**BRIEF PALAEONTOLOGICAL ASSESSMENT**
**(Desktop Study)**

# EXTENSION OF QUARRYING ON PORTION 12 OF FARM HARTENBOSCH 217 (MAANDAGSKOP CRUSHER), MOSSEL BAY, WESTERN CAPE

**By**

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**28 APRIL 2014**

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***SUMMARY***

The Maandagskop Quarry, on Portion 12 of Farm Hartenbosch 217 near Mossel Bay (Figure 1), is a stone-crushing operation that produces aggregate and sand for the construction industry. Otto Trust, the holder of the mining right, has applied to extend the quarry. This requires an Amendment of the Environmental Management Plan (EMP) for the quarry. PHS Consulting is managing the EMP amendment process.

This report is part of the Heritage Impact Assessment and assesses the palaeontological sensitivity of the formations impacted by the mining operation, with proposed mitigatory actions to be taken with respect to the occurrence of fossils during mining, for inclusion in the amended EMP.

The Maandagskop Quarry is situated on and exploits the conglomerates of the Buffelskloof Formation (Early Cretaceous, Uitenhage Group). As both of the alternatives for quarry expansion involve the Buffelskloof Formation, they are not distinguished with respect to palaeontological sensitivity.

The only fossil material recorded hitherto has been petrified wood. The poor fossil content is typical of the high-energy deposits of alluvial fans and coarse braided river systems. The palaeontological sensitivity of the Buffelskloof Formation is therefore LOW.

Notwithstanding, fossil bones are occasionally found in similar deposits and hard parts such as teeth and talons of dinosaurs. There is a similar low probability of comparable fossils being found in the Buffelskloof Formation. When very rare fossils are found in such low-sensitivity formations, they are often very significant additions to our geologic understanding of the strata.

In view of the low palaeontological impact of the quarrying of the Buffelskloof Formation only a basic degree of mitigation is appropriate. It is recommended that mine personnel watch out for (monitor) for the occurrence of fossil material. An alert for the uncovering of fossils must be included in the EMP, with personnel duly informed.

A collection should be made of the routine finds of fossil wood, for later deposition at a museum. Such a collection of specimens, representative of the range of material including smaller pieces, will be a valuable scientific contribution for future study.

Appendix 1 outlines monitoring by mining/construction personnel and general Fossil Find Procedures. This is a general guideline, to be adapted to circumstances.

In the event of possible fossil bone/teeth finds, the contracted palaeontologist or Heritage Western Cape must be contacted. The palaeontologist will assess the information and liaise with the owner, HWC and the ECO and a suitable response will be established.

**DECLARATION BY THE INDEPENDENT PERSON WHO COMPILED A SPECIALIST REPORT OR UNDERTOOK A SPECIALIST PROCESS**

**Brief Palaeontological Assessment (Desktop Study).**
**EXTENSION OF QUARRYING ON PORTION 12 OF FARM HARTENBOSCH 217, (MAANDAGSKOP CRUSHER), MOSSEL BAY, WESTERN CAPE**

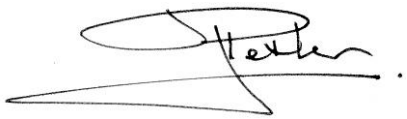
**Terms of Reference**

This assessment forms part of the Heritage Impact Assessment in the EIA process and it assesses the probability of palaeontological materials (fossils) being uncovered in the subsurface and being disturbed or destroyed in the process of bulk earth works. Mitigatory actions to be taken with respect to the occurrence of fossils during bulk earth works are proposed.

**Declaration**

I …**John Pether**……, as the appointed independent specialist hereby declare that I:

- act/ed as the independent specialist in the compilation of the above report;
- regard the information contained in this report as it relates to my specialist input/study to be true and correct, and
- do not have and will not have any financial interest in the undertaking of the activity, other than remuneration for work performed in terms of the National Environmetnal Management Act 107 of 1998 (NEMA), the EIA Regulations, 2010 and any specific environmental management Act;
- have and will not have any vested interest in the proposed activity proceeding;
- have disclosed to the Environmental Assessment Practitioner (EAP) any material information that has or may have the potential to influence the decision of the competent authority or the objectivity of any report, plan or document required in terms of the NEMA, the Environmental Impact Assessment Regulations, 2010 and any specific environmental management act;
- have provided the EAP with access to all information at my disposal regarding the application, whether such information is favourable to the applicant or not; and
- am aware that a false declaration is an offence in terms of regulation 71 of GN No. R. 543, 2010.



Signature of the specialist

Date: 28 April 2014

The author is an independent consultant/researcher and is a recognized authority in the field of coastal-plain and continental-shelf palaeoenvironments and is consulted by exploration and mining companies, by the Council for Geoscience, the Geological Survey of Namibia and by colleagues/students in academia pursuing coastal-plain/shelf projects.

**Expertise**

- Shallow marine sedimentology.
- Coastal plain and shelf stratigraphy (interpretation of open-pit exposures and on/offshore cores).
- Marine macrofossil taxonomy (molluscs, barnacles, brachiopods).
- Marine macrofossil taphonomy.
- Sedimentological and palaeontological field techniques in open-cast mines (including finding and excavation of vertebrate fossils (bones).
- Analysis of the shelly macrofauna of modern samples *e.g.* for environmental surveys.

