PROPOSED DEVELOPMENT OF WATER RETICULATION SYSTEM BETWEEN KEI ROAD AND BERLIN GENERAL, EASTERN CAPE

SCOPING REPORT
PALAEONTOLOGY

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1. Introduction

The palaeontological heritage of South Africa is unsurpassed and can only be described in superlatives. The South African palaeontological record gives us insight in *i.a.* the origin of life, mammals, dinosaurs and humans. Fossils are also used to identify rock strata and determine the geological context of the sub region with other continents and to study evolutionary relationships, sedimentary processes and palaeoenvironments. The Beaufort Group of the Karoo Supergroup contains amongst others approximately 70% of all known synapsid (also known as mammal-like reptile) fossils in the world which have played a crucial role in our understanding of the origin of mammals and the Permo-Triassic terrestrial palaeoenvironment including the existence of Gondwanaland.

The Heritage Act of South Africa stipulates that fossils and fossil sites may not be altered or destroyed. The purpose of this document is to detail the probability of finding fossils in the study area which may be impacted by the proposed development. The impact of the development can be ameliorated in several ways in the areas where fossils are common.

2. Terms of reference for the report

According to the South African Heritage Resources Act (Act 25 of 1999) (Republic of South Africa, 1999), certain clauses are relevant to palaeontological aspects for a terrain suitability assessment.

- **Subsection 35(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 with the detection or recovery of metals or archaeological material or objects, or use such equipment for the recovery of meteorites.
- **Subsection 35(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 procedures 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 form 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.

South Africa's unique and non-renewable palaeontological heritage is protected in terms of the NHRA. According to this act, heritage resources may not be excavated, damaged, destroyed or otherwise impacted by any development without prior assessment and without a permit from the relevant heritage resources authority.

As areas are developed and landscapes are modified, heritage resources, including palaeontological resources, are threatened. As such, both the environmental and heritage legislation require that development activities must be preceded by an

assessment of the impact undertaken by qualified professionals. Palaeontological Impact Assessments (PIAs) are specialist reports that form part of the wider heritage component of:

- Heritage Impact Assessments (HIAs) called for in terms of Section 38 of the National Heritage Resources Act, Act No. 25, 1999 by a heritage resources authority.
- Environmental Impact Assessment process as required in terms of other legislation listed in s. 38(8) of NHRA;
- Environmental Management Plans (EMPs) required by the Department of Mineral Resources.

HIAs are intended to ensure that all heritage resources are protected, and where it is not possible to preserve them in situ, appropriate mitigation measures are applied. An HIA is a comprehensive study that comprises a palaeontological, archaeological, built environment, living heritage, etc specialist studies. Palaeontologists must acknowledge this and ensure that they collaborate with other heritage practitioners. Where palaeontologists are engaged for the entire HIA, they must refer heritage components for which they do not have expertise on to appropriate specialists. Where they are engaged specifically for the palaeontology, they must draw the attention of environmental consultants and developers to the need for assessment of other aspects of heritage. In this sense, Palaeontological Impact Assessments that are part of Heritage Impact Assessments are similar to specialist reports that form part of the EIA reports.
The standards and procedures discussed here are therefore meant to guide the conduct of PIAs and specialists undertaking such studies must adhere to them.
The process of assessment for the palaeontological (PIA) specialist components of heritage impact assessments, involves:

Scoping stage in line with regulation 28 of the National Environmental Management Act (No. 107 of 1998) Regulations on Environmental Impact Assessment. This involves an **initial assessment** where the specialist evaluates the scope of the project (based, for example, on NID/BIDs) and advises on the form and extent of the assessment process. At this stage the palaeontologist may also decide to compile a **Letter of Recommendation for Exemption from further Palaeontological Studies**. This letter will state that there is little or no likelihood that any significant fossil resources will be impacted by the development. This letter should present a reasoned case for exemption, supported by consultation of the relevant geological maps and key literature.

