



PALAEONTOLOGICAL
IMPACT ASSESSMENT
PROPOSED
DEVELOPMENT OF THE
PIXLEY PARK REF AND
ASSOCIATED
INFRASTRUCTURE NEAR
DE AAR, NORTHERN CAPE
PROVINCE

2022



COMPILED FOR: CTS Heritage

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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A handwritten signature in black ink, appearing to read 'Elize Butler'.



The heritage 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	Relevant section in report
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 10
(d) The duration, date and season of the site investigation and the relevance of the season to the outcome of the assessment	Section 1 and 11
(e) a description of the methodology adopted in preparing the report or carrying out the specialised process inclusive of equipment and modelling used	Section 7 Approach and Methodology
(f) details of an assessment of the	Section 1 and 11



Requirements of Appendix 6 - GN R326 EIA Regulations of 7 April 2017	Relevant section in report
specific 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 alternative;	
(g) An identification of any areas to be avoided, including buffers	No buffers or areas of sensitivity identified Section 5
(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 7.1 – 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 11
(k) Any mitigation measures for inclusion in the EMPr	Section 12
(l) Any conditions for inclusion in the environmental authorisation	Section 12
(m) Any monitoring requirements for inclusion in the EMPr or environmental authorisation	Section 12
(n)(i) A reasoned opinion as to whether the proposed activity, activities or portions thereof should be authorised and	Section 1 and 11
(n)(iA) A reasoned opinion regarding the acceptability of the proposed	



Requirements of Appendix 6 - GN R326 EIA Regulations of 7 April 2017	Relevant section in report
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 11
(o) A description of any consultation process that was undertaken during the course of carrying out the study	Not applicable. A public consultation process will be conducted as part of the EIA and EMPr process. N/A
(p) A summary and copies if any comments that were received during any consultation process	N/A
(q) Any other information requested by the competent authority.	N/A
(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 CTS Heritage to conduct the Palaeontological Impact Assessment (PIA) to assess the Pixley Park REF (Renewable Energy Facility) near De Aar. To comply with the National Heritage Resources Act (No 25 of 1999, section 38) (NHRA), this PIA is necessary to verify 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 proposed Pixley Park REF project is underlain by Quaternary alluvium, the Karoo Dolerite Suite, as well as the Abrahamskraal Formation (Adelaide Subgroup, Beaufort Group, Karoo Supergroup). The proposed Pixley Park REF underlain by Quaternary alluvium, the Karoo Dolerite Suite, as well as the Abrahamskraal Formation (Adelaide Subgroup, Beaufort Group, Karoo Supergroup).

A site-specific field survey of the development footprint was conducted on foot and by motor vehicle on 16 to 17 October 2022. The following examples of fossil heritage were identified in the development footprint.

- Fragments of the posterior portion of a small tetrapod skeleton.
- A fragment of a tree fossil
- Fairly well-preserved ripple marks (about 1 m in diameter) were identified in the pan/dam areas.

Sediments of the Karoo Supergroup in this area are deeply weathered and in places baked by Jurassic dolerite. Extensive excavations into deep bedrock during the construction phase is not anticipated and it is thus considered that the proposed development will not lead to detrimental impacts on the palaeontological reserves of the area. The construction of the development may be authorised in its whole extent, as the development footprint is not considered sensitive in terms of palaeontological resources.

It is thus recommended that:

- The Environmental Control Officer (ECO), responsible for the development, should be aware of the possibility of finding fossils in the Adelaide Subgroup (Beaufort Group, Karoo Supergroup) and Quaternary deposits of the area.



- If Palaeontological Heritage is uncovered during surface clearing and excavations the **Chance find Protocol** attached should be implemented immediately. These discoveries ought to be protected (if possible, *in situ*) and the ECO 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) so that correct mitigation (recording and collection) can be carry out by a paleontologist.

Before any fossil material can be collected from the development site, the specialist involved would need to apply for a collection permit from SAHRA. Fossil material must be housed in an official collection (museum or university), while all reports and fieldwork should meet the minimum standards for palaeontological impact studies proposed by SAHRA (2012). 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.

TABLE OF CONTENTS

1 INTRODUCTION.....	3
2 QUALIFICATIONS AND EXPERIENCE OF THE AUTHOR.....	7
3 LEGISLATION.....	7
3.1 National Heritage Resources Act (25 of 1999)	7
4 OBJECTIVE.....	9
5 GEOLOGICAL AND PALAEONTOLOGICAL HISTORY.....	10
6 GEOGRAPHICAL LOCATION OF THE SITE.....	23
7 METHODS.....	23
7.1 Assumptions and Limitations	23
8 ADDITIONAL INFORMATION CONSULTED.....	23
9 SITE VISIT.....	24
10 ASSESSMENT METHODOLOGY AND IMPACT ASSESSMENT FORMAT.....	30
10.1 IMPACT ASSESSMENT TABLES:	30
11 FINDINGS AND RECOMMENDATIONS.....	30
12 CHANCE FINDS PROTOCOL.....	31
12.1 Background	31



12.2 Legislation	32
12.3 Chance Find Protocol	32
13 BIBLIOGRAPHY	33

LIST OF FIGURES

Figure 1: Google Earth Image (2022) of the location of the proposed Pixley Park REF, near De Aar in the Northern Cape Province.	4
Figure 2: Topography of the proposed Pixley Park REF, near De Aar in the Northern Cape Province.	5
Figure 3: Extract of the 1:250 000 Colesberg 3024 (Le Roux, 1998) Geological map (Council of Geoscience, Pretoria) indicating the proposed development underlain by quaternary alluvium (pale yellow; Quaternary), Jurassic dolerite (Jd, red), and Adelaide Subgroup (Pa, light green, Beaufort Group, Karoo Supergroup).	14
Figure 4: Updated Geology (Council of Geosciences, Pretoria) of the proposed Pixley Park REF indicates that the proposed development is underlain by the Quaternary alluvium, colluvium eluvium and gravel, the Karoo Dolerite Suite as well as Abrahamskraal Formation (Adelaide Subgroup, Beaufort Group, Karoo Supergroup).	17
Figure 5: Extract of the 1:250 000 SAHRIS PalaeoMap map (Council of Geosciences, Pretoria) indicating the Palaeontological Sensitivity of the proposed Pixley Park REF near De Aar in the Northern Cape.	18
Figure 6: Vertebrate biozonation range chart for the Main Karoo Basin of South Africa.	20
Figure 7: Tapinocephalus atherstonei, the index taxon of the Tapinocephalus Assemblage Zone, in lateral and dorsal view (Taken from Day and Rubidge, 2020).	21
Figure 8: Lateral and dorsal view of the index taxa of the Eosimops - Glanosuchus Subzone in (top) Eosimops newtoni; (bottom) Glanosuchus macrops. (Image taken from Day and Rubidge, 2020).	22
Figure 9: General flat topography of the proposed Pixley Park Development with patches of unvegetated areas but generally covered by low vegetation.	24
Figure 10: Prominent calcrete exposures overlies the mudrocks of the Abrahamskraal Formation on the banks of the dam (Figure above), with scattered dolerite fragments.	25



Figure 11: Example of a shallow, dry dam covered by grassy vegetation with green mudrock exposures on the sides, while dolerite core stones are present on the edge of the dam.....	25
Figure 12: Well-defined ripple marks in the centre of the dam/pan.....	26
Figure 13: Fragment of a tree fossil located on the edge of a dry dam surrounded by calcrete.....	27
Figure 14: Weathered tetrapod skeleton present in the mudrocks of the Abrahamskraal Formation.....	28
Figure 15: Scattered dolerite boulders loose on Quaternary deposits (left) and dolerite “koppie” on the right.....	29
Figure 16: Electricity infrastructure present throughout the development footprint.....	29

LIST OF TABLES

Table 1: Checklist for Specialist studies conformance with Appendix 6 of the EIA Regulations of 2014 (as amended).....	iv
Table 2: Legend of the 1:250 000 Colesberg 3024 (1998) Geological map (Council of Geoscience, Pretoria).....	15
Table 3: Lithology of the 1:250 000 Colesberg 3024 (1998) Geological map (Council of Geoscience, Pretoria).....	16
Table 4: Palaeontological Significance.....	18
Table 5: Impact Assessment.....	30

Appendix 1: Curriculum Vitae

Appendix 2: Assessment methodology and Impact Assessment Format Table



1



2 INTRODUCTION

Mulilo proposes the development of four PV facilities on Farm Wag 'n Bietjie 5, Portion 1 of Farm Riet Fountain 6, Portion 3 and 4 of Farm Carolus Poort 3 near De Aar in the Northern Cape Province. These facilities known as the Carolus PV, Fountain PV, Rietfontein PV and Wagt PV will have a combined output of 700MW. The Solar Cluster will connect to the new Vetlaagte Main Transmission Substation (MTS) via the Wag 'n Bietjie MTS.

