



PALAEONTOLOGICAL IMPACT ASSESSMENT

PART II EA AMENDMENT FOR THE
MOTUOANE HENNENMAN
EXPLORATION PROJECT IN THE
FREE STATE PROVINCE

2024

COMPILED for: EIMS

Requested by: PGS CONSULTING



Declaration of Independence

I, Elize Butler, declare that –

General declaration:

- I act as the independent palaeontological specialist in this application
- I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favorable to the applicant
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting palaeontological impact assessments, including knowledge of the Act, Regulations and any guidelines that have relevance to the proposed activity;
- I will comply with the Act, Regulations and all other applicable legislation;
- I will take into account, to the extent possible, the matters listed in section 38 of the NHRA when preparing the application and any report relating to the application;
- I have no, and will not engage in, conflicting interests in the undertaking of the activity;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the application by the competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- I will ensure that information containing all relevant facts in respect of the application is distributed or made available to interested and affected parties and the public and that participation by interested and affected parties is facilitated in such a manner that all interested and affected parties will be provided with a reasonable opportunity to participate and to provide comments on documents that are produced to support the application;
- I will provide the competent authority with access to all information at my disposal regarding the application, whether such information is favorable to the applicant or not
- All the particulars furnished by me in this form are true and correct;
- I will perform all other obligations as expected a palaeontological specialist in terms of the Act and the constitutions of my affiliated professional bodies; and



- I realize that a false declaration is an offense in terms of regulation 71 of the Regulations and is punishable in terms of section 24F of the NEMA.

Disclosure of Vested Interest

I do not have and will not have any vested interest (either business, financial, personal or other) in the proposed activity proceeding other than remuneration for work performed in terms of the Regulations.

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SIGNATURE:



The Palaeontological impact assessment report has been compiled considering the National Environmental Management Act 1998 (NEMA) and Environmental Impact Regulations 2014 as amended, requirements for specialist reports, Appendix 6, as indicated in the table below.

Table 1: Checklist for Specialist studies conformance with Appendix 6 of the EIA Regulations of 2014 (as amended)		
Requirements of Appendix 6 – GN R326 EIA Regulations of 7 April 2017	The relevant section in the report	Comment where not applicable.
1.(1) (a) (i) Details of the specialist who prepared the report	Page ii and Section 2 of Report – Contact details and company and Appendix A	-
(ii) The expertise of that person to compile a specialist report including a curriculum vita	Section 2 – refer to Appendix A	-
(b) A declaration that the person is independent in a form as may be specified by the competent authority	Page ii of the report	-
(c) An indication of the scope of, and the purpose for which, the report was prepared	Section 4 – Objective	-
(cA) An indication of the quality and age of base data used for the specialist report	Section 5 – Geological and Palaeontological history	-
(cB) a description of existing impacts on the site, cumulative impacts of the proposed development and levels of acceptable change;	Section 8	-



Table 1: Checklist for Specialist studies conformance with Appendix 6 of the EIA Regulations of 2014 (as amended)

Requirements of Appendix 6 – GN R326 EIA Regulations of 7 April 2017	The relevant section in the report	Comment where not applicable.
(d) The duration, date and season of the site investigation and the relevance of the season to the outcome of the assessment	Section 1,7 & 9	
(e) a description of the methodology adopted in preparing the report or carrying out the specialised process inclusive of equipment and modelling used	Section 4 Approach and Methodology	-
(f) details of an assessment of the specifically identified sensitivity of the site related to the proposed activity or activities and its associated structures and infrastructure, inclusive of a site plan identifying site alternatives;	Section 1,7 & 9	
(g) An identification of any areas to be avoided, including buffers	Section 1,7 & 9	
(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;	Section 5 – Geological and Palaeontological history	
(i) A description of any assumptions made and any uncertainties or gaps in knowledge;	Section 4.1 – Assumptions and Limitation	-
(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	Section 1 and 9	
(k) Any mitigation measures for inclusion in the EMPr	Section 10	



Table 1: Checklist for Specialist studies conformance with Appendix 6 of the EIA Regulations of 2014 (as amended)		
Requirements of Appendix 6 – GN R326 EIA Regulations of 7 April 2017	The relevant section in the report	Comment where not applicable.
(l) Any conditions for inclusion in the environmental authorisation	Section 10	
(m) Any monitoring requirements for inclusion in the EMPr or environmental authorisation	Section 1 and 9	
(n)(i) A reasoned opinion as to whether the proposed activity, activities or portions thereof should be authorised and	Section 1 and 9	
(n)(iA) A reasoned opinion regarding the acceptability of the proposed activity or activities; and		
(n)(ii) If the opinion is that the proposed activity, activities 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	Section 1 and 9	-
(o) A description of any consultation process that was undertaken during the course of carrying out the study	N/A	Not applicable. A public consultation process was handled as part of the Environmental Impact Assessment (EIA) and Environmental Management



Table 1: Checklist for Specialist studies conformance with Appendix 6 of the EIA Regulations of 2014 (as amended)		
Requirements of Appendix 6 – GN R326 EIA Regulations of 7 April 2017	The relevant section in the report	Comment where not applicable.
		Plan (EMP) process.
(p) A summary and copies of any comments that were received during any consultation process	N/A	Not applicable. To date, no comments regarding heritage resources that require input from a specialist have been raised.
(q) Any other information requested by the competent authority.	N/A	Not applicable.
(2) Where a government notice by the Minister provides for any protocol or minimum information requirement to be applied to a specialist report, the requirements as indicated in such notice will apply.	Section 3 compliance with SAHRA guidelines	



EXECUTIVE SUMMARY

Banzai Environmental was appointed by PGS HERITAGE on behalf of EIMS to conduct the Palaeontological Impact Assessment (PIA) associated with the additional nine exploration boreholes and ~30 km of nine new seismic transects within the approved Motuoane Hennenman Exploration Right Footprint (ref: 12/3/315) near Hennenman, in the Free State Province. In accordance with the National Environmental Management Act 107 of 1998 (NEMA) and to comply with the National Heritage Resources Act (No 25 of 1999, section 38) (NHRA), this PIA is necessary to confirm if fossil material could potentially be present in the planned development area, to evaluate the potential impact of the proposed development on the Palaeontological Heritage and to mitigate possible damage to fossil resources.

The study area is underlain by Quaternary deposits, while the largest portion of the development is underlain by the Adelaide Subgroup (Beaufort Group, Karoo Supergroup). Jurassic dolerite is present in the southern portion of the development. The PalaeoMap from the South African Heritage Resources Information System (SAHRIS) indicates that the Palaeontological Sensitivity of Quaternary sediments is Moderate, that of the Adelaide Subgroup is Very High, while the Palaeontological Sensitivity of Jurassic dolerite is Zero as it is igneous in origin and thus unfossiliferous (Almond and Pether, 2009; Almond *et al.*, 2013). The Palaeontological Sensitivity generated by the National Environmental Web-Based Screening Tool indicates that the Sensitivity of the proposed development is Very High. Updated Geology (Council of Geosciences) refined the geology and indicates that the proposed development is underlain by alluvium, colluvium, eluvium and gravel as well as the Balfour Formation (Adelaide Subgroup, Beaufort Group) and Jurassic dolerite (Groenewald *et al.*, 2014).

A site-specific field survey of the development footprint was conducted on foot and by motor vehicle on 12 September 2023. No fossiliferous outcrop was detected in the proposed development. This could be attributed to the lack of outcrops as well as the lush grassy vegetation in the area. Based on the site investigation as well as desktop research it is concluded that fossil heritage of scientific and conservational interest in the development footprint is rare. This is in contrast with the High Sensitivity allocated to the development area by the SAHRIS Palaeosensitivity Map and DFFE Screening Tool.



TABLE OF CONTENT

1	INTRODUCTION	1
1.1	Amendment to the 2017 Study	2
2	QUALIFICATIONS AND EXPERIENCE OF THE AUTHOR.....	5
3.	LEGISLATION.....	6
4.	METHODS AND TERMS OF REFERENCE.....	8
4.1	Assumptions and Limitations	10
5.	GEOLOGICAL AND PALAEONTOLOGICAL HISTORY	10
6.	ADDITIONAL INFORMATION CONSULTED	26
7.	SITE VISIT	26
8.	ASSESSMENT METHODOLOGY	28
8.1	Method of Environmental Assessment	28
9.	CONCLUSION.....	30
10.	CHANCE FINDS PROTOCOL	31
11.	BIBLIOGRAPHY	33



LIST OF FIGURES

Figure 1: Locality of the 2016 exploration right Application.	3
Figure 2: Site locality of the proposed Motuoane Hennenman seismic lines, in the Free State.	4
Figure 3: Extract of the 1:250 000 Kroonstad 2826 (2000) Geological Map (Council for Geosciences, Pretoria) indicating the study area near Hennenman in the Free State is underlain by Quaternary superficial sands (Qs, yellow), the Adelaide Subgroup (Pa, green) (Beaufort Group, Karoo Supergroup) as well as the Karoo dolerite (Jd, red).	11
Figure 4: Extract of the 1 in 250 000 SAHRIS PalaeoMap (Council of Geosciences) indicating the proposed study area near Hennenman in the Free State.	13
Figure 5: Palaeontological Sensitivity of Study site by the National Environmental Web-bases Screening Tool.	15
Figure 6: Updated Geology (Council of Geosciences, Pretoria) of the proposed study area near Hennenman in the Free State indicates that the development is mostly underlain by alluvium, colluvium eluvium and gravel (n-qg), the Balfour Formation (pbf) as well as Karoo Dolerite (jd).	16
Figure 7: Vertebrate biozonation range chart for the Main Karoo Basin of South Africa.	20
Figure 8: Lateral and dorsal views of skull of the dicynodont <i>Daptocephalus leoniceps</i> , the main biozone defining fossil (Image taken from Viglietti, 2020) and dorsal views (Image taken from Viglietti, 2020).	21
Figure 9: Skulls of the biozone defining fossils of the <i>Dicynodon-Theriognathus</i> Subzone in lateral and dorsal views. <i>Dicynodon lacerticeps</i> (top), <i>Theriognathus microps</i> (bottom) (Image taken from Viglietti, 2020).	22
Figure 10: Biozone defining fossils of the <i>Lystrosaurus maccaigi</i> - <i>Moschorhinus</i> Subzone. The skulls of the <i>Lystrosaurus maccaigi</i> (top) and <i>Moschorhinus kitchingi</i> (bottom) in lateral (Image taken from Viglietti, 2020).	23
Figure 11: Lateral and dorsal views of the index taxa defining the <i>Lystrosaurus declivis</i> Assemblage Zone. (top) <i>Lystrosaurus declivis</i> , (centre) <i>Thrinaxodon liorhinus</i> , (bottom) <i>Procolophon trigoniceps</i> (Image taken from Botha and Smith, 2020). Image taken from Viglietti, 2020.	24
Figure 12: Reconstruction of <i>Lystrosaurus</i> sp.	25
Figure 13: General view of the proposed development indicates a low topography with grassveld vegetation.	26
Figure 14: Quaternary superficial sands and alluvium in dry river bed.	27
Figure 15: Unfossiliferous dolerite koppie.	27



LIST OF TABLES

<i>Table 1: Checklist for Specialist studies conformance with Appendix 6 of the EIA Regulations of 2014 (as amended)</i>	<i>iv</i>
<i>Table 2: Legend to the Kroonstad 2726 (2000) Geological Map (Council for Geosciences, Pretoria).</i>	<i>12</i>
<i>Table 3: Palaeontological Sensitivity according to the SAHRIS PalaeoMap (Almond et al, 2013; SAHRIS website</i>	<i>14</i>

APPENDIX A: CV



GLOSSARY OF TERMS

Fossil

Mineralized bones of vertebrate and invertebrate animals, as well as plants. A trace fossil is the traces of animals/plants preserved in stone.

Heritage

That which is inherited and forms part of the National Estate (historical places, objects, fossils as defined by the National Heritage Resources Act No 25 of 1999).

Heritage resources

This means any place or object of cultural significance and can include (but not limited to) as stated under Section 3 of the NHRA,

- places, buildings, structures, and equipment of cultural significance.
- places to which oral traditions are attached or which are associated with living heritage.
- historical settlements and townscapes.
- landscapes and natural features of cultural significance.
- geological sites of scientific or cultural importance.
- archaeological and palaeontological sites.
- graves and burial grounds, and
- sites of significance relating to the history of slavery in South Africa.

