BANZAI ENVIRONMENTAL

PALAEONTOLOGICAL DESKTOP ASSESSMENT FOR THE PROPOSED PROSPECTING RIGHT COMBINED WITH A WASTE LICENCE APPLICATION TO PROSPECT FOR DIAMONDS ON PORTION 7 OF THE FARM ADEISESTAD 409, PORTION 1 OF THE FARM KALKPUNT 407, REMAINING EXTENT OF PORTION 21 AND PORTION 29 (PORTION OF PORTION 21) OF THE FARM UAP 418 & ON FARM 596 NEAR UPINGTON IN THE NORTHERN CAPE

NC30/5/1/1/2/112979PR

MAY 2022

COMPILED ON BEHALF OF:

MILNEX CC

Declaration of Independence

BANZAI ENVIRONMENTAL (PTY) LTD.
Reg No. 2015/332235/07 | VAT No. 4240303828

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

Tel: +27 844478759

Email: info@banzai-group.com

SIGNATURE: 

This 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	**Relevant section in report**
1.(1) (a) (i) Details of the specialist who prepared the report	Page ii and Section 2 of Report – Contact details and company and Appendix A
(ii) The expertise of that person to compile a specialist report including a curriculum vitae	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 9
(d) The duration, date and season of the site investigation and the relevance of the season to the outcome of the assessment	Desktop Assessment
(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 alternative;	Section 1 and 10
(g) An identification of any areas to be avoided, including buffers	Section 5 No buffers or areas of sensitivity identified
(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

Requirements of Appendix 6 – GN R326 EIA Regulations of 7 April 2017	Relevant section in report
(j) A description of the findings and potential implications of such findings on the impact of the proposed activity, including identified alternatives, on the environment	Section 11
(k) Any mitigation measures for inclusion in the EMPr	Section 11
(l) Any conditions for inclusion in the environmental authorisation	Section 11
(m) Any monitoring requirements for inclusion in the EMPr or environmental authorisation	Section 1 and 10
(n)(i) A reasoned opinion as to whether the proposed activity, activities or portions thereof should be authorised and	Section 1 and 10
(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 10
(o) A description of any consultation process that was undertaken during the course of carrying out the study	N/A
(p) A summary and copies if any comments that were received during any consultation process	N/A
(q) Any other information requested by the competent authority.	N/A
(2) Where a government notice by the Minister provides for any protocol or minimum information requirement to be applied to a specialist report, the requirements as indicated in such notice will apply.	Section 3 compliance with SAHRA guidelines

EXECUTIVE SUMMARY

Banzai Environmental was appointed by Milnex CC to conduct the Palaeontological Desktop Assessment (PDA) to assess the proposed Prospecting Right combined with a Waste Licence application to prospect for Diamond (Alluvial), Diamond (General), Diamonds and Diamonds (Kimberlite) on Portion 7 of the farm Adeisestad 409, Portion 1 of the farm Kalkpunt 407, Remaining Extent of Portion 21 and Portion 29 (portion of portion 21) of the farm UAP 418 & on Farm 596 near Upington, Registration Division: Gordonia, Northern Cape Province. To comply with the National Heritage Resources Act (No 25 of 1999, section 38) (NHRA), this PIA is necessary to verify if fossil material could potentially be present in the planned development area, to evaluate the potential impact of the proposed development on the Palaeontological Heritage and to mitigate possible damage to fossil resources.

The proposed development is underlain by sediments of the Gordonia Formation (Kalahari Group), Tertiary Calcrete, the Kalkpunt Formation of the Koras Group, as well as the Dagbreek Formation (Vaalkoppies Group, Namaqua-Natal Province). According to the PalaeoMap on the South African Heritage Resources Information System (SAHRIS) database, the Palaeontological Sensitivity of the Gordonia Formation is Moderate, while that of the Koras Group is Unknown and the Palaeontological Sensitivity of the Namaqua-Natal Province is Zero as it is igneous in origin (Almond and Pether 2008, SAHRIS website). A Low Palaeontological Significance has been allocated to the proposed development and **i**t is therefore considered that the proposed development will not lead to detrimental impacts on the palaeontological resources of the area. The construction and operation of the project may be authorised, as the whole extent of the development footprint is not considered sensitive in terms of palaeontological heritage.

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

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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Appendix A:

Curriculum Vitae Elize Butler

1 INTRODUCTION

Milnex CC was commissioned by Mopane Tree SA (Pty) Ltd as the independent environmental consultant to undertake the Scoping and EIA process for the proposed Prospecting Right combined with a Waste Licence application to prospect for Diamond (Alluvial), Diamond (General), Diamonds and Diamonds (Kimberlite) on Portion 7 of the farm Adeisestad 409, Portion 1 of the farm Kalkpunt 407, Remaining Extent of Portion 21 and Portion 29 (portion of portion 21) of the farm UAP 418 & on Farm 596 near Upington, Registration Division: Gordonia, Northern Cape Province. Banzai Environment was in turn appointed to conduct the Palaeontological Desktop Assessment for this project.

The proposed area comprises of cultivated fields while some areas are low scrubland and open bushes.

