PALAEONTOLOGICAL IMPACT ASSESSMENT: DESKTOP STUDY

Upgrading of Wastewater Treatment Works, Aberdeen Eastern Cape Province, RSA

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1. SUMMARY

The proposed development overlies Late Permian age sediments of the Lower Beaufort Group (Middleton Formation, Adelaide Subgroup). Potentially important fossil specimens of vertebrates (pereisaur reptiles, therapsids, amphibians, fish), vascular plants, invertebrates and trace fossils may be exposed during excavations into Beaufort Group bedrock (especially ancient overbank mudrocks) during development. Superficial alluvial deposits of the Kraairivier may also contain late Caenozoic fossils such as mammalian bones, teeth and horn cores. However, the scale of bedrock excavations proposed is small and the proposed development is not considered to pose a substantial threat to local fossil heritage. Therefore no further palaeontological mitigation is recommended.

Should obvious fossil remains be exposed during development, the position of any finds should be accurately recorded by the ECO on a 1: 50 000 map / aerial photo or with a GPS. Where practicable, fossil specimens, together with the surrounding rocky matrix, should be carefully collected, labelled, wrapped and handed over to a professional palaeontologist for examination. If substantial articulated skeletal material is discovered, the ECO should inform SAHRA and / or a professional palaeontologist so that it can be inspected *in situ* and, if necessary, sampled at the earliest opportunity.

2. INTRODUCTION & BRIEF

It is proposed to upgrade the Waste Water Treatment Works at Aberdeen, Eastern Cape Province (Camdeboo Municipality). The area that will be affected by the proposed development, including new ponds and wetlands, is indicated in Fig. 1 (Site location: 32° 28' 44.75" S, 24° 04' 17.72" E). According to the draft scoping report kindly provided by Dr Anton Bok, the upgrade of the WWTW will involve construction of the following new components:

- Two additional anaerobic ponds, each with an area of 674m^2 and depth of 3m (***i.e***. volume of 2 022m^3).
- Two additional primary ponds, with a total area of 14 910m^2 and depth of 1.5m (total volume of 22 365m^3).
- 4 secondary ponds with a total area of 10 720m^2 and a total volume of 16 080m^3.
- Constructed wetlands consisting of 3 separate units with a total area of 5880m^2.

Fresh bedrock excavations of more than half a meter depth are unlikely to be involved. New sewerage pipelines will be installed in the same position in the same trenches as the existing 75 mm pipes serving the settled sewerage system, which will be removed. Therefore no rock excavation or digging of new pipe trenches will be necessary.

Since the property overlies potentially fossiliferous rocks, a brief palaeontological desktop study has been commissioned by Anton Bok Aquatic Consultants cc, Port Elizabeth, on behalf of LHL Consulting Engineers. This is accordance with the requirements of the National Heritage Resources Act, 1999 (Act 25 of 1999).

FIG. 1. Position of study area (white ellipse) – waste water treatment works on the southeastern outskirts of Aberdeen, Eastern Cape.

3. GEOLOGY

As shown in the relevant 1: 250 000 geological map (Sheet 3224 Graaff-Reinet), the study area is underlain by Late Permian continental sediments of the Lower Beaufort Group (Karoo Supergroup), in particular the **Middleton Formation** (Pm). This forms the middle portion of the Adelaide Subgroup east of 24°E (Hill 1993, Johnson ***et al***., 2006).

The fluvial Middleton succession comprises recessive weathering, greenish grey to reddish overbank mudrocks with subordinate resistant-weathering, fine-grained channel sandstones deposited by large meandering river systems (Hill 1993, Johnson ***et al***. 2006). Dips in the study region are generally shallow (10-15°), with small-scale E-W fold axes to the north and south of Aberdeen township, so low levels of tectonic deformation are

expected. The Beaufort Group succession in the Aberdeen area is extensively intruded and baked by major **dolerite intrusions** (Jd) of Early Jurassic age (***c***. 183 million years old). The geological map shows the curved traces of large, probably dish-shaped, dolerite sills to the west and east of town. Surface exposure of Beaufort Group rocks just to the south of the study area is probably fairly good, judging from satellite images, especially in stream beds and dongas. However, Beaufort Group bedrock exposure within the development footprint itself is likely to be poor, given its situation close to the south bank of a major watercourse, the Kraairivier. Here the bedrock is probably overlain by a veneer of Late Caenozoic alluvium (sands, gravels, ***etc***) and may be extensively disrupted by calcrete (white soil limestone).

