# PALAEONTOLOGICAL IMPACT ASSESSMENT
## (Desktop Study)

## PROPOSED NATURE'S PATH ECO-LIFESTYLE VILLAGE ON PORTIONS 9 & 10 OF FARM MATJESFONTEIN 304, KEURBOOMSTRAND, PLETTENBERG BAY, WESTERN CAPE

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***SUMMARY***

The context of this assessment is the proposed Nature's Path Eco-Lifestyle Village on parts of Portions 9 & 10 of the Farm Matjesfontein No. 304, Keurboomstrand, near Plettenberg Bay, Bitou Municipality (Figures 1 & 2).

The main purposes of this palaeontological assessment are to:

- Outline the nature of possible 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 bulk earth works.

No site-specific information, such as a geotechnical/engineering report showing sections exposed in test pits, or an Archaeological Impact Assessment detailing surface exposures, is yet available.

The steeper, upper slopes of the main site are underlain by the Enon Formation that has low fossil potential. Identifiable teeth and bones are occasionally found, but fossil wood is the most common fossil material and includes lignified or petrified larger pieces such as logs that are seen more easily.

Excavations in the lower slope below ~12 m asl. have the greater fossil potential. The lower slopes are underlain by fossiliferous, Quaternary "raised beaches" deposited during higher sea levels. The overlying aeolian coversands and soil are apparently quite thin and thus the shelly marine deposits may be exposed in excavations.

The overlying aeolian coversands and the dune cordon ("luxury chalet" site) are likely to include archaeological material. Fossils may also be encountered in excavations around the vlei margins.

The likelihood of impact is medium *i.e*. it is likely to occur. It is recommended that the excavations be inspected by an archaeologist who must also report fossil occurrences.

Furthermore, personnel involved in the bulk earth works must keep a lookout for fossil and archaeological material such as bones, shells and Stone Age artefacts.

Appendices 1 and 2 outline monitoring by construction personnel and a general Fossil Find Procedures. In the event of fossil finds, the appointed palaeontologist will assess the information and liaise with the manager and the ECO and a suitable response will be established.

This assessment may be revised in the light of futher information from geotechnical test pits and the AIA.

***DECLARATION***

The author, John Pether, 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.

The author does not have any financial interest in the undertaking of the activity, other than the remuneration for the compilation of this report.

## *1 INTRODUCTION*

The context of this assessment is the proposed Nature's Path Eco-Lifestyle Village on parts of Portions 9 & 10 of the Farm Matjesfontein No. 304, Keurboomstrand, near Plettenberg Bay in the Bitou Municipality (Figures 1 & 2).. Sharples Environmental Services (*SES*) has been appointed to complete the EIA process for the proposed development.

This assessment has been prepared in compliance with the Heritage Western Cape request that a Scoping Palaeontological Impact Assessment be done (HWC RoD 1131/1257). It 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.


***Figure 1. Locations of the proposed development. Extract of 1:50000 topo-cadastral map 3423AB_1998_ED3_GEO. Chief Directorate: Surveys & Mapping.***

The main development is proposed on ~15 ha of the northern parts of Portions 9 & 10 of Farm 304 (Figure 2). This involves ~110 units and sports and commercial facilities. The proposal also includes a separate "luxury coastal unit" located at the beach on the flank of the dune cordon.

The main purposes of this palaeontological assessment are to:

- Outline the nature of possible 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 bulk earth works.

The report also includes a general fossil finds procedure for the appropriate responses to the discovery of paleontological materials during construction of excavations.


***Figure 2. Aerial view of the proposed Nature's Path Eco-Lifestyle Village on parts of Portions 9 & 10 of the Farm Matjesfontein No. 304, Keurboomstrand. Supplied by Sharples Environmental Services.***

## *2 APPLICABLE LEGISLATION*

The National Heritage Resources Act (NHRA No. 25 of 1999) protects archaeological and palaeontological sites and materials, as well as graves/cemeteries, battlefield sites and buildings, structures and features over 60 years old. The South African Heritage Resources Agency (SAHRA) administers this legislation nationally, with Heritage Resources Agencies acting at provincial level.

According to the Act (Sect. 35), it is an offence to destroy, damage, excavate, alter of remove from its original place, or collect, any archaeological, palaeontological and historical material or object, without a permit issued by the South African Heritage Resources Agency (SAHRA) or applicable Provincial Heritage Resources Agency, *viz*. Heritage Western Cape (HWC).

Notification of SAHRA or the applicable Provincial Heritage Resources Agency is required for proposed developments exceeding certain dimensions (Sect. 38).