**Membership Of Professional Bodies**

- South African Council of Natural Scientific Professions. Earth Science. Reg. No. 400094/95.
- Geological Society of South Africa.
- Palaeontological Society of Southern Africa.
- Southern African Society for Quaternary Research.
- Heritage Western Cape. Member, Permit Committee for Archaeology, Palaeontology and Meteorites.
- Accredited member, Association of Professional Heritage Practitioners, Western Cape.

## 1 INTRODUCTION

The Maandagskop Quarry, on Portion 12 of Farm Hartenbosch 217 near Mossel Bay (Figure 1), is a stone-crushing operation that produces aggregate and sand for the construction industry. Otto Trust, the holder of the mining right, has applied to extend the quarry. This requires an Amendment of the Environmental Management Plan (EMP) for the quarry. PHS Consulting is managing the application for the amendment of the EMP on behalf of Otto Trust.

Two alternatives for the quarry expansion have been advanced (Figure 2), both entailing about 6 ha of ground. The first alternative is the preferred one.

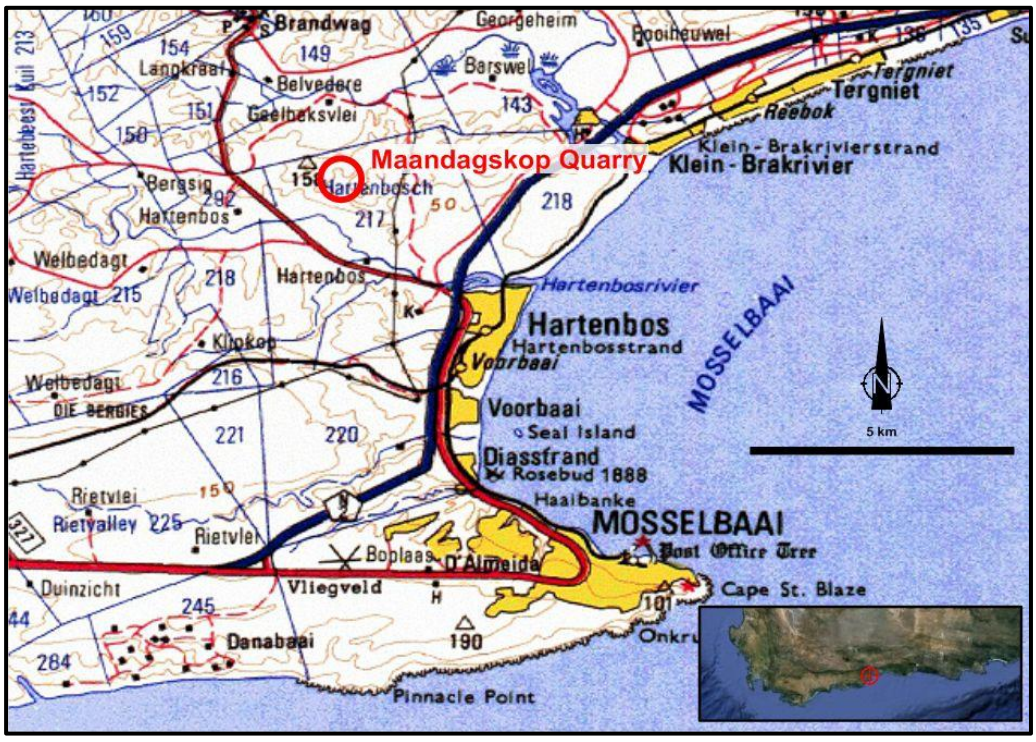
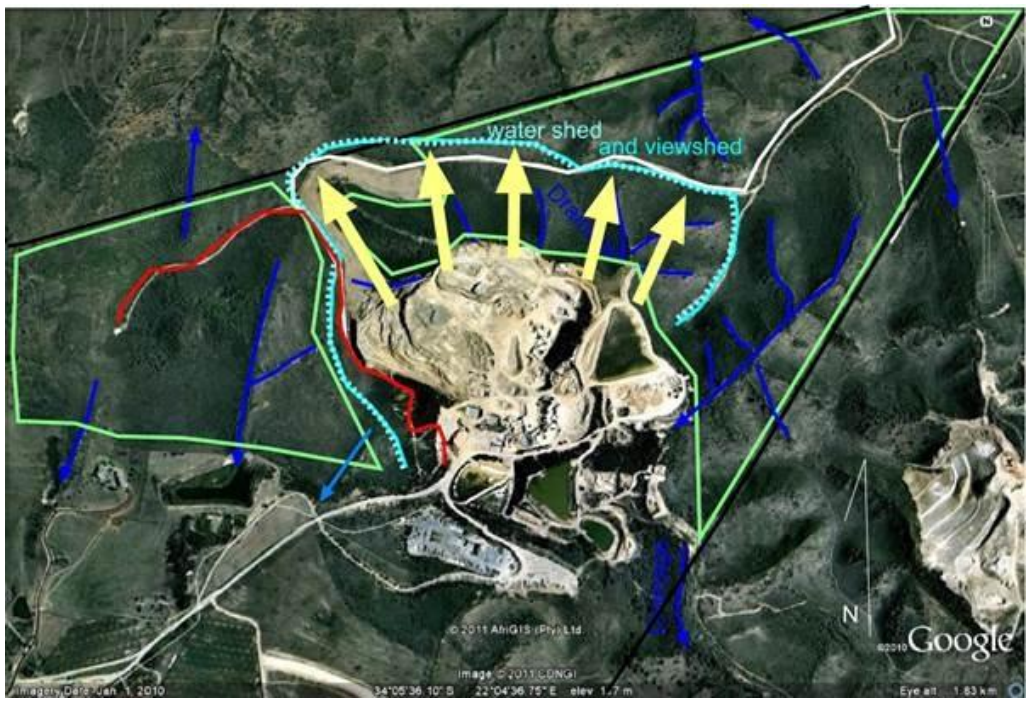



