

**HERITAGE IMPACT ASSESSMENT  
PROPOSED EXPANSION OR CONSTRUCTION  
OF BALANCING DAMS FOR THE  
VYEBOOM IRRIGATION BOARD ON  
KLIPFONTEIN FARM 23/82 AND  
TWAALFFONTEIN FARM 3/83, CALEDON**

**An assessment conducted under Section 38 (3) of the  
National Heritage Resource Act (No. 25 of 1999)**

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**September 2012**

## Executive Summary

Two **Notifications of Intent to Develop** (NIDs) were completed by BolandEnviro and submitted to Heritage Western Cape (HWC) Impact Assessment Review Committee (**IARCom**) for comment on the 26 June 2012. Since a number of proposed alternative dam and borrow pits sites are underlain by the potentially fossiliferous **Gydo Formation** (Bokkeveld Group), Heritage Western Cape requested a **Heritage Impact Assessment** (HIA) comprising a **Palaeontological Study** (Case No. 120627TS33, dated 18 July 2012). The HIA is part of the EIA process that is being conducted by Boland Environmental Consultants (BolandEnviro).

BolandEnviro requested **Dr John Almond of Natura Viva CC** conduct a Palaeontological Impact Assessment (PIA) for the proposed development. A brief field-based palaeontological assessment of the various alternative dam and borrow pit sites were undertaken on the 17<sup>th</sup> September 2012.

The development proposed by the **Vyeboom Irrigation Board** consists of developing either develop two new dams, or extend two existing dams, on farms situated the southern side of the Theewaterskloof Dam some 12 to 17 km southwest of the small town of Villiersdorp in the Caledon Magisterial District.

On **Farm Twaalfontein** (Farm 82, Portion 3) it is proposed to construct a new dam with a capacity of 100 000 cubic meters and wall height of 7 m, or to expand an existing dam. Three construction options (F1, F2, F3) are under consideration. The preferred option here is to extend the existing dam and this will require impermeable sealant material. Several possible sites in the vicinity for clay borrow pit to be exploited for sealant material to line the dam are under consideration (BP-C1, C2, C2b and C3).

On **Farm Klipfontein** (Farm 82, Portion 23) it is proposed to construct a new dam with a capacity of 54 000 cubic meters and wall height of 7 m, or to expand an existing dam. Two construction options (B1, B2) are under consideration. The preferred option here is to extend the existing dam.

The study area on **Farm Twaalfontein** overlaps the contact between cross-bedded fluvial sandstones of the Rietvlei Formation (Dr) at the top of the Table Mountain Group and the mudrocks of the Gydo Formation (Dg) at the base of the overlying Bokkeveld Group. The contact between these two units is faulted. Optional dam sites F1 and F2 overlie the relatively permeable Rietvlei sandstones and would require clay lining. Dam site F3 and all the optional borrow pit sites would be excavated into impermeable Gydo mudrocks.

The study area on **Farm Klipfontein** is entirely underlain by Gydo Formation mudrocks, although Rietvlei sandstones crop out just to the north on the far side of a SW-NE fault.

Field assessment of both the study areas shows that the Bokkeveld Group mudrocks in this region as a whole are deeply weathered, locally kaolinitised (cream coloured) and veined with ferruginous and manganese secondary minerals, usually imparting rusty, pinkish, lilac and ochreous hues. The proximity of both study areas to sizeable faults has probably promoted fracturing, groundwater movement and consequent deep weathering.

Cross-bedded sandstones of the Rietvlei Formation are exposed as subdued to prominent-weathering ridges to the southeast of dam site F on Twaalfontein. The Table Mountain Group rocks here show evidence of karstic (solution) weathering and are generally mantled by poorly sorted medium- to coarse colluvial gravels composed of angular to subrounded clasts of sandstone, ferricrete and vein quartz in a sandy matrix.