# *3 THRESHOLDS*

The areal scale of subsurface disturbance and exposure exceeds 300 m in linear length and 5000 $m^2$ (NHRA 25 (1999), Section 38 (1)). It must therefore be assessed for heritage impacts (an HIA) that includes assessment of potential palaeontological heritage (a PIA).

For the evaluation of the palaeontological impact it is the extent/scale of the deeper excavations to be made that are the main concern, mainly the section exposed by site levelling, trenches for foundations of buildings and tanks, trenches for connecting piping and electrical cabling, and excavations for sewerage pump stations, dams *etc*. Allied to this is the fossil potential of the formations that are excavated, varying from none to high.

# *4 APPROACH AND METHODOLOGY*

## *4.1 AVAILABLE INFORMATION*

The information relevant to the geological and fossil record of the area is that concerning marine coastal formations deposited during higher sea levels and the aeolian dunes and coversands that mantle them. The articles consulted are cited in the normal manner and included in the References section.

## *4.2 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 *i.e.* by monitoring excavations.

No site-specific information, such as a geotechnical/engineering report showing sections exposed in test pits, or an Archaeological Impact Assessment detailing surface exposures, is yet available.

## 5 GEOLOGICAL AND PALAEONTOLOGICAL SETTING

### 5.1 THE LOCAL GEOLOGY

The main development proposed is situated at the foot of the dissected edge of the "Coastal Platform" that forms the higher, older part of the coastal plain (Figure 3). This high "Coastal Platform" is considered to be the coastal manifestation of the old "African Surface", formed some time after the break up of the Gondwana supercontinent as Africa adjusted to its new margin seaboard, but now lifted up to its present altitude of between ~200-260 m asl. (Marker & Holmes, 2002). The "Coastal Platform" in this region is cut across Table Mountain Group (TMG) sandstones (quartzites) and shales, deposited 470-400 Ma (Ordovician and Silurian periods) (blue & purple, Figures 3 & 4).

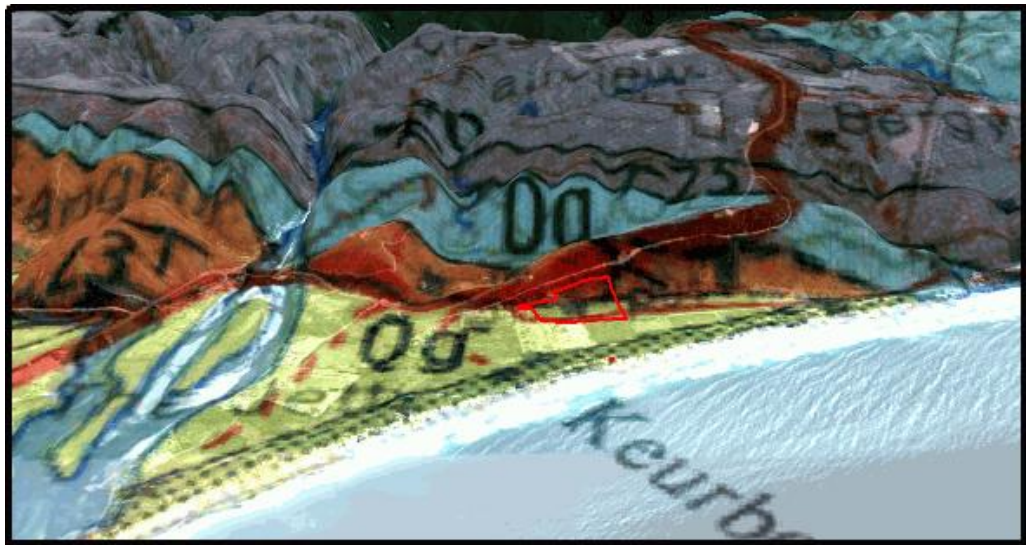


***Figure 3. Google Earth simulated oblique aerial view of the setting of the proposed development, draped with extract from 1:250 000 Geological Series 3322 Oudtshoorn. Council for Geoscience (Geological Survey), Department of Mineral & Energy Affairs, 1979.***

A prominent aspect of the region are deposits that relate to the breakup of the supercontinent Gondwana during late Jurassic to early Cretaceous time, between about 155 Ma and 134 Ma. The breakup landscape was rugged, with high areas forming long capes (horsts) between downfaulted segments (grabens), steep-sided basins into which deposition was erosional debris deposited as talus, forming the coarse, conglomeratic Enon Formation (Figure 4, Ke).