***Figure 1. Location of Maandagskop Quarry. Extract from 1:250000 topo-cadastral map 3322 Oudtshoorn. Chief Directorate National Geo-spatial Information of South Africa.***

This report is part of the Heritage Impact Assessment and assesses the probability of palaeontological materials (fossils) being uncovered in the subsurface and being disturbed or destroyed in the process of mining the stone-resource formation. The main purposes are to:

- Outline the nature of palaeontological/fossil heritage resources in the subsurface of the affected area.
- Suggest the mitigatory actions to be taken with respect to the occurrence of fossils during mining, for inclusion in the amended EMP for the mine.




**2a. Expansion Alternative 1 (Preferred).**


**2b. Expansion Alternative 2.**

***Figure 2. Alternatives for the expansion of Maandagskop Quarry. Kindly supplied by PHS Consulting.***

## 2 APPROACH AND METHODOLOGY

### 2.1 Available Information

The main information for the area is from Malan & Viljoen (1990), Viljoen & Malan (1993), Shone (2006) and the relevant geological maps, parts of which are reproduced in Figures 3 and 6. Other references are cited in the normal manner and included in the References section.

### 2.2 Assumptions and Limitations

It is not possible to predict the buried fossil content of an area other than in general terms. In particular, the important fossil bone material is generally sparsely scattered in most deposits and much depends on spotting this material as it is uncovered during digging and, in the case of mining, where it may be revealed during processes such as on sizing screens.

## 3 GEOLOGICAL SETTING

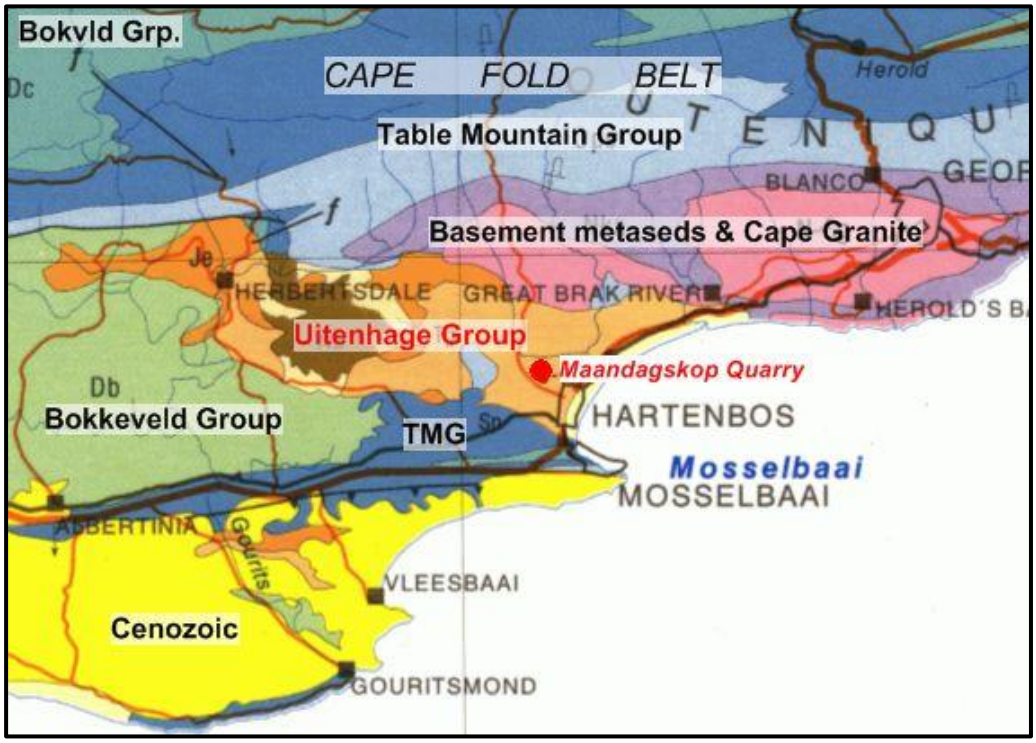



***Figure 3. Setting of the Uitenhage Group in the Herbertsdale/Mossel Bay Basin. Extract from the 1:1 Million Geological Map of the RSA and Kingdoms of Lesotho and Swaziland. 1997. Council for Geoscience.***

The bedrock in this region is mainly comprised of cemented sedimentary rocks of the **Cape Supergroup** (Figure 3). Table Mountain Group (TMG) sandstones (quartzites) and shales, deposited 470-400 Ma (Ordovician and Silurian periods) (Ma – million years ago) are the most prominent in the landscape as mountain ranges of the Cape Fold Belt. Bokkeveld Group

shales occur locally in synclinal valleys. The high, inner "Coastal Platform" in this region has been stripped of Cape Supergroup strata, exposing underlying, older (~560 Ma), highly-deformed basement metasediments of the Pre-Cape Kaaimans Group that were later intruded by the Cape Granites. All these folded old rocks are not of concern here.