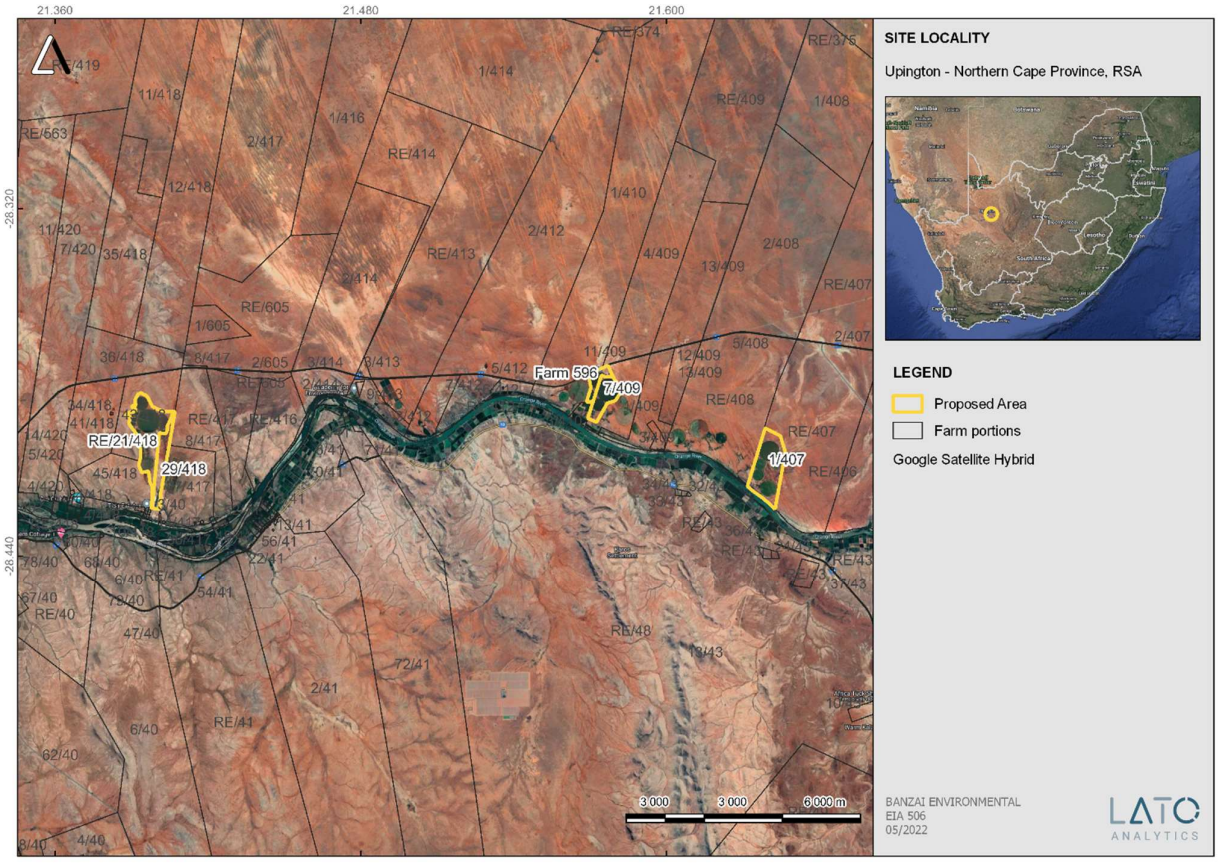

***Figure 1**: Location of the Prospecting Right combined with a Waste Licence application to prospect for Diamond (Alluvial), Diamond (General), Diamonds and Diamonds (Kimberlite) on Portion 7 of the farm Adeisestad 409, Portion 1 of the farm Kalkpunt 407, Remaining Extent of Portion 21 and Portion 29 (portion of portion 21) of the farm UAP 418 & on Farm 596 near Upington, Registration Division: Gordonia, Northern Cape Province.*

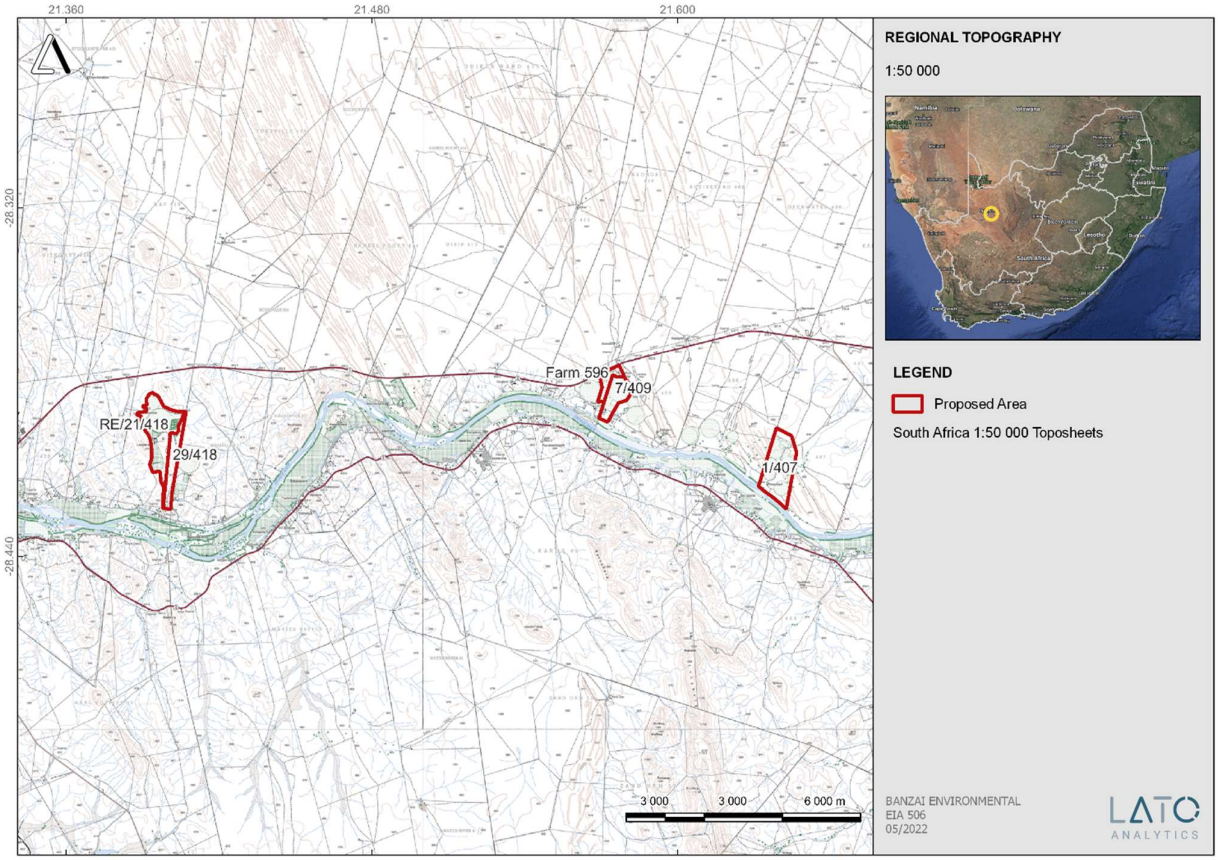

Figure 2: *Regional Topography of the proposed development*

The extensive diamondiferous gravels of the Lower Vaal, Harts, and Middle Orange River valleys are associated with remnants of outwash deposits formed during the retreat of the ancient Ghaap (Kaap) Valley glacial system and subsequent reworking and alluvial deposition by major rivers. These rivers included the proto- Vaal, - Orange, - Harts, and -Riet Rivers and their modem antecedents.