The area under consideration has a concave slope that is the south flank of a ridge comprised of the Enon Formation. On the lower slopes of the area the Enon conglomerates are covered by younger deposits (Figure 4, Qg), a unit described as "marine and estuarine terrace gravel and sand, partly calcareous". These deposits were laid down during the Quaternary Period at times when sea level was higher relative to the present level.

Before the Quaternary, sea level was much higher at times during the Miocene and Pliocene. In the Knysna region, Marker (1987) has recorded marine benches below the Coastal Platform, eroded at 120-140, 90, 60 and 30 m asl. This is in broad accord with the general sea level history preserved as actual marine formations elsewhere on the coast (*e.g*. De Hoopvlei and Alexandria formations). However, these older, fossiliferous marine formations are not preserved or are very cryptic in the Plettenberg area, have seemingly been eroded away and likely were not originally very extensive against the edge of the high Coastal Platform.

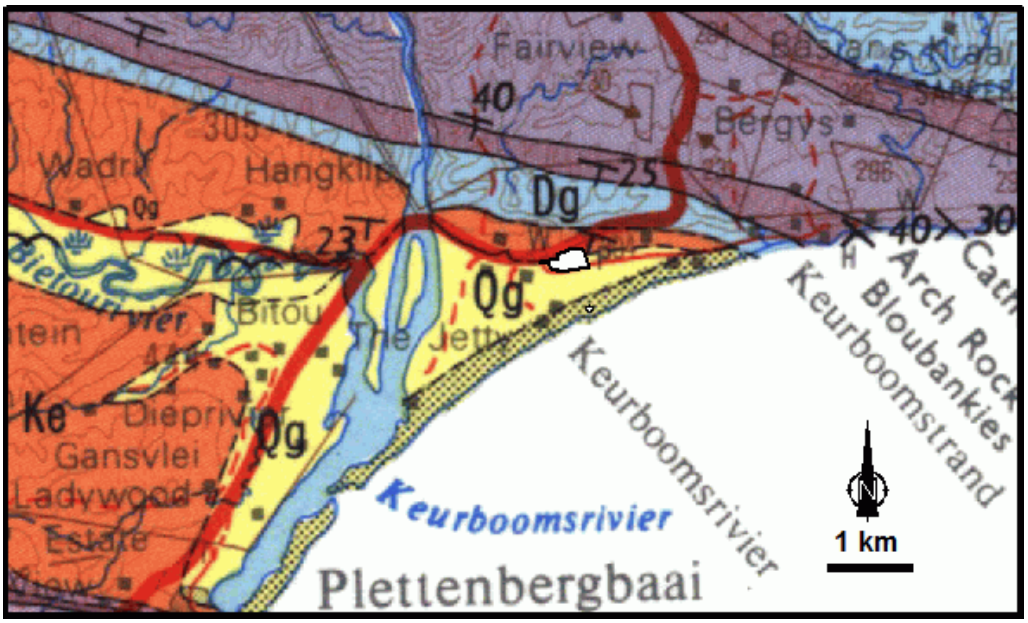


***Figure 4. Extract of 1:250 000 Geological Series 3322 Oudtshoorn. Council for Geoscience (Geological Survey), Department of Mineral & Energy Affairs, 1979.***

"Raised beach" deposits of Quaternary age are found below ~15 m asl around the coast of southern Africa. These deposits are expected under some thickness of windblown coversand. Beach deposits are expected up to +15 m asl. under the inner, landward portion. The outer portion is expected to be underlain by ~125 ka (thousand years ago) beach deposits of the Last Interglacial (LIG). These deposits are found up to ~+8 m asl. During the recent past, only 7-4 (7-4 ka BP (early to mid-Holocene), sea level was again higher than present by 2-3 m. This is the mid-Holocene highstand, now well documented at numerous continental-margin and island sites worldwide.

To the west, Malan has called similar deposits the Klein Brak Fm. (Malan & Viljoen, 1990, Malan, 1991). The Klein Brak Formation includes beach, estuarine/lagoonal and paralic vlei deposits. The latter reflect high water tables associated with nearby high sea level. A distinct fossil shell fauna is expected in the beach terrace deposits, *viz*. the "Swartkops Fauna", which comprises tropical species of both West African and Indo-Pacific origin that no longer occur along the coast today, as well as a number of extinct species

The cover of aeolian sands is thickest at the coast where a dune cordon parallels the shore. A small vlei is present at the foot of the slope of the main site.

