PALAEONTOLOGICAL SCOPING REPORT
(Desktop Study)

PROPOSED RESIDENTIAL DEVELOPMENT ON ERF 3122 HARTENBOS GARDEN ESTATE MOSSEL BAY MUNICIPALITY, MOSSEL BAY DISTRICT, WESTERN CAPE

BY
John Pether, M.Sc., Pr. Sci. Nat. (Earth Sci.)
Geological and Palaeontological Consultant
P. O. Box 48318, Kommetjie, 7976
Tel./Fax (021) 7833023
Cellphone 083 744 6295
jpether@iafrica.com

FOR
Cape Environmental Assessment Practitioners (Pty) Ltd.
(Cape EAPrac)
17 Progress Street, George
PO Box 2070, George 6530
Telephone: (044) 874 0365
Facsimile: (044) 874 0432
Web: www.cape-eaprac.co.za

CLIENT
Hartenbos Hills Propco (Pty) Ltd.

31 March 2021

EXECUTIVE SUMMARY

1. SITE NAME

Hartenbos Garden Estate. Proposed Residential Development on Erf 3122, Mossel Bay Municipality, Mossel Bay Magisterial District, Western Cape.

2. LOCATION

See Figure1. Erf 3122, is on a hilltop overlooking Hartenbos, just north of Mossel Bay

Property	Erf 3122 Hartenbos Garden Estate
Total area	60.52 ha
Development area	~24.2 ha
1:50 000 Topo-cadastral Sheet No.	3422AA MOSSEL BAY
Central Co-ordinate (Clubhouse)	-34.128347°S ; 22.086306°E
Magisterial District	Mossel Bay
Municipality	Mossel Bay

3. LOCALITY PLAN

See Figure 2.

4. PROPOSED DEVELOPMENT

The proposed development on Erf 3122 was previously known as “Hartenbos Heuwels”, with ATKV Hartenbos Strandoord as the applicant. The new Applicant, Hartenbos Hills Propco (Pty) Ltd., is now proceeding with the proposed residential development, renamed Hartenbos Garden Estate, with a slightly modified site layout. Cape EAPrac has been appointed to manage the updated Scoping and Environmental Impact Assessment process. The proposed development (Figure 2) entails the following components:

- 117 Larger houses on large stands (350-600 m2).
- 122 Smaller houses on smaller stands (≤350 m2).
- 40 Garden houses on 200 m2 stands.
- 144 Village apartments.
- 20 Care Centre apartments, 34 Care Centre rooms.
- Clinic, Sports Facilities, Club House and Restaurant.
- Associated bulk services, roads and entrance control.

The subsurface disturbance is typical of housing developments and mainly leveling and shallow trenches for foundations and services infrastructure.

5. PALAEONTOLOGICAL HERITAGE RESOURCES IDENTIFIED

Most of the development affects the stony soil developed on the Cretaceous **Buffelskloof Formation** (Uitenhage Group) and the underlying conglomerates and interbedded sandstones and siltstones (Fig. A below). Petrified fossil wood and other plant remains are expected. The fragmented bones and isolated teeth of dinosaurs could occur, but are exceptionally rare.

An outlier of Bredasdorp Group deposits underlies the summit of the hilltop in the north (Fig. A). The mid-Miocene marine **De Hoopvlei Formation** is affected only by the construction of the perimeter fence (post holes) and the making of a perimeter service road. It is possible that fossil marine shells

could be unearthed, particularly along the inner edge of the road cut-ins on the steeper slopes.

The most important change in the SDP relevant to potential impact on the later Miocene **Wankoe Formation** is the decision to create a conservation area in the northern area around the reservoir (Fig. A), where previously 16 plots were laid out on top of the Wankoe Formation aeolianite, which is of Moderate palaeontological sensitivity. Not building in this area reduces the potential impact on this palaeontological resource. The Wankoe Formation is now also affected only by the construction of the perimeter fence (post holes) and the making of a perimeter service road. Sparse bones may occur and any such material, both small and larger, is of high value. The land snails in these old aeolianites are of interest. The partly-overlying, late Quaternary **Qg coversand/soil** rarely sequesters fossils, but material associated with buried archaeological remains could occur.

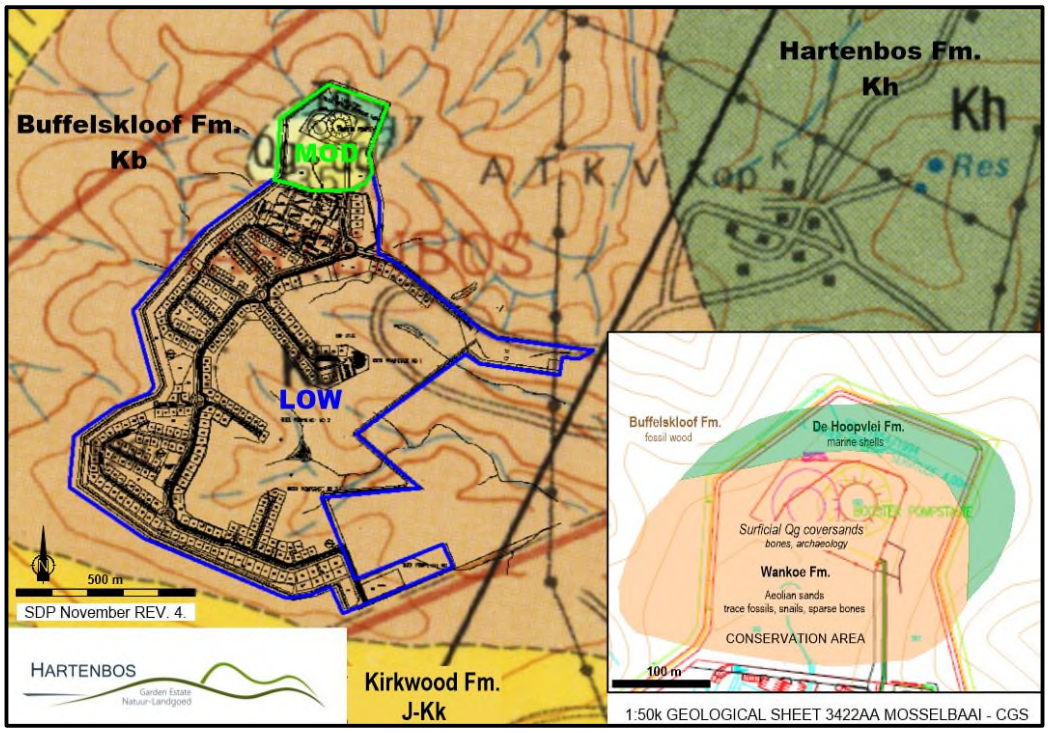


Figure A. Geological map and palaeontological sensitivities in the Project Area. Inset: Detail of area of Moderate sensitivity.

6. ANTICIPATED IMPACTS

The palaeontological sensitivity of the formations (App. 1) is reflected by the Intensity rating. In particular, the De Hoopvlei and Wankoe formations are of considerable age and thus any enclosed fossils will be of scientific interest, but a lengthy duration for post-depositional alteration lowers the fossil preservation potential.

IMPACT CRITERIA RATINGS					
FORMATION	**EXTENTS**	**DURATION**	**INTENSITY**	**PROBABILITY.**	**SIGNIFICANCE**
Qg coversand	Local	Permanent	Low	Improbable	MODERATE (low)
Wankoe Fm.	Local	Permanent	Medium	Possible	MODERATE (high)
De Hoopvlei Fm.	Local	Permanent	Medium	Possible	MODERATE (high)

Buffelskloof Fm.	Local	Permanent	Low	Possible	MODERATE (low)

7. RECOMMENDATIONS

A practical monitoring and mitigation programme must be implemented during the Construction Phases of the proposed housing development. The following measures apply to all earthworks affecting all four formations listed above. The field supervisor/foreman and workers involved in digging excavations must be informed of the need to watch for fossils and buried potential archaeological material. Section 8.2 provides measures for inclusion in the Construction Phase EMP and the **Fossil Finds Procedure** included as Appendix 3 provides guidelines to be followed in the event of fossil finds.

It is also recommended that fresh exposures of the marine beds that may be created during construction, such as along the perimeter road, are recorded and sampled by a palaeontologist. To this end the ECO must liaise with the contracted palaeontologist as to the progress of road construction earthworks.

It is proposed that exposures of the De Hoopvlei Formation Miocene beds and the overlying Wankoe Formation that may be created along the perimeter road are highlighted by explanatory signage. Should the fossil content indeed indicate a mid-Miocene age for the De Hoopvlei Formation this site will be an important, new stratotype locality. This would represent a positive outcome of regional to national consequence.

8. SCREENING REPORT – PALAEONTOLOGICAL SENSITIVITY

According to the Screening Report the entire area is of Very High sensitivity. However, this caution was based on a superseded 1:250 000 geological map. Subsequent, more detailed mapping reproduced herein depicts the geological formations in more detail, also differentiating the fossil potential. Please refer to Appendix 4 for details.

DECLARATION OF INDEPENDENCE

PALAEONTOLOGICAL SCOPING REPORT (Desktop Study).

PROPOSED RESIDENTIAL DEVELOPMENT ON ERF 3122, HARTENBOS GARDEN ESTATE.

MOSSEL BAY MUNICIPALITY, MOSSEL BAY DISTRICT, WESTERN CAPE.

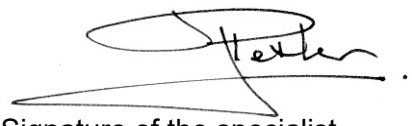
Terms of Reference

This assessment forms part of the Heritage Assessment and it assesses the overall palaeontological (fossil) sensitivities of formations underlying the Project Area in terms of the proposed development.

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 NEMA, the Environmental Impact Assessment Regulations, 2014 and any specific environmental management Act;
- have and will not have any vested interest in the proposed activity proceeding;
- have disclosed to the 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, 2014 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 48 of the 2014 NEMA EIA Regulations.



Signature of the specialist

Date: 31 MARCH 2021

CURRICULUM VITAE

John Pether, M.Sc., Pr. Sci. Nat. (Earth Sci.)

