Palaeontological Heritage Impact assessment for quarry extension at the Orchards, east of Makhanda/Grahamstown.

Prepared for: Makana Brick

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General Declaration

I, Dr Rob Gess, declare that –

- I act as the independent Specialist in this application;
- I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favorable to the applicant;
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting environmental impact assessments, including knowledge of the Act, regulations and any guidelines that have relevance to the proposed activity;
- I will comply with the Act, regulations and all other applicable legislation;
- I will take into account, to the extent possible, the matters listed in regulation 8 of the regulations when preparing the application and any report relating to the application;
- I have no, and will not engage in, conflicting interests in the undertaking of the activity;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the application by the competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- I will provide the competent authority with access to all information at my disposal regardingthe application, whether such information is favorable to the applicant or not;
- all the particulars furnished by me in this form are true and correct;
- I will perform all other obligations as expected from an environmental assessment practitioner in terms of the Regulations; and
- I realize that a false declaration is an offence and is punishable in terms of section 24F of the Act.

Disclosure of Vested Interest

I do not have and will not have any vested interest (either business, financial, personal or other) in the proposed activity proceeding other than remuneration for work performed in terms of the Amendments to Environmental Impact Assessment Regulations, 2014 as amended.

Legislative Background

The National Heritage Act (Act 25 of 1999) safeguards all heritage resources. As per Sections 35 and 38 of the Act, any palaeontological report is a part of the Heritage Impact Assessment. Section 35 is concerned with the protection of archaeological, palaeontological, and meteorite resources found in South Africa, except for fossils that originate outside of the country.

(1) the protection of archaeological and palaeontological sites and material and meteorites is the responsibility of a provincial heritage resources authority.
(2) all archaeological objects, palaeontological material and meteorites are the property of the State. (3) Any person who discovers archaeological or palaeontological objects or material or a meteorite in the course of development or agricultural activity must immediately report the find to the responsible heritage resources authority, or to the nearest local authority offices or museum, which must immediately notify such heritage resources authority.
(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 in the detection or recovery of metals or archaeological and palaeontological material or objects, or use such equipment for the recovery of meteorites.
(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 procedure 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 from 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.
(6) The responsible heritage resources authority may, after consultation with the owner of the

land on which an archaeological or palaeontological site or a meteorite is situated, serve a notice on the owner or any other controlling authority, to prevent activities within a specified distance from such site or meteorite.

According to Section 38 (1), a Heritage Impact Assessment is necessary to assess any potential impacts on palaeontological heritage within the development footprint where:

(a) the construction of a road, wall, power line, pipeline, canal or other similar form of linear development or barrier exceeding 300 m in length;
(b) the construction of a bridge or similar structure exceeding 50 m in length;
(c) any development or other activity which will change the character of a site—
i. exceeding 5 000 m2 in extent; or
ii. involving three or more existing erven or subdivisions thereof; or
iii. involving three or more erven or divisions thereof which have been consolidated within the past five years; or
iv. the costs of which will exceed a sum set in terms of regulations by SAHRA or a provincial heritage resources authority,
v. the re-zoning of a site exceeding 10 000 m² in extent;
vi. or any other category of development provided for in regulations by SAHRA or a Provincial heritage resources authority.

Contents:

Background

Makana Brick is applying to register a mining right on a portion of the farm The Orchards in accordance with Regulation 42 of the mining titles registration act 16 of 1967. The Orchards is situated to the north of Makhanda (Grahamstown) along the ridge which includes Governors Kop. Rob Gess Consulting was contracted to conduct a PIA as part of the EIA process.