Past and present work has shown that the majority of the alluvial diamonds found in gravel deposits along all of the middle Orange River terraces are, typically, found in two distinct gravel horizons. These comprise an upper, deflation deposit (locally known as Rooikoppie gravels) overlying fluvial-alluvial units, often known as Primary gravels.

The older gravel sequence formed deposits of considerable thickness, often in excess of 15m and consisting of rapidly aggraded (or dumped) material. The sequence is compacted and frequently cemented with secondary calcrete. Basal gravels, typically, comprise the lower half to one third of the fluvial-alluvial sedimentary sequence and rest directly on the bedrock. The unit (around 5m thick) generally comprises a poorly sorted assemblage of large boulders (up to 45 cm in diameter at the base of the unit), cobbles and pebbles set in a sandy matrix that is considered to have been deposited by a large, high-energy braided system that would be readily capable of transporting diamonds.

The overlying suspended gravels represent gravel bars that have migrated down the river system and have not incised into the bedrock. The units have also been shown to contain diamonds. Diamond grades are usually lower than for the basal deposits owing to their being diluted by finer-grained pebble, sand, and silt lenses. The thickness of the suspended gravel unit varies from 3 – 7m and may represent large volumes of material.

2 QUALIFICATIONS AND EXPERIENCE OF THE AUTHOR

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

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 OBJECTIVE

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.

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

Mitigation usually 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 is possible because our knowledge of local palaeontological heritage may be increased

The terms of reference of a PIA are as follows:

General Requirements:

- Adherence to the content requirements for specialist reports in accordance with Appendix 6 of the EIA Regulations 2014, as amended.
- Adherence to all applicable best practice recommendations, appropriate legislation, and authority requirements.

- Submit a comprehensive overview of all appropriate legislation, guidelines.
- Description of the proposed project and provide information regarding the developer and consultant who commissioned the study.
- Description and location of the proposed development and provide geological and topographical maps.
- Provide Palaeontological and geological history of the affected area.
- Identification 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 proposed diamond prospecting and waste licence application near Upington is depicted on the 1: 250 000 Upington 2820 Geological Map (1988) (Council of Geosciences, Pretoria) (**Figure 3; Table 2**). According to this map the proposed development is underlain by the following sediments: Gordonia Formation of the Kalahari Group (Qg, white with yellow dashes), Tertiary Calcrete (T, yellow), the Kalkpunt Formation (Nka, light brown) of the Koras Group as well as the Dagbreek Formation (Mda, blue-purple) (Vaalkoppies Group, Namaqua-Natal Province). Shape files (distributed by the Council of Geosciences, Pretoria) of the development indicates that the development area is underlain by the Koras Group and is depicted in **Figure 4**.

The Cenozoic Kalahari Group is the most widespread body of terrestrial sediments in southern Africa. The Cenozoic sands and calcretes of the Kalahari Group range in thickness from a few metres to more than 180m (Partridge et al., 2006). The youngest formation of the Kalahari group is the Gordonia Formation (present in the development) which is generally termed Kalahari sand and comprises of red aeolian sands that covers most of the Kalahari Group sediments. The pan sediments of the area originated from the Gordonia Formation and contains white to brown fine-grained silts, sands, and clays. Some of the pans consist of clayey material mixed with evaporates that shows seasonal effects of shallow saline groundwaters. Quaternary alluvium, aolian sands, surface limestone, silcrete, and terrace gravels are also included in the Kalahari Group (Kent 1980).

These fossils represent terrestrial plants and animals with a close resemblance to living forms. Fossil assemblages include bivalves, diatoms, gastropod shells, ostracods, and trace fossils. Late Cenozoic calcrete may comprise of bones, horn corns as well as mammalian teeth. Tortoise remains have also been uncovered as well as trace fossils which includes termite and insect's burrows and mammalian trackways. Amphibian and crocodile remains have been uncovered where the depositional settings in the past were wetter.

Bedrock of the Namaqua-Natal Province underlays the Kalahari Group. The Namaqua-Natal Province comprise of igneous and metamorphic rocks (e.g., gneisses, schists, quartzites, amphibolites) plus major granitic and gabbroic (norite) intrusions), that was formed during the Namaqua Orogeny about 1200 to 1000 Ma (million years ago). These rocks forms outcrops in the Northern Cape as well as in KwaZulu Natal. Research has found that these rocks form part of an uninterrupted, 400-km wide and 1400-km-long arced orogenic belt that underlies the Phanerozoic Karoo Supergroup (Cornell et al, 2006). The Namaqua-Natal Metamorphic Province comprise of metasediments that are unfossiliferous. This bedrock is exposed in places where the sedimentary deposits of the Kalahari Group has been eroded away. Kalahari Group sedimentary deposits on the edge of the Kalahari Basin is thin. The basal pebbly sands (Eden Formation) that were deposited in braided streams (Haddon, 2000) may overly the bedrock. Calcretes present in the Mokalanen Formation have formed in several sediments e.g., colluvium, windblown sands as well as ephemeral streams and pans. Sometimes these calcretes may attain considerable thickness and represents polyphase development during the last 5Ma (late Miocene/Pliocene). The calcretes are overlain by red aeolian sands (Gordonia Formation) of the Kalahari. Calcrete deposits may accumulate in pans beneath the aeolian sands. Radiometric dating could thus far not establish a precise boundary between the Quaternary and Tertiary (Kent,1980). The Gordonia Formation (Kalahari Group) are dated as Late Pliocene/Early Pleistocene to Recent times by the Middle to Later Stone Age stone tools recovered from them (Dingle et al, 1983).

The banded gneisses of the Vaalkoppies Group are highly deformed and may characterize the reworking of older granitic basement rocks of about 1750–1900 Ma during the Kheis Orogeny that was later overprinted by the Namaqua event. The Vaalkoppies Group appears as a linear, southeast-trending belt from about 20 km north of Upington to Putsonderwater. Here the Group is cut by the Brakbosch Shear Zone and exposed in the east by the antiform between Kleinbegin and Karos. In the west the group contacts with the Trooilapspan Shear Zone set against the basal conglomerate of the Areachap Group. The Wilgenhoutsdrif Group overlies the Group in the northeast. The contact with the Brulpan Group is tectonic in nature.