Independent Consultant/Researcher recognized as an authority with 37 years' experience in the field of coastal-plain and continental-shelf palaeoenvironments, fossils and stratigraphy, mainly involving the West Coast/Shelf of southern Africa. Has been previously employed in academia (South African Museum) and industry (Trans Hex, De Beers Marine). At present an important involvement is in Palaeontological Impact Assessments (PIAs) and mitigation projects in terms of the National Heritage Resources Act 25 (1999) (~250 PIA reports to date) and is an accredited member of the Association of Professional Heritage Practitioners (APHP). Continues to be involved as consultant to offshore and onshore marine diamond exploration ventures. Expertise includes:

- Coastal plain and shelf stratigraphy (interpretation of open-pit exposures, on/offshore cores and exploration drilling).
- Sedimentology and palaeoenvironmental interpretation of shallow marine, aeolian and other terrestrial surficial deposits.
- Marine macrofossil taxonomy (molluscs, barnacles, brachiopods) and biostratigraphy.
- Marine macrofossil taphonomy.
- Sedimentological and palaeontological field techniques in open-cast mines (including finding and excavation of vertebrate fossils (bones).

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.
- Association of Professional Heritage Practitioners (APHP), Western Cape. Accredited Member No. 48.

Past Clients Palaeontological Assessments

AECOM SA (Pty) Ltd.	Guillaume Nel. Env. Management Consultants.
Agency for Cultural Resource Management (ACRM).	Klomp Group.
AMATHEMBA Environmental.	Megan Anderson, Landscape Architect.
Anél Blignaut Environmental Consultants.	Ninham Shand (Pty) Ltd.
Arcus Gibb (Pty) Ltd.	PD Naidoo & Associates (Pty) Ltd.
ASHA Consulting (Pty) Ltd.	Perception Environmental Planning.
Aurecon SA (Pty) Ltd.	PHS Consulting.
BKS (Pty) Ltd. Engineering and Management.	Resource Management Services.
Bridgette O'Donoghue Heritage Consultant.	Robin Ellis, Heritage Impact Assessor.
Cape Archaeology, Dr Mary Patrick.	Savannah Environmental (Pty) Ltd.
Cape EAPrac.	Sharples Environmental Services cc
CCA Environmental (Pty) Ltd.	Site Plan Consulting (Pty) Ltd.
Centre for Heritage & Archaeological Resource Management	Strategic Environmental Focus (Pty) Ltd.
Chand Environmental Consultants.	UCT Archaeology Contracts Office (ACO).
CK Rumboll & Partners.	UCT Environmental Evaluation Unit
CNdV Africa	Urban Dynamics.
CSIR - Environmental Management Services.	Van Zyl Environmental Consultants
Digby Wells & Associates (Pty) Ltd.	ENVIRO DINAMIK.
Enviro Logic	Wethu Investment Group Ltd.
Environmental Resources Management SA (ERM).	Withers Environmental Consultants.
Greenmined Environmental	

Stratigraphic consulting including palaeontology

Afri-Can Marine Minerals Corp	Council for Geoscience
De Beers Marine (SA) Pty Ltd.	De Beers Namaqualand Mines.
Geological Survey Namibia	IZIKO South African Museum.
Namakwa Sands (Pty) Ltd	NAMDEB

CONTENTS

1	INTRODUCTION	1
2	PROJECT DESCRIPTION	2
3	APPLICABLE LEGISLATION	3
4	METHODOLOGY	4
4.1	LITERATURE	4
4.2	ASSUMPTIONS AND LIMITATIONS	4
4.3	PALAEONTOLOGICAL SENSITIVITY RATING	4
5	GEOLOGICAL AND PALAEONTOLOGICAL SETTING	4
5.1	THE CAPE SUPERGROUP	4
5.2	THE UITENHAGE GROUP	6
5.3	THE BREDASDORP GROUP	7
6	EXPECTED PALAEONTOLOGY AND SENSITIVITIES	9
6.1	THE BUFFELSKLOOF FORMATION	9
6.2	THE DE HOOPVLEI FORMATION	10
6.3	THE WANKOE FORMATION	10
6.4	THE QG COVERSAND	12
7	POTENTIAL IMPACTS AND RISKS	12
7.1	NATURE OF THE IMPACT OF BULK EARTH WORKS ON FOSSILS	12
7.2	EXTENTS	13
7.3	DURATION	13
7.4	INTENSITY	13
7.5	PROBABILITY	14
7.6	IMPACT SIGNIFICANCE RATINGS	14
7.7	CUMULATIVE IMPACT	15
8	RECOMMENDATIONS	15
8.1	MONITORING	15
8.2	BASIC MEASURES FOR THE CONSTRUCTION PHASE EMP	16
8.3	FIELD INSPECTION BY PALAEONTOLOGIST	17
8.4	A LOCAL GEOHERITAGE SITE	17
9	REFERENCES	17
10	APPENDIX 1. - PALAEONTOLOGICAL SENSITIVITY RATING	19

11 APPENDIX 2. - METHODOLOGY FOR ASSESSING THE SIGNIFICANCE OF IMPACTS 20

12 APPENDIX 3 - FOSSIL FIND PROCEDURE 22

12.1 MONITORING 22
12.2 EXPECTED FOSSIL FINDS 22
12.3 PROCEDURE FOR FOSSIL FINDS 23
12.4 APPLICATION FOR A PERMIT TO EXCAVATE AND COLLECT 24

13 APPENDIX 4 – NOTE ON SCREENING REPORT - PALAEONTOLOGY 26

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 (alluvial).

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.

Conglomerate: A cemented gravel deposit.

Coversands: Aeolian blanket deposits of sandsheets and smaller 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.

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: The remains of parts of animals and plants found in sedimentary deposits. Most commonly hard parts such as bones, teeth and shells which in lithified sedimentary rocks are usually altered by petrification (mineralization). Also impressions and mineral films in fine-grained sediments that preserve indications of soft parts. Fossils plants include coals, petrified wood and leaf impressions, as well as microscopic pollen and spores. Marine sediments

contain a host of microfossils that reflect the plankton of the past and provide records of ocean changes. Nowadays also includes molecular fossils such as DNA and biogeochemicals such as oils and waxes. A trace fossil is the track or footprint of a fossil animal that is preserved in stone or consolidated sediment.

Graben: An elongated block of the earth's crust lying between two faults and displaced downwards relative to the blocks on either side, as in a rift valley.

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.

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 formed on a palaeosurface. The soil 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.

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.

Rhizolith: Fossil root. Most commonly formed by pedogenic carbonate deposition around the root and developed in palaeosols.

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

Stratotype locality: The place where deposits regarded as defining the characteristics of a particular geological formation occur.

Tectonic: Relating to the structure of the earth's crust and the large-scale processes which take place within it (faulting and earthquakes, crustal uplift or subsidence.

Trace fossil: A structure or impression in sediments that preserves the behaviour of an organism, such as burrows, borings and nests, feeding traces (sediment processing), farming structures for bacteria and fungi, locomotion burrows and trackways and traces of predation on hard parts (tooth marks on bones, borings into shells by predatory gastropods and octopuses).

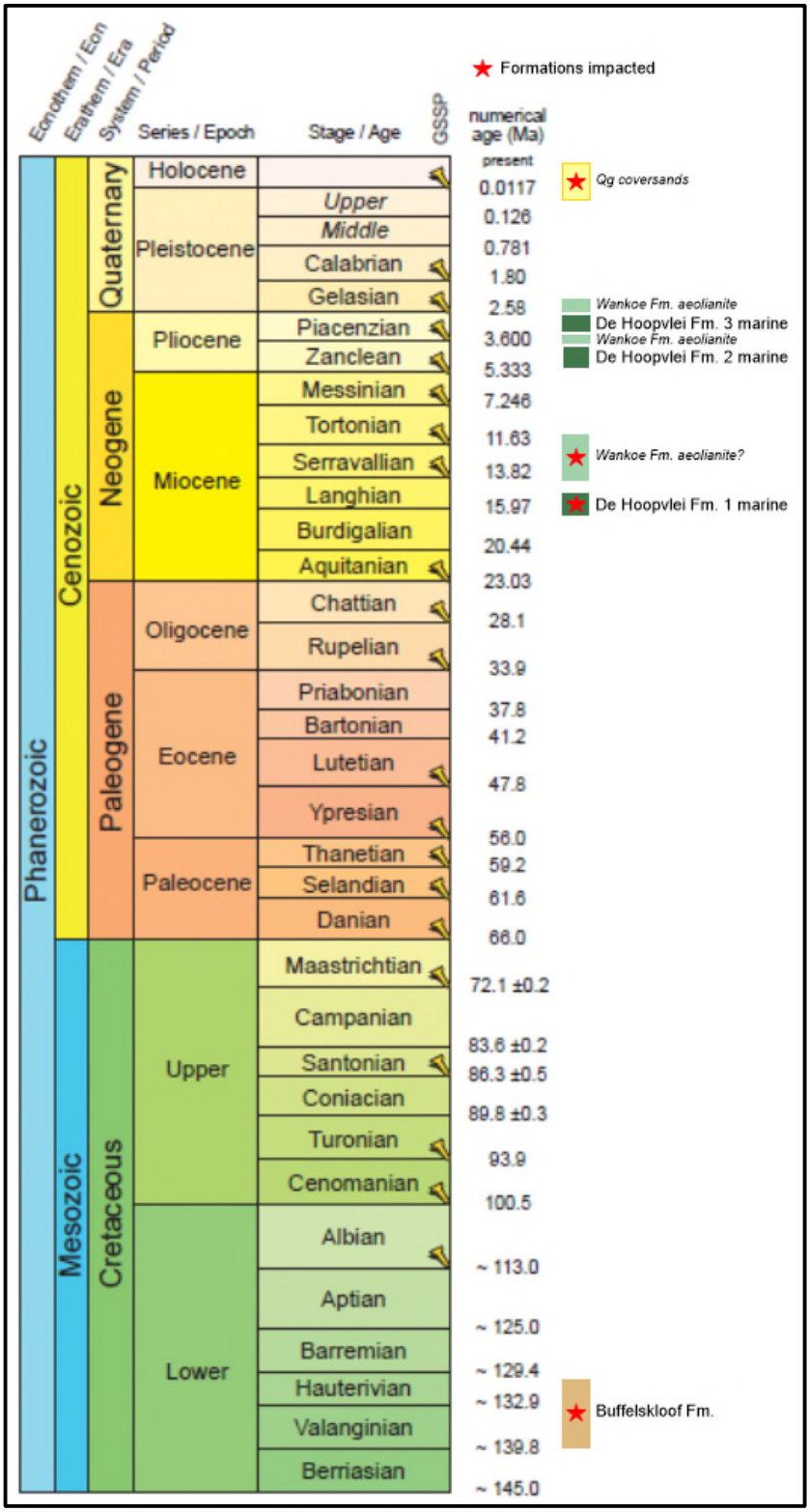
GEOLOGICAL TIME SCALE TERMS

For more detail 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. Not used for durations not extending from the Present. For a duration only “kyr” is used.