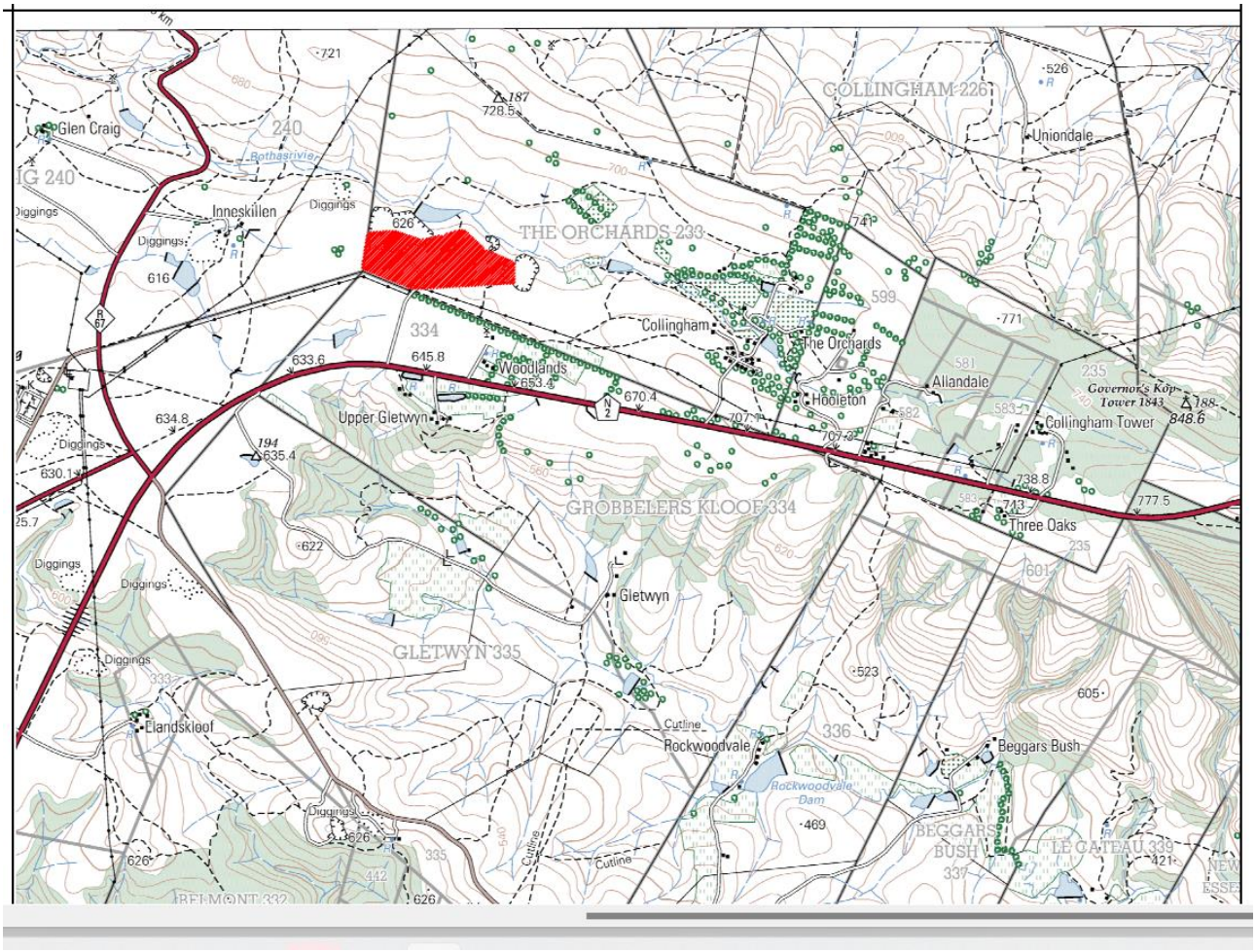

Figure 1: Map showing proposed mining right.