Palaeontology

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 comprises of fossilised remains or traces of past life.



Abbreviations

BA	Basic Assessment
DEA	Department of Environmental Affairs
DFFE	Department of Forestry, Fisheries and the Environment
CA	Competent Authority
ECO	Environmental Control Officer
EMPr	Environmental Management Programme
ESO	Environmental Site Officer
HIA	Heritage Impact Assessment
Ma	Millions of years ago
NEMA	National Environmental Management Act
NHRA	National Heritage Resources Act
PIA	Palaeontological Impact Assessment
PSSA	Palaeontological Society of South Africa
SAHRA	South African Heritage Resources Agency
SAHRIS	South African Heritage Resources Information System
S&EIA	Scoping & Environmental Impact Assessment
ToR	Terms of Reference



1 INTRODUCTION

Motuoane Energy (Pty) Ltd prepared and submitted an application to the Petroleum Agency South Africa (PASA) in 2017 for a hydrocarbon exploration right under the Mineral and Petroleum Resources Development Act (Act 28 of 2002 - MPRDA, as amended). In accordance with the National Environmental Management Act (Act 107 of 1998, as amended) (NEMA) an application for Environmental Authorisation (EA) through a Scoping and EIA was submitted to PASA in 2017 in support of the application for the exploration right. The EA was issued in July 2017 (ref: 12/3/315). However, the EA was only for three (3) drilling wells, and it did not include the seismic surveys. The applicant proposes to undertake an addition of ten (10) new exploration boreholes and approximately 30 km of new seismic transects (known) as well as additional future drilling well and seismic surveys (if necessary) within the approved exploration right footprint.

The approved exploration area is located over an area of approximately 149 377 hectares (ha), covering various farms near the town of Hennenman, within the Free State Province, extending north from approximately Theunissen, north east towards Kroonstad, and east of Virginia and Hennenman. The proposed study area is in the Matjhabeng, Masilonyana, and Moqhaka local municipalities in the Lejweleputswa District Municipality and the Fezile Dabi District Municipality, respectively (Figure 1).

Environmental Impact Management Services (EIMS) was appointed to conduct the necessary studies for the Exploration Right Application and in turn appointed PGS Heritage to conduct the heritage impact assessment for the proposed Motuoane Hennenman Exploration Right. Dr Lloyd Rossouw (Palaeo Field Services) was in turn appointed to conduct a palaeontological desktop and field-based palaeontological impact assessment for the proposed Exploration Right Area and Exploration Footprint Area.

Dr Rossouw found that the development was underlain by late Cenozoic alluvial deposits from the Vet, Sand, Vals, and Doring Rivers, as well as related Quaternary catchment areas. These deposits, together with pan edges and spring sites, are regarded as extremely scarce paleontological resources containing a plethora of palaeontological evidence on Plio-Pleistocene mammal evolution and palaeoenvironmental change. The sediments have been assigned a high level of palaeontological sensitivity.

The study's most notable fossil bearing rocks are connected with Permian deposits of the Karoo Supergroup, specifically the Eccu Group Volksrust Formation and the lower Adelaide Subgroup of the Beaufort Group. These deposits have a moderate to very high palaeontological value and contain one of the world's finest assemblages of vertebrate, invertebrate, and plant fossils. Dr Rossouw found that the Paleontological resources are thought to be unlikely to be disturbed or destroyed during the project's planning stage, but they could be very vulnerable throughout the construction, operation, and decommissioning phases.



However, Dr Rossouw did have several concerns: He stated that without suitable recording tools, it will be difficult to assess how negatively industrial activities have affected the sediments that contain fossils beneath the research region; however, it is important to note that these consequences are typically negative and permanent on the fossil heritage. He noted that there is a very good chance that the drilling process will have an effect on the palaeontologically sensitive units identified in the assessment, specifically the Volksrust Formation, Adelaide Subgroup, and late Cenozoic floodplain deposits connected to the Vet, Sand, Doring, and Vals River systems and associated Quaternary catchments.

Dr. Rossouw acknowledged that SAHRA did not have an official position on groundwater and was of the personal opinion that groundwater, and deep-seated aquifers in particular, are by definition a fossil resource in addition to being an important heritage resource shared by all South Africans. Dr. Rossouw added that the proposed drilling activities could have a negative impact on the quantity and quality of groundwater aquifers (including unmapped aquifers), such as the penetration of hydrocarbons and associated gas into fractured aquifers and the migration of deep-seated groundwater to shallow aquifers, which could result in a No-Go Alternative for the study area. He noted that it was the applicant's responsibility to select drilling and groundwater experts who were properly competent to provide specific mitigation measures for any potential impact on groundwater resources that may emerge from the planned development.

Dr. Rossouw thus advised the following preventative steps:

- The applicant should employ a qualified palaeontologist to undertake a field assessment (phase 1 palaeontological impact assessment) at each of the drilling sites once the locations are confirmed.
- The palaeontologist must submit an application for a valid permit from SAHRA for the collection / removal of fossils at each site relevant to the project.
- Planned drilling and associated industrial activities within the study area should be preceded by an appropriate palaeontological field assessment.

1.1 Amendment to the 2017 Study

The original Environmental Application (EA) was released in July 2017 (ref: 12/3/315). However, the EA only addressed three drilling wells and neglected to take seismic factors into account. The applicant wishes to add ten more exploration boreholes and undertake approximately 30 km of new seismic transects, therefore an EA Amendment procedure has been initiated.

In order to analyze the palaeontological impact of the projected 9 boreholes and about 30 km of additional seismic transects, the current study was commissioned.

Please note that this study must be read in combination with the study by Dr Rossouw for the Motuoane Hennenman Exploration Right Application and the mitigation measures mentioned in that report is still valid.

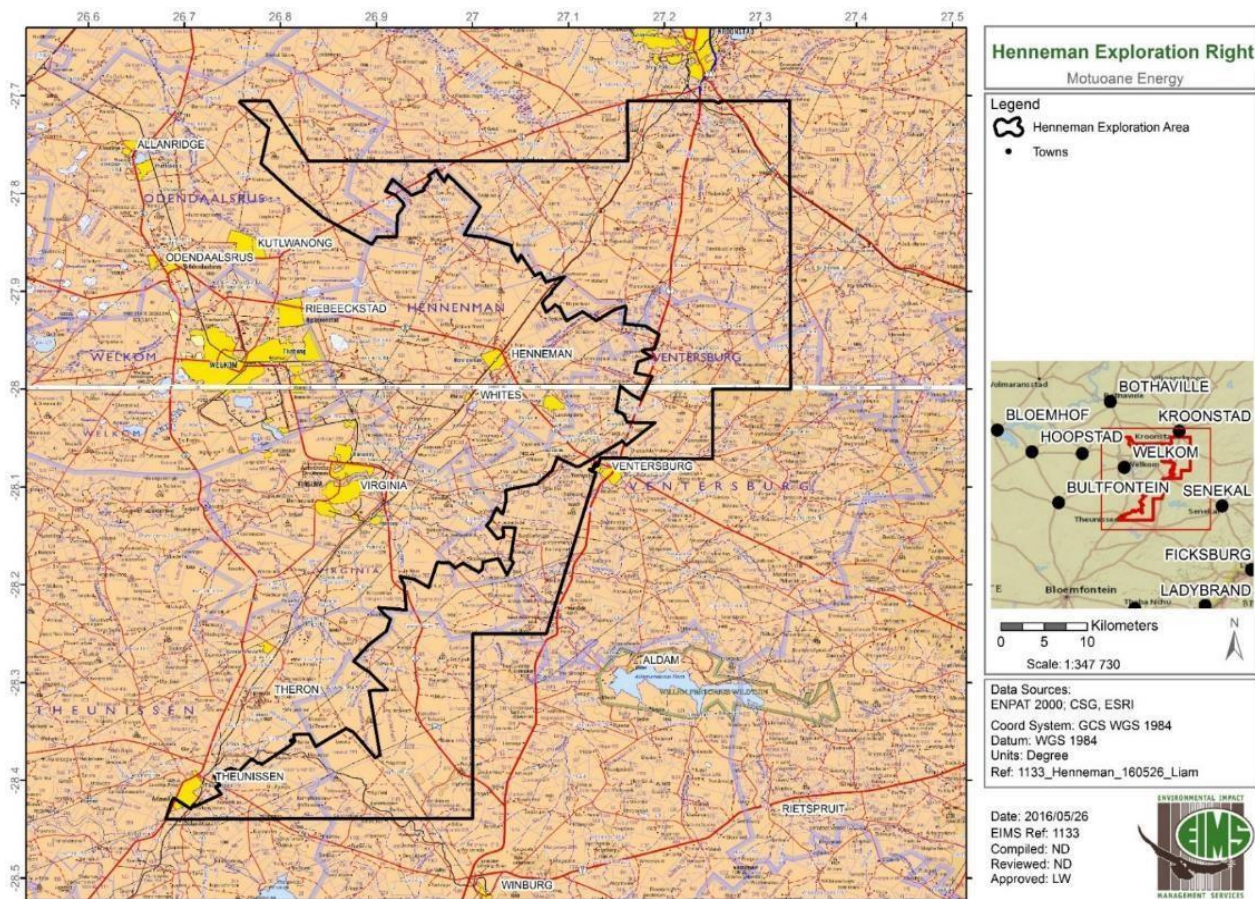


Figure 1: Locality of the 2016 exploration right Application.

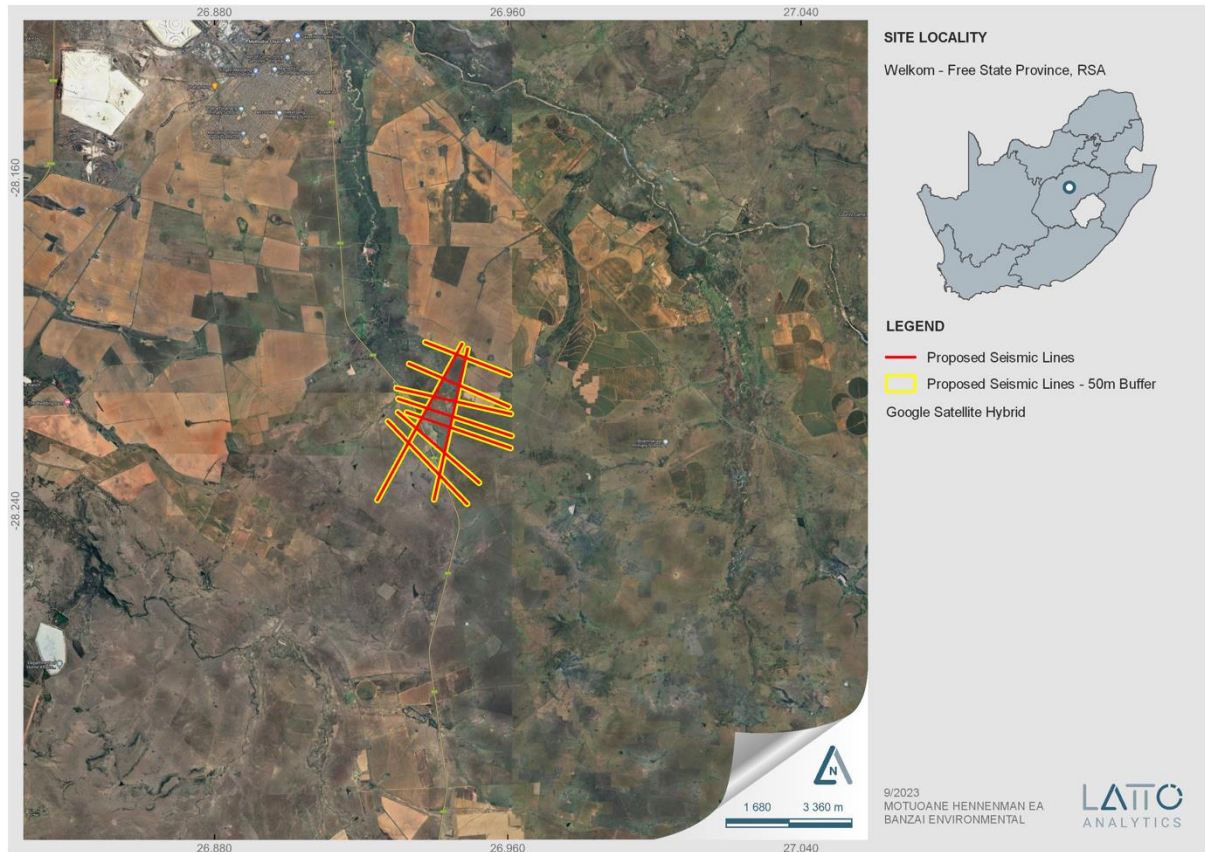


Figure 2: Site locality of the proposed Motuoane Hennenman seismic lines, in the Free State.



