PALAEONTOLOGICAL FIELD ASSESSMENT FOR THE PROPOSED BURLINGTON FARM CITRUS DEVELOPMENT, EASTERN CAPE

Compiled for:
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Prepared by
Banzai Environmental
27 October 2020

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

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SIGNATURE: 

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: NEMA Table

Requirements of Appendix 6 – GN R326 EIA Regulations of 7 April 2017	**Relevant section in 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 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 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 alternatives;	Section 1 and 11	
(g) An identification of any areas to be avoided, including buffers	Section 1 and 11	
(h) A map superimposing the activity including the associated structures and infrastructure on the	Section 5 – Geological and	

Requirements of Appendix 6 – GN R326 EIA Regulations of 7 April 2017	Relevant section in report	Comment where not applicable.
environmental sensitivities of the site including areas to be avoided, including buffers;	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 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	-
(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 will be conducted as part of the EIA and EMPr process.
(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	Not applicable.

Requirements of Appendix 6 – GN R326 EIA Regulations of 7 April 2017	Relevant section in report	Comment where 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 **isi-Xwiba Consulting** to conduct the Palaeontological Impact Assessment (PIA) to assess Burlington Farm Citrus Development in the Eastern Cape. The National Heritage Resources Act (No 25 of 1999, section 38) (NHRA), states that a Palaeontological Impact Assessment is necessary to determine the presence of fossil material within the planned development. This study is thus necessary to evaluate the effect of the construction on the palaeontological heritage.

The development footprint is mainly underlain by Quaternary Superficial Deposits while a small portion is underlain by the Middleton Formation of the Adelaide Subgroup (Beaufort Group, Karoo Supergroup). According to the PalaeoMap of the South African Heritage Resources Information System (SAHRIS) the Palaeontological Sensitivity of the Quaternary Superficial Deposits is Low but locally High while that of the Adelaide Subgroup is Very High.

A site-specific field survey of the development footprint was conducted on foot and by motor vehicle on 15 July 2020. Elsewhere in the Karoo Basin numerous fossils have been uncovered in these geological sediments but in the development footprint no fossiliferous outcrops were uncovered during the site visit. The development footprint also includes two alternatives that have been proposed for the Hydro Plant. As both alternatives fall in the Quaternary no preferred alternative has been identified from a Palaeontological perspective**.** The scarcity of fossil heritage at the proposed development footprint indicates that the impact of the proposed development will be of a medium significance in palaeontological terms. It is consequently recommended that no further palaeontological heritage studies, ground truthing and/or specialist mitigation are required pending the discovery of newly discovered fossils.

If fossil remains are discovered during any phase of construction, either on the surface or exposed by excavations the **Chance Find Protocol** must be implemented by the EC in charge of these developments. These discoveries ought to be protected (if possible, *in situ*) and the EC must report to SAHRA (Contact details: Eastern Cape Provincial Heritage Resources Authority (ECPHR); Corner Scholl and Amalinda Drive, East London, 5247, email: info@ecphra.org.za; Tel 043 7450888; Web: www.ecphra.org.za) so that correct mitigation (recording and collection) can be carry out by a paleontologist.

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Appendix A: CV

1 INTRODUCTION

Burlington (Pty) Ltd plans to convert Burlington Dairy Farm to citrus orchards. The development will involve the conversion of indigenous vegetation as well as existing pastures under center pivot and perma-set irrigation to citrus orchards. Burlington Farm has a registered water allocation (Great Fish River Irrigation Scheme) that is considered sufficient to irrigate the proposed project area. The abstraction weir and canal (Hougham Abrahamson) that provides water to Golden Valley is situated on the property.

Currently the farm is utilized as a dairy farm on pastures under irrigation with 473 ha developed under 12 centre pivots and perma-set sprinkler systems. The remainder of the farm consists of natural grazing (indigenous vegetation), Transnet railway line and the Hougham Abrahamson Irrigation canal.

The applicant proposes to transform the farming operation in a phased approach over years (Phase 1 to 6) from dairy to Citrus with the final phase in 2033 (depending on the economy). The development requires the conversion of indigenous vegetation and the transformation of approximately 473 ha of current pastures under centre pivot and perma-set irrigation to citrus orchards under drip irrigation. A total of 584 ha will be developed for Citrus production. This includes orchard roads and a 6 ha footprint for the off-stream storage dam etc. The development will have an impact on indigenous vegetation, construction of the off-stream storage dam, hydro-plant and pump station (riparian habitat) and the pipelines and will include:

- Transformation of existing irrigation lands under pastures to citrus orchards
- Transformation of indigenous vegetation to cultivated land for planting of citrus
- Development of a solar and hydro-plant for generation and distribution of electricity
- Development of an off-stream storage dam with a total capacity of 222 618 m³ (±6 ha of indigenous vegetation will be removed)
- Development of farm access roads with a width >4 m and road reserve 8 m within orchards
- Development of 2 x bulk water pipelines with an internal diameter of 500 mm and a total length of 1 800 m each – pipelines to be laid parallel to each other
- Development of pump station at the Hougham Abrahamson Irrigation Scheme diversion weir

The following information was obtained from **isi-Xwiba Consulting**

1.1 INFRASTRUCTURE

1.1.1 Renewable Energy

Current energy source is Eskom supply via the Blue Crane Municipality. The supply is erratic, which will have a negative impact of both the quality and volume of fruit produced.

The Eskom supply will be retained but reliance and usage thereon will be reduced by the construction two (2) alternative sources of renewable energy. The total (combined) electricity output from both renewable energy sources will be 1.046 MW.

The alternative renewable energy sources are

- photovoltaic installation (0.9 MW); and
- a hydro-plant (0.146 MW)

Photovoltaic Solar Panels (PV)

Photovoltaic solar panels use sunlight through the "photovoltaic effect" to generate direct electric current (DC) in a direct electricity production process. The DC is then converted to AC, usually with the use of inverters, in order to be distributed on the power network.

- Footprint area = 1,6 ha (16 000 m² including fencing), sited on an area of existing cultivated pasture
- Number of panels = 2 304 (at maximum size)
- Height of panel mounted on frame = 1.5 meters (in horizontal position)
- Total electricity output (full operation) = 0.9 MW (to cater for a 450 KW motor load, system capable of up to 900 KW at peak under standard radiation levels and temperatures)
- Transmission and distribution of electricity to the pumps with a capacity of 640 VOLTS, no overhead lines – will be cabled.

Installation of the solar panels will be implemented in two (2) phases with 1 152 (number) of panels in phase 1 followed by the 1 152 (remainder) as required.
Construction will consist of mounting individual solar panel frames with footings on concrete bases of 400mm x 400mm x 500mm.