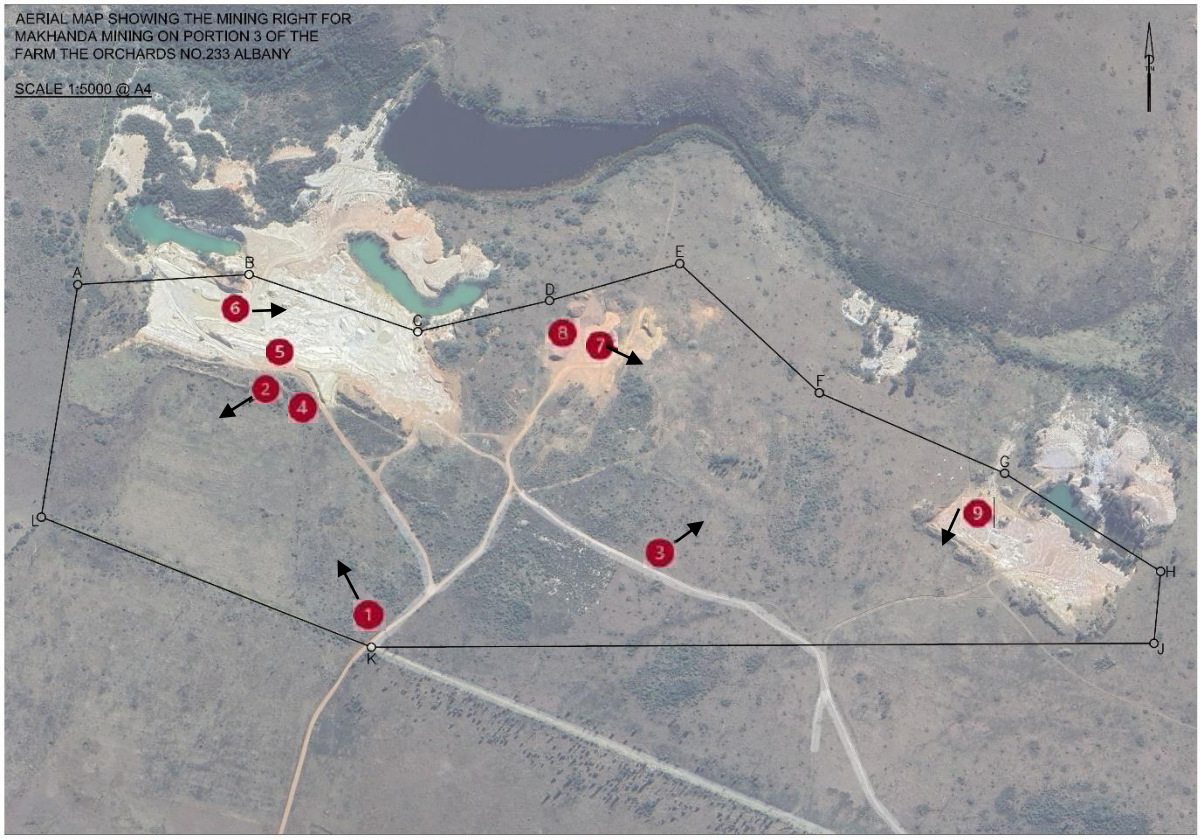

Figure 2: Arial view of proposed mining right area with photo points indicated.

Geological Overview

The proposed mining right overlies strata of the Late Devonian to early Carboniferous portions of the Witteberg Group, the upper portion of the Cape Supergroup. The majority of the area is underlain by the strata of the Famennian aged (372-360 myo) **Witpoort Formation**, with the unconfirmed possibility that portions of the stratigraphically overlying **Kweekvlei Formation** (of the lowermost Lake Mentz subgroup), may be encroached on in the extreme south. These are, in part, capped by relict portions of Silcrete of the **Grahamstown Formation -** formed as a hard crust at surface during deep leaching of underlying strata during the Cretaceous period. This leaching reciprocally reduced much of the underlying mudstone to kaolinite – which is the intended mining target.

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 Ordovician period. The Witteberg Group is the uppermost of three subdivisions of the Cape supergroup and was laid down during the Late Devonian and early Carboniferous periods.

The Orchards Farm is situated on the Botha's Hill – Governor's Kop Ridge which represents a giant exhumed north-east to south-west trending anticlinal (upwardly bent) fold of resilient Witpoort Formation quartzite – which is overturned towards the east. A thick bed of black shale, uplifted within the fold, runs the length of the ridge. Erosion on the overlying quartzitic strata exposed this shale to leaching, and during wetter phases it has largely been reduved to white

kaolin clay. Differential weathering of this clay has resulted in a valley running longitudinally along the top of the ridge. The kaolininitised shale has been periodically mined through the 20th century at various points along the ridge, including immediately adjacent to the current mining licence application area. In previous mining areas less leached material is sometimes exposed at depth, and may also be exposed as mining moves south, and potentially into areas that still retain overlying quartzite.