2 QUALIFICATIONS AND EXPERIENCE OF THE AUTHOR

Mrs. Elize Butler conducted the current study. For developments in the Free State, KwaZulu-Natal, Eastern, Central, and Northern Cape, Northwest, Gauteng, Limpopo, and Mpumalanga, she has completed almost 300 palaeontological impact assessments. She has an MSc (*cum laude*) in Zoology with a focus in Palaeontology from the University of the Free State in South Africa, and she has more than 30 years of experience in the field. She has knowledge of finding, collecting, and curating fossils. She began conducting PIAs in 2014 and has been a member of the Palaeontological Society of South Africa (PSSA) since 2006.



3. LEGISLATION

3.1 National Heritage Resources Act (25 of 1999)

Cultural Heritage in South Africa, includes all heritage resources, is protected by the National Heritage Resources Act (Act 25 of 1999) (NHRA). Heritage resources as defined in Section 3 of the Act include **“all objects recovered from the soil or waters of South Africa, including archaeological and palaeontological objects and material, meteorites and rare geological specimens”**.

The identification, evaluation and assessment of any cultural heritage site, artefact or finds in the South African context is required and governed by the following legislation:

- National Environmental Management Act (NEMA) Act 107 of 1998
- National Heritage Resources Act (NHRA) Act 25 of 1999
- Minerals and Petroleum Resources Development Act (MPRDA) Act 28 of 2002
- Notice 648 of the Government Gazette 45421- general requirements for undertaking an initial site sensitivity verification where no specific assessment protocol has been identified.

The next section in each Act is directly applicable to the identification, assessment, and evaluation of cultural heritage resources.

GNR 982 (Government Gazette 38282, 14 December 2014) promulgated under the National Environmental Management Act (NEMA) Act 107 of 1998

- Basic Assessment Report (BAR) – Regulations 19 and 23
- Environmental Impacts Assessment (EIA) – Regulation 23
- Environmental Scoping Report (ESR) – Regulation 21
- Environmental Management Programme (EMPr) – Regulations 19 and 23

National Heritage Resources Act (NHRA) Act 25 of 1999

- Protection of Heritage Resources – Sections 34 to 36
- Heritage Resources Management – Section 38

MPRDA Regulations of 2014

Environmental reports to be compiled for application of mining right – Regulation 48

- Contents of scoping report – Regulation 49
- Contents of environmental impact assessment report – Regulation 50



- Environmental management programme – Regulation 51
- Environmental management plan – Regulation 52

The NEMA (No 107 of 1998) states that an integrated EMP should (23:2 (b)) “...identify, predict and evaluate the actual and potential impact on the environment, socio-economic conditions and cultural heritage”.

In agreement with legislative requirements, EIA rating standards as well as SAHRA policies the following comprehensive and legally compatible PIA report have been compiled.

Palaeontological heritage is exceptional and non-renewable and is protected by the NHRA. Palaeontological resources and may not be unearthed, broken moved, or destroyed by any development without prior assessment and without a permit from the relevant heritage resources authority as per section 35 of the NHRA.

This Palaeontological Impact assessment forms part of the Heritage Impact Assessment (HIA) and adhere to the conditions of the Act. According to **Section 38 (1)**, an HIA is required to assess any potential impacts to palaeontological heritage within the development footprint where:

- the construction of a road, wall, power line, pipeline, canal or other similar form of linear development or barrier exceeding 300 m in length.
- the construction of a bridge or similar structure exceeding 50 m in length.
- any development or other activity which will change the character of a site—
- (Exceeding 5 000 m² in extent; or
- involving three or more existing erven or subdivisions thereof; or
- involving three or more erven or divisions thereof which have been consolidated within the past five years; or
- the costs of which will exceed a sum set in terms of regulations by SAHRA or a provincial heritage resources authority
- the re-zoning of a site exceeding 10 000 m² in extent.
- or any other category of development provided for in regulations by SAHRA or a Provincial heritage resources authority.



4. METHODS AND TERMS OF REFERENCE

The present field-based PIA assesses the potential impacts on Fossil Heritage on the development. This study forms part of the Heritage Impact Assessment Report. According to the "SAHRA Archaeology, Palaeontology and Meteorites (APM) Guidelines: Minimum Standards for the Archaeological and Palaeontological Components of Impact Assessment Reports" the purpose of the PIA is: 1) to identify the palaeontological importance of the rock formations in the footprint; 2) to evaluate the palaeontological magnitude of the formations; 3) to clarify the **impact** on fossil heritage; and 4) to suggest how the developer might protect and lessen possible damage to fossil heritage.

Calculations of the palaeontological state of each rock segment and the potential impact of development on fossil history take into account the palaeontological status of the rocks, the type of development, and the amount of bedrock removed.

The Provisional DFFE Screening Tool, the SAHRIS Palaeosensitivity map, all Palaeontological Impact Assessment reports for the same area, Google Earth images, topographical and geological maps, as well as academic articles about specimens from the development area and Assemblage Zones, are all used to create scoping reports.

When the development footprint has a moderate to high palaeontological sensitivity, a field-based assessment is necessary. A desktop or field assessment of the exposed rock is used to evaluate the significance of the proposed development's impact, and recommendations for more research or mitigation are made. Excavations for the project often only take place during the building phase, changing the terrain and destroying or permanently encasing fossils at or below the ground surface. Then, access to Fossil Heritage will no longer be available for academic study.

When doing a site investigation, a palaeontologist examines the local development as well as the quantity and variety of fossils found there. This can be demonstrated by looking at representative fossiliferous rock exposures (most igneous and metamorphic rocks are not fossiliferous, whereas sedimentary rocks contain fossil heritage). Examined rock exposures frequently contain a sizeable portion of the stratigraphic unit, which is primarily made up of recently exposed (unweathered) rock. These exposures may be man-made (such as quarries, open building excavations, even railway and road cuttings) or natural (such as cliffs, and dongas as well as rocky outcrops along stream or river banks). It is usual practice for palaeontologists to record well-preserved fossils (GPS, and stratigraphic data) during field assessment examinations.



Although mitigation is often done prior to construction, it may take place if potentially fossiliferous bedrock is revealed. Fossil collection and documentation are examples of mitigation. A permit from SAHRA must be obtained before beginning any fossil excavation, and the material must be stored at an authorized facility. When mitigation is properly used, it is possible to have a positive impact by raising awareness of the palaeontological past of the area.

By physically evaluating bedrock outcrops to determine their lithology and fossil richness and crisscrossing the development footprint, one can assess an area's fossil potential. Because the presence of fossils at the surface is so unexpected, an average sample size of the region is investigated. To be clear, however, the lack of fossils in a development footprint does not automatically suggest that there is no palaeontologically important material present on the site (on or below the ground surface).

The terms of reference of a PIA are as follows:

General Requirements:

- Adherence to the content requirements for specialist reports in accordance with Appendix 6 of the EIA Regulations 2014, as amended;
- Adherence to all applicable best practice recommendations, appropriate legislation and authority requirements;
- Submit a comprehensive overview of all appropriate legislation, guidelines;
- Describe of the proposed project and provide information regarding the developer and consultant who commissioned the study;
- Describe location of the proposed development and provide geological and topographical maps
- Provide palaeontological and geological history of the affected area;
- Identify sensitive areas to be avoided (providing shapefiles/kmls) in the proposed development;
- Evaluate the significance of the planned development during the Pre-construction, Construction, Operation, Decommissioning Phases and Cumulative impacts. Potential impacts should be rated in terms of the direct, indirect and cumulative:
 - a. **Direct impacts** are impacts that are caused directly by the activity and generally occur at the same time and at the place of the activity.
 - b. **Indirect impacts** of an activity are indirect or induced changes that may occur as a result of the activity.
 - c. **Cumulative impacts** are impacts that result from the incremental impact of the proposed activity on a common resource when added to the impacts of other past, present or reasonably foreseeable future activities.
- Fair assessment of alternatives (infrastructure alternatives have been provided);
- Recommend mitigation measures to minimise the impact of the proposed development; and



- Detail the implications of specialist findings for the proposed development (such as permits, licenses etc.).

4.1 Assumptions and Limitations

The geology of the area is the focal point of geological maps, and the sheet explanations of the Geological Maps were not intended to focus on palaeontological heritage. Many inaccessible areas of South Africa have never been examined by palaeontologists, and data is typically dependent solely on aerial pictures. Locality and geological information in museums and university databases is out of date, and data acquired in the past is not always adequately documented.

Comparable Assemblage Zones in other places are also used to provide information on the existence of fossils in areas that have not before been recorded. When similar Assemblage Zones and geological formations are used for Desktop studies, it is commonly assumed that exposed fossil exists within the footprint.

5. GEOLOGICAL AND PALAEONTOLOGICAL HISTORY

The geology of the proposed Motuoane Hennenman study site in the Free State is depicted on the 1: 250 000 Kroonstad 2826 (2000) Geological Map (Council for Geosciences, Pretoria) (Figure 3, Table 2). This map indicates that the study area is underlain by a small area of Quaternary superficial sands (Qs, yellow) as well as Quaternary alluvium (pale yellow, single bird figure) near Merriespruit, the largest area of the development is underlain by the Adelaide Subgroup (Pa, green) (Beaufort Group, Karoo Supergroup) while the southern portion of the development is underlain by Jurassic dolerite. The PalaeoMap (Figure 4, Table 3) of the South African Heritage Resources Information System (SAHRIS) indicates that the Palaeontological Sensitivity of Quaternary sediments is Moderate (green), that of the Adelaide Subgroup is Very High (red) and that of the Jurassic dolerite is Zero (grey) as it is igneous in origin and thus unfossiliferous (Almond and Pether, 2009; Almond *et al.*, 2013). The Palaeontological Sensitivity generated by the National Environmental Web-Based Screening Tool (depicted in Figure 5) indicates that the Sensitivity of the proposed development is Very High. Updated Geology (Council of Geosciences) refined the geology and indicates that the proposed development is underlain by alluvium, colluvium, eluvium and gravel (n-qg) as well as the Balfour Formation (pdf) (Adelaide Subgroup, Beaufort Group) and Jurassic dolerite (Figure 6, Groenewald *et al.*, 2014).