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. Not used for durations not extending from the Present. For a duration only “Myr” is used.



Mesozoic and Cenozoic chronostratigraphy and the ages of formations present in the Project Area. From: International Commission on Stratigraphy, Chronostratigraphic Chart 2016-12.pdf.

1 INTRODUCTION

The context of this Scoping Report is a proposed residential development on Erf 3122, a property of ~60 ha that is on a hill overlooking Hartenbos, just north of Mossel Bay (Figure 1). The proposed development on Erf 3122 was previously known as "Hartenbos Heuwels", with ATKV Hartenbos Strandoord as the applicant. The new Applicant, Hartenbos Hills Propco (Pty) Ltd., is now proceeding with the proposed residential development, renamed Hartenbos Garden Estate, with a slightly modified site layout. Cape EAPrac has been appointed to manage the updated Scoping and Environmental Impact Assessment process.

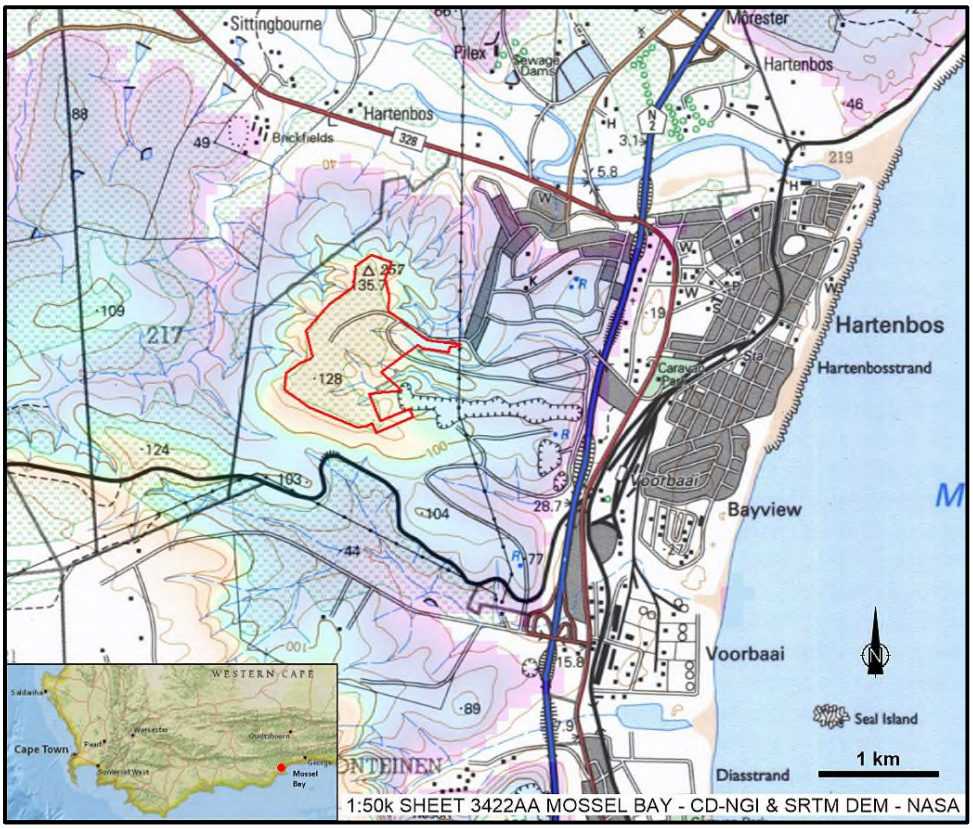


Figure 1. Location of Erf 3122, "Hartenbos Garden Estate" proposed for development.

This report forms part of the Heritage Scoping Report 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 the bulk earth works involved in the proposed project.

The main Terms of Reference of this palaeontological scoping assessment are to:

- Outline the nature of possible palaeontological/fossil heritage resources in the subsurface of the affected area.
- Evaluate the impacts of the proposed development in terms of the palaeontological sensitivity of the fossil content.
- Suggest the mitigatory actions to be taken with respect to the occurrence of fossils during bulk earth works.

2 PROJECT DESCRIPTION

THE PROJECT AREA	
Property	Erf 3122 Hartenbos Garden Estate
Total area	60.52 ha
Development area	~24.2 ha
1:50 000 Topo-cadastral Sheet No.	3422AA MOSSEL BAY
Central Co-ordinate (Clubhouse)	-34.128347°S ; 22.086306°E
Magisterial District	Mossel Bay
Municipality	Mossel Bay

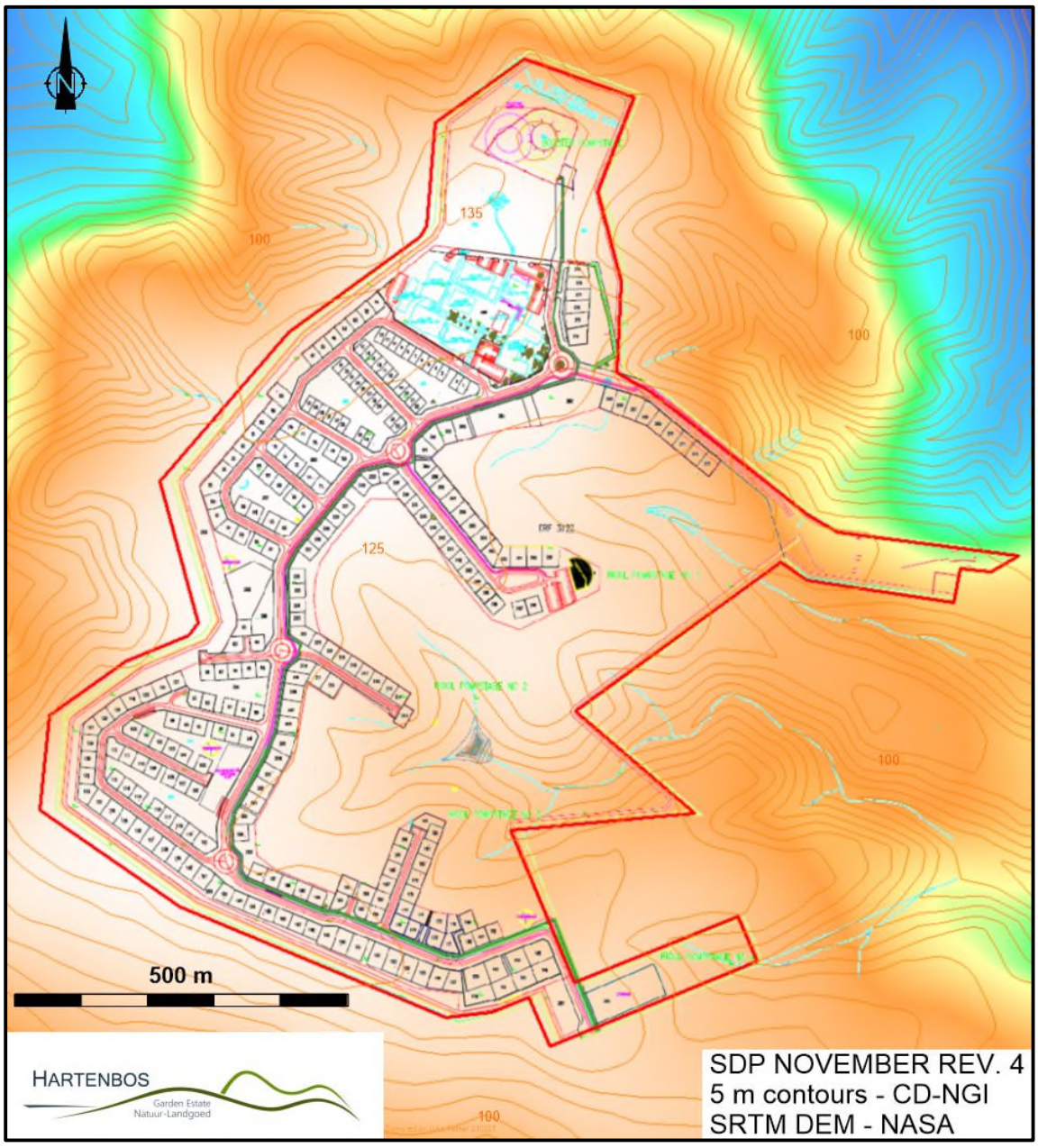


Figure 2. Proposed Site Development Plan for Erf 3122, Hartenbos Garden Estate. Courtesy of Hartenbos Hills Propco and Cape EAPrac.

The constraints footprint of the proposed development has not changed, but there have been changes to the internal layout of the Site Development Plan (SDP). The proposed development (Figure 2) entails the following components:

- 117 Larger houses on large stands (350-600 m2).
- 122 Smaller houses on smaller stands (≤350 m2).
- 40 Garden houses on 200 m2 stands.
- 144 Village apartments.
- 20 Care Centre apartments.
- 34 Care Centre rooms.
- Clinic.
- Sports facilities.
- Club house and restaurant.
- Associated bulk services, roads and entrance control.

The housing development will typically include excavations for site and road levelling, trenches for electricity, water, telecoms and sewerage infrastructure, foundations of buildings and excavations for the storm water management system. It may include retention dams, sewerage pump stations and buried water and fuel tanks.

The most important change in the SDP relevant to impact is the decision to create a conservation area for the “Mosselbaai Bruin Kopervlerkie” butterfly in the northern area around the reservoir, where previously 16 plots were laid out on top of the Wankoe Formation aeolianite, which is of Moderate palaeontological sensitivity. Not building in this area reduces the potential impact on palaeontological resources.

3 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). The areal scale of the proposed development involves subsurface disturbance and exposure which exceed 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).

4 METHODOLOGY

4.1 LITERATURE

The main information for the area is from Malan & Viljoen (1990) and Viljoen and Malan (1993) and the relevant geological maps, parts of which are reproduced in Figures 4 and 7. Shone (2006) provides a useful summary of the formations relevant to the study area. Other references 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 a formation in a specific area other than in general terms, based upon finds and observations from the wider region. 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.