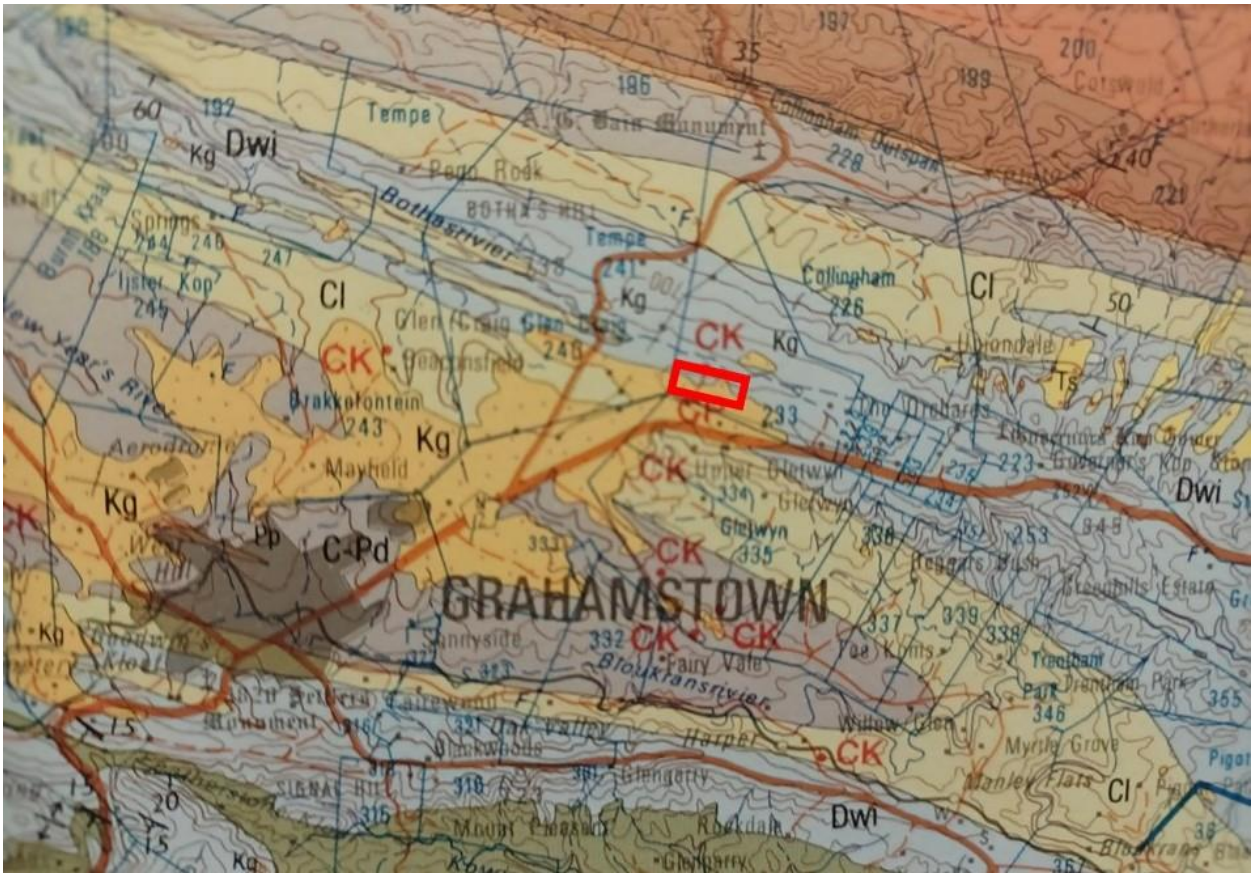

Figure 1: Extract of the Geological Survey map of the Makhanda/Grahamstown area with the proposed mining right application area indicated by a red rectangle. Blue (Dwi) represents the Witpoort Formation (Witteberg Group), light green (Cl) represents the Lake Mentz Subgroup (Witteberg Group), grey (C-Pd) represents the Dwyka Formation (Karoo Supergroup) and mustard (Kg) represents the capping of Grahamstown Formation silcrete.

Palaeontology of affected strata

The **Witpoort Formation** is Famennian (uppermost Devonian) in age. That is approximately 359 to 372 million years old. It is a largely quatzitic unit representing mature sandy strata deposited along a linear barrier island type coast. The lower portion of the Witpoort Formation tends to have a brownish weathering character, whereas the upper portion (sometimes referred to as the Perdepoort Member) tends to comprise much cleaner whiter weathering quartzites. Particularly around Makhanda/Grahamstown black shale lenses are interbedded within the

Witpoort Formation quartzites. These are interpreted as estuarine deposits preserved during brief transgressive events, and have proven remarkably fossiliferous.