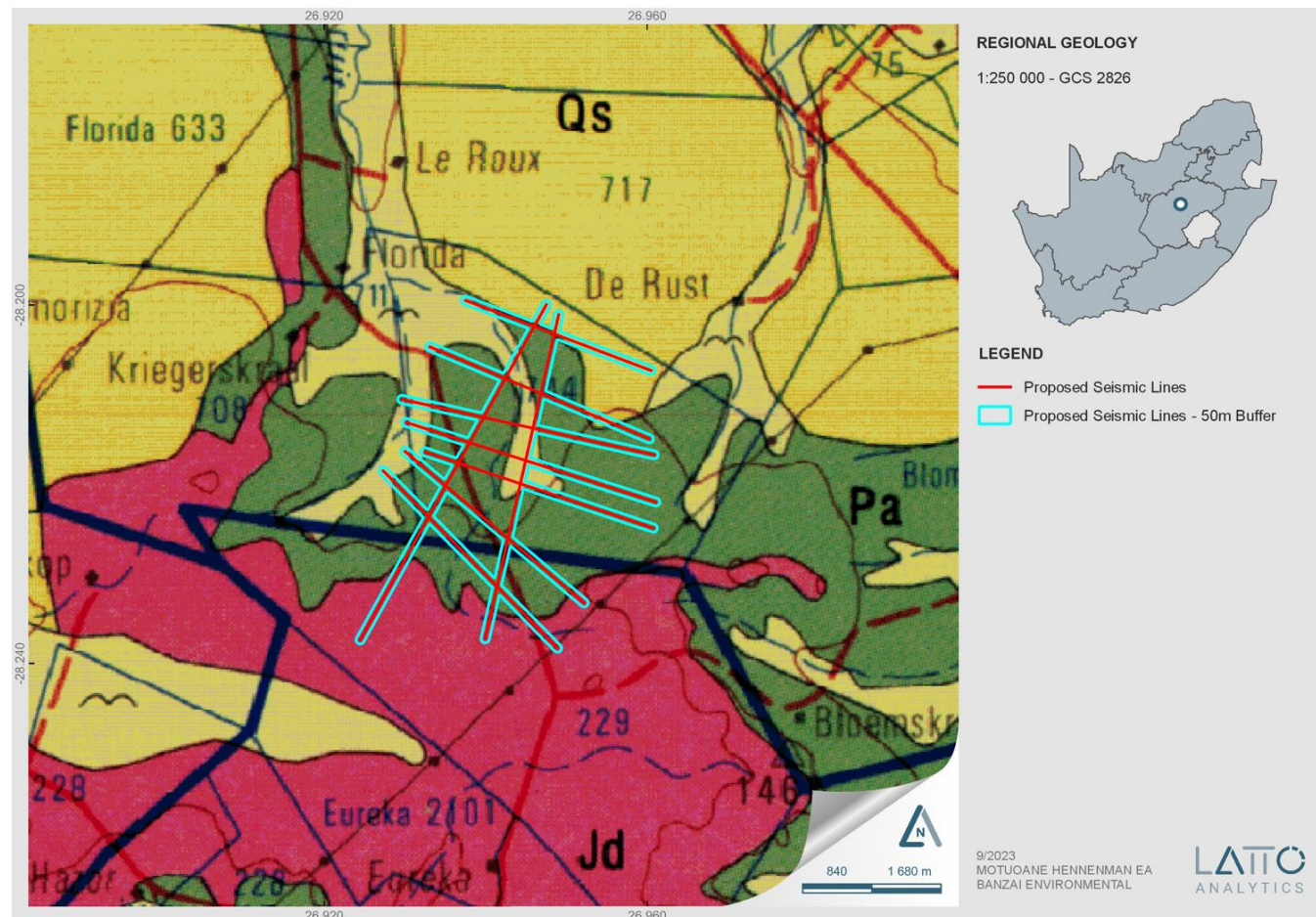


Figure 3: Extract of the 1:250 000 Kroonstad 2826 (2000) Geological Map (Council for Geosciences, Pretoria) indicating the study area near Hennenman in the Free State is underlain by Quaternary superficial sands (Qs, yellow), the Adelaide Subgroup (Pa, green) (Beaufort Group, Karoo Supergroup) as well as the Karoo dolerite (Jd, red).



Table 2: Legend to the Kroonstad 2726 (2000) Geological Map (Council for Geosciences, Pretoria).

Relevant sediments are indicated in a red square

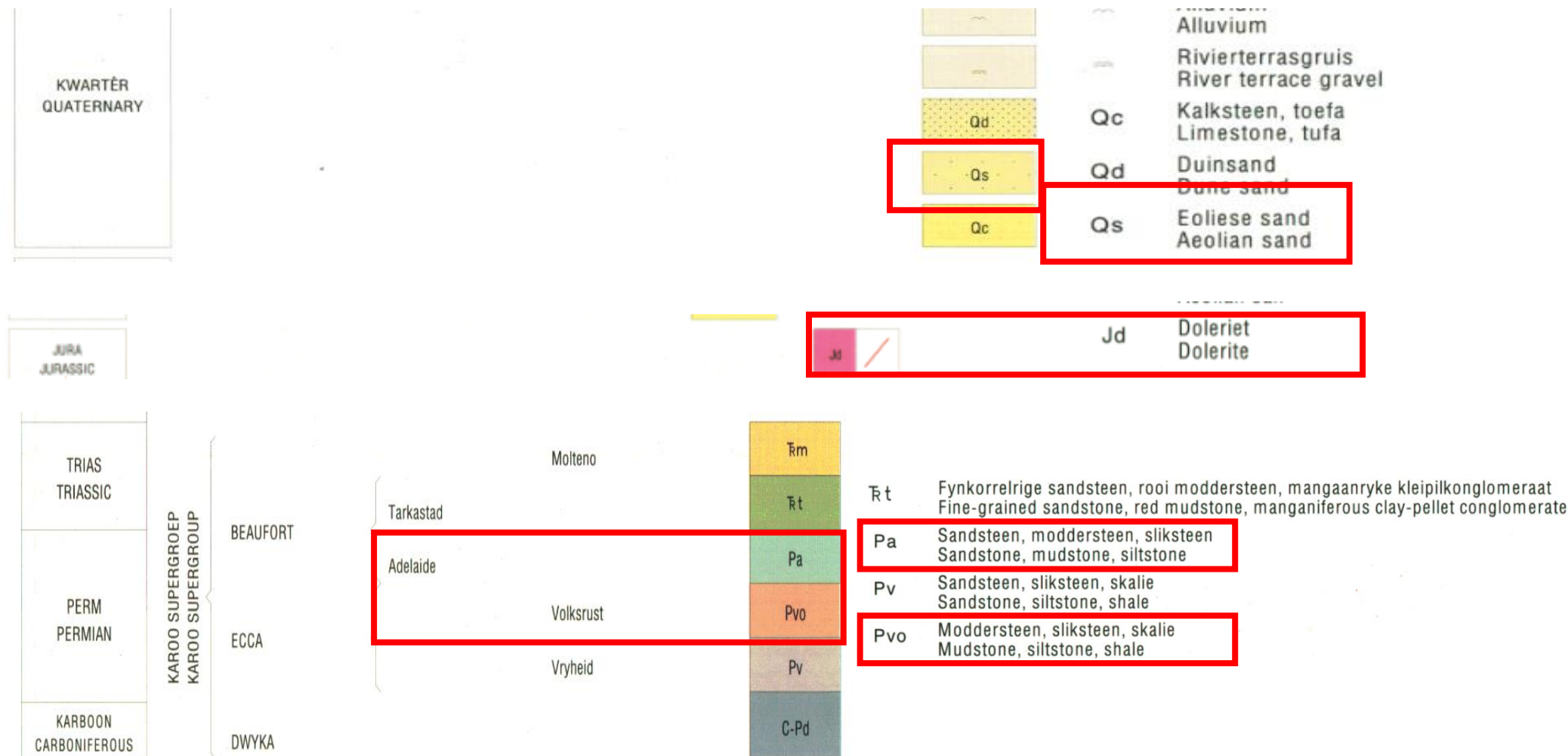




Figure 4: Extract of the 1 in 250 000 SAHRIS PalaeoMap (Council of Geosciences) indicating the proposed study area near Hennenman in the Free State.



Table 3: Palaeontological Sensitivity according to the SAHRIS PalaeoMap (Almond et al, 2013; SAHRIS website)

Colour	Sensitivity	Required Action
RED	VERY HIGH	Field assessment and protocol for finds is required
ORANGE/YELLOW	HIGH	Desktop study is required and based on the outcome of the desktop study; a field assessment is likely
GREEN	MODERATE	Desktop study is required
BLUE	LOW	No palaeontological studies are required however a protocol for finds is required
GREY	INSIGNIFICANT/ZERO	No palaeontological studies are required
WHITE/CLEAR	UNKNOWN	These areas will require a minimum of a desktop study. As more information comes to light, SAHRA will continue to populate the map.

The SAHRIS Palaeosensitivity map (Figure 3) indicates that the proposed development is underlain by sediments with a Very High (red), Moderate (green) and Zero (grey) Palaeontological Sensitivity.

MAP OF RELATIVE PALEONTOLOGY THEME SENSITIVITY



Very High sensitivity	High sensitivity	Medium sensitivity	Low sensitivity
X			

Sensitivity Features:

Sensitivity	Feature(s)
Medium	Features with a Medium paleontological sensitivity
Very High	Features with a Very High paleontological sensitivity

Figure 5: Palaeontological Sensitivity of Study site by the National Environmental Web-bases Screening Tool.

The DFFE National Environmental Web-based Screening Tool indicates that the Palaeontological Sensitivity of the development is Very High (dark red) (Figure 5) and corresponds with the Palaeontological Sensitivity on the SAHRIS PalaeoMap (Figure 4). However, no fossiliferous outcrops were identified during the site investigation on 12 September 2023. The Palaeontological Sensitivity is thus contested with actual findings in the field.

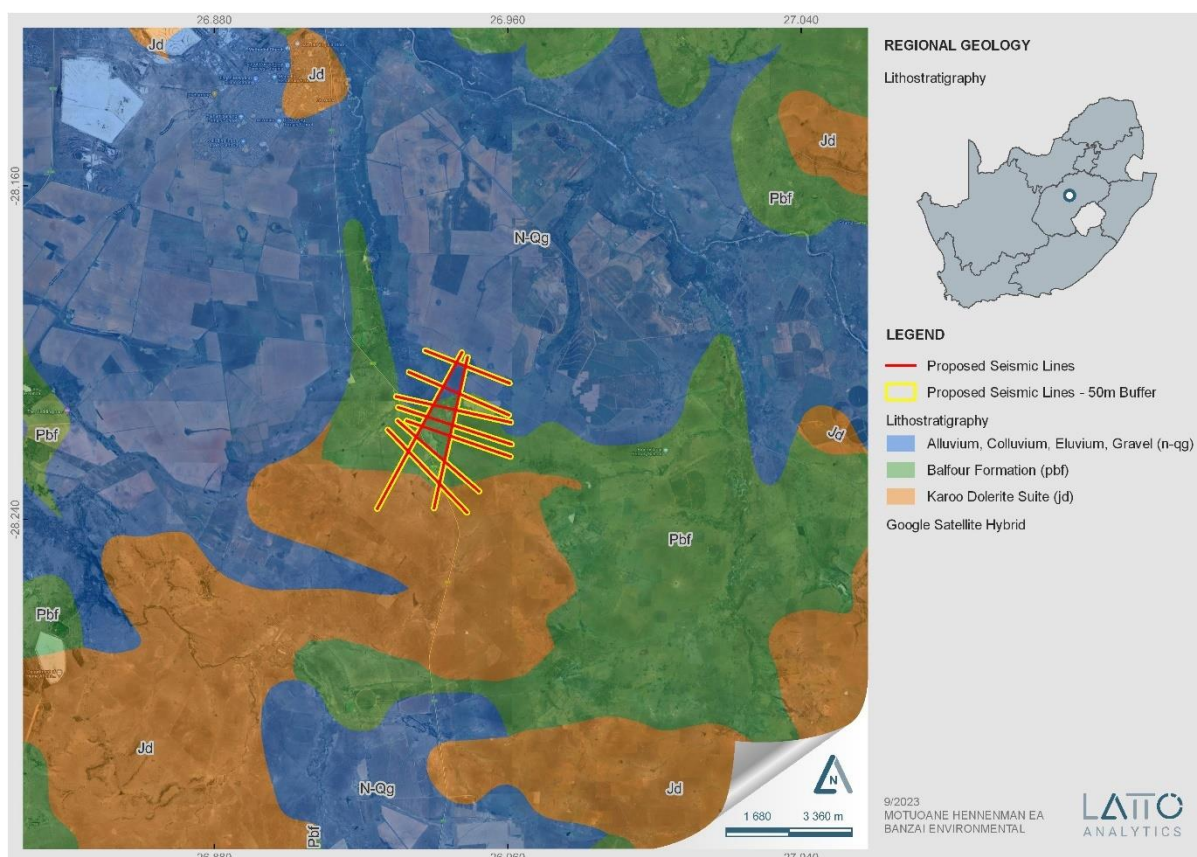


Figure 6: Updated Geology (Council of Geosciences, Pretoria) of the proposed study area near Hennenman in the Free State indicates that the development is mostly underlain by alluvium, colluvium eluvium and gravel (n-qg), the Balfour Formation (pbf) as well as Karoo Dolerite (jd).

The study area is mostly flat to mildly sloping, with some short grassland. In various portions of the study area, there are several low hills. At depth the Karoo Supergroup is underlain by Ventersdorp Supergroup lavas and Witwatersrand Supergroup sediments.