The previous, thorough site survey for the Archaeological Impact Assessment (Nilssen, 2010) did not observe any fossil occurrences on the surface or in erosional gullies. An additional site survey specifically for fossils was deemed unnecessary. This report is a desktop study with respect to the vicinity of the Project Area. Notwithstanding, the author is familiar with the geology of the region from previous field observations in the broader area.

4.3 PALAEONTOLOGICAL SENSITIVITY RATING

On the basis of the known fossil content of a formation it may be classified in terms of Palaeontological Sensitivity, ranging from NO POTENTIAL to HIGH (Appendix 1). For the rating of impact, the palaeontological sensitivity rating replaces the "Intensity" or Magnitude" criterion of standard impact assessments. See Appendix 4 for comment on the Screening Report "palaeo-sensitivity" rating. The impact rating assessment scheme used herein is appended (Appendix 2).

5 GEOLOGICAL AND PALAEONTOLOGICAL SETTING

5.1 THE CAPE SUPERGROUP

Erf 3122 is situated on a hill west of Hartenbos and encompasses the hilltop and its eastern slopes, the latter dissected by the headwaters of a number of drainages (Figure 3). Elevations range from 96-137 m asl. and the hill has a flattish summit mainly about 125 m asl.

The bedrock in this region is comprised of cemented sedimentary rocks of the **Cape Supergroup**, *viz.* **Table Mountain Group** sandstones (quartzites) and shales of the **Bokkeveld Group**, deposited 500-360 million years ago (Ma) (Ordovician, Silurian and Devonian periods). Compression of these deposits ~250 Ma produced the Cape Fold Belt, with mountain ridges of Table Mountain group quartzites and plains and valleys of the softer Bokkeveld shales.

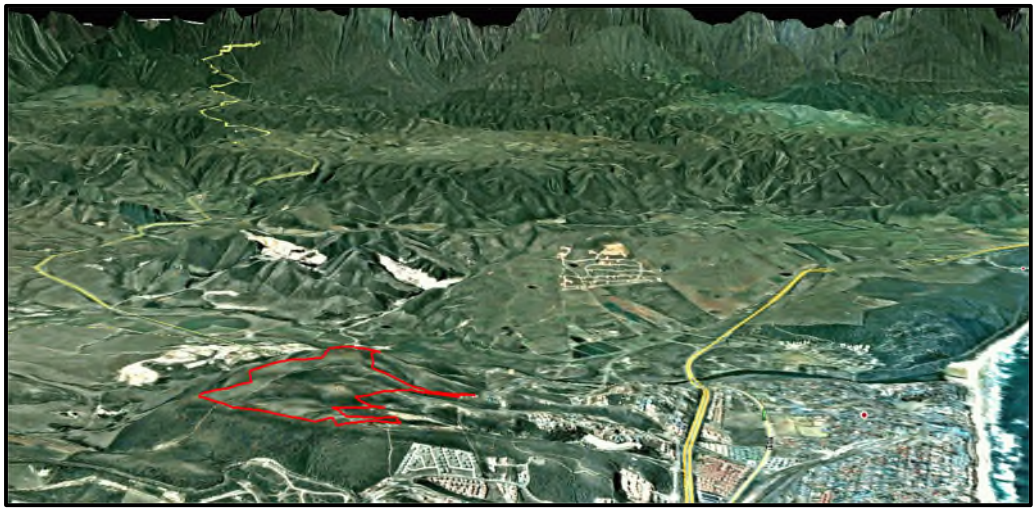


Figure 3. Geomorphic setting of Erf 3122, Hartenbos. Simulated oblique aerial view from Google Earth.

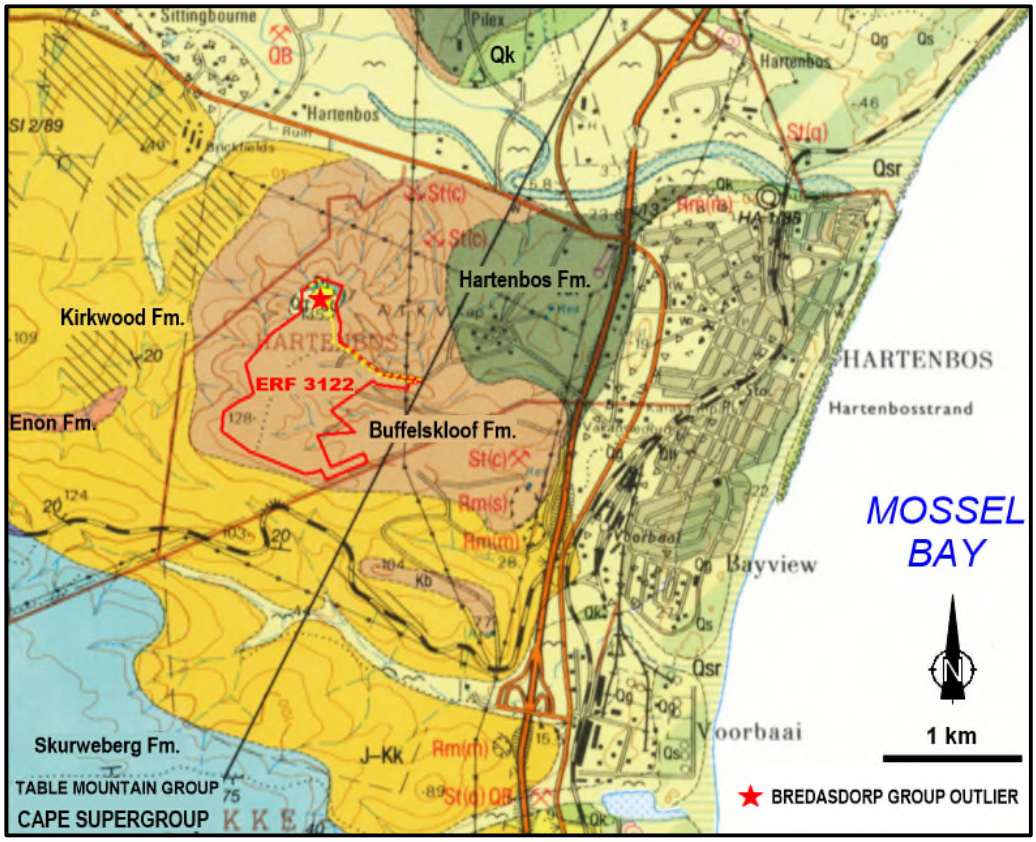


Figure 4. Geology of the Project Area surrounds. Extract of 1:50 000 Geological Series 3422AA Mosselbaai. Council for Geoscience.

The Cape Supergroup rocks were extensively disrupted by faulting during the breakup of supercontinent Gondwana. The high ground south of the Project Area is comprised of quartzites of the **Skurweberg Formation** of upper part of the Table Mountain Group (Figure 4), but this bedrock is down-faulted beneath the Project Area.

5.2 THE UITENHAGE GROUP

The faulting produced steep slopes flanking new local basins (grabens) which were filled with a "fresh" suite of sediments (Figure 5). These late Jurassic and early Cretaceous sediments, deposited between about 155 Ma and 134 Ma, are called the **Uitenhage Group**, as they are best exposed in the Algoa area. Erf 3122 is situated on Uitenhage Group deposits (Figure 4).

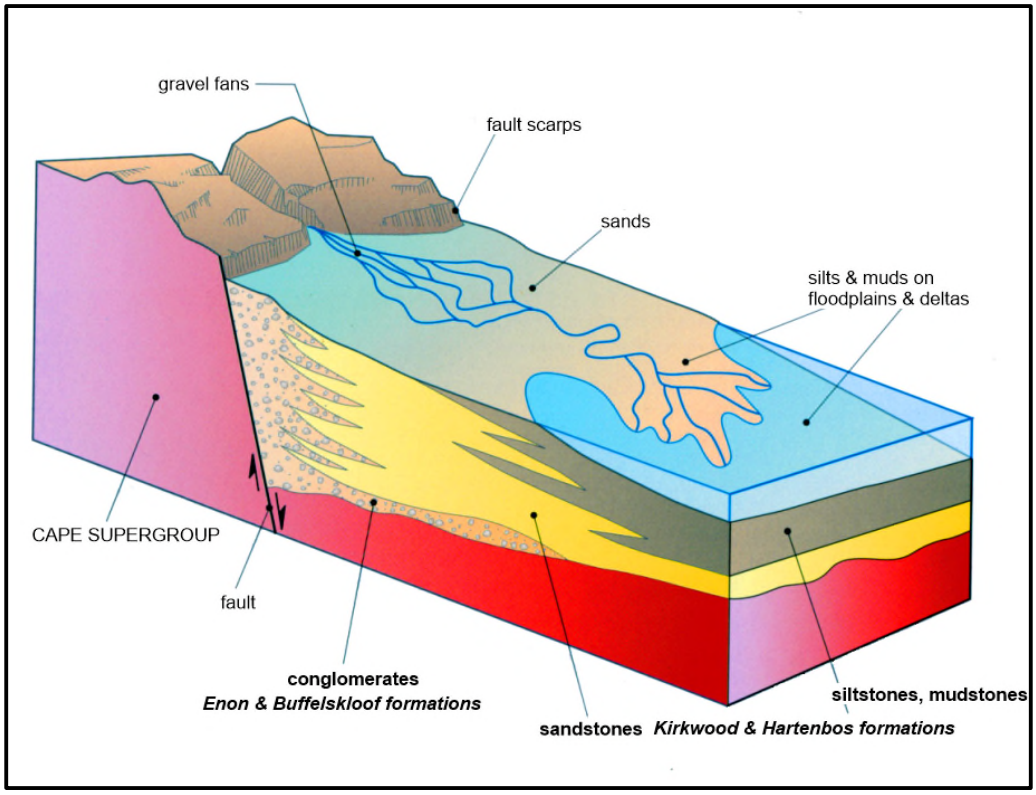


Figure 5. Depositional model of the Uitenhage Group in the Algoa Basin. Adapted from McCarthy & Rubidge, 2005.

