PALAEONTOLOGICAL HERITAGE SPECIALIST ASSESSMENT: COMBINED FIELD-BASED & DESKTOP STUDY

PROPOSED LODGE AT LION FARM, EKLAND SAFARIS NEAR LOUIS TRICHARDT, SOUTPANSBERG DISTRICT, LIMPOPO PROVINCE

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EXECUTIVE SUMMARY

Manupont (Pty) Ltd is proposing to construct a 60-bed lodge with associated infrastructure on the Remainder of Farm Juliana 647 MS and Portion 1 of Farm Coen Brits 646 MS, within the boundaries of the Lion Farm located within Ekland Safaris. The project area is situated *c*. 30 km N of Louis Trichardt in the Soutpansberg District of Limpopo Province, RSA . Three lodge site options (1 to 3) are under consideration.

The project area for the Ekland Safaris lodge near Louis Trichardt, Limpopo Province, is underlain by Karoo Supergroup sediments of potentially high palaeontological sensitivity in the south and by low-sensitivity Precambrian basement rocks, Quaternary sands, gravels and alluvium in the north. Lodge site option 3 overlying Quaternary sandy alluvium is not at all problematic from a palaeontological heritage viewpoint. The prominent rocky outcrops of Bobbejaankop, where lodge site options 1 and 2 are located, represent some of the best known exposures of Early Jurassic desert sandstones of the Clarens Formation (Karoo Supergroup) in the Alldays 1: 250 000 sheet area (Brandl 2002) and are therefore of special geo-heritage interest. While important fossils of dinosaurs and other vertebrates, petrified wood and trace fossils (*e.g.* dinosaur trackways) have been reported from the Clarens Formation elsewhere in Limpopo, no fossil remains were observed during the recent palaeontological field visit to the lodge site options 1 and 2. The Clarens Formation sandstones at Bobbejaanskop display a range of typical karstic (solution) weathering features with poor preservation of original sedimentary structures (*e.g.* dune cross-bedding, such as well-seen in the Castle Koppies area just to the west). Surface weathering may have obscured or destroyed any fossils originally present here.

It is concluded that the proposed lodge development does not pose a significant threat to local fossil heritage resources and there are no objections on palaeontological heritage grounds to the tourism infrastructure project, nor is there a preference for any particular lodge site option. No further specialist palaeontological mitigation or monitoring is recommended here.

It should be noted that any new fossil finds made in the area would be of geotourism as well as scientific research interest and the Chance Fossil Finds Protocol appended to this report should be applied by the

responsible ECO during construction. If any substantial fossil remains (*e.g.* vertebrate bones, teeth, petrified wood) are found during construction SAHRA should be notified immediately (Contact details: SAHRA, 111 Harrington Street, Cape Town. PO Box 4637, Cape Town 8000, South Africa. Phone: +27 (0)21 462 4502. Fax: +27 (0)21 462 4509. Web: www.sahra.org.za). This is so that appropriate mitigation (*i.e.* recording, sampling or collection) by a palaeontological specialist can be considered and implemented, at the developer's expense.

These recommendations must be incorporated into the Environmental Management Programme for the lodge development. The palaeontologist concerned with mitigation work will need a valid collection permit from SAHRA. All work would have to conform to international best practice for palaeontological fieldwork and the study (*e.g.* data recording fossil collection and curation, final report) should adhere to the minimum standards for Phase 2 palaeontological studies published by SAHRA (2013).

1. INTRODUCTION

1.1. Project outline and brief

The company Manupont (Pty) Ltd is proposing to construct a 60-bed lodge with associated structures and infrastructure on the Remainder of the Farm Juliana 647 MS and Portion 1 of the Farm Coen Brits 646 MS, located within the boundaries of the Lion Farm located within Ekland Safaris. The project area is situated on the northern foothills of the Soutpansberge Range and just east of the N1, *c*. 30 km N of Louis Trichardt and *c.* 50 km SSW of Musina in the Soutpansberg District, Limpopo Province, RSA (Fig. 1). Three lodge site options (1 to 3) are under consideration (Figs. 2 & 3, 6 to 8).

The client is submitting an application for Environmental Authorisation for all listed activities associated with the construction and operation of the lodge which will be submitted to the Limpopo Department of Economic Development, Environment and Tourism (LEDET) in terms of the NEMA 107 of 1998 *via* a Basic Assessment process. A Water Use Licence Application will be submitted to the Department of Water and Sanitation for activities triggered that are listed within section 21 of the National Water Act 36 of 1998. The Basic Assessment process is being co-ordinated by Aurecon South Africa (Pty) Ltd (Contact details: Ms Anne-Mari White. Aurecon South Africa (Pty) Ltd. Address: 10 Nel Street, Sonheuwel Central, Nelspruit, 1200. Tel: (013) 752 7055. Fax: 086 5711464. E-mail: Anne-Mari.White@aurecongroup.com).

A Phase 1 Heritage Impact Assessment (HIA), required in terms of Section 38(1) of the South African Heritage Resources Act (25 of 1999), will also be submitted to the Provincial Heritage Resources Authority of Limpopo (LIHRA). The HIA is being conducted by G&A Heritage (Pty) Ltd (Contact details: Mr Stephan Gaigher. G&A Heritage (Pty) Ltd. 38A Vorster Street, Louis Trichardt 0920. Cell: 073 752 6583. Tel: 015 516 1561. E-mail: stephan@gaheritage.co.za). Since the project footprint overlies potentially fossiliferous sediments of the Karoo Supergroup, a desktop Palaeontological Assessment was initially commissioned as part of the HIA by G&A Heritage (Pty) Ltd (Almond 2018).

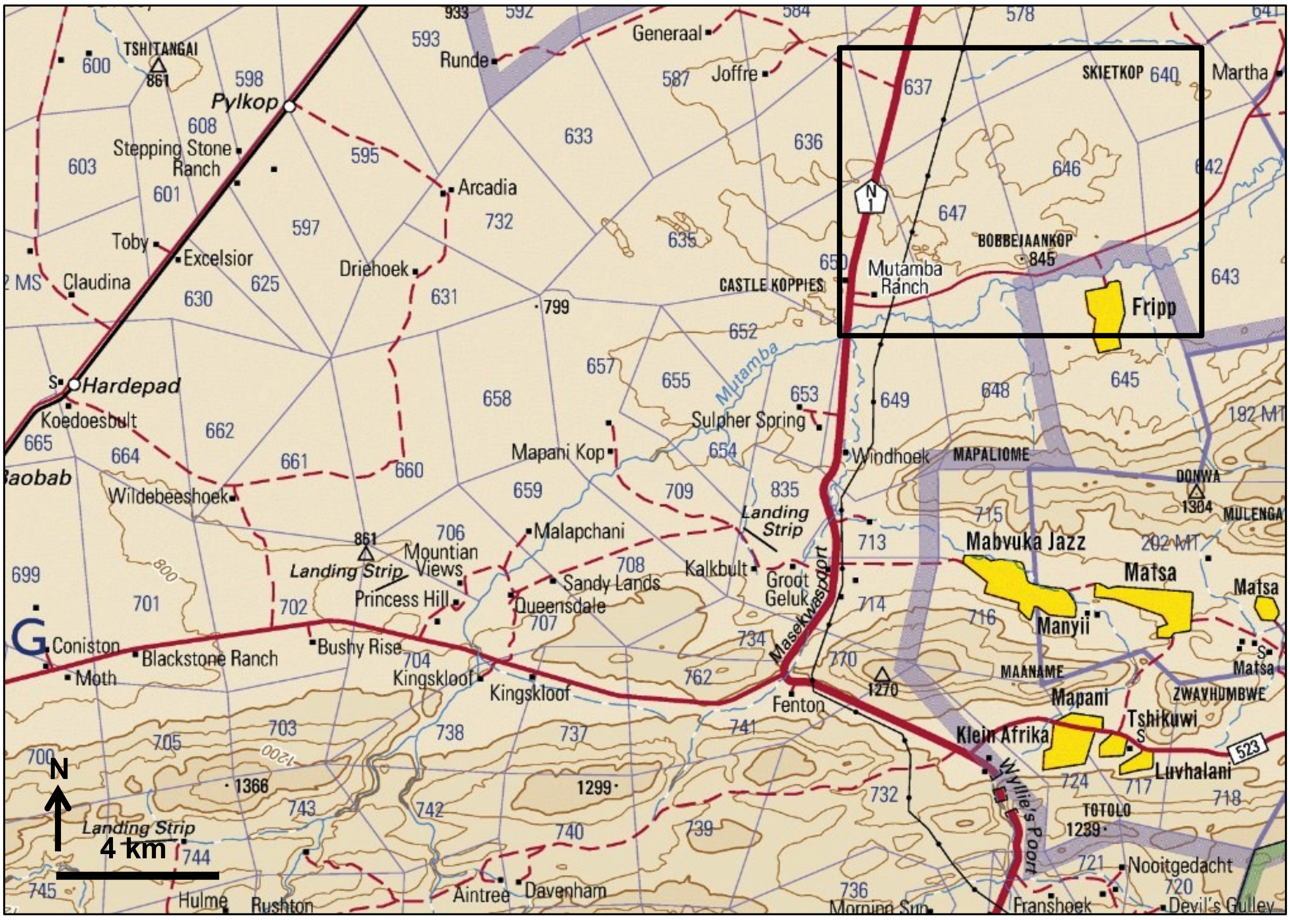

Figure 1. Extract from 1: 25 000 topographical sheet 2228 Alldays (Courtesy of the Chief Directorate: National Geo-spatial Information, Mowbray) showing the approximate location of the proposed lodge development on the Remainder of Farm Juliana 647 MS and Portion 1 of Farm Coen Brits 646 MS (black rectangle), situated *c.* 30 km N of Louis Trichardt and *c.* 50 km SSW of Musina, Soutpansberg District, Limpopo Province, RSA.

The palaeontological desktop study (Almond 2018) made the following recommendations:

> *Lodge site option 3 overlying Quaternary alluvium as well as the airfield footprint that overlies a range of low-sensitivity basement rocks are not problematic from a palaeontological heritage viewpoint. However, the prominent rocky outcrops of Bobbejaankop, where lodge site options 1 and 2 are located, represent some of the best known exposures of Early Jurassic desert sandstones of the Clarens Formation in the Alldays 1: 250 000 sheet area and are therefore of special geo-heritage interest. They might also feature important, unrecorded fossil remains of dinosaurs and other vertebrates, petrified wood and trace fossils (e.g. trackways), such as are reported from the Clarens Formation elsewhere in Limpopo. Potentially detrimental impacts to any unrecorded fossil remains and geosites posed by lodge construction as well as increased human activity on Bobbejaankop need to be considered and assessed. It is therefore recommended that a palaeontological field survey of the project area, with a special focus on Bobbejaankop, be conducted before authorization for a lodge or any other major development on this rocky outcrop is granted.*

The present field-based palaeontological heritage assessment report was accordingly commissioned by G&A Heritage (Pty) Ltd.