The grid connection infrastructure will comprise of the following:

- The onsite 132kV switching station - 100m x 100m and 30m height
- 132kV Overhead Power Line (OHPL) – 30m height from the switching station to the MTS within a 200m grid corridor
- Extension of the 132kV Busbar at the MTS
- 132kV Feeder Bay at the MTS
- Extension of the 400kV Busbar at the MTS
- 400/132kV Transformer at the MTS
- Generic electrical infrastructure EMPs
- Access Road to switching station and along the powerline route up to the MTS

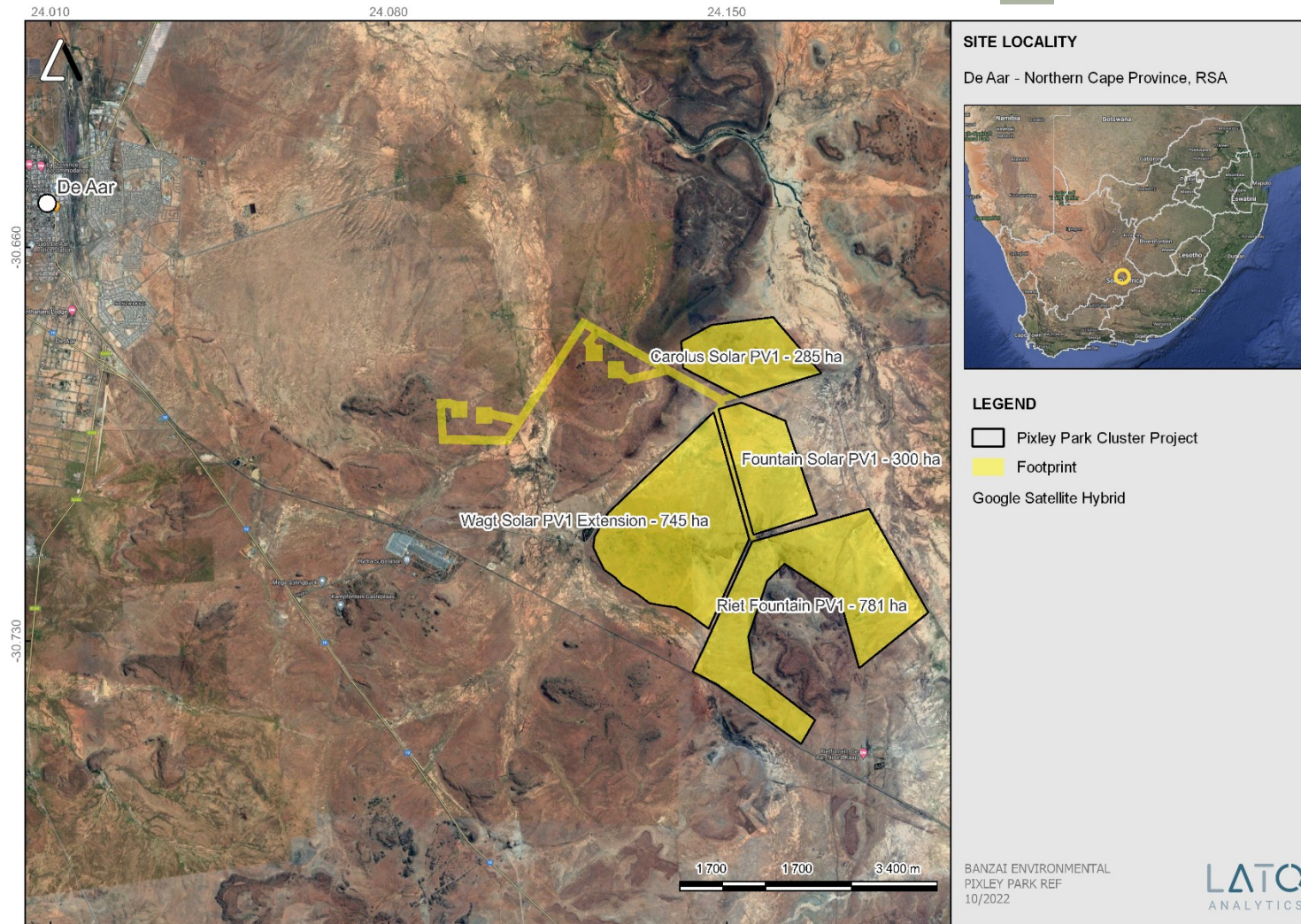


Figure 1: Google Earth Image (2022) of the location of the proposed Pixley Park REF, near De Aar in the Northern Cape Province.

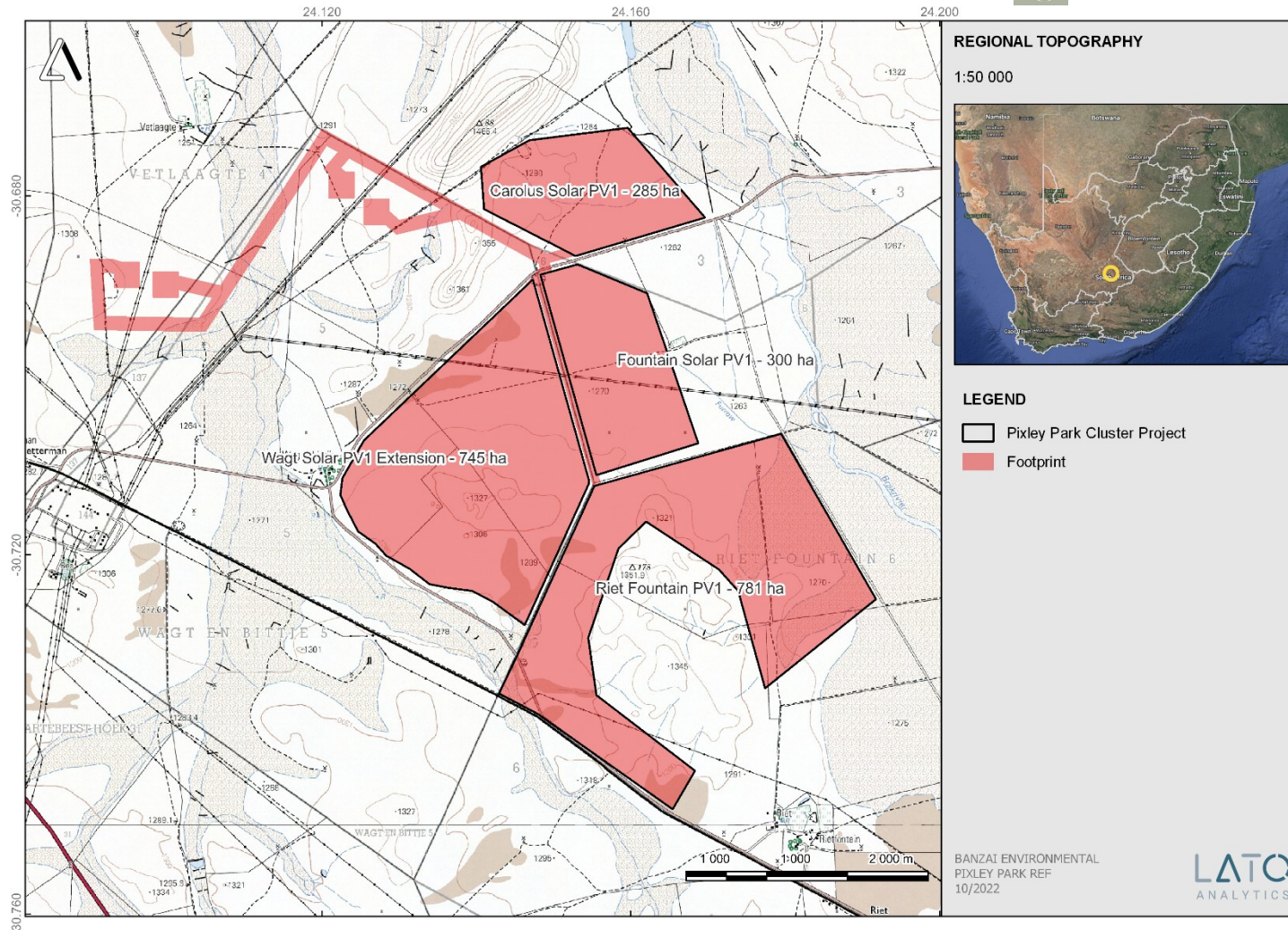


Figure 2: Topography of the proposed Pixley Park REF, near De Aar in the Northern Cape Province.



3 QUALIFICATIONS AND EXPERIENCE OF THE AUTHOR

This present study has been conducted by Mrs Elize Butler. She has conducted approximately 300 palaeontological impact assessments for developments in the Free State, KwaZulu-Natal, Eastern, Central, and Northern Cape, Northwest, Gauteng, Limpopo, and Mpumalanga. She has an MSc (*cum laude*) in Zoology (specializing in Palaeontology) from the University of the Free State, South Africa, and has been working in Palaeontology for more than twenty-five years. She has experience in locating, collecting, and curating fossils. She has been a member of the Palaeontological Society of South Africa (PSSA) since 2006 and has been conducting PIAs since 2014.

4 LEGISLATION

4.1 National Heritage Resources Act (25 of 1999)

Cultural Heritage in South Africa, includes all heritage resources, and 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 following section in each Act are 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 has 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 adheres 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.

5 OBJECTIVE

The aim of a Palaeontological Impact Assessment (PIA) is to minimise the effect of the development on potential fossils at the development site and to determine the potential impact on palaeontological resources.

According to the “SAHRA 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.

The palaeontological status of each rock section is calculated as well as the possible impact of the development on fossil heritage by a) the palaeontological importance of the rocks, b) the type of development and c) the quantity of bedrock removed.

When the development footprint has a moderate to high palaeontological sensitivity a field-based assessment is necessary. The desktop and the field survey of the exposed rock determine the impact significance of the planned development and recommendations for further studies or mitigation are made. Destructive impacts on palaeontological heritage usually only occur during the construction phase while the excavations will change the current topography and destruct or permanently seal-in fossils at or below the ground surface. Fossil Heritage will then no longer be accessible for scientific research.

Mitigation usually precedes construction or may occur during construction when potentially fossiliferous bedrock is exposed. Mitigation comprises the collection and recording of fossils. Preceding excavation of any fossils a permit from SAHRA must be obtained and the material will have to be housed in a permitted institution. When mitigation is applied correctly, a positive impact is possible because our knowledge of local palaeontological heritage may be increased.

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.
- Description of the proposed project and provide information regarding the developer and consultant who commissioned the study.
- Description and location of the proposed development and provide geological and topographical maps.
- Provide Palaeontological and geological history of the affected area.
- Identification of sensitive areas to be avoided (providing shapefiles/kml's) in the proposed development.
- Evaluation of 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** 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
- Implications of specialist findings for the proposed development (such as permits, licenses etc).