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 5). Farther downslope from these coarse alluvial fans were the sandy and muddy flood plains of the rivers, called the **Kirkwood Formation**. Another phase of tectonic activity and movement on the prominent faults during the early Cretaceous (140-130 Ma) led to the deposition of the conglomeratic **Buffelskloof Formation,** which was deposited, like the Enon Fm., in mountain-slope alluvial fan and braided-stream settings (Figure 6). Interfingering and overlying the Buffelskloof Formation to the seaward (east) in this area are sandy and muddy/clayey beds which represent alluvial and deltaic deposition in the basin, called the **Hartenbos Formation** (Figures 4, 6).

The hill upon which Erf 3122 is situated ("ATKV Kop") consists of Buffelskloof Formation conglomerates and interbedded sandstones and siltstones (Figures 4, 7, 8).

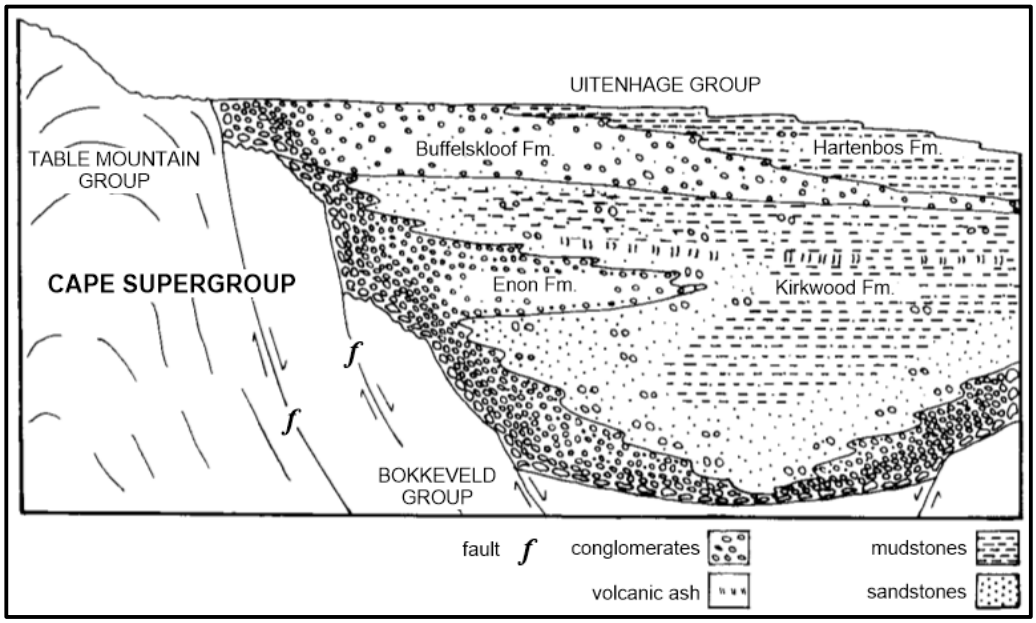


Figure 6. Schematic lithostratigraphy of the Uitenhage Group in the Herbertsdale/Mossel Bay Basin. Adapted from Viljoen & Malan, 1993.

5.3 THE BREDASDORP GROUP

The subsequent geological history of the region involves coastal-plain marine platform development and the deposition of coastal-plain shallow-marine formations that relate to periods of high sea level during the Cenozoic Era and the aeolian (dune) formations that cover them. In Figure 3 the high (180-300 m asl.), old "Coastal Platform" bevel can be seen in the background. It dates back to early Cenozoic (Eocene) times (older than ~30 Ma), as is evident by marine limestones of this age in the Eastern Cape, but marine deposits of this age have not been preserved in the southern Cape.

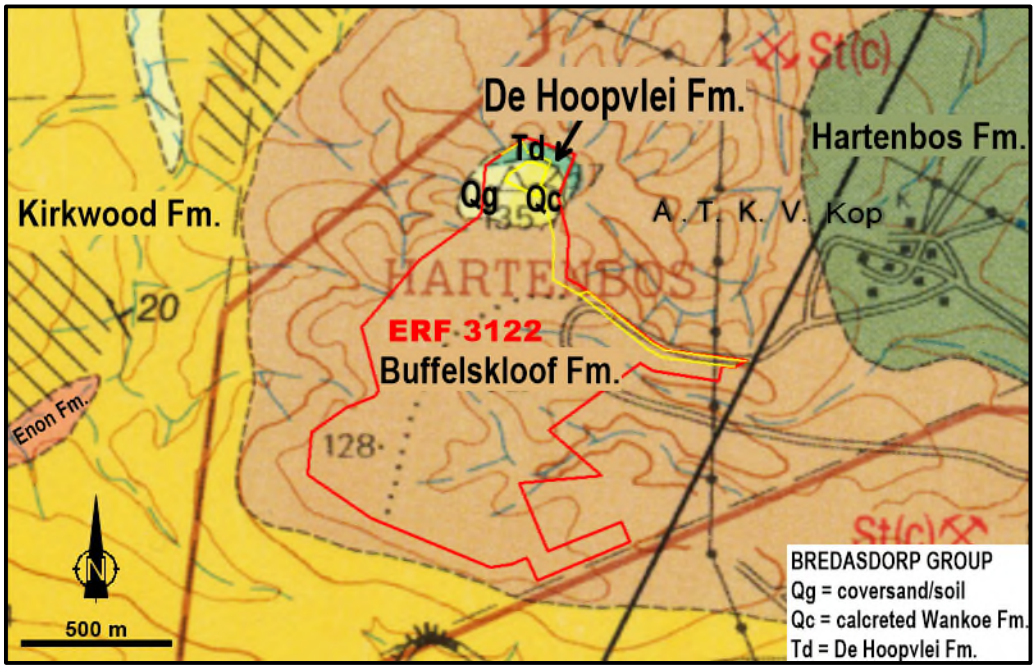


Figure 7. Detail of Figure 4 showing the remnant of the De Hoopvlei Formation shelly conglomerate beneath calcreted sands. Reservoir and pipeline servitudes indicated in yellow.

Subsequent high sea levels formed benches with overlying marine formations below the old, high Coastal Platform. These relate to high sea levels which are dated to ~16-15 Ma (late Early Miocene), to ~5-4 Ma (early Pliocene) and to ~3.0 Ma (late Pliocene) (Pether *et al*., 2000; Roberts *et a*l., 2006), these being times of global warmth and melting ice caps. The coastal-plain deposits of the southern Cape collectively comprise the **Bredasdorp Group**. The marine Miocene and Pliocene formations, although of three distinctly different ages, are currently all included in an over-arching unit called the **De Hoopvlei Formation**. Similarly, the aeolian formations of various Mio-Pliocene ages are all included in the **Wankoe Formation** (Viljoen & Malan, 1993).

The Erf 3122 hilltop, along with other local summits in the range of 120-140 m asl., represents the remnants of a younger marine platform that has been dissected and reduced. This 120-140 m asl. platform was fashioned during high sea levels of the Mid-Miocene Climatic Optimum, 16-14 Ma, and when the sea receded the platform was left with a cover of shelly marine conglomerates and sands and overlying terrestrial coastal-plain deposits. These Mid-Miocene De Hoopvlei Formation marine deposits have mostly been flushed off the eroded remnants of the platform, but small patches have been preserved on the summit of "ATKV Kop" at Trig. Beacon 257 (Figure 7, Td) and the ridge summit on Vaale Valley 219 (Figure 8).

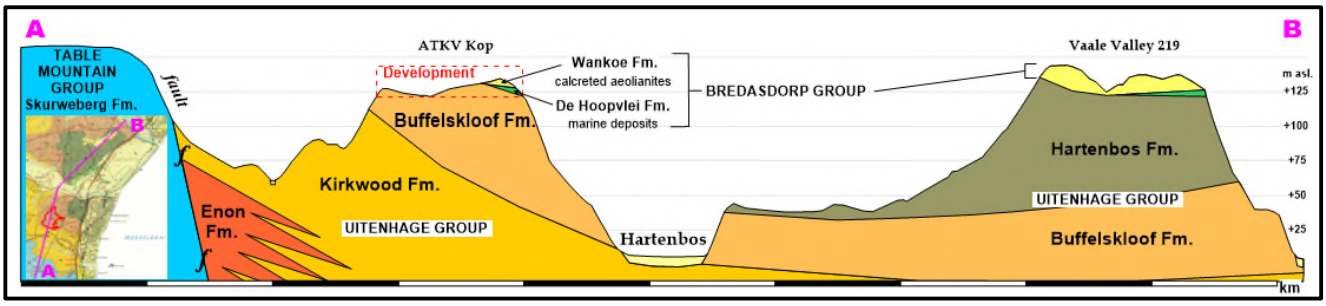


Figure 8. Geological cross section of the Hartenbos area illustrating the context of the proposed development.

The marine beds are overlain by Quaternary (Q) units mapped as non-shelly aeolian sand (**Qg**) and calcrete (**Qc**) (Figure 7). Whereas unit Qg is a coversand, the calcrete Qc is assumed to have formed within the upper part of an older aeolianite such as the **Wankoe Formation**. Wankoe Formation aeolianites blanket much of the coastal plain and are evident in the regional landscape as old, calcrete-capped, rounded dune ridges ("Wankoe se Rante" or "Die Harde Duine") and in places are up to ~300 m thick (Malan, 1990).

These old, cemented dunes, of greyish-yellow to orange hues, are generally calcareous due to the comminuted shell fragment content (Malan, 1990). These beds are relatively poorly described due to the cover of well-vegetated sandy soils, but exposures in road cuttings and limestone quarries reveal their nature. Units with dune crossbedding are common, but much of the formation is massive or structureless due to re-deposition of the upper parts of dunes by colluvial slope wash, pedogenic (soil-forming) processes and diagenesis involving dissolution and re-precipitation of the carbonate shell content. Interbedded reddened palaeosols and fossil root beds mark palaeosurfaces formed during less windy/wetter intervals of reduced sand accumulation and stabilization and calcretes developed beneath the palaeosurfaces of longer duration.

The maximum ages of these old aeolianites are the ages of the marine formations that underlie them and thus the Wankoe Formation aeolianites must also become younger towards the coast. However, age gap varies considerably and the time of dune deposition may be significantly younger than the eroded marine formation finally being covered up. The oldest Wankoe aeolianites at high elevation could be of later Miocene age, similar to the Prospect Hill Formation aeolianites on the West Coast which are dated to 12-9 Ma on the basis of finds of fossil eggshell of an extinct ostrich. The youngest Wankoe Formation aeolianites postdate the younger ~3 Ma old part of the underlying De Hoopvlei Formation and could be latest Pliocene or early Quaternary in age.