A series of lenses at Waterloo Farm, to the south of Grahamstown, have provided southern Africa's most important Late Devonian locality, representing an entire coastal estuarine ecosystem and adjacent terrestrial environment. It has yielded fragmentary remains of Africa's earliest known four legged animals, the aquatic tetrapods, *Tutusius umlambo* and *Umzantsia amazana* and 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 Tristichopterids. Of these nine have as yet been described including the world's oldest lamprey fossil, *Priscomyzon riniensis,* and Africa's earliest coelacanth from the world's oldest known coelacanth nursery, *Serenichthys kowiensis.* Seaweeds, brack-water charophytes and fresh to brack-water bivalves have been described and a giant Eurypterid identified. The terrestrial realm is represented by the remains of a scorpion, *Gondwanascorpio emzantsiensis,* the oldest known terrestrial animal from the supercontinent Gondwana, Dozens of land plant taxa have been revealed, including zosterophylls, lycopods (eg. *Kowieria alveofolis, Colpodexylon pullumpedes* and *Leptophloem rhombicum*), iridopteralian-like plants (*Flabellopteris lococannensis*), sphenophytes (eg *Rinistachya hilleri*) and early progymnosperms, such as *Archaeopteris notosaria*, southern Africa's earliest known fossil tree. Abundant trace fossils have also been collected. 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.

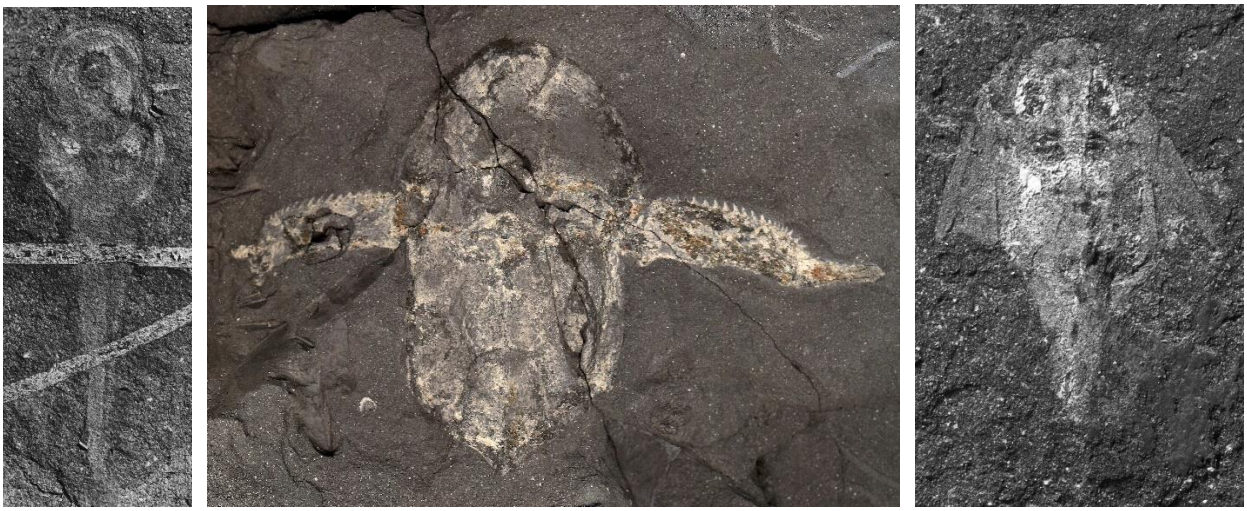

Figure 3: Selection of fossils recovered from a black shale lens at Waterloo Farm: top left, 4.2 cm long *Priscomyzon riniensis* (the world's oldest fossil lamprey); *top middle*, 6.5 cm long head and trunk armour of a young *Bothriolepis africana*, an antiarch placoderm fish; top right, 2.5 cm long neonatal *Groenlandaspis riniensis*, an arthrodire placoderm fish.