1.2. Legislative context for palaeontological assessment studies

The various categories of heritage resources recognised as part of the National Estate in Section 3 of the National Heritage Resources Act (Act 25 of 1999) include, among others:

- geological sites of scientific or cultural importance;
- palaeontological sites;
- palaeontological objects and material, meteorites and rare geological specimens.

According to Section 35 of the National Heritage Resources Act, dealing with archaeology, palaeontology and meteorites:

(1) The protection of archaeological and palaeontological sites and material and meteorites is the responsibility of a provincial heritage resources authority.

(2) All archaeological objects, palaeontological material and meteorites are the property of the State.

(3) Any person who discovers archaeological or palaeontological objects or material or a meteorite in the course of development or agricultural activity must immediately report the find to the responsible heritage resources authority, or to the nearest local authority offices or museum, which must immediately notify such heritage resources authority.

(4) No person may, without a permit issued by the responsible heritage resources authority—

(a) destroy, damage, excavate, alter, deface or otherwise disturb any archaeological or palaeontological site or any meteorite;

(b) destroy, damage, excavate, remove from its original position, collect or own any archaeological or palaeontological material or object or any meteorite;

(c) trade in, sell for private gain, export or attempt to export from the Republic any category of archaeological or palaeontological material or object, or any meteorite; or

(d) bring onto or use at an archaeological or palaeontological site any excavation equipment or any equipment which assist in the detection or recovery of metals or archaeological and palaeontological material or objects, or use such equipment for the recovery of meteorites.

(5) When the responsible heritage resources authority has reasonable cause to believe that any activity or development which will destroy, damage or alter any archaeological or palaeontological site is under way, and where no application for a permit has been submitted and no heritage resources management procedure in terms of section 38 has been followed, it may—

(a) serve on the owner or occupier of the site or on the person undertaking such development an order for the development to cease immediately for such period as is specified in the order;

(b) carry out an investigation for the purpose of obtaining information on whether or not an archaeological or palaeontological site exists and whether mitigation is necessary;

(c) if mitigation is deemed by the heritage resources authority to be necessary, assist the person on whom the order has been served under paragraph *(a)* to apply for a permit as required in subsection (4); and

(d) recover the costs of such investigation from the owner or occupier of the land on which it is believed an archaeological or palaeontological site is located or from the person proposing to undertake the development if no application for a permit is received within two weeks of the order being served.

Minimum standards for the palaeontological component of heritage impact assessment reports (PIAs) have been published by SAHRA (2013).

1.3. Approach to the desktop palaeontological heritage study

The approach to this desktop palaeontological heritage study is briefly as follows. Fossil bearing rock units occurring within the broader study area are determined from geological maps and satellite images. Known fossil heritage in each rock unit is inventoried from scientific literature, previous assessments of the broader study region, and the author's field experience and palaeontological database (See Table 1). Based on this data as well as field examination of representative exposures of all major sedimentary rock units present, the impact significance of the proposed development is assessed and recommendations for any necessary further studies or mitigation are made.

In preparing a palaeontological desktop study the potentially fossiliferous rock units (groups, formations *etc.*) represented within the study area are determined from geological maps and satellite images. The known fossil heritage within each rock unit is inventoried from the published scientific literature, previous palaeontological impact studies in the same region, and the author's field experience (consultation with professional colleagues as well as examination of institutional fossil collections may play a role here, or later following field assessment during the compilation of the final report). This data is then used to assess the palaeontological sensitivity of each rock unit to a development (Provisional tabulations of palaeontological sensitivity of all formations in the Limpopo Province have already been compiled by J. Almond and colleagues; *cf* Groenewald & Groenewald 2014).

The likely impact of the proposed development on local fossil heritage is then determined on the basis of (1) the palaeontological sensitivity of the rock units concerned, and (2) the nature and scale of the development itself, most significantly the extent of fresh bedrock excavation envisaged. When rock units of moderate to high palaeontological sensitivity are present within the development footprint, a Phase 1 field assessment study by a professional palaeontologist is usually warranted to identify any palaeontological hotspots and make specific recommendations for any mitigation required before or during the construction phase of the development.

On the basis of the desktop and Phase 1 field assessment studies, the likely impact of the proposed development on local fossil heritage and any need for specialist mitigation are then determined. Adverse palaeontological impacts normally occur during the construction rather than the operational or decommissioning phase. Phase 2 mitigation by a professional palaeontologist – normally involving the recording and sampling of fossil material and associated geological information (*e.g.* sedimentological data) may be required (a) in the pre-construction phase where important fossils are already exposed at or near the land surface and / or (b) during the construction phase when fresh fossiliferous bedrock has been exposed by excavations. To carry out mitigation, the palaeontologist involved will need to apply for a palaeontological collection permit from the relevant heritage management authority (*e.g.* SAHRA for Limpopo Province). It should be emphasized that, *provided that appropriate mitigation is carried out*, the majority of developments involving bedrock excavation can make a *positive* contribution to our understanding of local palaeontological heritage.

1.4. Assumptions & limitations

The accuracy and reliability of palaeontological specialist studies as components of heritage impact assessments are generally limited by the following constraints:

1. Inadequate database for fossil heritage for much of the RSA, given the large size of the country and the small number of professional palaeontologists carrying out fieldwork here. Most development study areas have never been surveyed by a palaeontologist.

2. Variable accuracy of geological maps which underpin these desktop studies. For large areas of terrain these maps are largely based on aerial photographs alone, without ground-truthing. The maps generally depict only significant ("mappable") bedrock units as well as major areas of superficial "drift" deposits (alluvium, colluvium) but for most regions give little or no idea of the level of bedrock outcrop, depth of superficial cover (soil *etc.*), degree of bedrock weathering or levels of small-scale tectonic deformation, such as cleavage. All of these factors may have a major influence on the impact significance of a given development on fossil heritage and can only be reliably assessed in the field.

3. Inadequate sheet explanations for geological maps, with little or no attention paid to palaeontological issues in many cases, including poor locality information.

4. The extensive relevant palaeontological "grey literature" - in the form of unpublished university theses, impact studies and other reports (*e.g*. of commercial mining companies) - that is not readily available for desktop studies.

5. Absence of a comprehensive computerized database of fossil collections in major RSA institutions which can be consulted for impact studies. A Karoo fossil vertebrate database is now accessible for impact study work.

In the case of palaeontological desktop studies without supporting Phase 1 field assessments these limitations may variously lead to either:
(a) *underestimation* of the palaeontological significance of a given study area due to ignorance of significant recorded or unrecorded fossils preserved there, or

(b) *overestimation* of the palaeontological sensitivity of a study area, for example when originally rich fossil assemblages inferred from geological maps have in fact been destroyed by tectonism or weathering, or are buried beneath a thick mantle of unfossiliferous "drift" (soil, alluvium *etc.*).

Since most areas of the RSA have not been studied palaeontologically, a palaeontological desktop study usually entails *inferring* the presence of buried fossil heritage within the study area from relevant fossil data collected from similar or the same rock units elsewhere, sometimes at localities far away. Where substantial exposures of bedrocks or potentially fossiliferous superficial sediments are present in the study area, the reliability of a palaeontological impact assessment may be significantly enhanced through field assessment by a professional palaeontologist. In the present case, site visits to the various loop and borrow pit study areas in some cases considerably modified our understanding of the rock units (and hence potential fossil heritage) represented there.

In the case of the Ekland Safaris Lion Farm project area near Louis Trichardt, Limpopo Province, the main limitation for fossil heritage studies is the paucity of previous field-based specialist palaeontological studies in the Tshipise Karoo Basin, and indeed in the Limpopo Province as a whole. It is noted, for example, that HIAs for several major coal mining projects to the east, west and northwest of the present study area (*e.g.* Chapudi Coal Project, Greater Soutpansberg Mopane Coal Project, Generaal Coal Project) do not have a palaeontological heritage component.

1.5. Information sources

The information used in this combined field-based and desktop study was based on the following:

1. Project outlines, kmz files and maps provided by G&A Heritage;

2. A review of the relevant scientific literature, including published geological maps and accompanying sheet explanations (*e.g.* Brandl 1981, Brandl 2002, Groenewald & Groenewald 2014) (Note that no relevant PIA reports for the region could be traced on SAHRIS);