A **Palaeontological Desktop Study** – the palaeontologist will investigate available resources (geological maps, scientific literature, previous impact assessment reports, institutional fossil collections, satellite images or aerial photos , etc) to inform an assessment of fossil heritage and/or exposure of potentially fossiliferous rocks within the study area. A Desktop studies will conclude whether a further field assessment is warranted or not. Where further studies are required, the desktop study would normally be an integral part of a field assessment of relevant palaeontological resources.

A **Phase 1 Palaeontological Impact Assessment** is generally warranted where rock units of high palaeontological sensitivity are concerned, levels of bedrock exposure within the study area are adequate; large-scale projects with high potential heritage impact are planned; and where the distribution and nature of fossil remains in the proposed project area is unknown. In the recommendations of Phase 1, the specialist will inform whether further monitoring and mitigation are necessary. The Phase 1 should identify the rock units and significant fossil heritage resources present, or by inference likely to be present, within the study area, assess the palaeontological significance of these rock units, fossil sites or other fossil heritage, comment on the impact of the development on palaeontological heritage resources and make recommendations for their mitigation or conservation, or for any further specialist studies that are required in order to adequately assess the nature, distribution and conservation value of palaeontological resources within the study area.

A **Phase 2 Palaeontological Mitigation** involves planning the protection of significant fossil sites, rock units or other palaeontological resources and/or the recording and sampling of fossil heritage that might be lost during development, together with pertinent geological data. The mitigation may take place before and / or during the construction phase of development. The specialist will require a Phase 2 mitigation permit from the relevant Heritage Resources Authority before Phase 2 may be implemented.

A **'Phase 3' Palaeontological Site Conservation and Management Plan** may be required in cases where the site is so important that development will not be allowed, or where development is to co-exist with the resource. Developers may be required to enhance the value of the sites retained on their properties with appropriate interpretive material or displays as a way of promoting access of such resources to the public.

The assessment reports will be assessed by the relevant heritage resources authority, and depending on which piece of legislation triggered the study, a response will be given in the form of a Review Comment or Record of Decision (ROD). In the case of PIAs that are part of EIAs or EMPs, the heritage resources authority will issue a comment or a record of decision that may be forwarded to the consultant or developer, relevant government department or heritage practitioner and where feasible to all three.

3. Details of study area and the type of assessment:

The relevant literature and geological maps for the region in which the development is proposed to take place, have been studied for this Scoping Report.

