Palaeontological Heritage Impact Assessment for housing development north of Grahamstown and development in Belmont Valley

Prepared for: Belmont DevCo

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Background

The Belmont DevCo plans to relocate Grahamstown's current golf course to the Belmont Valley in the Albany District, Eastern Cape Province of South Africa and in doing so develop a residential scheme in its place. The proposed residential scheme will cover the existing golf course, which is situated outside the urban edge of Grahamstown.

1. The residential scheme will comprise of approximately 850, 500m^2 plots, a student village and shopping centre, all of which will house for a community in excess of 4000-6000 individuals.

2. The Belmont DevCo plans to relocate and re-develop Grahamstown's current golf course to the Belmont Valley in the Albany District, Eastern Cape Province of South Africa. The proposed site is on portions 1 and 2 of the farm Willow Glen and portion 6 of Belmont farm, all of which are situated approximately 8km northeast of Grahamstown.

Rob Gess Consulting was contracted to conduct a phase one Palaeontological Impact Assessment for this proposed development.

Geology and Palaeontology

The areas intended for development overlie strata of the upper portion of the Cape Supergroup and lowermost portion of the unconformably overlying Karoo Supergroup. In addition, portions of the Cape Supergroup rocks are capped by relict patches of Silcrete, belonging to the Grahamstown Formation, formed as a product of deep leaching during the Cretaceous.

Cape Supergroup rocks represent sediments deposited in the Agulhas Sea, which had opened to the south of the current southern African landmass, in response to early rifting between Africa and South America during the Ordivician.

The Witteberg Group is the uppermost of three subdivisions of the Cape Supergroup and was laid down during the Late Devonian.

The stratigraphically lowest Witteberg Group strata present (according to the Geological Survey) belong to the Late Devonian (Famennian) **Witpoort Formation (Lake Mentz Subgroup, Witteberg Group, Cape Supergroup)**. This largely quatzitic unit represents mature sandy strata deposited along a linear barrier island type coast. Particularly around Grahamstown black shale lenses, interpreted as estuarine deposits preserved during brief transgressive events, have proved remarkably fossiliferous. A series of lenses at Waterloo Farm, to the south of Grahamstown, have provided southern Africa's most important Late Devonian locality, which has yielded at least 20 taxa of fossil fish (including jawless fish (Agnatha), armoured fish (Placodermi), spiny sharks (Acanthodii), sharks (Chondrichthyes), ray finned fish (Actinopterygii) and lobe finned fishes (Sarcopterygii) including Coelacanths

(Actinistia), lungfish (Dipnoi) and Osteolepiformes. Dozens of plant and algal taxa, remains of giant eurypterids and other arthropods as well as abundant trace fossils have also been collected. The top of the Witpoort Formation coincides with the end of the Devonian and is similar in age to the end-Devonian extinction event. Witpoort Formation quartzites have yielded a range of plant stem taxa and trace fossils. Lag deposits of bone have not, as yet, been discovered, but may be expected.

The early to mid Carboniferous is represented by overlying mudstone and sandy units of the remainder of the **Lake Mentz Subgroup (Witteberg Group, Cape Supergroup**). These were deposited as sediment during the last phase of the Agulhas Sea, by which time it was much restricted and was possibly (at least partially) cut off from the open sea. The **Waaipoort Formation** (uppermost **Lake Mentz Subgroup Witteberg Group, Cape Supergroup**) provides evidence for a post-extinction Agulhas Sea fauna, dominated by a range of ray-finned-fish (Actinopterygii), but also containing a relict shark and 2 types of spiny sharks (Acanthodii).

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. Lowermost Karoo strata of the Dwyka and lower Ecca Groups were affected by folding in the vicinity of the Cape Fold Belt.