6 GEOLOGICAL AND PALAEONTOLOGICAL HISTORY

The geology of the proposed Pixley Park REF near De Aar in the Northern Cape Province is depicted on the 1:250 000 Colesberg 3024 (Le Roux, 1998) Geological map (Council of Geoscience, Pretoria) (**Figure 3, Table 2**). According to this map, the proposed development is underlain by quaternary alluvium (pale yellow; Quaternary), Jurassic dolerite (Jd, red), and Adelaide Subgroup (Pa, light green, Beaufort Group, Karoo Supergroup). The geology has recently been updated (Council of Geosciences, Pretoria) and these maps indicate that the proposed development is underlain by Quaternary alluvium, colluvium eluvium and gravel, the



Karoo Dolerite Suite and the Abrahamskraal Formation (Adelaide Subgroup, Beaufort Group, Karoo Supergroup) (**Figure 4**).

The PalaeoMap of the South African Heritage Resources Information System indicates that the Palaeontological Sensitivity of the Quaternary alluvium is Moderate, while that of the Jurassic Dolerite is Zero/Insignificant. The Palaeontological Sensitivity of the Abrahamskraal Formation (Adelaide Subgroup) is Very High (Almond and Pether, 2009; Almond *et al.*, 2013) (**Figure 5**).

The Quaternary superficial deposits (yellow, single bird figure) are the youngest geological deposits formed during the most recent geological period (approximately 2.6 million years ago to present). Most of the superficial deposits are unconsolidated sediments and consist of clay, gravel, sand, silt, that form relatively thin, discontinuous patches of sediments or larger spreads onshore. These sediments comprise of channel, floodplain and stream deposits, talus gravels and glacial drift sediments. The Quaternary deposits are very important because palaeoclimatic changes are reflected in the different geological formations (Hunter *et al.*, 2006). During the climate fluctuations in the Cenozoic Era most geomorphologic features in southern Africa were formed (Maud, 2012). Barnosky (2005) indicated that various warming and cooling events occurred in the Cenozoic but states that climatic changes during the Quaternary Period, specifically the last 1.8 Ma, were the most drastic climate changes relative to all climate variations in the past. Climate variations that occurred 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).

Quaternary fossil assemblages are normally rare and low in diversity and occur over a wide-ranging geographic area. These fossil assemblages may in some cases occur in extensive alluvial and colluvial deposits cut by dongas. In the past palaeontologists did not focus on Cenozoic superficial deposits although they sometimes comprise of significant fossil deposits. These fossil assemblages resemble modern animals and may comprise of mammalian teeth, bones and horn cores, reptile skeletons and fragments of ostrich eggs. Microfossils, non-marine mollusc shells are also known from Quaternary deposits. Plant material such as foliage, wood, pollens and peats are recovered as well as trace fossils like vertebrate tracks, burrows, termitaria (termite heaps/ mounds) and rhizoliths (root casts). Quaternary scree comprises of rubble and will not contain fossils.

Prominent in the development area is the dolerite “koppies”. These outcrops form part of the Karoo Igneous Province is one of the world’s classic continental flood basalt (CFB) provinces that was formed during the Early Jurassic Period. This province occurs over a comprehensive area in southern Africa and comprises a widespread system of well-developed igneous bodies (dykes, sills) that invaded the sediments of the Main Karoo Basin. Flood basalts do not typically form any visible volcanic structures, but with a series of outbursts form a suite of fissures of sub-



horizontal lava flows that may vary in thickness. The Karoo is considered to be an old flood basalt province and is preserved today as erosional remnants of a more extensive lava cap that covered much of southern Africa in the geological past. This Suite is unfossiliferous.

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 (**Figure 7**; Kitching 1977, 1978; Keyser *et al*, 1977, Rubidge 1995, Smith *et al*, 2020; Viglietti 2020).

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. In the northern Normandien formation the basin consists of coarse to very coarse sandstones and granulstones. Coarsening-upward cycles are present in the lower part of the Normandien Formation while the mudrocks and sandstone units usually form fining-upward cycles. These cycles are positioned on erosion surfaces which is overlain by thin intraformational mud-pellet conglomerate and vary in thickness from a few meters to tens of meters. Singular sandstone units could vary from 6 meters to 60 meters in the south thinning northwards.

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 cross-bedding as well as current ripple lamination. The bases of the sandstone units are massive beds, while ripple lamination is usually confined to thin sandstones towards the top of the thicker units. The mudrocks of the Adelaide Subgroup usually has 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 Adelaide Subgroup is approximately 5 000 m thick in the southeast, but this decreases to about 800m in the centre of the basin which thins out to about 100 to 200m in the north. The Lower Adelaide Subgroup represented in the development consists of the Abrahamskraal Formation that comprises of transitional brackish lacustrine to fluvial, greenish-grey sandstones grading upwards into fine-grained siltstones and mudstones. The Abrahamskraal Formation is about 2 500 m thick.

The Biozone represented in the Pixley REF Custer area is represented by the *Tapinocephalus* Assemblage Zone (AZ). As the second oldest tetrapod biozone in the Karoo, the *Tapinocephalus* AZ is basically restricted to the Abrahamskraal Formation. The lower margin of the AZ is variable due to diachrony. This AZ comprises of the upper third of the *Abrahamskraal* Formation in the southwestern boundary of the basin, has an undefined span between Middleton in the south and



Beaufort West. East of Middleton and north of Sutherland in the Cape Province the AZ comprises the whole of the *Abrahamskraal* AZ. In the southern Free State, it is present in the Lower Adelaide Subgroup (Groenewald *et al.*, 2019).

The *Tapinocephalus* AZ is a rich tetrapod assemblage zone that consists of basal members of therapsid clades Biarmosuchia, Anomodontia, Dicynodontia, Therocephalia, and Gorgonopsia; basal members of the parareptilian clade Pareiasauria; and rare varanopids as well as derived members of the therapsid clade Dinocephalia. The *Tapinocephalus* AZ is characterised by the tapinocephalid dinocephalian species *Tapinocephalus atherstonei* (**Figure 8**) and *Moschops capensis*, the dicynodont *Eosimops newtoni*, and *Robertia broomiana* and the pareiasaur *Bradysaurus baini*.

This AZ includes dinocephalians (*Moschops capensis*), basal pareiasaurs (*Bradysaurus*) that co-occur with pylaeecephalid dicynodonts *Eosimops* and *Robertia* (**Figure 9**). This AZ has a maximum thickness of about 1500 m it comprises of the upper two thirds of the *Abrahamskraal* Formation. The Assemblage Zone can be subdivided into two subzones based on the absence of the dicynodont *Diictodon feliceps*: in the lower *Eosimops* - *Glanosuchus* Subzone and the presence of *Diictodon* in the upper *Diictodon* *Eosimops* - *Glanosuchus* Subzone. The contact between these subzones is the first appearance of *Diictodon felips* at the base of the Moordenaars Member. The upper part of the biozone reflects the Capitanian mass extinction and the low diversity post extinction. The first appearance of *Endothiodon bathystoma* terminates the zone

Fossilized bones are generally encrusted with calcareous material and sometimes smaller fossils are entirely concealed in micritic nodules. In the northern margin of the basin the calcitic crusts is grey to greenish in colour while in the southern margin of the basin the nodules are very hard and often grey with orange weathering due to of low-grade metamorphism related to the proximity of the Cape Fold Belt (Day and Rubidge, 2020).

The *Eosimops* - *Glanosuchus* Subzone is at its thickest 1 100 m. This subzone consists of siltstones, sandstones, and mudstones with erosively-based upward fining cycles (Paiva, 2015; Smith and Keyser, 1995, Wilson *et al.*, 2014). A 60 to 85 siltstone: mudstone ration is present in this succession with a greenish-grey to bluish-grey and less common greyish-red to purple colour. (Cole *et al.*, 2016).