Quaternary superficial deposits are the youngest geological deposits formed during the most recent period (approximately 2.6 million years ago to present). Most of the superficial deposits are unconsolidated sediments and consist of calcretes, sand, silt and clay, and they form relatively thin, often discontinuous patches of sediments. The Quaternary deposits reveal palaeoclimatic changes in the geological formations (Hunter et al., 2006). The climatic fluctuations in the Cenozoic Era were responsible for the formation of most geomorphologic features (Maud, 2012). Various warming and cooling events occurred in the Cenozoic but climatic changes during the Quaternary, specifically the last 1.8 Ma, were the most drastic climate changes relative to all climate variations in the past Barnosky (2005). Climate in the Quaternary Period were both drier and wetter than the present and resulted in changes in river flow patterns, sedimentation processes and vegetation variation (Tooth et al., 2004).

The fossil assemblages of this Group are generally very low in diversity, but locally high and occur over a wide range. Quaternary deposits are especially important when in fluvial environments along water



courses (pale yellow, single bird figure, present in the development). These fossils represent terrestrial plants and animals with a close resemblance to living forms. Fossil assemblages include diatoms, gastropod shells, bivalves, ostracods and trace fossils as well as mammalian bones and teeth as well as coprolites, freshwater molluscs and plant microfossils). Various authors have described fossilized hyena burrows in Late Pleistocene alluvial sediments of the Modder River (Broom 1909 a, b; Cooke 1955; Churchill et al. 2000; Rossouw 2006). Fossilized hyena lairs are occasionally located outside the present river valleys along localized spring deposits and calcified pan dunes (Scott & Brink 1991). Fossiliferous sediments (local peat deposits) occur within calcified pan dunes in this region (Horowitz et al. 1978; Scott and Klein 1981; Butzer 1984). These types of pans formed when the prevailing winds blew aeolian sands (unconsolidated material) into newly formed lunettes on the lee side of the deflation hollows and sometimes provided a site for hyena burrows and prehistoric human habitation.

Pleistocene vertebrate fossils and plant microfossils are associated with spring and pan deposits [e.g., Florisbad, (northwest of Bloemfontein, Baden Baden (north of Dealesville,) Liebenbergspan (Voigts Post), Deelpaan between Bloemfontein and Petrusburg) (Brink 1987, 1988; Scott & Rossouw 2005)]. Florisbad has been declared a Provincial Heritage Site while Erfkroon is another valuable fossil site along the Modder River. Fossils in these areas occur over large areas in erosion gullies. Stone artefacts from the earlier part of the Middle Stone Age and the Later Stone Age have also been uncovered and are sometimes associate with bones (Churchill et al. 2000). The palaeontology of the Quaternary superficial deposits has been relatively neglected in the past. Late Cenozoic calcrete may comprise of bones, horn corns as well as mammalian teeth. Tortoise remains have also been uncovered as well as trace fossils which includes termite and insect's burrows and mammalian trackways. Amphibian and crocodile remains have been uncovered where the depositional settings in the past were wetter.

Partially calcretised older alluvium deposits often overlies dolerite. Gravelly colluvial and eluvial deposits are dominated by hornfels, sandstone, and dolerite rubble that mantles most hillslopes and plateaus. The topographically relief of the Beaufort Group in the development footprint is low as can be seen in the Site Visit Section (Section 7).

The Karoo igneous province is one of the worlds classic continental basalt (CFB) provinces. This province consists of intrusive and extrusive rocks that occur over a large area (Duncan et al, 2006). Generally, the flood basalts do not contribute to prominent volcanic structures, but instead are formed by successive eruptions from a set of fissures that form sub-horizontal lava flows (sills and dykes) varying in thickness. This lava caps the landscape on which they erupted. As the Karoo is an old flood basalt province it is today preserved as erosional fragments of a more extensive lava cap that covered much of southern Africa in the geological past. It is estimated that the Karoo lava outcrop currently covered at least 140 000 km² while it was larger in the past [~2 000 000 km² (Cox 1970, 1972)].

The Karoo Igneous Province contains a large volume of flood basalts as well as silicic volcanic rocks. These units are comprised of rhyodacite and rhyolitic magma and crops out along the Lebombo monocline. Individual units span up to 60 km and sometimes show massive pyroclastic structures and



are thus classified as rheoignimbrites. The basal lavas lie conformable on the Clarens Formation but in specific localities sandstone erosion occurred before the volcanic eruptions took place. Lock *et al* (1974) found evidence in the Eastern Cape that in the early stages of volcanism magma interacted with ground water to produce volcanoclastic deposits as well as phreatic and phreatomagmatic diatremes. Eales *et al* (1984) also found evidence of aqueous environments during early volcanism by the existence of pillow lavas and associated hyaloclastite breccias and thin lenses of fluvial sandstones interbedded with the lowermost magmas.

Underlying the superficial deposits is a series of Karoo sandstones, mudstones, and shales, that was deposited under fluvial environments of the Adelaide Subgroup (Beaufort Group). The Beaufort Group is the third of the main subdivisions of the Karoo Supergroup. The Beaufort group overlays the Eccia Group and consists essentially of sandstones and shales, deposited in the Karoo Basin from the Middle Permian to the early part of the Middle Triassic periods and was deposited on land through alluvial processes. The Beaufort Group covers a total land surface area of approximately 200 000 km² in South Africa and is the first fully continental sequence in the Karoo Supergroup and is divided into the Adelaide and the overlying Tarkastad Subgroups (Figure 7). The Adelaide subgroup rocks are deposited under a humid climate that allowed for the establishment of wet floodplains with high water tables and are interpreted to be fluvio-lacustrine sediments. The Adelaide Subgroup is approximately 5 000m thick in the southeast, but this decreases to about 800m in the centre of the basin which decreases to about 100 to 200m in the north.

The Adelaide Subgroup contains alternating greyish-red, bluish-grey, or greenish grey mudrocks in the southern and central parts of the Karoo Basin with very fine to medium-grained, grey lithofeldspathic sandstones. Thicker sandstones of the Adelaide are usually multi-storey and usually have cut-and-fill features. The sandstones are characterized internally by horizontal lamination together with parting lineation and less frequent trough crossbedding as well as current ripple lamination. The bases of the sandstone units are extensive beds, while ripple lamination is usually confined to thin sandstones towards the top of the thicker units. The mudrocks of the Adelaide Subgroup usually have massive and blocky weathering. Sometimes desiccation cracks and impressions of raindrops are present. In the mudstones of the Beaufort Group calcareous nodules and concretions occur throughout.

The flood plains of the Beaufort Group (Karoo Supergroup) are internationally renowned for the early diversification of land vertebrates and provide the worlds' most complete transition from early "reptiles" to mammals. The Beaufort Group is subdivided into a series of biostratigraphic units based on its faunal content (Kitching 1977, 1978; Keyser *et al*, 1977, Rubidge 1995, Smith *et al*, 2020; Viglietti 2020) (Figure 7). A portion of the proposed development is underlain by the Balfour Formation (Figure 6) which is divided in the *Daptocephalus* (DAZ) which in turn is divided in the upper (younger) *Lystrosaurus maccaigi* - *Moschorhinus* and lower (older) *Dicynodon-Theriognathus* Subzones (Figure 7-12; Viglietti, 2020).

The dicynodont, *Daptocephalus leoniceps* is the main biozone defining fossil of the *Daptocephalus* Assemblage Zone (Figure 8). The *Daptocephalus* Assemblage Zone (DaAZ) is characterised by the co-



occurrence of the dicynodontoid *Daptocephalus leoniceps*, the therocephalian *Theriongnathus microps*, and the cynodont *Procynosuchus delaharpeae*. The DaAZ comprise of two subzones representing the two distinct faunal assemblages in this assemblage zone. The Dicynodon -Theriongnathus Subzone (Figure 9) (in co-occurrence with *Daptocephalus*) is present in the lower *Daptocephalus* Assemblage Zone while the *Lystrosaurus maccaigi* – Moschorhinus kitchingi Subzone (Figure 10) is present in the upper DaAZ. The defining taxa of the latter subzone is *L. maccaigi*, *Daptocephalus* and *Moschorhinus*. This Zone is characterized by the co-occurrence of the two therapsids namely *Dicynodon* and *Theriongnathus* (Figure 9). The *Daptocephalus* Assemblage Zone of the Beaufort Group shows the greatest vertebrate diversity and includes numerous well-preserved genera and species of dicynodonts, biarmosuchians, gorgonopsian, therocephalian and cynodont therapsid Synapsida. Captorhinid Reptilia are also present while eosuchian Reptilia, Amphibia and Pisces are rarer in occurrence. Trace fossils of vertebrates and invertebrates as well as *Glossopteris* flora plants have also been described.

The *Daptocephalus* Assemblage Zone (AZ) expands into the lower Palingkloof of the Upper Balfour Formation (most probably not present in the study area). The lower Palingkloof Member is of special importance as it precedes the Permo-Triassic Extinction Event which destroyed the vertebrate fauna and extinguished the diverse glossopterid plants. The lower *Lystrosaurus declivis* AZ forms part of the Katberg Formation. Fauna and flora from this assemblage zone is rare as few genera survived the Permo-Triassic Extinction Event. The *Lystrosaurus declivis* AZ is characterized by the dicynodont, *Lystrosaurus*, and captorhinid reptile, *Procolophon*, biarmosuchian and gorgonopsian Therapsida that did not survive into the *Lystrosaurus* Assemblage Zone although the therocephalian and cynodont Therapsida are present in moderate quantities. Captorhinid Reptilia is reduced, but this interval is characterised by a unique diversity of oversize amphibians while fossil fish, millipedes and diverse trace fossils have also been recorded.



Age	Gp		West of 24° E	East of 24° E	Free State / KwaZulu-Natal	Vertebrate Assemblage Zones	Vertebrate Subzones					
JURASSIC	STORMBERG			Drakensberg Gp	Drakensberg Gp	Massospondylus						
		Clarens Fm		Clarens Fm								
		upper Elliot Fm		upper Elliot Fm								
TRIASSIC	Tarkastad Subgp	lower Elliot Fm		lower Elliot Fm	Scalenodontoides							
		Molteno Fm		Molteno Fm								
		Burgersdorp Fm		Driekoppen Fm	Cynognathus	Cricodon-Ufudocyclops Trirachodon-Kannemeyeria Langbergia-Gargainia						
		Katberg Fm		Verkyerskop Fm	Lystrosaurus declivis							
		PERMIAN		BEAUFORT	Adelaide Subgp	Teekloof Fm	Balfour Fm	Normandem Fm	Palingkloof M.			
									Elandsberg M.	Harrismith M.	Daptocephalus	Lystrosaurus maccaigi-Moschorhinus
									Ripplemead M.	Schoondraai M.		
			Jaggaboersnek M.						Rooinekke M.	Dicynodon-Theriongnathus		
			Oudeberg M.						Frankfort M.			
									Cistecephalus			
Middleton Fm	Endothiodon								Tropidostoma-Gorgonops Lycosuchus-Eunotosaurus			
Abrahamskraal Fm	Tapinocephalus								Diictodon-Styracocephalus Eosimops-Glanosuchus			
Waterford Fm	Eodicynodon											
Tierberg/Fort Brown												
ECCA												

Figure 7: Vertebrate biozonation range chart for the Main Karoo Basin of South Africa.

Solid lines indicate known ranges, dotted lines indicate suspected but not confirmed ranges, single dot represents the stratigraphic position of the taxa that have only been recovered from a single bed.

Wavy lines indicate unconformities. (PLYCSR=Pelycosauria and MAMMFMES+Mammaliaformes.

Gp=group, Subgp-Supbroup, Fm=Formation, M=Member

The geology of the proposed development is indication by the red polygon.