The **Dwyka Group** (**Karoo Supergroup),** particularly here in the south of the basin consists almost exclusively of diamictite known as the Dwyka tillite. This is a distinctive rock type which, when freshly exposed, consists of a hard fine-grained blueish-black matrix in which abundant roughly shaped clasts are embedded. These vary greatly in both lithology and size. During the formation of the Dwyka, beginning in the late Carboniferous, southern Africa drifted over the south pole, whilst simultaneously, the world was experiencing a cold episode. Glaciers flowing into the flooded Karoo basin broke up, melted and discharged a mixture of finely ground rock flour and rough chunks of rock. These formed the matrix and clasts of the Dwyka tillite. Within the study area fossils are not known from the **Dwyka Group (Karoo Supergroup)**.

During the Cretaceous and early Tertiary Periods much of Africa was weathered down to a number of level horizons collectively known as the African Surface. The area in the vicinity of Grahamstown was reduced to a flat plain close to sea level, remnants of which are referred to as the Grahamstown Peneplane. During the Tertiary, mudstones, shales and diamictites were leached to considerable depth, transforming them into soft white kaolin clay. Silica, iron and magnesium from these rocks was carried in solution by groundwater and deposited near the ground surface due to steady evaporation of mineral rich waters. This lead to the formation of a hard mineralised capping layer, often consisting of silicified soil. Resultant silcretes are referred to as the **Grahamstown Formation**. Though occasional occurrences of root and stem impressions have been recorded from the Grahamstown Formation it is generally considered unfossiliferous.

With subsequent reduction of the relative sea level, deep valleys have carved back from the retreating coastline, cutting deep valleys and catchment areas into the African Surface.