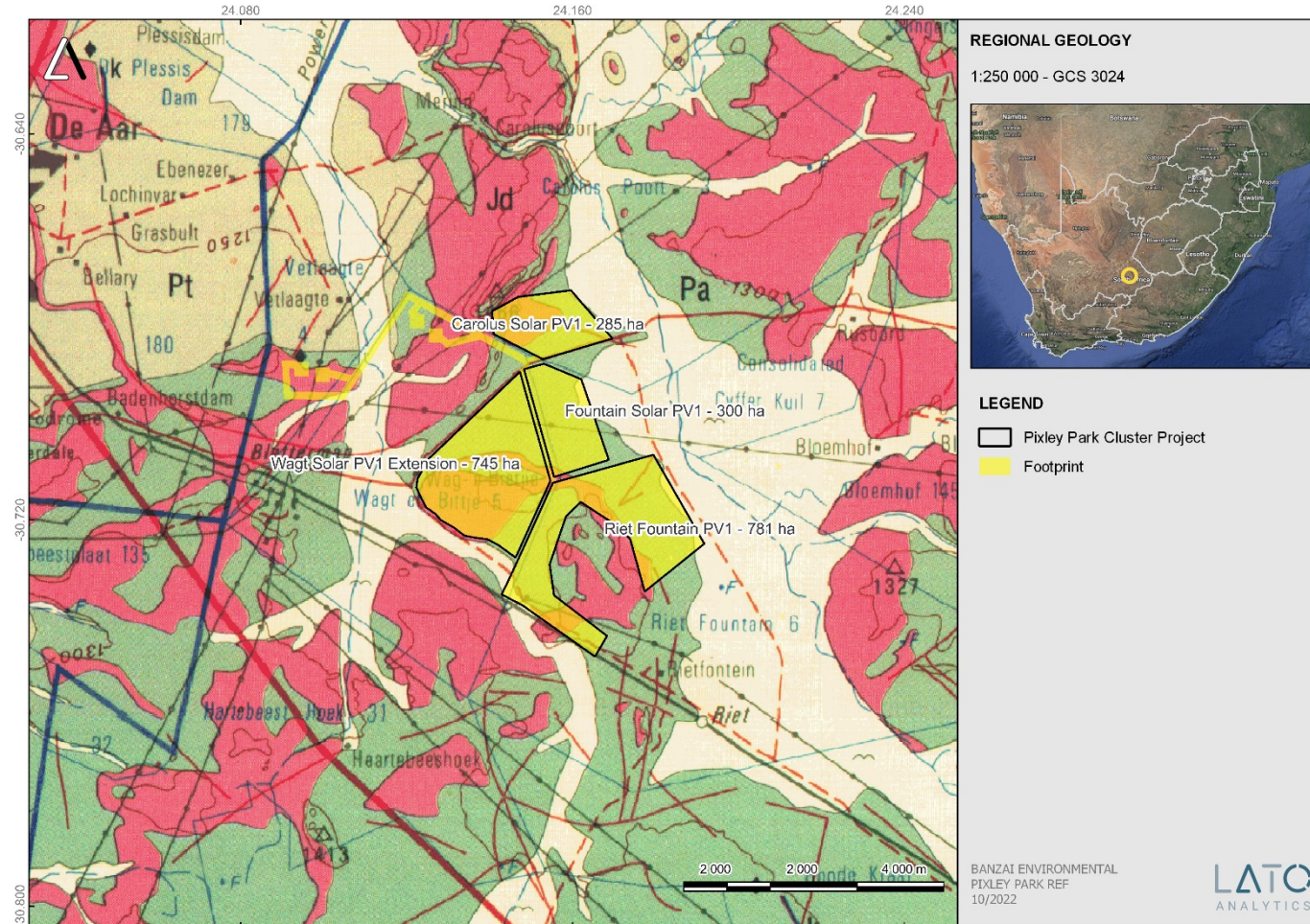


Figure 3: Extract of the 1:250 000 Colesberg 3024 (Le Roux, 1998) Geological map (Council of Geoscience, Pretoria) indicating the proposed development underlain by quaternary alluvium (pale yellow; Quaternary), Jurassic dolerite (Jd, red), and Adelaide Subgroup (Pa, light green, Beaufort Group, Karoo Supergroup).



Table 2: Legend of the 1:250 000 Colesberg 3024 (1998) Geological map (Council of Geoscience, Pretoria)


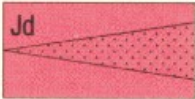
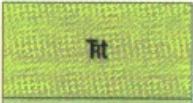
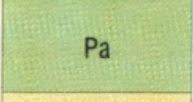
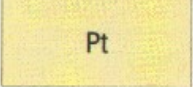
	GROUP GROEP	SUBGROUP SUBGROEP	FORMATION FORMASIE
QUATERNARY KWARTÊR			 Qc
JURASSIC JURA			 Jd
TRIASSIC TRIAS	KAROO SUPERGROUP KAROO SUPERGROEP	BEAUFORT	 Tt
PERMIAN PERM			 Pa
		Tarkastad	 Pt
		Adelaide	
			Katberg
			Tierberg
		ECCA	

Table : Lithology of the 1:250 000 Colesberg 3024 (1998) Geological map (Council of Geoscience, Pretoria)

LITHOLOGY / LITOLOGIE

Alluvium and debris

Qc	Calcrete Kalkreet
Jd	Dolerite, granophyric (); dyke ( Doleriet, granofiries (); gang ()
Tt	Yellowish-grey fine-grained sandstone with interbedded brownish-red to grey mudstone Gelerige grys fynkorrelrige sandsteen met tussengelaagde bruinerige tot grys moddersteen
Pa	Blue-grey silty mudstone, subordinate brownish-red mudstone; sandstone Blougrys slikkige moddersteen, ondergeskikte bruinerige rooi moddersteen; sandsteen
Pt	Blue-grey to black shale with carbonate-rich concretions; subordinate siltstone and sandstone in upper part Blougrys tot swart skalie met karbonaatryke konkresies; ondergeskikte sliksteen en sandsteen in boonste gedeelte

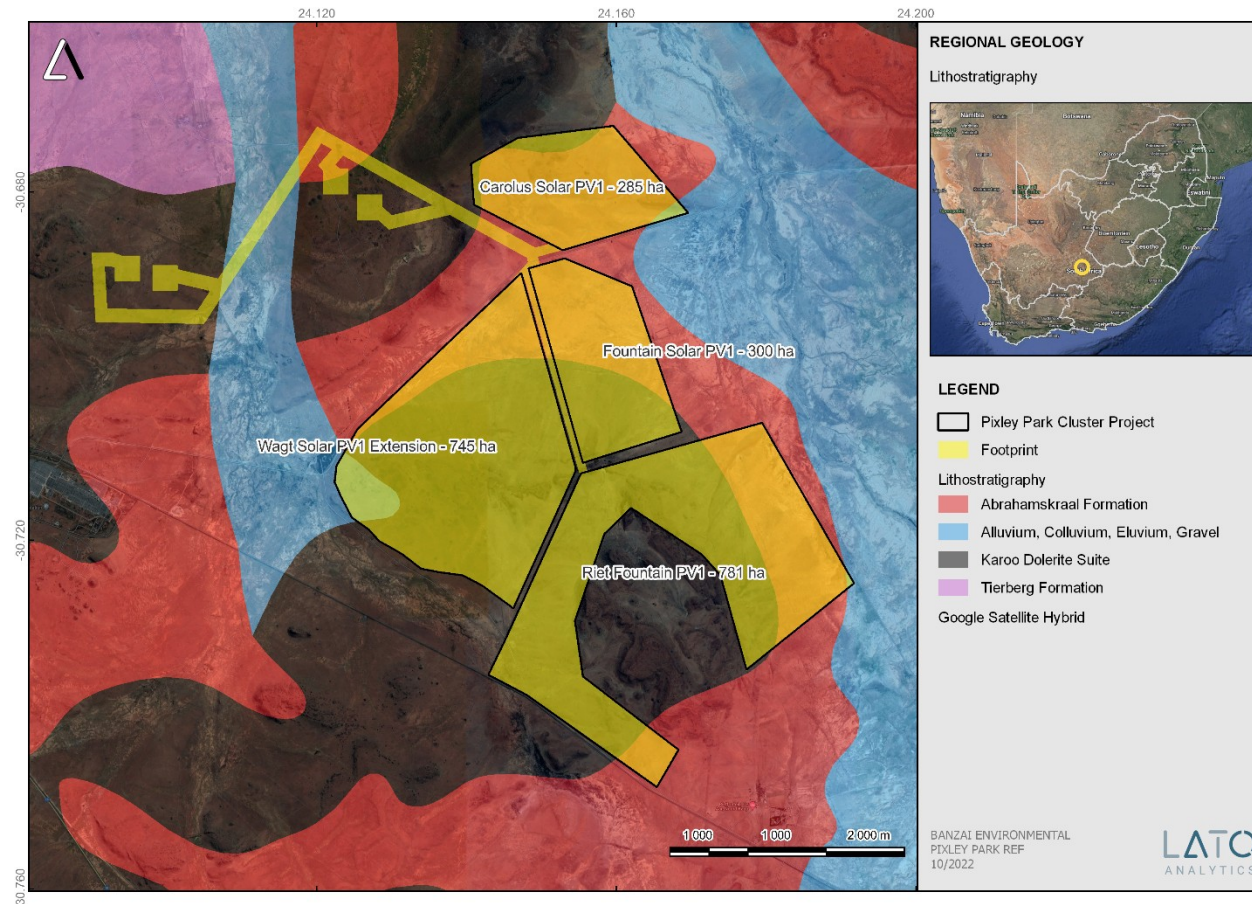


Figure 4: Updated Geology (Council of Geosciences, Pretoria) of the proposed Pixley Park REF indicates that the proposed development is underlain by the Quaternary alluvium, colluvium eluvium and gravel, the Karoo Dolerite Suite as well as Abrahamskraal Formation (Adelaide Subgroup, Beaufort Group, Karoo Supergroup).

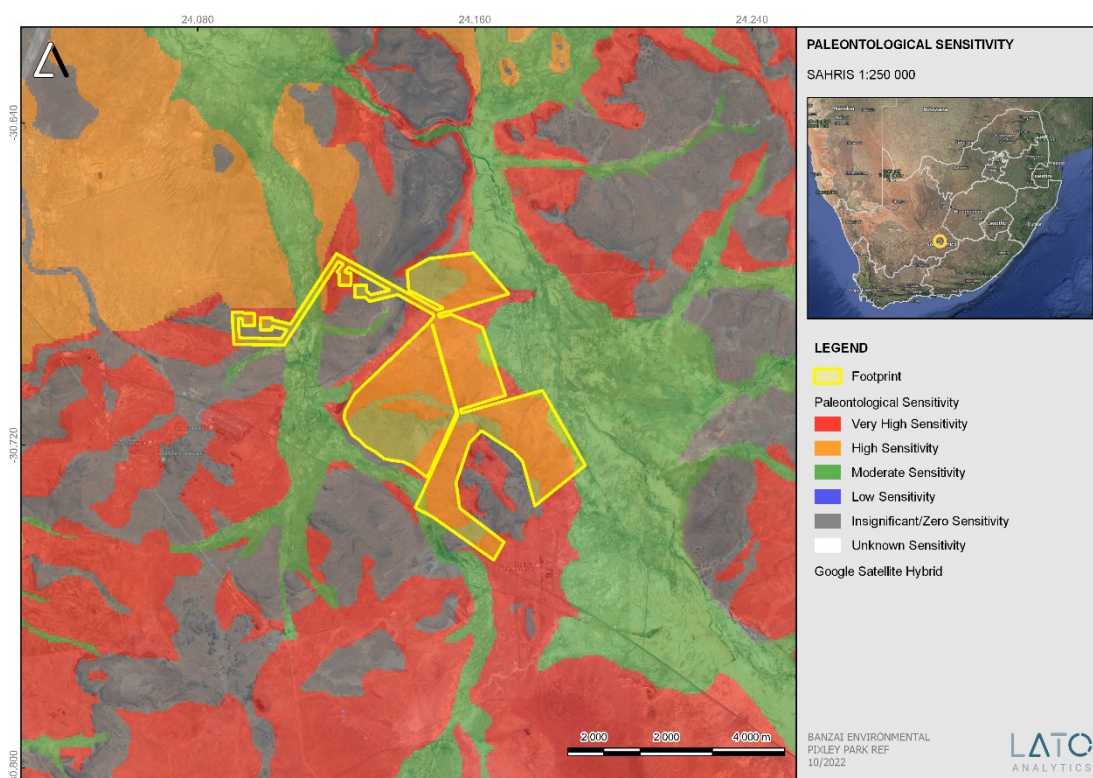


Figure 5: Extract of the 1:250 000 SAHRIS PalaeoMap map (Council of Geosciences, Pretoria) indicating the Palaeontological Sensitivity of the proposed Pixley Park REF near De Aar in the Northern Cape.