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The Dagbreek Formation (in the Karos-Kleinbegin anticline) comprise of light-colored quartzites, medium-grained quartz-muscovite and scattered kyanite porphyroblasts with fractured quartzite. This formation, west of the Brakbosch Shear Zone, is folded into a hook-shaped interference of which only the western limb is preserved. This succession includes sericite schist grading westwards into muscovite quartzite interspersed with dark-grey granofels and banded paragneiss, as well as migmatite containing biotite, feldspar, garnet, hornblende, quartz, and magnetite. Sillimanite comprises usually of light-colored quartzites and sporadically forms elongated nodules and is frequently retrograded to muscovite. In the west, leucosomes and biotite veins accompany high-grade migmatite. The laterally persistent layers and dislocated granofels and gneiss succession, contains amphibolite.

The northern part of the Kaaien Hills comprise of the Dagbreek Formation that is underlain by the 800-mthick Sultanaoord Formation. The Dagbreek Formation comprise of glassy, white quartzites that is up to 250 m thick and interbedded with schist and red-weathering phyllonite. These metapelitic intercalations are highly deformed, displaying various structures for example kink bands, chevron folds and rods. The Dagbreek Formation is dated as between 1800 to 2100 Ma (Barton and Burger, 1983).

The Lithostratigraphy of the Koras Group has been documented by Sanderson-Damstra (1982) and Moen (1987) and is indicated in the Table 2.

Table 2: *Lithostratigraphy of the Koras Group (taken from Cornell et al, 2006)*

NORTHERN DOMAIN	CENTRAL DOMAIN	SOUTHERN DOMAIN
Kalkpunt Formation	Kalkpunt Formation	
Welgevind Formation	Adeisestad Formation (northern part only)	Leeuwdraai Formation
Rouxville Formation	Rouxville Formation	Rouxville Formation
		Ezelfontein Formation
	Swartkopsleegte Formation	Swartkopsleegte Formation
Rusplaas Formation	Bossienek Formation	
Boom River Formation	Boom River Formation	Boom River Formation
Christiana Formation	Christiana Formation (?)	Christiana Formation (?)

To the east and north of the Upington metamorphic rocks of the Kaaien Terrane is unconformably overlain by the Koras Group. This zircon-age of this group is about 1180 Ma (Botha et al, 1979) . The Koras Group consist of a subalkaline bimodal volcanic Suite that comprises of a rhyolite and basalt with intermediate rocks only in associated intrusions. The basic members are K-rich and calc-alkaline with shoshonitic tendencies (Grobler et al, 1977; Damstra, 1982) and Moen (1987). The Koras Group in the development footprint is represented by the Kalkpunt formation.

The **Kalkpunt Formation** comprises of conglomerate and minor shale, as well as red-brown sandstone. In both the central and northern domains this Formation fills basins with faulted eastern boundaries. In the eastern central domain, the basal polymict conglomerate is about 700m thick. These pebbles contain jaspilite and banded iron-formation from the Transvaal Supergroup, demonstrating a larger source area, which is in contrast with the underlying conglomerates that does not contain the BIF and jaspilite. The conglomerate grades up into fine-grained, cross-bedded sandstone with sporadic red mud flakes and conglomerate layers. Characteristic of the northern domain is the sandstone deposits conformably overlying the Welgevind lava. The deposit thins from 3000m in the central domain to 1450 m in the north. Outliers of quartz-feldspar porphyry protrude through Nama and Dwyka Group sediments west of the northern domain. West of the northern domain the Nama and

Dwyka Groups are protruded by outliers of quartz-feldspar porphyritic rock. Koras related intrusions is found mostly in the northern domain while quartz-feldspar porphyritic dykes of 15 m wide and several kilometers long form a northeast-trending swarm north and east of Upington.