**The overall impact significance of the proposed dam and borrow pit developments on local fossil heritage is considered to be VERY LOW because:**

- The **Rietvlei Formation sandstones are fluvial in origin and unfossiliferous**, as well as modified by karstic weathering, in this area.
- The **Gydo Formation mudrocks here are highly weathered**, so any original fossils embedded within them have been destroyed. Deep chemical weathering has probably been promoted by faulting in the vicinity of both the study areas.
- Soils and surface gravels mantling the Palaeozoic bedrocks in the region are of very low palaeontological sensitivity.

**It is therefore recommended that exemption from further specialist palaeontological studies and mitigation be granted for the proposed dam and borrow pit developments.**

Should any substantial fossil remains (e.g. vertebrate bones and teeth, shells, petrified wood) be encountered during excavation, however, these should be safeguarded by the ECO and reported to Heritage Western Cape (Jenna Lavin Tel 021 483 9543) for appropriate mitigation by a professional palaeontologist.

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## **RECOMMENDED EXEMPTION FROM FURTHER PALAEOLOGICAL STUDIES & MITIGATION:**

### **PROPOSED DEVELOPMENT OF TWO DAMS & ASSOCIATED BORROW PITS ON FARMS KLIPFONTEIN & TWAALFONTEIN NEAR VILLIERSDORP, WESTERN CAPE**

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**September 2012**

#### **1. OUTLINE OF PROPOSED DEVELOPMENTS**

As part of the Vyeboom Irrigation Scheme it is proposed to either develop two new dams, or extend two existing dams, on farms situated the southern side of the Theewaterskloof Dam some 12 to 17 km southwest of the small town of Villiersdorp in the Caledon Magisterial District.

On **Farm Twaalfontein** (Farm 82, Portion 3) it is proposed to construct a new dam with a capacity of 100 000 cubic meters and wall height of 7 m, or to expand an existing dam. Three construction options (F1, F2, F3) are under consideration (Fig. 2). The preferred option here is to extend the existing dam (Alternative F1 in Fig. 2) and this will require impermeable sealant material. Several possible sites in the vicinity for a large clay borrow pit to be exploited for sealant material to line the dam are under consideration (BP-C1, C2, C2b and C3).

Since several of the proposed dam sites and all borrow pit sites are underlain by the potentially fossiliferous Gydo Formation (Bokkeveld Group), an HIA comprising a Palaeontological Study has been requested for this project by Heritage Western Cape (Case No. 120627TS33, dated 18 July 2012).

On **Farm Klipfontein** (Farm 82, Portion 23) it is proposed to construct a new dam with a capacity of 54 000 cubic meters and wall height of 7 m, or to expand an existing dam. Two construction options (B1, B2) are under consideration (Fig. 3). The preferred option here is to extend the existing dam (Alternative B1 in Fig. 3).

Since the proposed dam sites are underlain by the potentially fossiliferous Gydo Formation (Bokkeveld Group), an HIA comprising a Palaeontological Study has been requested for this project by Heritage Western Cape (Case No. 120627TS33, dated 18 July 2012).

A brief field-based palaeontological assessment of the various alternative dam and borrow pit sites was commissioned by BolandEnviro CC, Worcester (Contact details: Mr N.J. Wullschleger, BolandEnviro CC, 74 Stockenstroum Street, Worcester 6850; tel: 023 347-0336 ; email: info@BolandEnviro.co.za).