The Cape Supergroup rocks were extensively disrupted by faulting during the breakup of supercontinent Gondwana and a "fresh" suite of sediments filled the basins so created. Along the South Coast, the pattern of crustal stretching and faulting was complex and many local basins were formed. These late Jurassic and early Cretaceous sediments, deposited between about 155 Ma and 130 Ma, are called the **Uitenhage Group**, as they are best exposed in the Algoa area (in the Algoa Basin).

This early Cretaceous landscape was quite rugged, with high areas forming long capes between the downfaulted segments of crust, into which coastal river floodplains debouched at the head of extensive arms of the sea. Several volcanoes studded the landscape. The lowermost deposits filling the fault-bounded basins, called the **Enon Formation**, are overwhelming conglomerates eroded from the high ground above fault scarps by rivers (Figure 4). Farther downslope from these coarse alluvial fans were sandy and muddy flood plains of the rivers, called the **Kirkwood Formation**. At the new coast were deltas, estuaries and marine embayments, the environments in which the mainly marine **Sundays River Formation** sediments were deposited.

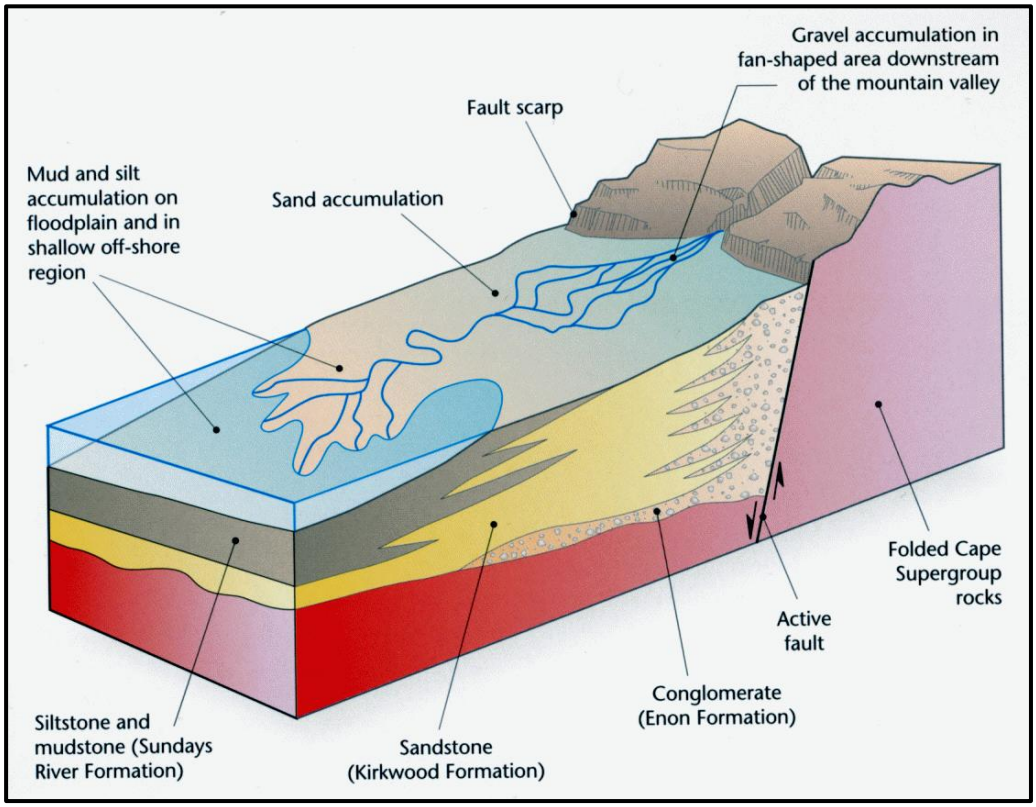



***Figure 4. Depositional model of the Uitenhage Group in the Algoa Basin. From McCarthy & Rubidge (Eds.), 2005.***

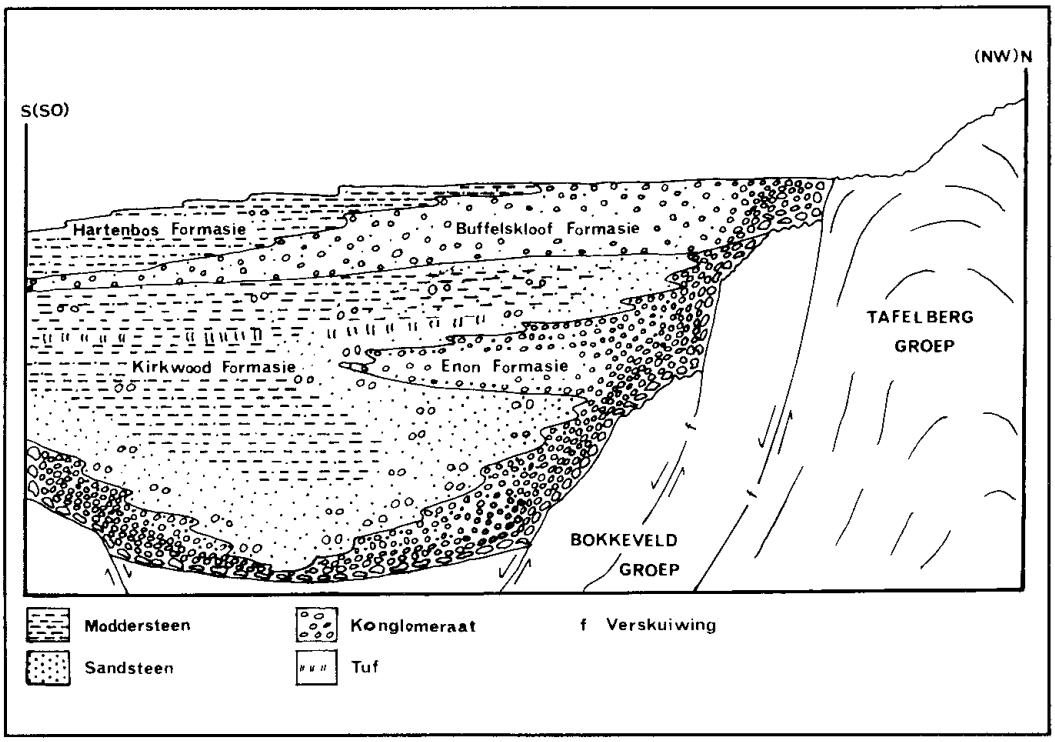