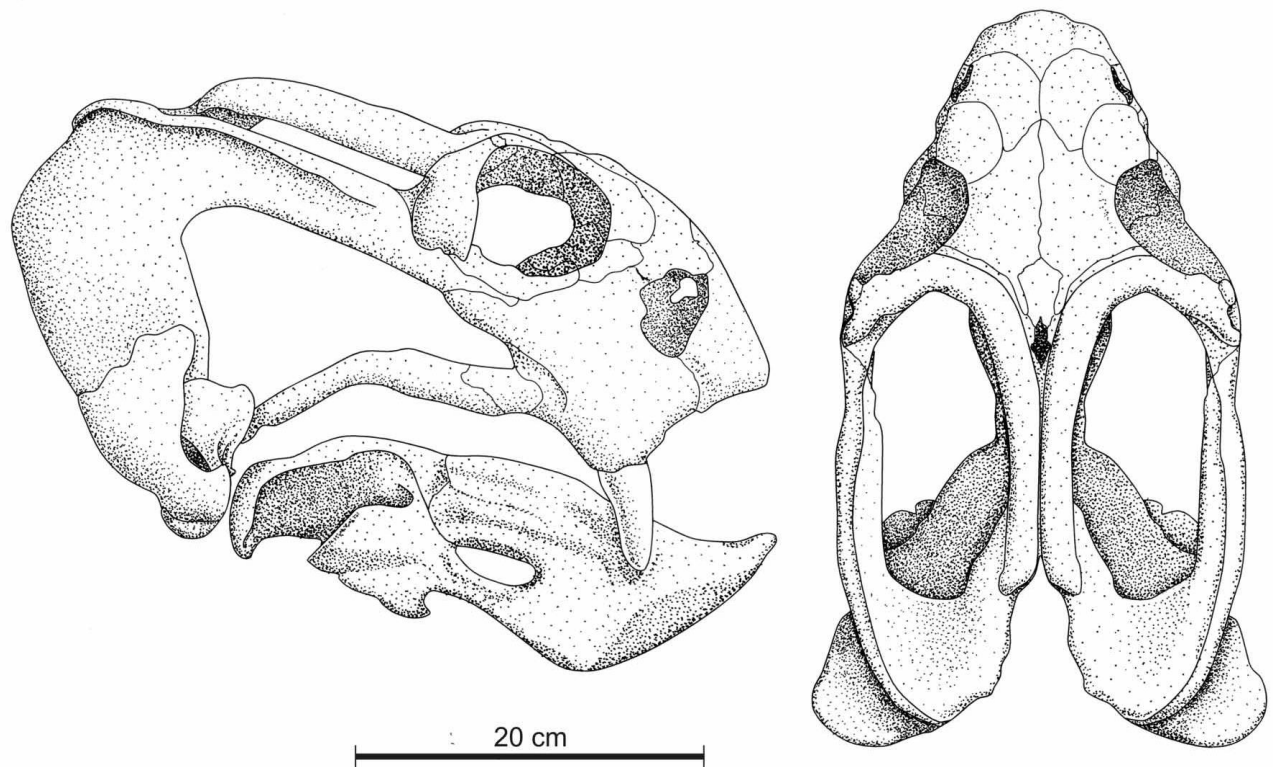


Figure 8: Lateral and dorsal views of skull of the dicynodont *Daptocephalus leoniceps*, the main biozone defining fossil (Image taken from Viglietti, 2020) and dorsal views (Image taken from Viglietti, 2020).

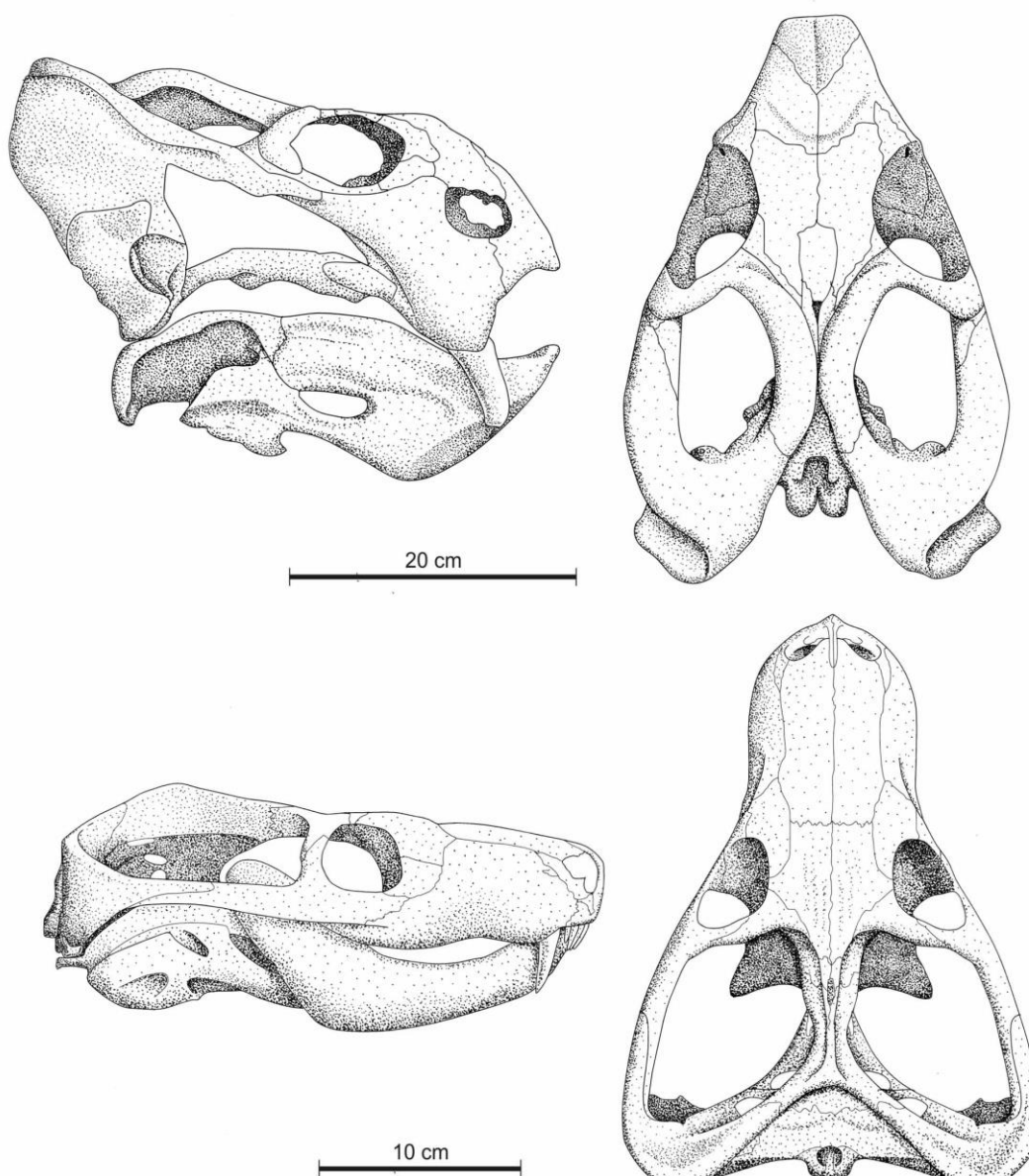


Figure 9: Skulls of the biozone defining fossils of the *Dicynodon-Theriognathus* Subzone in lateral and dorsal views. *Dicynodon lacerticeps* (top), *Theriognathus microps* (bottom) (Image taken from Viglietti, 2020).

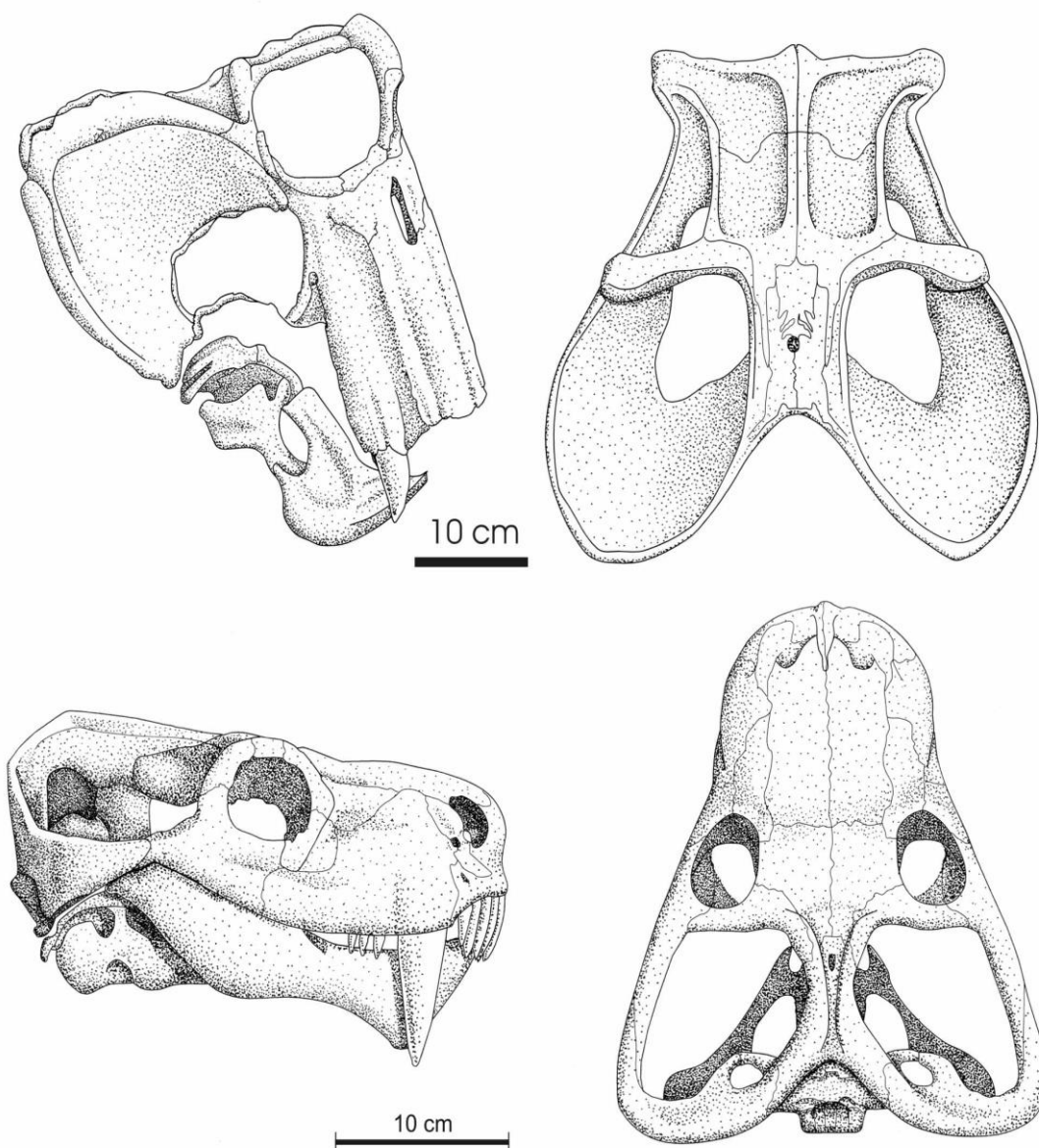


Figure 10: Biozone defining fossils of the *Lystrosaurus maccaigi*- *Moschorhinus* Subzone. The skulls of the *Lystrosaurus maccaigi* (top) and *Moschorhinus kitchingi* (bottom) in lateral (Image taken from Viglietti, 2020).