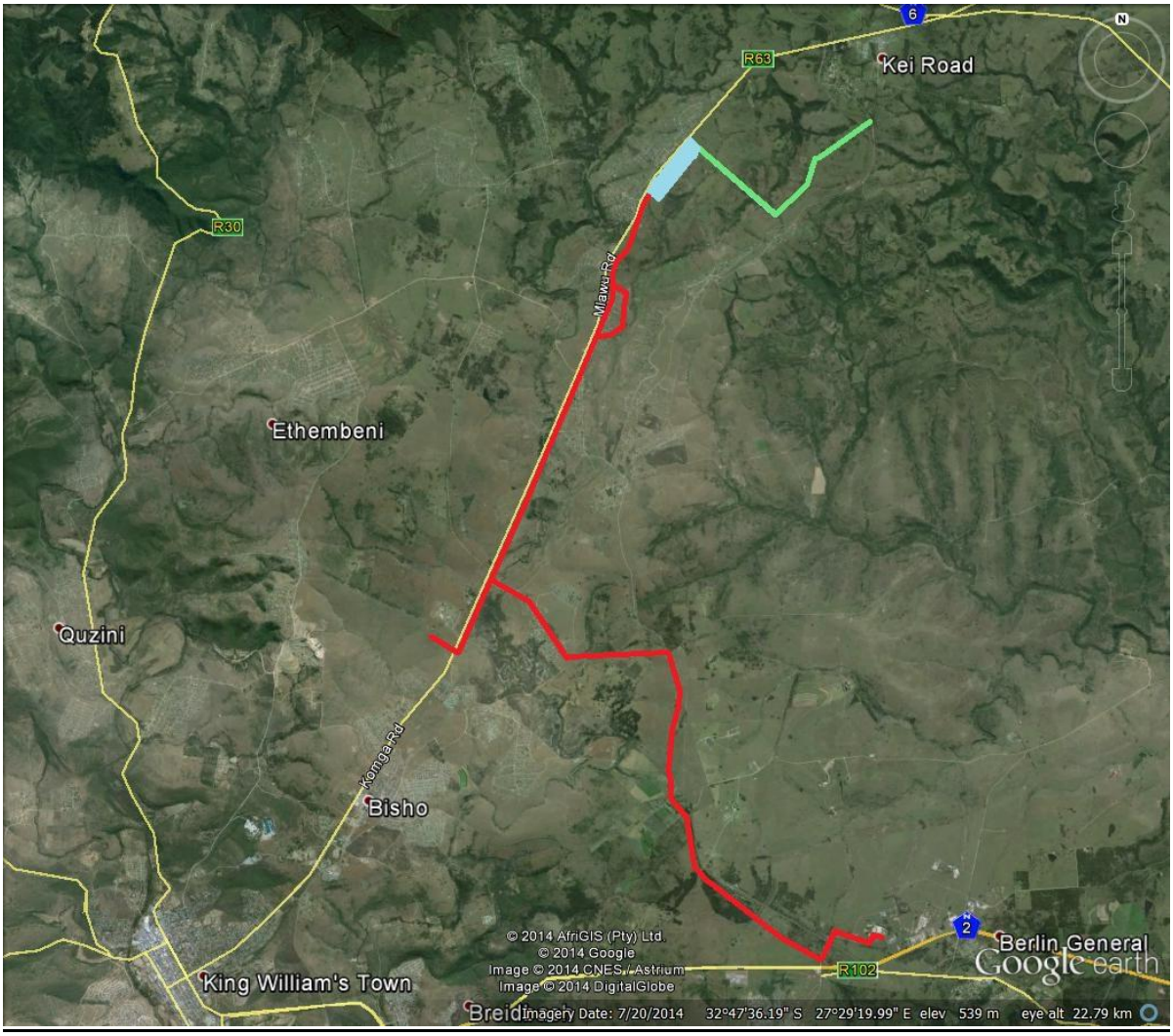

Figure 1: Google Earth photo indicating the study area (red, green and blue lines)

The study site is situated in the Eastern Cape Province between the towns of Kei Road and Berlin General north east of King William's Town. The area is mountainous and several streams are found on all sides of the proposed development. The study site is surrounded by farms.