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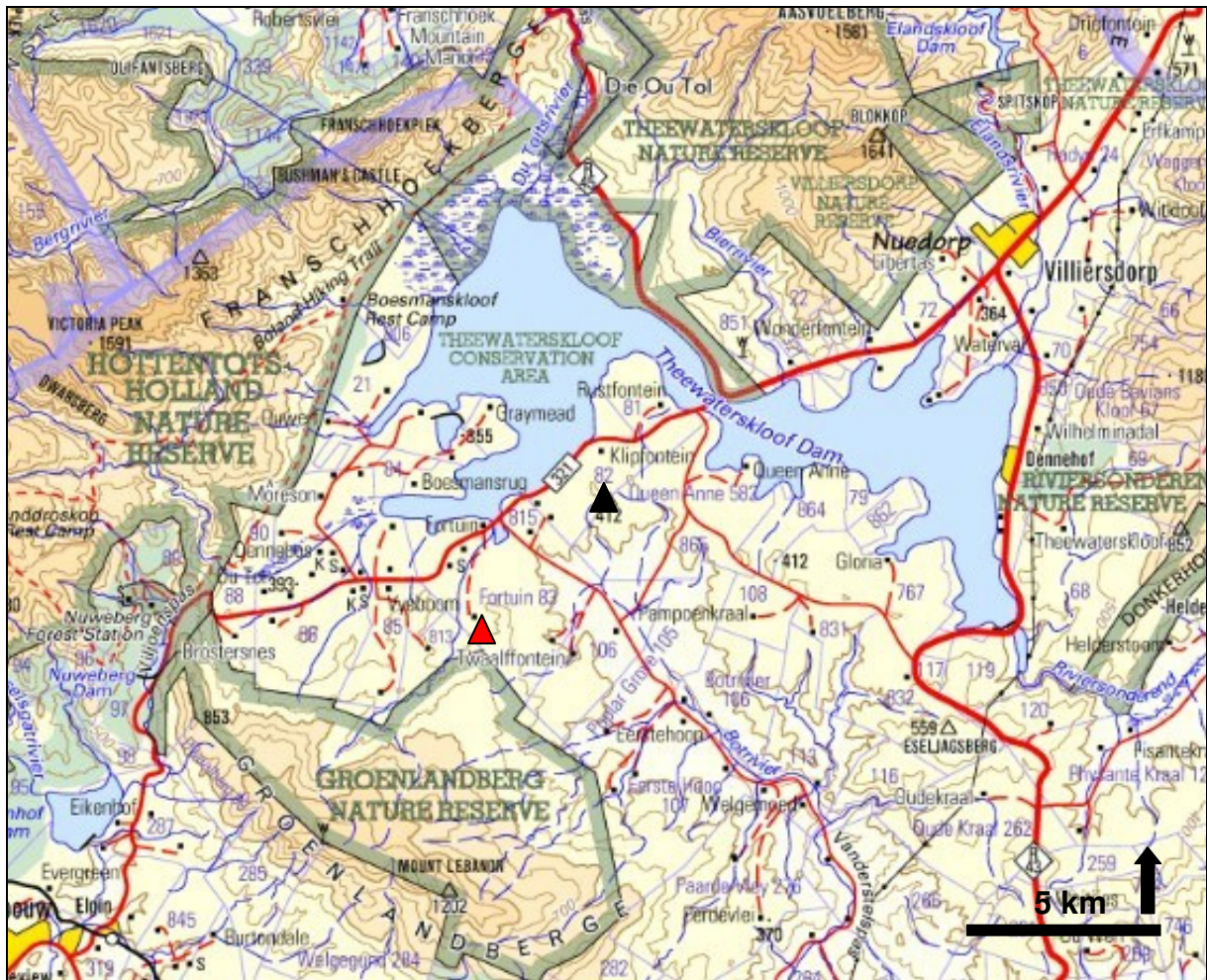


Fig. 1. Extract from 1: 250 000 topographical sheet 3319 Worcester (Courtesy of the Chief Directorate Surveys & Mapping, Mowbray) showing the approximate location of the two study areas on Farm Twaalfontein (red triangle) and Klipfontein (black triangle), situated on the southern side of the Theewaterskloof Dam some 12 - 17 km southwest of Villiersdorp, Caledon Magisterial District, Western Cape.