According to the SAHRIS Palaeosensitivity map (**Figure 5**) the proposed development is underlain by sediments of Very High (red), High (orange) and Moderate (green) and Zero (grey) Palaeontological Sensitivity.

Table 2: Palaeontological Significance

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 colours on the PalaeoMap indicate the following degrees of sensitivity: red = very highly sensitive; orange/yellow = high; green = moderate; blue = low; grey = insignificant/zero



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		
				Clarens Fm	Clarens Fm	<i>Massospondylus</i>	
				upper Elliot Fm	upper Elliot Fm		
				lower Elliot Fm	lower Elliot Fm	<i>Scalenodontoides</i>	
				Molteno Fm	Molteno Fm		
TRIASSIC	Tarkastad Subgp			Burgersdorp Fm	Driekoppen Fm	<i>Cynognathus</i>	<i>Cricodon-Ufudocyclops</i> <i>Trirachodon-Kannemeyeria</i> <i>Langbergia-Gargainia</i>
				Katberg Fm	Verkyerskop Fm	<i>Lystrosaurus declivis</i>	
				Palingkloof M.			
				Elandsberg M.	Harrismith M.		<i>Lystrosaurus maccaigi-Moschorhinus</i>
				Ripplemead M.	Schoondraai M.	<i>Daptocephalus</i>	
				Daggaboersnek M.	Rooinekke M.		<i>Dicynodon-Theriongnathus</i>
				Oudeberg M.	Frankfort M.		
						<i>Cistecephalus</i>	
						<i>Endothiodon</i>	<i>Tropidostoma-Gorgonops</i> <i>Lycosuchus-Eunotosaurus</i>
						<i>Tapinocephalus</i>	<i>Diictodon-Styracocephalus</i> <i>Eosimops-Glanosuchus</i>
PERMIAN	BEAUFORT	Adelaide Subgp	Teekloof Fm	Steenkampsvlakte M.			
				Oukloof M.			
				Hoedemaker M.			
				Poortjie M.			
				Abrahamskraal Fm	Koonap Fm		
ECCA				Waterford Fm	Waterford Fm		
				Tierberg/Fort Brown	Fort Brown		

Figure 6: 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 (Taken from Smith et al, 2020). The proposed development is indication in blue

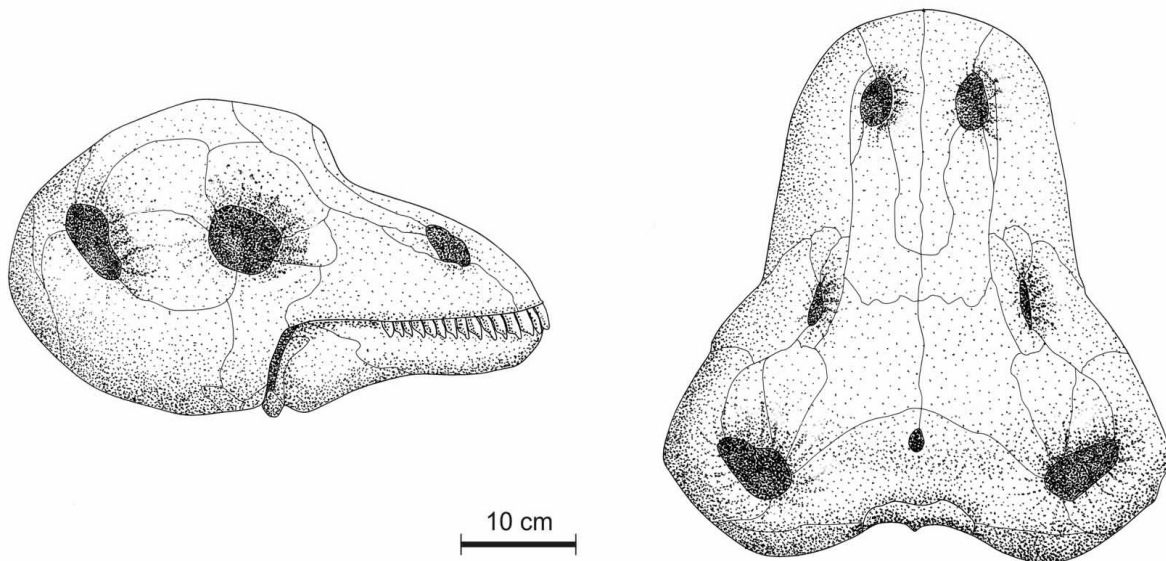


Figure 7: *Tapinocephalus atherstonei*, the index taxon of the Tapinocephalus Assemblage Zone, in lateral and dorsal view (Taken from Day and Rubidge, 2020).

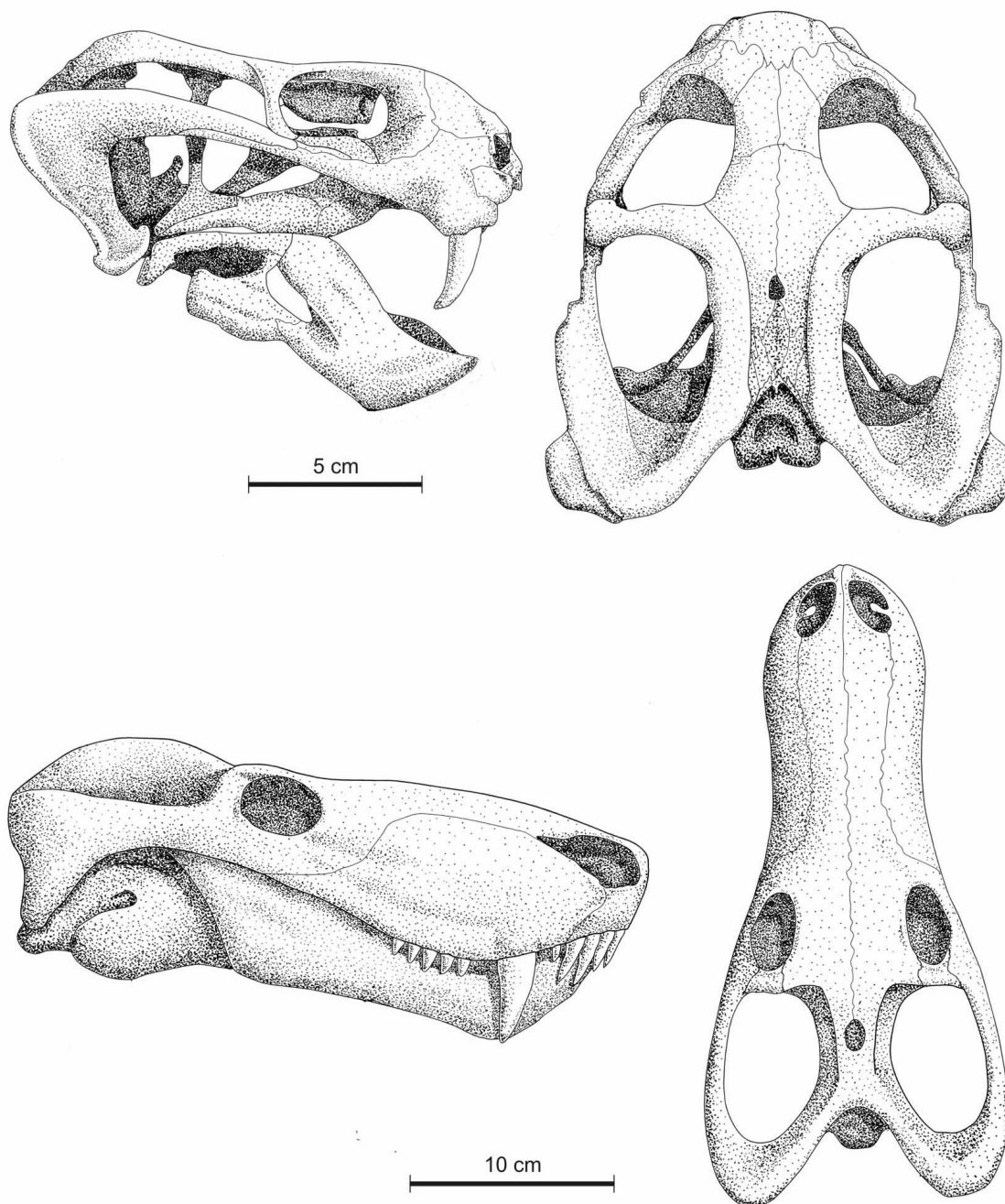


Figure 8: Lateral and dorsal view of the index taxa of the Eosimops - Glanosuchus Subzone in (top) *Eosimops newtoni*; (bottom) *Glanosuchus macrops*. (Image taken from Day and Rubidge, 2020).



7 GEOGRAPHICAL LOCATION OF THE SITE

The proposed Pixley REF cluster consists of four PV facilities and is located on Farm Wag 'n Bietjie 5, Portion 1 of Farm Riet Fountain 6, Portion 3 and 4 of Farm Carolus Poort 3 about 17 km south east of De Aar in the Northern Cape Province. The electrical infrastructure and farms of the proposed development is located to the north and north east of the Hydra substation. Three completed solar farms lie northwest of the Pixley Cluster and consists of the De Aar Solar and Paarde Valley solar farms. On the plateau north east of the development is a completed 144MW wind farm. These farms are currently utilized for the grazing of sheep.

8 METHODS

The aim of a desktop study is to evaluate the risk to palaeontological heritage in the proposed development. This includes all trace fossils and fossils. All available information is consulted to compile a desktop study and includes Palaeontological impact assessment reports in the same area, aerial photos, and Google Earth images, topographical as well as geological maps.

