Palaeontological Impact Assessment for Nieu Bethesda Water Treatment Plant and water pipeline.

Prepared for: CEN Integrated Environmental Management Unit

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Background

CEN Integrated Environmental Management Unit has been appointed by Aurecon Engineers (for the Camdeboo Local Municipality) to:

1. Undertake the necessary environmental assessments for the **proposed augmentation of the existing waste water treatment works (WWTW)** situated on the municipal commonage grounds ("koeikamp") in Nieu-Bethesda to increase the capacity from 2555 m3 to 97 000 m3 per annum. This is needed to provide residences and commercial sites in Pienaarsig and the village of Nieu-Bethesda with water-borne sanitation.

2. Apply in terms of Section 24(G) read together with sections 24 (F) and 7 of the National Environmental Management Amendment Act (Act No 62 of 2008) to the Department of Economic Development and Environmental Affairs to grant the Camdeboo Municipality **rectification for the unlawful commencement of activities** identified in terms of the EIA Regulations (2006) (the original WWTW was constructed without an environmental authorisation).

Aurecon Engineers have recommended that the existing WWTW be augmented by constructing a two-phased plant comprising a concrete septic tank and lined oxidation pond combination within an extended fenced site at the existing WWTW. A final decision regarding the type of lining of the ponds is pending. The inlet works will be upgraded, and the existing irrigation dam will be utilised. To mitigate potential environmental impacts, septic tanks will be covered with soil so that only access and inspection covers are exposed, floral growth in the ponds will be stimulated. It is also recommended that effluent should be used to irrigate sports fields and/or agricultural land. There is an existing irrigation line that takes effluent from the existing WWTW to a sportsfield to the west of the cemetery in town.

The existing Waste Water Treatment Works (WWTW) is situated east of and adjacent to the N9 and approximately 800 m north of the village of Nieu-Bethesda. The existing work site will be used for the proposed upgrade.

Rob Gess Consulting was subcontracted to conduct a palaeontological impact assessment.