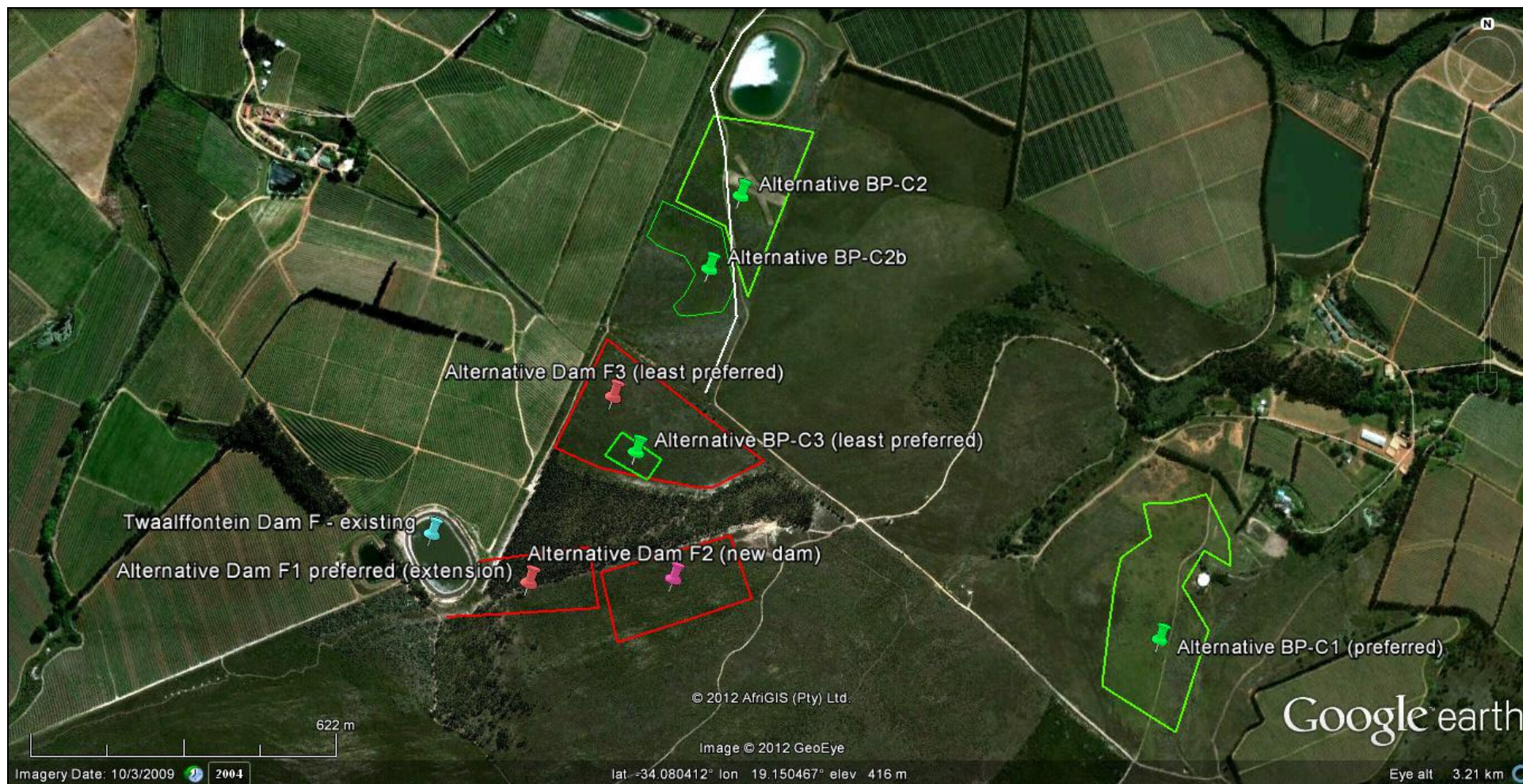


Fig. 2. Google earth© satellite image of the study area on the Farm Twaalfontein showing the various site options for the proposed new or extended dam (in red) and the associated clay borrow pit (in green).