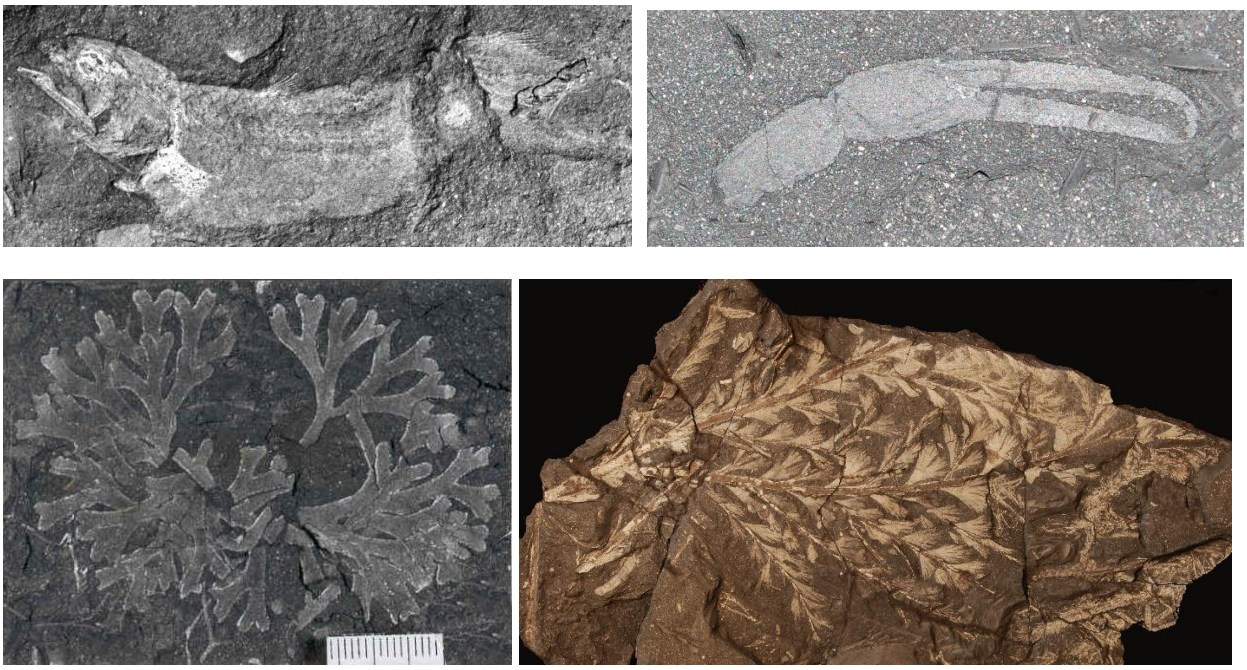

Figure 4: Selection of fossils recovered from a black shale lens at Waterloo Farm: *top left*, 5.5 cm long type specimen of the coelacanth *Serenichthys kowiensis*; *top right*, 3,4 cm long pincer of the scorpion, *Gondwanascorpio emzantsiensis* (the oldest known terrestrial animal from Gondwana); *bottom left*, 7 cm across tuft of the seaweed *Hungerfordia fionae*; *bottom right*, 30 cm long fronds of the progymnosperm tree *Archaeopteris notosaria* (the oldest known species of woody tree from southern Africa).

Figure 5: Fossils in quartzites at Waterloo Farm: left lycopod *Leptophloem rhombicum* stems; right, progymnosperm *Archaeopteris* trunk.

In 2015 roadworks to the east of the orchards, along the Governor's Kop section of the N2 at Coombs Hill and Rabbit Ridge, uncovered a number of palaeontologically important black shale

lenses. Those along Rabbit Ridge (Green Hills) represented exposure of an extensive vertically tilted black shale horizon that yielded evidence for a monotaxic assemblage of lingulid brachiopods (*Dignomia* sp.) in a back-barrier tidal flats environment. This represented the first record of predominantly marine invertebrate shells within the Witpoort Formation. These sites also produced fragmentary plant remains, an arthrodire placoderm skull roof and extensive trace fossils.

Figure 6: *left*, Lingulid brachiopods and a lycopod stem on a slab from Rabbit ridge; *right*, Chris Harris, chief excavator of Rabbit Ridge and Coombs Hill at a shale outcrop on Rabbit Ridge in 2015.

The roadworks at Coombs Hill, slightly further to the east revealed a number of black shale horizons, which contained more than one species of bivalve, in addition to a wealth of plant fossils, some of which are remarkable well preserved. Plant fossils included lycopod taxa new to science and the best preserved fronds of the progymnosperm tree, *Archaeopteris notosaria* known. Study of these is ongoing with, as yet one species of lycopod, *Colpodexylon mergae*, having been formerly described.