4. Geological setting

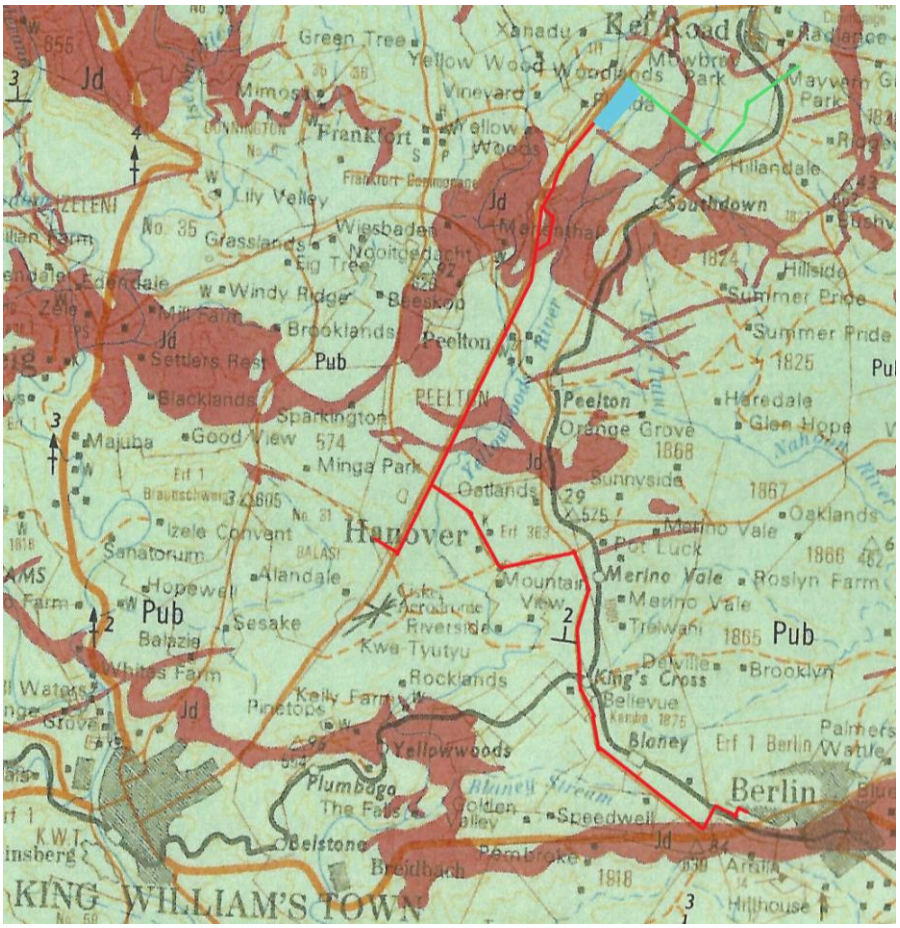

Figure 2: Geology of the study area (adapted from the King William's Town 3226 1:250 000 Geology Map (Geological Survey, 1976)

LEGEND:

Geology				
Jd	Dolerite			Jurassic
Pub	Grey mudstone, sandstone, shale	Balfour Formation of the Adelaide Subgroup	Beaufort Group of the Karoo Supergroup	Permian
Study area				
	Proposed potable water pipeline			
	Proposed raw water pipeline			
	Proposed dam			

The study site falls within the Balfour Formation of the Beaufort Group of the Karoo Supergroup (see Fig.2). The geology of the study area is dominated by sedimentary rocks consisting of sandstones and mudstones which were set down from the late Permian to the beginning of the Triassic as flood plain deposits. Dolerite sills and dykes intruded into these deposits during the Jurassic.

The Balfour Formation occurs under the Katberg Formation of the Tarkastad Subgroup and above the Middleton Formation of the Adelaide Subgroup. The Balfour Formation includes the upper part of the Adelaide Subgroup and part of what used to be interpreted as the lower to middle Beaufort (Johnson & Keyser, 1976).

Except for some grey shale in the middle part of the Balfour Formation (± 5% of the total thickness), the Adelaide Subgroup consists of alternating layers a few metres to a few tens of metres thick of grey, fine-grained sandstone (± 25%) and greenish-grey, bluish-grey mudstone (±70%) (Johnson & Keyser, 1976).

The Balfour Formation consists of a fluvial succession which was set down in the foredeep of the Karoo Basin from the late Permian to the onset of the Triassic. At the same time, an upward change in fluvial styles can be observed within each sequence, from initial higher to final lower energy systems. Fining-upwards cycles are common within this formation which suggests that there was a gradual decrease in slope during orogenic loading. Proximal sequences show transitions from braided to meandering systems, while the distal sequences show changes from sand-bed to fine-grained meandering systems (Catuneanu & Elango, 2001). Sandstones show horizontal lamination (“flat-bedding”) with primary current-lineation on the bedding-planes, trough cross-bedding and micro-cross-lamination. The mudstones are poorly stratified or massive. Wave-formed ripple-marks are common in the shales of the Balfour Formation (Johnson & Keyser, 1976).

The top of the Adelaide Subgroup can be defined as a horizon above which sandstone predominates over mudstone. Red mudstone is relatively abundant in the mudstones immediately below the boundary (over an interval of 50-100m), in contrast to the absence of red mudstone in the rest of the Balfour Formation (Johnston *et al*., 2006). The change in sandstone colour from grey in the Balfour Formation to pinkish-grey in the overlying Katberg Formation is also diagnostic (Johnson & Keyser, 1976).