4. PALAEONTOLOGY

4.1. Beaufort Group bedrock

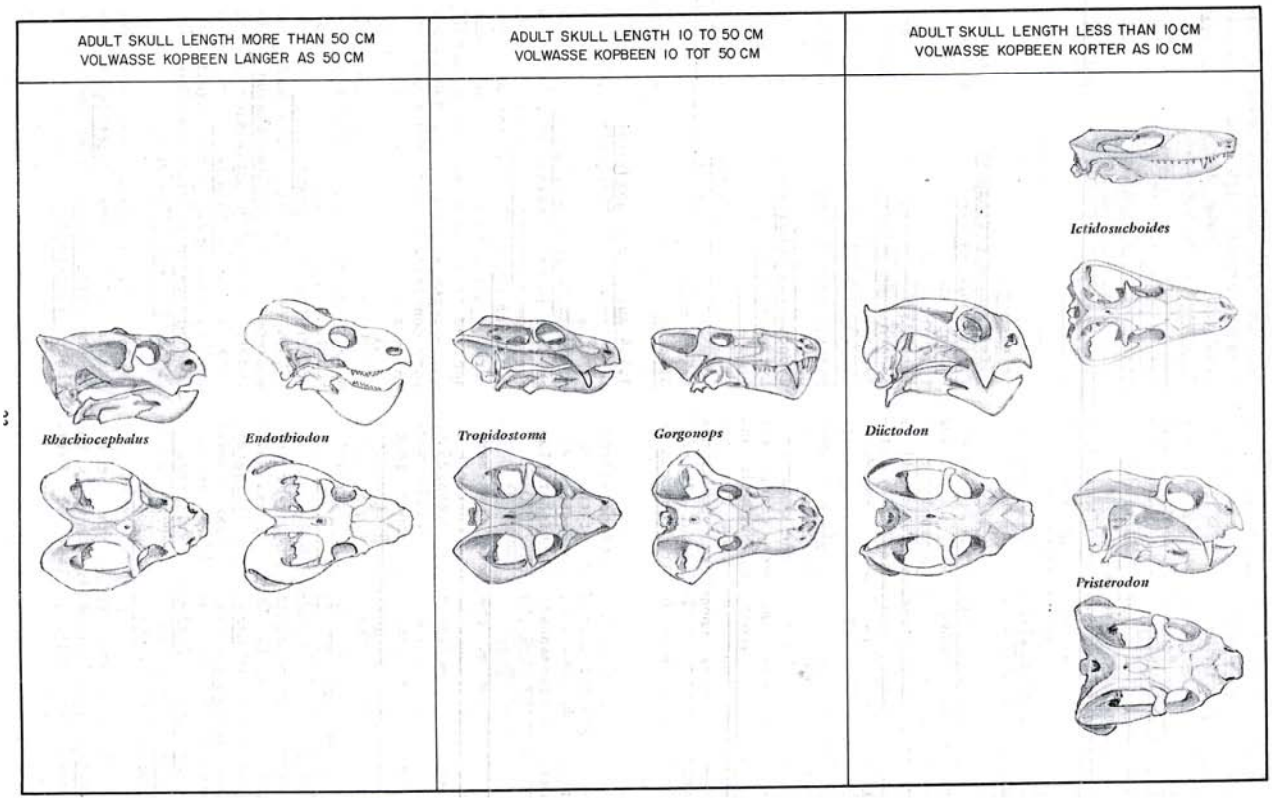

Fig. 2. Skulls of characteristic fossil vertebrates (all therapsids) from the *Tropidostoma* Assemblage Zone (From Keyser & Smith 1979). *Gorgonops* is a flesh-eating gorgonopsian, *Ictidosuchoides* is an insectivore, while the remainder are two-tusked, herbivorous dicynodonts.

The Middleton Formation comprises portions of three successive Beaufort Group fossil assemblage zones (AZ) that are based on the occurrence of specific genera and species of fossil therapsids. These are, in order of decreasing age, the ***Pristerognathus***, ***Tropidostoma*** and ***Cistecephalus*** Assemblage Zones (Rubidge 1995). These biozones have been assigned to the Wuchiapingian Stage of the Late Permian Period, with an approximate age range of 260-254 million years (Rubidge 2005). According to published maps showing the distribution of the Beaufort assemblage zones within the Main Karoo Basin (Keyser & Smith 1979, Hill 1993, Rubidge 1995), the Aberdeen area lies within the

Tropidostoma Assemblage Zone (= lower ***Cistecephalus*** Biozone or ***Tropidostoma-Endothiodon*** Assemblage Zone of earlier authors; see table 2.2 in Hill 1993).