## *5.2 EXPECTED PALAEONTOLOGY*

On the steep upper slope, cutbacks will have to be made into the Enon Formation for levelling of sites and for roads. Fossils are very scarce in the Enon Formation; transported bone fragments, isolated teeth and lignified wood have been found (Figure 5). There is a low probability of fossils being found on the steeper slopes of the property underlain by the Enon Formation.

The bulk earth works for the proposed development are those associated with residential infrastructure, *i.e*. trenches for water supply, cabling and sewerage. These relatively shallow excavations are not expected to significantly expose underlying marine deposits. However, the thickness of the aeolian sand and sandy-soil cover is not known by the writer. It is probable that in places the "marine and estuarine terrace gravel and sand " is exposed or under thin cover, since such material has been mapped as the local surface unit, rather than an aeolian unit. Deeper excavations (*e.g*. >1 m) could penetrate to the fossiliferous beds.

Terrestrial fossils and archaeological material occur in the aeolian sands, often in association. The excavations for infrastructure will mainly disturb this uppermost material.

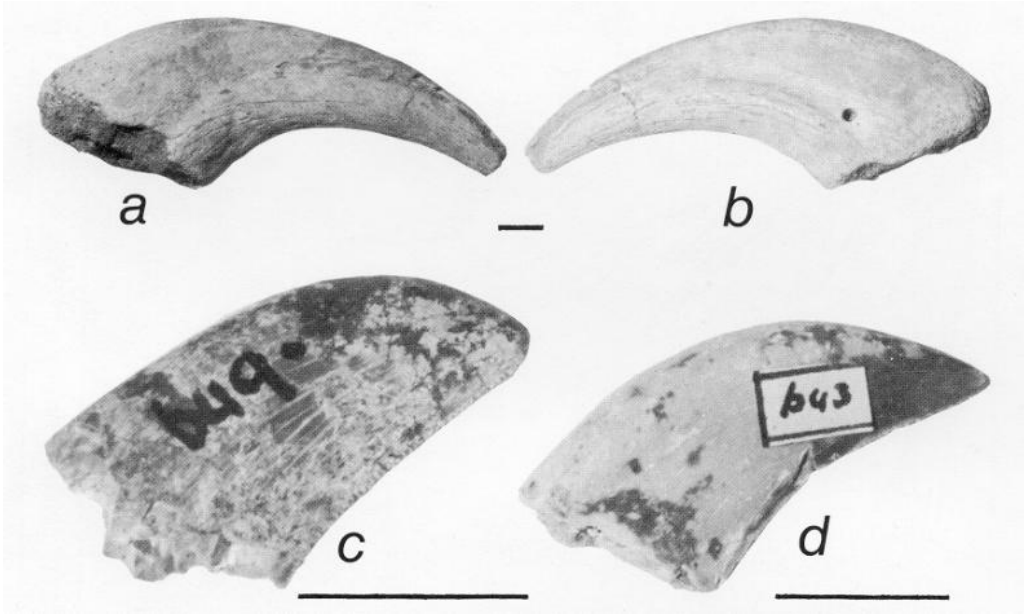


***Figure 5. Examples of dinosaur talons (top) and teeth (bottom) that could be found in the Enon Formation. All scale bars ARE 1 CM. From Mateer, 1987.***

A storm water drainage system will be installed, discharging into the local wetland on the lower slope. Conceivably, this may involve deeper excavations in places. The vlei/wetland may have fluctuated in size in the past and vlei/marsh deposits will be encountered. As local sources of water, vleis attract the larger herbivores from the surrounding area, their predators and scavengers and thus become a spot where fossils occur. . There is the fossil record of the pond/vlei life itself, like the frogs, aquatic snails and small fish, as well as environmentally sensitive microfossils such as ostracods (microscopic crustaceans with often very specific requirements). Ancient ponds and vleis, as natural traps of windborne material, also provide a glimpse of the greater,

surrounding vegetation, in the form of pollen capsules from near and far, and windborne charcoal fragments from fires, usually of fairly close origin.

At the coast, bulk earthworks for the “luxury coastal unit” situated on the dune cordon are not expected to reach the underlying marine deposits, but could also uncover terrestrial fossils and archaeological material in the aeolian sands.

## *6 NATURE OF THE IMPACT OF BULK EARTH WORKS ON FOSSILS*

Fossils are rare objects, often preserved due to unusual circumstances. This is particularly applicable to vertebrate fossils (bones), which tend to be sporadically preserved and have high value w.r.t. palaeoecological and biostratigraphic (dating) information. Such fossils are non-renewable resources. Provided that no subsurface disturbance occurs, the fossils remain sequestered there.