5. Palaeontology of the study area

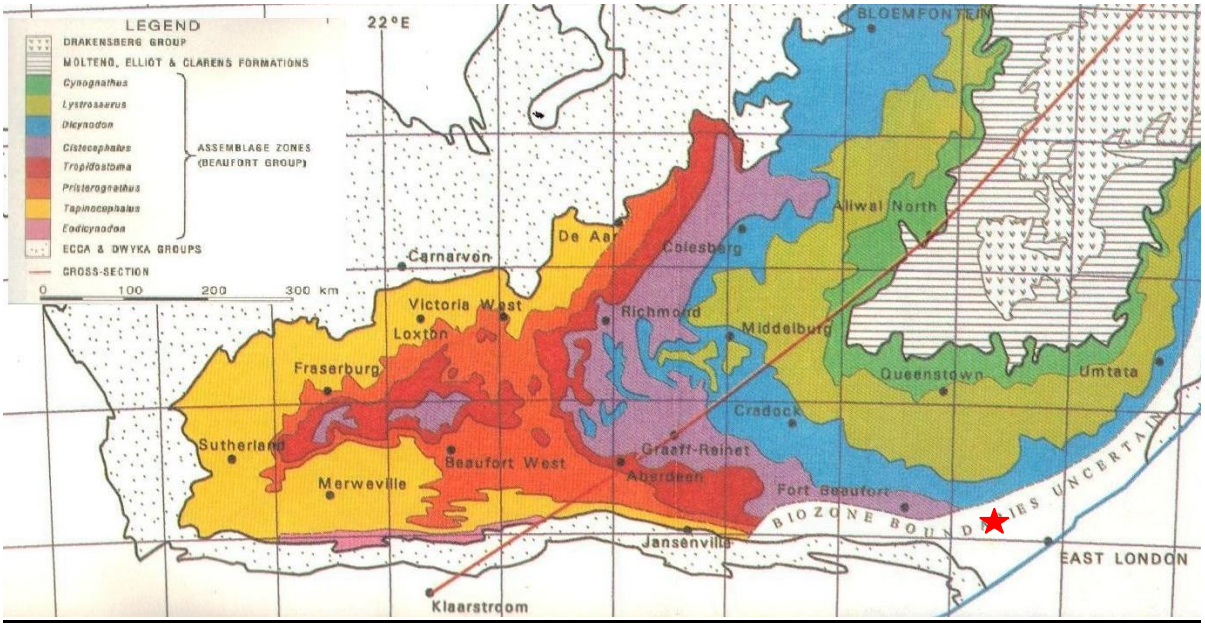

Figure 3: Biostratigraphical map indicating the Karoo Supergroup strata including the biozonation of the Karoo Supergroup (adapted from Rubidge,1995). The red star indicates the study area

Although the biozonation of the study area is less obvious than other parts of the Main Karoo Basin (see Fig.3), fossils are known from this region. The study area falls within the Balfour Formation of the Beaufort Group which is renowned for its synapsid, anapsid and basal tetrapod fossils. *Glossopteris* leaf imprints and fragments of silicified wood occur throughout the subgroup (Johnson & Keyser, 1976).

The Balfour Formation coincides with the upper part of the Adelaide Subgroup which is dominated by the *Dicynodon* Assemblage Zone. In this region (east of 25°E) the lower part of the *Dicynodon* Assemblage Zone and the underlying *Cistecephalus* Assemblage Zone become indistinguishable (Keyser & Smith, 1978).

The lower part of the Balfour Formation yields fossils associated with the *Cistecephalus* Assemblage Zone such as the dicynodonts *Diictodon* (Fig. 4), *Cistecephalus* (Fig. 5), *Oudenodon* (Fig.8), *Aulacephalodon*, *Pristerodon* and *Emydops* and theriodonts including therocephalians such as *Ictidosuchops* and *Ictidosuchoides* and gorgonopsians (Fig. 6) such as *Gorgonops*, *Lycaenops* and *Prorubidgea*.

