BANZAI ENVIRONMENTAL

PALAEONTOLOGICAL IMPACT ASSESSMENT

INFRASTRUCTURE DEVELOPMENT AND UPGRADES WITHIN THE GREAT FISH RIVER NATURE RESERVE, EASTERN CAPE PROVINCE

April 2023

Compiled for JG Afrika

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.

PALAEONTOLOGICAL CONSULTANT: Banzai Environmental (Pty) Ltd

CONTACT PERSON: Elize Butler

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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: NEMA Table

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 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;9 & 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 specifically identified sensitivity of the site related to the	Section 1; & 11	

Table 1: NEMA Table		
Requirements of Appendix 6 – GN R326 EIA Regulations of 7 April 2017	**The relevant section in the report**	**Comment where not applicable.**
proposed activity or activities and its associated structures and infrastructure, inclusive of a site plan identifying site alternatives;		
(g) An identification of any areas to be avoided, including buffers	Section 1 & 11	
(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 1 and 11	
(l) Any conditions for inclusion in the environmental authorisation	Section 1 and 11	
(m) Any monitoring requirements for inclusion in the EMPr or environmental authorisation	Section 1 and 11	
(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 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	-

Table 1: NEMA Table		
Requirements of Appendix 6 – GN R326 EIA Regulations of 7 April 2017	**The relevant section in the report**	**Comment where not applicable.**
(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 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 JG Afrika to conduct the Palaeontological Impact Assessment (PIA) to assess the proposed Development and Upgrades within the Great Fish River Nature Reserve, Makana Local Municipality, Raymond Mahlaba Local Municipality and Ngqushwa Local Municipality, Eastern Cape Province. This PIA is compiled to comply with the National Heritage Resources Act (No 25 of 1999, section 38) (NHRA), to confirm if fossil material could potentially be present in the planned development area and to evaluate the impact of the proposed development on the Palaeontological Heritage and to mitigate possible damage to fossil resources.

The proposed development is underlain by a small area of Quaternary superficial sediments along the Fish River, Jurassic Dolerite, the Middleton and Koonap Formations of the Adelaide Subgroup (Beaufort Group, Karoo Supergroup). According to the PalaeoMap of South African Heritage Resources Information System the Palaeontological Sensitivity of the Quaternary superficial deposits is Moderate; that of the Adelaide Subgroup is Very High while the Palaeontological Sensitivity of the Jurassic Dolerite is Zero.

In the last few decades extensive research and collecting have been conducted by palaeontologists and the National Palaeontological databases indicate that the GFRNR area is fossiliferous. A two day-site-specific field survey of the development footprint was conducted on foot and motor vehicle in late February and early March of 2023. New fossiliferous sites containing *in situ Glossopteris* leaves, and trace fossils were detected. Loose fragments of fossilized wood were also detected during the site visit.

It is recommended that a buffer of 5m is placed around the *in-situ* trace fossil and 15m buffer around the *Glossopteris* and loose wood fossils. If possible, these fossils could be used for educational purposes with information available for the tourists. By implementing mitigation measures the significance of the impact will be reduced to low. If mitigation measures are followed the development will not lead to detrimental impacts on the palaeontological reserves of the area and construction of the development may be authorised to its whole extent.

Recommendations:

- The Environmental Control Officer (ECO) for this project must be informed that the Adelaide Subgroup (Beaufort Group, Karoo Supergroup) has a Very High Palaeontological Sensitivity.
- Training of accountable supervisory personnel by a qualified palaeontologist in the recognition of fossil heritage is necessary.

- If Palaeontological Heritage is uncovered during surface clearing and excavations the Chance find Protocol attached should be implemented immediately. Fossil discoveries ought to be protected and the ECO/site manager must report to South African Heritage Resources 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) so that mitigation (recording and collection) can be carried out.
- 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).
- These recommendations should be incorporated into the Environmental Management Plan for the proposed development.

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Appendix A:

1 INTRODUCTION

Information provided by JG Africa (Pty) Ltd

The Eastern Cape Parks and Tourism Agency (ECPTA) appointed JG Afrika (Pty) Ltd to apply for Environmental Authorisation (EA) for the proposed infrastructure development and upgrading works within the Great Fish River Nature Reserve (GFRNR) located within the Makana Local Municipality, Raymond Mhlaba Local Municipality as well as the Ngqushwa Local Municipality of the Eastern Cape Province.

1.1 Description of the Proposed Development

The following activities will form part of infrastructure development and upgrades:

1.1.1 Perimeter fence and perimeter road (jeep track) and associated gabion structures:

- Repair and maintenance to sections of the perimeter fence around the reserve.
- A new 3m wide and approximately 100km long road (jeep track) running along the perimeter fence where currently no road exists; and,
- Installation of new gabions structures along this perimeter track.

1.1.2 Internal roads and associated culvert and/or gabion structures:

- Upgrading of sections of the existing internal gravel road network measuring approximately 3m wide and with a cumulative length of approximately 75km.
- Installation of new culverts and/or gabions along the internal road alignment; and,
- In addition, a few sections of new road will also be developed to connect to the existing road sections along the alignment. The width will not exceed 3m.

1.1.3 Dams and pipeline infrastructure associated with existing boreholes:

- Upgrading of three (3) existing dams at Botha's Post, Ballysaggart and Inkerman. Each of these dams have a current capacity not exceeding 600kℓ. Once upgraded by means of excavation, each dam will have a new capacity of approximately 2 000kℓ. The height of each dam wall, after upgrading, will not exceed 5m.
- Decommissioning of eleven (11) unwanted dams by removal of dam walls and the earth to be spread over the area of the dams; and,
- Installation of new pipeline infrastructure associated with three existing boreholes. Water pipelines will be installed between the boreholes and existing dams to be upgraded. Such pipelines will not be larger than 0.065m in diameter. Location of these pipe alignments must still be confirmed but will be placed along existing roads and tracks where possible.

1.1.4 Airfields (runway) strips:

- Refurbishment of the airfield (runway) strips at Kamadolo and Double Drift. The Kamadolo airfield strip will also be extended by 100m x 15m, thereby increasing the footprint of the airfield by 1 500m^2 (0.15ha).

1.1.5 Accommodation units:

- Construction of a security manager's house (approximately 160 m^2 in size) and installation of twelve (12) modular field ranger accommodation units (approximately 42 m^2 each) distributed into three (3) clusters of four (4) units each. The required services in terms of water and sanitation will be installed. The accommodation units will be using septic tanks and French drains. The cumulative length of the water and sewage pipelines will not exceed 1km and will have a diameter less than 0.065m. A single 6,000ℓ tank would suffice for each cluster, while a 1,750ℓ tank will be installed for the security manager's house.

1.1.6 Workshop and fuel storage:

- The development of a fuel storage facility and vehicle workshop to be located right next to each other with a combined footprint of approximately 280m^2. The volume of fuel to be stored at the proposed storage facility will be approximately 5m^3.

Not all the above infrastructure components will require an Environmental Authorisation (EA). Those components indicated above in red trigger Listed Activities or may potentially trigger Listed Activities. Confirmation on the complete list of infrastructure components triggering Listed Activities, and thus requiring an EA, will be confirmed with the Competent Authority during a pre-application meeting.

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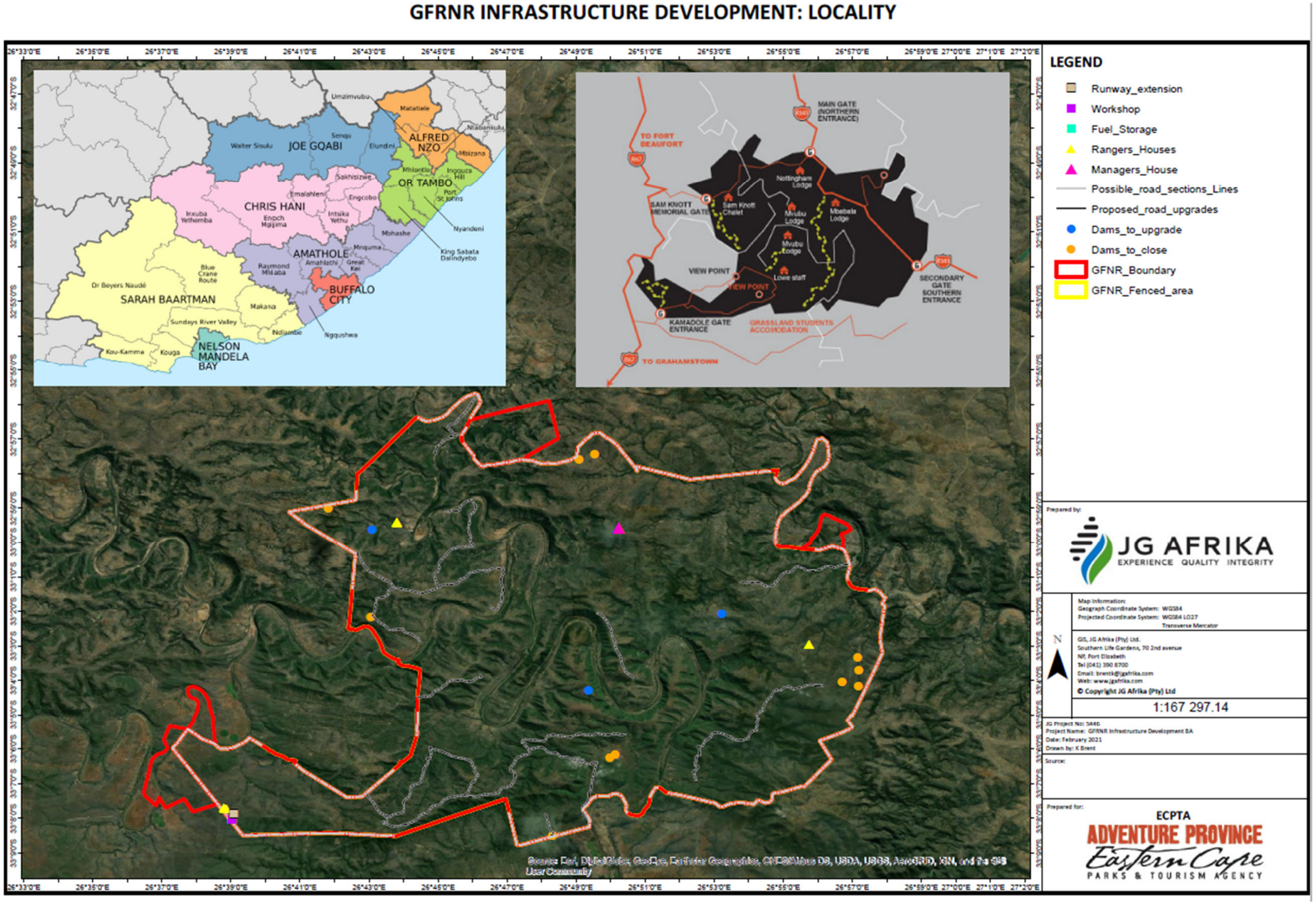


***Figure 1**: Aerial photo indicating the location of the GFRNR locality*

2 SPECIALIST CREDENTIALS

This study has been conducted by Mrs Elize Butler. She has conducted approximately 400 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 thirty 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.

A curriculum vitae is included in Appendix 1 of this specialist input report.

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 m^2 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 TERMS OF REFERENCE

The present field-based PIA assesses the potential impacts on Fossil Heritage in the development. The aim of a Palaeontological Impact Assessment (PIA) is to decrease the effect of the development on potential fossils at the development site.

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.

All possible information is consulted to compile a scoping report, and this includes the following: SAHRIS Palaeosensitivity map, all Palaeontological Impact Assessment reports in the same area; aerial photos and Google Earth images, topographical and geological maps as well as scientific articles of specimens from the development area and Assemblage Zones.

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.

During a site investigation the palaeontologist does not only survey the development but also tries to determine the density and diversity of fossils in the development area. This is confirmed by examining representative exposures of fossiliferous rocks (sedimentary rocks contain fossil heritage whereas igneous and metamorphic rocks are mostly unfossiliferous). Rock exposures that are investigated usually contains a large portion of the stratigraphic unit, can be accessed easily and comprise of unweathered (fresh) exposed rock. These exposures may be natural

(rocky outcrops in stream or river banks, cliffs, dongas) but could also be artificial (quarries, open building excavations and even railway and road cuttings). It is common practice for palaeontologist to log well-preserved fossils (GPS, and stratigraphic data) during field assessment studies.

Mitigation usually precede 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 as possible because our knowledge of local palaeontological heritage may be increased.

The fossil potential of the GFRNR development area was determined by criss-crossing the development footprint and by physically investigating the bedrock outcrops to determine the lithology and fossil content of the outcrops. Selected potentially fossiliferous sites (e.g., along drainage lines, hillslopes and erosion gullies) were specifically investigated. Representative investigations of crevasse splay and channel sandstones were also conducted. Fossils occurring at the surface is very unpredictable and as the area is very large and a representative sample size of the area has been investigated. The outcome of a site investigation is limited due to the time and cost of a detailed investigation. Fossil sites are usually discovered by chance and a representative subsample is all that can be hoped for. However, it is important to note that the absence of fossils in a development footprint does not necessarily mean that palaeontological significant material is not present on site (on or beneath 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.
- 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 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).