3. Examination of relevant 1: 250 000 topographical maps and Google Earth© satellite images;

4. A short site visit by the author and an assistant on14 December 2018;

5. The author's previous field experience with the formations concerned and their palaeontological heritage (Table 1).

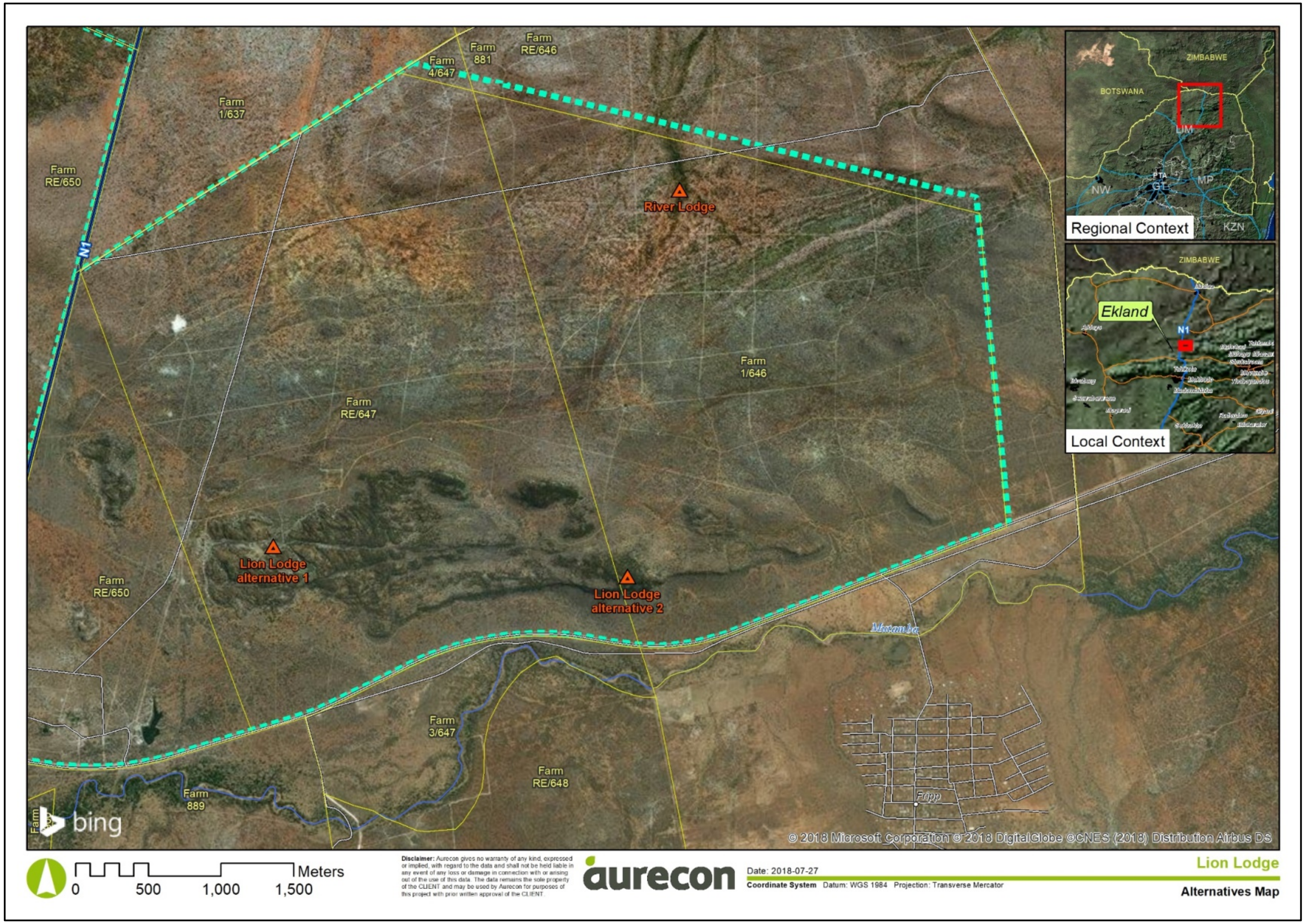

Figure 2. Satellite image of the project area for the proposed Ekland Safaris lodge near Louis Trichardt, Limpopo Province, showing the land portions concerned and three lodge site options under consideration.

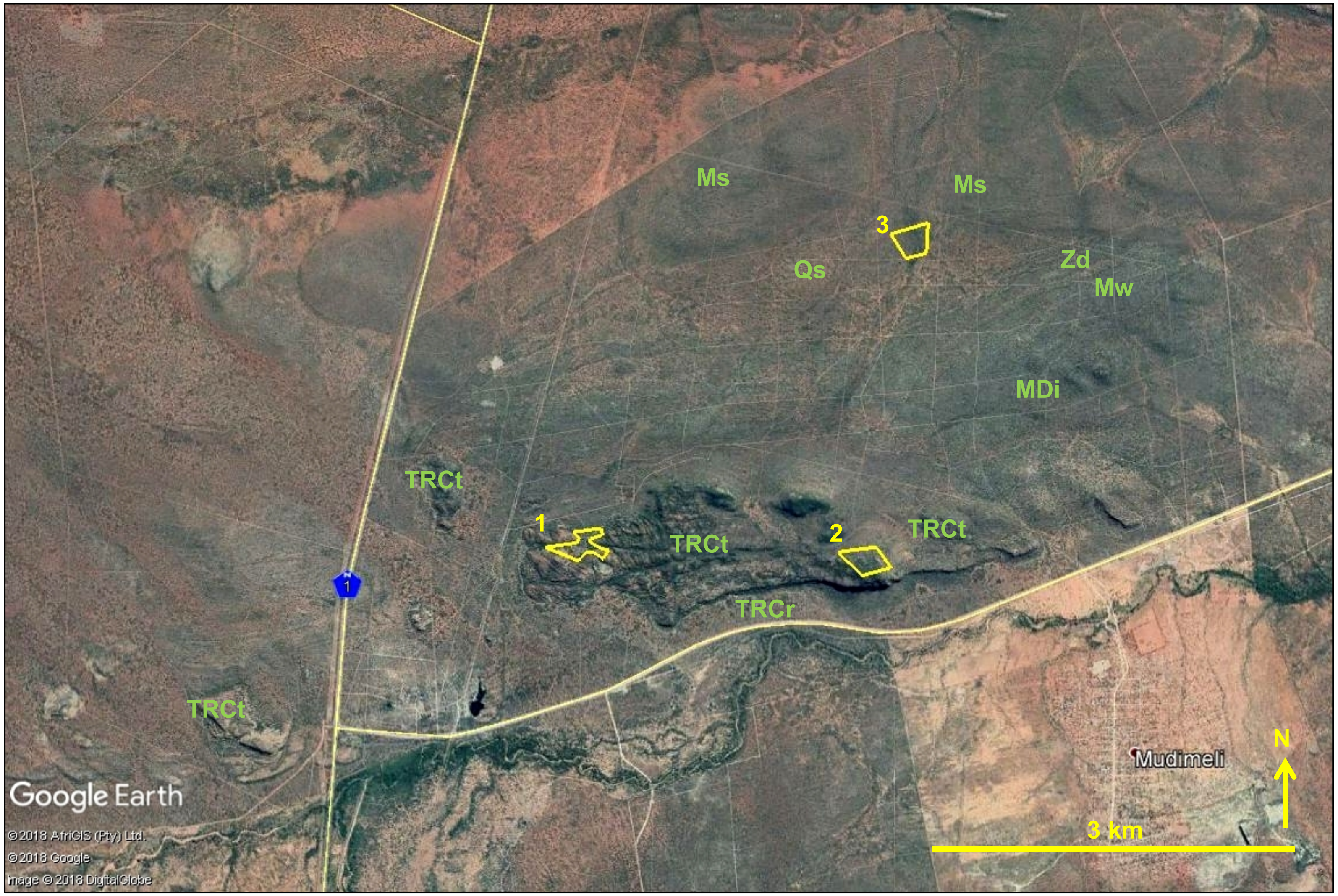

Figure 3. Google Earth© satellite image of the project area for the proposed Ekland Safaris lodge near Louis Trichardt showing in yellow the footprints of the three lodge sites under consideration (1 to 3). The green symbols refer to bedrock units identified on the basis of the geological map shown in Figure 4 (Please refer to figure legend there). Rocky upland areas in the southern portion of the project area (lodge sites 1 & 2) are underlain by Clarens Formation sandstones (TRct) while Site 3 is underlain by Late Caenozoic sandy soils (Qs).

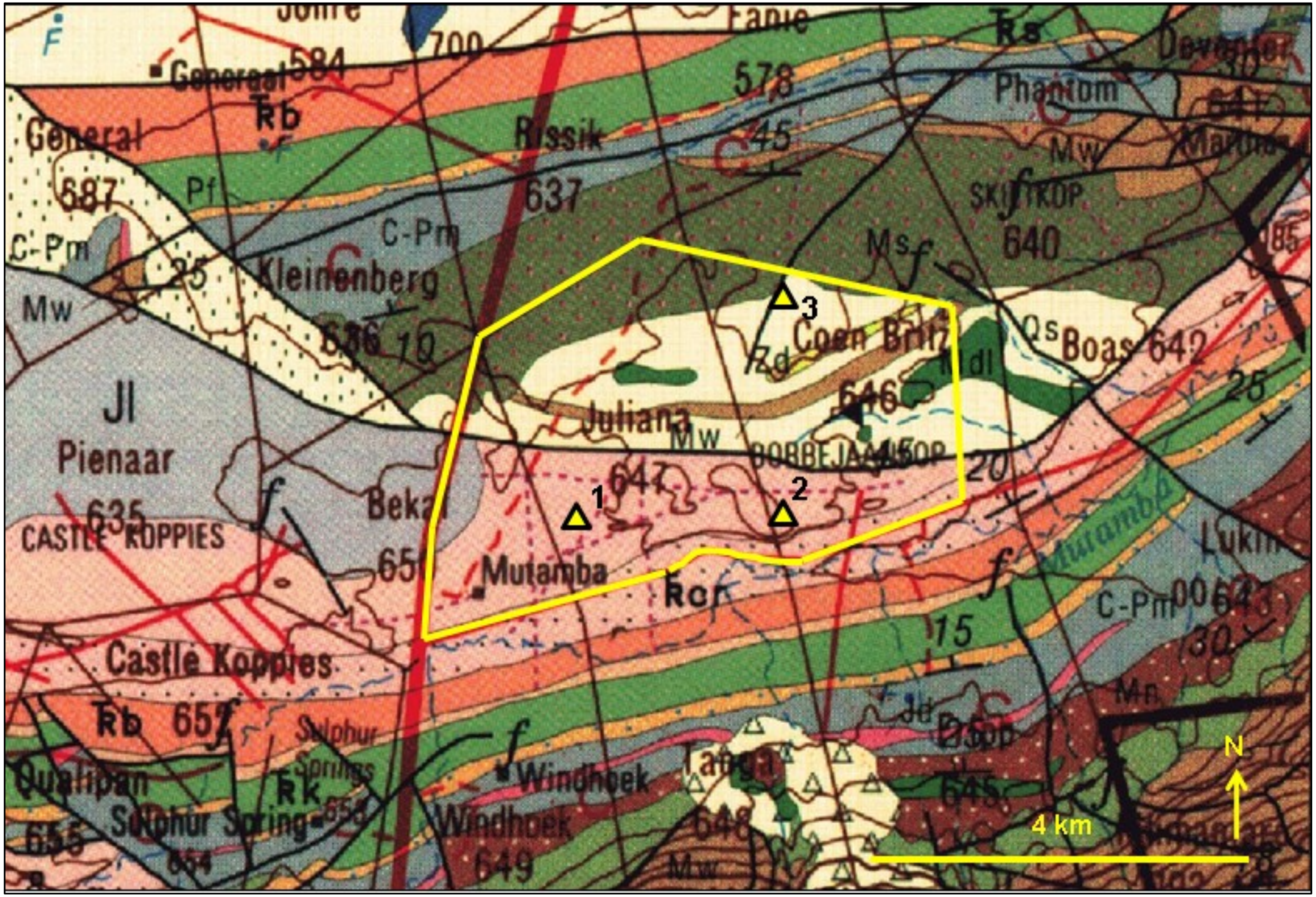

Figure 4. Extract from 1: 250 000 geology sheet 2228 Alldays (Council for Geoscience, Pretoria) showing the geology of the Ekland Safaris lodge project area (yellow poygon) near Louis Trichardt, Limpopo Province. The three numbered lodge site options are shown by yellow triangles. Please see following page for a key to the main rock units represented here.