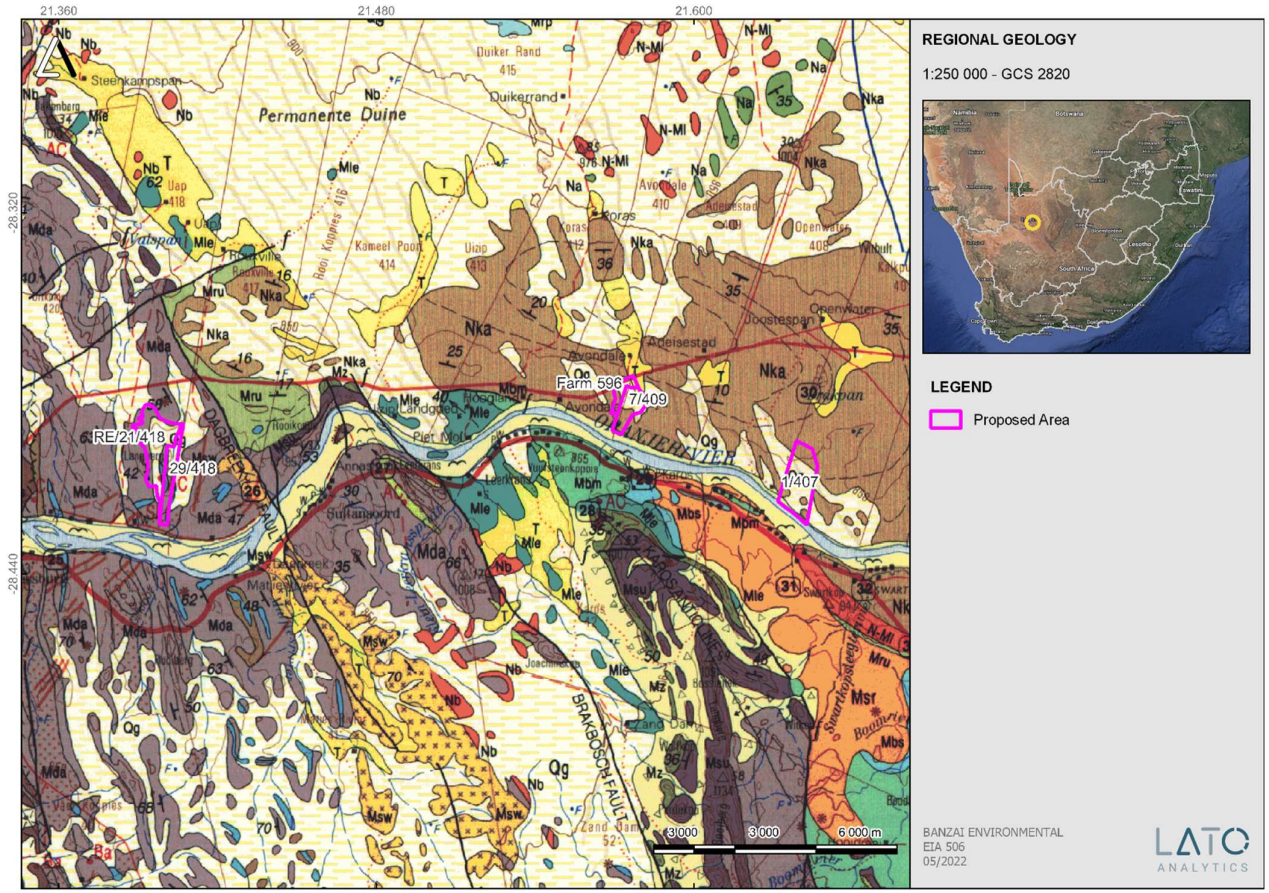
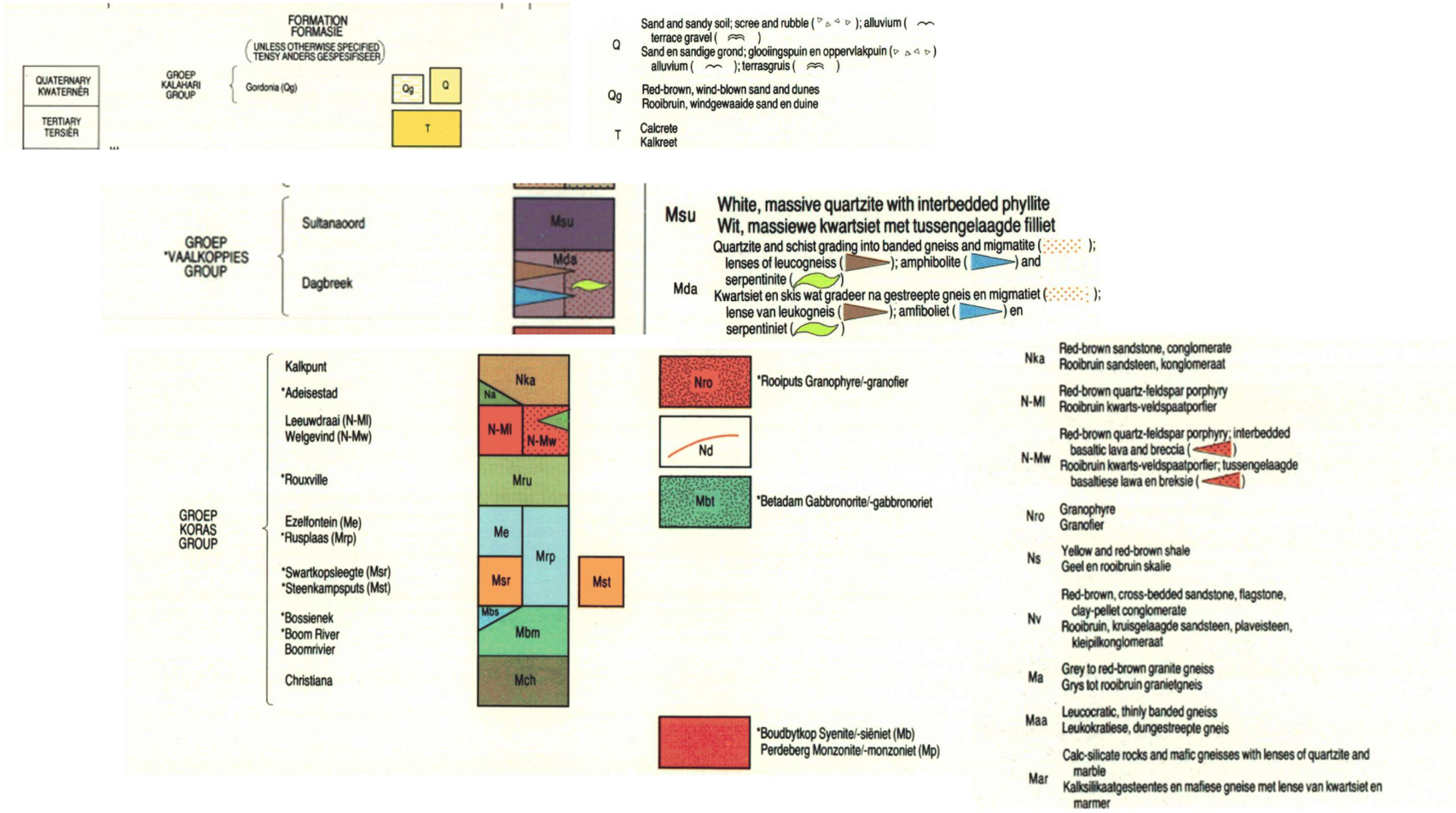


***Figure 3**: Extract of the 1: 250 000 Upington 2820 Geological Map (1988) (Council of Geosciences, Pretoria) indicating the geology of the proposed prospecting and waste licence application near Upington in the Northern Cape Province.*

This map indicates that the development is underlain by the Gordonia Formation (white with yellow dashes; Qg) of the Kalahari Group, Tertiary Calcrete (T, yellow), the Kalkpunt Formation (Nka, light brown) of the Koras Group as well as the Dagbreek Formation (Mda, blue-purple) (Vaalkoppies Group, Namaqua-Natal Province).