5 GEOLOGICAL AND PALAEONTOLOGICAL HISTORY

The geology of the proposed Great Fish River Nature Reserve Development and Upgrades in the Eastern Cape is depicted on the 1:250 000 King William 's Town 3226 (1976) and 3326 Grahamstown (1995) Geological maps (Council of Geoscience) (Figure 2, Table 2-3). These geology maps indicates that the proposed development is underlain by Quaternary superficial sediments along the Fish River and Katriver (yellow single bird figure), Jurassic Dolerite (red; Jd) crossing the development from a north-west to south-east direction. The development is also underlain by sediments of the Middleton [Pub/Pm], Koonap (Pk) Formations (Adelaide Subgroup, Beaufort Group, Karoo Supergroup) as well as the Fort Brown Formation (Ecca Group, Karoo Supergroup). Updated geology (Figure 4, Council for Geosciences, Pretoria) indicates that the proposed GFRNR is underlain by the Fort Brown and Waterford Formations (Ecca Group, Karoo Supergroup), as well as the Abrahamskraal and Balfour Formations (Adelaide Subgroup, Beaufort Group, Karoo Supergroup). The PalaeoMap of the South African Heritage Resources Information System (Figure 5, Table 4) indicates that the Palaeontological Sensitivity of the Adelaide Subgroup is Very High, that of the Cenozoic Superficial deposits and Fort Brown Formation is Moderate and the Palaeontological Sensitivity of the Jurassic dolerite is Zero. Due to the Very High Sensitivity of the Adelaide Group a site visit was triggered.

Sediments close to the Fish- and Katriver is Quaternary superficial deposits (Q; yellow; single bird figure) of the Schelm Hoek Formation of the Algoa Group (Table 2). Sediments comprise of calcareous sand (aeolian) shell middens, soil horizons and alluvium. These superficial deposits

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. Important palaeoclimatic changes are reflected in the Quaternary deposits (Hunter et al., 2006). Maud (2012) found that most geomorphologic features in southern Africa were formed during the Cenozoic climate fluctuations. 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 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 generally 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 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 corns as well as skeletons (including reptile skeletons) and fragments of ostrich eggs. Microfossils and 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).

Crossing the development is Jurassic dolerite running from the north-west to the south-east of the footprint. The dolerite forms part of the Karoo Igneous Province that is a classic continental flood basalt province formed during the Early Jurassic (Figure 2, Table 2-3). Dolerite occurs over a large area in southern Africa and comprises of 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 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 GFRNR development is mainly underlain by mudstones, sandstones, and shales, which were deposited under fluvial environments of the Adelaide Subgroup. The Adelaide Subgroup forms part of the Beaufort Group. The Beaufort Group is the third of the main subdivisions of the Karoo Supergroup. This group overlays the Ecca 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. The Beaufort Group was deposited on land through alluvial processes. This Group covers a total land surface area of approximately 200 000 km^2 in South Africa and is the first

fully continental sequence in the Karoo Supergroup. The Beaufort Group is divided into the Adelaide and the overlying Tarkastad Subgroup. 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 (Johnson *et al* 2006).

In the south eastern portion of the Karoo Basin the Adelaide Subgroup consists of the Koonap, Middleton and Balfour Formations. According to the updated geology all of these formations are present in the GFRNR development. West of 24° the Adelaide Subgroup is represented by the Abrahamskraal and Teekloof Formations and in the north the Group is represented by the Normandien Formation. 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 thinness out to about 100 to 200m in the north. The Balfour Formation is approximately 200 m thick, while the Abrahamskraal Formation is about 2 500 m thick and the Teekloof Formation 1 000 m. The Normandien Formation is only about 320 m thick.

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. The Balfour formation in the development footprint comprise of greenish- to bluish-grey and greyish-red mudstone, siltstone, subordinate sandstone. In the northern Normandien formation the basin consists of course to very coarse sandstones and granulostones. 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, but thick sandstone units are also present in the northern Normandien Formation (Groenewald1989, 1990).

The 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 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 apart from in the Normandien and Daggaboersnek Member (Groenewald1989, 1990). Sometimes desiccation cracks and impressions of raindrops are present. In the mudstones of the Beaufort Group calcareous nodules and concretions occur throughout.

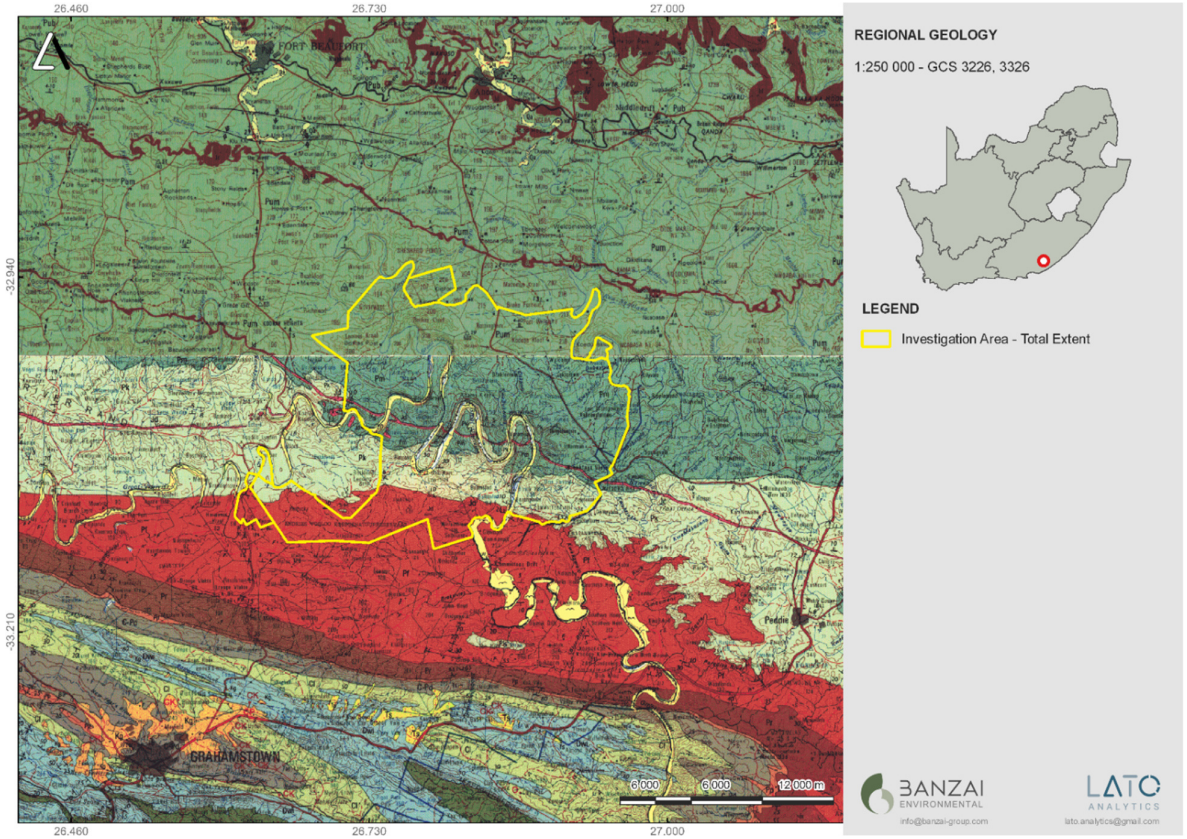


***Figure 2**. Extract of the 1:250 000 King William 's Town 3226 (1976) and 3326 Grahamstown (1995) Geological maps (Council of Geoscience) indicating the regional geology of the GFRNR, in Eastern Cape Province. The development is underlain by alluvium (yellow, single bird figure), Fort Brown Formation (Pf, brick red) of the Ecca Group, as well as the Koonap (Pk, light green) and Middelton Formation (Pm, Pum, green) of the Adelaide Subgroup.*

Table 2: Legend of the 1:250 000 King William 's Town 3226 (1976) Geological Map (Council for Geosciences, Pretoria)

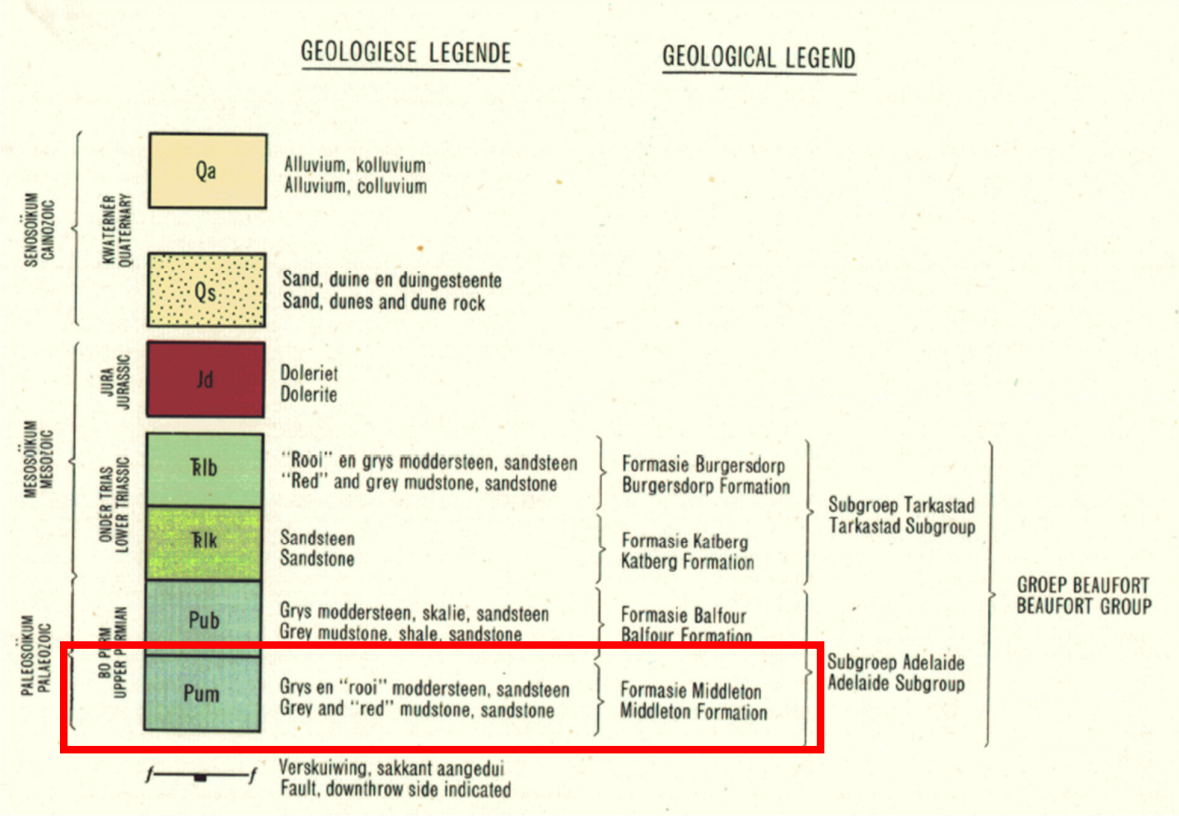
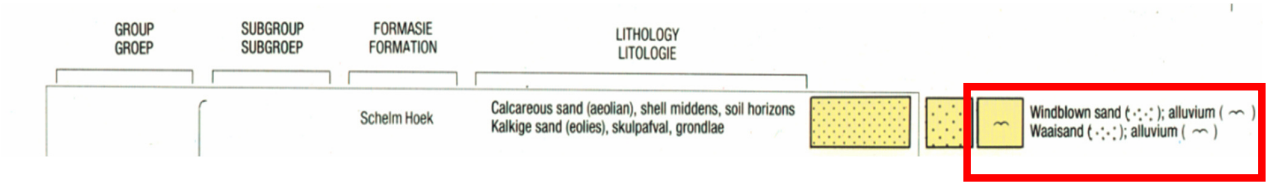
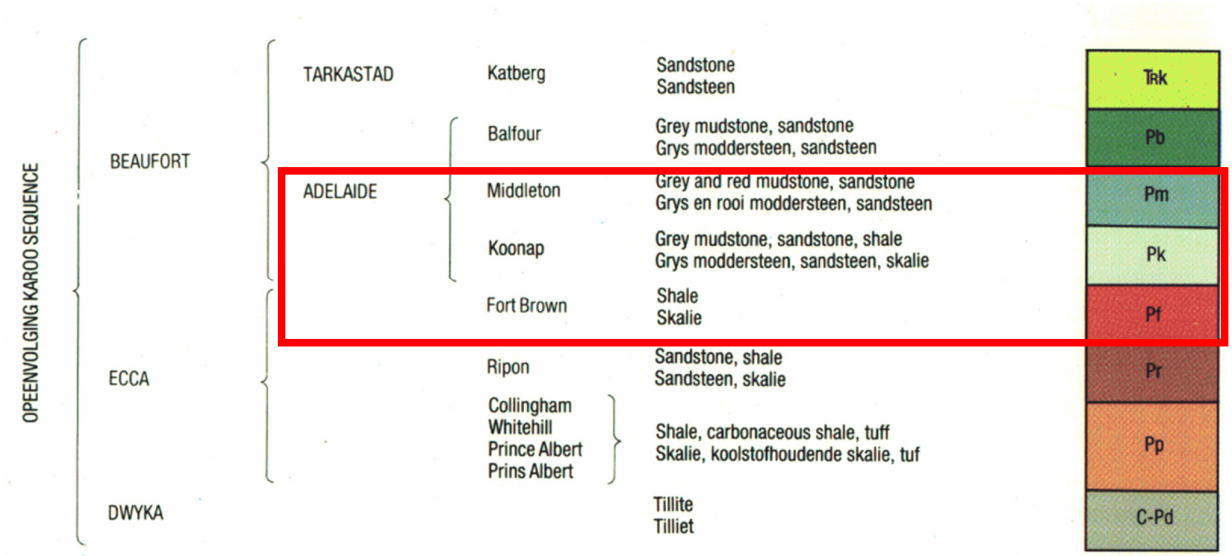