Figure 4: *Diictodon* skeleton

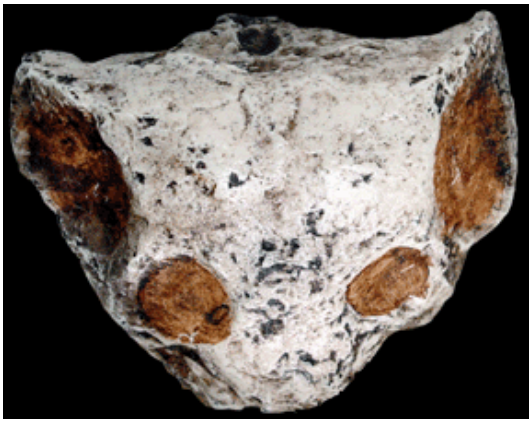

Figure 5: *Cistecephalus* skull

Figure 6: Gorgonopsian skull

Fossils associated with the *Dicynodon* Assemblage Zone, include dicynodonts such as *Dicynodon* (Fig.7), *Oudenodon* (Fig.8) and *Pelanomodon* and theriodonts including gorgonopsians such as *Lycaenops*, *Prorubidgea* and *Rubidgea* and therocephalians such as *Theriognathus* (Fig.9), *Ictidosuchops* (Fig.10) and *Ictidosuchoides*.

Figure 7: *Dicynodon* skull

Figure 8: *Oudenodon* skull

Figure 9: *Theriognathus* skull

Figure 10: *Ictidosuchops* skull

The upper part of the Balfour Formation, consisting of the Palingkloof Member, yields fossils from the *Lystrosaurus* Assemblage Zone specifically members of the dicynodont *Lystrosaurus* and the captorhinid *Procolophon* (Rubidge *et al*., 1995). These fossils will not be present in the study area because of its southerly location with regard to the contact between the Dicynodon and Lystrosaurus Assemblage Zones (see Fig.3).

References:

Catuneanu, O. & Elago, H.N. (2001), Tectonic control on fluvial styles: the Balfour Formation of the Karoo Basin, South Africa. Sedimentary Geology 130(304): 291-313.

Geological Survey (1976) King William's Town 3226 1: 250 000 Geology Map

Johnson, M.R. & Keyser, A.W. 1976. Explanatory notes map sheet 3226 King William's Town 3226 1: 250 000, Geological Survey, Pretoria.

Johnson, M.R.; Van Vuuren, C.J.; Visser, J.N.J.; Cole, D.I.; Wickens, H. De V.; Christie, A.D.M.; Roberts, D.L. & Brandl, G. (2006). Sedimentary rocks of the Karoo Supergroup, pp. 461-499. *In*: Johnson. M.R., Anhaeusser, C.R. & Thomas, R.J. (Eds.) *The geology of South Africa*. Geological Society of South Africa, Johannesburg & the Council for Geoscience, Pretoria.

Keyser, A.W. & Smith, R.M.H. 1978. Vertebrate biozonation of the Beaufort Group with special reference to the western Karoo basin. Annals of the Geological Survey of South Africa, 12:1-35.

Rubidge, B.S. (e*d.*) (1995). Biostratigraphy of the Beaufort Group (Karoo Supergroup), Biostratigraphic Series no.1, South African Committee for Stratigraphy, Council for Geoscience.

6. Conclusion and Recommendations:

The *Cistecephalus* and *Dicynodon* Assemblage Zones are moderately fossil rich. There is a possibility that fossils will be discovered within the study area.

Mitigation

The study site needs to be investigated before construction and after excavations have taken place. Fossils exposed on the surface need to be salvaged before construction.

A working relationship should be established between the ECO and the project palaeontologist. Excavations should be halted if fossils are uncovered during the process and the ECO should contact the palaeontologist for advice before continuing excavations or construction.

Due to the fact that it would be impractical and very expensive for a qualified palaeontologist to be present at the site for the duration of construction, the responsibility of the recording of fossil localities as they are discovered will fall upon the ECO. Fossil localities should be recorded in all cases by means of photographs and GPS readings and written up in a log book with the date, locality, photograph number and short description of the site.