The total footprint area will be fenced off with a security fence 2.4 m in height

1.1.2 Hydro-plant (Mr B van Heerden – Hydrovision)

The hydro-plant will be powered with "throw-away" water discharged from the Hougham Abrahamson Irrigation canal via a flushing sluice installed on the canal. The area at the existing "throw-away" pipe is eroded and the system is undermined and there is concern that continued use over the long-term will undermine the discharge pipe and canal thus impacting on the entire HAIS. The preferred site is therefore located ±80 m upstream of the existing HAIS "throw-away" pipe.

- Total turbine output of 146 kVa (0.146 MW) when in full operation with one turbine – there is no "heating" of water in this system
- Transmission and distribution of generated electricity with a capacity of 146 kVa (.146 MW) to the farming operation, buildings, pumps, etc. Should the transmission be very far from the source the losses could amount to ±3%
- Construction footprint = <2 000 m² (clearance of riparian habitat)

Development will be implemented in two (2) phases. It is noted that the canal is only closed for one (1) month of the year for general maintenance. It is impractical to close off the canal at other times as this would cut off water from downstream users resulting in crop losses.

Construction/installation of the hydro-plant and associated infrastructure should be done during the winter months (dry season)
Construction/installation requires:

Phase 1 – Will comprise of excavation of the area between the canal and down into the river, installation of the infrastructure including concrete works, backfilling of the excavated area and protection works for the river embankment. All impacted areas to be re-vegetated. Can be done at any time as it will not affect the safety and day to day operation of the irrigation canal.

- Excavation of the river embankment as depicted in the attached conceptual drawing with an Impact area ±480 m² - gradients of the excavation must comply with the construction regulations and the OHSA.
- a wider area will need to be cleared to allow for entry of an excavator and placement of excavated material and an additional impact footprint of ±1 500 m² may be required – total impact footprint of <2 000 m² ;
- Clearance of vegetation between the flood plain and the river should be limited to the excavation area only. Excavated material may be placed on the flood plain, for backfilling and removal of excess material to spoil. No excavated material may be left within the flood zone, post-constriction;
- All denuded impact areas shall be rehabilitated and re-established to vegetation; and
- the existing DWS measuring weir will be left in place, however the electronic equipment may be moved

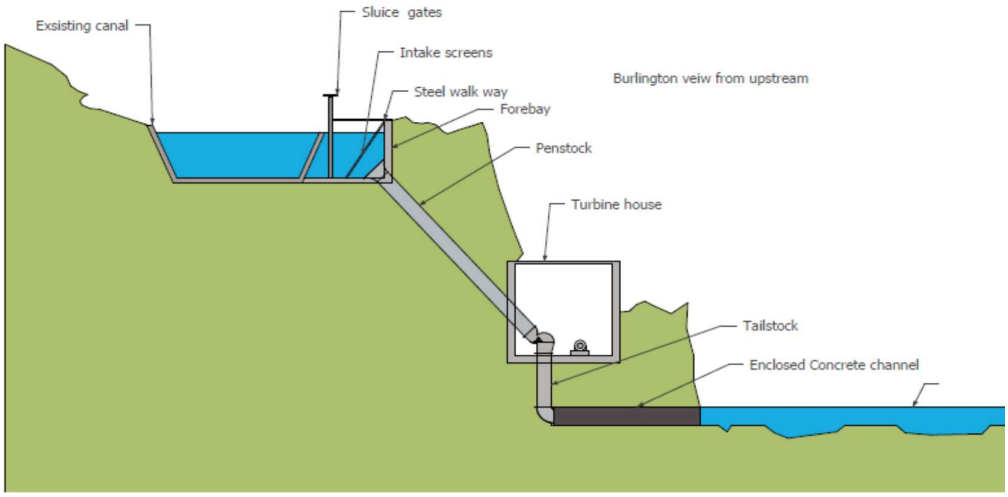
The area from the canal into the river will be excavated to a total width of ±6 m (excavator) over a distance of ±80 m to accommodate the 800 mm Ø "throw away" pipe for the turbine plus an additional pipe for emergency "throw away" should work be required on the turbine.

Phase 2 - No widening of the canal will be required, but a concrete lining will be placed inside the existing earth canal over a distance of ±20 m at the point where the "throw away" and hydro plant will be installed. Phase 2 will include construction of sluices and DWS measuring weir, breaking through into the canal and connection to the hydro-plant and removal of the existing DWS measuring weir. Also cast concrete lining of the earth canal for approximately 20 m to ensure the canal's structural stability is not compromised. This lining is needed as the water is being diverted and monitored at this location, which will create increase in velocity resulting in cavitation.

Motivation for re-alignment of the "throw away" point:

Consultation with the water bailiff for the Hougham Abrahamson irrigation Scheme canal refers:
At present the water for this canal is controlled through sluices at the Burlington Weir. As the first point of measurement is ±6 km downstream, controlling the amount of water required is very difficult due to the long lead time to let water flow down the canal. The new concept would be to permanently open the sluice gates at Burlington Weir to ensure that optimal / maximum flow is always available at the "throw away", which will be located at the proposed turbine site. As this new point of control is then less than 100 meters away from its existing position, controlling the water required for water users downstream can be easily and effectively managed. At present it takes in excess of 3 hours for water to come through from the weir to the measurement unit. The current system of closing off the water for a few days at a time and then opening it up again results in debris with (reeds, branches etc.) blocking the canal, which need to be manually cleared every time. The canal supply water will thus be effectively managed electronically at the "throw away" point as the maximum required water downstream will permanently be available at this point. This will make the water bailiffs work much easier and give him the required level of control. It will also not be necessary to continuously clean the debris lodged in the canal, every time water is opened up at the Burlington weir.

Concept design drawing – side elevation:



1.2 Pump Station

Abstraction of water will be slightly upstream of the Hougham Abrahamson Irrigation Scheme diversion weir and not from the canal. The 7 existing pump stations along the canal will be decommissioned as the centre pivots are removed and the pastures transformed to citrus

The new pump station will consist of:

- Concrete platform constructed ± 2 m above water level (riparian habitat).

  The platform will measure 12 m x 3 m x 150 mm (w x b x d)
- A winch for each pump will be mounted on top of the bank above each pump for removal of the pump-sets during periods of high flow (floods). The bank can be smoothed and grassed to stop potential washing away or concrete pathways/slipways constructed on which the trailers will run.
- 6 x 75 Kw pumps – each pump-set mounted on a 4-wheel trailer fitted with a canopy. Pumps will be installed as demand increases with initial placement of 3 pumps
- Reed bed cleared for ±30 m up the secondary flood channel for abstraction

The only construction required within the riparian area and in close proximity to the river will be a concrete slab for the pumps as per above dimensions. At the top there will be a concrete block for a winch mounting.