Key to rock units within the project area represented on the 1: 250 000 geological map:

1. BEIT BRIDGE COMPLEX (Archaean)

Dowe Complex (Zd, yellow) – metaquartzites and associated high-grade metamorphic rocks

2. SOUTPANSBERG GROUP (Proterozoic)

Sibasa Formation (Ms, olive green with stipple) – basaltic lavas and minor sandstones
Wylie's Poort Formation (Mw, brown) – quartzites with minor conglomerates, shales

3. PRE-KAROO INTRUSIONS (Proterozoic, *c.* 1.6 Ga)

Diabase dykes & sills (Mdl, dark green) – basic igneous intrusions

4. KAROO SUPERGROUP (Late Carboniferous – Early Jurassic)

Clarens Formation -
Red Rocks Member (TRcr, pink with stipple) – reddish argillaceous sandstones with minor limestones
Tshipise Member (TRct, pink) – pale aeolian sandstones

5. LEBOMBO GROUP (Early Jurassic)

Letaba Formation (Jl, grey) – basic lavas within minor sandstone interbeds

6. LATE CAENOZOIC SUPERFICIAL SEDIMENTS

Sandy soils (Qs, pale yellow)

2. GEOLOGICAL OUTLINE OF THE PROJECT AREA

The Ekland Safaris lodge project area near Louis Trichardt in Limpopo Province is situated on the border between the Soutpansberg and Eastern Limpopo Flats Geomorphic Provinces of the RSA, as defined by Partridge *et al.* (2010). The area comprises hilly terrain on the northern margins of the east-west trending Soutpansberg Range that is draned by the Mutamba River and its tributaries. As seen on satellite images (Figs. 2 & 3, 6 to 8), lodge site options 1 and 2 are both located in a west-east tract of elevated, ruggedly rocky terrain known as Bobbejaankop (700-845 m amsl) towards the southern edge of the study area. The lodge site option 3 lies further north, close to a shallow, well-wooded drainage line traversing lower- and flatter-lying bushveld terrain.

The geology of the project area is shown on 1: 250 000-scale geology sheet 2228 Alldays published by the Council for Geoscience, Pretoria (Fig. 4), with an accompanying sheet explanation by Brandl (2002). Also relevant here is the geological explanation to the adjoining 1: 250 000 sheet Messina by Brandl (1981). The southern sector of the project area is underlain by **Karoo Supergroup** continental sediments of Triassic to Jurassic age that form part of the fault-bound **Tshipise Basin** of Limpopo (Johnson *et al.* 2006). The stratigraphy of the Karoo succession in the Tshipise Basin is outlined by Johnson *et al.* (2006) (Fig. 5) based on earlier accounts by McCourt and Brandl (1980), Van der Berg (1980) and Brandl (1981) and has since been reviewed in a benchmark lithostratigraphic account of the Clarens Formation by Bordy & Head (2018). Rock units mapped within the broader project area include the **Red Rocks Member** (TRcr, pink with dark stipple) and the overlying **Tshipise Member** (TRct, pink). Both of these sandstone-dominated units were originally included within the **Clarens Formation** by Brandl (1981) and Johnson *et al.* (2006). However, the Red Rocks Member has since been correlated with the Elliot Formation of the Main Karoo while the Tshipise Member (as well as the Castle Koppies Formation of Van der Berg 1980) is now equated with the Clarens Formation *sensu stricto* (*cf* Bordy 2006, Bordy & Head 2018).

The Red Rocks Member (local Elliot Formation) comprises up to 150 m of fine-grained, pinkish to reddish or mottled argillaceous sandstone with occasional m-thick limestone interbeds towards the base. In the south-eastern sector of the Messina 1: 250 000 sheet this unit also contains conglomerates with sandstone, quartzite and lava clasts within a reddish sandy matrix. No exposures of this member are reported in the Alldays sheet area, however.

The overlying Tshipise Member (= Clarens Formation) is also up to 150 m thick and consists of pale white to cream-hued aeolianites, variously massive or showing large-scale aeolian cross-beds reflecting deposition as barchan dunes in an arid sandy desert setting. Calcareous diagenetic concretions may occur towards the base which has a gradational contact with the underlying, poorly-exposed Red Rocks Member. The Tshipise beds tends to weather prominently and often build cliffs and caves ("Cave Sandstone"). Secondary silicification along well-defined fractures is commonly seen. Brandl (2002) notes that the Bobbejaankop outcrops east of the N1 – where the lodge site options 1 and 2 are located - are among the best known exposures of the Tshipise Member in the Alldays sheet area, so this area is certainly of geoscientific conservation value (Figs. 6, 7 & 9). A series of equally rugged *koppies* of Clarens sandstone extend west of the here in the Castle Koppies area (Fig. 10).

The Karoo sedimentary succession in the Tshipise Basin was terminated by voluminous eruption of basaltic lavas of the **Letaba Formation** (**Lebombo Group**) which forms part of the Early Jurassic Karoo Igneous Province (*c*. 183 Ma; Duncan & Marsh 2006). Lenticular arenitic (sandy) units up to a few meters thick are locally interbedded with the dark grey lavas in the Alldays sheet area. A small area of Letaba lavas is mapped close to the N1 on the south-western margins of the project area.

The lower-lying, and topographically more subdued, northern half of the project area (Figs. 8, 9 foreground) contrasts strongly with the southern, Karoo Supergroup-dominated half, from which it is separated by a major E-W trending fault (= local margin of the Tshipise Basin). The northern sector is underlain at depth by a range of Precambrian bedrocks assigned to the Archaean **Beit Bridge Complex**, the Proterozoic **Soutpansberg Group** and unnamed **diabase intrusions** (weathered dolerite) of pre-Karoo age. The Beit Bridge Complex, with only a narrow outcrop area in the northeast, is represented here by the metaquartzite-dominated **Mount Dowe Group** which also contains a range of other high-grade metasedimentary facies. The Soutpansberg Group is represented by braided alluvial quartzites (often cross-bedded and rippled) of the **Wyllie's Poort Formation** with subordinate pebbly conglomerates and shales, as well as by basaltic lavas of the **Sibasa Formation** that may also have sandy interbeds. The outcrops of these ancient basement rocks are extensively mantled by **Quaternary sandy soils** and downwasted rubbly gravels, and locally by sandy to gravelly along drainage lines.

Lodge site options 1 and 2 are situated on the Tshipise Member (= Clarens Formation) outcrop area. The Clarens sandstones that are well-exposed along the margins of Site 1 are apparently massive with no clear evidence of the large scale aeolian cross-beds reported elsewhere in the Alldays 1: 250 000 sheet area (Brandl 2002, his pl. 34) and in the Castle Koppies area (Figs. 6, 10 to 17). They build ruiniform to rounded, whale-backed to undulating outcrops. The outcrops are extensively jointed with NNW-SSE fracture sets (alternative large scale dune features) apparent on satellite images of western end of Bobbejaankop (Fig. 6). Apparent thick bedding in vertical sections may be a secondary artefact (Fig. 12). The sediments are pale creamy yellow when fresh with a roughly-textured, scabby, orange-brown weathering crust. The exposures show extensive evidence of karstic (solution) weathering such as widening of open joints, prominent-weathering quartz veins along fractures, pitted honeycomb weathering, shallow solution hollows (*kamenitza*) and case hardening with the development of scaly or tesselated, polygonally-patterned, crocodile-like surfaces, prominent "chicken heads" and spalling of platy or blocky rock fragments. Many finely pitted or scalloped rock surfaces are also lichen-covered, and lichen etching may also have played an important role here, as documented elsewhere in the Clarens Formation outcrop area, such as in the Golden Gate National Park of the Free State (Grab *et al.* 2011).

Tough pale, well-jointed and well-sorted, grey quartzites with a conchoidal fracture encountered at low elevations just north of the lodge site option 2 study area (Figs. 7, 18 & 19) might represent well-cemented, massive Clarens sandstones as mapped (and expected south of the Karoo basin boundary fault). Alternatively they might represent Precambrian basement rocks (*e.g.* Wylie's Poort Formation of the Soutpansberg Group) unconformably underlying the Clarens beds along the basin margin (Tabular cross-bedded, laminated reddish-brown quartzites exposed in a stream bed *c*. 130 m north of the Site 2 study area resemble Soutpansberg Group rocks) (Fig. 20). The lower, northern sector of Site 2 is mantled by orange-brown sandy to gravelly soils with local ferricrete development and extensive surface gravels of pale quartzite / Clarens sandstone, including occasional boulder-sized blocks (Fig. 21). The steeper slopes and upland areas in the south are built of massive, well-jointed, pale grey quartzite and sandstone with a pitted to scaly-tesselated surface weathering. Scabby karstic-weathered outcrops run along the northern foot slopes of the *koppie*.

The lodge site option 3 (Figs. 8, 22 & 23) is underlain by Late Caenozoic alluvium close to a drainage line that may well be incised along a substantial fault. Precambrian basement rocks beneath the cover sediments probably belong to the Soutpansberg Group. The terrain here is arid bushveld with thick alluvial sandy soils and occasional surface blocks and gravels of granitic material and ferruginous quartzite.