Fig. 3. Google earth© satellite image of the study area on the Farm Klipfontein showing the two site options for the proposed new or extended dam (in red).



## 2. GEOLOGICAL BACKGROUND

The geology of the two dam study areas near Villiersdorp is shown on 1: 250 000 geology sheet 3319 Worcester (Gresse & Theron 1992) (Fig. 4). The terrain here is gently hilly and levels of bedrock exposure are generally low to very low due to soil and vegetation cover (renosterveld, eucalyptus plantations). However, informative small exposures of bedrocks can be seen in incised farm tracks, stream gullies and test pits, while more extensive exposures are available in road cuttings along the R312 which runs along the southern shore of Theewaterskloof Dam between the two study areas (Fig. 5).

The study area on Farm Twaalfontein overlaps the contact between cross-bedded fluvial sandstones of the Early Devonian **Rietvlei Formation (Dr)** at the top of the Table Mountain Group and the basinal marine mudrocks of the Early Devonian **Gydo Formation (Dg)** at the base of the overlying Bokkeveld Group. The contact between these two units is a faulted one here, as shown on the geological map. Optional dam sites F1 and F2 overlie the relatively permeable Rietvlei sandstones and would require clay lining. Dam site F3 and all the optional borrow pit sites would be excavated into impermeable Gydo mudrocks.

The study area on Farm Klipfontein is entirely underlain by Gydo Formation mudrocks, although Rietvlei sandstones crop out just to the north on the far side of a SW-NE fault.

Field assessment of both the study areas shows that the Bokkeveld Group mudrocks in this region as a whole are deeply weathered, locally kaolinitised (cream coloured) and veined with ferruginous and manganese secondary minerals, usually imparting rusty, pinkish, lilac and ochreous hues (Figs. 5, 8 & 9). Fresher-looking, dark grey mudrocks are only very rarely observed. The proximity of both study areas to sizeable faults has probably promoted fracturing, groundwater movement and consequent deep weathering. The Bokkeveld Group rocks are usually mantled with fine silty to gravelly soils, but downwasted surface gravels of ferruginised siltstone, ferricrete, wackes and minor vein quartz are also commonly seen (Fig. 9).

Cross-bedded buff-weathering sandstones of the Rietvlei Formation are exposed as subdued to prominent-weathering ridges to the southeast of dam site F on Twaalfontein (Fig. 6). The Table Mountain Group rocks here show evidence of karstic (solution) weathering and are generally mantled by poorly sorted medium- to coarse colluvial gravels composed of angular to subrounded clasts of sandstone, ferricrete and vein quartz in a sandy matrix (Fig. 7).