Table 3: *Legend of the 1:250 000 3326 Grahamstown (1995) Geological Map (Council for*





Geosciences, Pretoria)

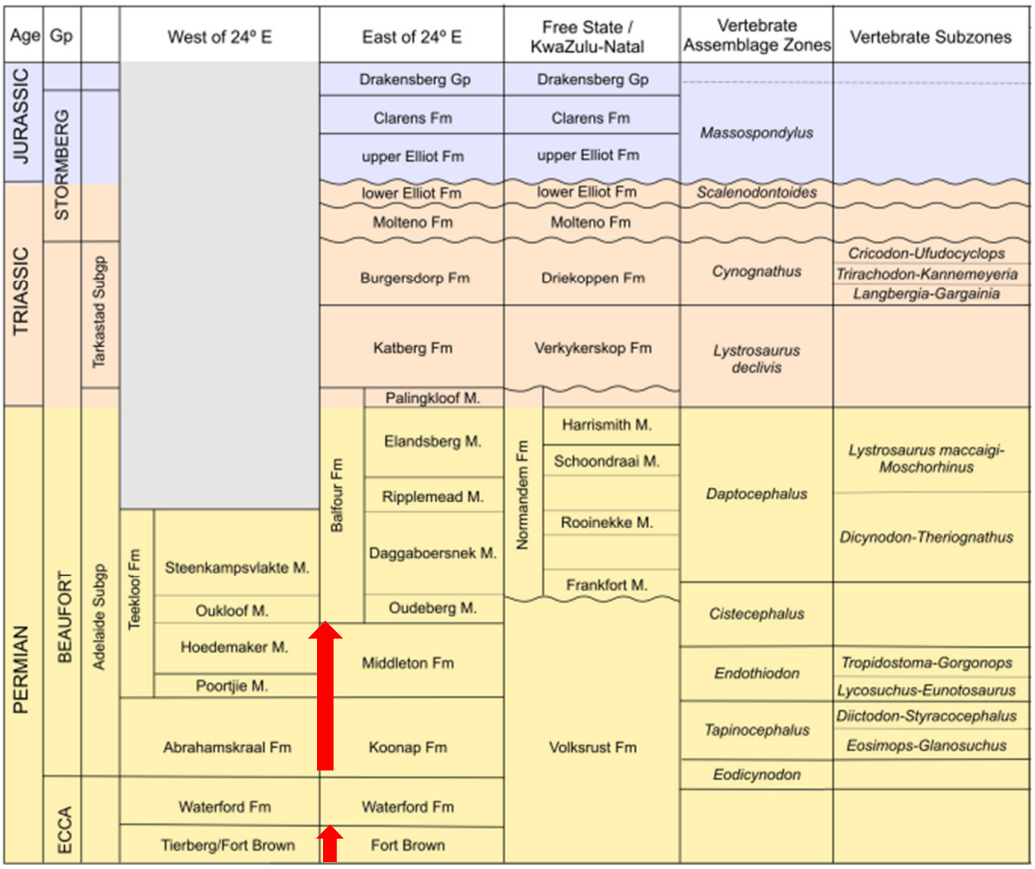


***Figure 3**: Vertebrate biozonation range chart for the Main Karoo Basin of South Africa. Solid lines indicate known ranges, dotted lines indicate suspected but not confirmed ranges, single dot represents the stratigraphic position of the taxa that have only been recovered from a single bed. Wavy lines indicate unconformities. (PLYCSR=Pelycosauria and MAMMFMES+Mammaliaformes. Gp=group, Subgp-Supbroup, Fm=Formation, M=Member. The proposed cemetery development is indication by the red arrow.*

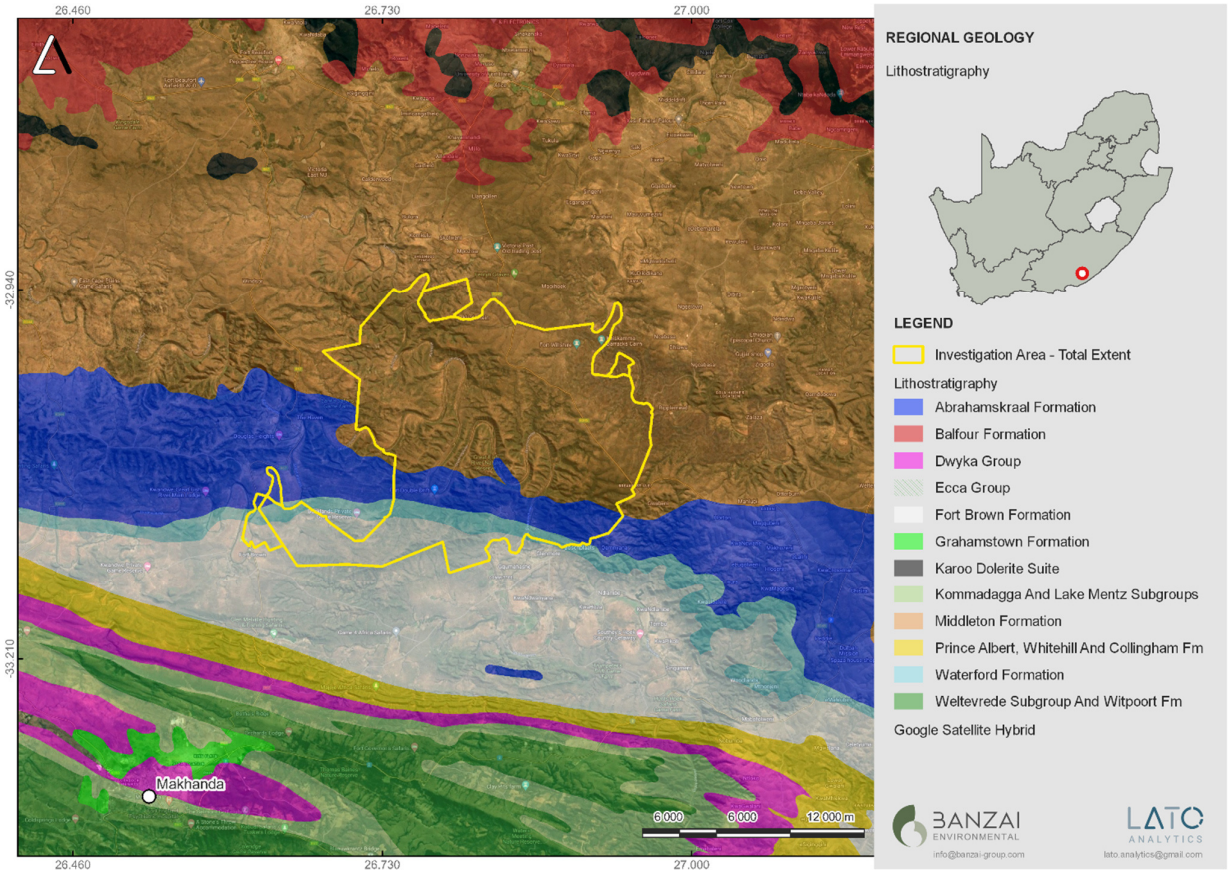


***Figure 4**: Updated geology (Council for Geosciences, Pretoria) indicates that the proposed GFRNR is underlain by the Fort Brown and Waterford Formation (Ecca Group, Karoo Supergroup, as well as the Abrahamskraal and Balfour Formations (Adelaide Subgroup, Beaufort Group, Karoo Supergroup.*

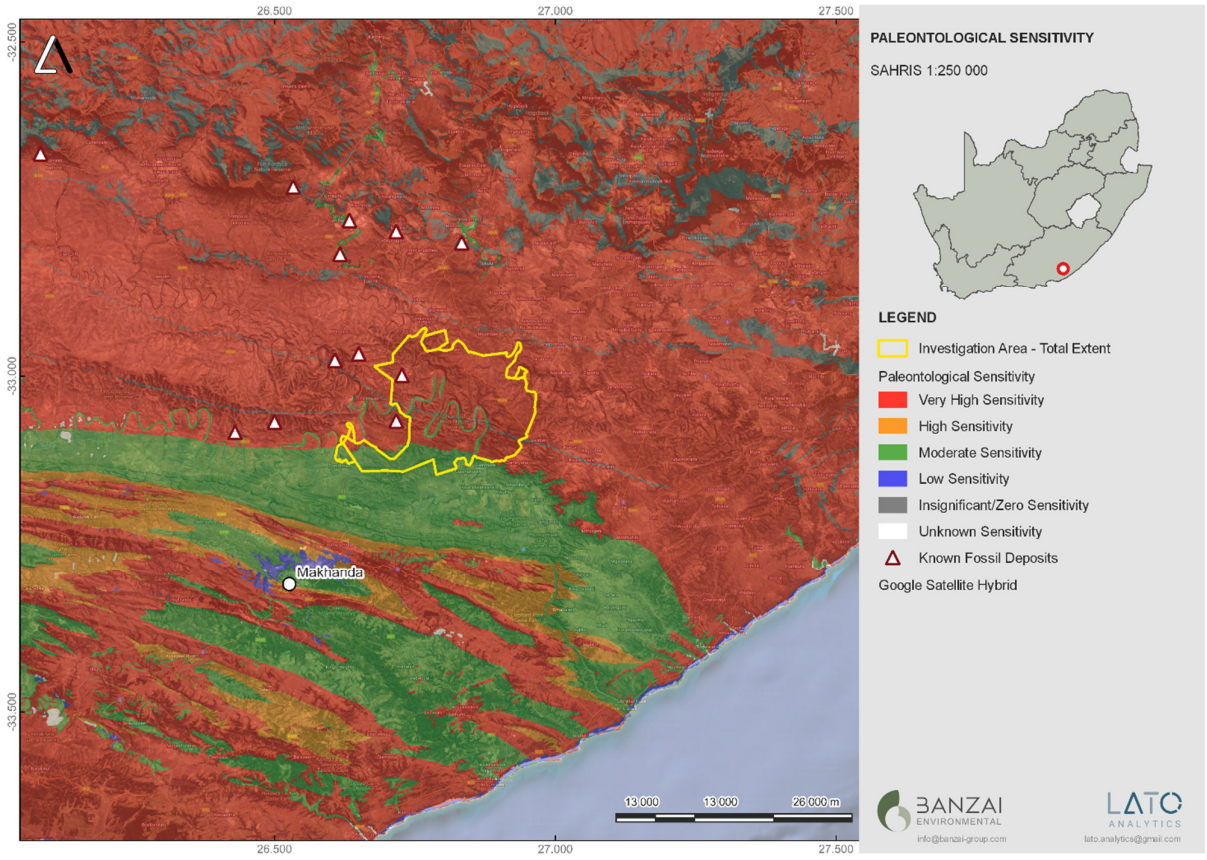


***Figure 5**: Extract of the 1 in 250 000 SAHRIS PalaeoMap map (Council of Geosciences) indicating the development in yellow. Fossils finds recorded on the National Palaeontological Database is indicated in white triangles.*

The SAHRIS Palaeosensitivity map (Figure 5) indicates that the development is underlain by sediments with a Very High (red), Moderate (green) and Zero (grey) Palaeontological Significance.

Table 4: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 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 3**) (Kit ching1977, 1978; Keyser *et al*, 1977, Rubidge 1995, Smith *et al,* 2020; Viglietti 2020).