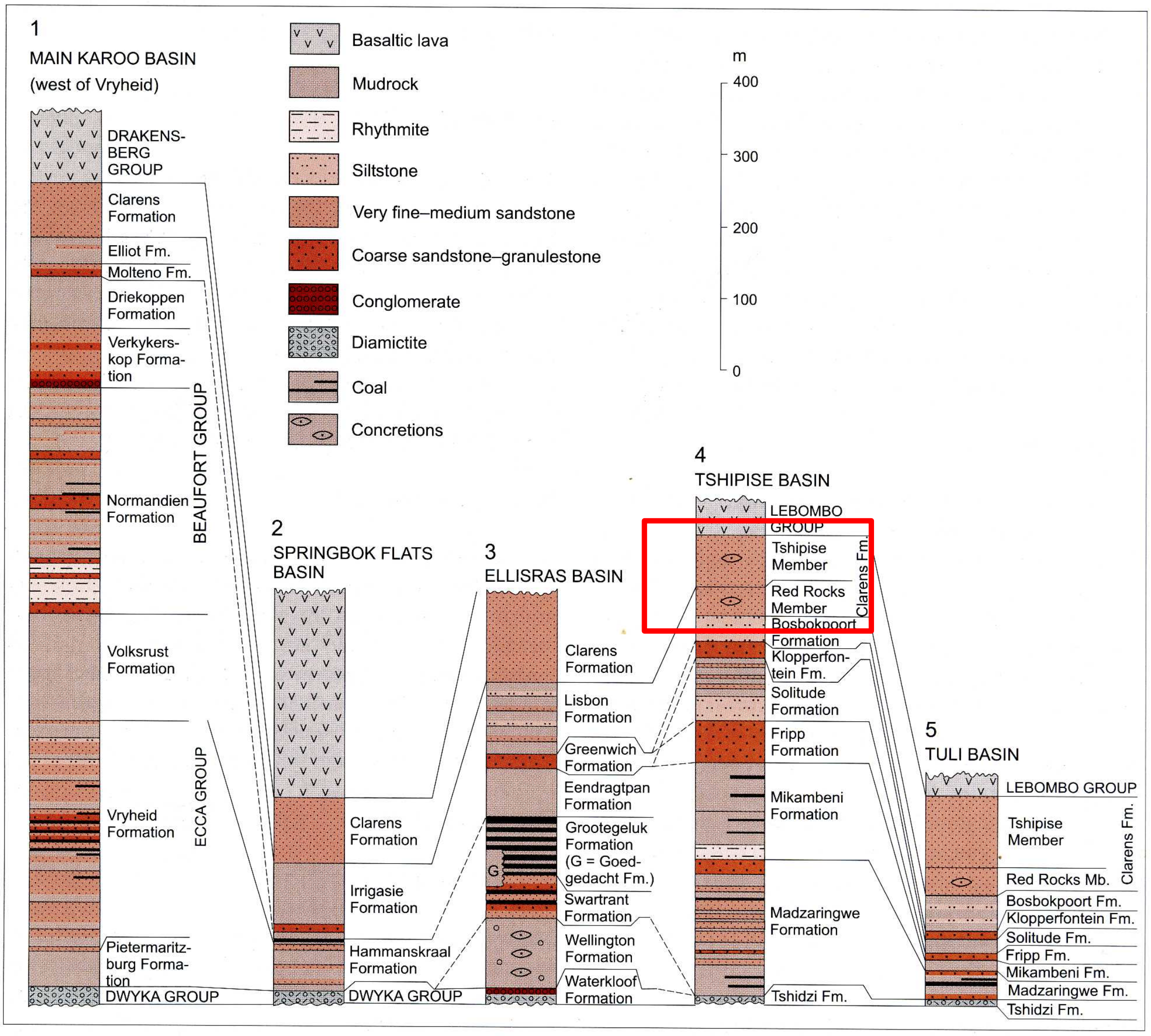

Figure 5. Lithostratigraphy of the Karoo Supergroup succession in the Tshipise Basin (column 4) and proposed correlations with other Karoo basins in the RSA (From Johnson *et al.* 2006). Rock units represented in the present study area are outlined in red. Note that the Red Rocks Member has now been correlated with the Elliot Formation while the Tshipise Member is now equated with the Clarens Formation *sensu stricto* (Bordy & Head 2018).

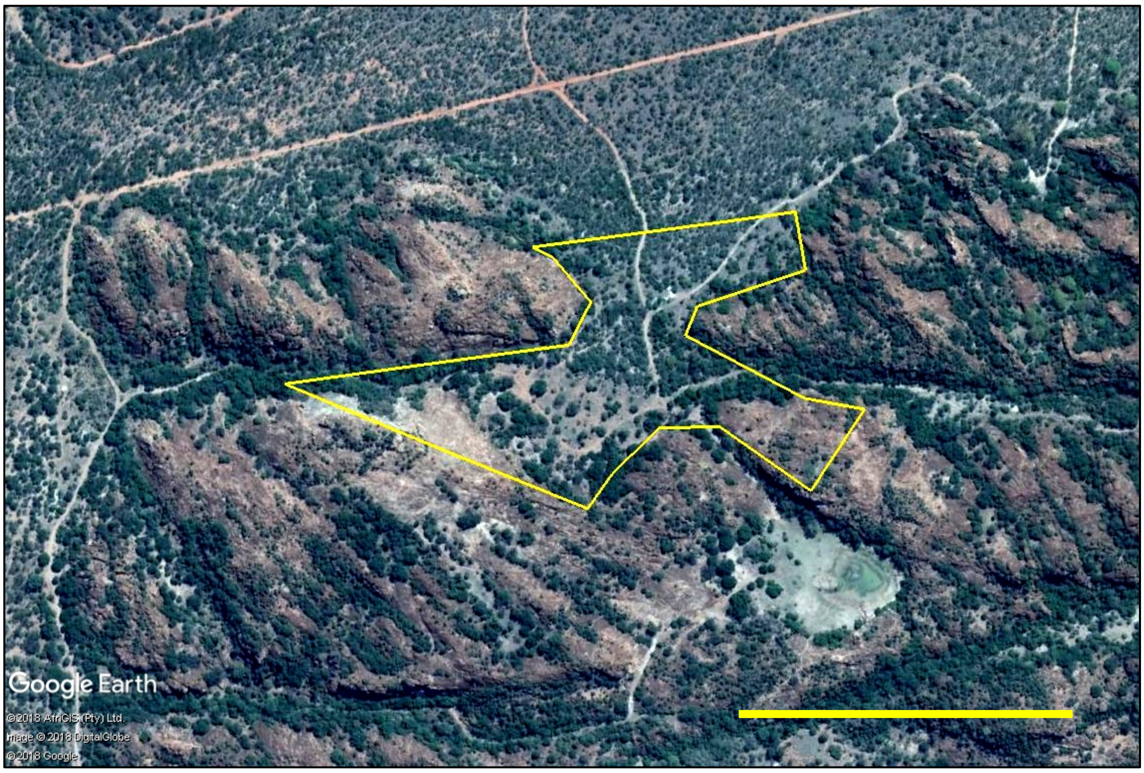

Figure 6. Google Earth© satellite image of Clarens aeolian sandstones in the Site 1 project area on Bobbejaankop (yellow polygon) (Scale bar = 300 m). Sets of NNW-SSE trending ridges and furrows may be large-scale dune features, or possibly fracture patterns.

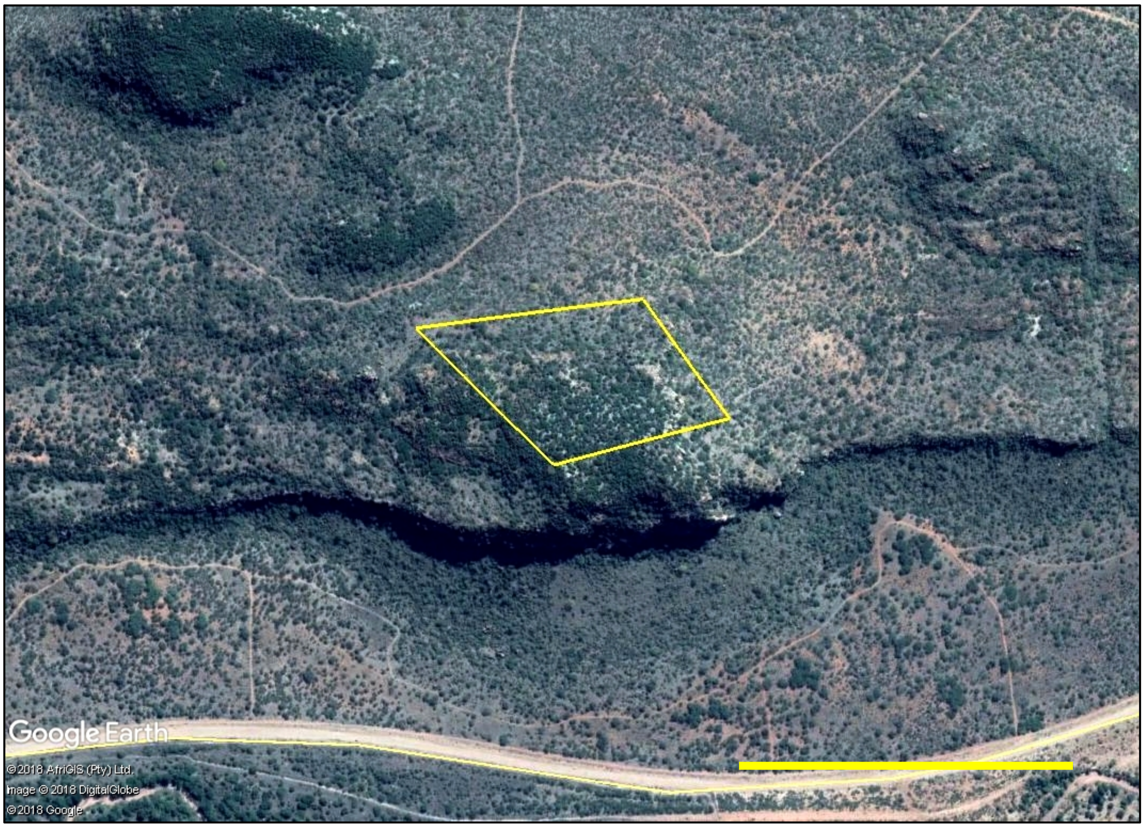

Figure 7. Google Earth© satellite image of the Site 2 project area, Bobbejaankop (yellow polygon) (Scale bar = 500 m). The region N of the prominent W-E scarp is mapped as Tshipise Member / Clarens Formation with the Red Rocks Member (Elliot Formation) underlying low ground to the south.