When excavations are made they furnish the “windows” into the coastal plain depository that would not otherwise exist and thereby provide access to the hidden fossils . The impact is positive for palaeontology, provided that efforts are made to watch out for and rescue the fossils. Fossils and significant observations will be lost in the absence of management actions to mitigate such loss. This loss of the opportunity to recover them and their contexts when exposed at a particular site is irreversible.

The status of the potential impact for palaeontology is not neutral or negligible.

Although coastal coversands are not generally very fossiliferous, it is quite possible that fossiliferous material could occur. The very scarcity of fossils makes for the added importance of watching for them.

There remains a medium to high risk of valuable fossils being lost in spite of management actions to mitigate such loss. Machinery involved in excavation may damage or destroy fossils, or they may be hidden in “spoil” of excavated material.

## *7 SIGNIFICANCE*

The general significances of coastal-plain fossils involves:

- The history of coastal-plain evolution.
- The history of past climatic changes, past biota and environments.
- Associations of fossils with buried archaeological material and human prehistory.
- For radiometric and other dating techniques (rates of coastal change).

- Preservation of materials for the application of yet unforeseen investigative techniques.

The developments have potential as a record of higher sea-levels during the Quaternary Period. The Keurbooms estuary and its barrier-beach and tidal-inlet system is one of the most studied of such systems on the South Africa coast (Rust & Reddering, 1985). The historical changes to the system during the last ~100 years are approximately known, but its earlier history, preserved in the deposits around the margins and nearby coast, is not well studied.

The small wetland may preserve a palaeoenvironmental record of changes since prehistoric times.

# *8 IMPACT ASSESSMENT*

## *8.1 NATURE OF THE IMPACT*

### *8.1.1 Extents*

The physical extent of impacts on potential palaeontological resources relates directly to the extents of subsurface disturbance.

The cultural, heritage and scientific impacts are of regional to national extent, as is implicit in the NHRA 25 (1999) legislation and, if scientifically important specimens or assemblages are uncovered, are of international interest. This is evident in the amount of foreign-funded research that takes place by scientists of other nationalities. Loss of opportunities that may arise from a significant fossil occurrence (tourism, employment) filters down to regional/local levels.

### *8.1.2 Duration*

The initial duration of the impact is shorter term (< year) and primarily related to the period over which infrastructural excavations are made. This is the "time window" for mitigation.

In the longer term, the development "sterilizes" the palaeontological heritage resource potential within its extents, as the subsurface is "sealed" beneath roads, buildings and urban gardens. This translates to a cumulative impact, as fossiliferous coastal deposits are covered by developments mostly lacking mitigations protocols.

The impact of both the finding or the loss of fossils is permanent. The found fossils must be preserved "for posterity"; the lost, overlooked or destroyed fossils are lost to posterity.

### *8.1.3 Intensity*

Thus the potential impact of bulk earth works on fossil resources is high in the absence of mitigation. As mentioned, it is quite likely that scientifically valuable fossils may be lost in spite of mitigation.

### *8.1.4 Probability*

The likelihood of impact is medium *i.e*. it is likely to occur and is in the range of possible to probable.

### *8.1.5 Confidence*

The level of confidence of the probability and intensity of impact is medium to high.

## *8.2 IMPACTS AND SIGNIFICANCE OF ALTERNATIVES*

### *8.2.1 Ratings of Significance by Formation*

Methodogy is in Appendix 3.

| **Enon Formation** | **Score** |
|---|---|
| Duration/temporal scale | 5 |
| Extent/spatial scale | 3 |
| Severity/benefit | 2 |
| | 10 |
| Likelihood/probability | 2 |
| **Significance Rating** | **12** |

| **Coversand and marine deposits <12 m asl.** | **Score** |
|---|---|
| Duration/temporal scale | 5 |
| Extent/spatial scale | 3 |
| Severity/benefit | 2 |
| | **10** |
| Likelihood/probability | 3 |
| **Significance Rating** | **13** |

| **Dune cordon** | **Score** |
|---|---|
| Duration/temporal scale | 5 |
| Extent/spatial scale | 3 |
| Severity/benefit | 2 |
| Effect | **10** |
| Likelihood/probability | 1 |
| **Significance Rating** | **11** |