8.1 Assumptions and Limitations

When conducting a PIA several factors can affect the accuracy of the assessment. The focal point of geological maps is the geology of the area, and the sheet explanations were not meant to focus on palaeontological heritage. Many inaccessible regions of South Africa have not been reviewed by palaeontologists and data is generally based on aerial photographs. Locality and geological information of museums and universities databases have not been kept up to date or data collected in the past have not always been accurately documented. Comparable Assemblage Zones in other areas is used to provide information on the existence of fossils in an area which was not yet been documented. When similar Assemblage Zones and geological formations for Desktop studies is used it is generally **assumed** that exposed fossil heritage is present within the footprint.

9 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 CTS Heritage
- 1:250 000 Colesberg 3024 (Le Roux, 1998) Geological map (Council of Geoscience, Pretoria).

Shape files produced by the Council of Geosciences (Pretoria).



- The desktop assessment of the site conducted by Dr Kimberley Chapelle.
- Various other renewable Energy facilities have been developed in the area (Almond, J.E. 2010a; Almond, J.E. 2010b.; Almond, J.E. 2010c; Almond, J.E. 2012a; Almond, J.E. 2012b; Almond, J.E. 2012c.

10 SITE VISIT

A site-specific field survey of the development footprint was conducted on foot and by motor vehicle on 16 and 17 October 2022. The proposed development is located on relatively flat lying terrain with dolerite “koppies” in places which are igneous in origin and thus unfossiliferous. Electrical infrastructure is present throughout the development footprint. The following examples of Palaeontological Heritage were identified in the footprint.

- Posterior portion of a small tetrapod skeleton.
- A fragment of a tree fossil
- Fairly well-preserved ripple marks (about 1 m in diameter) were identified near and in the dam areas.



Figure 9: General flat topography of the proposed Pixley Park Development with patches of unvegetated areas but generally covered by low vegetation.



Figure 11: Example of a shallow, dry dam covered by grassy vegetation with green mudrock exposures on the sides, while dolerite core stones are present on the edge of the dam.



Figure 10: Prominent calccrete exposures overlies the mudrocks of the Abrahamskraal Formation on the banks of the dam (Figure above), with scattered dolerite fragments.



Figure 12: Well-defined ripple marks in the centre of the dam/pan.

GPS Coordinates -30.689094; 24.148486



Figure 13: Fragment of a tree fossil located on the edge of a dry dam surrounded by calcrete.

GPS coordinates: -30.708851; 24.115137



Figure 14: Weathered tetrapod skeleton present in the mudrocks of the Abrahamskraal Formation
GPS coordinates-30.682075; 24.168772



Figure 15: Scattered dolerite boulders loose on Quaternary deposits (left) and dolerite “koppie” on the right.



Figure 16: Electricity infrastructure present throughout the development footprint.





11 ASSESSMENT METHODOLOGY AND IMPACT ASSESSMENT FORMAT

11.1 IMPACT ASSESSMENT TABLES:

Table 3: Impact Assessment

NATURE: It is possible that buried palaeontological resources may be impacted by the proposed development in the preferred location				
		Without Mitigation		With Mitigation
MAGNITUDE	H (4)	According to the SAHRIS Palaeosensitivity Map (Figure 4), the area proposed for development of the PV facilities is underlain by sediments that have very high palaeontological sensitivity.	L (2)	According to the SAHRIS Palaeosensitivity Map (Figure 4), the area proposed for development of the PV facilities is underlain by sediments that have very high palaeontological sensitivity.
DURATION	H (5)	Where manifest, the impact will be permanent.	H (5)	Where manifest, the impact will be permanent.
EXTENT	L (1)	Limited to the development footprint	L (1)	Limited to the development footprint
PROBABILITY	L (4)	It is that significant fossils will be impacted	L (2)	It is unlikely that significant fossils will be impacted
SIGNIFICANCE	L	(1+5+4) x4=40	L	(1+5+2) x2=16
STATUS		Negative		Neutral
REVERSIBILITY	L	Any impacts to heritage resources that do occur are irreversible	L	Any impacts to heritage resources that do occur are irreversible
IRREPLACEABLE LOSS OF RESOURCES?	L	Likely	L	Not Likely
CAN IMPACTS BE MITIGATED		Yes		
MITIGATION: <ul style="list-style-type: none">• The attached Chance Fossil Finds Procedure must be implemented for the duration of construction activities• Should any previously unrecorded palaeontological resources be identified during the course of construction activities, work must cease in the immediate vicinity of the find, and SAHRA must be contacted regarding an appropriate way forward.				
RESIDUAL RISK: None				

12 FINDINGS AND RECOMMENDATIONS

The proposed Pixley Park REF underlain by Quaternary alluvium, the Karoo Dolerite Suite, as well as the Abrahamskraal Formation (Adelaide Subgroup, Beaufort Group, Karoo Supergroup).

A site-specific field survey of the development footprint was conducted on foot and by motor vehicle on 16 to 17 October 2022. The following examples of fossil heritage were identified in the development footprint.

- Fragments of the posterior portion of a small tetrapod skeleton.
- A fragment of a tree fossil



- Fairly well-preserved ripple marks (about 1 m in diameter) were identified near and in the pan/dam areas.

Sediments of the Karoo Supergroup in this area are deeply weathered and in places baked by Jurassic dolerite. Extensive excavations into deep bedrock during the construction phase is not anticipated and it is thus considered that the proposed development will not lead to detrimental impacts on the palaeontological reserves of the area. The construction of the development may be authorised in its whole extent, as the development footprint is not considered sensitive in terms of palaeontological resources.

It is thus recommended that:

- The Environmental Control Officer (ECO), responsible for the development, should be aware of the possibility of finding fossils in the Adelaide Subgroup (Beaufort Group, Karoo Supergroup) and Quaternary deposits of the area.
- If Palaeontological Heritage is uncovered during surface clearing and excavations the **Chance find Protocol** attached should be implemented immediately. These discoveries ought to be protected (if possible, *in situ*) and the ECO 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) so that correct mitigation (recording and collection) can be carry out by a paleontologist.
- Before any fossil material can be collected from the development site, the specialist involved would need to apply for a collection permit from SAHRA. Fossil material must be housed in an official collection (museum or university), while all reports and fieldwork should meet the minimum standards for palaeontological impact studies proposed by SAHRA (2012). 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.

13 CHANCE FINDS PROTOCOL

The following procedure will only need to be followed if fossils are uncovered during excavation.

13.1 Background

A fossil is the naturally preserved remains (or traces) of plants or animals embedded in rock. These plants and animals lived in the geologic past 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 the construction site. 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.

13.2 Legislation

Cultural Heritage in South Africa (includes all heritage resources) is protected by the **National Heritage Resources Act (Act 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 is 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.

13.3 Chance Find Protocol

- 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). (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.
- In the event that the fossil cannot be stabilized the fossil may be collected with extreme care by the ESO (site manager). 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 Heritage Agency has issued the written authorization, the developer may continue with the development on the affected area.

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Appendix 1: -

CURRICULUM VITAE

ELIZE BUTLER

PROFESSION: Palaeontologist

YEARS' EXPERIENCE: 29 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. Zoology (*Cum laude*), 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 and Collection Manager	National Museum, Bloemfontein 1998-currently



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 Woodhouse 729, 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 Leeuwborg 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.

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 desktop assessment of the establishment of the proposed residential and mixed-use development on the remainder of portion 7 and portion 898 of the



farm Knopjeslaagte 385 Ir, located near Centurion within the Tshwane Metropolitan Municipality of Gauteng Province. Bloemfontein.

Butler, E. 2017. Palaeontological impact assessment for the proposed development of a new cemetery, near Kathu, Gamagara local municipality and John Taolo Gaetsewe district municipality, Northern Cape. Bloemfontein.

Butler, E. 2017. Palaeontological Impact Assessment of The Proposed Development of The New Open Cast Mining Operations on The Remaining Portions Of 6, 7, 8 And 10 Of the Farm Kwaggafontein 8 In the Carolina Magisterial District, Mpumalanga Province. Bloemfontein.

Butler, E. 2017. Palaeontological Desktop Assessment for the Proposed Development of a Wastewater Treatment Works at Lanseria, Gauteng Province. Bloemfontein.

Butler, E. 2017. Palaeontological Scoping Report for the Proposed Construction of a Warehouse and Associated Infrastructure at Perseverance in Port Elizabeth, Eastern Cape Province.

Butler, E. 2017. Palaeontological Desktop Assessment for the Proposed Establishment of a Diesel Farm and a Haul Road for the Tshipi Borwa mine Near Hotazel, In the John Taolo Gaetsewe District Municipality in the Northern Cape Province. Bloemfontein.

Butler, E. 2017. Palaeontological Desktop Assessment for the Proposed Changes to Operations at the UMK Mine near Hotazel, In the John Taolo Gaetsewe District Municipality in the Northern Cape Province. Bloemfontein.

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Butler, E. 2017. Palaeontological desktop assessment of the proposed development of a 3000 MW combined cycle gas turbine (CCGT) in Richards Bay, Kwazulu-Natal. Bloemfontein.

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Butler, E. 2017. Palaeontological Impact Assessment of the proposed mining of the farm Zandvoort 10 in the Albert Luthuli Local Municipality, Gert Sibande District Municipality, Mpumalanga Province. Bloemfontein.



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Butler, E. 2017. Palaeontological impact assessment of the proposed development of the sport precinct and associated infrastructure at Merrifield Preparatory school and college, Amathole Municipality, East London. PGS Heritage. Bloemfontein.

Butler, E. 2017. Palaeontological impact assessment of the proposed construction of the Lehae training and fire station, Lenasia, Gauteng Province. Bloemfontein.

Butler, E. 2017. Palaeontological Desktop Assessment of the proposed development of the new open cast mining operations of the Impunzi mine in the Mpumalanga Province. Bloemfontein.

Butler, E. 2017. Palaeontological Desktop Assessment of the construction of the proposed Viljoenskroon Munic 132 KV line, Vierfontein substation and related projects. Bloemfontein.