***Table 3**:Legend of the 1: 250 000 Upington 2820 Geological Map (1988) (Council of Geosciences, Pretoria)*



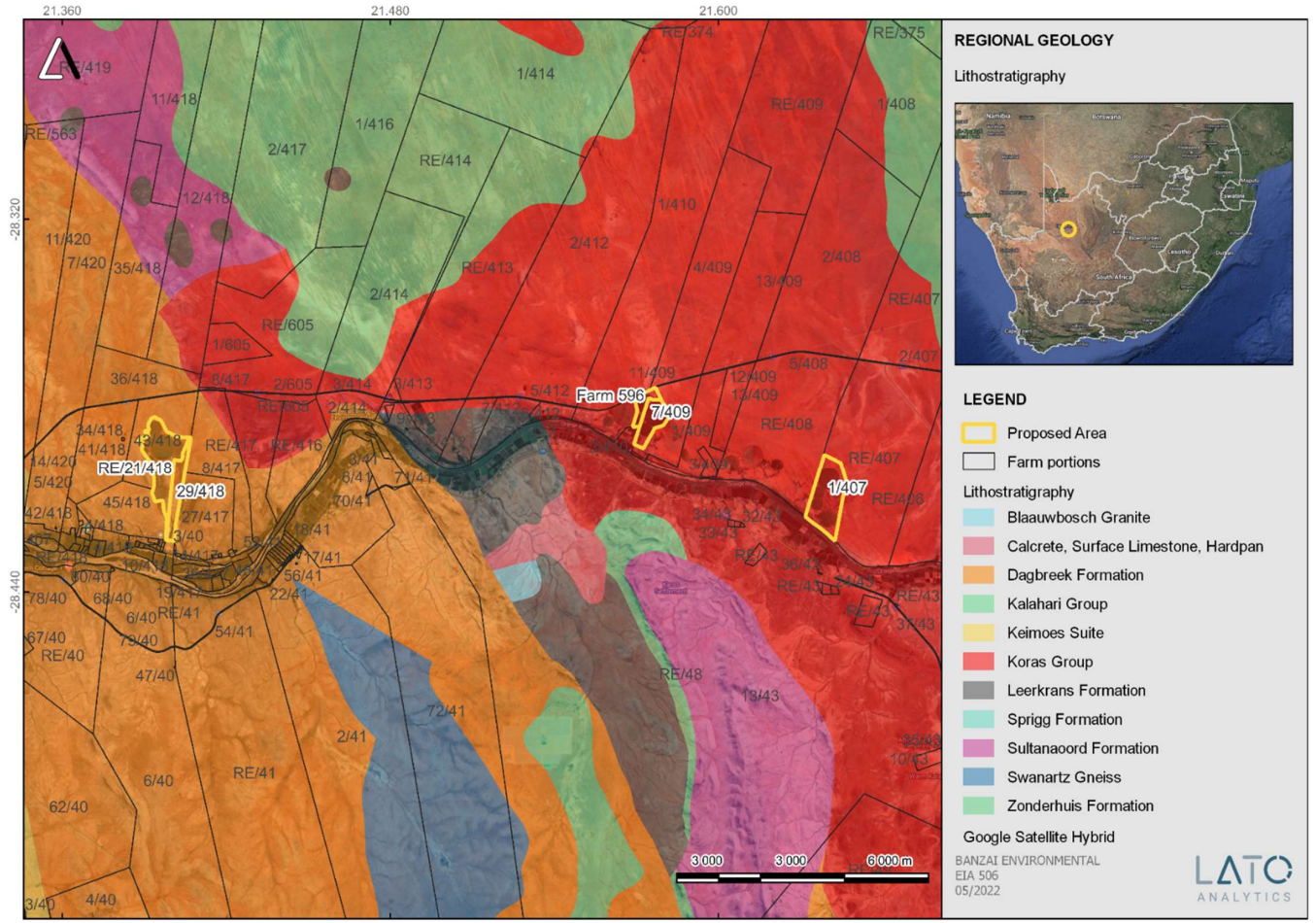


***Figure 4**: Geology indicated by Shape Files (Council for Geosciences, Pretoria). According to this map the development is underlain by the Dagbreek Formation of the Vaalkoppies Group as well as the Koras Group.*