***Figure 5. Schematic stratigraphy in the Herbertsdale/Mossel Bay Basin. From Viljoen & Malan, 1993.***

The several fault-bounded basins hosting the Uitenhage Group differ in detail. Figure 5 schematically shows the sequence in the Herbertsdale-Mossel Bay Basin where an additional two formations are recognized capping the Uitenhage infill, *viz*. the Buffelskloof and Hartenbos formations.

The **Buffelskloof Formation** is a pale conglomerate with sandy lenses derived from the Table Mountain Group quartzites and was deposited, like the Enon, in mountain-slope alluvial fan and braided-stream settings. Significantly, this formation overlies strata of the Enon and Kirkwood formations that have been tilted northwards, indicating another phase of tectonic activity and movement on the prominent faults, causing renewed erosion of the Cape Fold Belt highlands. (The name “Buffelskloof Formation” now supersedes the previous name “Brandwag Formation”)

To the seaward (east) the **Hartenbos Formation** generally overlies the Buffelskloof Formation, but in detail the formations appear to interfinger. The Hartenbos Formation consists of sandy and muddy/clayey beds and, like the Kirkwood Formation, is considered to represent fluvio-deltaic deposition “downstream” from the apron of alluvial fans (Figures 3, 4).

The Buffelskloof and Hartenbos formations have an estimated age of 140-130 Ma (Early Cretaceous, Valanginian & Hauterivian stages) and represent terrestrial coastal environments that are evidently contemporaneous with the marine Sundays River Formation deposited offshore (Viljoen & Malan, 1993).