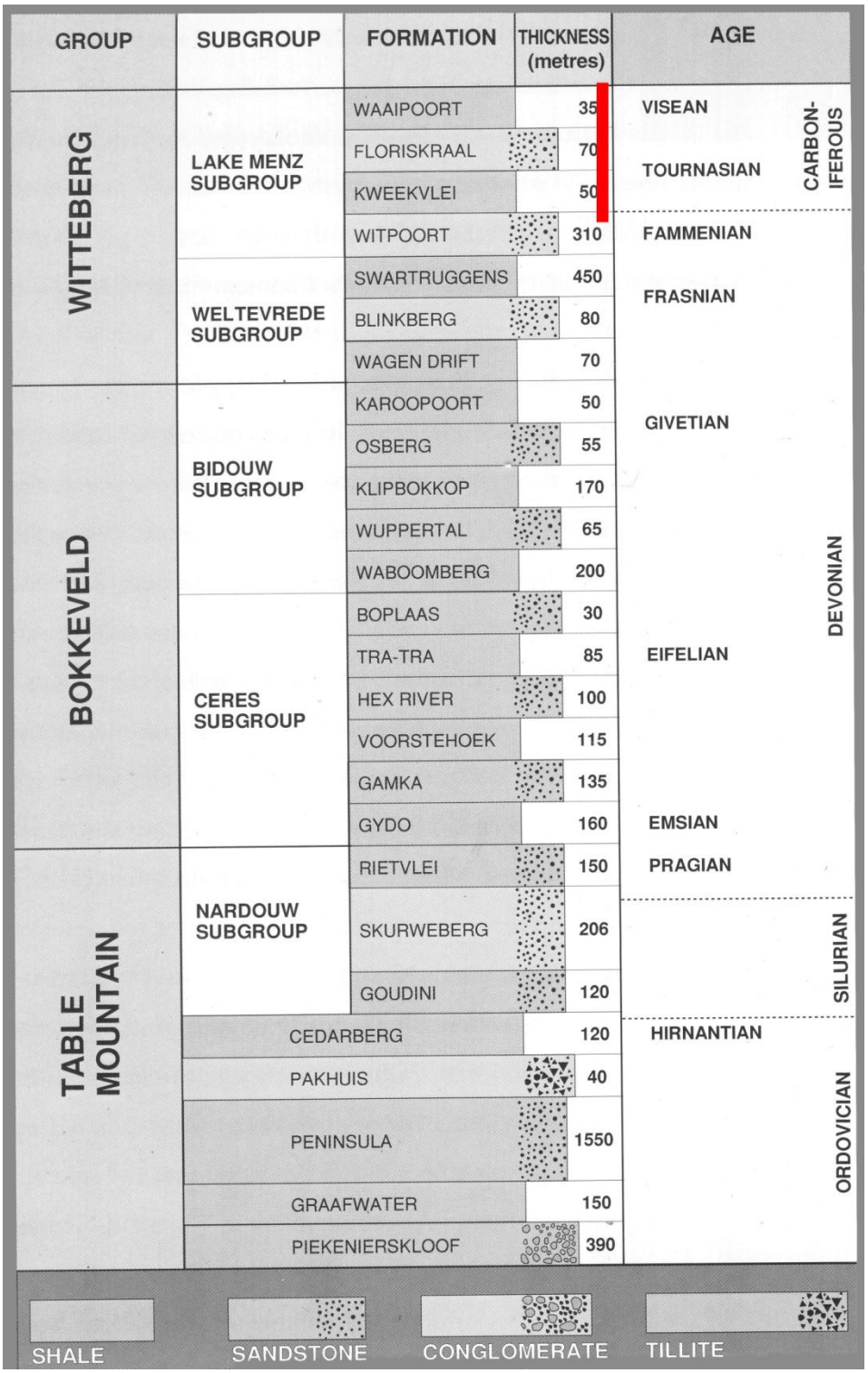

Figure 1: Stratigraphic column of the Cape Supergroup modified after Theron and Thamm (1990) following Cotter (2000). Red line indicates strata impacted by the development (according to the geological survey maps).