According to the Updated Geology (**Figure 4**) the Balfour Formation is represented in the GFRNR development area (**Figure 6-12**). This Formation is divided in the *Daptocephalus* Assemblage Zone (DAZ) that in turn is divided in the upper (younger) *Lystrosaurus maccaigi - Moschorhinus* (**Figure 11**) and lower (older) *Dicynodon-Theriognathus Subzones.* The *Daptocephalus* Assemblage Zone (AZ) expands into the lower Palingkloof of the Upper Balfour Formation. This Zone is characterized by the occurrence of the two therapsids namely *Daptocephalus* and *Theriognathus (***Figure 6-7***)*. The *Daptocephalus* AZ 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 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 (**Figure 3**). Vertebrate fossils are mostly found in the mudrock units between channel sandstones in the *Lystrosaurus declivis Assemblage Zone.* Specimens are well preserved and articulated skull and skeleton specimens have been abundantly found. Several bonebeds have been recorded. A common fossil taxon to the floodplain bonebeds is juvenile *Lystrosaurus declivis* (**Figure 8**) that most probably died due to severe drought conditions (Smith and Botha, 2005, Viglietti et al., 2013, Smith and Botha-Brink, 2014). Numerous positively identified skeletons have been identified in burrows in this Assemblage Zone (Bordy et al., 2011; Botha-Brink, 2017, Damiani

et al., 2003, Kitching, 1977; Modesto and Botha-Brink, 2010; Smith and Botha-Brink, 2014). Synchrotron scanning made it possible for Fernandez, et al., 2013 to describe a burrow cast from the Early Triassic of the Karoo (Figure 10). This scan depicts a unique mixed-species association of an injured temnospondyl amphibian (*Broomistega*) sheltering in a burrow inhabited by an aestivating *Thrinaxodon*.

The GFRNR development area is also represented by the Middelton (Pm/ Pub) and Koonap (Pk) Formations of the Adelaide Subgroup (Rubidge 1995, Smith 2012; Viglietti et al 2015).

Figure 3 shows the biozonation of the main Karoo Basin and indicates that the development is biostratigraphically represented by the *Tapinocephalus, Endothiodon* and a portion of the *Cistecephalus* Assemblage Zones (AZ).

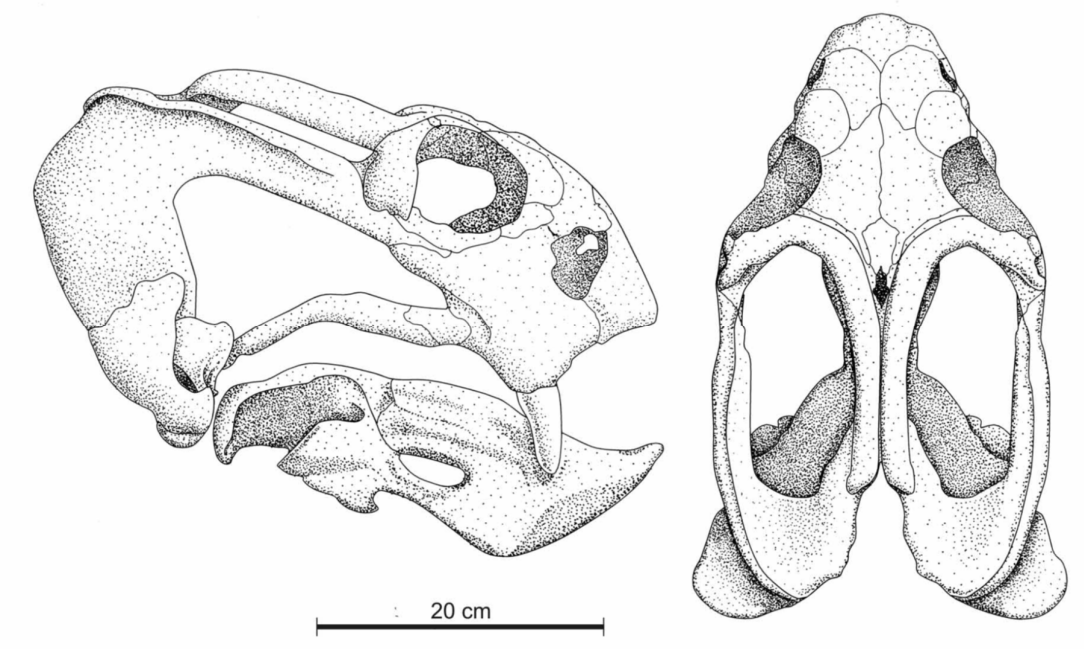


***Figure 6**: Lateral and dorsal views of skull of the dicynodont Daptocephalus leoniceps, the main Daptocephalus AZ defining fossil (Image taken from Viglietti, 2020).*

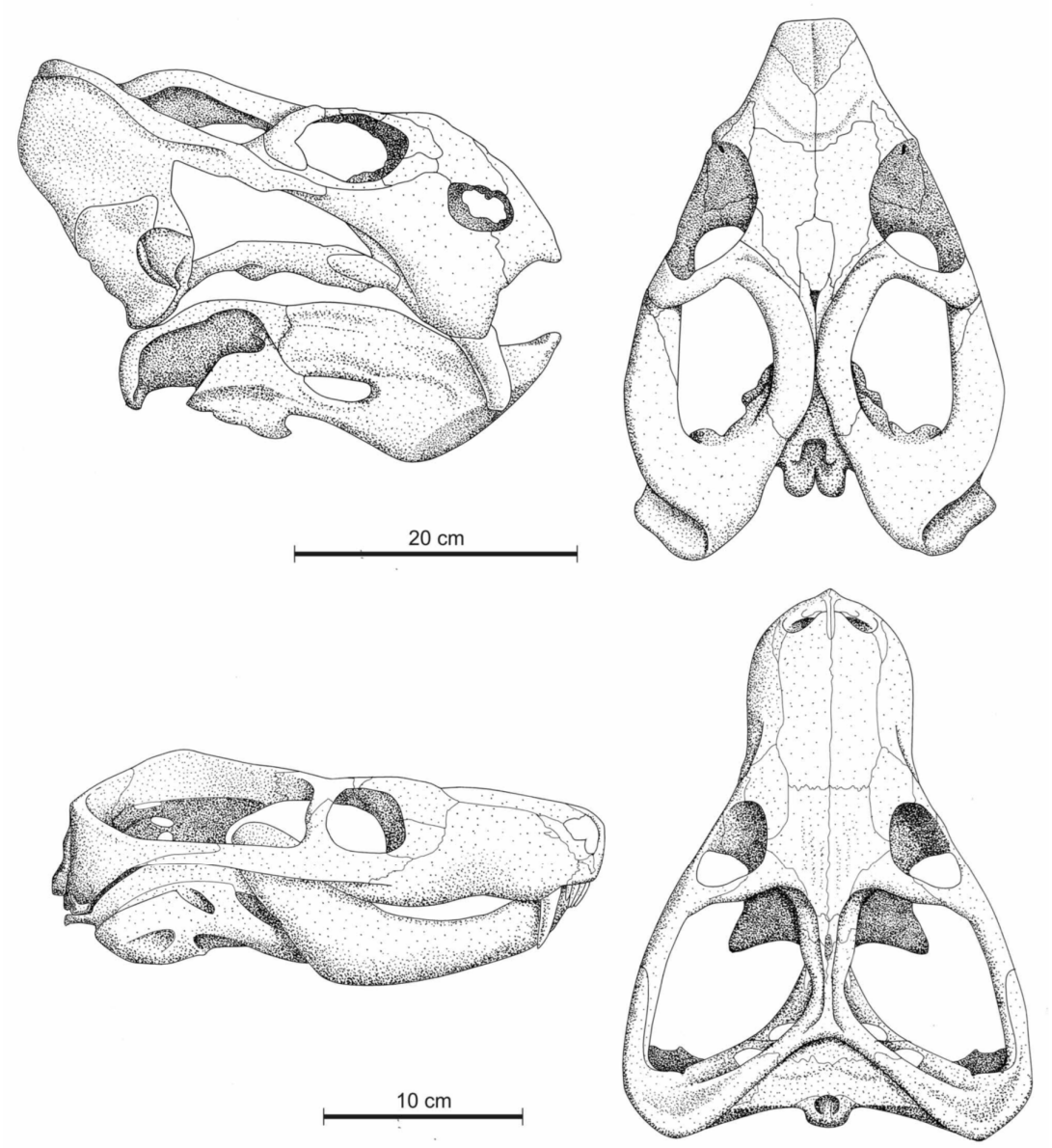


***Figure 7**: Skulls of the biozone defining fossils of the Dicynodon-Theriognathus Subzone in lateral and dorsal views. Dicynodon lacerticeps (top), Theriognathus microps (bottom) (Image taken from Viglietti, 2020).*

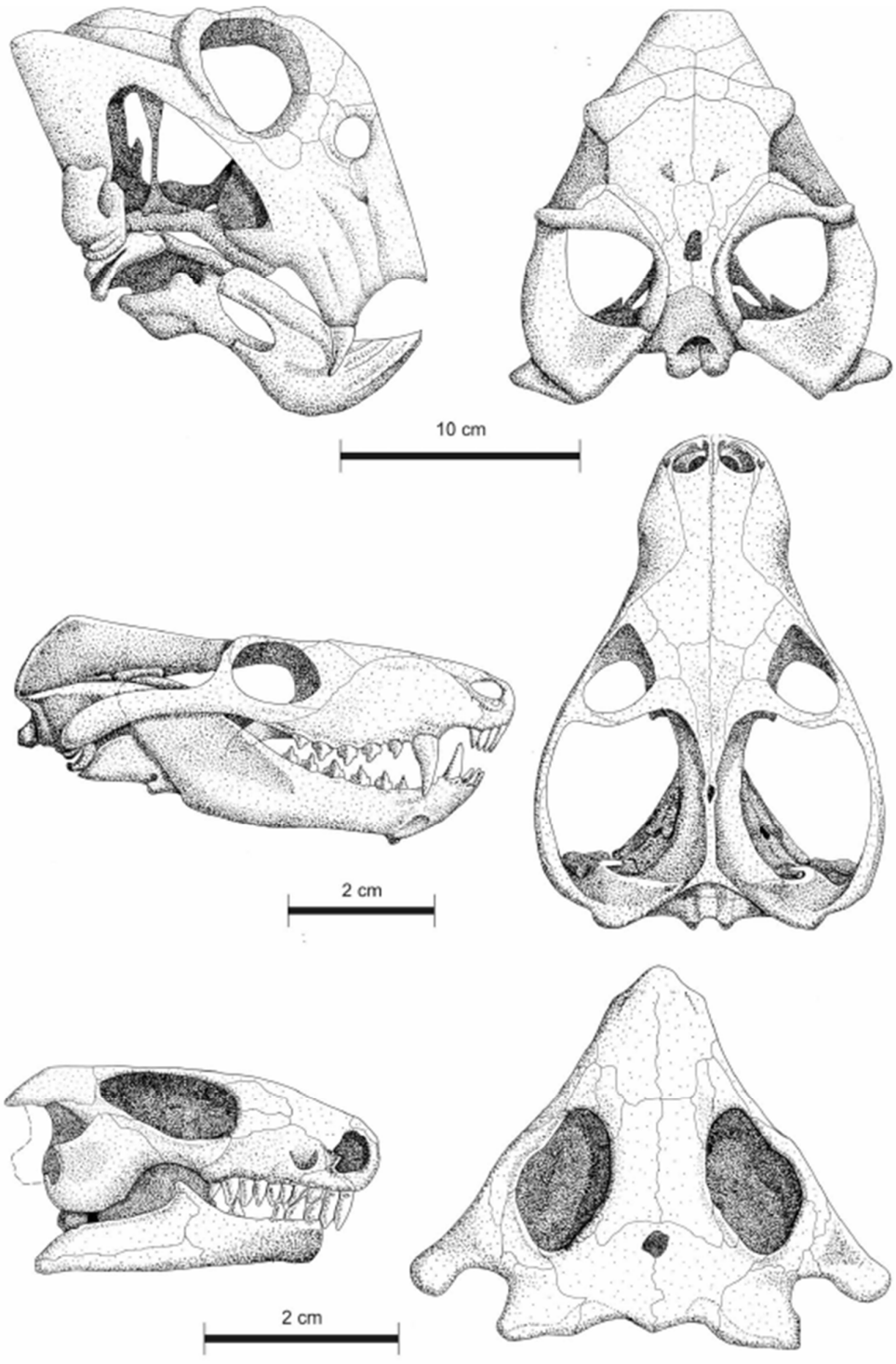


***Figure 8**: Lateral and dorsal views of the index taxa defining the Lystrosaurus declivis Assemblage Zone. (top) Lystrosaurus declivis, (centre) Thrinaxodon liorhinus, (bottom) Procolophon trigoniceps (Image taken from Botha and Smith, 2020).*