***The Maandagskop Quarry is situated on and exploits the conglomerates of the Buffelskloof Formation – Figure 6.***

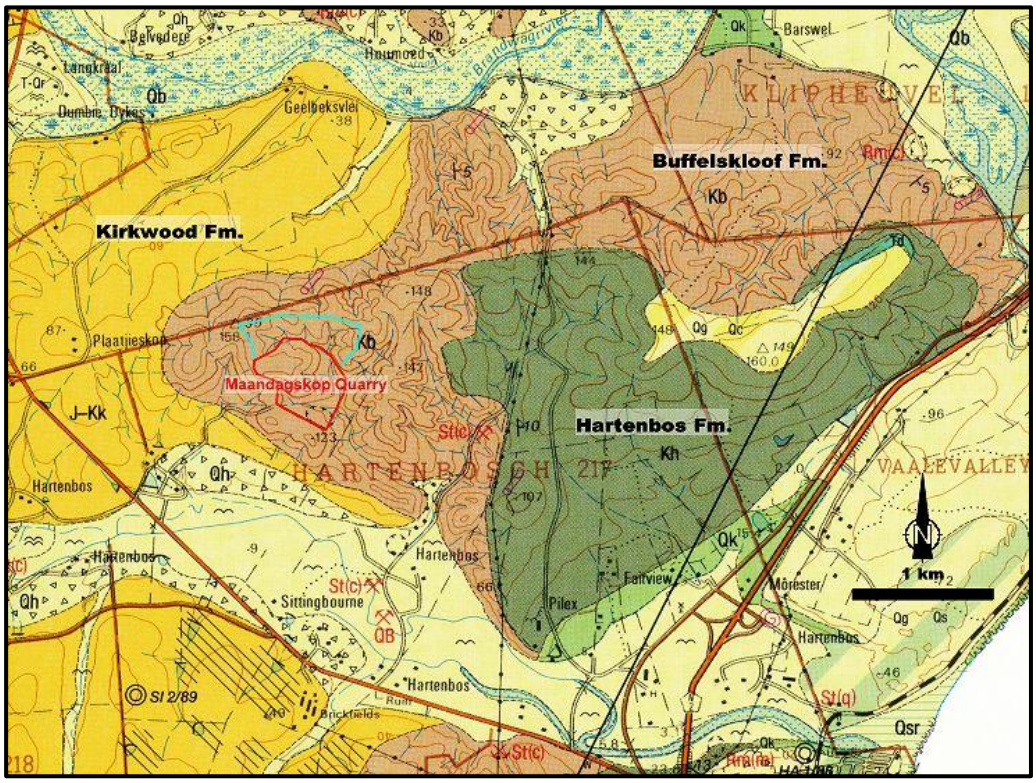



***Figure 6. Geology of the area. Extract of 1:50 000 Geological Series 3422AA. Geological Survey, Department of Mineral & Energy Affairs.***

The subsequent geological history of the region involves coastal-plain marine platform development and shallow-marine deposits that relate to periods of high sea level and warm climates during the Cenozoic Era. During intervening intervals of low sea level, corresponding with “ice ages” the rivers were incised, valleys were deepened and widened and the marine platforms were dissected. These sea-level oscillations were superimposed on a subcontinetal margin that periodically underwent slow uplift, raising the older palaeoshorelines to higher-elevation positions.

The vicinity of Maandagskop Quarry was last lapped by the sea ~16 Ma, during the Mid Miocene Warm Period . One may imagine a palaeoshoreline of coarse gravel beaches formed of the reworked Buffelskloof cobbles. Evidently these marine deposits, the older part of the De Hoopvlei Formation of the Bredasdorp Group, have now been eroded away in the Maandagskop area.

## *4 EXPECTED PALAEONTOLOGY*

As both of the considered alternatives for quarry expansion involve the Buffelskloof Formation, they are not distinguished with respect to palaeontological sensitivity.

Petrified and semi-petrified fossil wood logs are reported from the base of the Buffelskloof Formation (Viljoen & Malan, 1993). Pieces of fossil wood are

found in the quarry (Scoping Report, Sect. 4.1). This is evidently the only fossil material found hitherto.

The poor fossil content is typical of high-energy sedimentary environments such as alluvial fans and coarse braided river systems. Notwithstanding, fossil bones are occasionally found in similar deposits, usually abraded and "rolled". Hard parts such as teeth and talons have been found in the Enon Formation (Figure 7). There is a similar low probability of comparable fossils being found in the Buffelskloof Formation.

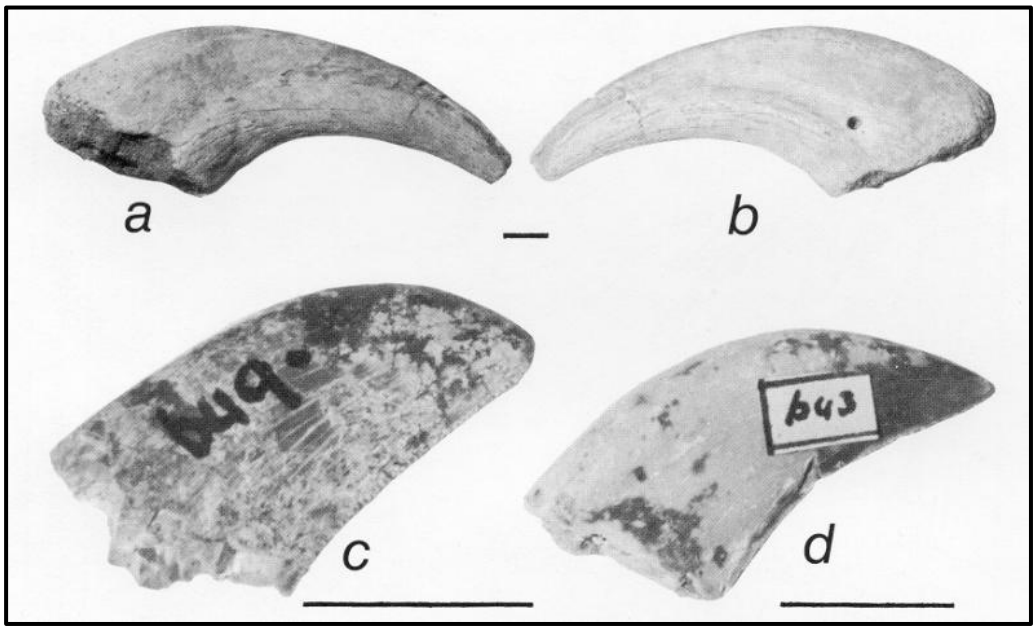



***Figure 7. Examples of dinosaur talons (top) and teeth (bottom) that could be found in the Buffelskloof Formation. All scale bars are 1 cm. From Mateer, 1987.***

The palaeontological sensitivity of the Buffelskloof Formation is therefore LOW.

The quarrying operation may expose the top of the Kirkwood Formation, in the quarry floor below the Buffelskloof conglomerates. The Kirkwood Formation has high fossil potential: mainly petrified wood, lignites and leaves (ferns, cycads, conifers) (Almond & Pether, 2008). A variety of small to large dinosaurs (theropods, sauropods, ornithopods), other reptiles, and Mesozoic mammals, have been found. These is some possibility that fossils from the Kirkwood Formation, mostly wood/plant material, may be exposed, both *in situ* or reworked into the base of the Buffelskloof Formation. As the Kirkwood deposits are quite weathered and will only be "skimmed during the mining, the palaeontological sensitivity is also rated as LOW in this particular context.