### *8.2.2 Impacts and Significance of Alternatives*

| Alternative Description | Without Mitigation | | With Mitigation | |
|---|---|---|---|---|
| | **Nature of Impact** | **Significance** | **Nature of Impact** | **Significance** |
| **Alternative 1:** Includes all of the following activities:<br>1. Cutbacks on steep upper slopes (Enon formation).<br>2. Bulk earth works on flatter aeolian sand areas.<br>3. Bulk earthworks on dune cordon for "coastal unit". | 1. Negative, loss of fossils may occur.<br>2. Negative, loss of fossils will probably occur.<br>3. Negative, but archaeological material is expected. | 1. Mod-High<br>2. Mod-High<br>3. Moderate | 1. Potentially positive as fossils may be found.<br>2. Positive if exposures of fossils are sampled and described.<br>3.Potentially positive as archaeological material and fossils may be found. | 1. Mod-High<br>2. Mod-High<br>3. Moderate |
| **Alternative 2:** Includes only the following two activities:<br>·1. Cutbacks on steep upper slopes (Enon formation).<br>2. Bulk earth works on flatter aeolian sand areas. | 1. Negative, loss of fossils may occur.<br>2. Negative, loss of fossils will probably occur. | 1. Mod-High<br>2. Mod-High | 1. Potentially positive as fossils may be found.<br>2. Positive if exposures of fossils are sampled and described. | 1. Mod-High<br>2. Mod-High |
| **Alternative 3:** Includes only the following activity:<br>2. Bulk earth works on flatter aeolian sand areas. | 2. Negative, loss of fossils will probably occur. | 2. Mod-High | 2. Positive if exposures of fossils are sampled and described. | 2. Mod-High |
| **Alternative 4 (No-go):** No development activities take place on the property. | Fossils are not destroyed, but no new fossils finds are exposed. | Negligible or neutral. | | |

Note that although the significance is moderate to high, due to the rarity and scientific importance of fossils and their permanent loss if destroyed or unnoticed, or positive impact if found during mitigation, the fossil potentials of the sites/alternatives do not directly influence the decisions to proceed with the developments.

## *9 RECOMMENDATIONS*

The Enon Formation has low fossil potential, but identifiable teeth and bones are occasionally found. Fossil wood is the most common fossil material and includes lignified or petrified larger pieces such as logs.

Excavations below ~12 m asl. may expose the “marine and estuarine terrace gravel and sand”, a known fossiliferous deposit. Overlying coversand and soil may include both fossils and archaeological material and such may also be found in the deposits of the vlei margins.

Recommendations for palaeontological mitigation are affected by those for archaeological mitigation. In most cases, when monitoring and inspection of excavations is recommended in the AIA, separate monitoring for fossil occurrences is not necessary (see Appendix 1).

It is recommended that the excavations be inspected by an archaeologist who must also report fossil occurrences. Excavations in the lower slope below ~12 m asl. have the greater fossil potential.

Furthermore, personnel involved in the bulk earth works must keep a lookout for fossil and archaeological material such as bones, shells and Stone Age artefacts.

Appendices 1 and 2 outline monitoring by construction personnel and a general Fossil Find Procedures.

## *10 APPLICATION FOR A PALAEONTOLOGICAL PERMIT*

A permit from Heritage Western Cape (HWC) is required to excavate fossils. The applicant should be the qualified specialist responsible for assessment, collection and reporting (palaeontologist).

A permit has not been applied for prior to the making of excavations. Should fossils be found that require rapid collecting, application for a retrospective palaeontological permit will be made to HWC immediately.

The application requires details of the registered owners of the sites, their permission and a site-plan map.

All samples of fossils must be deposited at a SAHRA-approved institution.

## *11 REPORTING*

Should fossils be found a detailed report on the occurrence/s must be submitted. This report is in the public domain and copies of the report must be deposited at the IZIKO S.A. Museum and Heritage Resources Western Cape. It must fulfil the reporting standards and data requirements of these bodies.

The report will be in standard scientific format, basically:

- A summary/abstract.
- Introduction.
- Previous work/context.
- Observations (incl. graphic sections, images).
- Palaeontology.
- Interpretation.
- Concluding summary.
- References.
- Appendices

The draft report will be reviewed by the client, or externally, before submission of the Final Report.

## *12 REFERENCES*


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## *13 GLOSSARY*

~ (tilde): Used herein as “approximately” or “about”.

Aeolian: Pertaining to the wind. Refers to erosion, transport and deposition of sedimentary particles by wind. A rock formed by the solidification of aeolian sediments is an aeolianite.

AIA: Archaeological Impact Assessment.

Alluvium: Sediments deposited by a river or other running water.