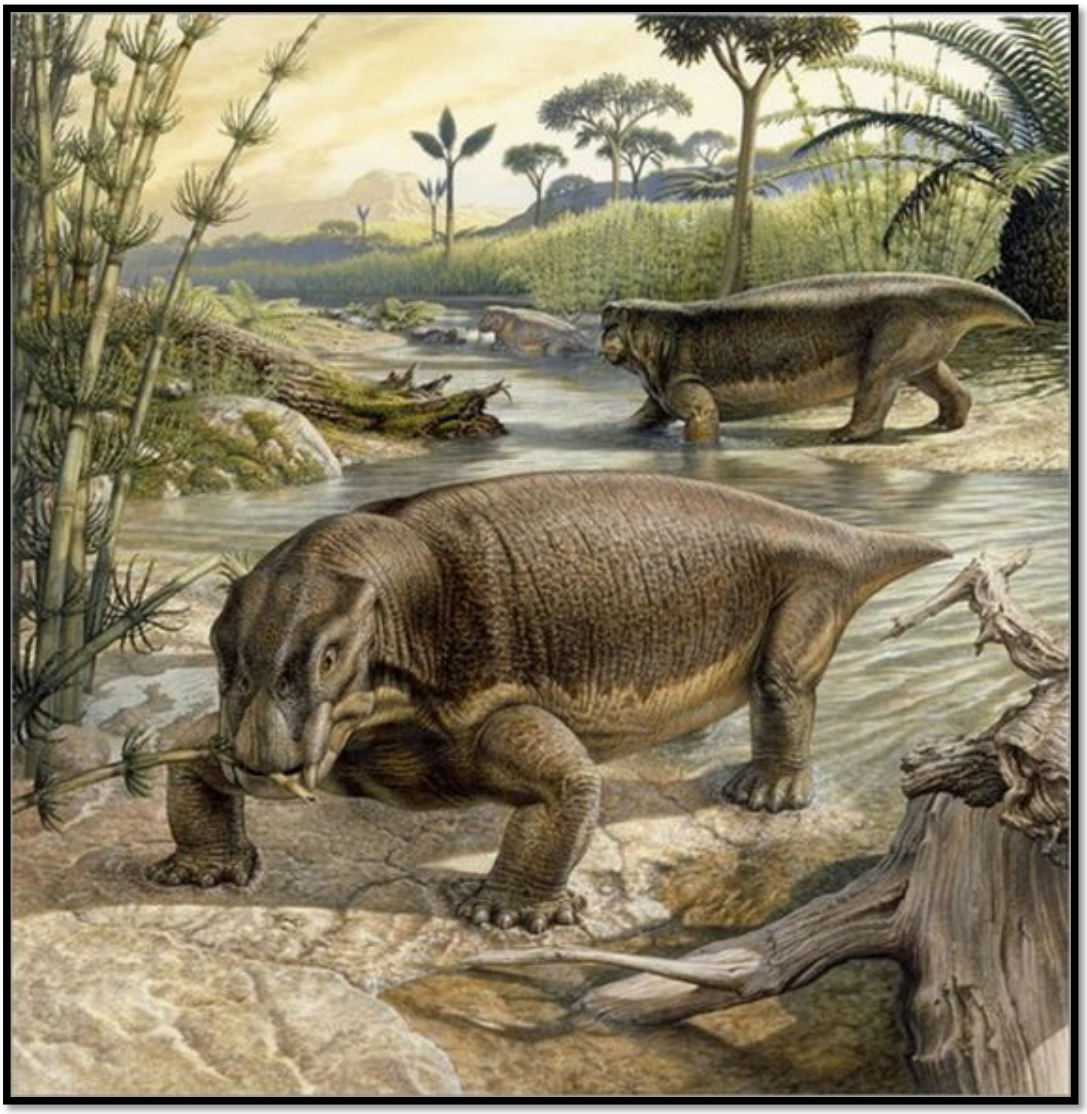


***Figure 9**: Reconstruction of Lystrosaurus*

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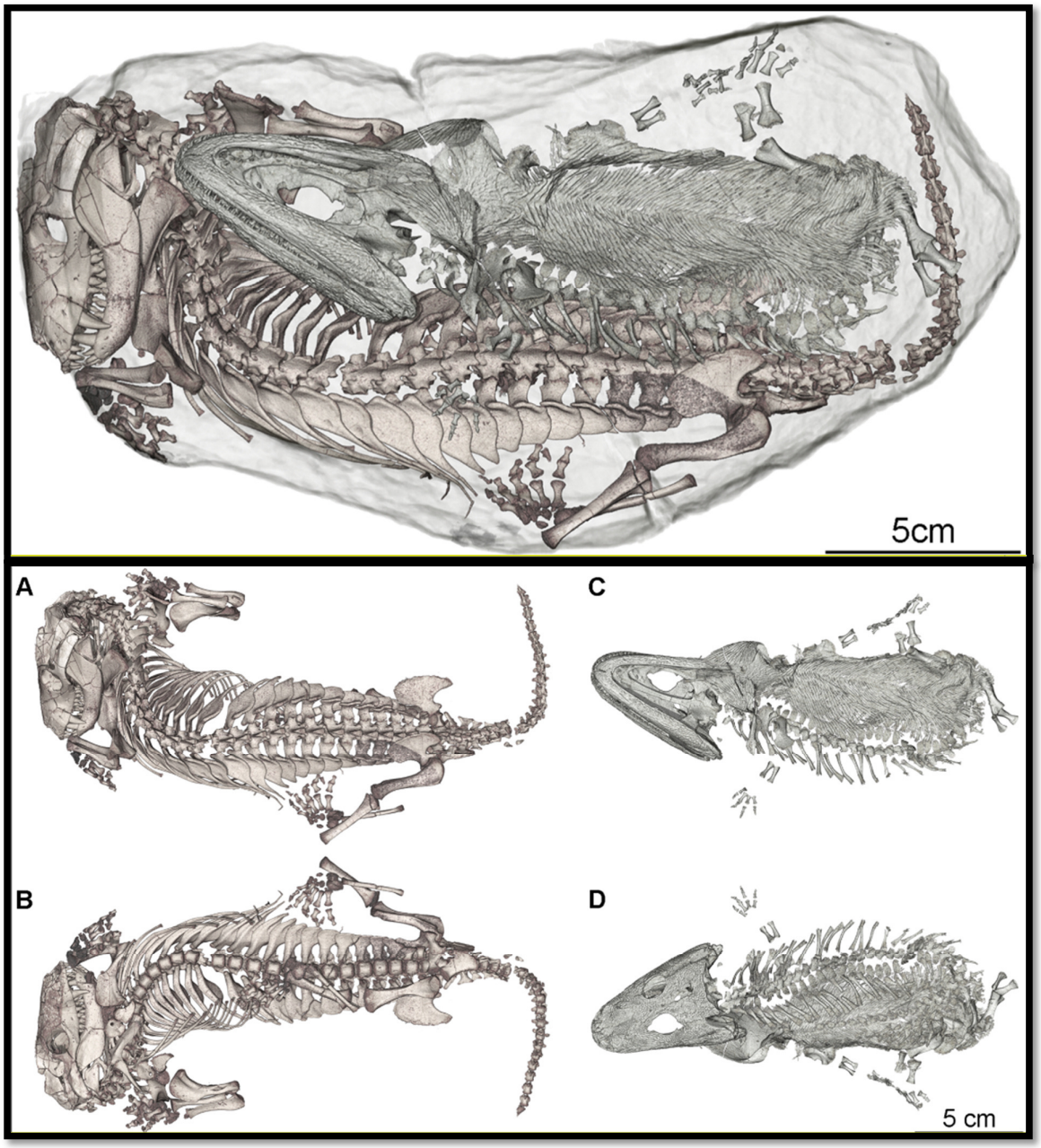

***Figure 10**: Synchrotron scan of a burrow cast from the Early Triassic indicates an injured temnospondyl amphibian (*Broomistega*) that sheltered in a burrow occupied by an aestivating therapsid (*Thrinaxodon*) Image taken from Fernandez, et al., 2013.*

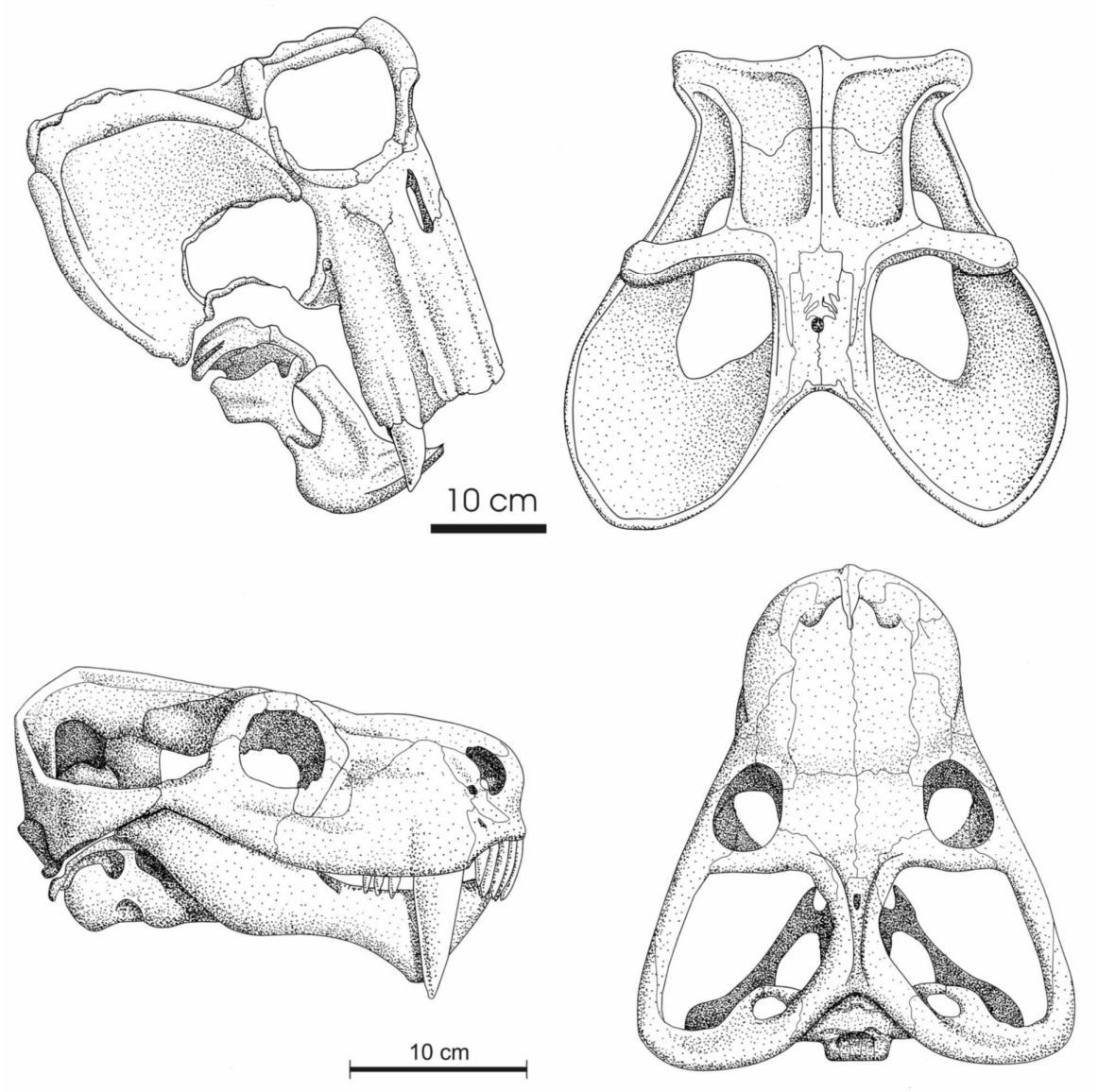

***Figure 11**: Biozone defining fossils of the Lystrosaurus maccaigi- Moschorhinus Subzone. The skulls of the Lystrosaurus maccaigi (top) and Moschorhinus kitchingi (bottom) in lateral (Image taken from Viglietti, 2020).*

The *Cistecephalus* Assemblage Zone (CiAZ) has recently been radiometrically-dated and ages range from 256 to 255 My (million years). This diverse AZ is dominated by small herbivorous dicynodonts like *Pristerodon* and *Diictodon* as well as the molelike *Cistecephalus*. Larger herbivores include *Aulacephalod*on, *Dinanomodon*, *Rhachiocephalus*, and Endothiodon that is very rare. Large carnivores include the gorgonopsians *Aelurognathus*, *Smilesaurus*, and *Rubidgea* while smaller carnivores include,

Eutherocephalians (*Ictidosuchops* and *Itidosuchoides). Scylacocephalus, Lycaenops* and *Aloposaurus* represents the gorgonopsians. Pararepiles and Pareiasaurus are also present. The biozone defining fossils of the CiAZ is *Cistecephalus*, *Oudenodon* and *Aulacephalodon* and is depicted in Figure 12.

In the southern Karoo Basin, west of 24°, the CiAZ spans the upper section of the Teekloof Formation. In the basin east of 24°, the CiAZ is present in the uppermost section of the Middleton Formation and lowermost section of the Balfour Formation. Vertebrate fossils in the CiAZ are found in the olive-grey, grey, and dark reddish-brown mudrock sequences. Smith (1993) interpreted the CiAZ as floodplain deposits comprising of proximal and distal flood basin facies, levee, and crevasse splay. Catuneanu et al., (2005) found that these sediments accumulated between numerous low sinuosity rivers that flowed across broad low-angle distributary fans from the Gondwanide foothills to the eastern and western sub-basins. Tetrapod fossils are generally found in the 0,5 to 1m thick proximal floodplain facies consisting of massive olive grey siltstone beds. Fossils usually comprise of disarticulated skulls and skeletons while articulated skeletons are extremely rare. Bones are usually enveloped by pedogenically precipitated calcareous nodular material soon after burial thus protecting them from later compaction (Smith, 2020). Concentrations of pockets of *Cistecephalus* skulls occur throughout a large area in the CiAZ. It is suggested that these pockets were deposited during a generally wetter floodplain environment. Smith (2020) also describes fish scale lenses, non-marine bivalve (Palaeomutela) conglomerates as well as bone clusters and fish scale-bearing coprolites to support this interpretation.