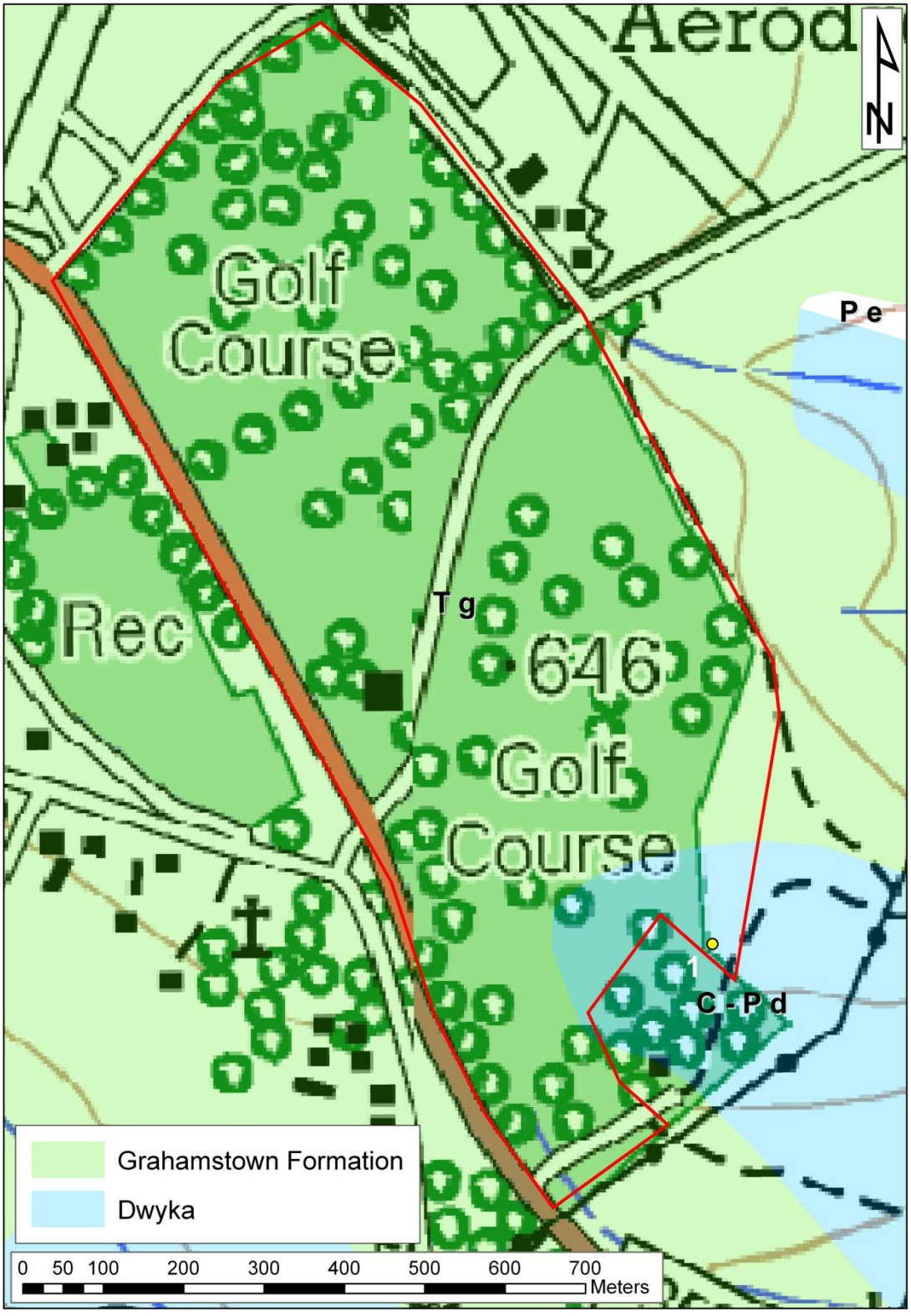

Figure 2: Map of the current Golf Course north of Grahamstown with overlay of geology according to the Geological survey (see key) and study area (red outline), interest point 1 (yellow dot).