It is important for the ECO to familiarise him- or herself with the fossils which could be expected in this region. It is very important that the ECO accompanies the palaeontologist on his or her site visits in order to be sensitised to the occurrence and appearance of fossils in their natural state.

The excavations and collection of fossils should be performed by a qualified palaeontologist and with a permit from the South African Heritage Resources Agency. The fossils should preferably be donated to a fossil repository after collection – in this case the Albany Museum in Grahamstown.

Palaeontological specialist:
Dr JF Durand (Sci. Nat.)
BSc Botany & Zoology (RAU), BSc Zoology (WITS), Museology Dipl. (UP),
Higher Education Diploma (RAU), PhD Palaeontology (WITS)

Experience:
Palaeontological assessments:

- Urban development in Cradle of Humankind World Heritage Site (Gauteng): Letamo, Honingklip, Windgat, Sundowners, Ekutheni
- Urban development at Goose Bay, Vereeniging, Gauteng
- Urban development on Portions 98, 99, 179, 236, 284 and 364 of the farm Waterkloof 306 JQ, Rustenburg, North West Province
- Upgrade of R21 between N12 and Hans Strydom Drive, Gauteng
- Vele Colliery, Limpopo Province
- De Wildt 50 MW Solar Power Station, Gauteng
- 10 MW PV Plant Potchefstroom, North West Province
- Omega 342 50MW Solar Power Station, Viljoenskroon, Free State
- Springfontein wind and solar energy facility, Free State
- Solar power plant, Bethal, Mpumalanga
- Diamond mine on Endora, Limpopo Province
- Development at Tubatse Ext.15, Limpopo Province
- Manganese mine south of Hotazel, Northern Cape
- Wind energy facility at Cookhouse, Eastern Cape
- Energy facility at Noupoort, Northern Cape
- Fluorspar mine near Wallmannsthal, Gauteng
- ESKOM power line, Dumo, KwaZulu-Natal
- ESKOM Gamma-Omega 765KV transmission line, Western Cape
- ESKOM 44KV power line at Elandspruit near Middelburg, Mpumalanga
- ESKOM Makopane Substation, Limpopo Province
- ESKOM Platreef Substation and power lines to Borutho MTS Substation, Limpopo Province
- Marang B - a 3 x 500MVA 400/132kV Main Transmission Substation east of Rustenburg, North West Province
- Upgrading of storm water infrastructure in Valencia, Addo, Sundays River Valley Municipality, Eastern Cape
- Development of a 10 MW Solar Energy facility on the Farm Liverpool 543 KQ Portion 2 at Koedoeskop, Limpopo Province
- Development of a fluorspar mine at Wallmannsthal, North of Pretoria
- Extension of limestone mine on the farms Buffelskraal 554 KQ Portion1 and Krokodilkraal 545 KQ, Limpopo Province
- 3 x 132KV power line from the Lesideng Substation within Fetakgomo and Greater Sekhukhune Local Municipalities of Sekhukhune District, Limpopo Province
- Lesego Platinum Mine, Sekhukhune Area, Steelpoort, Limpopo Province
- Proposed mine at Hotazel, Northern Cape
- Pollution control dams at Transalloys in Clewer near Emalahleni (Witbank), Mpumalanga
- Erection of spill points on the Farm Kwikstaart 431 KQ Portion 2, Thabazimbi, Limpopo Province
- Ethemba Dam, Swaziland

- Bridge at Busingatha, Kwazulu/Natal

Palaeontological research:

- Gauteng: Wonder Cave
- KwaZulu/Natal: Newcastle, Mooi River, Rosetta, Impendle, Himeville Underberg, Polela & Howick Districts, Sani Pass
- Eastern Cape: Cradock District, Algoa Basin
- Western Cape: Clanwilliam District
- Free State: Memel & Warden Districts
- Limpopo Province: Nyalaland (KNP), Vhembe Reserve, Pont Drift
- Zimbabwe: Sentinel Ranch, Nottingham