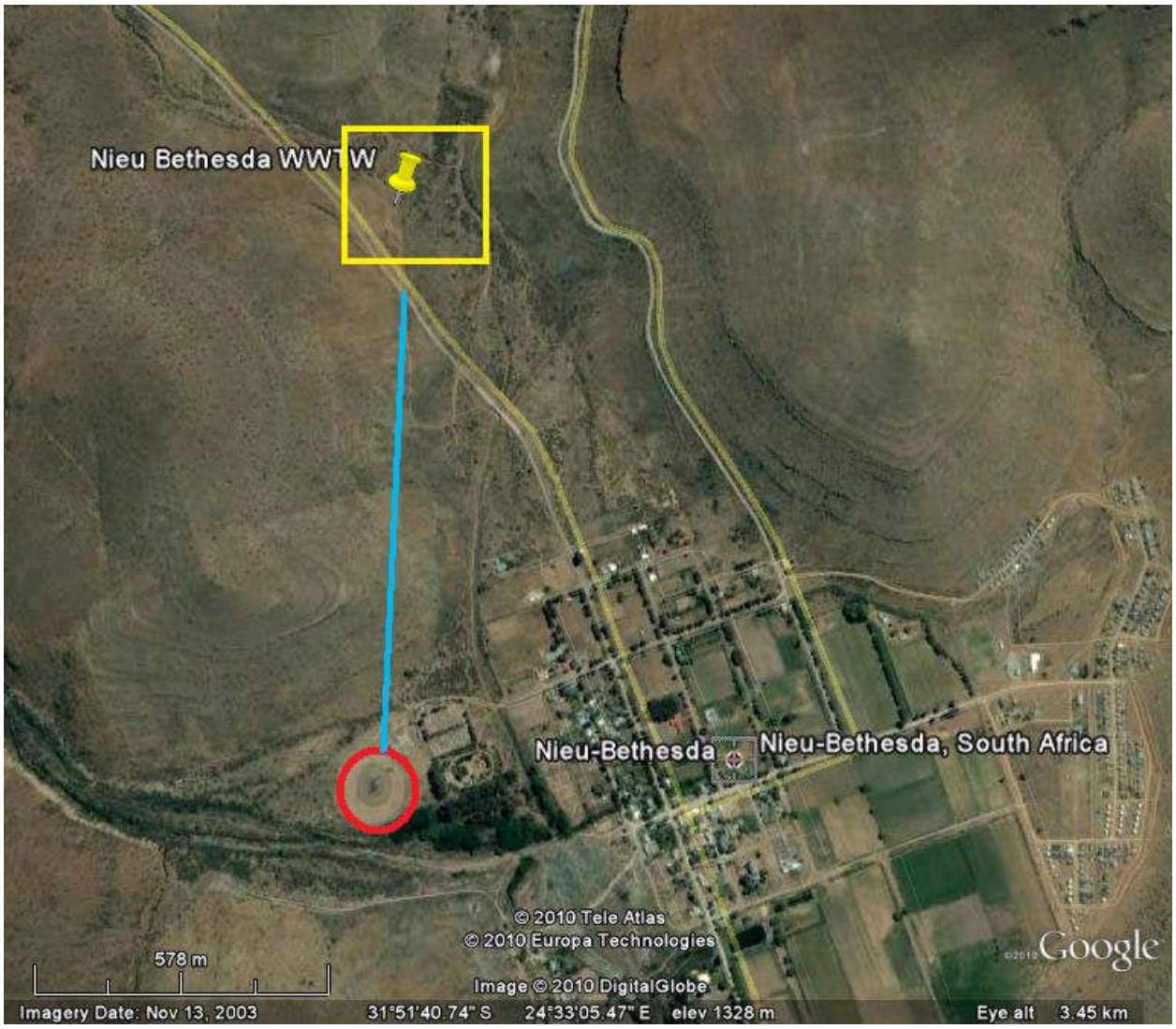

Figure 1: A Google Earth Image showing the relative location of proposed activities (yellow square: WWTW site, blue line: existing irrigation line, red circle: sportsfield).

Geology

The entire Nieu Bethesda valley is underlain by mudstones and sandstones of the upper Permian Balfour Formation (Adelaide Subgroup, Beaufort Group, Karoo Supergroup).

The strata of the Karoo Supergroup were deposited within the Karoo sedimentary Basin, which resulted from shortening and thickening of the southern margin of Africa, with coeval folding and uplift of the Cape Supergroup strata along its southern margin. The Karoo Supergroup strata are between 310 and 182 million years old and span the Upper Carboniferous to Middle Jurassic Periods. During this interval the basin evolved from an inland sea, to a giant lake fed by seasonal meandering (and at times braided) rivers. This lake steadily shrank as it filled with sediment and

the basin's rate of subsidence stabilised. The land became increasingly arid and was covered with wind blown sand towards the end of its cycle. Finally the subcontinent was inundated with basaltic lava that issued from widespread linear cracks within the crust, to form the capping basalts of the Drakensberg Group.

The sediments of the mid Beaufort Group Balfour Formation were deposited at a time when the Karoo Sea was largely silted up and rivers arising in the Cape Fold Belt Mountains, to the south, meandered across extensive flood planes into an inland lake. Sands were deposited along the river channels whereas periodic flooding deposited muds on the flood planes. These in time came to form the interbedded sandstones and mudstones of the Balfour Formation.

During the formation of the volcanic Drakensberg Group (during the Jurassic), crack like fissues in the earths crust became filled with molten lava that later cooled to form dolerite dykes. Other magma was injected under pressure between horizontal sedimentary strata and cooled to form extensive horizontal sills of dolerite. This dolerite forms the capping on the hills and Mountains of the Voorsneeuberg which surround Nieu Bethesda, but are not encountered in the study area.