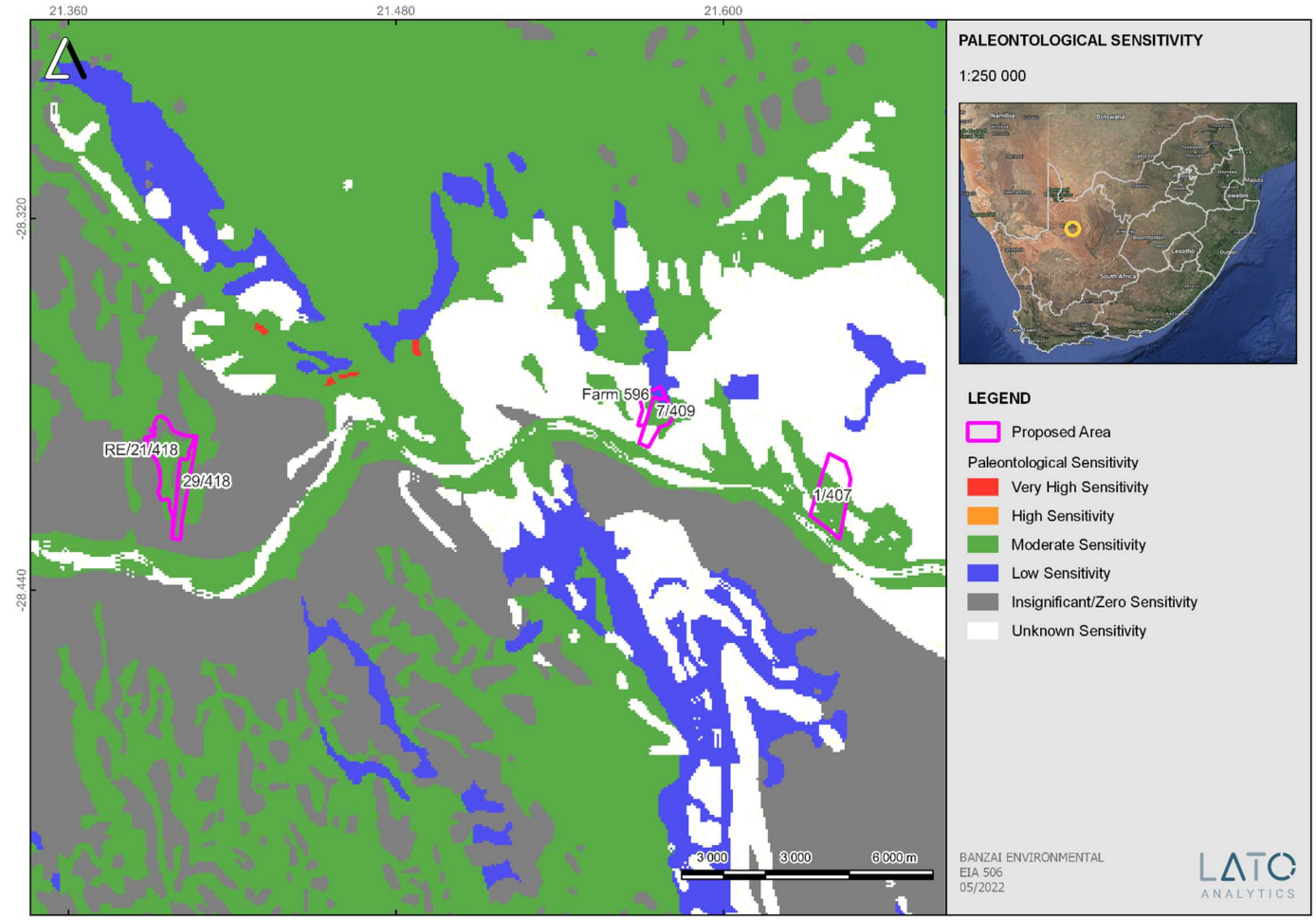


Figure 5: *Extract of the 1 in 250 000 SAHRIS PalaeoMap (Council of Geosciences) indicating the location of the proposed development.*

According to the SAHRIS Palaeosensitivity map (**Figure 5**) the proposed development is underlain by sediments with a Moderate (green), Low (blue), Zero (grey) and unknown (white) Palaeontological Significance.

***Table 4**: SAHRIS Palaeosensitivity ratings table. The relevant sensitivities are highlighted*

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.**

6 GEOGRAPHICAL LOCATION OF THE SITE

The proposed development is located about 49km East of Upington next to the N14 (Northern Cape Province).

The following information was obtained from Milnex CC.

***Table 5**: Locality of the proposed development*

Farm Name:	1) Portion 7 of the farm Adeisestad 409 Title deed: T581/2014 Registration division: Gordonia RD Province: Northern Cape 2) Portion 1 of the farm Kalkpunt 407 Title Deed: T658/2013 Registration Division: Gordonia Rd Province: Northern Cape 3) Remaining extent of portion 21 of the farm UAP 418 Title Deed: T726/2014 Registration Division: Gordonia Rd Province: Northern Cape 4) Portion 29 (portion of portion 21) of the farm UAP 418 Title Deed: T462/1990 Registration Division: Gordonia Rd Province: Northern Cape 5) Farm 596 Title Deed: T581/2014 Registration Division: Gordonia Rd Province: Northern Cape
Application area (Ha)	810.485 ha
Magisterial district:	Siyanda District Municipality
Local Municipality	Khara Hais Local Municipality
Registration Division	Gordonia
Distance and direction from nearest town	The property is located approximately 49km East of Upington adjacent the N14 in the Northern Cape Province.
21 digit Surveyor General Code for each farm portion	C02800000000059600000 C02800000000040900007 C02800000000040700001 C02800000000041800000 C02800000000041800029
Minerals Applied for	DIAMONDS ALLUVIAL DIAMONDS GENERAL DIAMONDS IN KIMBERLITE DIAMONDS

***Table 6**:Farm coordinates*

Farms	Longitude	Latitude
1. Portion 7 of the farm Adeisestad 409	21° 24' 25.429" E	28° 23' 24.433" S
	21° 24' 22.995" E	28° 23' 24.472" S
2. Portion 1 of the farm Kalkpunt 407	21° 24' 13.277" E	28° 23' 24.396" S
	21° 24' 2.805" E	28° 23' 21.843" S
3. Remaining Extent of portion 21 of the farm UAP 418	21° 23' 53.616" E	28° 23' 17.977" S
	21° 23' 48.130" E	28° 23' 8.614" S
4. Portion 29 (portion of portion 21) of the farm UAP 418	21° 23' 47.565" E	28° 23' 7.481" S

5. Farm 596	21° 23' 47.240" E	28° 23' 6.930" S
	21° 23' 46.862" E	28° 23' 6.412" S
	21° 23' 46.447" E	28° 23' 5.909" S
	21° 23' 46.025" E	28° 23' 5.412" S
	21° 23' 45.519" E	28° 23' 4.976" S
	21° 23' 45.007" E	28° 23' 4.574" S
	21° 23' 44.449" E	28° 23' 4.190" S
	21° 23' 43.869" E	28° 23' 3.844" S
	21° 23' 42.619" E	28° 23' 3.293" S
	21° 23' 41.319" E	28° 23' 2.874" S
	21° 23' 39.937" E	28° 23' 2.632" S
	21° 23' 38.462" E	28° 23' 0.872" S
	21° 23' 35.002" E	28° 23' 1.903" S
	21° 23' 32.397" E	28° 23' 3.032" S
	21° 23' 32.494" E	28° 23' 4.702" S
	21° 23' 31.970" E	28° 23' 5.115" S
	21° 23' 31.044" E	28° 23' 6.077" S
	21° 23' 30.318" E	28° 23' 7.084" S
	21° 23' 29.705" E	28° 23' 8.209" S
	21° 23' 29.344" E	28° 23' 9.401" S
	21° 23' 29.154" E	28° 23' 10.621" S
	21° 23' 29.137" E	28° 23' 11.855" S
	21° 23' 29.238" E	28° 23' 12.473" S
	21° 23' 29.523" E	28° 23' 13.649" S
	21° 23' 30.032" E	28° 23' 14.850" S
	21° 23' 30.709" E	28° 23' 15.896" S
	21° 23' 28.864" E	28° 23' 16.575" S
	21° 23' 25.000" E	28° 23' 16.828" S
	21° 23' 24.732" E	28° 23' 19.433" S
	21° 23' 29.039" E	28° 23' 19.280" S
	21° 23' 29.311" E	28° 23' 24.469" S
	21° 23' 24.211" E	28° 23' 24.867" S
	21° 23' 16.616" E	28° 23' 25.904" S
	21° 23' 15.936" E	28° 23' 28.558" S
	21° 23' 22.488" E	28° 23' 30.720" S
	21° 23' 20.291" E	28° 23' 38.926" S
	21° 23' 21.916" E	28° 23' 41.165" S
	21° 23' 25.975" E	28° 23' 46.209" S
	21° 23' 32.805" E	28° 23' 54.083" S
	21° 23' 34.000" E	28° 23' 57.509" S
	21° 23' 35.195" E	28° 24' 0.693" S
	21° 23' 36.673" E	28° 24' 11.747" S
	21° 23' 36.741" E	28° 24' 21.982" S
	21° 23' 35.501" E	28° 24' 25.703" S
	21° 23' 34.021" E	28° 24' 30.209" S
	21° 23' 38.371" E	28° 24' 40.004" S
	21° 23' 46.465" E	28° 24' 38.451" S
	21° 23' 48.530" E	28° 24' 38.813" S
	21° 23' 49.803" E	28° 24' 50.934" S
	21° 23' 53.599" E	28° 24' 58.286" S