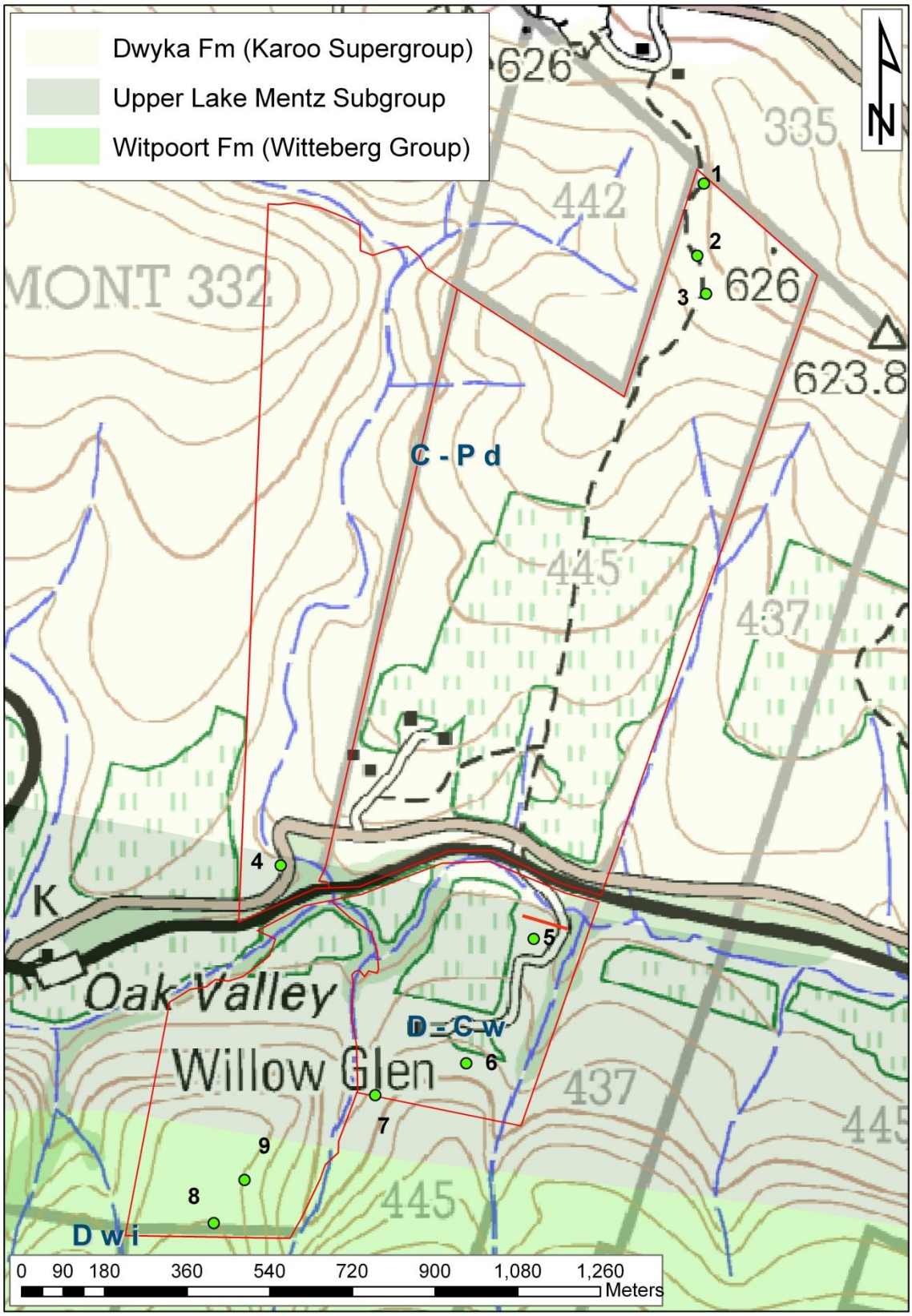

Figure 2: Map of portion of Belmont Valley intended for development, with overlay of geology according to the Geological Survey (see key) and study area (red outline), interest points 1-9 (yellow dots). Short red line at pt.5 indicates position of Witteberg/Dwyka contact.

Site Visits

The proposed development areas were surveyed on foot during February 2012.

North of Grahamstown

The area to the north of Grahamstown is currently a golf course. Small outcrops of silcrete are situated within the 'roughs' and to the south of the course, to the south of where the survey map places the boundary with the underlying Dwyka diamictite (Fig.2 point 1, Fig. 4). Here and elsewhere on the golf course the Grahamstown Formation takes the form of a tan to reddish iron rich silcrete embedding angular quartzite and vein quartz pebbles probably derived from Witpoort Formation strata. No indication of ancient wetlands was observed.

Figure 4. Sicretes of the Grahamstown Formation consisting of unsorted angular quartzitic pebbles, presumably derived from weathering of nearby Witpoort formation uplands, cemented in a tan to reddish iron rich silcrete matrix. In the south of the study area north of Grahamstown. Scale bar in centimetres.

Belmont Valley

In Belmont Valley the eastern side of the valley (see Figure 5) is comprised entirely of Dwyka Group diamictite and products of its breakdown. This was confirmed during the site visit, though it was found that the contact with underlying Witteberg strata was somewhat to the west of the position shown on the map.

Figure 5. Eastern side of the Belmont Valley development area taken from above the western side of the study area. Note kaolin quarry to the east of the study area (top left of photo).

In the extreme east of the study area (ie. between Fig.3. pt.1 and pt.3) remnants of the silcrete that caps the ridge are encountered. Immediately to the east of the study area this silcrete overlies kaolin clay derived from leached Dwyka diamictite, (see Fig.5). An old kaolin prospecting pit (Fig.3 pt.2, Fig. 7) however reveals that within the study area the Dwyka diamictite, even immediately below the silcrete, is not leached to the grade of kaolin but exists as a crumbly yellowish sub clay.