1.3 Off-stream Storage Dam

Off-stream storage dam with associated discharge valves and fencing
Capacity = ±222 618 m³
Maximum height of earth wall = m
Full supply storage footprint area of ±6 ha currently indigenous vegetation
Located at a high point on the farm for gravity reticulation into the low flow drip irrigation systems
Construction method will be “excavation to fill”

1.4 Pipelines

1.4.1 Rising mains (pipelines to off-stream storage dam)

Two pipelines to be installed from pump station to off-stream storage dam. One pipeline to be constructed at commencement with the second ±5 years later when additional pumps are installed. Pipeline to be placed through culvert at railway line - Transnet approval required.

Diameter of pipelines = 500 mm Ø
Total length of each pipeline = ±1 800 m
Total construction footprint = ±13 600 m²
Trenching through arable land area = ±2 m deep
Trenching in areas with shallow rock - ±1 m deep
HDPE pipe used in areas of surface rock

1.4.2 Irrigation reticulation pipelines

Mainlines feeding orchards will have a total length of ±9 410 m and will differ in size; ranging from 315mm COD down to 110mm COD.

1.5 Farm Access Roads (4m – 8m)

Farm access roads to be developed within the orchard areas. Positions not known until final orchard layout and irrigation design is completed. The only areas where there will be an impact are in areas of indigenous vegetation to be transformed.

1.6 Development of orchards

Total actual planned orchard production area of 550 ha with a total of 590 ha transformed to allow for access roads within orchards and the off-stream storage dam

1.7 Time Frames

Dependent on cash flow and time of issuance of EA and therefore subject to change.

Activity	**Year**
Hydro-plant	2021
Solar Power - Phase 1 & Phase 2	2021 - 2022
Pump station at weir	2022 - 2024
Off-stream storage dam	2022
Mainline – Phase 1 & Phase 2	2022 - 2024
Phase 1 orchards on virgin ground and including single pivot adjacent to N10	2023
Orchards (Transformation of pastures) Phases 2 - 6	2024 - 2033

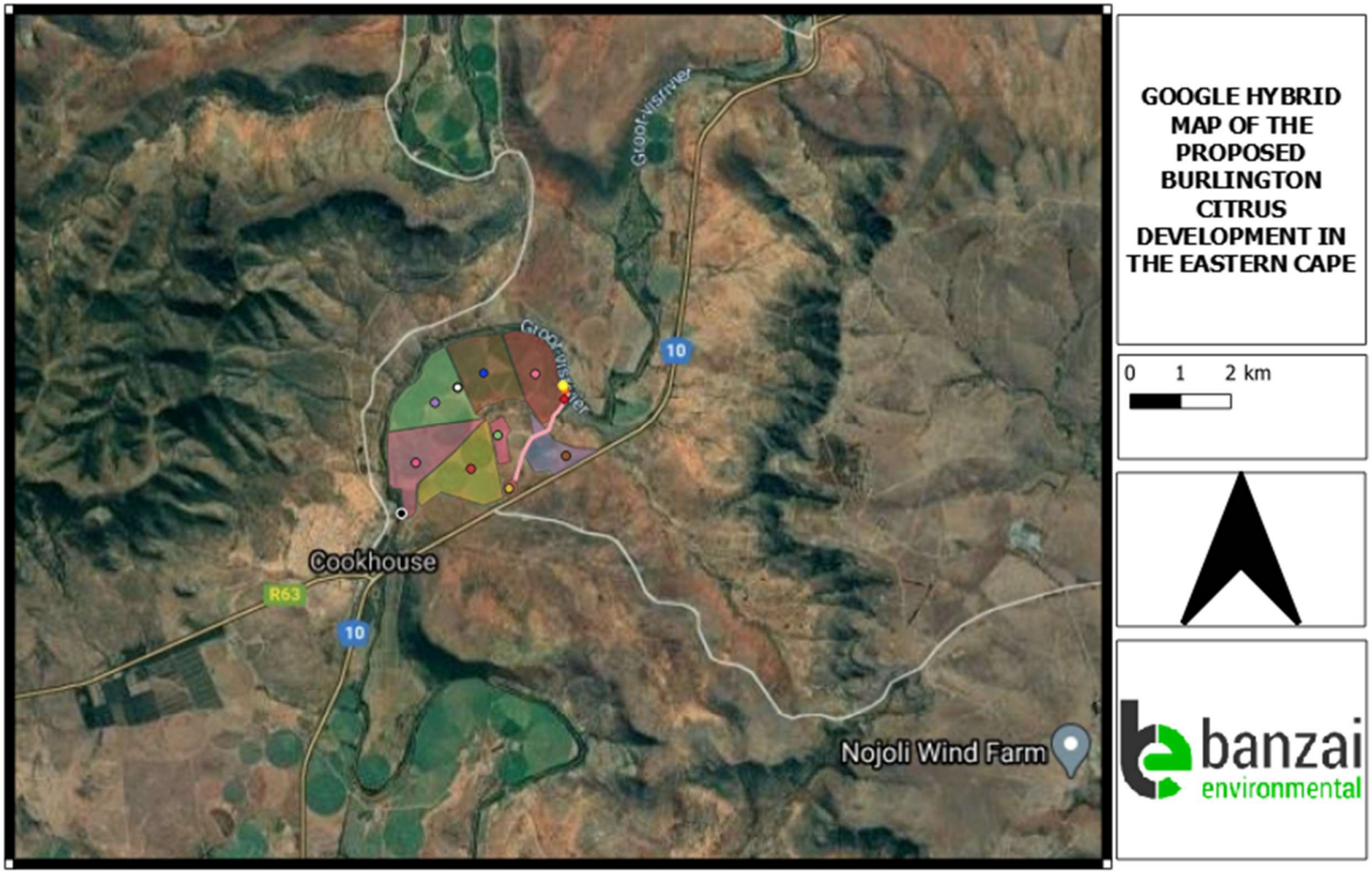


Figure 1:Google Earth Image (2020) indicating the locality of the proposed Burlington Citrus Development in the Eastern Cape