The **Qg** coversand has apparently been derived by the weathering of the underlying calcreted aeolianite and marine deposits, as is suggested by its limited distribution.

6 EXPECTED PALAEONTOLOGY AND SENSITIVITIES

6.1 THE BUFFELSKLOOF FORMATION

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 surrounding quarries exploiting the Buffelskloof conglomerates to produce crushed aggregate.

Figure 9. Examples of dinosaur talon (top) and teeth (bottom) that could be found in the Buffelskloof Formation. All scale bars are 1 cm. From Mateer, 1987.

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 dinosaur teeth and talons have been found in the similar Enon Formation (Figure 9) (Mateer, 1987). There is a similar low

probability of comparable fossils being found in the Buffelskloof Formation. The palaeontological sensitivity of the Buffelskloof Formation is therefore LOW.

6.2 THE DE HOOPVLEI FORMATION

The patch of De Hoopvlei Formation forming the summit of ATKV Kop is considered similar to an analogous occurrence on a hilltop on Vaale Valley 219 (~5 km to the NE; Figure 8). This is a poorly-sorted marine conglomerate in which oyster shells are preserved (Figure 10) (Viljoen & Malan, 1993). Other fossil shells are not mentioned, but moulds of shells are often present in such occurrences.

These shelly marine conglomerates are at the highest elevation at which such beds are recorded (~120 m asl.). However, the mid-Miocene fossil fauna is poorly recorded due to poor preservation and the difficulties of studying shell moulds. Most of the shelly fauna recorded from the De Hoopvlei Formation has been sourced from the younger, lower-lying, Pliocene parts in which the shell content is better preserved. A study of the cryptic fossils in the high-elevation outcrops of the De Hoopvlei Formation is likely to reveal an assemblage that differs from the existing, "bulk" species assemblage recorded hitherto.

Consequently, the high-elevation outcrops of the De Hoopvlei Formation, such as on Erf 3122, are accorded MODERATE palaeontological sensitivity (Figure 11).

Figure 10. Example of De Hoopvlei Formation shelly conglomerate exposed on hilltop ~120 m asl. on Vaale Valley 219. From Viljoen & Malan, 1993.

6.3 THE WANKOE FORMATION

Hitherto only fossil land snails have been reported from the Wankoe Formation (*Trigonephrus*, *Trachycystis*, *Achatina*, *Tropidophora*). Due to post-depositional alteration occurrences tend mainly to be poorly preserved or moulds of the dissolved shells. Such processes, together with relatively few good exposures, apparently account for the few observations of the presence of fossils. However, there is no reason why the Wankoe aeolianites should differ markedly in their fossil content from that typical of the other aeolianites

of the coastal plains, other than that the fossils have been rendered more obscure and require closer observations to discover them.

The Wankoe Formation is expected to have included an ambient fossil background typical of aeolianites. Trace fossils such as plant root casts, insect burrows, termitaria, mole burrows and tracks of animals are associated with the palaeosols and buried surfaces which also include various land snails, tortoises and micromammals such as rodent and mole bones. Fragments of ostrich eggshell may occur. The small land snails and tiny rodent fossils reflect the local palaeoenvironment such as the vegetation type. Larger animal bones (antelopes, zebra, rhino, elephant, pigs, ostrich etc.) are sparsely scattered on the palaeosurface formed on the underlying eroded marine deposits, on the subsequent palaeosurfaces within the aeolianites, and in the capping pedogenic calcrete. The interdune areas between dune ridges host deposits associated with vleis, pans and springs which are richly fossiliferous, including fossil plant material and aquatic snails and frogs. However, given the summit context of the aeolianite preserved on ATKV Kop, interdune deposits are not expected. The aeolianite on ATKV Kop is assumed to be an older part of the Wankoe Formation and, as is the case with older aeolianites on the West Coast, if preserved the fossils are likely to be extinct forms.

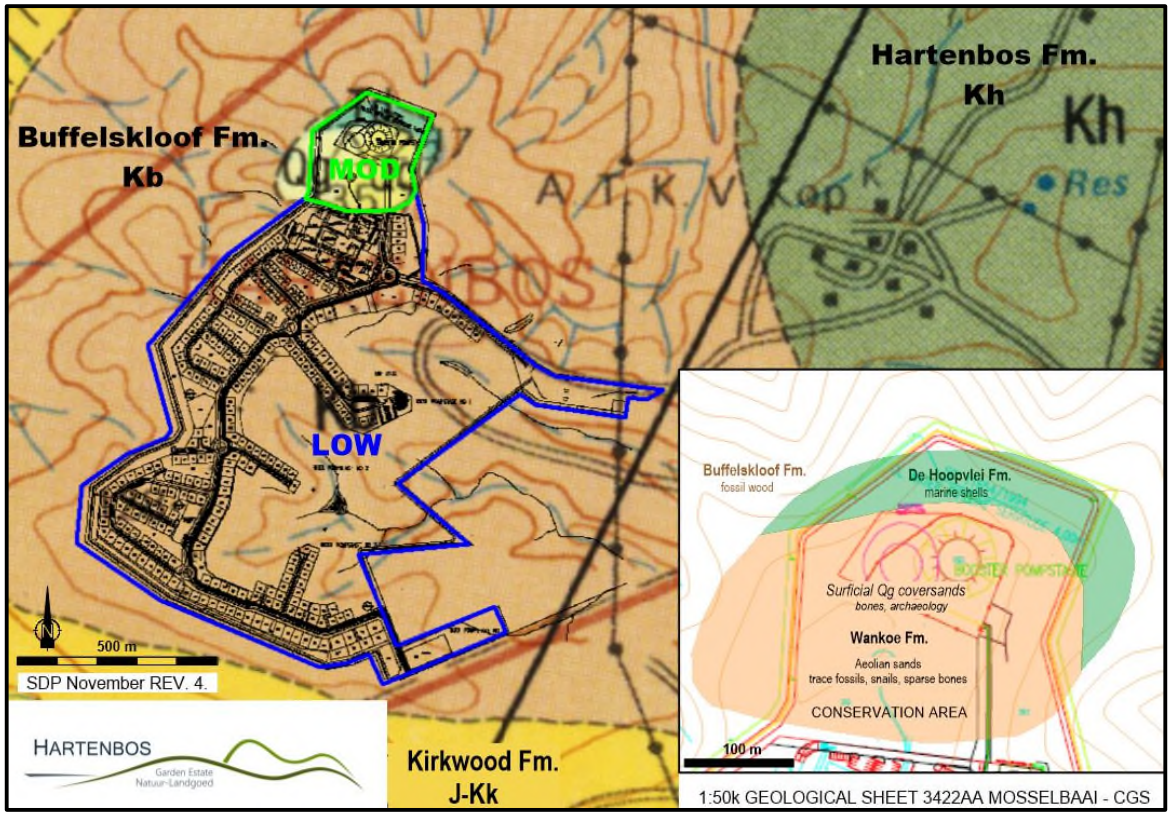


Figure 11. A: Palaeontological sensitivities in the Project Area. B: Detail of area of Moderate sensitivity.

This high-elevation patch of the Wankoe Formation on Erf 3122 is accorded MODERATE palaeontological sensitivity (Figure 11). Although its considerable age (later Miocene?) and concomitant higher degree of post-depositional alteration are unfavourable for fossil preservation, a fossil content may remain as moulds and replacements/petrifactions.

6.4 THE QG COVERSAND

Fossils eroded out of the underlying formations may occur within the Qg sandy soils or beneath on the surface of the calcrete. Younger fossil material of Quaternary age associated with archaeological material may also occur. Dissolution pits in the calcrete may sequester micromammal material. The underlying eroded aeolianite slopes may manifest harder overhangs and ledges separated by hollowed–out softer intervals. The latter are further exploited by burrowing, making small caves that are occupied by carnivores, particularly by hyaenas that make dens in them. Their bone-collecting behaviour results in concentrations of bones of antelopes and smaller carnivores in these lairs. Several important fossil fauna assemblages have been found in this context of ancient dens that were later abandoned and filled in with slopewash and windblown sand. Although obviously superimposed and post-dating the deposition of the Wankoe aeolianites, these not-uncommon occurrences are fossil bonanzas.

In considering that fossil finds are relatively rare in thin coversands and ongoing soil-forming processes are not favourable for fossil preservation, the palaeontological sensitivity of the Qg sandy soil is rated as LOW. Furthermore, the summit context is non-depositional and unfavourable for the burial and preservation of fossil material. Buried shell and bone in the surficial soils are likely to be in an archaeological context, as would be evident by the presence of stone tools. Nevertheless, “primary” fossil bones do occur very sparsely and fossil finds uncovered in coastal developments are typically large bones that get noticed, such as bigger antelopes and buffalo, rhino, bushpigs and elephants. A nearby example is the fossil elephant found on the Fisantekraal Estate near Stilbaai.

7 POTENTIAL IMPACTS AND RISKS

7.1 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 with respect to palaeoecological and biostratigraphic (dating) information. Such fossils are non-renewable resources. Provided that no subsurface disturbance occurs, the fossils remain sequestered there.

Overall the palaeontological sensitivity of coastal deposits is HIGH (Almond & Pether, 2008) due to previous fossil finds of high scientific importance. 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. 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.

7.2 EXTENTS

The physical extent of impacts on potential palaeontological resources relates directly to the extents of subsurface disturbance involved in the installation of infrastructure during the Construction Phase, *i.e*. LOCAL.

However, unlike an impact that has a defined spatial extent (*e.g*. loss of a portion of a habitat), 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 palaeontological research that takes place in South Africa by scientists of other nationalities. Loss of opportunities that may arise from a significant fossil occurrence (tourism, employment) filters down to regional/local levels.

7.3 DURATION

The initial duration of the impact is shorter term (<5 years) and primarily related to the Construction Phase when excavations for infrastructure are made. This is the "time window" for mitigation. However, a large housing development may have several construction phases over the medium term (5 to 15 years).

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. The duration of impact is thus PERMANENT with or without mitigation.

7.4 INTENSITY

The intensity or magnitude of impact relates to the palaeontological sensitivities of the formations (Appendix 1). Moreover, the scale of subsurface disturbance must be considered, for instance the shallow infrastructure for housing *vs*. the large volumes removed during quarrying. For this proposed development of Erf 3122 it is assumed that excavation depths for infrastructure installation and foundations will generally not exceed ~2 metres in depth.

