemented.

The Mitigation is done in order to rescue representative fossil material from the study area to allow and record the nature of each locality and establish its age before it is destroyed and to make samples accessible for future research. It also interprets the evidence recovered to allow for education of the public and promotion of palaeontological heritage.

Should further fossil material be discovered during the course of the development (*e. g.* during bedrock excavations), this must be safeguarded, where feasible *in situ,* and reported to a palaeontologist or to the Heritage Resources authority. In situations where the area is considered palaeontologically sensitive (*e. g.* Karoo Supergroup Formations, ancient marine deposits in the interior or along the coast) the palaeontologist might need to monitor all newly excavated bedrock. The developer needs to give the palaeontologist sufficient time to assess and document the finds and, if necessary, to rescue a representative sample.

When a Phase 2 palaeontological impact study is recommended, permission for the development to proceed can be given only once the heritage resources authority has received and approved a Phase 2 report and is satisfied that (a) the palaeontological resources under threat have been adequately recorded and sampled, and (b) adequate development on fossil heritage, including, where necessary, *in situ* conservation of heritage of high significance. Careful planning, including early consultation with a palaeontologist and heritage management authorities, can minimise the impact of palaeontological surveys on development projects by selecting options that cause the least amount of inconvenience and delay.

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

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

1. The developer needs to clearly stake or peg-out (survey) the areas affected by the mining/ construction/ development operations and dig representative trenches and if possible supply geological borehole data. When the route is better defined, it is recommended that a specialist undertake a ‘walk through’ of the entire road as well as construction areas, including camps and access roads, prior to the start of any construction activities, this may be done in sections.
2. Fossils likely to occur are for example the dinosaurs from the Elliot Formation, these are present in the mudstone (or any other fossiliferous layer ranked as VERY HIGH or HIGH) or other vertebrates from the Beaufort Group (or any other fossiliferous layer). The palaeontologist needs to survey the overburden, subsoil and topsoil at least once a week.
3. When clearing topsoil, subsoil or overburden and hard rock (outcrop) is found, the contractor needs to stop all work.
4. A Palaeobotanist / palaeontologist (contact SAHRIS for list) must then inspect the affected areas and trenches for fossiliferous outcrops / layers. The contractor / developer may be asked to move structures, and put the development on hold.
5. If the palaeontologist / palaeobotanist is satisfied that no fossils will be destroyed or have removed the fossils, development and removing of the topsoil can continue.
6. After this process the same palaeontologist / palaeobotanist will have to inspect and offer advice through the Phase 2 Mitigation Process. Bedrock excavations for

footings may expose, damage or destroy previously buried fossil material and must be inspected.

7. When permission for the development is granted, the next layer can be removed, if this is part of a fossiliferous layer, then with the removal of each layer of sediment, the palaeontologist / palaeobotanist must do an investigation (a minimum of once every week).
8. At this stage the palaeontologist / palaeobotanist in consultation with the developer / mining company must ensure that a further working protocol and schedule is in place. Onsite training should take place, followed by an annual visit by the palaeontologist / palaeobotanist.

Fossil excavation if necessary during Phase 2:

1. Photography of fossil / fossil layer and surrounding strata.
2. Once a fossil has been identified as such, the task of extraction begins.
3. It usually entails the taking of a GPS reading and recording lithostratigraphic, biostratigraphic, date, collector and locality information.
4. Using Paraloid (B-72) as an adhesive and protective glue, parts of the fossil can be kept together (not necessarily applicable to plant fossils).
5. Slowly chipping away of matrix surrounding the fossil using a geological pick, brushes and chisels.
6. Once the full extent of the fossil / fossils is visible, it can be covered with a plaster jacket (not necessarily applicable to plant fossils).
7. Chipping away sides to loosen underside.
8. Splitting of the rock containing palaeobotanical material should reveal any fossils sandwiched between the layers.

This document forms part of the Environmental Monitoring Programme. For practical reasons a palaeontologist/palaeobotanist may be required to be on site once a week. If any fossil material is discovered then a Phase 2 rescue operation may be necessary, and a permit will be required.

SAHRA has the following documents in place:

- Guidelines to Palaeontological Permiting policy.
- Minimum Standards: Palaeontological Component of Heritage Impact Assessment reports.
- Guidelines for Field Reports.
- Palaeotechnical Reports (Eastern Cape, Northern Cape, Mpumalanga, Gauteng, Western Cape, Free State and Limpopo).