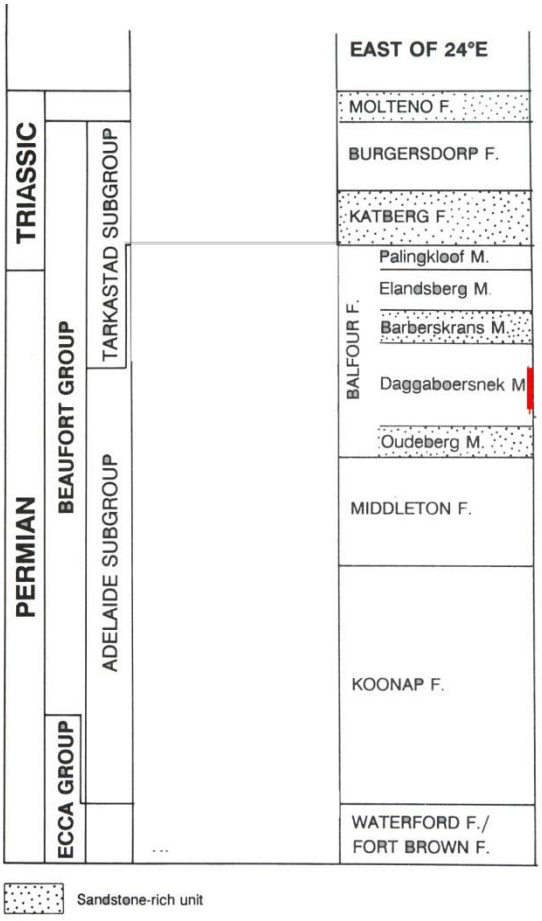

Figure 2: Stratigraphy of Permotriassic sedimentary rocks in the Eastern Cape. Red line represents strata affected by the proposed development. F. = Formation, M. = Member
(modified after Rubidge *et al*. In *Biostratigraphy of the Beaufort Group* (1995), Council for Geoscience)

Palaeontology

The flood planes of the Beaufort Group provide an internationally important record of life during the early diversification of land vertebrates. Giant amphibians coexisted with diapsid reptiles (the ancestors of dinosaurs, birds and most modern reptiles), anapsids (which probably include the ancestors of tortoises) and synapsids (the dominant group of the time which included the diverse therapsids (including the ancestors of mammals)). Rocks of the Beaufort Group provide the worlds most complete record of the important transition from early reptiles to mammals.

Therapsid diversity, along with that of most plant and animals was decimated during the end-Permian extinction event, a serious contender for the most severe extinction event to affect life on Earth. Ongoing research on the effects of this extinction event is facilitated by the detailed record, afforded by Beaufort Group strata, of life immediately before and after the event, as well as the gradual recovery of life afterwards.

The Beaufort Group is subdivided into a series of biostratigraphic units on the basis of its faunal content. Most of the Balfour Formation, including that exposed in the study area, corresponds to the *Dicynodon* Assemblage Zone. Characterised by the co-occurence of *Dicynodon* and *Theriognathus* this zone demonstrates the Beaufort Groups greatest diversity of vertebrate taxa, including numerous taxa of dicynodont, biarmosuchian, gorgonopsian and therocephalian and cynodont therapsid Synapsida, together with diverse captorhinid Reptilia and less well represented eosuchian Reptilia, Amphibia and Pisces.

The effects of the end Permian extinction event are also evident in the extensive and important record of fossil plants present in the rocks of the Karoo. Faunas of Permian age are dominated by a wide range of early seed plants, the Glossopteridales (which probably include the ancestors of modern gymnosperms and ultimately angiosperms). The *Dicynodon* Assemblage Zone has furthermore yielded *Schizoneura* and *Dadoxlon* (fossil wood).

Invertebrate trace fossils have are also known.

Site visit

The rectangular fenced area for the **Sewerage Ponds** was investigated. Existing sewerage ponds on the easterly side closest to river appear to have been excavated out of deep river terrace alluvium. Recent test pits towards the south west and in centre of fenced area also indicate thick river terrace alluvium (Figure 3). The ground rises steeply towards the north western corner in which green mudstones of the Beaufort group have been intercepted and used as aggregate on an internal road.

The existing pond outside the fenced area appears to have been excavated from the same quaternary river terrace as the fenced ponds and the test trenches. Development only of this river terrace would minimise any chance of danger to palaeontological heritage.

Figure 3: Deep recent alluvium exposed in a test trench near the centre of the enclosure for the ponds.

The **Waterline** between the ponds and the playing field was also investigated.

Between the ponds and the quarry (Figure 6, purple) the route is largely covered in soily alluvium penetrated by small animal burrows which show some depth of cover. Occasional fragmented outcrops of more sandy rich material occur.

The route passes east of the small **quarry**, (in which fine mudstone is preserved), and will not impact on it.

From the **quarry to the "Outcrop Slope"** (Figure 6, green) the route is covered in soily alluvium and does not contain much outcrop.

The **"Outcrop Slope"** (Figure 6, green), refers to a slope encountered where the route cuts the spur of a hill to the east of Niew Bethesda, overlooking the playing field. Here the steep slope exposes fined grained, greeny blue mudstones and palaeosols (Figure 4). A single fossil bone fragment was found *in situ* along the pipe route in this area (Figure 5). More bony material is likely to have once occurred here but may have been reduced due to the close proximity of the outcrop to Nieu Bethesda with its high popular awareness of bony fossils. It is reasonably likely that excavation of the pipeline through this area will interrupt palaentological material.

Between the Outcrop Slope and the playing field the pipeline descends the slope, once more crossing the "foot" of alluvium mantling the hill and adjacent to the stream bed. The playing field is situated in sandy river alluvium.