Most of the development affects the stony soil developed on the Buffelskloof Formation and the underlying conglomerates and interbedded sandstones and siltstones. Given the area/volume entailed it is possible that petrified fossil wood could occur. The De Hoopvlei Formation is affected only by the construction of the perimeter fence (post holes) and the making of a perimeter service road (Figure 11). From the fact that this formation was mapped at this location it may be assumed that fossiliferous outcrop exists and that it is not everywhere thickly covered by soil and colluvium. It is possible that marine shell fossils could be unearthed, particularly along the inner edge of the road cut-ins on the steeper slopes. Similarly, the Wankoe Formation is affected only by the construction of the perimeter fence (post holes) and the making of

a perimeter service road where it is possible that fossil bones could occur. For reasons mentioned above the Qg coversand is unlikely to sequester important fossils, but buried archaeological remains could occur.

FORMATION	AGE	INTENSITY
Qg coversand/soil	Mid-late Quaternary	LOW
Wankoe Fm.	Later Miocene?	MEDIUM
De Hoopvlei Fm.	Mid Miocene	MEDIUM
Buffelskloof Fm.	Cretaceous	LOW

7.5 PROBABILITY

FORMATION	FOSSILS	PROBABILITY
Qg coversand/soil	Mammal bones, archaeology?	IMPROBABLE
Wankoe Fm.	Mammal bones	POSSIBLE
De Hoopvlei Fm.	Marine shells	POSSIBLE
Buffelskloof Fm.	Fossil wood	POSSIBLE

7.6 IMPACT SIGNIFICANCE RATINGS

The impact ratings for the formations, according to the scheme in Appendix 2, are presented below.

CRITERIA RATINGS SUMMARY				
FORMATION	**EXTENTS**	**DURATION**	**INTENSITY**	**PROB.**
Qg coversand	Local	Permanent	Low	Improbable
Wankoe Fm.	Local	Permanent	Medium	Possible
De Hoopvlei Fm.	Local	Permanent	Medium	Possible
Buffelskloof Fm.	Local	Permanent	Low	Possible

SIGNIFICANCE CRITERIA SCORING						
FORMATION	**EXT.**	**DUR.**	**INTEN.**	**PROB.**	**EFFECT**	**SIGNIFICANCE**
Qg coversand	1	4	2	1	8	MODERATE (low)
Wankoe Fm.	1	4	4	2	11	MODERATE (high)
De Hoopvlei Fm.	1l	4t	4	2	11	MODERATE (high)
Buffelskloof Fm.	1	4	2	2	9	MODERATE (low)

In terms of the rating scheme the proposed development has impacts of MODERATE or MEDIUM significance on the palaeontological resources of all the formations. This may be differentiated as Low Moderate for those formations of Low palaeontological sensitivity (Buffelskloof, Qg coversand) and High Moderate for those of Medium sensitivity (De Hoopvlei, Wankoe).

The Moderate/medium levels of significance indicate that the palaeontological impacts do not greatly influence the decision to develop the area, but appropriate mitigatory measures are required.

If paleontological mitigation is applied to this project as recommended it is possible that this development will to some extent alleviate the negative cumulative impact on paleontological resources in the region.

NATURE OF IMPACT SUMMARY		
	Without mitigation	**With mitigation**
Significance	Moderate	Moderate
Status	Negative	Positive
Reversibility	Irreversible	Irreversible
Irreplaceable loss of resources?	Yes	Partly
Cumulative Impact		
Can impacts be mitigated?	Partly	
Mitigation:	• Monitoring of all construction-phase excavations. • Inspection, sampling and recording of selected exposures of the De Hoopvlei and Wankoe formations.	

7.7 CUMULATIVE IMPACT

The cumulative result of coastal developments is the inevitable permanent loss of fossils. In the longer term, built developments "sterilize" the palaeontological heritage resource potential within their extents, as the subsurface is sealed beneath roads, buildings and urban gardens. This translates to a cumulative impact, as fossiliferous coastal deposits are continuously being covered by developments often lacking mitigation protocols.

Conversely, with due attention to mitigation and the successful rescue of fossils, there is an accumulation of scientific evidence and knowledge about the evolution of the southern African fauna, the past palaeoenvironments and the contexts of our prehistoric ancestors.

8 RECOMMENDATIONS

There are no NO-GO areas on Erf 3122 with respect to palaeontological concerns, providing that a practical monitoring and mitigation programme is implemented during the Construction Phase/s of the proposed housing development.

8.1 MONITORING

It is not usually practical for a specialist or a designated monitor to be continuously present during the Construction Phase. Nevertheless, immediate interventions are particularly required if fossil bones are turned up during earth works. These are rare and scientifically valuable and every effort should be made to spot them and effect rescue of them. It is therefore proposed that personnel involved in the making of excavations keep a lookout for fossil material during digging. The field supervisor/foreman and workers involved in

digging excavations must be informed of the need to watch for fossils and buried potential archaeological material. Workers seeing potential objects are to report to the field supervisor who, in turn, will report to the Environmental Control Officer (ECO). The ECO will inform the developer/owner and contact the palaeontologist contracted to be on standby in the case of fossil finds. The latter will liaise with Heritage Western Cape (HWC) on the nature of the find and consequent actions (permitting and collection of find). The **Fossil Finds Procedure** included as Appendix 3 provides guidelines to be followed in the event of fossil finds.

8.2 BASIC MEASURES FOR THE CONSTRUCTION PHASE EMP

The following measures apply to all earthworks affecting all four formations discussed above. The Fossil Finds Procedure includes a summary of the main kinds of fossils expected.

OBJECTIVE: To see and rescue fossil material that may be exposed in the excavations made for installation of the housing infrastructure.		
Project components	Foundation excavations, trenches for sanitation & drainage, spoil from excavations.	
Potential impact	Loss of fossils by their being unnoticed and/ or destroyed.	
Activity/ risk source	All bulk earthworks.	
Mitigation: target/ objective	To facilitate the likelihood of noticing fossils and ensure appropriate actions in terms of the relevant legislation.	
Mitigation: Action/ control	**Responsibility**	**Timeframe**
Inform staff of the need to watch for potential fossil occurrences.	The Client, the EIA practitioner, the ECO & contractors.	Pre-construction.
Inform staff of the Fossil Finds Procedures to be followed in the event of fossil occurrences.	ECO/specialist.	Pre-construction.
Monitor for presence of fossils.	Contracted personnel and ECO, monitoring archaeologist.	Construction.
Liaise on nature of potential finds and appropriate responses.	ECO and specialist, HWC.	Construction.
Obtain permit from HWC for fossil finds collection.	Specialist.	Construction
Excavate main finds, inspect pits & record and sample excavations.	Specialist.	Construction.
Performance Indicator	Reporting of and liaison about possible fossil finds. Fossils noticed and rescued. Scientific record of fossil contexts and temporary exposures in earthworks.	

8.3 FIELD INSPECTION BY PALAEONTOLOGIST

In the field/on-site recording, excavation and collection will duly occur in the event of a significant fossil find.

However, the De Hoopvlei Formation shelly marine conglomerates on ATKV Kop occupy a nearly unique geomorphological context on a hilltop and are at the highest elevation at which such beds are recorded (~120 m asl.). The marine beds are likely to be of mid-Miocene age (~16 Ma), as opposed to exposures of Pliocene age (5 & 3 Ma) which occur at lower elevations on valley flanks. As mentioned above, the fossil fauna should include unique elements and the marine deposits on ATKV Kop are deserving of closer attention and due recording. Apparently there is no obvious outcrop of the marine bed at present. It is thus recommended that fresh exposures of the marine beds that may be created during construction, such as along the perimeter road, are recorded and sampled by a palaeontologist. To this end the ECO must liaise with the contracted palaeontologist as to the progress of road construction earthworks

8.4 A LOCAL GEOHERITAGE SITE

It is proposed that exposures of the De Hoopvlei Formation Miocene beds and the overlying Wankoe Formation that may be created along the perimeter road are highlighted by explanatory signage. Should the fossil content indeed indicate a mid-Miocene age for the De Hoopvlei Formation this site will be an important, new stratotype locality. This represents a positive outcome of regional to national consequence.

9 REFERENCES

Almond, J.E. & Pether, J. 2008. Palaeontological heritage of the Western Cape. Interim SAHRA Technical Report, 20 pp. Natura Viva cc., Cape Town.

Malan, J.A. 1990. The stratigraphy and sedimentology of the Bredasdorp Group, southern Cape Province, South Africa. M.Sc. Thesis, University of Cape Town, Cape Town. 197 pp.

Malan, J.A. & Viljoen, J.H.A. 1990. Mesozoic and Cenozoic geology of the Cape South coast. Guidebook Geocongress '90. Geological Society of South Africa PO3, 1–81.

Mateer, N.J. 1987. A new report of a theropod dinosaur from South Africa. Palaeontology 30: 141-145.

McCarthy, T. & Rubidge, B. 2005. The Story of Earth and Life: a southern African perspective on a 4.6-billion year journey. Struik, Cape Town, 334 pp.

Nilssen, P. 2010. Archaeological Impact Assessment. Proposed rezoning, subdivision and residential development: Erf 3122, Hartenbos, Mossel Bay, Western Cape Province. Prepared for Mr Schalk Cilliers, ATKV-Hartenbos Strandoord. 10 August 2010. 29 pp.

Pether, J, Roberts, D.L. & Ward, J.D. 2000. Deposits of the West Coast (Chapter 3). In: Partridge, T.C. and Maud, R.R. eds. The Cenozoic of

Southern Africa. Oxford Monographs on Geology and Geophysics No. 40. Oxford University Press: 33-55.

Roberts, D.L., Botha, G.A., Maud, R.R. & Pether, J. 2006. Coastal Cenozoic Deposits. In: Johnson, M. R., Anhaeusser, C. R. and Thomas, R. J. (eds.), The Geology of South Africa. Geological Society of South Africa, Johannesburg/Council for Geoscience, Pretoria. 605-628.

Shone, R.W. 2006. Onshore post-Karoo Mesozoic deposits. In: Johnson, M.R., Anhaeusser, C.R. & Thomas, R.J. (Eds.) The geology of South Africa, pp. 541-552. Geological Society of South Africa, Marshalltown.