Archaeology: Remains resulting from human activity which are in a state of disuse and are in or on land and which are older than 100 years, including artefacts, human and hominid remains and artificial features and structures.

asl.: above (mean) sea level.

Bedrock: Hard rock formations underlying much younger sedimentary deposits.

Calcareous: sediment, sedimentary rock, or soil type which is formed from or contains a high proportion of calcium carbonate in the form of calcite or aragonite.

Calcrete: An indurated deposit (duricrust) mainly consisting of Ca and Mg carbonates. The term includes both pedogenic types formed in the near-surface soil context and non-pedogenic or groundwater calcretes related to water tables at depth.

Clast: Fragments of pre-existing rocks, *e.g*. sand grains, pebbles, boulders, produced by weathering and erosion. Clastic – composed of clasts.

Colluvium: Hillwash deposits formed by gravity transport downhill. Includes soil creep, sheetwash, small-scale rainfall rivulets and gullying, slumping and sliding processes that move and deposit material towards the foot of the slopes.

Coversands: Aeolian blanket deposits of sandsheets and dunes.

Duricrust: A general term for a zone of chemical precipitation and hardening formed at or near the surface of sedimentary bodies through pedogenic and (or) non-pedogenic processes. It is formed by the accumulation of soluble minerals deposited by mineral-bearing waters that move upward, downward, or laterally by capillary action, commonly assisted in arid settings by evaporation. Classified into calcrete, ferricrete, silcrete.

ESA: Early Stone Age. The archaeology of the Stone Age between 2 000 000 and 250 000 years ago.

EIA: Environmental Impact Assessment.

EMP: Environmental Management Plan.

Ferricrete: Indurated deposit (duricrust) consisting predominantly of accumulations of iron sesquioxides, with various dark-brown to yellow-brown hues. It may form by deposition from solution or as a residue

after removal of silica and alkalis. Like calcrete it has pedogenic and groundwater forms. Synonyms are laterite, iron pan or “koffieklip”.

Fluvial deposits: Sedimentary deposits consisting of material transported by, suspended in and laid down by a river or stream.

Fm.: Formation.

Fossil: Mineralised bones of animals, shellfish, plants and marine animals. A trace fossil is the track or footprint of a fossil animal that is preserved in stone or consolidated sediment.

Heritage: That which is inherited and forms part of the National Estate (Historical places, objects, fossils as defined by the National Heritage Resources Act 25 of 1999).

HIA: Heritage Impact Assessment.

LSA: Late Stone Age. The archaeology of the last 20 000 years associated with fully modern people.

LIG: Last Interglacial. Warm period 128-118 ka BP. Relative sea-levels higher than present by 4-6 m. Also referred to as Marine Isotope Stage 5e or “the Eemian”.

Midden: A pile of debris, normally shellfish and bone that have accumulated as a result of human activity.

MSA: Middle Stone Age. The archaeology of the Stone Age between 20-300 000 years ago associated with early modern humans.

Palaeontology: The study of any fossilised remains or fossil traces of animals or plants which lived in the geological past and any site which contains such fossilised remains or traces.

Palaeosol: An ancient, buried soil whose composition may reflect a climate significantly different from the climate now prevalent in the area where the soil is found. Burial reflects the subsequent environmental change.

Palaeosurface: An ancient land surface, usually buried and marked by a palaeosol or pedocrete, but may be exhumed by erosion (*e.g*. wind erosion/deflation) or by bulk earth works.

Peat: partially decomposed mass of semi-carbonized vegetation which has grown under waterlogged, anaerobic conditions, usually in bogs or swamps.

Pedogenesis/pedogenic: The process of turning sediment into soil by chemical weathering and the activity of organisms (plants growing in it, burrowing animals such as worms, the addition of humus *etc.*).

Pedocrete: A duricrust formed by pedogenic processes.

PIA: Palaeontological Impact Assessment.

SAHRA: South African Heritage Resources Agency – the compliance authority, which protects national heritage.

Stone Age: The earliest technological period in human culture when tools were made of stone, wood, bone or horn. Metal was unknown.

## *13.1 GEOLOGICAL TIME SCALE TERMS (YOUNGEST TO OLDEST).*

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 11.7–135 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.

Pliocene: Epoch from 5.3-2.6 Ma.

Miocene: Epoch from 23-5 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, 200-145 Ma.

Precambrian: Old crustal rocks older than 542 Ma (pre-dating the Cambrian).

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## *14 APPENDIX 1 – MONITORING FOR FOSSILS*

A regular monitoring presence over the period during which excavations are made, by either an archaeologist or palaeontologist, is generally not practical.