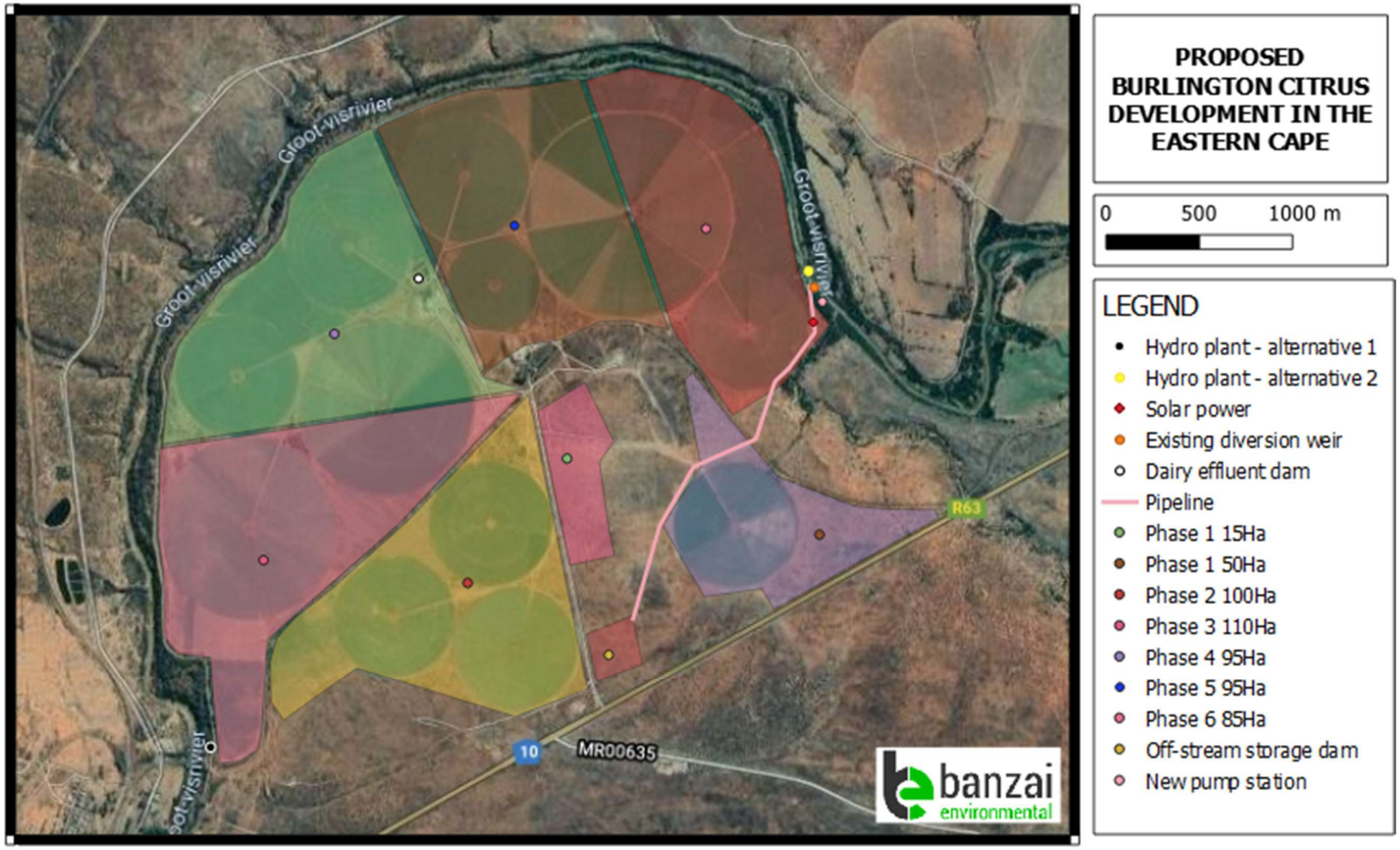


Figure 2: Close-up Google Earth Image (2020) indicating the locality of the proposed Burlington Citrus Development in the Eastern Cape.

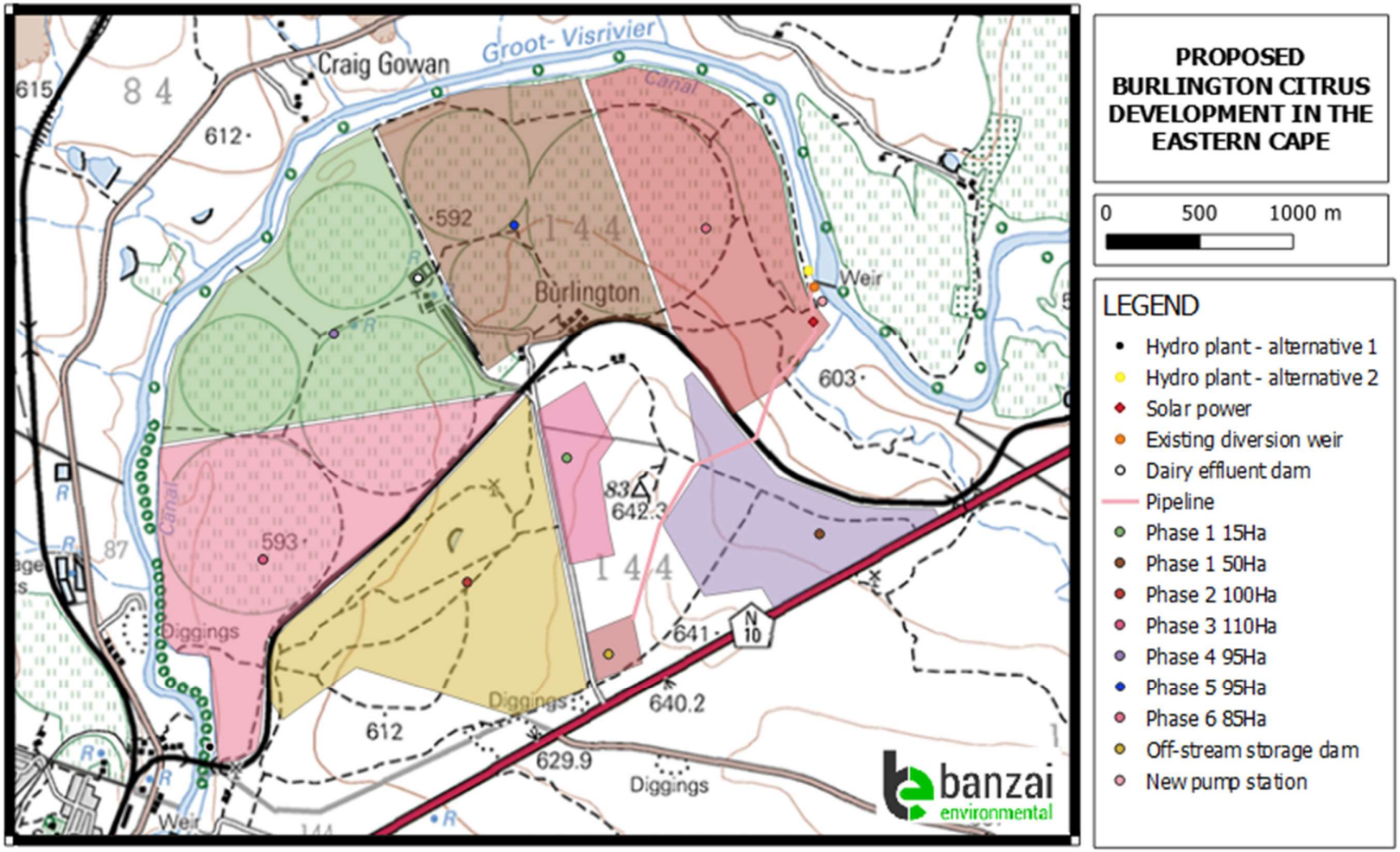


Figure 3: Locality of the proposed Burlington Citrus Development in the Eastern Cape.