	21° 23' 52.468" E	28° 25' 24.248" S
	21° 23' 52.942" E	28° 25' 24.301" S
	21° 24' 3.786" E	28° 25' 25.527" S
	21° 24' 5.464" E	28° 25' 5.156" S
	21° 34' 28.051" E	28° 22' 38.953" S
	21° 34' 8.679" E	28° 23' 32.586" S
	21° 34' 21.023" E	28° 23' 37.412" S
	21° 34' 30.904" E	28° 23' 21.918" S
	21° 34' 32.610" E	28° 23' 19.552" S
	21° 34' 36.087" E	28° 23' 13.725" S
	21° 34' 47.509" E	28° 23' 10.613" S
	21° 34' 49.997" E	28° 23' 7.496" S
	21° 34' 53.064" E	28° 23' 3.363" S
	21° 34' 54.078" E	28° 22' 59.964" S
	21° 34' 54.313" E	28° 22' 56.167" S
	21° 34' 53.538" E	28° 22' 53.890" S
	21° 34' 51.915" E	28° 22' 51.181" S
	21° 34' 50.725" E	28° 22' 48.880" S
	21° 34' 48.671" E	28° 22' 46.482" S
	21° 34' 46.549" E	28° 22' 45.054" S
	21° 34' 44.504" E	28° 22' 41.053" S
	21° 34' 33.153" E	28° 22' 41.039" S
	21° 38' 19.356" E	28° 23' 44.700" S
	21° 38' 40.884" E	28° 23' 54.456" S
	21° 38' 47.904" E	28° 24' 15.012" S
	21° 38' 33.225" E	28° 25' 25.435" S
	21° 38' 23.965" E	28° 25' 17.655" S
	21° 38' 19.771" E	28° 25' 14.616" S
	21° 38' 15.505" E	28° 25' 11.524" S
	21° 38' 11.224" E	28° 25' 8.655" S
	21° 38' 7.411" E	28° 25' 6.355" S
	21° 38' 2.266" E	28° 25' 2.989" S
	21° 37' 57.979" E	28° 24' 59.871" S
	21° 37' 54.159" E	28° 24' 57.139" S
	21° 34' 37.432" E	28° 22' 27.215" S
	21° 34' 9.326" E	28° 22' 38.300" S
	21° 34' 13.143" E	28° 22' 54.301" S
	21° 34' 6.889" E	28° 23' 12.474" S
	21° 34' 16.239" E	28° 23' 11.660" S

7 METHODS

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

7.1 Assumptions and Limitations

When conducting a PIA several factors can affect the accuracy of the assessment. The focal point of geological maps is the geology of the area, and the sheet explanations were not meant to focus on palaeontological

heritage. Many inaccessible regions of South Africa have not been reviewed by palaeontologists and data is generally based on aerial photographs. Locality and geological information of museums and universities databases have not been kept up to date or data collected in the past have not always been accurately documented.

Comparable Assemblage Zones in other areas is used to provide information on the existence of fossils in an area which was not yet been documented. When similar Assemblage Zones and geological formations for Desktop studies is used it is generally **assumed** that exposed fossil heritage is present within the footprint**.**

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).
- A Google Earth map with polygons of the proposed development was obtained from Milnex cc.
- 1: 250 000 Upington 2824 Geological Map (1988) (Council of Geosciences, Pretoria)
- Shape files produced by the Council of Geosciences (Pretoria).

9 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:

Table 7*:* 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 + probability + reversibility + irreplaceability + duration + cumulative effect) x magnitude/intensity = X.** 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

9.1 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. As fossil heritage will be destroyed the impact is irreversible. The significance of the impact occurring will be high pre-mitigation and low post-mitigation.

***Table 8**:* Summary of Impact Tables

	Site	Probability	Duration	Magnitude	Reversibility	Irreplicable Loss	Cumulative Effect	Significance
	1	2	4	1	4	4	2	17

10 FINDINGS AND RECOMMENDATIONS

The proposed development is underlain by sediments of the Gordonia Formation (Kalahari Group), Tertiary Calcrete, the Kalkpunt Formation of the Koras Group, as well as the Dagbreek Formation (Vaalkoppies Group,

Namaqua-Natal Province). According to the PalaeoMap on the South African Heritage Resources Information System (SAHRIS) database, the Palaeontological Sensitivity of the Gordonia Formation is Moderate, while that of the Koras Group is Unknown and the Palaeontological Sensitivity of the Namaqua-Natal Province is Zero as it is igneous in origin (Almond and Pether 2008, SAHRIS website). A Low Palaeontological Significance has been allocated to the proposed development and it is therefore considered that the proposed development will not lead to detrimental impacts on the palaeontological resources of the area. The construction and operation of the project may be authorised, as the whole extent of the development footprint is not considered sensitive in terms of palaeontological heritage.

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

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.

11 CHANCE FIND PROTOCOL

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

11.1 LEGISLATION

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

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

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

11.2 INTRODUCTION

This informational document is intended for workmen and foremen on construction sites. It describes the actions to be taken when construction activities accidentally uncover 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.

11.3 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.
- If the fossil cannot be stabilized the fossil may be collected with extreme care by the ESO. Fossils finds must be stored in tissue paper and in an appropriate box while due care must be taken to remove all fossil material from the rescue site.
- Once the Heritage Agency has issued the written authorization, the developer may continue with the development on the affected area.

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Appendix A

CURRICULUM VITAE

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	National Museum, Bloemfontein
and Collection Manager	1998–currently

TECHNICAL REPORTS

Butler, E. 2014. Palaeontological Impact Assessment of the proposed development of private dwellings on portion 5 of farm 304 Matjesfontein Keurboomstrand, Knysna District, Western Cape Province. Bloemfontein.

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