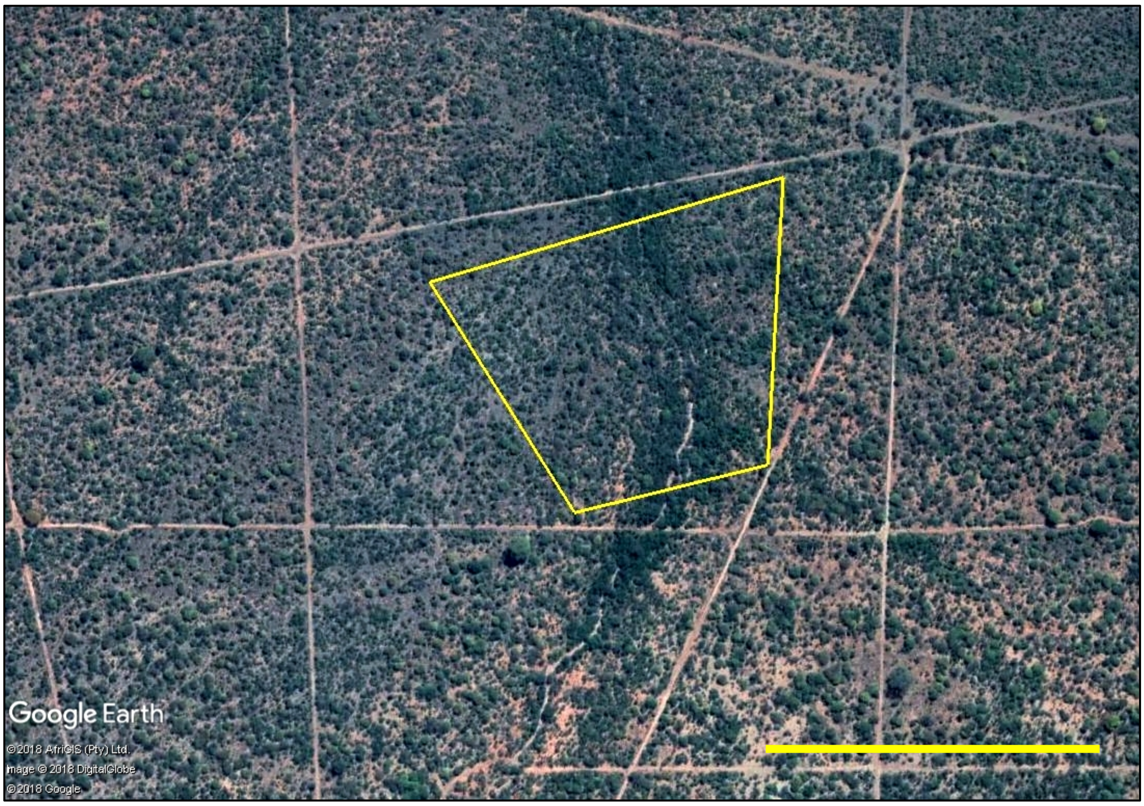

Figure 8. Google Earth© satellite image of the Site 3 project area (yellow polygon) (Scale bar = 300 m) spanning a small drainage line in flat-lying sandy busheveld *c*. 2 km to the north of Bobbejaankop.

Figure 9. View towards Bobbejaankop (orange-hued Clarens Formation) from the north with the Soutpansberg Range in the background and sandy to gravelly bushveld terrain in the foreground.

Figure 10. Large-scale aeolian cross-bedding reflecting north-directed palaeocurrents seen within the Tshipise Member (= Clarens Formation) in the Castle Koppies area to the west of the N1 (2.75 km SW of Lodge Site 1 on Bobbejaankop). The Castle Koppies Formation of Van der Berg (1980) was based on such outcrops.

Figure 11. Whale-backed domes of weathered Tshipise Member / Clarens Formaiton aeolian sandstone in the Site 1 study area.

Figure 12. Close-up of cliff section through Tshipise Member / Clarens Formation aeolianites (wind-blown sands) seen in the previous figure showing irregular subhorizontal bedding or pseudobedding.

Figure 13. Polygonal tessellated sandstone surface (crocodile-skin or tortoise weathering), Site 1 study area – a consequence of multi-phase karstic (solution) weathering and case hardening.

Figure 14. Steep-sided solution hollows (*kamenitza*) in the Clarens sandstone bedrocks at Site 1 – a typical karstic weathering feature.

Figure 15. Scabby weathered surface of Clarens sandstone with spalling of platy blocks and flakes, Site 1 study area.

Figure 16. Solution hollow (foreground) and honeycomb weathering (background) of Clarens sandstones, Site 1 study area.

Figure 17. Scaly-weathered surface of Clarens sandstone dome in the Site 1 study area. The surface is patinated with living lichens and biological etching by lichen colonies has probably played an important role in bedrock weathering here.

Figure 18. View southwards towards the Clarens sandstone ridge in the Site 2 study area with blocky sandstone colluvial rubble in the foreground.

Figure 19. Massive, well-jointed and indurated Clarens sandstone in the Site 2 study area (N-facing scarp) showing rounded, conchoidal fracture in the foreground and scabby karstic weathering surface in the background.

Figure 20. Bedrock exposure in stream bed *c*. 130 m north of the Site 2 study area showing N-dipping tabular cross-sets within laminated sandstones or quartzites (Hammer = 30 cm). It is unclear if these belong to the Clarens Formation or perhaps to the Precambrian Soutpansberg Group.

Figure 21. Sandy to gravelly colluvial soils in the N sector of Site 2 with angular sandstone surface gravels and rusty-brown ferricerete development.

Figure 22. Thick sandy alluvial soils in flat-lying bushveld terrain close to a shallow drainage line, Site 3 study area.

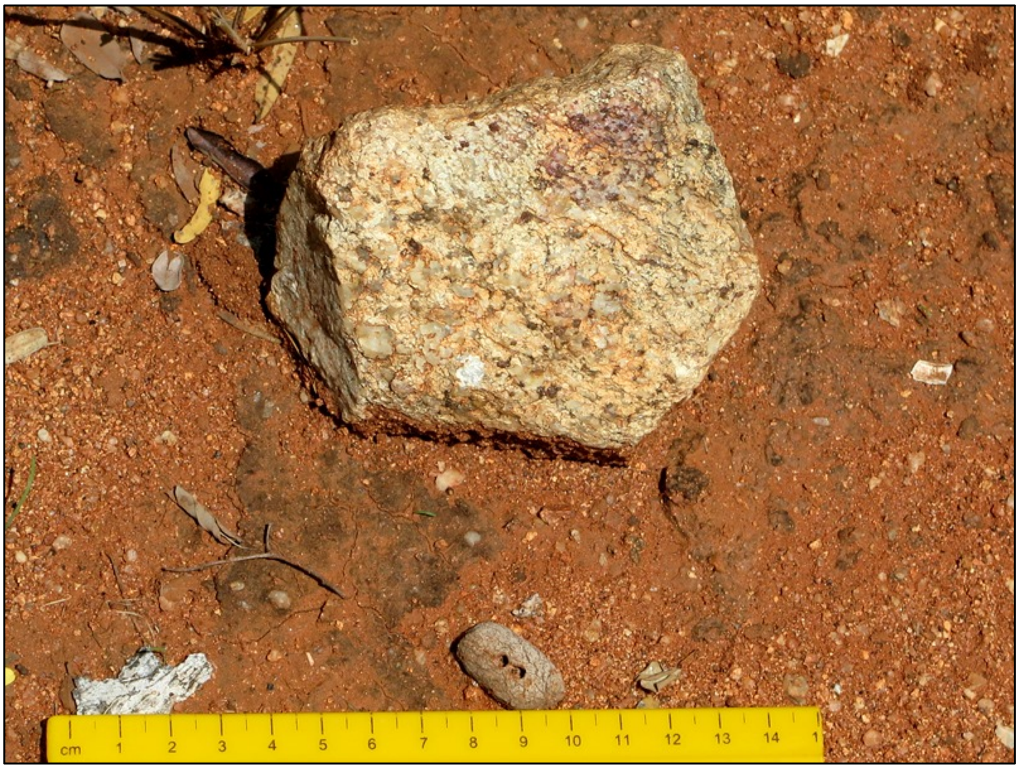

Figure 23. Sparse angular surface gravels of granitic material in the Site 3 study area (scale in cm).

3. PALAEONTOLOGICAL HERITAGE

The palaeontology of the sedimentary bedrocks represented in the Ekland Safaris lodge project area is poorly known - as indeed is the palaeontology of the Limpopo Province as a whole. This reflects in part the lack of good bedrock exposures of the more readily-weathered Karoo Supergroup sediments, but also the paucity of field studies by palaeontologists - including impact specialists (The lack of PIAs for several major mining developments along the northern margins of the Soutpansberg is highly regrettable in this regard).

The fossil record and inferred palaeontological sensitivity of the rock units found within the study area is outlined in Table 1 below. Note that none of the Precambrian basement units is palaeontologically sensitive, so they will not be treated further here.

The **Clarens Formation** has yielded a surprising diversity of fossil taxa within the various Karoo-aged basins of southern Africa, despite the arid sandy desert setting of the majority of these rocks (*cf* MacRae 1999, McCarthy & Rubidge 2005, Knoll 2005, Bordy & Head 2018 and extensive refs. therein). Some of the fossils are associated with interdune ephemeral lake deposits. These fossil biotas are assigned to the *Massospondylus* Assemblage Zone of Early Jurassic age (*c.* 200-180 Ma) (Rubidge 2005, Smith *et al.* 2012) and include groups such as:

- **Vascular plants** - arthrophyte ferns, conifers and cycads as well as petrified logs, occasional thin coals;
- **Freshwater crustaceans** (conchostracans, triopsid tadpole shrimps, ostracods), insects;
- **Trace fossils** of invertebrates such as arthropods (*e.g.* contentious termitaria) and molluscs;
- **Primitive bony fish** (*e.g.* well-known mass-mortality occurrences of *Semionotus*);
- A variety of **dinosaurs**, including prosauropods and sauropodomorphs (*e.g.* the common *Massospondylus*), heterodontosaurid and fabrosaurid ornithischians, as well as dinosaur trackways, coprolites and eggshells;
- **Crocodylomorphs**;
- Rare advanced **cynodonts** including some of the earliest true **mammaliaforms**.

These Clarens fossil assemblages are not only of interest in illuminating the long-lost arid desert ecosystems of Pangaea but also document an important interval in terrestrial evolution and biotic turnover between the major Late Triassic mass extinct event of *c*. 201 Ma and a second order, Early Jurassic extinction that coincided with intense igneous activity in the Karoo-Ferrar Large Igneous Province at around 183 Ma. The vertebrate fauna is of special interest for its dinosaur remains and rare fossils of small-bodied cynodont therapsids that shed light on the evolution of early mammals.

While the geology and palaeontology of the better-exposed Clarens Formation of the Tuli Basin in northern Limpopo has been well studied (*e.g.* Bordy & Catuneanu 2002), the Tshipise Basin outcrop area of this formation is much more poorly known. To the author's knowledge, no Karoo fossils have yet been recorded from the present study area near Louis Trichardt or in its vicinity. Dinosaur skeletal remains and trackways

– probably attributable to "*Euskelosaurus*", *Massospondylus* or comparable prosauropods – have been recorded from the Tuli Basin in the Alldays 1: 250 000 sheet area (Van Eeden & Keyser 1971, Brandl 2002 and refs. therein) but not, as far as known, from the Tshipise Basin. Most of the Karoo fossil plant and dinosaur finds from the Karoo successions of Limpopo Province have been located within the Tuli Basin in the comparatively well-explored Kruger Park region (*cf* McCourt & Brandl 1980, Van der Berg 1980, Brandl 1981, Visser 1984, Van Heerden 1979, Durand 1996, Durand 2001, Durand 2009, Bordy 2006).