In general, the following broad categories of fossils might be expected here (Keyser & Smith 1979, Anderson & Anderson 1985, Hill 1993, Smith & Keyser ***in*** Rubidge 1995, Cole ***et al***., 2004, Almond ***et al***. 2008):

- isolated petrified bones to articulated skeletons of **terrestrial vertebrates** such as true **reptiles** (notably large pareiasaurs) and **therapsids** or "mammal-like reptiles" (diverse dicynodonts, gorgonopsians, therocephalians) (Fig. 2)
- aquatic vertebrates such as large **temnospondyl amphibians** (usually disarticulated), and palaeoniscoid bony fish (often represented by scattered scales rather than intact fish)
- freshwater **bivalves**
- **trace fossils** such as worm, arthropod and tetrapod burrows and trackways, coprolites
- **vascular plant remains** including leaves, twigs, roots and petrified woods ("***Dadoxylon***") of the ***Glossopteris*** Flora (usually sparse, fragmentary), especially glossopterids and arthrophytes (horsetails) (See Hill 1993 for silicified wood from the Aberdeen area).

As far as the biostratigraphically important tetrapod remains are concerned, the best fossil palaeontological material is generally found within overbank mudrocks, whereas fossils preserved within channel sandstones tend to be fragmentary and water-worn (Rubidge 1995, Smith 1993). Many fossils are found in association with ancient soils (palaeosol horizons) which can usually be recognised by concentrations of calcrete nodules.

As a consequence of their proximity to large dolerite intrusions in the Aberdeen area, the Beaufort Group sediments here may well have been thermally metamorphosed or "baked" (***ie***. recrystallised, impregnated with secondary minerals). Embedded fossil material of phosphatic composition, such as bones and teeth, is frequently altered by baking – bones may become blackened, for example - and can be very difficult to extract from the hard matrix by mechanical preparation (Smith & Keyser, p. 23 ***in*** Rubidge 1995).

4.2. Caenozoic alluvium

Various types of superficial deposits ("drift") of geologically young Late Caenozoic (Miocene / Pliocene to Recent) age occur throughout the Karoo region. They include pedocretes (***eg*** calcretes), colluvial slope deposits (dolerite scree ***etc***), river alluvium, as well as spring and pan sediments (***eg*** Partridge ***et al***. 2006). These Karoo drift deposits have been comparatively neglected in palaeontological terms for the most part. However, alluvial sediments such as those expected in the study area may occasionally contain important fossil biotas, notably the bones, teeth and horn cores of mammals (***eg*** Skead 1980, Klein 1984, MacRae 1999, Partridge & Scott 2000). Other late Caenozoic fossil biotas from these superficial deposits include non-marine molluscs (bivales, gastropods), ostrich egg shells, trace fossils (***eg*** calcretised termitaria, coprolites), and plant remains such as peats or palynomorphs (pollens) in organic-rich alluvial horizons.

5. RECOMMENDATIONS

Given the very limited depth and scale of excavations involved in the proposed development, it is unlikely that substantial volumes of potentially-fossiliferous, fresh (***ie*** unweathered) bedrock will be exposed. Superficial drift deposits (***eg*** river alluvium) in the study area are also potentially fossiliferous, but fossil remains here are likely to be sparse. The predicted impact of the development on palaeontological heritage is therefore small, and no further mitigation in this respect is recommended.

Given the (albeit limited) potential for scientifically important fossil vertebrates being found, however, any sizeable new bedrock exposures should be inspected at intervals by the responsible Environmental Control Officer (ECO) before they are infilled or sealed. It is strongly recommended that the ECO for this development visit a Karoo palaeontological display (***eg*** the Lex Bremner Collection at the Reinet Museum or the Rubidge Collection at the farm Wellwood 578, Graaff-Reinet) before the start of operations so that they acquire some familiarity with the appearance of typical Beaufort Group fossil material. Well-illustrated accounts of Karoo fossils have been published by Cluver (1978), MacRae (1999) and McCarthy and Rubidge (2005).

Should fossils be encountered during excavations, they should be carefully collected, with adherent matrix where necessary, given a provisional reference number (***e.g.*** marked on masking tape) and carefully wrapped in newspaper. It is ***essential*** that the locality where the fossil is found be accurately marked on a 1: 50 000 map, aerial photo or recorded by GPS; specimens without locality information are of limited scientific value. These fossils should be submitted for inspection by a professional palaeontologist ***at the earliest opportunity***. Some of this material may be of scientific interest - in which case it should be deposited ultimately in an approved repository (***e.g.*** Iziko South African Museum, Cape Town) – while other specimens may be of educational value and might be donated for display purposes.

If well-articulated skeletons are encountered during construction, they should ***NOT*** be informally excavated since this will almost invariably lead to damage and loss of useful contextual information (***e.g.*** taphonomy – data on mode of death and burial of animals). If feasible, the skeleton should be photographed (with scale), covered with a protective layer of loose sediment, and the site marked and carefully recorded (GPS / 1: 50 000 map / aerial photograph). The Environmental Control Officer should immediately inform SAHRA and / or a professional palaeontologist so that the specimen can be examined ***in situ*** and, if necessary, professionally excavated.

6. ACKNOWLEDGEMENTS

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