2 QUALIFICATIONS AND EXPERIENCE OF THE AUTHOR

The author (Elize Butler) has an MSc in Palaeontology from the University of the Free State, Bloemfontein, South Africa. She has been working in Palaeontology for more than twenty-six years. She has experience in locating, collecting and curating fossils, including exploration field trips in search of new localities in the Karoo Basin. She has been a member of the Palaeontological Society of South Africa for 14 years. She has been conducting PIAs since 2014.

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**".

Palaeontological heritage is unique and non-renewable and is protected by the NHRA. Palaeontological resources 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)**, a 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 300m in length;
- the construction of a bridge or similar structure exceeding 50m in length;
- any development or other activity which will change the character of a site—
    a. (exceeding 5 000 m² in extent; or
    b. involving three or more existing erven or subdivisions thereof; or
    c. involving three or more erven or divisions thereof which have been consolidated within the past five years; or
    d. the costs of which will exceed a sum set in terms of regulations by SAHRA or a provincial heritage resources authority
    e. the re-zoning of a site exceeding 10 000m² in extent;
- or any other category of development provided for in regulations by SAHRA or a Provincial heritage resources authority.

4 OBJECTIVE

The objective of a Palaeontological Impact Assessment (PIA) is to determine the impact of the development on potential palaeontological material at the site.

According to the "SAHRA APM Guidelines: Minimum Standards for the Archaeological and Palaeontological Components of Impact Assessment Reports" the aims of the PIA are: 1) to **identify** the palaeontological status of the exposed as well as rock formations just below the surface in the development footprint 2) to estimate the **palaeontological importance** of the formations 3) to determine the **impact** on fossil heritage; and 4) to recommend how the developer ought to protect or mitigate damage to fossil heritage.

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/kmls) 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 are impacts that result from the incremental impact of the proposed activity on a common resource when added to the impacts of other past, present or reasonably foreseeable future activities.
- Fair assessment of alternatives (infrastructure alternatives have been provided);
- Recommend mitigation measures to minimise the impact of the proposed development; and

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

5 GEOLOGICAL AND PALAEONTOLOGICAL HISTORY

The proposed Burlington Citrus farm is depicted on the 1:250 000 3224 Graaff Reinet Geological Map (Council of Geoscience) (Figure 4). The development footprint is mainly underlain by Quaternary Superficial Deposits while a small portion is underlain by the Middleton Formation of the Adelaide Subgroup (Beaufort Group, Karoo Supergroup). According to the PalaeoMap of the South African Heritage Resources Information System (SAHRIS) the Palaeontological Sensitivity of the Quaternary Superficial Deposits is Low but locally High while that of the Adelaide Subgroup is Very high (Almond *et al*, 2013; SAHRIS website).

The Quaternary superficial deposits are the youngest geological deposits formed during the most recent geological period (approximately 2.6 million years ago to present). The rocks and sediments are found at or near the Earth's surface. 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 beach sand, channel, floodplain and stream deposits, talus gravels and glacial drift sediments.

The Quaternary deposits are very important due to the palaeoclimatic changes that 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 where 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 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 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 Caenozoic 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, 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).

The Adelaide subgroup rocks were deposited under a humid climate that allowed for the establishment of wet floodplains with high water tables and are interpreted to be fluvio-lacustrine sediments. The proposed development is partially underlain by the Middleton Formation*:* This formation had a semi-arid climate that supported a lush flora and fauna that thrived along meander belts and semi-permanent lakes. Cyclic deposits of lenticular sandstone bodies grading into greenish-grey mudstone. The thickest formation in this succession, constituting 37% of the Beaufort Group and 47% of the Adelaide Subgroup. The formation has lenses of red mudstone which are likely to have been deposited in a sub-aerial fluvial environment.

The Middleton Formation (Adelaide Subgroup, Beaufort Group, Karoo Supergroup) is biostratigraphically subdivided in the upper *Pristerognathus*, *Tropidostoma* and lower Cistecephalus Assemblage zones (Rubidge 1995, Figure 5). Vertebrate fossils known from the Middleton Formation include amphibians, anapsids and therapsids (Rubidge, 2005, Table 2). Anapsid fossil diversity declines in the Middleton Formation, while therapsid taxa (e.g. Dicynodontia and Gorgonopsia) show diversification in the *Tropidostoma* and mostly in the *Cistecephalus* AZs (Rubidge 2005). The *Cistecephalus* AZ is characterized by the presence of a numerous dicynodont species e.g. *Diictodon, Pristerodon, Cistecephalus, Aulacephalodon* and *Oudenodon*. Plant fossils are also present in this formation and comprise of Glossopteris and Schizoneura. The overlying *Pristerognathus* AZ has a relatively low vertebrate biodiversity (Nicolas and Rubidge 2010).