During the present site visit no vertebrate skeletal remains, trackways or other fossil material was recorded from the three proposed lodge site options in the Lion Farm on the Remainder of the Farm Juliana 647 MS and Portion 1 of the Farm Coen Brits 646 MS.

4. CONCLUSIONS AND RECOMMENDATIONS

The project area for the Ekland Safaris lodge near Louis Trichardt, Limpopo Province, is underlain by Karoo Supergroup sediments of potentially high palaeontological sensitivity in the south and by low-sensitivity Precambrian basement rocks, Quaternary sands, gravels and alluvium in the north. Lodge site option 3 overlying Quaternary sandy alluvium is not problematic from a palaeontological heritage viewpoint. The prominent rocky outcrops of Bobbejaankop, where lodge site options 1 and 2 are located, represent some of the best known exposures of Early Jurassic desert sandstones of the Clarens Formation in the Alldays 1: 250 000 sheet area (Brandl 2002) and are therefore of special geo-heritage interest. While important fossils of dinosaurs and other vertebrates, petrified wood and trace fossils (*e.g.* dinosaur trackways) have been reported from the Clarens Formation elsewhere in Limpopo, no fossil remains were observed during the recent palaeontological field visit to the lodge site options 1 and 2. The Clarens Formation sandstones at Bobbejaanskop display a range of typical karstic (solution) weathering features with poor preservation of original sedimentary structures (*e.g.* dune cross-bedding such as well-seen in the Castle Koppies area just to the west). Surface weathering may have obscured or destroyed any fossils originally present here.

It is concluded that the proposed lodge development does not pose a significant threat to local fossil heritage resources and there are no objections on palaeontological heritage grounds to the tourism infrastructure project, nor is there a preference for any particular lodge site option. No further specialist palaeontological mitigation or monitoring is recommended here.

It should be noted that any new fossil finds made in the area would be of geotourism as well as scientific research interest and the Chance Fossil Finds Protocol appended to this report should be applied by the responsible ECO during construction. If any substantial fossil remains (*e.g.* vertebrate bones, teeth, petrified wood) are found during construction SAHRA should be notified immediately (Contact details: SAHRA, 111 Harrington Street, Cape Town. PO Box 4637, Cape Town 8000, South Africa. Phone: +27 (0)21 462 4502. Fax: +27 (0)21 462 4509. Web: www.sahra.org.za). This is so that appropriate mitigation (*i.e.* recording, sampling or collection) by a palaeontological specialist can be considered and implemented, at the developer's expense.

These recommendations must be incorporated into the Environmental Management Programme for the lodge development. The palaeontologist concerned with mitigation work will need a valid collection permit from SAHRA. All work would have to conform to international best practice for palaeontological fieldwork and the study (*e.g.* data recording fossil collection and curation, final report) should adhere to the minimum standards for Phase 2 palaeontological studies published by SAHRA (2013).

5. ACKNOWLEDGEMENTS

Mr Stephan Gaigher of G&A Heritage (Pty) Ltd, Louis Trichardt, is thanked for commissioning this study and for providing the relevant background information as well as a useful series of field photographs from the project area. The site visit was facilitated by Stephan Gaigher, Anne-Mari White (Aurecon Group) as well as by Lee Still and his colleague Christo at Ekland Safaris, all of whom are thanked for their assistance. Finally, I am very grateful to Ms Madelon Tusenius for logistical support and companionship in the field.

6. REFERENCES

ALMOND, J.E. 2018. Proposed lodge at Lion Farm, Ekland Safaris near Louis Trichardt, Soutpansberg District, Limpopo Province. Palaeontological heritage specialist assessment: desktop study, 21 pp. Natura Viva cc, Cape Town.

BARKER, O.B., BRANDL, G., CALLAGHAN, C.C., ERIKSSON, P.G. & VAN DER NEUT, M. 2006. The Soutpansberg and Waterberg Groups and the Blouberg Formation. In: Johnson, M.R., Anhaeusser, C.R. & Thomas, R.J. (Eds.) The geology of South Africa, pp. 301-318. Geological Society of South Africa, Marshalltown.

BORDY, E. 2006. Sedimentological investigation of the Lower Karoo in the Chapudi Coal Project Area (Tshipise Basin, Limpopo Province, South Africa). Research report complied for Rio Tinto Mining & Exploration Ltd, 28 pp.

BORDY, E. M., CATUNEANU, O. (2002). Sedimentology and palaeontology of upper Karoo aeolian strata (Early Jurassic) in the Tuli Basin, South Africa. Journal of African Earth Sciences 35/2, 301-314.

BORDY, E. & HEAD, H.V. 2018. Lithostratigraphy of the Clarens Formation (Stormberg Group, Karoo Supergroup), South Africa. South African Journal of Geology 121(1):119-130.

BRANDL, G. 1981. The geology of the Messina area. Explanation to 1: 250 000 geology sheet 2230 Messina, 35 pp. Council for Geoscience, Pretoria.

BRANDL, G. 2002. The geology of the Alldays area. Explanation to 1: 250 000 geology sheet 2228 Alldays, 71 pp. Council for Geoscience, Pretoria.

DUNCAN, A.R. & MARSH, J.S. 2006. The Karoo Igneous Province. In: Johnson, M.R., Anhaeusser, C.R. & Thomas, R.J. (Eds.) The geology of South Africa, pp. 501-520. Geological Society of South Africa, Marshalltown.

DURAND, J. F. 1996. First vertebrate fossil discovery in the Kruger National Park. South African Journal for Science, 92(7), 302.

DURAND, J.F. 2001. The oldest baby dinosaurs from Africa. Journal for African Earth Sciences, 33(3-4), 597-603.

DURAND, J.F. 2009. Vele Colliery project: desk top study palaeontology, 22 pp.

GRAB, S.W., GOUDIE, A.S., VILES, H.A. & WEBB, N. 2011. Sandstone geomorphology of the Golden Gate Highlands National Park, South Africa, in a global context. Koedoe 53, Art. #985, 14 pages. doi:10.4102/koedoe. v53i1.985

GROENEWALD, G. & GROENEWALD, D. 2014. Palaeontological heritage of Limpopo. SAHRA palaeotechnical report, 22 pp.

HUTSON, J.M. & CAIN, C.R. 2008. Reanalysis and reinterpretation of the Kalkbank faunal accumulation, Limpopo Province, South Africa. Journal of Taphonomy 6, 399-428.

KLEIN, R.G. 1984. The large mammals of southern Africa: Late Pliocene to Recent. In: Klein, R.G. (Ed.) Southern African prehistory and paleoenvironments, pp 107-146. Balkema, Rotterdam.

KNOLL, F. 2005. The tetrapod fauna of the Upper Elliot and Clarens Formations in the main Karoo Basin (South Africa and Lesotho). Bulletin de la Societe geologique de France, 176, 81-91.

MACRAE , C. 1999. Life etched in stone. Fossils of South Africa. 305 pp. The Geological Society of South Africa, Johannesburg.

McCARTHY, T. & RUBIDGE, B. 2005. The story of Earth and life: a southern African perspective on a 4.6-billion-year journey. 334pp. Struik, Cape Town.

McCOURT, S. & BRANDL, G. 1980. A lithostratigrapic subdivision of the Karoo Sequence in the northeastern Transvaal. Annals of the Geological Survey of South Africa 14, 51-56.

PARTRIDGE, T.C., BOTHA, G.A. & HADDON, I.G. 2006. Cenozoic deposits of the interior. In: Johnson, M.R., Anhaeusser, C.R. & Thomas, R.J. (Eds.) The geology of South Africa, pp. 585-604. Geological Society of South Africa, Marshalltown.

PARTRIDGE, T.C., DOLLAR, E.S.J., MOOLMAN, J. & DOLLAR, L.H. 2010. The geomorphic provinces of South Africa, Lesotho and Swaziland: a physiographic subdivision for earth and environmental scientists. Transactions of the Royal Society of South Africa 65, 1-47.

RUBIDGE, B.S. 2005. Re-uniting lost continents – fossil reptiles from the ancient Karoo and their wanderlust. 27th Du Toit Memorial Lecture. South African Journal of Geology 108, 135-172.

SAHRA 2013. Minimum standards: palaeontological component of heritage impact assessment reports, 15 pp. South African Heritage Resources Agency, Cape Town.

SMITH, R., RUBIDGE, B. & VAN DER WALT, M. 2012. Therapsid biodiversity patterns and paleoenvironments of the Karoo Basin, South Africa. Chapter 2 pp. 30-62 in Chinsamy-Turan, A. (Ed.) Forerunners of mammals. Radiation, histology, biology. xv + 330 pp. Indiana University Press, Bloomington & Indianapolis.

VAN DER BERG, H.J. 1980. Die sedimentologie van die Soutpansberg-steenkoolveld met spesiale verwysing na steenkoolvorming. Unpublished MSc thesis, University of the Orange Free State, Bloemfontein.

VAN EEDEN, O.R. & KEYSER, A.W. 1971. Fossielspore in die Holkranssandsteen op Pont Drift, Distrik Soutpansberg, Transvaal. Annals of the Geological Survey of South Africa 9, 135-137.

VAN HEERDEN, J. 1979. The morphology and taxonomy of *Euskelesaurus* (Reptilia: Saurischa; Late Triassic) from South Africa. Navorsinge van die Nasionale Museum, Bloemfontein 4, 21-84.

VISSER, J.N.J. 1984. A review of the Stormberg Group and Drakensberg volcanics in southern Africa. Palaeontologia africana 25, 5-27.

7. QUALIFICATIONS & EXPERIENCE OF THE AUTHOR

Dr John Almond has an Honours Degree in Natural Sciences (Zoology) as well as a PhD in Palaeontology from the University of Cambridge, UK. He has been awarded post-doctoral research fellowships at Cambridge University and in Germany, and has carried out palaeontological research in Europe, North America, the Middle East as well as North and South Africa. For eight years he was a scientific officer (palaeontologist) for the Geological Survey / Council for Geoscience in the RSA. His current palaeontological research focuses on fossil record of the Precambrian - Cambrian boundary and the Cape Supergroup of South Africa. He has recently written palaeontological reviews for several 1: 250 000 geological maps published by the Council for Geoscience and has contributed educational material on fossils and evolution for new school textbooks in the RSA.