The field supervisor/foreman and workers involved in digging excavations must be encouraged and informed of the need to watch for potential fossil and buried archaeological material. Workers seeing potential objects are to report to the field supervisor who, in turn, will report to the ECO. The ECO will inform the archaeologist and/or palaeontologist contracted to be on standby in the case of fossil finds.

To this end, responsible persons must be designated. This will include hierarchically:

- The field supervisor/foreman, who is going to be most often in the field.
- The Environmental Control Officer (ECO) for the project.
- The Project Manager.

Should the monitoring of the excavations be a stipulation in the Archaeological Impact Assessment, the contracted Monitoring Archaeologist (MA) can also monitor for the presence of fossils and make a field assessment of any material brought to attention. The MA is usually sufficiently informed to identify fossil material and this avoids additional monitoring by a palaeontologist. In shallow coastal excavations, the fossils encountered are usually in an archaeological context.

The MA then becomes the responsible field person and fulfils the role of liaison with the palaeontologist and coordinates with the developer and the Environmental Control Officer (ECO). If fossils are exposed in non-archaeological contexts, the palaeontologist should be summoned to document and sample/collect them.

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## 15 APPENDIX 2 - 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. However, they may also serve as a guideline for other fossil material that may occur.

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

### 15.1 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.
- 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 4:** 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.

### 15.2 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.

## *15.3 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.

## *15.4 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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## 16 APPENDIX 3 – RATING METHODOLOGY

**Table 8-1: Criterion used to rate the significance of an impact**

| | | | | |
|---|---|---|---|---|
| EFFECT | **Temporal scale** | | | **Score** |
| | Short term | Less than 5 years | | 1 |
| | Medium term | Between 5 and 20 years | | 2 |
| | Long term | Between 20 and 40 years (a generation) and from a human perspective almost permanent. | | 3 |
| | Permanent | Over 40 years and resulting in a permanent and lasting change that will always be there | | 4 |
| | **Spatial Scale** | | | |
| | Localised | At localised scale and a few hectares in extent | | 1 |
| | Study area | The proposed site and its immediate environs | | 2 |
| | Regional | District and Provincial level | | 3 |
| | National | Country | | 3 |
| | International | Internationally | | 4 |
| | **Severity** | | **Benefit** | |
| | Slight / Slightly Beneficial | Slight impacts on the affected system(s) or party (ies) | Slightly beneficial to the affected system(s) or party (ies) | 1 |
| | Moderate / Moderately Beneficial | Moderate impacts on the affected system(s) or party(ies) | An impact of real benefit to the affected system(s) or party (ies) | 2 |
| | Severe / Beneficial | Severe impacts on the affected system(s) or party (ies) | A substantial benefit to the affected system(s) or party (ies) | 4 |
| | Very Severe / Very Beneficial | Very severe change to the affected system(s) or party(ies) | A very substantial benefit to the affected system(s) or party (ies) | 8 |
| LIKELIHOOD | **Likelihood** | | | |
| | Unlikely | The likelihood of these impacts occurring is slight | | 1 |
| | May Occur | The likelihood of these impacts occurring is possible | | 2 |
| | Probable | The likelihood of these impacts occurring is probable | | 3 |
| | Definite | The likelihood is that this impact will definitely occur | | 4 |

**Table 8-2: The matrix that will be used for the impacts and their likelihood of occurance**

| Likelihood | Effect | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 |
| 1 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 |
| 2 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 |
| 3 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 |
| 4 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |

**Table 8-3: The significance rating scale**

| Significance | Description | Score |
|---|---|---|
| Low | Ac acceptable impact for which mitigation is desirable but not essential. The impact by itself is insufficient even in combination with other low impacts to prevent the development being approved. These impacts will result in either positive or negative medium to short term effects on the social and/or natural environment. | 4-7 |
| Moderate | An important impact which requires mitigation. The impact is insufficient by itself to prevent the implementation of the project but which in conjunction with other impacts may prevent its implementation. These impacts will usually result in either a positive or negative medium to long-term effect on the social and/or natural environment. | 8-11 |
| High | A serious impact, if not mitigated, may prevent the implementation of the project (if it is a negative impact). These impacts would be considered by society as constituting a major and usually a long-term change to the (natural &/or social) environment and result in severe effects or beneficial effects. | 12-15 |
| Very High | A very serious impact which, if negative, may be sufficient by itself to prevent implementation of the project. The impact may result in permanent change. Very often these impacts are unmitigable and usually result in very severe effects, or very beneficial effects. | 16-20 |

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