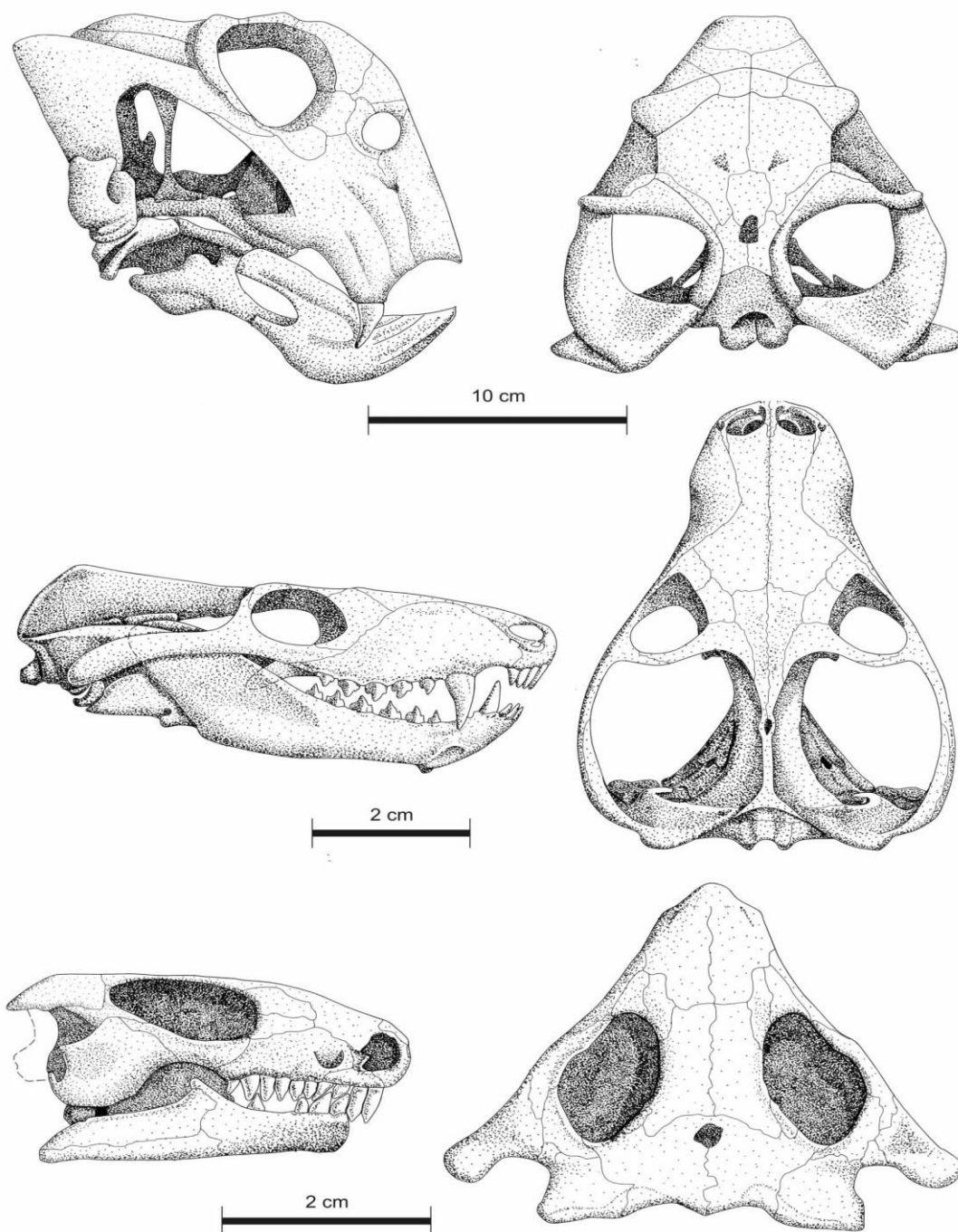


Figure 11: Lateral and dorsal views of the index taxa defining the *Lystrosaurus declivis* Assemblage Zone. (top) *Lystrosaurus declivis*, (centre) *Thrinaxodon liorhinus*, (bottom) *Procolophon trigoniceps* (Image taken from Botha and Smith, 2020). Image taken from Viglietti, 2020.

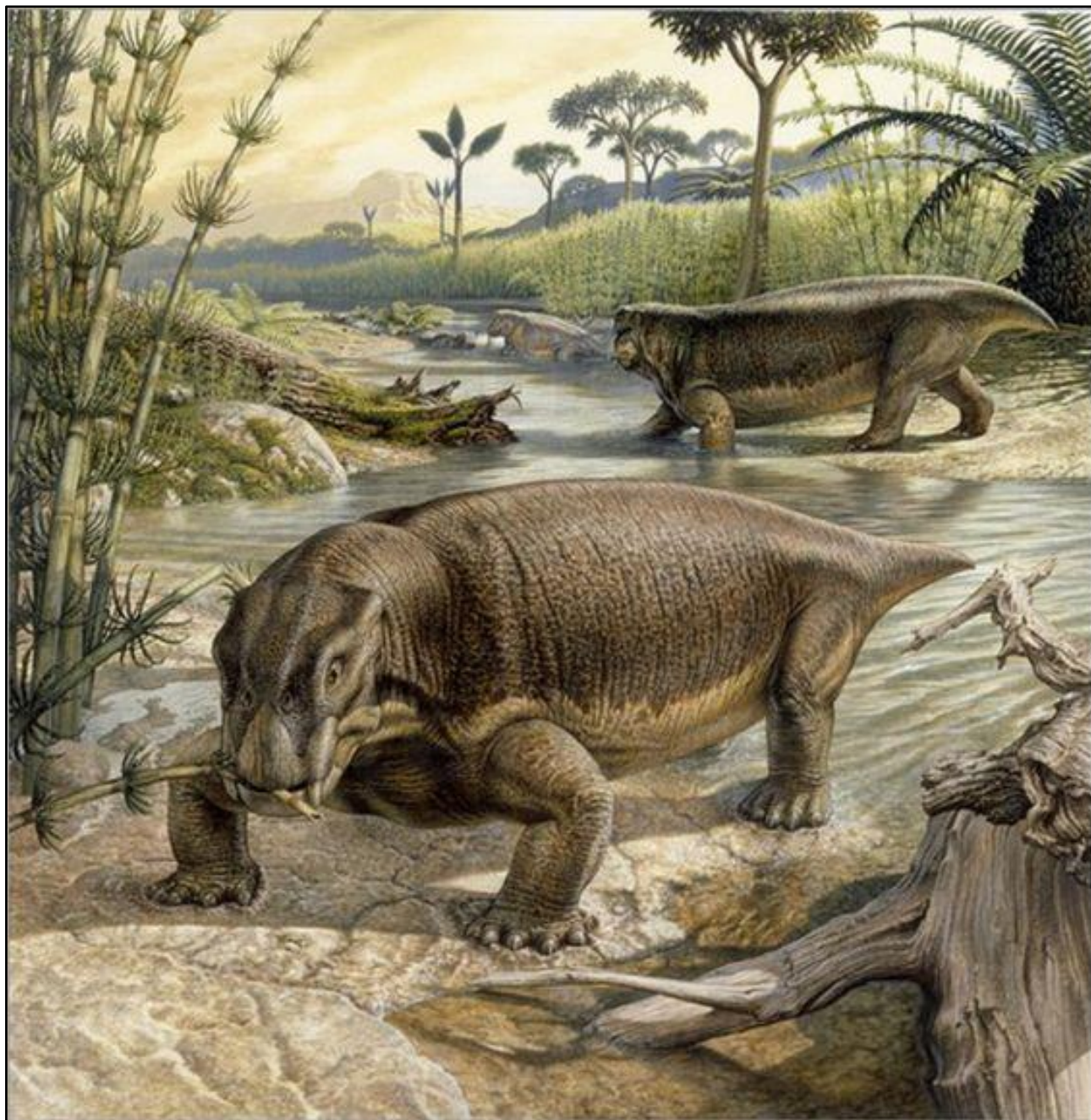


Figure 12: Reconstruction of *Lystrosaurus* sp.

<https://i.pinimg.com/564x/ac/7b/13/ac7b132d1d9882e6d9f9af804820a21e.jpg>

6. ADDITIONAL INFORMATION CONSULTED

In compiling this report the following sources were consulted:

- Geological map 1:100 000, Geology of the Republic of South Africa (Visser 1984)
- A Google Earth map with polygons of the proposed development was obtained from SiVEST.
- 1:250 000 2726 Kroonstad (2000) Geological Map (Council for Geosciences, Pretoria)
- Updated geological shape files (Council for Geosciences, Pretoria)
- National Environmental Web-based Screening Tool

7. SITE VISIT

A site-specific field survey of the development footprint was conducted on foot and by motor vehicle on 12 September 2023. No fossiliferous outcrops were identified during the site visit.



Figure 13: General view of the proposed development indicates a low topography with grassveld vegetation.



Figure 14: Quaternary superficial sands and alluvium in dry river bed.



Figure 15: Unfossiliferous dolerite koppie.



8. ASSESSMENT METHODOLOGY

8.1 Method of Environmental Assessment

An assessment of the impact significance of the proposed Motuoane Hennenman seismic lines in the Free State indicates that development is underlain Quaternary superficial deposits (sands as well as alluvium, the Balfour Formation (Adelaide Subgroup, Beaufort Group, Karoo Supergroup) as well as Jurassic dolerite.

Nature of the Impact

The proposed development will entail the drilling of an additional 10 boreholes as well as the seismic survey.

Geographical extent of the impact

Impacts on fossil heritage will only occur during the construction (exploration) phase of the development when new excavations and/or drilling into fresh potentially fossiliferous bedrock takes place. The extent of the area of potential impact is thus limited to the project site.

Sensitive areas

The proposed development is underlain by potentially fossiliferous Quaternary sediments as well as the Highly fossiliferous Balfour Formation (Adelaide Subgroup, Beaufort Group).

Duration of the Impact

The expected duration of the impact is potentially permanent too long term. In the absence of mitigation procedures (and if fossils are present in the development area) the harm or destruction of palaeontological heritage will be permanent.

Potential Significance of the Impact

The destruction/damage of fossil heritage in the development, will be permanent and irreversible. Any fossil heritage in the development area is considered to be of scientific and culturally significant and thus any negative impact on the fossil heritage will be highly significant.

Severity/ Beneficial scale

The development of the proposed Motuoane Hennenman seismic lines may be beneficial, as the excavations may uncover fossils hidden beneath the surface and would have remained unknown to science.

**Intensity of impact occurring**

Probable significant impacts on palaeontological heritage during the construction phase are low.

Probability

According to the Geology of the proposed development area, fossil heritage can be found in the proposed area.

Mitigation

If fossil heritage is present in the development footprint, any negative or detrimental impact on these fossils can be mitigated by describing and collecting of the well-preserved fossils (by a professional palaeontologist). Mitigation should take place after vegetation clearance and before the ground is levelled for construction. A SAHRA permit will be required for fossil collection and the fossil heritage must be housed in an accredited institution (university or museum). If fossil heritage cannot be excavated a buffer could be placed around the fossil heritage thus protecting the fossils and fossil locality.

Degree of irreversible Loss

Impacts on fossil heritage are generally irreversible. Scientifically all well-documented records and palaeontological studies of any fossils exposed during construction would represent a positive impact. The possibility of a negative impact on the palaeontological heritage of the area can be reduced by the implementation of adequate mitigation procedures. If mitigation is undertaken the benefit scale for the project will be beneficial.

Irreplaceable loss

Fossil heritage may be present in the fossiliferous sediments underlaying the development. Significant loss of fossil heritage may be limited by taking a precautionary approach.

Impact Summary

Environmental parameter	Issues	Rating prior to mitigation	Average	Rating post mitigation	Average
Planning Phase the Motuoane Hennenman seismic lines	No Impact		No Impact		
Construction (exploration) Stage	Destroy or permanently seal-in fossils at or below the surface that are then no longer	-13	Negative Medium impact	6	Low positive



Motuoane Hennenman seismic lines	available for scientific study				
Decommissioning the Motuoane Hennenman seismic lines	No Impact		No Impact		

9. CONCLUSION

A site-specific field survey of the development footprint was conducted on foot and by motor vehicle on 12 September 2023. No fossiliferous outcrop was detected in the proposed development. This could be attributed to the lack of outcrops as well as the lush grassy vegetation in the area. Based on the site investigation as well as desktop research it is concluded that fossil heritage of scientific and conservational interest in the development footprint is rare. This is in contrast with the High Sensitivity allocated to the development area by the SAHRIS Palaeosensitivity Map and DFFE Screening Tool. **A medium Palaeontological Significance has been allocated for the construction (exploration), operational and decommissioning phases of the development.** As the No-Go Alternative considers the option of 'do nothing' and maintaining the status quo, it will have a Neutral impact on the Palaeontological Heritage of the development. **The Cumulative impacts of the development near Kroonstad is considered to be medium pre- mitigation and Low post mitigation and falls within the acceptable limits for the project.** It is therefore considered that the proposed development will not lead to damaging impacts on the palaeontological resources of the area. **The construction of the development may thus be permitted in its whole extent, as the development footprint is not considered sensitive in terms of palaeontological resources.** It is consequently recommended that no further palaeontological heritage studies, ground truthing and/or specialist mitigation are required pending the discovery of newly discovered fossils.

If fossil remains are discovered during any phase of construction, either on the surface or exposed by excavations the **Chance Find Protocol** must be implemented by the ECO/site manager in charge of these developments. These discoveries ought to be protected (if possible, *in situ*) and the ECO/site manager must report to SAHRA (Contact details: SAHRA, 111 Harrington Street, Cape Town. PO Box 4637, Cape Town 8000, South Africa. Tel: 021 462 4502. Fax: +27 (0)21 462 4509. Web: www.sahra.org.za) and Free State Heritage Resources Authority so that mitigation (recording and collection) can be carry out by a paleontologist.