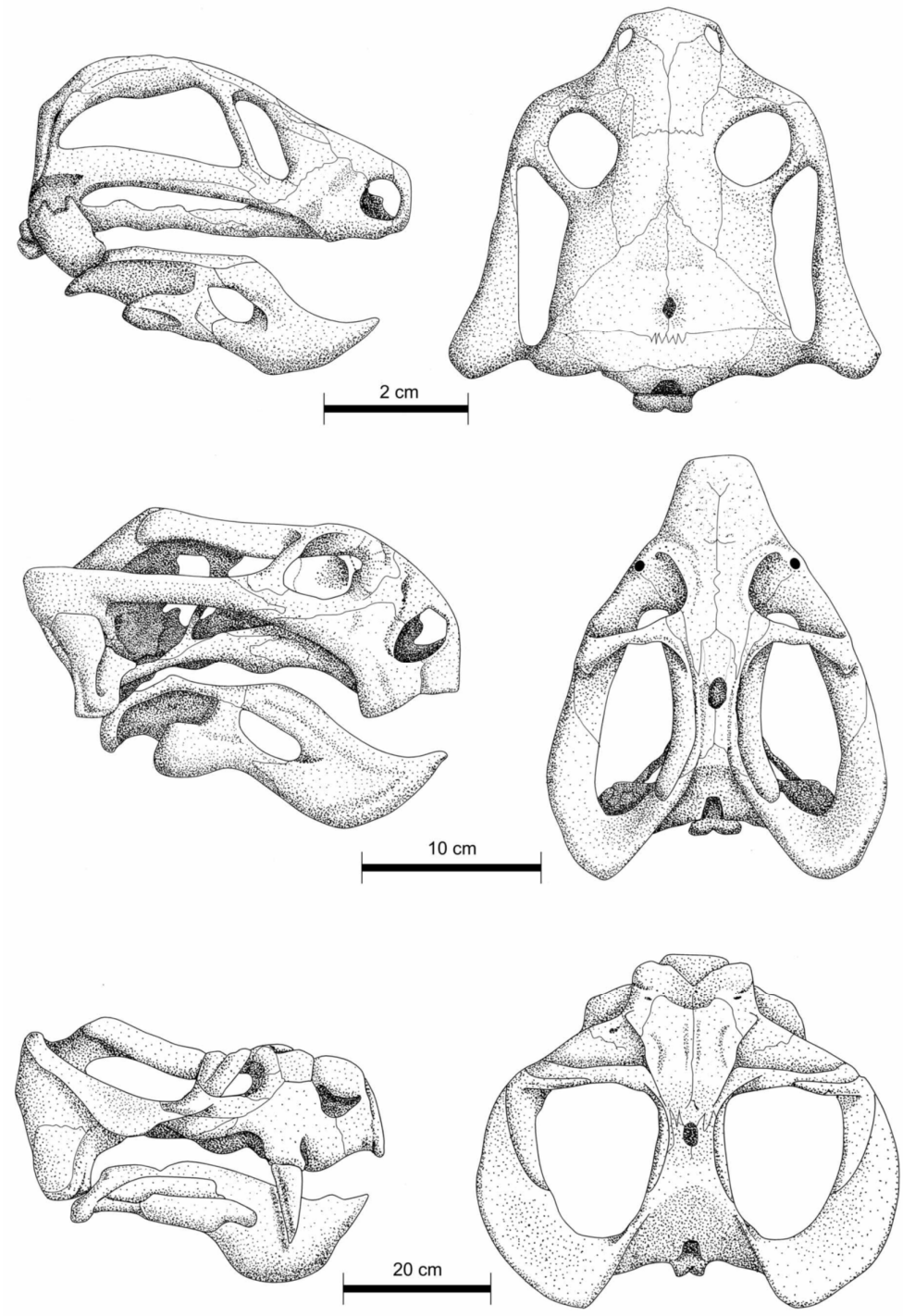

***Figure 12**: Lateral and dorsal views of Cistecephalus microrhinus (top), Oudenodon bainii (centre) and, Aulacephalodon bainii (bottom), the biozone-defining fossils of the Cistecephalus Assemblage Zone. (Image taken from Smith 2020).*

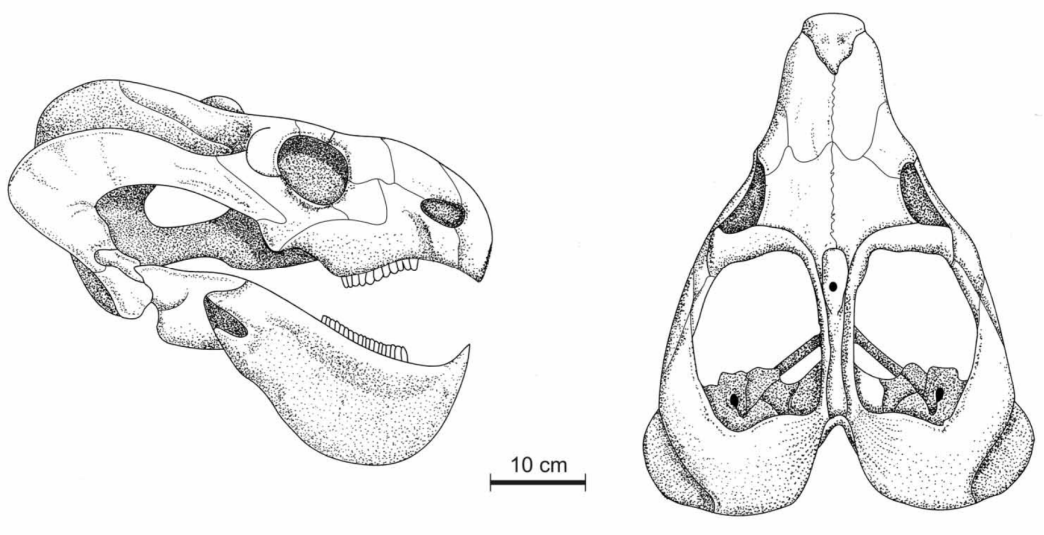

***Figure 13**: Endothiodon bathystoma, in lateral and dorsal views is the biozone defining fossil of the Endothiodon Assemblage Zone (Image taken from Day and Smith, 2020).*

The dicynodont genera *Endothiodon* (Figure 13), *Emydops, Diictodon, Pristerodon* and the gorgonopsian Gorgonops characterizes the *Endothiodon* AZ. In South Africa, *Endothiodon* is most probably represented by the single species *Endothiodon bathystoma* (Brink, 1986; Cox and Angielczyk, 2015; Maharaj, 2018) that becomes abundant after the Capitanian mass extinction. Endothiodon is very rarely recovered from other intervals.

Characterizing taxa of the *Lycosuchus – Eunotosaurus* Subzone is *Eunotosaurus africanus* and the lycosuchid theroceohalian *Lycosuchus vanderrieti* (Figure 15) that co-occur with Endothiodon. This Subzone represents the first stage of ecological recovery after the Capitanian mass extinction. (Day *et al*., 2013; Kammerer *et al*., 2015) and records the stratigraphically lowest occurrence of large gorgonopsians and bauroid therocephalians. Basal therocephalians include the scylacosaurid *Glanosuchus macrops* while the small gorgonopsian *Eriphostoma microdon* is also present in this Subzone. This Subzone mostly corresponds with the arenaceous Poortjie Member with a sandstone mudrock ratio of 1:2. A sudden increase of sandstone bodies is present at the base of this member and the change from single-storied to multi-storied channel sandstone geometries. Mudrocks are represented by subordinate dark-reddish brown mudstone and greenish-grey siltstone. Roussouw and De Villiers [1952) describes calcareous nodular horizons that weathers to a brown colour as well as thin sheets of pink-weathering silicified siltstone.

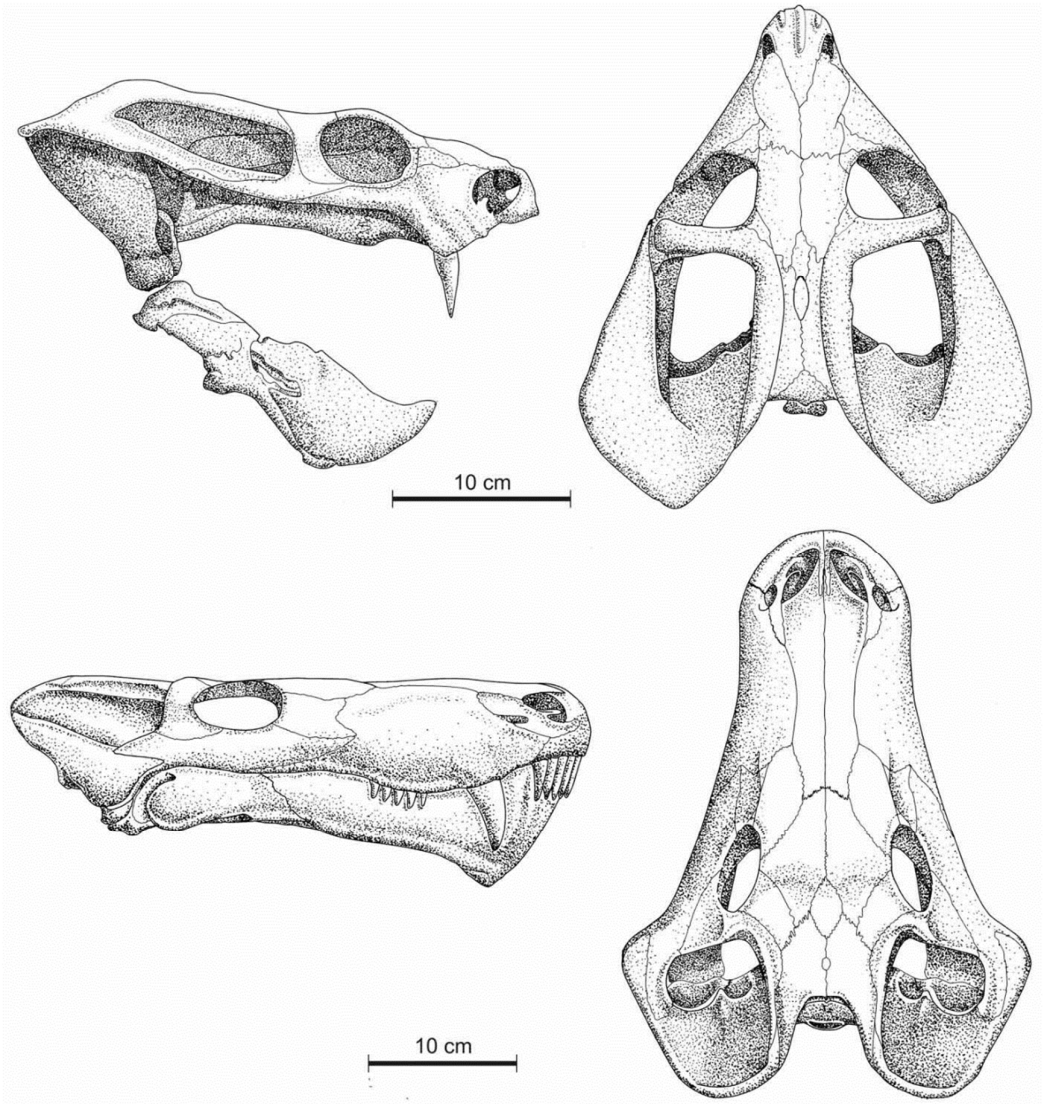

***Figure 14**: Lateral and dorsal views of the index taxa of the Tropidostoma – Gorgonops Subzone namely (top) Tropidostoma dubium, (bottom) Gorgonops torvus (Image taken from Day and Smith, 2020).*