Figure 7: Black shale and fossils from Coombs Hill: *top left*, black shale disturbed during roadworks at Coombs Hill, *top right*, new species of lycopod plant.

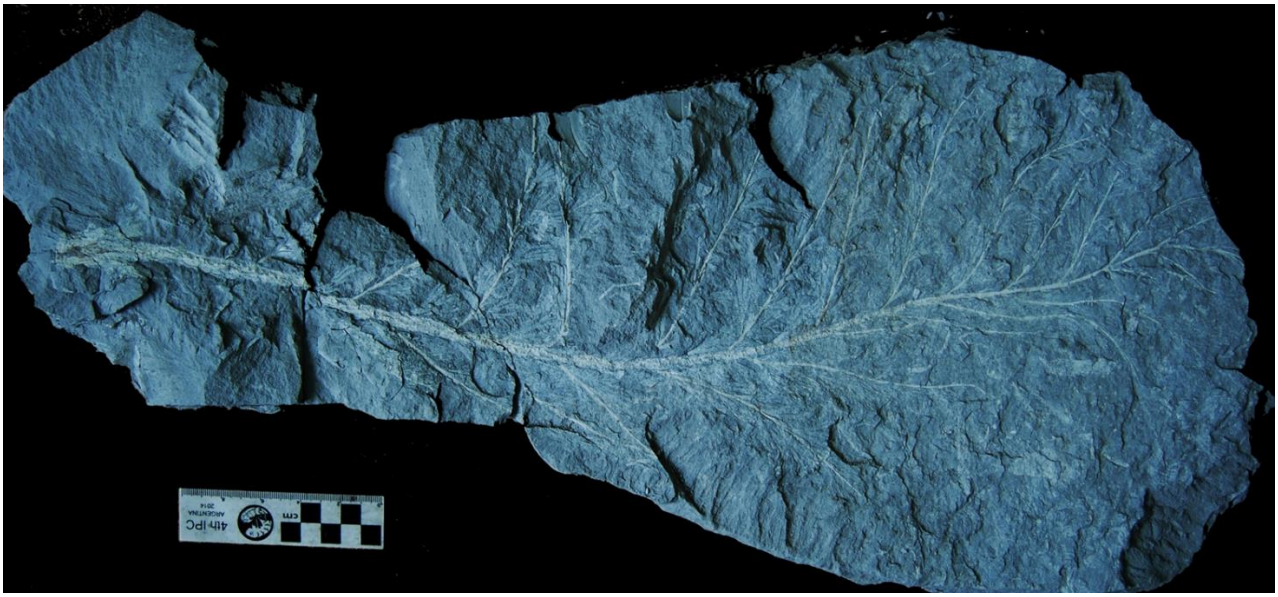

Figure 8: Frond of *Archaeopteris notosaria* from Coombs Hill.

Fossil black shales (commonly fossiliferous) are interbedded with quartzites all along the ridge though these are generally reduced to soil or clay near surface. They are normally revealed where quarrying or roadworks cut into the land surface, for example in the hardrock quarry 3.2 kilometres north northwest of the orchards site (along the same horizon). Black shales here were protected from leaching by overlying quartzitic strata which have been penetrated by quarrying. Preliminary investigation revealed these to contain silvery white plant fossil fragments.

Figure 9: Stacked Witpoort Formation quartzite strata in a quarry 3.2 kilometres north northwest of the orchards site, overlying black shale visible at bottom right.

Figure 10: Black carbonaceous shale exposed in a quartzite quarry 3.2 kilometres north northwest of the orchards site showing reddish possibly sideritic layers (left) and silvery white fossil plant fragments (right).

The top of the Witpoort Formation coincides with the end of the Devonian and is similar in age to the end-Devonian extinction event. It is overlain by rocks of the early Carboniferous aged Lake Mentz Subgroup. The End Devonian Mass Extinction Event completely changed diversity patterns of life on Earth, wiping out all placoderm (armoured fish) as well as most acanthodians (spiny finned fish) and lobe finned fish groups. Thereafter, ray-finned fish and sharks dominated the waters, and tetrapods (animals with four legs) went on to populate the land. Although there are as yet no tetrapods known from South Africa's early Carboniferous rocks, there are a number of fish fossil sites that well illustrate this change in fish diversity. Most famous of these is the 'Lake Mentz' site from near the Darlington Dam in the Addo National Park. Here several layers of rock covered in fossil fish of many species have been discovered. These appear to have died suddenly from cold or lack of oxygen. In strong contrast to the fish of the Waterloo Farm site, the fish from near Darlington Dam are all ray-finned fish, the group of fish that dominates our seas, lakes and rivers today. Some shark and acanthodian remains have also been recovered from the Lake Mentz Subgroup. These fish rich layers are generally associated with the middle portion of the Lake Mentz subgroup (the Waaipoort Formation) which will not be impacted by the quarry.