Butler, E. 2017. Palaeontological Desktop Assessment of the proposed rehabilitation of 5 ownerless asbestos mines. Bloemfontein.

Butler, E. 2017. Palaeontological Desktop Assessment of the proposed development of the Lephalale coal and power project, Lephalale, Limpopo Province, Republic of South Africa. Bloemfontein.

Butler, E. 2017. Palaeontological Impact Assessment of the proposed construction of a 132KV powerline from the Tweespruit distribution substation (in the Mantsopa local municipality) to the Driedorp rural substation (within the Naledi local municipality), Free State province. Bloemfontein.

Butler, E. 2017. Palaeontological Desktop Assessment of the proposed development of the new coal-fired power plant and associated infrastructure near Makhado, Limpopo Province. Bloemfontein.

Butler, E. 2017. Palaeontological Impact Assessment of the proposed construction of a Photovoltaic Solar Power station near Collett substation, Middelburg, Eastern Cape. Bloemfontein.

Butler, E. 2017. Palaeontological Impact Assessment for the proposed township establishment of 2000 residential sites with supporting amenities on a portion of farm 826 in Botshabelo West, Mangaung Metro, Free State Province. Bloemfontein.

Butler, E. 2017. Palaeontological Desktop Assessment for the proposed prospecting right project without bulk sampling, in the Koa Valley, Northern Cape Province. Bloemfontein.



Butler, E. 2017. Palaeontological Desktop Assessment for the proposed Aroams prospecting right project, without bulk sampling, near Aggeneys, Northern Cape Province. Bloemfontein.

Butler, E. 2017. Palaeontological Impact Assessment of the proposed Belvior aggregate quarry II on portion 7 of the farm Maidenhead 169, Enoch Mgijima Municipality, division of Queenstown, Eastern Cape. Bloemfontein.

Butler, E. 2017. PIA site visit and report 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. 2017. Palaeontological Impact Assessment of the proposed construction of Tina Falls Hydropower and associated power lines near Cumbu, Mthlontlo Local Municipality, Eastern Cape. Bloemfontein.

Butler, E. 2017. Palaeontological Desktop Assessment of the proposed construction of the Mangaung Gariep Water Augmentation Project. Bloemfontein.

Butler, E. 2017. Palaeontological Impact Assessment of the proposed Belvoir aggregate quarry II on portion 7 of the farm Maidenhead 169, Enoch Mgijima Municipality, division of Queenstown, Eastern Cape. Bloemfontein.

Butler, E. 2017. Palaeontological Impact Assessment of the proposed construction of the Melkspruit-Rouxville 132KV Power line. Bloemfontein.

Butler, E. 2017. Palaeontological Desktop Assessment of the proposed development of a railway siding on a Portion of portion 41 of the farm Rustfontein 109 is, Govan Mbeki local municipality, Gert Sibande district municipality, Mpumalanga Province. Bloemfontein.

Butler, E. 2017. Palaeontological Impact Assessment of the proposed consolidation of the proposed Ilima Colliery in the Albert Luthuli local municipality, Gert Sibande District Municipality, Mpumalanga Province. Bloemfontein.

Butler, E. 2017. Palaeontological Desktop Assessment of the proposed extension of the Kareerand Tailings Storage Facility, associated borrow pits as well as a storm water drainage channel in the Vaal River near Stilfontein, North West Province. Bloemfontein.

Butler, E. 2017. Palaeontological Desktop Assessment of the proposed construction of a filling station and associated facilities on the Erf 6279, district municipality of John Taolo Gaetsewe District, Ga-Segonyana Local Municipality Northern Cape. Bloemfontein.

Butler, E. 2017. Palaeontological Desktop Assessment of the proposed of the Lephalale Coal and Power Project, Lephalale, Limpopo Province, Republic of South Africa. Bloemfontein.

Butler, E. 2017. Palaeontological Desktop Assessment of the proposed Overvaal Trust PV Facility, Buffelspoort, North West Province. Bloemfontein.



Butler, E. 2017. Palaeontological Impact Assessment of the proposed development of the H₂ Energy Power Station and associated infrastructure on Portions 21; 22 And 23 of the farm Hartebeestspruit in the Thembisile Hani Local Municipality, Nkangala District near Kwamhlanga, Mpumalanga Province. Bloemfontein.

Butler, E. 2017. Palaeontological Impact Assessment of the proposed upgrade of the Sandriver Canal and Klippan Pump station in Welkom, Free State Province. Bloemfontein.

Butler, E. 2017. Palaeontological Impact Assessment of the proposed upgrade of the 132kv and 11kv power line into a dual circuit above ground power line feeding into the Urania substation in Welkom, Free State Province. Bloemfontein.

Butler, E. 2017. Palaeontological Desktop Assessment of the proposed Swaziland-Mozambique border patrol road and Mozambique barrier structure. Bloemfontein.

Butler, E. 2017. Palaeontological Impact Assessment of the proposed diamonds alluvial & diamonds general prospecting right application near Christiana on the remaining extent of portion 1 of the farm Kaffraria 314, registration division HO, North West Province. Bloemfontein.

Butler, E. 2017. Palaeontological Desktop Assessment for the proposed development of Wastewater Treatment Works on Hartebeesfontein, near Panbult, Mpumalanga. Bloemfontein.

Butler, E. 2017. Palaeontological Desktop Assessment for the proposed development of Wastewater Treatment Works on Rustplaas near Piet Retief, Mpumalanga. Bloemfontein.

Butler, E. 2018. Palaeontological Impact Assessment for the Proposed Landfill Site in Luckhoff, Letsemeng Local Municipality, Xhariep District, Free State. Bloemfontein.

Butler, E. 2018. Palaeontological Impact Assessment of the proposed development of the new Mutsho coal-fired power plant and associated infrastructure near Makhado, Limpopo Province. Bloemfontein.

Butler, E. 2018. Palaeontological Impact Assessment of the authorisation and amendment processes for Manangu mine near Delmas, Victor Khanye local municipality, Mpumalanga. Bloemfontein.

Butler, E. 2018. Palaeontological Desktop Assessment for the proposed Mashishing township establishment in Mashishing (Lydenburg), Mpumalanga Province. Bloemfontein.

Butler, E. 2018. Palaeontological Desktop Assessment for the Proposed Mlonzi Estate Development near Lusikisiki, Ngquza Hill Local Municipality, Eastern Cape. Bloemfontein.

Butler, E. 2018. Palaeontological Phase 1 Assessment of the proposed Swaziland-Mozambique border patrol road and Mozambique barrier structure. Bloemfontein.



Butler, E. 2018. Palaeontological Desktop Assessment for the proposed electricity expansion project and Sekgame Switching Station at the Sishen Mine, Northern Cape Province. Bloemfontein.

Butler, E. 2018. Palaeontological field assessment of the proposed construction of the Zonnebloem Switching Station (132/22kV) and two loop-in loop-out power lines (132kV) in the Mpumalanga Province. Bloemfontein.

Butler, E. 2018. Palaeontological Field Assessment for the proposed re-alignment and de-commissioning of the Firham-Platrand 88kv Powerline, near Standerton, Lekwa Local Municipality, Mpumalanga province. Bloemfontein.

Butler, E. 2018. Palaeontological Desktop Assessment of the proposed Villa Rosa development In the Buffalo City Metropolitan Municipality, East London. Bloemfontein.

Butler, E. 2018. Palaeontological field Assessment of the proposed Villa Rosa development In the Buffalo City Metropolitan Municipality, East London. Bloemfontein.

Butler, E. 2018. Palaeontological desktop assessment of the proposed Mookodi – Mahikeng 400kV line, North West Province. Bloemfontein.

Butler, E. 2018. Palaeontological Desktop Assessment for the proposed Thornhill Housing Project, Ndlambe Municipality, Port Alfred, Eastern Cape Province. Bloemfontein.

Butler, E. 2018. Palaeontological desktop assessment of the proposed housing development on portion 237 of farm Hartebeestpoort 328. Bloemfontein.

Butler, E. 2018. Palaeontological desktop assessment of the proposed New Age Chicken layer facility located on holding 75 Endicott near Springs in Gauteng. Bloemfontein.

Butler, E. 2018 Palaeontological Desktop Assessment for the development of the proposed Leslie 1 Mining Project near Leandra, Mpumalanga Province. Bloemfontein.

Butler, E. 2018. Palaeontological field assessment of the proposed development of the Wildealskloof mixed use development near Bloemfontein, Free State Province. Bloemfontein.

Butler, E. 2018. Palaeontological Field Assessment of the proposed Megamor Extension, East London. Bloemfontein

Butler, E. 2018. Palaeontological Impact Assessment of the proposed diamonds Alluvial & Diamonds General Prospecting Right Application near Christiana on the Remaining Extent of Portion 1 of the Farm Kaffraria 314, Registration Division HO, North West Province. Bloemfontein.

Butler, E. 2018. Palaeontological Impact Assessment of the proposed construction of a new 11kV (1.3km) Power Line to supply electricity to a cell tower on farm 215 near Delpotshoop in the Northern Cape. Bloemfontein.



Butler, E. 2018. Palaeontological Field Assessment of the proposed construction of a new 22 kV single wood pole structure power line to the proposed MTN tower, near Britstown, Northern Cape Province. Bloemfontein.

Butler, E. 2018. Palaeontological Exemption Letter for the proposed reclamation and reprocessing of the City Deep Dumps in Johannesburg, Gauteng Province. Bloemfontein.

Butler, E. 2018. Palaeontological Exemption letter for the proposed reclamation and reprocessing of the City Deep Dumps and Rooikraal Tailings Facility in Johannesburg, Gauteng Province. Bloemfontein.

Butler, E. 2018. Proposed Kalabasfontein Mine Extension project, near Bethal, Govan Mbeki District Municipality, Mpumalanga. Bloemfontein.

Butler, E. 2018. Palaeontological Desktop Assessment for the development of the proposed Leslie 1 Mining Project near Leandra, Mpumalanga Province. Bloemfontein.