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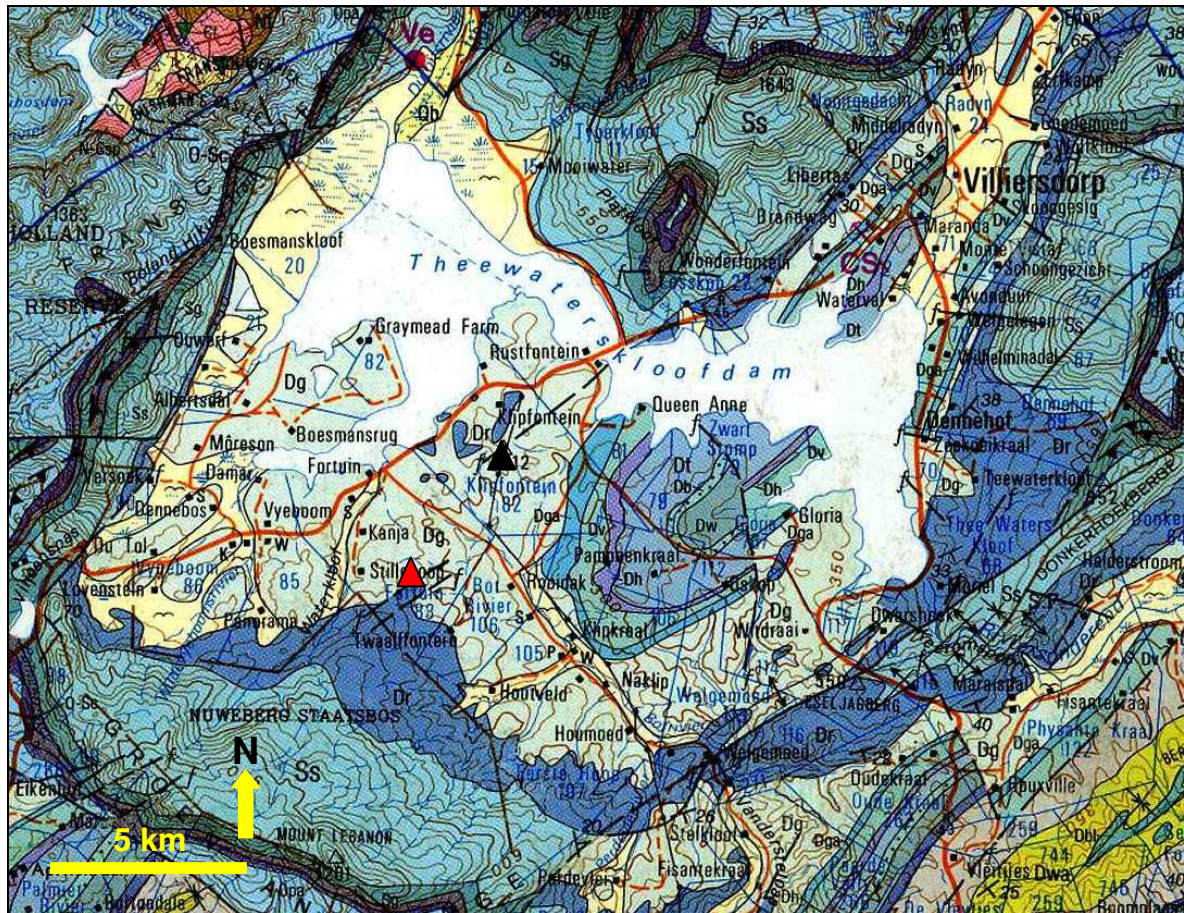


Fig. 4. Extract from 1: 250 000 geological sheet 3319 Worcester (Council for Geoscience, Pretoria) showing the approximate location of the two study areas on Farm Twaalfontein (red triangle) and Klipfontein (black triangle) near Villiersdorp. Early Devonian sedimentary rock units underlying the two study sites include the Rietvlei Formation in the uppermost Table Mountain Group (Dr, dark blue) and the Gydo Formation at the base of the Bokkeveld Group (Dg, pale blue-green).

### 3. PALAEOLOGICAL HERITAGE

The bulk of the **Rietvlei Formation** succession in the Worcester sheet study region is interpreted as a braided fluvial deposit (Theron & Basson 1989, Gresse & Theron 1992). Marine influence increases markedly towards the east where fully marine, low-diversity shelly faunas dominated by thick-shelled pleurothyrellid brachiopods are recorded (Almond 2008 and refs. therein). These invertebrates are the first representatives of the cool-water Malvinokaffric Realm biotas within the Cape Basin and establish an Early Devonian (Lochkovian / Pragian) age for the formation (Boucot 1999). As elsewhere within the Table Mountain Group, mudrock-rich intervals within the Rietvlei Formation are associated with low diversity ichnoassemblages – mainly vertical “pipe rock” burrows of filter-feeding invertebrates - that imply intermittent shallow marine transgressions over the sandy, near coastal braid plain.

No fossils are recorded from the Rietvlei Formation in the Worcester sheet area by Gresse & Theron (1992) and none were observed during the field assessment.