In the later part of the Carboniferous and early part of the Permian period, during the breakup of Gondwana, the Agulhas Sea floor was folded up into a chain of high mountains that separated the Karoo Basin from the Sea. The area thereafter became an erosional environment and largely ceased to accumulate sediments. Around 200 million years later, 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 and shales 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.

Site visit

The proposed development area was surveyed by vehicle and on foot on the 7th of July 2023. The majority of the proposed area is undisturbed and eroded to a flat surface, with virtually no visible outcrop of strata (figs 11-13).

Small outcrops of southerly dipping Witpoort Formation quartzites were however observed in places (eg. Fig. 14), and in piles where they had been cleared off underlying clay (Fig 15). Within the former excavation a profile illustrates leached shale with small interbedded sandstone lenses (Fig. 16) and purer clay strata, at depth, towards the heart of the former quarry, though still retaining original bedding (Fig. 17). In the far east of the proposed mining right cleaner kaolin is observable near to surface (Fig. 18). This is covered by silcrete, either in a layer of soil bound nodules (Fig 19) or in massive layers (Fig. 20).

Figure 11: View north east from point 1 (Fig. 2).

Figure 12: View southwest from point 2 (Fig. 2).

Figure 13: View east northeast from point 3 (Fig. 2).

Figure 14: Small outcrop of southerly dipping Witpoort Formation quartzite at pt 4 (Fig 3).

Figure 15: Large chunks of cross bedded Witpoort FDormation quartzite cleared off underlying clay and dumped near point 4.

Figure 16: Thin sandstone layer bedded within clay (formerly shale) of the Witpoort fFormation at point 5 (Fig. 2).

Figure 17: pale clay derived from leached Witpoort Formation Black shale seen looking easterly from point 11 (Fig. 2) – at depth within existing excavation.

Figure 18: Profile showing cleaner kaolinite close to surface in the east of the area, looking south from point 9 (Fig. 2).

Figure 19: Small nodules of silcrete formed within the soil, visible at point 7 (Fig. 2) where topsoil has previously been cut back.

Figure 20: Chunk of massive silcrete previously cleared to one side of small quarry at point 8 (Fig. 2).

Conclusions and Recommendations.

Almost the entire area is deeply underlain by strata of the Witpoort Formation, which are variably overlain by silcrete of the Grahamstown Formation. These form part of the northern limits of the Grahamstown peneplain - a flat plain, eroded adjacent to the then coastline during the Cretaceous Period. In places small outcrops of Witpoort Formation quartzite were observed to the south of historic diggings. The lateral extent of the quartzites was not, however, apparent due to cover of soil and vegetation.

Historic diggings in the north of the proposed mining right have targeted a thick bed of kaolin clay derived from an (originally black) mudstone layer. This was folded up in an east-west oriented anticlinal fold - the top of which was truncated during formation of the peneplain. Due to its proximity to surface the shale was subsequently reduced to kaolin by deep leaching during and following the Cretaceous period – the silica and metallic elements having crystalised out near surface to produce the silcrete capping. As a result of the kaolinization of the strata their probable original palaeontological interest has been entirely destroyed.

It remains possible, however, that as the fold dives down in a southerly direction it may, in places still be capped by southwardly dipping sheets of quartzitic strata. If this is the case it may be that there are areas which have not been entirely kaolonised and where fossils may still be discernible in the strata.

Should therefore, during extension of the quarry, more shaly material of a grey to black colour be encountered to the south, a palaeontologist should be contacted to assess them for palaeontological potential.

During disturbance of quartzitic strata, notice should also be taken in case impressions of plant stems or bony plates of fish are disturbed. Should the possibility of any such material be suspected a palaeontologist should be contacted to assess the possible fossils.

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