Butler, E. 2018. Palaeontological Desktop Assessment of the proposed Mookodi – Mahikeng 400kV Line, North West Province. Bloemfontein.

Butler, E. 2018. Environmental Impact Assessment (EIA) for the Proposed 325mw Rondekop Wind Energy Facility between Matjiesfontein and Sutherland in the Northern Cape Province.

Butler, E. 2018. Palaeontological Impact Assessment of the proposed construction of the Tooverberg Wind Energy Facility, and associated grid connection near Touws River in the Western Cape Province. Bloemfontein.

Butler, E. 2018. Palaeontological impact assessment of the proposed Kalabasfontein Mining Right Application, near Bethal, Mpumalanga.

Butler, E. 2019. Palaeontological Desktop Assessment of the proposed Westrand Strengthening Project Phase II.

Butler, E. 2019. Palaeontological Field Assessment for the proposed Sirius 3 Photovoltaic Solar Energy Facility near Upington, Northern Cape Province

Butler, E. 2019. Palaeontological Field Assessment for the proposed Sirius 4 Photovoltaic Solar Energy Facility near Upington, Northern Cape Province

Butler, E. 2019. Palaeontological Field Assessment for Heuningspruit PV 1 Solar Energy Facility near Koppies, Ngwathe Local Municipality, Free State Province.

Butler, E. 2019. Palaeontological Field Assessment for the Moeding Solar Grid Connection, North West Province.

Butler, E. 2019. Recommended Exemption from further Palaeontological studies for the Proposed Agricultural Development on Farms 1763, 2372 And 2363, Kakamas South Settlement, Kai! Garib Municipality, Mgcawu District Municipality, Northern Cape Province.



Butler, E. 2019. Recommended Exemption from further Palaeontological studies: of Proposed Agricultural Development, Plot 1178, Kakamas South Settlement, Kai! Garib Municipality

Butler, E. 2019. Palaeontological Desktop Assessment for the Proposed Waste Rock Dump Project at Tshipi Borwa Mine, near Hotazel, Northern Cape Province:

Butler, E. 2019. Palaeontological Exemption Letter for the proposed DMS Upgrade Project at the Sishen Mine, Gamagara Local Municipality, Northern Cape Province

Butler, E. 2019. Palaeontological Desktop Assessment of the proposed Integrated Environmental Authorisation process for the proposed Der Brochen Amendment project, near Groblershoop, Limpopo

Butler, E. 2019. Palaeontological Desktop Assessment of the proposed updated Environmental Management Programme (EMPr) for the Assmang (Pty) Ltd Black Rock Mining Operations, Hotazel, Northern Cape

Butler, E. 2019. Palaeontological Desktop Assessment of the proposed Kriel Power Station Lime Plant Upgrade, Mpumalanga Province

Butler, E. 2019. Palaeontological Impact Assessment for the proposed Kangala Extension Project Near Delmas, Mpumalanga Province.

Butler, E. 2019. Palaeontological Desktop Assessment for the proposed construction of an iron/steel smelter at the Botshabelo Industrial area within the Mangaung Metropolitan Municipality, Free State Province.

Butler, E. 2019. Recommended Exemption from further Palaeontological studies for the proposed agricultural development on farms 1763, 2372 and 2363, Kakamas South settlement, Kai! Garib Municipality, Mgcawu District Municipality, Northern Cape Province.

Butler, E. 2019. Recommended Exemption from further Palaeontological Studies for Proposed formalisation of Gamakor and Noodkamp low-cost Housing Development, Keimoes, Gordonia Rd, Kai !Garib Local Municipality, ZF Mgcawu District Municipality, Northern Cape Province.

Butler, E. 2019. Recommended Exemption from further Palaeontological Studies for proposed formalisation of Blaauwskop Low-Cost Housing Development, Kenhardt Road, Kai !Garib Local Municipality, ZF Mgcawu District Municipality, Northern Cape Province.

Butler, E. 2019. Palaeontological Desktop Assessment of the proposed mining permit application for the removal of diamonds alluvial and diamonds kimberlite near Windsorton on a certain portion of Farm Zoelen's Laagte 158, Registration Division: Barkly Wes, Northern Cape Province.

Butler, E. 2019. Palaeontological Desktop Assessment of the proposed Vedanta Housing Development, Pella Mission 39, Khâi-Ma Local Municipality, Namakwa District Municipality, Northern Cape.



Butler, E. 2019. Palaeontological Desktop Assessment for The Proposed 920 KWP Groenheuwel Solar Plant Near Augrabies, Northern Cape Province

Butler, E. 2019. Palaeontological Desktop Assessment for the establishment of a Super Fines Storage Facility at Amandelbult Mine, Near Thabazimbi, Limpopo Province

Butler, E. 2019. Palaeontological Impact Assessment for the proposed Sace Lifex Project, Near Emalahleni, Mpumalanga Province

Butler, E. 2019. Palaeontological Desktop Assessment for the proposed Rehau Fort Jackson Warehouse Extension, East London

Butler, E. 2019. Palaeontological Desktop Assessment for the proposed Environmental Authorisation Amendment for moving 3 Km of the Merensky-Kameni 132KV Powerline

Butler, E. 2019. Palaeontological Impact Assessment for the proposed Umsobomvu Solar PV Energy Facilities, Northern and Eastern Cape

Butler, E. 2019. Palaeontological Desktop Assessment for six proposed Black Mountain Mining Prospecting Right Applications, without Bulk Sampling, in the Northern Cape.

Butler, E. 2019. Palaeontological field Assessment of the Filling Station (Rietvlei Extension 6) on the Remaining Portion of Portion 1 of the Farm Witkoppies 393JR east of the Rietvleidam Nature Reserve, City of Tshwane, Gauteng

Butler, E. 2019. Palaeontological Desktop Assessment of The Proposed Upgrade of The Vaal Gamagara Regional Water Supply Scheme: Phase 2 And Groundwater Abstraction

Butler, E. 2019. Palaeontological Desktop Assessment of The Expansion of The Jan Kempdorp Cemetery on Portion 43 Of Farm Guldenskat 36-Hn, Northern Cape Province

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ANNEXURE 2: Assessment Methodology and Impact Assessment Format Table

Direct, indirect and cumulative impacts of the impacts identified above will be assessed according to the following standard methodology:

- The **nature** which shall include a description of what causes the effect, what will be affected and how it will be affected.
- The **extent** wherein it will be indicated whether the impact will be local (limited to the immediate area or site of development) or regional, and a value between 1 and 5 will be assigned as appropriate (with 1 being low and 5 being high).
- The **duration** wherein it will be indicated whether:
 - o The lifetime of the impact will be of very short duration (0 - 1 years) – assigned a score of 1;
 - o The lifetime of the impact will be of short duration (2 - 5 years) – assigned a score of 2;
 - o Medium-term (5 - 15 years) – assigned a score of 3;
 - o Long-term (> 15 years) – assigned a score of 4; or
 - o Permanent – assigned a score of 5.
- The **magnitude** quantified on a scale from 0 - 10 where 0 is small and will have no effect on the environment, 2 is minor and will result in an impact on processes, 4 is low and will cause a slight impact on processes, 6 is moderate and will result in processes continuing but in a modified way, 8 is high (processes are altered to the extent that they temporarily cease) and 10 is very high and results in complete destruction of patterns and permanent cessation of processes.
- The **probability** of occurrence, which shall describe the likelihood of the impact actually occurring. Probability will be estimated on a scale of 1 - 5 where 1 is very improbable (probably will not happen), 2 is improbable (some possibility, but of low likelihood), 3 is probable (distinct possibility), 4 is highly probable (most likely) and 5 is definite (impact will occur regardless of any prevention measures).
- The **significance** which shall be determined through a syntheses of the characteristics described above and can be assessed as low, medium or high; and
- The **status**, which is described as positive, negative or neutral.
- The degree to which the impact can be reversed.
- The degree to which the impact may cause irreplaceable loss of resources.
- The degree to which the impact can be mitigated.

The **significance** is calculated by combining the criteria in the following formula:

$$S = (E + D + M) \times P$$

S = Significance weighting

E = Extent



D = Duration

M = Magnitude

P = Probability

The **significance weightings** for each potential impact are as follows:

- < 30 points: Low (i.e. where this impact would not have a direct influence on the decision to develop in the area);
- 30 – 60 points: Medium (i.e. where the impact could influence the decision to develop in the area unless it is effectively mitigated); and
- > 60 points: High (i.e. where the impact must have an influence on the decision process to develop in the area).

NATURE: It is possible that buried palaeontological resources may be impacted by the proposed development in the preferred location				
		Without Mitigation		With Mitigation
MAGNITUDE	L (1)	According to the SAHRIS Palaeosensitivity Map (Figure 4), the area proposed for development of the PV facilities is underlain by sediments that have very high palaeontological sensitivity.	L (1)	According to the SAHRIS Palaeosensitivity Map (Figure 4), the area proposed for development of the PV facilities is underlain by sediments that have very high palaeontological sensitivity.
DURATION	H (5)	Where manifest, the impact will be permanent.	H (5)	Where manifest, the impact will be permanent.
EXTENT	L (1)	Limited to the development footprint	L (1)	Limited to the development footprint
PROBABILITY	L (1)	It is unlikely that significant fossils will be impacted	L (1)	It is unlikely that significant fossils will be impacted
SIGNIFICANCE	L	(1+5+1)x1=7	L	(1+5+1)x1=7
STATUS		Negative		Negative
REVERSIBILITY	L	Any impacts to heritage resources that do occur are irreversible	L	Any impacts to heritage resources that do occur are irreversible
IRREPLACEABLE LOSS OF RESOURCES?	L	Unlikely	L	Not Likely
CAN IMPACTS BE MITIGATED		Yes		
MITIGATION: <ul style="list-style-type: none">• The attached Chance Fossil Finds Procedure must be implemented for the duration of construction activities• Should any previously unrecorded palaeontological resources be identified during the course of construction activities, work must cease in the immediate vicinity of the				



find, and SAHRA must be contacted regarding an appropriate way forward.

RESIDUAL RISK:

None