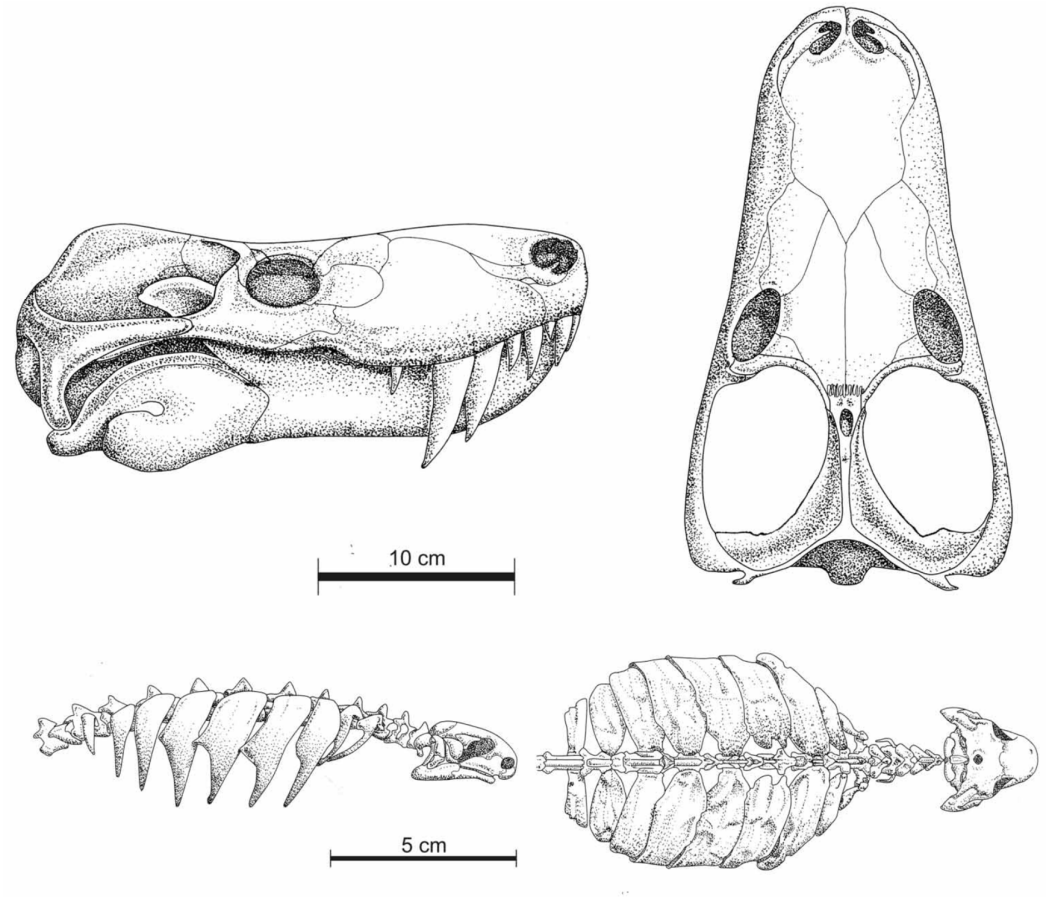

***Figure 15**: Lateral and dorsal views of Lycosuchus vanderrieti (top), and Eunotosaurus africanus (bottom), the biozone defining taxa of the Lycosuchus – Eunotosaurus Subzone (Image taken from Day and Smith, 2020).*

A renewed uplift in the Gondwanides (about 260 Mya) caused a variety of sand-dominated braided streams flowing northeasterly and crossing the southern Karoo alluvial plains in the direction of an intracontinental sea (Rubidge, 2005).

The predominantly mudrock *Tropidostoma-Gorgonops* Subzone is a sequence of fluvio-lacustrine strata. Vertebrate fossils are mostly found in massively bedded thick greenish-grey siltstone with minor mudstone intercalations occurring between the main channel sandstones. These sediments are thick coarsening upwards sequences of between 5 to 10m thick and is understood to be prograding crevasse

splay complexes. The latter was deposited by repeated overbank flood events originating from the channel banks and accumulating in lowland flood basins. Scattered oblate pedogenic carbonate nodules forming horizons is present in massive siltstones. This is interpreted to be calcic vertisols that were deposited under a seasonally dry humid-temperate climate (Smith, 1993) at the base of meanderbelt slopes.

The *Tropidostoma* - *Gorgonops* Subzone has a greater abundance of taxons than the *Lycosuchus* - *Eunotosaurus* Subzone. This Subzone is characterised by the presence of rare basal cynodonts. large gorgonopsians, basal baurioid therocephalians, cryptodont dicynodonts, and small pareiasaurs. Fossils in this Subzone is predominately found in overbank facies

Fossils of the *Tropidostoma-Gorgonops* Subzone (Figure 14) are mainly found in the overbank facies — particularly in the fine-grained sandstone and massive siltstone sheets of the proximal floodplain facies (Smith, 1993). This subzone is known for its dense cluster of *Diictodon* skulls that are found in a patch of 20 to 50m. *Diictodon* (Smith, 1993) and *Youngina* (Smith and Evans, 1995) juvenile aggregations has been described in the literature.

Fossils are usually disarticulated unweathered, well-preserved specimens while fully articulated specimens are usually intercurled paired skeletons. Fossils bones are usually enclosed in smooth-surfaced calcareous pedogenic nodular material. Rare burrow casts accredited to the digging activity of dicynodonts is present in the in the lower part of the subzone but absent in the upper section. Coprolites comprising of bones has also been recovered. The *Tropidostoma* - *Gorgonops* Subzone reaches a thickness of between 130 and 150m along the Nuweveld escarpment and becomes thinner in the north (Day and Rubidge, 2019).

A portion of the development is underlain by the Koonap Formation. As the second oldest tetrapod biozone in the Karoo, the *Tapinocephalus* AZ is basically restricted to this 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 (Figure 16) 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* 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 pylaecephalid dicynodonts *Eosimops* and *Robertia*. 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.

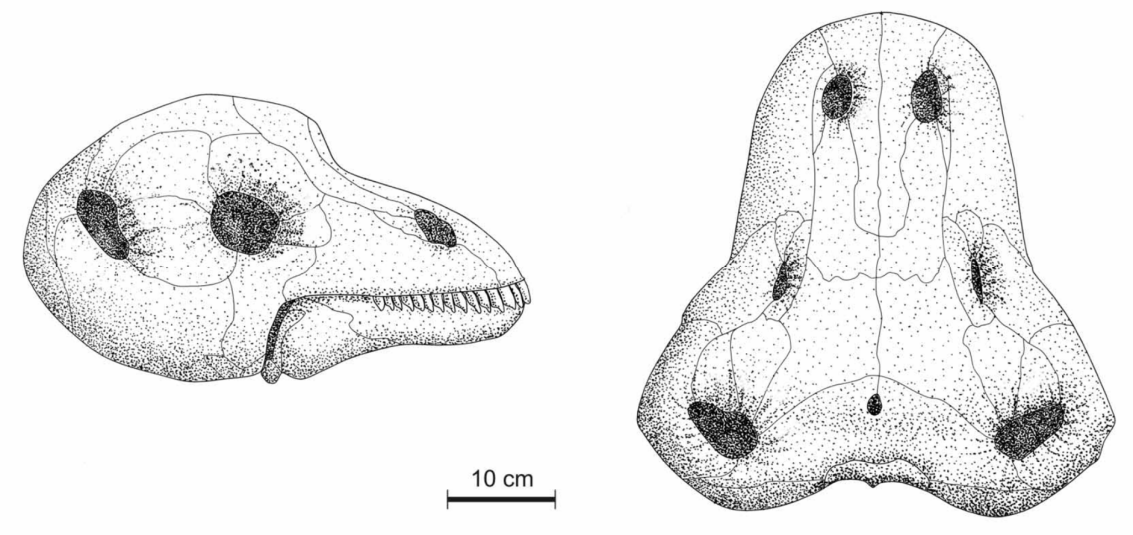

***Figure 16**: Tapinocephalus atherstonei, the index taxon of the Tapinocephalus Assemblage Zone, in lateral and dorsal view (Image taken from Day and Rubidge, 2020).*

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.

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).

The Waterford Formation (Figure 3) of the Ecca Group is about 270 million years old and is a thick (500-770 m) deltaic deposit. The Beaufort- Ecca contact in the southern and western Karoo depicts a change from a subaqueous to a subaerial delta plain (Rubidge et al, 2000). This sandstone-rich, resistant-weathering Formation comprises of mudrock or clastic rhythmite units and very fine-grained, lithofeldspathic sandstones. Khaki to grey lithofeldspathic sandstones that may be speckled, while dark grey mudrocks are structured into broadly coarsening-upwards prograding cycles. Wave-ripple bedding planes are commonly present as well as ball-and pillow structures. Trace fossils are common in this formation and consist of burrows, tubes, and trails. Fossil plants are represented by petrified wood and equisetaleans.

The majority of the Tierberg Formation (Ecca Group; Karoo Supergroup) comprises of well-laminated, dark grey to black shale (Johnson et al 2006). Some yellowish tuffaceous beds up to 10cm thick occur in the lower part of the succession along the western and northern margins of the Basin. Calcareous concretions are common towards the top of the formation. Clastic rhythmites occur at various levels in the sequence (Cole, 2005). This formation is considered to be a deep-water deposit associated with event beds. The Tierberg formation is known for its rare trace fossils assemblages. Vascular plants (including petrified wood) and palynomorphs of Glossopteris flora have been found while crustaceans, shelly marine invertebrates, insects, and fish fossils as well as microfossils have been identified.

6 GEOGRAPHICAL LOCATION OF THE SITE

The Proposed Infrastructure Development and Upgrades of the Great Fish River Nature Reserve is in the Makana Local Municipality, Raymond Mahlaba Local Municipality and Ngqushwa Local Municipality, Eastern Cape Province. The GFRNR spans the Great Fish River in the south-east of the Eastern Cape. The study area is located north-west of the N2, halfway between King William's Town and Makhanda (Grahamstown) (Figure 1). The central point of the study site is Latitude: 33°06'38.55" S; Longitude: 26°49'41.83" E.

7 METHODS

The aim of a desktop study is to evaluate the possible risk to palaeontological heritage in the proposed development. This includes all trace fossils as well as all fossils in the proposed footprint. All possible information is consulted to compile a desktop study, and this includes the following: all Palaeontological Impact Assessment reports in the same area; aerial photos and Google Earth images, topographical as well as geological maps.

7.1 Assumptions and Limitations

The focal point of geological maps is the geology of the area and the sheet explanations of the Geological Maps were not meant to focus on palaeontological heritage. Many inaccessible regions of South Africa have never been reviewed by palaeontologists and data is generally based on aerial photographs alone. 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.

Areas with similar Assemblage Zones in other areas is also used to provide information on the existence of fossils in an area which has not documented in the past. When using similar Assemblage Zones and geological formations for Desktop studies it is generally assumed that exposed fossil heritage is present within the footprint. A field-assessment will thus improve the accuracy of the desktop assessment and thus this study has been commissioned.

8 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).
- 1: 250 000 3226 King William's Town Geological map (1976) (Council of Geoscience, Pretoria)
- 1: 250 000 3326 Grahamstown Geological map (1995) (Council of Geoscience, Pretoria)
- A Google Earth map with polygons of the proposed development was obtained from JG Afrika.

9 SITE VISIT

A two-day site-specific field survey of the development footprint was conducted on foot and motor vehicle on 25 February and 7 March 2023 by Mr Ryan Nel based at Rhodes University. As the GFRNR area is very large a representative sample of the area has been investigated. Several fossiliferous sites were identified during the site visit. The following photographs of the site was taken (Figure 17-35).

***Figure 17**: Facing North-Large sandstone outcrop south of the Katriver.*

***Figure 18**: Beaufort Group-Purple to green siltstone with grey sandstone lens between siltstone layers.*

Figure 19: Blue-grey Beaufort siltstone mantled by loose unsorted sandstone.

Figure 20: Typical waterbodies present in the proposed development.

***Figure 21**:Typical Beaufort outcrop comprising of purple siltstone west of the Great Fish River mantled by loos sandstone scree.*

***Figure 22**: Tilted strata containing from bottom to top - massive sandstone, green grey siltstone capped with another smaller lens of sandstone. Layers dipping in a westerly direction.*

***Figure 23**: Potentially fossiliferous siltstone outcrops of the Adelaide Subgroup were found to be unfossiliferous.*

***Figure 24**:Sandstone lens located between siltstone layers. No fossils were uncovered.*

***Figure 25**: Sandstone lenses overlain with siltstone*

***Figure 26**: Trace fossils identified in siltstone (see photo above)*

GPS: -32.983259; 26.697282

***Figure 27**: Sandstone and siltstone layers becoming finer upwards*

***Figure 28**: Glossopteris leaf fragments (see photo above)*

GPS -32.983454; 26.697533

Figure 29: Loose wood fragment

GPS -33.006447; 26.711727

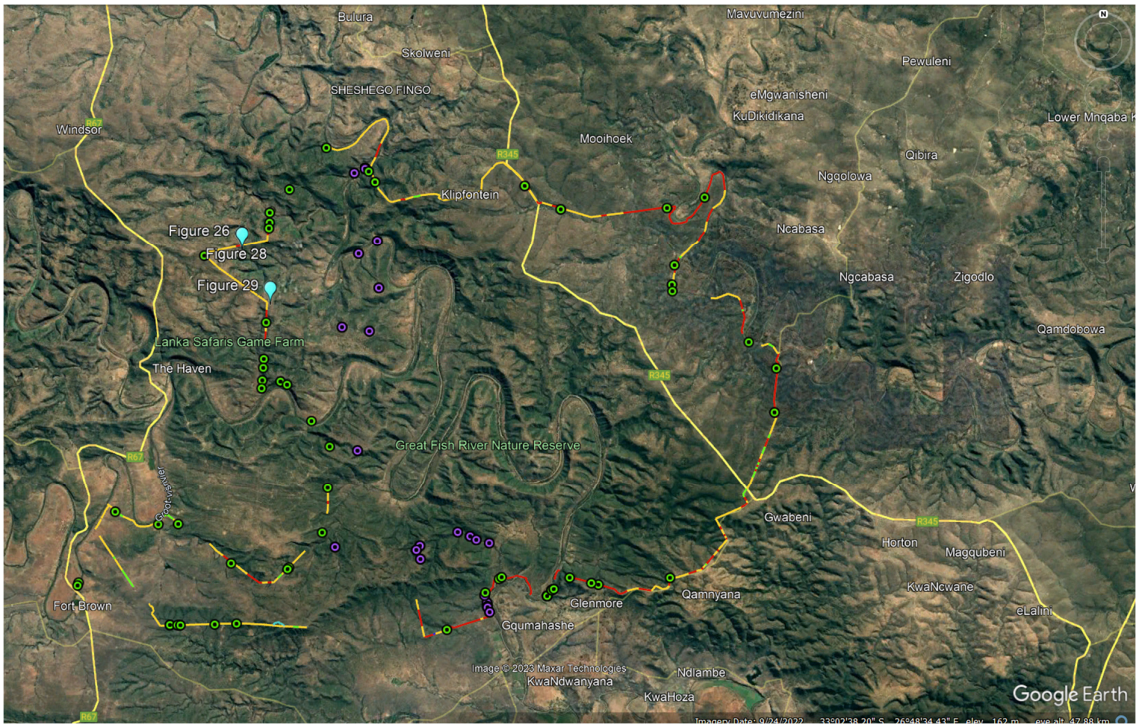

Figure 30: A Few Fossiliferous sites identified in the proposed GFRNR development.