## *5 RECOMMENDATIONS*

In view of the low palaeontological impact of the quarrying of the Buffelskloof Formation only a basic degree of mitigation is appropriate. Notwithstanding,

when fossils are found in such low-sensitivity formations, they are often very significant additions to our geologic understanding of the strata.

It is recommended that mine personnel watch out for (monitor) for the occurrence of fossil material. An alert for the uncovering of fossils must be included in the EMP, with personnel duly informed. The EMP should promote an awareness that rare fossil dinosaur bones or teeth could be turned up during ripping, loading and screening of the deposit.

A collection should be made of the routine finds of fossil wood, for later deposition at a museum. Such a collection of specimens, representative of the range of material including smaller pieces, will be a valuable scientific contribution for future study.

Appendix 1 outlines monitoring by mining/construction personnel and general Fossil Find Procedures. This is a general guideline, to be adapted to circumstances.

In the event of possible fossil bone/teeth finds, the contracted palaeontologist or Heritage Western Cape must be contacted. The palaeontologist will assess the information and liaise with the owner, HWC and the ECO and a suitable response will be established.

## *6 REFERENCES*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Viljoen, J.H.A. & Malan, J.A. 1993. Die geologie van die gebiede 3421 BB Mosselbaai and 3422 AA Herbertsdale. Toeligting tot Blaai 3421 BB and 3422 AA. Geological Survey. Government Printer, Pretoria.


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## 7 GEOLOGICAL TIME SCALE TERMS.

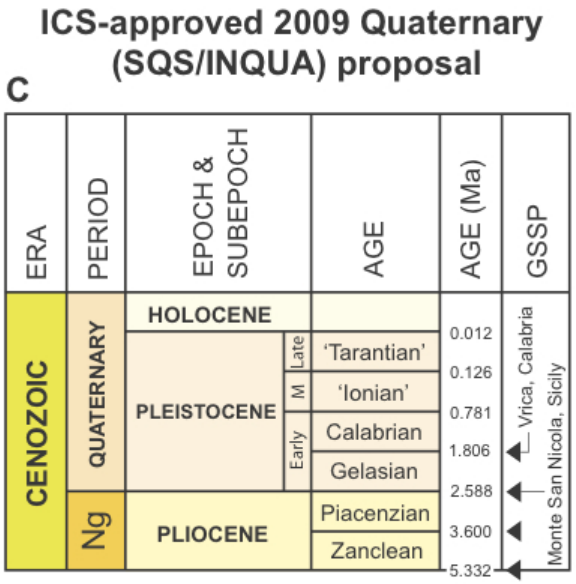
***For more information see www.stratigraphy.org***

ka: Thousand years or kilo-annum ($10^3$ years). Implicitly means "ka ago" *i.e*. duration from the present, but "ago" is omitted. The "Present" refers to 1950 AD. Generally not used for durations not extending from the Present. Sometimes "kyr" is used instead.

Ma: Millions years, mega-annum ($10^6$ years). Implicitly means "Ma ago" *i.e.* duration from the present, but "ago" is omitted. The "Present" refers to 1950 AD. Generally not used for durations not extending from the Present.

Holocene: The most recent geological epoch commencing 11.7 ka till the present.

Pleistocene: Epoch from 2.6 Ma to 11.7 ka. Late Pleistocene 11.7–126 ka. Middle Pleistocene 135–781 ka. Early Pleistocene 781–2588 ka (0.78-2.6.Ma).




Quaternary: The current Period, from 2.6 Ma to the present, in the Cenozoic Era. The Quaternary includes both the Pleistocene and Holocene epochs. As used herein, early and middle Quaternary correspond with the Pleistocene divisions, but late Quaternary includes the Late Pleistocene and the Holocene.

Pliocene: Epoch from 5.3-2.6 Ma.

Miocene: Epoch from 23-5.3 Ma.

Oligocene: Epoch from 34-23 Ma.

Eocene: Epoch from 56-34 Ma.

Paleocene: Epoch from 65-56 Ma.

Cenozoic: Era from 65 Ma to the present. Includes Paleocene to Holocene epochs.

Cretaceous: Period in the Mesozoic Era, 145-65 Ma.

Jurassic: Period in the Mesozoic Era, 201-145 Ma.

Mesozoic: Era from 252-65 Ma. IncludesTriassic, Jurassic and Cretaceous Periods.

## 8 APPENDIX 1 - FOSSIL FIND PROCEDURES

In the context under consideration, it is improbable that fossil finds will require declarations of permanent “no go” zones. At most a temporary pause in activity at a limited locale may be required. The strategy is to rescue the material as quickly as possible.

The procedures suggested below are in general terms, to be adapted as befits a context. They are couched in terms of finds of fossil bones that usually occur sparsely. However, they may also serve as a guideline for other fossil material that may occur.

In contrast, fossil shell layers are usually fairly extensive and can be easily documented and sampled.

Bone finds can be classified as two types: isolated bone finds and bone cluster finds.