Preceding any collection of fossil material, the specialist would need to apply for a collection permit from SAHRA. Fossil material must be curated in an accredited collection (museum or university collection), while all fieldwork and reports should meet the minimum standards for palaeontological impact studies suggested by SAHRA.



10. CHANCE FINDS PROTOCOL

The following procedure will only be followed if fossils are uncovered during the excavation phase of the development.

Legislation

Cultural Heritage in South Africa (includes all heritage resources) is protected by the **National Heritage Resources Act (Act No 25 of 1999) (NHRA)**. According to Section 3 of the Act, all Heritage resources include **"all objects recovered from the soil or waters of South Africa, including archaeological and palaeontological objects and material, meteorites and rare geological specimens"**.

Palaeontological heritage is unique and non-renewable and is protected by the NHRA and are the property of the State. It is thus the responsibility of the State to manage and conserve fossils on behalf of the citizens of South Africa. Palaeontological resources may not be excavated, broken, moved, or destroyed by any development without prior assessment and without a permit from the relevant heritage resources authority as per section 35 of the NHRA.

A fossil is the naturally preserved remains (or traces thereof) of plants or animals embedded in rock. These organisms lived millions of years ago. Fossils are extremely rare and irreplaceable. By studying fossils, it is possible to determine the environmental conditions that existed in a specific geographical area millions of years ago.

This informational document is intended for workmen and foremen on construction sites. It describes the actions to be taken when mining or construction activities accidentally uncovers fossil material.

It is the responsibility of the Environmental Site Officer (ESO) or site manager of the project to train the workmen and foremen in the procedure to follow when a fossil is accidentally uncovered. In the absence of the ESO, a member of the staff must be appointed to be responsible for the proper implementation of the chance find protocol as not to compromise the conservation of fossil material.

Chance Find Procedure

- If a chance find is made the person responsible for the find must immediately **stop working** and all work that could impact that finding must cease in the immediate vicinity of the find.
- The person who made the find must immediately **report** the find to his/her direct supervisor which in turn must report the find to his/her manager and the ESO or site manager. The ESO or site manager must report the find to the relevant Heritage Agency (South African Heritage Research Agency, SAHRA) and/or Free State Heritage Resources Authority. (Contact details: SAHRA, 111 Harrington Street, Cape Town. PO Box 4637, Cape Town 8000, South Africa.



- Tel: 021 462 4502. Fax: +27 (0)21 462 4509. Web: www.sahra.org.za. The information to the Heritage Agency must include photographs of the find, from various angles, as well as the GPS co-ordinates.
- A preliminary report must be submitted to the Heritage Agency within **24 hours** of the find and must include the following: 1) date of the find; 2) a description of the discovery and a 3) description of the fossil and its context (depth and position of the fossil), GPS co-ordinates.
- Photographs (the more the better) of the discovery must be of high quality, in focus, accompanied by a scale. It is also important to have photographs of the vertical section (side) where the fossil was found.
- Upon receipt of the preliminary report, the Heritage Agency will inform the ESO (or site manager) whether a rescue excavation or rescue collection by a palaeontologist is necessary.
- The site must be secured to protect it from any further damage. **No attempt** should be made to remove material from their environment. The exposed finds must be stabilized and covered by a plastic sheet or sand bags. The Heritage agency will also be able to advise on the most suitable method of protection of the find.
- If the fossil cannot be stabilized the fossil may be collected with extreme care by the ESO. Fossils finds must be stored in tissue paper and in an appropriate box while due care must be taken to remove all fossil material from the rescue site.
- Once the Heritage Agency has issued the written authorization, the developer may continue with the development on the affected area.



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Appendix A

CURRICULUM VITAE

PROFESSION: Palaeontologist
YEARS' EXPERIENCE: 30 years in Palaeontology
EDUCATION: B.Sc Botany and Zoology, 1988
University of the Orange Free State

B. Sc (Hons) Zoology, 1991
University of the Orange Free State

Management Course, 1991
University of the Orange Free State

M. Sc. *Cum laude* (Zoology), 2009
University of the Free State

Dissertation title: The postcranial skeleton of the Early Triassic non-mammalian Cynodont *Galesaurus planiceps*: implications for biology and lifestyle

MEMBERSHIP

Palaeontological Society of South Africa (PSSA) 2006-currently

EMPLOYMENT HISTORY

Part time Laboratory assistant Department of Zoology & Entomology
University of the Free State Zoology 1989-1992

Part time laboratory assistant Department of Virology
University of the Free State Zoology 1992

Research Assistant National Museum, Bloemfontein 1993 – 1997

Principal Research Assistant National Museum, Bloemfontein
and Collection Manager 1998–2022



TECHNICAL REPORTS

- Butler, E. 2014. Palaeontological Impact Assessment of the proposed development of private dwellings on portion 5 of farm 304 Matjesfontein Keurboomstrand, Knysna District, Western Cape Province. Bloemfontein.
- Butler, E. 2014. Palaeontological Impact Assessment for the proposed upgrade of existing water supply infrastructure at Noupoot, Northern Cape Province. 2014. Bloemfontein.
- Butler, E. 2015. Palaeontological impact assessment of the proposed consolidation, re-division, and development of 250 serviced erven in Nieu-Bethesda, Camdeboo local municipality, Eastern Cape. Bloemfontein.
- Butler, E. 2015. Palaeontological impact assessment of the proposed mixed land developments at Rooikraal 454, Vrede, Free State. Bloemfontein.
- Butler, E. 2015. Palaeontological exemption report of the proposed truck stop development at Palmiet 585, Vrede, Free State. Bloemfontein.
- Butler, E. 2015. Palaeontological impact assessment of the proposed Orange Grove 3500 residential development, Buffalo City Metropolitan Municipality East London, Eastern Cape. Bloemfontein.
- Butler, E. 2015. Palaeontological Impact Assessment of the proposed Gonubie residential development, Buffalo City Metropolitan Municipality East London, Eastern Cape Province. Bloemfontein.
- Butler, E. 2015. Palaeontological Impact Assessment of the proposed Ficksburg raw water pipeline. Bloemfontein.
- Butler, E. 2015. Palaeontological Heritage Impact Assessment report on the establishment of the 65 mw Majuba Solar Photovoltaic facility and associated infrastructure on portion 1, 2 and 6 of the farm Witkoppies 81 HS, Mpumalanga Province. Bloemfontein.
- Butler, E. 2015. Palaeontological Impact Assessment of the proposed township establishment on the remainder of portion 6 and 7 of the farm Sunnyside 2620, Bloemfontein, Mangaung metropolitan municipality, Free State, Bloemfontein.
- Butler, E. 2015. Palaeontological Impact Assessment of the proposed Woodhouse 1 photovoltaic solar energy facilities and associated infrastructure on the farm Woodhouse729, near Vryburg, North West Province. Bloemfontein.
- Butler, E. 2015. Palaeontological Impact Assessment of the proposed Woodhouse 2 photovoltaic solar energy facilities and associated infrastructure on the farm Woodhouse 729, near Vryburg, North West Province. Bloemfontein.
- Butler, E. 2015. Palaeontological Impact Assessment of the proposed Orkney solar energy farm and associated infrastructure on the remaining extent of Portions 7 and 21 of the farm Wolvehuis 114, near Orkney, North West Province. Bloemfontein.
- Butler, E. 2015. Palaeontological Impact Assessment of the proposed Spectra foods broiler houses and abattoir on the farm Maiden Manor 170 and Ashby Manor 171, Lukhanji Municipality, Queenstown, Eastern Cape Province. Bloemfontein.
- Butler, E. 2016. Palaeontological Impact Assessment of the proposed construction of the 150 MW Noupoot concentrated solar power facility and associated infrastructure on portion 1 and 4 of the farm Carolus Poort 167 and the remainder of Farm 207, near Noupoot, Northern Cape. Prepared for Savannah Environmental. Bloemfontein.
- Butler, E. 2016. Palaeontological Impact Assessment of the proposed Woodhouse 1 Photovoltaic Solar Energy facility and associated infrastructure on the farm Woodhouse 729, near Vryburg, North West Province. Bloemfontein.
- Butler, E. 2016. Palaeontological Impact Assessment of the proposed Woodhouse 2 Photovoltaic Solar Energy facility and associated infrastructure on the farm Woodhouse 729, near Vryburg, North West Province. Bloemfontein.
- Butler, E. 2016. Proposed 132kV overhead power line and switchyard station for the authorised Solis Power 1 CSP project near Upington, Northern Cape. Bloemfontein.
- Butler, E. 2016. Palaeontological Impact Assessment of the proposed Senqu Pedestrian Bridges in Ward 5 of Senqu Local Municipality, Eastern Cape Province. Bloemfontein.
- Butler, E. 2016. Recommendation from further Palaeontological Studies: Proposed Construction of the Modderfontein Filling Station on Erf 28 Portion 30, Founders Hill, City of Johannesburg, Gauteng Province. Bloemfontein.



- Butler, E. 2016. Recommendation from further Palaeontological Studies: Proposed Construction of the Modikwa Filling Station on a Portion of Portion 2 of Mooihoek 255 Kt, Greater Tubatse Local Municipality, Limpopo Province. Bloemfontein.
- Butler, E. 2016. Recommendation from further Palaeontological Studies: Proposed Construction of the Heidedal filling station on Erf 16603, Heidedal Extension 24, Mangaung Local Municipality, Bloemfontein, Free State Province. Bloemfontein.
- Butler, E. 2016. Recommended Exemption from further Palaeontological studies: Proposed Construction of the Gunstfontein Switching Station, 132kv Overhead Power Line (Single or Double Circuit) and ancillary infrastructure for the Gunstfontein Wind Farm Near Sutherland, Northern Cape Province. Savannah South Africa. Bloemfontein.
- Butler, E. 2016. Palaeontological Impact Assessment of the proposed Galla Hills Quarry on the remainder of the farm Roode Krantz 203, in the Lukhanji Municipality, division of Queenstown, Eastern Cape Province. Bloemfontein.
- Butler, E. 2016. Chris Hani District Municipality Cluster 9 water backlog project phases 3a and 3b: Palaeontology inspection at Tsomo WTW. Bloemfontein.
- Butler, E. 2016. Palaeontological Impact Assessment of the proposed construction of the 150 MW Noupoot concentrated solar power facility and associated infrastructure on portion 1 and 4 of the farm Carolus Poort 167 and the remainder of Farm 207, near Noupoot, Northern Cape. Savannah South Africa. Bloemfontein.
- Butler, E. 2016. Palaeontological Impact Assessment of the proposed upgrading of the main road MR450 (R335) from Motherwell to Addo within the Nelson Mandela Bay Municipality and Sunday's River valley Local Municipality, Eastern Cape Province. Bloemfontein.
- Butler, E. 2016. Palaeontological Impact Assessment construction of the proposed Metals Industrial Cluster and associated infrastructure near Kuruman, Northern Cape Province. Savannah South Africa. Bloemfontein.
- Butler, E. 2016. Palaeontological Impact Assessment for the proposed construction of up to a 132kv power line and associated infrastructure for the proposed Kalkaar Solar Thermal Power Plant near Kimberley, Free State and Northern Cape Provinces. PGS Heritage. Bloemfontein.
- Butler, E. 2016. Palaeontological Impact Assessment of the proposed development of two burrow pits (DR02625 and DR02614) in the Enoch Mgijima Municipality, Chris Hani District, Eastern Cape.
- Butler, E. 2016. Ezibeleni waste Buy-Back Centre (near Queenstown), Enoch Mgijima Local Municipality, Eastern Cape. Bloemfontein.
- Butler, E. 2016. Palaeontological Impact Assessment for the proposed construction of two 5 Mw Solar Photovoltaic Power Plants on Farm Wildebeestkuil 59 and Farm Leeuwbosch 44, Leeudoringstad, North West Province. Bloemfontein.
- Butler, E. 2016. Palaeontological Impact Assessment for the proposed development of four Leeuwberg Wind farms and basic assessments for the associated grid connection near Loeriesfontein, Northern Cape Province. Bloemfontein.
- Butler, E. 2016. Palaeontological impact assessment for the proposed Aggeneys south prospecting right project, Northern Cape Province. Bloemfontein.
- Butler, E. 2016. Palaeontological impact assessment of the proposed Motuoane Ladysmith Exploration right application, KwaZulu Natal. Bloemfontein.
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