The lower part of the **Bokkeveld Group** in the Western Cape (Ceres Subgroup *plus* lowermost Bidouw Subgroup) – and in particular the **Gydo Formation** - is known for its rich fossil assemblages of shallow marine invertebrates of the Malvinokaffric Faunal Province of Gondwana



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(Cooper 1982, Oosthuizen 1984, Hiller & Theron 1988, Theron & Johnson 1991, MacRae 1999, Almond *in* De Beer *et. al.* 2002, Thamm & Johnson 2006, Almond 2008). Key fossil groups here include trilobites, brachiopods, various subgroups of molluscs (bivalves, gastropods, nautiloids *etc*), and echinoderms (starfish, brittle stars, crinoids, carpoids, sea cucumbers *etc*), with several minor taxa including corals, conulariids, tentaculitids, bryozoans and rare fish remains, among others (Almond 1997, Anderson *et al.* 1999). These shelly fossil assemblages – generally preserved as impressions or moulds, but occasionally in the Gydo Formation also embedded within phosphatic, limestone or siliceous nodules – are especially abundant within the mudrock-dominated units such as the Gydo, Voorstehoek and Waboomberg Formations in their more distal (offshore) outcrop areas. Thin lenticles of shelly debris, known as *coquinas*, have been concentrated by storm activity and mainly consist of disarticulated specimens.

Gydo Formation fossils from various localities in the Worcester sheet area are listed by Gresse & Theron (1992), but apparently not from the Villiersdorp area. Sparse shelly fossils have been collected, however, from Lower Bokkeveld mudrocks exposed at newly excavated dam sites in the area between Villiersdorp and Worcester by the author (Almond, unpublished observations). No fossil remains were observed within the weathered Bokkeveld mudrocks at either of the present study areas during field assessment.

**The overall palaeontological sensitivity of the Twaalfontein and Klipfontein study areas is assessed as VERY LOW.**



**Fig. 5. Extensive road cutting through deeply-weathered, multi-hued mudrocks of the Gydo Formation exposed along the R321 between the two study sites.**





**Fig. 6. Subdued exposure of weathered (leached), cross-bedded sandstones of the Rietvlei Formation within F2 dam site study area on Twaalfontein.**



**Fig. 7. Poorly-sorted, partially ferruginised colluvial gravels mantling the Rietvlei Formation outcrop area within F1 dam site study area on Twaalfontein.**





**Fig. 8.** Weathered, ferruginised mudrocks of the Gydo Formation exposed in a farm track close to the F3 dam site on Twaalfontein (Hammer = 29 cm).



**Fig. 9.** Trackway exposure of weathered, ferruginised Gydo Formation mudrocks and downwasted surface gravels within the study area on Farm Klipfontein (Hammer = 29 cm).

#### 4. CONCLUSIONS & RECOMMENDATIONS

The overall impact significance of the proposed dam and borrow pit developments on local fossil heritage is considered to be **VERY LOW** because:

- The **Rietvlei Formation sandstones are fluvial in origin and unfossiliferous**, as well as modified by karstic weathering, in this area.
- The **Gydo Formation mudrocks here are highly weathered**, so any original fossils embedded within them have been destroyed. Deep chemical weathering has probably been promoted by faulting in the vicinity of both the study areas.
- Soils and surface gravels mantling the Palaeozoic bedrocks in the region are of very low palaeontological sensitivity.

**It is therefore recommended that exemption from further specialist palaeontological studies and mitigation be granted for the proposed dam and borrow pit developments.**

Should any substantial fossil remains (*e.g.* vertebrate bones and teeth, shells, petrified wood) be encountered during excavation, however, these should be safeguarded by the ECO and reported to Heritage Western Cape for appropriate mitigation by a professional palaeontologist.

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## 6. 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 under the aegis of his Cape Town-based company *Natura Viva* cc. He is 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 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**