### 8.1 ISOLATED BONE FINDS

In the process of digging the excavations, isolated bones may be spotted in the hole sides or bottom, or as they appear on the spoil heap. By this is meant bones that occur singly, in different parts of the excavation. If the number of distinct bones exceeds 6 pieces, the finds must be treated as a bone cluster (below).

*Response by personnel in the event of isolated bone finds*

- **Action 1:** An isolated bone exposed in an excavation or spoil heap must be retrieved before it is covered by further spoil from the excavation and set aside.
- **Action 2:** The site foreman and ECO must be informed.
- **Action 3:** The responsible field person (site foreman or ECO) must take custody of the fossil. The following information to be recorded:
    - Position (excavation position).
    - Depth of find in hole.
    - Digital image of hole showing vertical section (side).
    - Digital image of fossil.
- **Action 4:** The fossil should be placed in a bag (*e.g.* a Ziplock bag), along with any detached fragments. A label must be included with the date of the find, position info., depth.
- **Action 5:** ECO to inform the developer, the developer contacts the standby archaeologist and/or palaeontologist. ECO to describe the occurrence and provide images asap. by email.

*Response by Palaeontologist in the event of isolated bone finds*

The palaeontologist will assess the information and liaise with the developer and the ECO and a suitable response will be established.

## *8.2 BONE CLUSTER FINDS*

A bone cluster is a major find of bones, *i.e*. several bones in close proximity or bones resembling part of a skeleton. These bones will likely be seen in broken sections of the sides of the hole and as bones appearing in the bottom of the hole and on the spoil heap.

*Response by personnel in the event of a bone cluster find*

- **Action 1:** Immediately stop excavation in the vicinity of the potential material. Mark (flag) the position and also spoil that may contain fossils.
- **Action 2:** Inform the site foreman and the ECO.
- **Action 3:** ECO to inform the developer, the developer contacts the standby archaeologist and/or palaeontologist. ECO to describe the occurrence and provide images asap. by email.

*Response by Palaeontologist in the event of a bone cluster find*
The palaeontologist will assess the information and liaise with the developer and the ECO and a suitable response will be established. It is likely that a Field Assessment by the palaeontologist will be carried out asap.

It will probably be feasible to "leapfrog" the find and continue the excavation farther along, or proceed to the next excavation, so that the work schedule is minimally disrupted. The response time/scheduling of the Field Assessment is to be decided in consultation with developer/owner and the environmental consultant.

The field assessment could have the following outcomes:

- If a human burial, the appropriate authority is to be contacted (see AIA). The find must be evaluated by a human burial specialist to decide if Rescue Excavation is feasible, or if it is a Major Find.
- If the fossils are in an archaeological context, an archaeologist must be contacted to evaluate the site and decide if Rescue Excavation is feasible, or if it is a Major Find.
- If the fossils are in an palaeontological context, the palaeontologist must evaluate the site and decide if Rescue Excavation is feasible, or if it is a Major Find.

## *8.3 RESCUE EXCAVATION*

Rescue Excavation refers to the removal of the material from the just the "design" excavation. This would apply if the amount or significance of the exposed material appears to be relatively circumscribed and it is feasible to remove it without compromising contextual data. The time span for Rescue Excavation should be reasonably rapid to avoid any or undue delays, *e.g*. 1-3 days and definitely less than 1 week.

In principle, the strategy during mitigation is to "rescue" the fossil material as quickly as possible. The strategy to be adopted depends on the nature of the occurrence, particularly the density of the fossils. The methods of collection would depend on the preservation or fragility of the fossils and whether in loose or in lithified sediment. These could include:

- On-site selection and sieving in the case of robust material in sand.
- Fragile material in loose/crumbly sediment would be encased in blocks using Plaster-of Paris or reinforced mortar.

If the fossil occurrence is dense and is assessed to be a “Major Find”, then carefully controlled excavation is required.

## *8.4 MAJOR FINDS*

A Major Find is the occurrence of material that, by virtue of quantity, importance and time constraints, cannot be feasibly rescued without compromise of detailed material recovery and contextual observations.
A Major Find is not expected.

*Management Options for Major Finds*
In consultation with developer/owner and the environmental consultant, the following options should be considered when deciding on how to proceed in the event of a Major Find.

*Option 1: Avoidance*

Avoidance of the major find through project redesign or relocation. This ensures minimal impact to the site and is the preferred option from a heritage resource management perspective. When feasible, it can also be the least expensive option from a construction perspective.

The find site will require site protection measures, such as erecting fencing or barricades. Alternatively, the exposed finds can be stabilized and the site refilled or capped. The latter is preferred if excavation of the find will be delayed substantially or indefinitely. Appropriate protection measures should be identified on a site-specific basis and in wider consultation with the heritage and scientific communities.

This option is preferred as it will allow the later excavation of the finds with due scientific care and diligence.

*Option 2: Emergency Excavation*

Emergency excavation refers to the “no option” situation wherein avoidance is not feasible due to design, financial and time constraints. It can delay construction and emergency excavation itself will take place under tight time constraints, with the potential for irrevocable compromise of scientific quality. It could involve the removal of a large, disturbed sample by excavator and conveying this by truck from the immediate site to a suitable place for “stockpiling”. This material could then be processed later.

Consequently, emergency excavation is not a preferred option for a Major Find.

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