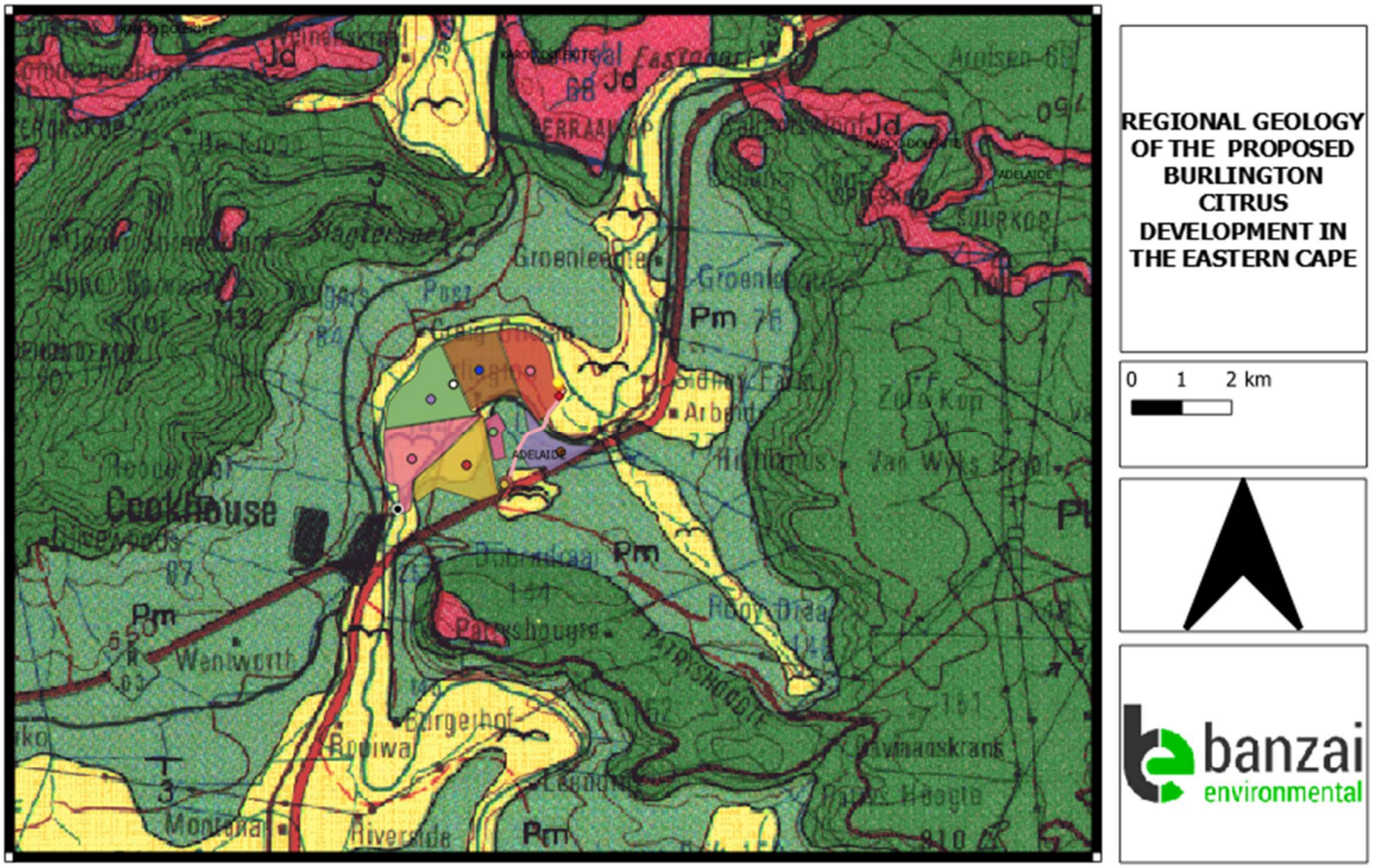
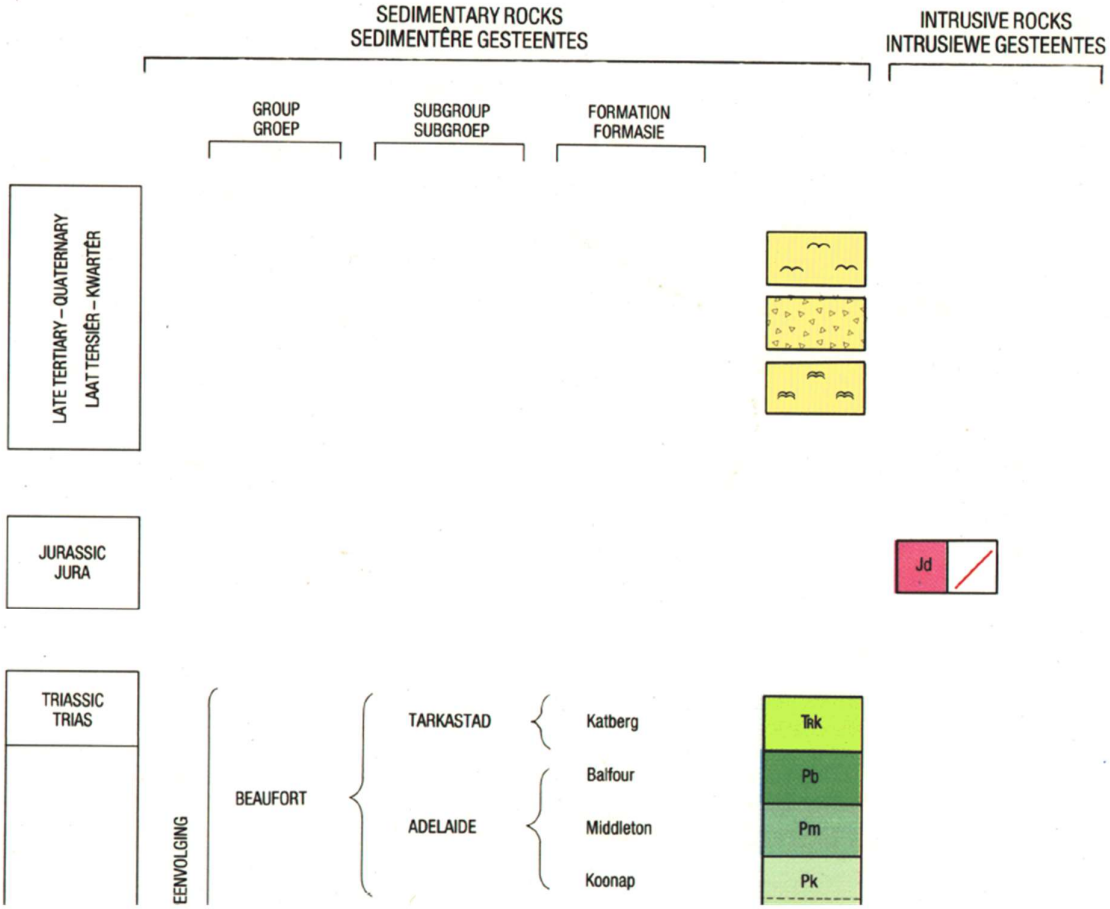


Figure 4: Extract of the 1:250 000 3224 Graaff Reinet Geological Map (Council of Geoscience) indicating the locality of the Burlington Citrus Development in the Eastern Cape. Map drawn by QGIS 2.18.28.



Legend:

Yellow with bird-like figure- Quaternary Alluvium

Jd- red- Dolerite

T_Rk-Triassic- Katberg Formation, Tarkastad Subgroup, Beaufort Group, Karoo Supergroup- Red and greenish grey mudstone as well as sandstone

Pb- Permian- Balfour Formation, Adelaide Subgroup, Beaufort Group, Karoo Supergroup; Mudstone greenish grey, red in places, shale and sandstone

Pk- Permian- Koonap Formation, Adelaide Subgroup, Beaufort Group, Karoo Supergroup; mudstone, greenish grey, red in places, sandstone, occasional thin cherty beds, lowermost reddish mudstone.