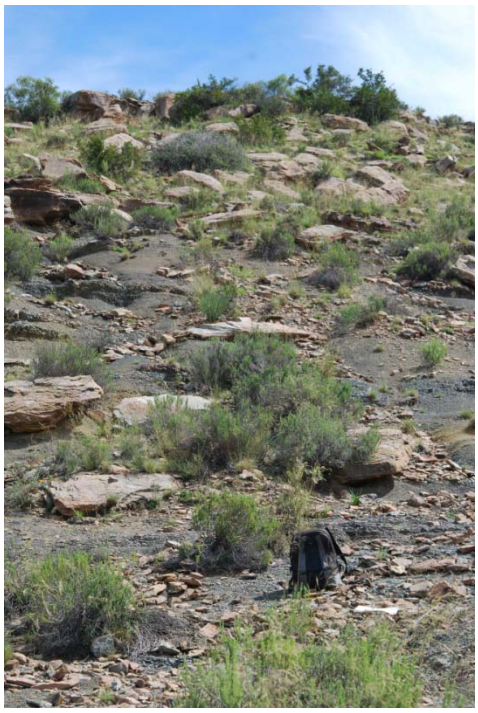

Figure 4: Blue-green mudstones exposed on the "outcrop slope" along the water route, east of Nieu Bethesda.

Figure 5: Fossil bone fragment *in situ*, in mudstones, where the water pipe route crosses the "outcrop slope".

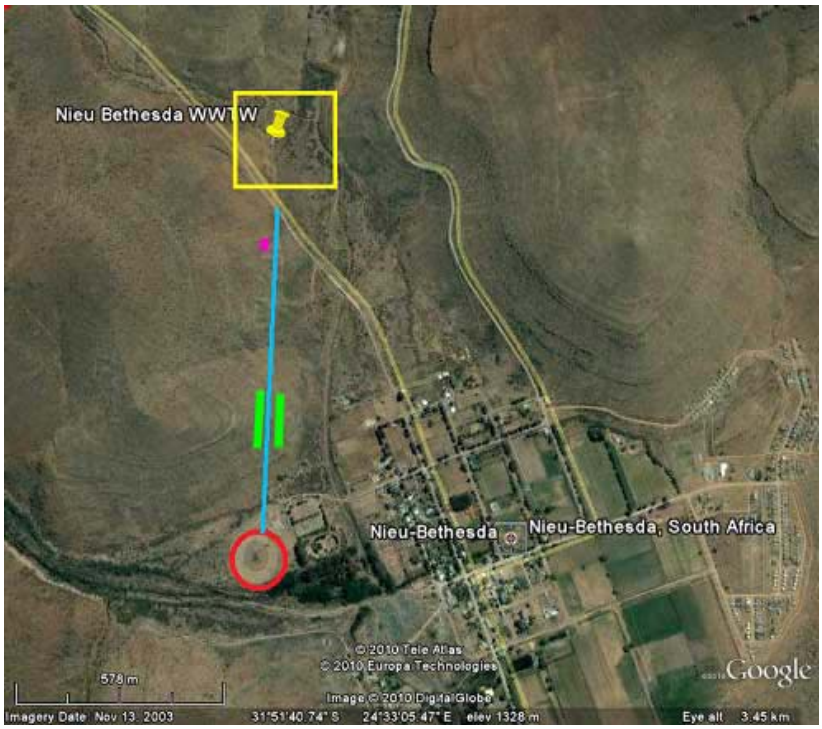

Figure 6: A Google Earth Image showing areas of paaeontological sensitivity relative to proposed activities (yellow square: WWTW site, blue line: existing irrigation line, red circle: sportsfield), purple: old quarry, green, intersection of water line with potentially fossiliferous mudstones.

Conclusion and Recommendations

It is unlikely that palaeontological heritage material will be disturbed during development of the ponds, as the area designated for this activity is almost entirely sited on deep river alluvium of recent age.

Most of the waterline is also sited across geologically recent talus and alluvium that comprise a low angle “foot” along the base of the hill.

Where the waterline crosses the shaly slope (marked in green on Figure 6) any further development or excavation may expose palaeontological material. It is recommended that any excavation in this area should be monitored for disturbance of fossil bone.

It is recommended that monitoring is either carried out by a palaeontologist or alternatively by someone from the James Kitching Fossil Centre in Nieu Bethesda on the recommendation of Dr Rubidge.