Figure 6. Grahamstown formation silcrete in east of Belmont Valley study area (Fig. 3 pt. 1)

Figure. 7. Crumbly yellow weathered diamictite exposed in a prospecting pit in the extreme east of the study area (Fig. 3 pt.1)

Small outcrops of diamictite are found throughout the western side of the study area, extending to the west of the mapped area. These are well exposed in the roadside sloot at, for example Fig. 3 pt. 4. (Figure 8)

Figure 8. Dwyka diamictite exposed to the west of its mapped outcrop area at Fig.3. pt.4.

The western side of Belmont Valley exposes overturned strata representing the locally stratigraphically uppermost strata of the Witteberg Group and the stratigraphically lowermost deposits of the Dwyka Group (Karroo Supergroup). The contact (red line) between these strata is well exposed in a small quarry (Fig. 3. Pt. 5.).

Figure 9 Western side of Belmont Valley area from the eastern side. Development area extends approximately half way up the valley side. Note small quarry at bottom left.

Within this quarry (Fig. 3. Pt. 5.) the strata are near vertical and overturned such that the stratigraphically overlying Dwyka Group deposits physically underlie Witteberg group strata. The adjacent uppermost Witteberg Group strata exhibit overturned ripple cross beds highlighted by iron concentrated in palaeoripple troughs (Fig. 10). Other, more clay rich strata preserve fossilised plant fragments (Fig. 11).

Figure 10: Overturned ripple cross beds preserved in Witteberg Group strata immediately stratigraphically underlying Dwyka Group (at pt.5. Fig. 3) . Scale in centimetres.

Figure 11: Plant fragments preserved in locally uppermost Witteberg Group strata at pt.5 (Fig. 3). Scale bars = 1cm.

Quartzitic strata that define the valley side and that have been mapped as belonging to the upper Lake Mentz subgroup are (eg. Fig. 3 pts. 6 and 7) are also near vertical to overturned (see fig. 12).

Figure 12: Overturned Witteberg Group quartzites exposed at point 7 (Fig. 3)

The most westerly (stratigraphically lowest) quartzites within the study area were considered by the Geological Survey to belong to the Witpoort Formation (lower Lake Mentz Subgroup, Witteberg Group). A reassessment of the local boundary between these units is, however, in great need of revue.

Figure 13: Witteberg quartzite strata in the far west of the study area at point 8 (Fig. 3)

The presence of impressions of mud chip lag deposits in Witteberg strata at point 9 (Fig. 3) suggests probable proximity to a river mouth. No plant stem or bone impressions were, however, observed.

Figure 14: Casts of mud chips, possibly deposited as a lag deposit within shoreline sands near a river mouth.

Conclusions and Recommendations

North of Grahamstown

In the area north of Grahamstown where the current golf course is situated it is extremely unlikely that any significant palaeontological resources will be disturbed at any stage during the project. **Should any suspected fossils be uncovered during construction a palaeontologist should immediately be notified**.

Belmont Valley

It can be said with confidence that within the Belmont Valley study area, all land to the east of the Blaaukrantz River, (chiefly underlain as it is by weathered Dwyka diamictite) has an almost zero likelihood of containing any palaeontological material.

To the **west of the Blaaukrantz River**, however, where Witteberg Group strata underlie the study site, particularly where mudstones and shales are likely to be exposed, (such as between the river and the foot of the hills it is *probable* that plant (and possibly fish) fossils will be disturbed by earth moving activities such as road construction and the landscaping of the proposed golf course. Though the disturbance of such fossils is likely to be *localised*, a particularly significant find could be of *international* importance. Destruction of material would be of a *severe permanent* nature though *long term benefit* could be gained from the discovery of significant new material.

Although it is difficult to numerically quantify potential palaeontological impacts according to standard models it can be said that potential palaeontological impacts to the east of the Blaaukrantz River in Belmont Valley are of *Moderate Significance*. Any negative impact resultant from disturbance of fossiliferous bedrock could be mitigated to a benefit to science if the disturbed material was sampled and studied.

It is therefore recommended that within this restricted area all large scale earthworks including road construction, pond excavation, levelling etc. should be monitored by a palaeontologist.

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