Pm- Permian- Middleton Formation, Adelaide Subgroup, Beaufort Group, Karoo Supergroup Greenish grey and red mudstone, sandstone

Table 2: Geology and lithology of the development area (*modified from Almond et al, 2009*)

Geological Unit	Rock Types & Age	Fossil Heritage	Comments
Neogene Pleistocene Drift-Alluvium	alluvium, aeolian sands, lake sediments *etc* in the interior Late Miocene and younger (correlated with Alexandria Fm *etc*, Algoa Group)	pollens, freshwater molluscs, mammal bones and teeth *etc*	
BEAUFORT GROUP Adelaide Subgroup: Koonap, Middleton, Balfour Fms	Continental (fluvial, lacustrine) siliciclastic sediments, pedocretes (calcretes) Late Permian to Early Triassic C.266-250 Ma	Diverse terrestrial and freshwater tetrapods of Tapinocephalus to Cynognathus Biozones (amphibians, true reptiles, synapsids – especially therapsids), palaeoniscoid fish, freshwater bivalves, trace fossils (including tetrapod trackways), sparse vascular plants (Glossopteris Flora, including petrified wood)	Biozonation of Beaufort Group in some areas of E. Cape still requires resolution Richest Permo-Triassic tetrapod fauna from Pangaea / Gondwana Important evidence of the evolution of mammalian characters among therapsids Continental record of Late Permian Mass Extinction Events
KAROO DOLERITE SUITE Intrusive dolerites Early Jurassic range		NO fossils in dolerites	Late Jurassic extinction event attributed to Karoo-Ferrar Large Igneous Province

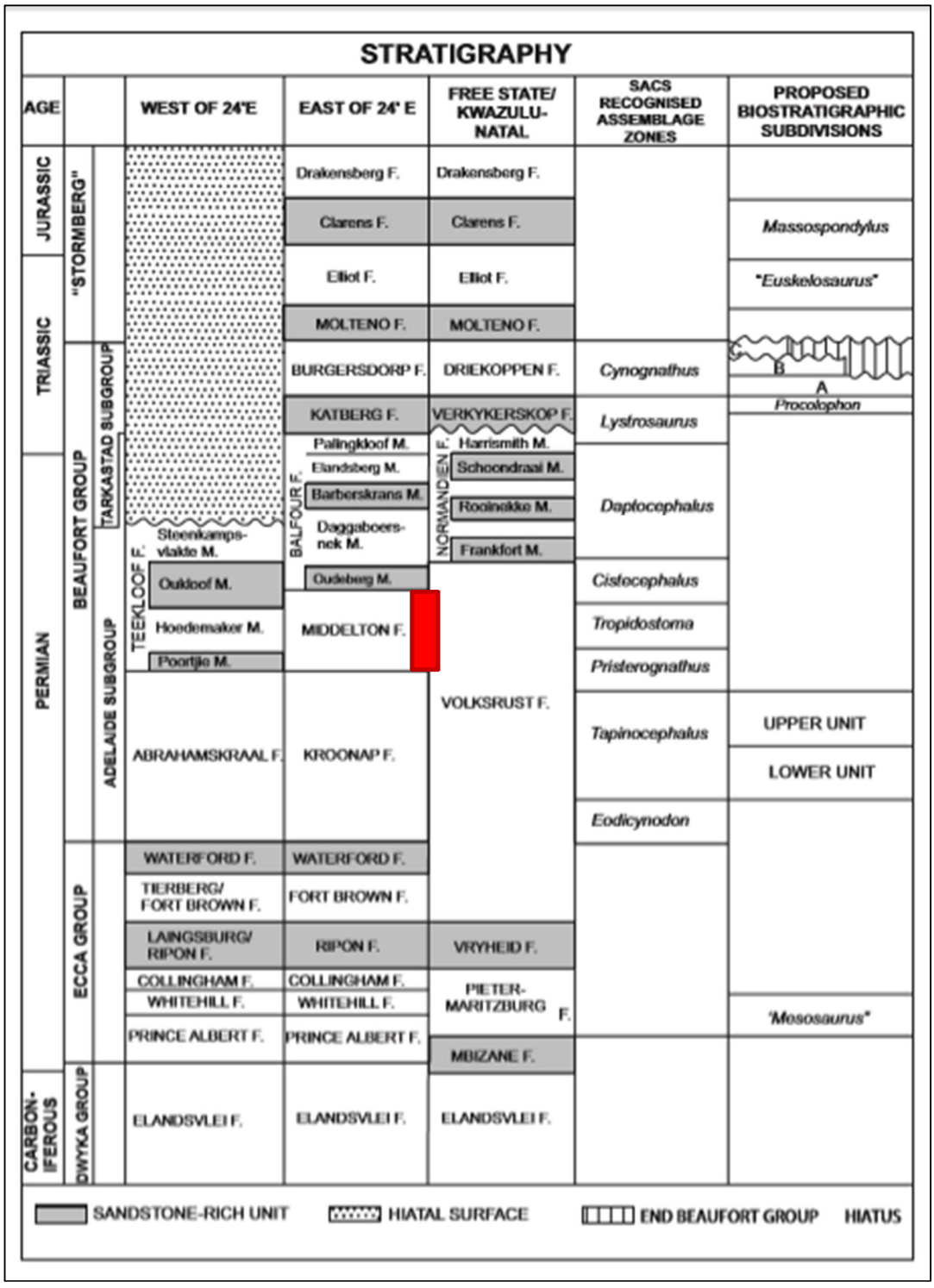


Figure 5 - Lithostratigraphic (rock-based) and biostratigraphic (fossil-based) subdivisions Beaufort Group of the Karoo Supergroup with rock units and fossil assemblage zones relevant to the present study marked in red (Modified from Rubidge 1995). Abbreviations: F. = Formation, M. = Member