Since 2002 Dr Almond has also carried out palaeontological impact assessments for developments and conservation areas in the Western, Eastern and Northern Cape, Limpopo, Gauteng, KwaZulu- Natal, Mpumalanga, North West and Free State under the aegis of his Cape Town-based company *Natura Viva* cc. He has been a long-standing member of the Archaeology, Palaeontology and Meteorites Committee for Heritage Western Cape (HWC) and an advisor on palaeontological conservation and management issues for the Palaeontological Society of South Africa (PSSA), HWC and SAHRA. He is currently compiling technical reports on the provincial palaeontological heritage of Western, Northern and Eastern Cape for SAHRA and HWC. Dr Almond is an accredited member of PSSA and APHP (Association of Professional Heritage Practitioners – Western Cape).

Declaration of Independence

I, John E. Almond, declare that I am an independent consultant and have no business, financial, personal or other interest in the proposed development project, application or appeal in respect of which I was appointed other than fair remuneration for work performed in connection with the activity, application or appeal. There are no circumstances that compromise the objectivity of my performing such work.

Dr John E. Almond
Palaeontologist
***Natura Viva* cc**

GEOLOGICAL UNIT		ROCK TYPES & AGE	FOSSIL HERITAGE	COMMENTS
CAENOZOIC SUPERFICIAL DEPOSITS		Aeolian sand, alluvium, colluvium, spring tufa (calcareous) and sinter (siliceous), lake deposits, peats, pedocretes or duricrusts (calcrete, ferricrete), soils	Very wide range of possible fossil remains, though these are often sparse, such as: mammalian bones and teeth, tortoise remains, ostrich eggshells, non-marine mollusc shells, ostracods, diatoms and other microfossil groups, trace fossils (*e.g.* calcretised termitaria, rhizoliths, burrows, vertebrate tracks), freshwaterstromatolites, plant material such as peats, foliage, wood, pollens . Fossil leaves and palynomorphs within calc tufa	Poorly investigated palaeontologically.
KAROO IGNEOUS PROVINCE	**LEBOMBO GROUP** **Jl- Letaba & Sabie River Fms** **Jj – Jozini Fm** **Jt – Tschokwane Granophyre**	Up to 13 km of volcanic rocks (basic and acid lavas) and rare interbedded sandstones Early Jurassic 183 ± 2 Ma	Fossils might occur within thin sedimentary intervals (*e.g.* plants, traces, vertebrate bones)	Karoo-Ferrar igneous intrusions are probably associated with Early Jurassic global mass extinction event
	KAROO DOLERITE SUITE **Jd**	Dolerite intrusions (dykes, sills) Early Jurassic 183 ± 2 Ma	NO FOSSILS	
KAROO SUPERGROUP **(Late Carboniferous to Early Jurassic)** **TSHIPISE BASIN** **(including Lebombo Belt)**	**Elliot & Clarens Fms (TRc)**	**Tshipise Member** – cream-coloured aeolian sst, playa lake deposits (+ Clarens) **Red Rocks Member** – Pale red sst with calcareous concretions (= Elliot)	Trackways and skeletal remains of dinosaurs (*Massospondylus*). Stratigraphy uncertain.	Tshipise Basin: • Comprises several fault-bound basins within the Limpopo Belt • The precise stratigraphic context of recorded dinosaur fossils is often unclear in the literature • Historical records of fossil plants along the Sabie River (Kruger Park) in the late C19. • Ecca equivalent plant fossils include leaves, *Vertebraria* root systems and petrified wood. *N.B.* Stratigraphy shown on 1: 250 000 maps has since been revised, implying new correlations with the Karoo Supergroup succession in the Main Karoo Basin (See Bordy 2006, Bordy & Head 2018)
	Bosbokpoort Fm (P-TRkb) Prob. = Elliot	Red mudrocks and sst with calcareous concretions, arid meandering fluvial setting	Dinosaur remains – including juveniles - in red siltstones (*e.g.* Nyalaland, Kruger Park) attributed to several genera including "*Euskelesaurus"* and *Massospondylus* (but straitigraphy uncertain)	
	Klopperfontein Fm (P-TRkb) Correlated variously with Molteno and Elliot Fms	Braided fluvial sandstones, grits, minor conglomerates	No fossils recorded	
	Solitude Fm (P-TRs) U. part poss. = Elliot L. part prob. = Molteno	Purple and grey mudrocks, sandstones and minor coals, meandering fluvial setting.	Coal floras including *Dicroidium* in basal Solitude succession. Dinosaur remains supposedly recorded from this unit may rather be from the younger Bosbokport Fm (qv)	
	Fripp Fm (Pm) Prob. = Molteno	Braided fluvial sandstones, grits, conglomerates, mudrocks	*Dicroidium* flora in upper part of succession (*i.e.* Triassic)	
	Mikambeni Fm (Pm) Prob. = Ecca Gp.	Fluvial mudstones, carbonaceous shales, sandstones, coals. Siderite nodules	Glossopterid coal flora. Siderite nodules might also be fossiliferous (*cf* Euamerican Carboniferous Coal Measures)	
	Madzaringwe Fm (Pm) Prob. = Ecca Gp.	Fluvial sandstones, siltstones and shales plus coals	Glossopterid coal flora	
	Tschidzi Fm (Pm) = Dwyka Group	Glacial and fluvioglacial diamictite, sst	No fossils recorded	

PROTEROZOIC RED BED SUCCESSIONS **SOUTPANSBERG GROUP** **Ms – Stayt Fm** **Mt – Sibasa & Tshifhefhe Fms** **Mf – Fundudzi Fm** **Mw – Wyllie's Poort Fm** **Mnz – Nzhelele Fm** **Mmb – Mabaligwe Fm**	Continental "red beds" - predominantly braided stream deposits (sandstones, conglomerates with minor mudrocks), Also beach, tidal flat, lacustrine, aeolian and possible marine shelf sediments . Basaltic lavas in Sibasa and Musekwa Formations of Soutpansberg Group Early to Mid Proterozoic (Mokolian) *c.* 2 to 1.7 Ga	No fossils recorded. *N.B.* Earliest known terrestrial cyanobacterial mats recorded from similar aged playa lake deposits of the Makgabeng Fm (Waterberg Group) (1.8 Ga).	Early Proterozoic "red beds" provide evidence for the development of an oxygenated atmosphere after *c.* 2Ga
ARCHAEAN GRANITE-GNEISS BASEMENT **(*e.g.* Beit Bridge Complex: Mount Dowe Group, Zd)**	Intrusive granitoids, gneisses, migmatites, metaquartzites and other high grade metamorphic rocks Early to Late Archaean 3.6 –2.4 (Swazian / Randian)	NO FOSSILS	These ancient rocks build one of the oldest surviving blocks of continental crust (Kaapvaal Craton) The famous Sand River Gneisses of the Limpopo Belt near Messina (previously designated National Monument) are spectacular examples of highly metamorphosed early crustal rocks (3.4 to 3.2 Ga)

Table 1: Summary of known fossil heritage from the main rock units represented in the study area near Louis Trichardt, Limpopo Province. Font colour gives an indication of inferred palaeontological sensitivity (black = VERY LOW; blue = LOW; green = MEDIUM; RED = HIGH).

<table>
<tr><td colspan="3">APPENDIX: CHANCE FOSSIL FINDS PROCEDURE: Lodge on Remainder of the Farm Juliana 647 MS and / or Portion 1 of the Farm Coen Brits 646 MS</td></tr>
<tr><td>Province & region:</td><td colspan="2">LIMPOPO PROVINCE, Soutpansberg District</td></tr>
<tr><td>Responsible Heritage Resources Authority</td><td colspan="2">SAHRA (Contact details: Dr Ragna Redelstorff, SAHRA, P.O. Box 4637, Cape Town 8000. Tel: 021 202 8651. Email: rredelstorff@sahra.org.za or Ms Natasha Higgitt. Tel: 021 462 4502. Email: nhiggitt@sahra.org.za)</td></tr>
<tr><td>Rock unit(s)</td><td colspan="2">Clarens Formation (Karoo Supergroup), Late Caenozoic alluvium</td></tr>
<tr><td>Potential fossils</td><td colspan="2">Vertebrate (including dinosaur) bones, teeth, trackways, petrified wood or other plant material mammalian bones, teeth & horn cores</td></tr>
<tr><td rowspan="5">ECO protocol</td><td colspan="2">1. Once alerted to fossil occurrence(s): alert site foreman, stop work in area immediately (N.B. safety first!), safeguard site with security tape / fence / sand bags if necessary.</td></tr>
<tr><td colspan="2">2. Record key data while fossil remains are still in situ:
• Accurate geographic location – describe and mark on site map / 1: 50 000 map / satellite image / aerial photo
• Context – describe position of fossils within stratigraphy (rock layering), depth below surface
• Photograph fossil(s) in situ with scale, from different angles, including images showing context (e.g. rock layering)</td></tr>
<tr><td>3. If feasible to leave fossils in situ:
• Alert Heritage Resources Authority and project palaeontologist (if any) who will advise on any necessary mitigation
• Ensure fossil site remains safeguarded until clearance is given by the Heritage Resources Authority for work to resume</td><td>3. If not feasible to leave fossils in situ (emergency procedure only):
• Carefully remove fossils, as far as possible still enclosed within the original sedimentary matrix (e.g. entire block of fossiliferous rock)
• Photograph fossils against a plain, level background, with scale
• Carefully wrap fossils in several layers of newspaper / tissue paper / plastic bags
• Safeguard fossils together with locality and collection data (including collector and date) in a box in a safe place for examination by a palaeontologist
• Alert Heritage Resources Authority and project palaeontologist (if any) who will advise on any necessary mitigation</td></tr>
<tr><td colspan="2">4. If required by Heritage Resources Authority, ensure that a suitably-qualified specialist palaeontologist is appointed as soon as possible by the developer.</td></tr>
<tr><td colspan="2">5. Implement any further mitigation measures proposed by the palaeontologist and Heritage Resources Authority</td></tr>
<tr><td>Specialist palaeontologist</td><td colspan="2">Record, describe and judiciously sample fossil remains together with relevant contextual data (stratigraphy / sedimentology / taphonomy). Ensure that fossils are curated in an approved repository (e.g. museum / university / Council for Geoscience collection) together with full collection data. Submit Palaeontological Mitigation report to Heritage Resources Authority. Adhere to best international practice for palaeontological fieldwork and Heritage Resources Authority minimum standards.</td></tr>
</table>