10 ASSESSMENT METHODOLOGY

10.1 Method of Environmental Assessment

Impact assessment must take account of the nature, scale, and duration of impacts on the environment whether such impacts are positive or negative. Each impact is also assessed according to the following project phases:

- Construction.
- Operation; and
- Decommissioning.

Where necessary, the proposal for mitigation or optimization of an impact should be detailed. A brief discussion of the impact and the rationale behind the assessment of its significance should also be included. The rating system is applied to the potential impacts on the receiving environment and

includes an objective evaluation of the mitigation of the impact. In assessing the significance of each impact, the following criteria is used:

Table 5: The Rating System		
The Nature of the Impact is the possible destruction of fossil heritage		
GEOGRAPHICAL EXTENT		
This is defined as the area over which the impact will be experienced.		
1	Site	The impact will only affect the site.
2	Local/district	Will affect the local area or district.
3	Province/region	Will affect the entire province or region.
4	International and National	Will affect the entire country.
PROBABILITY		
This describes the chance of occurrence of an impact.		
1	Unlikely	The chance of the impact occurring is extremely low (Less than a 25% chance of occurrence).
2	Possible	The impact may occur (Between a 25% to 50% chance of occurrence).
3	Probable	The impact will likely occur (Between a 50% to 75% chance of occurrence).
4	Definite	Impact will certainly occur (Greater than a 75% chance of occurrence).
DURATION		
This describes the duration of the impacts. Duration indicates the lifetime of the impact because of the proposed activity.		
1	Short term	The impact will either disappear with mitigation or will be mitigated through natural processes in a span shorter than the construction phase (0 – 1 years), or the impact will last for the period of a relatively short construction

		period and a limited recovery time after construction, thereafter it will be entirely negated (0 – 2 years).
2	Medium term	The impact will continue or last for some time after the construction phase but will be mitigated by direct human action or by natural processes thereafter (2 – 10 years).
3	Long term	The impact and its effects will continue or last for the entire operational life of the development but will be mitigated by direct human action or by natural processes thereafter (10 – 30 years).
4	Permanent	The only class of impact that will be non-transitory. Mitigation either by man or natural process will not occur in such a way or such a time span that the impact can be considered indefinite.
INTENSITY/ MAGNITUDE		
Describes the severity of an impact.		
1	Low	Impact affects the quality, use and integrity of the system/component in a way that is barely perceptible.
2	Medium	Impact alters the quality, use and integrity of the system/component but system/component continues to function in a moderately modified way and maintains general integrity (some impact on integrity).
3	High	Impact affects the continued viability of the system/ component, and the quality, use, integrity and functionality of the system or component is severely impaired and may temporarily cease. High costs of rehabilitation and remediation.
4	Very high	Impact affects the continued viability of the system/component, and the quality, use, integrity and functionality of the system or component permanently ceases and is irreversibly impaired. Rehabilitation and remediation often impossible. If possible, rehabilitation and remediation often unfeasible due to extremely high costs of rehabilitation and remediation.

REVERSIBILITY		
This describes the degree to which an impact can be successfully reversed upon completion of the proposed activity.		
1	Completely reversible	The impact is reversible with implementation of minor mitigation measures.
2	Partly reversible	The impact is partly reversible but more intense mitigation measures are required.
3	Barely reversible	The impact is unlikely to be reversed even with intense mitigation measures.
4	Irreversible	The impact is irreversible, and no mitigation measures exist.
IRREPLACEABLE LOSS OF RESOURCES		
This describes the degree to which resources will be irreplaceably lost because of a proposed activity.		
1	No loss of resource	The impact will not result in the loss of any resources.
2	Marginal loss of resource	The impact will result in marginal loss of resources.
3	Significant loss of resources	The impact will result in significant loss of resources.
4	Complete loss of resources	The impact is result in a complete loss of all resources.
CUMULATIVE EFFECT		
This describes the cumulative effect of the impacts. A cumulative impact is an effect which may not be significant but may become significant if added to other existing or potential impacts emanating from other similar or diverse activities because of the project activity in question.		
1	Negligible cumulative impact	The impact would result in negligible to no cumulative effects.
2	Low cumulative impact	The impact would result in insignificant cumulative effects.
3	Medium cumulative impact	The impact would result in minor cumulative effects.
4	High cumulative impact	The impact would result in significant cumulative effects
SIGNIFICANCE		

Significance is determined through a synthesis of impact characteristics. Significance is an indication of the importance of the impact in terms of both physical extent and time scale, and therefore indicates the level of mitigation required. The calculation of the significance of an impact uses the following formula:

(**Extent (1) + probability (3) + reversibility (4) + irreplaceability (4) + duration (4) + cumulative effect) (4) x magnitude/intensity (4) = 80.**

The summation of the different criteria will produce a non-weighted value. By multiplying this value with the magnitude/intensity, the resultant value acquires a weighted characteristic which can be measured and assigned a significance rating.

Points	Impact significance rating	Description
6 to 28	Negative low impact	The anticipated impact will have negligible negative effects and will require little to no mitigation.
6 to 28	Positive low impact	The anticipated impact will have minor positive effects.
29 to 50	Negative medium impact	The anticipated impact will have moderate negative effects and will require moderate mitigation measures.
29 to 50	Positive medium impact	The anticipated impact will have moderate positive effects.
51 to 73	Negative high impact	The anticipated impact will have significant effects and will require significant mitigation measures to achieve an acceptable level of impact.
51 to 73	Positive high impact	The anticipated impact will have significant positive effects.
74 to 96	Negative very high impact	The anticipated impact will have highly significant effects and are unlikely to be able to be mitigated adequately. These impacts could be considered "fatal flaws".
74 to 96	Positive very high impact	The anticipated impact will have highly significant positive

10.2 Summary of Impact Tables

The expected duration of the impact is assessed as potentially permanent to long term. Only the site will be affected. In the absence of mitigation procedures (should fossil material be present within the affected area) the damage or destruction of any palaeontological materials will be permanent and there

will be, and the loss of Fossil Heritage will be irreplaceable. The severity of the impact is very high pre mitigation. With mitigation measures the significance will be reduced to medium.

11 FINDINGS AND RECOMMENDATIONS

The proposed development is underlain by a small area of Quaternary superficial sediments along the Fish River, Jurassic Dolerite, the Middleton and Koonap Formations of the Adelaide Subgroup (Beaufort Group, Karoo Supergroup). According to the PalaeoMap of South African Heritage Resources Information System the Palaeontological Sensitivity of the Quaternary superficial deposits is Moderate; that of the Adelaide Subgroup is Very High while the Palaeontological Sensitivity of the Jurassic Dolerite is Zero.

In the last few decades extensive research and collecting have been conducted by palaeontologists and the National Palaeontological databases indicate that the GFRNR area is fossiliferous. A two day-site-specific field survey of the development footprint was conducted on foot and motor vehicle in early March 2023. New fossiliferous sites containing in situ Glossopteris leaves, and trace fossils were detected. Loose fragments of fossilized wood were also detected during the site visit.

It is recommended that a buffer of 5m is placed around the *in-situ* trace fossil and 15m buffer around the *Glossopteris* and loose wood fossils. If possible, these fossils could be used for educational purposes with information available for the tourists. By implementing mitigation measures the significance of the impact will be reduced to low. If mitigation measures are followed the development will not lead to detrimental impacts on the palaeontological reserves of the area and construction of the development may be authorised to its whole extent.

Recommendations:

- The Environmental Control Officer (ECO) for this project must be informed that the Adelaide Subgroup (Beaufort Group, Karoo Supergroup) has a Very High Palaeontological Sensitivity.
- Training of accountable supervisory personnel by a qualified palaeontologist in the recognition of fossil heritage is necessary.
- If Palaeontological Heritage is uncovered during surface clearing and excavations the Chance find Protocol attached should be implemented immediately. Fossil discoveries ought to be protected and the ECO/site manager must report to South African Heritage Resources 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) so that mitigation (recording and collection) can be carried out.

- 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).
- These recommendations should be incorporated into the Environmental Management Plan for the proposed development.

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APPENDIX A

ELIZE BUTLER

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

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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.

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

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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

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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 Delportshoop 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.
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environmental affairs
Department:
Environmental Affairs
REPUBLIC OF SOUTH AFRICA

DETAILS OF THE SPECIALIST, DECLARATION OF INTEREST AND UNDERTAKING UNDER OATH

	(For official use only)
File Reference Number:	
NEAS Reference Number:	DEA/EIA/
Date Received:	

Application for authorisation in terms of the National Environmental Management Act, Act No. 107 of 1998, as amended and the Environmental Impact Assessment (EIA) Regulations, 2014, as amended (the Regulations)

PROJECT TITLE

Palaeontological Impact Assessment (PIA) to assess the proposed Development and Upgrades within the Great Fish River Nature Reserve, Makana Local Municipality, Raymond Mahlaba Local Municipality and Ngqushwa Local Municipality, Eastern Cape Province.

Kindly note the following:

1. This form must always be used for applications that must be subjected to Basic Assessment or Scoping & Environmental Impact Reporting where this Department is the Competent Authority.
2. This form is current as of 01 September 2018. It is the responsibility of the Applicant / Environmental Assessment Practitioner (EAP) to ascertain whether subsequent versions of the form have been published or produced by the Competent Authority. The latest available Departmental templates are available at https://www.environment.gov.za/documents/forms.
3. A copy of this form containing original signatures must be appended to all Draft and Final Reports submitted to the department for consideration.
4. All documentation delivered to the physical address contained in this form must be delivered during the official Departmental Officer Hours which is visible on the Departmental gate.
5. All EIA related documents (includes application forms, reports or any EIA related submissions) that are faxed; emailed; delivered to Security or placed in the Departmental Tender Box will not be accepted, only hardcopy submissions are accepted.

Departmental Details

Postal address:
Department of Environmental Affairs
Attention: Chief Director: Integrated Environmental Authorisations
Private Bag X447
Pretoria
0001

Physical address:
Department of Environmental Affairs
Attention: Chief Director: Integrated Environmental Authorisations
Environment House
473 Steve Biko Road
Arcadia

Queries must be directed to the Directorate: Coordination, Strategic Planning and Support at:
Email: EIAAdmin@environment.gov.za

1. SPECIALIST INFORMATION

Specialist Company Name:	Banzai Environmental Pty Ltd			
B-BBEE	Contribution level (indicate 1 to 8 or non-compliant)	Level 4	Percentage Procurement recognition	51%
Specialist name:	Elize Butler			
Specialist Qualifications:	MSc			
Professional affiliation/registration:				
Physical address:	14 Eddie de Beer, Dan Pienaar, Bloemfontein			
Postal address:	14 Eddie de Beer, Dan Pienaar, Bloemfontein			
Postal code:	9301	Cell:	084 4478 759	
Telephone:		Fax:		
E-mail:	info@banzai-group.com			

2. DECLARATION BY THE SPECIALIST

I, Elize Butler, declare that –

- I act as the independent 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 favourable to the applicant;
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting the specialist report relevant to this application, 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 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;
- all the particulars furnished by me in this form are true and correct; and
- I realise that a false declaration is an offence in terms of regulation 48 and is punishable in terms of section 24F of the Act.

Signature of the Specialist

Banzai Environmental

Name of Company:

22 May 2023

Date

2. UNDERTAKING UNDER OATH/ AFFIRMATION

I, Elize Butler, swear under oath / affirm that all the information submitted or to be submitted for the purposes of this application is true and correct.

Signature of the Specialist

Banzai Environmental Pty Ltd

Name of Company

22 May 2023

Date

Signature of the Commissioner of Oaths

2023-05-22

Date

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BAYSWATER
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