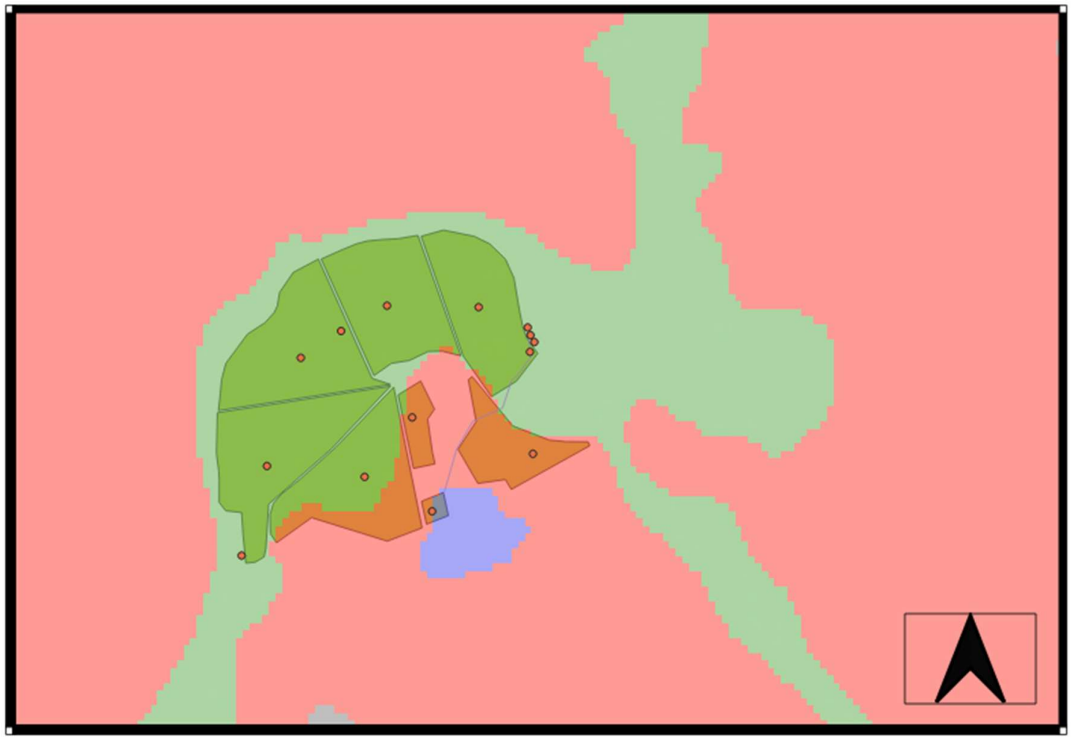


Figure 6: Extract of the 1 in 250 000 SAHRIS PalaeoMap map (Council of Geosciences) indicating the location of the proposed development.

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.

According to the SAHRIS palaeo sensitivity map (Figure 6) there is a High chance of finding fossils in the Adelaide Subgroup while finding fossils in the Quaternary is Low but locally High.

6 GEOGRAPHICAL LOCATION OF THE SITE

The proposed Citrus development is located on the Remainder of Portion 1 (Burlington) of the Farm Doorndraai Farm No. 144, Nxuba Municipality, Registration Division of Bedford, Eastern Cape Province. The proposed development is 859,8111 ha in extent.

Coordinates of Burlington farm is: 32º 43' 23.68" S & 25º 49' 40.98" E

7 METHODS

The aim of a desktop study is to evaluate the risk to palaeontological heritage in the proposed development. This include 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.

7.1 Assumptions and Limitations

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 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.

Comparable Assemblage Zones in other areas is sourced to provide information on the existence of fossils in an area which was 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.**

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 3224 Graaff Reinet Geological Map (Council of Geoscience)
- A Google Earth map with polygons of the proposed development was obtained from isi-Xwiba Consulting CC.

9 SITE VIST

A one-day site specific field survey of the proposed development on the Remainder of Portion 1 (Burlington) of the Farm Doorndraai Farm No. 144, Nxuba Municipality, Registration Division of Bedford, Eastern Cape Province was conducted on foot and by motor vehicle on 15 July 2020. Elsewhere in the Karoo Basin numerous fossils have been uncovered in these geological sediments but in the development footprint no fossiliferous outcrops were uncovered during the site visit.

Figure 7: Flat topography on the off-stream storage dam development footprint
GPS coordinates 32°44'8.45"S 25°49'53.79"E

Figure 8: Flat topography and low vegetation without any outcrops t

GPS coordinates 32°46'17"S 25°47'53"E

Figure 9: Low vegetation

GPS coordinates 32°43'32.13"S 25°49'51.04"E

Figure 10: Grassy vegetation without any outcrops

GPS coordinates 32°43'32.63"S 25°50'14.53"E

10 IMPACT ASSESSMENT METHODOLOGY

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 optimisation 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:

NOTE: it is important to note the three alternatives proposed for this project has the same Geology and there is therefore NO Preference between the three alternatives. The rating for the alternatives will consequently be the same.

Table 3: The Rating System-

NATURE		
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 as a result 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 still 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 as a result 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 in itself may not be significant but may become significant if added to other existing or potential impacts emanating from other similar or diverse activities as a result 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) (3) x magnitude/intensity (2) = 48.** 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

10.1 Summary of Impact Tables

Loss of fossil heritage will be a negative impact. Only the site will be affected by the proposed development. The expected duration of the impact is assessed as potentially permanent to long term. In the absence of mitigation procedures, the damage or destruction of any palaeontological materials will be permanent. Impacts on palaeontological heritage during the construction phase could potentially occur and are regarded as having a high probability. The significance of the impact occurring will be medium.

11 FINDINGS AND RECOMMENDATIONS

The development footprint is mainly underlain by Quaternary Superficial Deposits while a small portion is underlain by the Middleton Formation of the Adelaide Subgroup (Beaufort Group, Karoo Supergroup). According to the PalaeoMap of the South African Heritage Resources Information System (SAHRIS) the Palaeontological Sensitivity of the Quaternary Superficial Deposits is Low but locally High while that of the Adelaide Subgroup is Very High.

A site-specific field survey of the development footprint was conducted on foot and by motor vehicle on 15 July 2020. Elsewhere in the Karoo Basin numerous fossils have been uncovered in these geological sediments but in the development footprint no fossiliferous outcrops were uncovered during the site visit. The development footprint also includes two alternatives that have been proposed for the Hydro Plant. As both alternatives fall in the Quaternary no preferred alternative

has been identified from a Palaeontological perspective**.** The scarcity of fossil heritage at the proposed development footprint indicates that the impact of the proposed development will be of a medium significance in palaeontological terms. 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.

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.If fossil remains are discovered during any phase of construction, either on the surface or exposed by excavations the **Chance Find Protocol** must be implemented by the EC in charge of these developments. These discoveries ought to be protected (if possible, *in situ*) and the EC must report to SAHRA (Contact details: Eastern Cape Provincial Heritage Resources Authority (ECPHR); Corner Scholl and Amalinda Drive, East London, 5247, email: info@ecphra.org.za; Tel 043 7450888; Web: www.ecphra.org.za) so that correct mitigation (recording and collection) can be carry out by a paleontologist.

12 CHANCE FINDS PROTOCOL

A following procedure will only be followed if fossils are uncovered during excavation.

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

12.2 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.

12.3 Introduction

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

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

12.4 Chance Find Procedure

- If a chance find is made the person responsible for the find must immediately **stop working** and all work that could impact that finding must cease in the immediate vicinity of the find.
- The person who made the find must immediately **report** the find to his/her direct supervisor which in turn must report the find to his/her manager and the ESO or site manager. The ESO or site manager must report the find to the relevant Heritage Agency (South African Heritage Research Agency, SAHRA). (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 A – Elize Butler CV

CURRICULUM VITAE

ELIZE BUTLER

PROFESSION:	Palaeontologist
YEARS' EXPERIENCE:	26 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 and Collection Manager	National Museum, Bloemfontein 1998–currently

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