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.

---oooOOOooo---

10 APPENDIX 1. - PALAEONTOLOGICAL SENSITIVITY RATING

Palaeontological Sensitivity refers to the likelihood of finding significant fossils within a geologic unit.

HIGH: Assigned to geological formations known to contain palaeontological resources that include rare, well-preserved fossil materials important to on-going palaeoclimatic, palaeobiological and/or evolutionary studies. Fossils of land-dwelling vertebrates are typically considered significant. Such formations have the potential to produce, or have produced, vertebrate remains that are the particular research focus of palaeontologists and can represent important educational resources as well.

MODERATE: Formations known to contain palaeontological localities and that have yielded fossils that are common elsewhere, and/or that are stratigraphically long-ranging, would be assigned a moderate rating. This evaluation can also be applied to strata that have an unproven, but strong potential to yield fossil remains based on its stratigraphy and/or geomorphologic setting.

LOW: Formations that are relatively recent or that represent a high-energy subaerial depositional environment where fossils are unlikely to be preserved, or are judged unlikely to produce unique fossil remains. A low abundance of invertebrate fossil remains can occur, but the palaeontological sensitivity would remain low due to their being relatively common and their lack of potential to serve as significant scientific resources. However, when fossils are found in these formations, they are often very significant additions to our geologic understanding of the area. Other examples include decalcified marine deposits that preserve casts of shells and marine trace fossils, and fossil soils with terrestrial trace fossils and plant remains (burrows and root fossils)

MARGINAL: Formations that are composed either of volcaniclastic or metasedimentary rocks, but that nevertheless have a limited probability for producing fossils from certain contexts at localized outcrops. Volcaniclastic rock can contain organisms that were fossilized by being covered by ash, dust, mud, or other debris from volcanoes. Sedimentary rocks that have been metamorphosed by the heat and pressure of deep burial are called metasedimentary. If the meta sedimentary rocks had fossils within them, they may have survived the metamorphism and still be identifiable. However, since the probability of this occurring is limited, these formations are considered marginally sensitive.

NO POTENTIAL: Assigned to geologic formations that are composed entirely of volcanic or plutonic igneous rock, such as basalt or granite, and therefore do not have any potential for producing fossil remains. These formations have no palaeontological resource potential.

Adapted from Society of Vertebrate Paleontology. 1995. Assessment and Mitigation of Adverse Impacts to Nonrenewable Paleontologic Resources - Standard Guidelines. News Bulletin, Vol. 163, p. 22-27.

---oooOOOooo---

11 APPENDIX 2. - METHODOLOGY FOR ASSESSING THE SIGNIFICANCE OF IMPACTS

EFFECT	**Duration/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**
	Extents/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**
	Intensity/Magnitude (Palaeontological Sensitivity)		
	No Potential	Formations entirely lacking fossils such as igneous rocks.	**0**
	Marginal	Limited probability for producing fossils from certain contexts at localized outcrops.	**1**
	Low	Depositional environment where fossils are unlikely to be preserved, or are judged unlikely to produce unique fossil remains.	**2**
	Medium	Strong potential to yield fossil remains based on stratigraphy and/or geomorphologic setting.	**4**
	High	Formations known to contain palaeontological resources that include rare, well-preserved fossil materials.	**8**
PROBABILITY	**Probability/Likelihood**		
	Improbable	The likelihood of these impacts occurring is slight.	**1**
	Possible	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**

The total score recorded for the effects plus probability is then read off the matrix below to determine the overall significance of the impact.

PROBABILITY	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

Significance	Description	Score
Low	An 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.	**12-16**
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**

---oooOOOooo---

12 APPENDIX 3 - FOSSIL FIND PROCEDURE

12.1 MONITORING

A constant monitoring presence over the period during which excavations for developments 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/Site Agent.

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 sufficiently informed to identify potential fossil material and liaise with the palaeontologist.

12.2 EXPECTED FOSSIL FINDS

FORMATION	AGE	FOSSILS
Qg coversand/soil	Mid-late Quaternary	Very sparse bones, archaeology?
Wankoe Fm.	Later Miocene?	Sparse bones, land snails.
De Hoopvlei Fm.	Mid Miocene	Marine shells, fish teeth, very rare bones.
Buffelskloof Fm.	Cretaceous	Fossil wood, dinosaur teeth?

A map is provided below (FFP Figure 1) showing the geological formations underlying the Project Area.

Most of the development affects the stony soil developed on the **Buffelskloof Formation** and the underlying conglomerates and interbedded sandstones and siltstones. Petrified fossil wood and other plant remains are expected. The fragmented bones and isolated teeth of dinosaurs could occur, but are exceptionally rare.

The marine **De Hoopvlei Formation** is affected only by the construction of the perimeter fence (post holes) and the making of a perimeter service road. It is possible that fossil marine shells could be unearthed, particularly along the inner edge of the road cut-ins on the steeper slopes.

The **Wankoe Formation** is affected only by the construction of the perimeter fence (post holes) and the making of a perimeter service road. It is possible

that fossil mammal bones could be unearthed, similarly along the road cut-ins. The land snails in these old aeolianites are of interest. Sparse bones are expected and any such material, both small and larger, is of high value.

The **Qg coversand/soil** rarely sequesters fossils, but material associated with buried archaeological remains could occur.

12.3 PROCEDURE FOR FOSSIL FINDS

In the process of digging the excavations fossils may be spotted in the hole sides or bottom, or as they appear in excavated material on the spoil heap.

Response by personnel in the event of fossil finds

Stop work at fossil find. The site foreman and ECO must be informed.

Protect the find site from further disturbance and safeguard all fossil material in danger of being lost such as in the excavator bucket and scattered in the spoil heap.

The ECO or site agent must immediately inform Heritage Western Cape (HWC) and/or the contracted standby palaeontologist of the find and provide via email the information about the find, as detailed below.

- Date
- Position of the excavation (GPS) and depth.
- A description of the nature of the find.
- Digital images of the excavation showing vertical sections (sides) and the position of the find showing its depth/location in the excavation.
- A reference scale must be included in the images (tape measure, ranging rod, or object of recorded dimensions).
- Close-up, detailed images of the find (with scale included).

Heritage Western Cape has provided a Fossil Finds Procedure and a Recording Form which is included overleaf and is also available from:
http://www.sahra.org.za/sahris/sites/default/files/heritagereports/HWC%20Procedure%20Chance%20finds%20of%20Palaeontological%20Material%20June%202016.pdf

Heritage Western Cape (HWC) and/or the contracted standby palaeontologist will assess the information and a suitable response will be established which will be reported to the developer and the ECO, such as whether rescue excavation or rescue collection by a palaeontologist is necessary or not.

The response time/scheduling of the rescue fieldwork is to be decided in consultation with developer/owner and the ECO. It will probably be feasible to “leapfrog” the find and proceed to the next excavation, or continue a trench excavation farther along, so that the work schedule and machine time is minimally disrupted. The strategy is to rescue the material as quickly as possible.

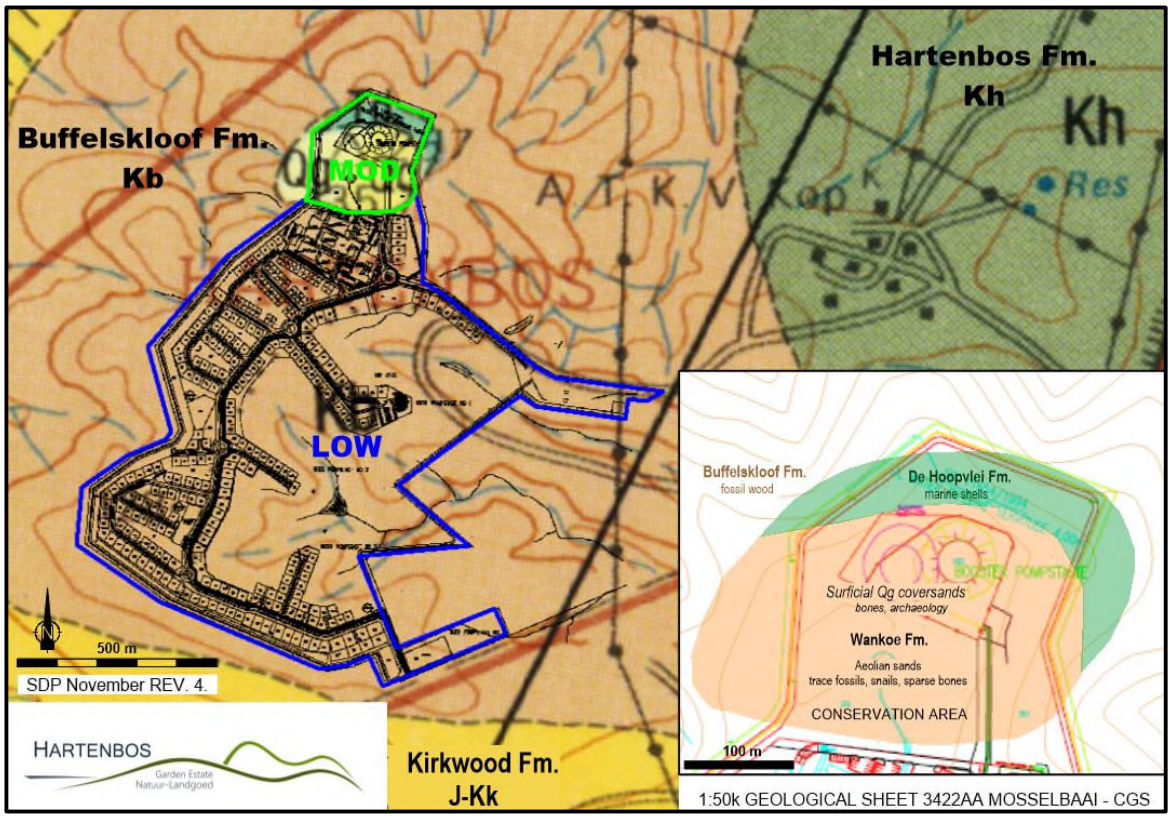
12.4 APPLICATION FOR A PERMIT TO EXCAVATE AND COLLECT

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

Should fossils be found that require rapid collecting, application for a palaeontological permit must be made to HWC immediately.

In addition to the information and images of the find, the application requires details of the registered owners of the sites, their permission and a site-plan map.

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

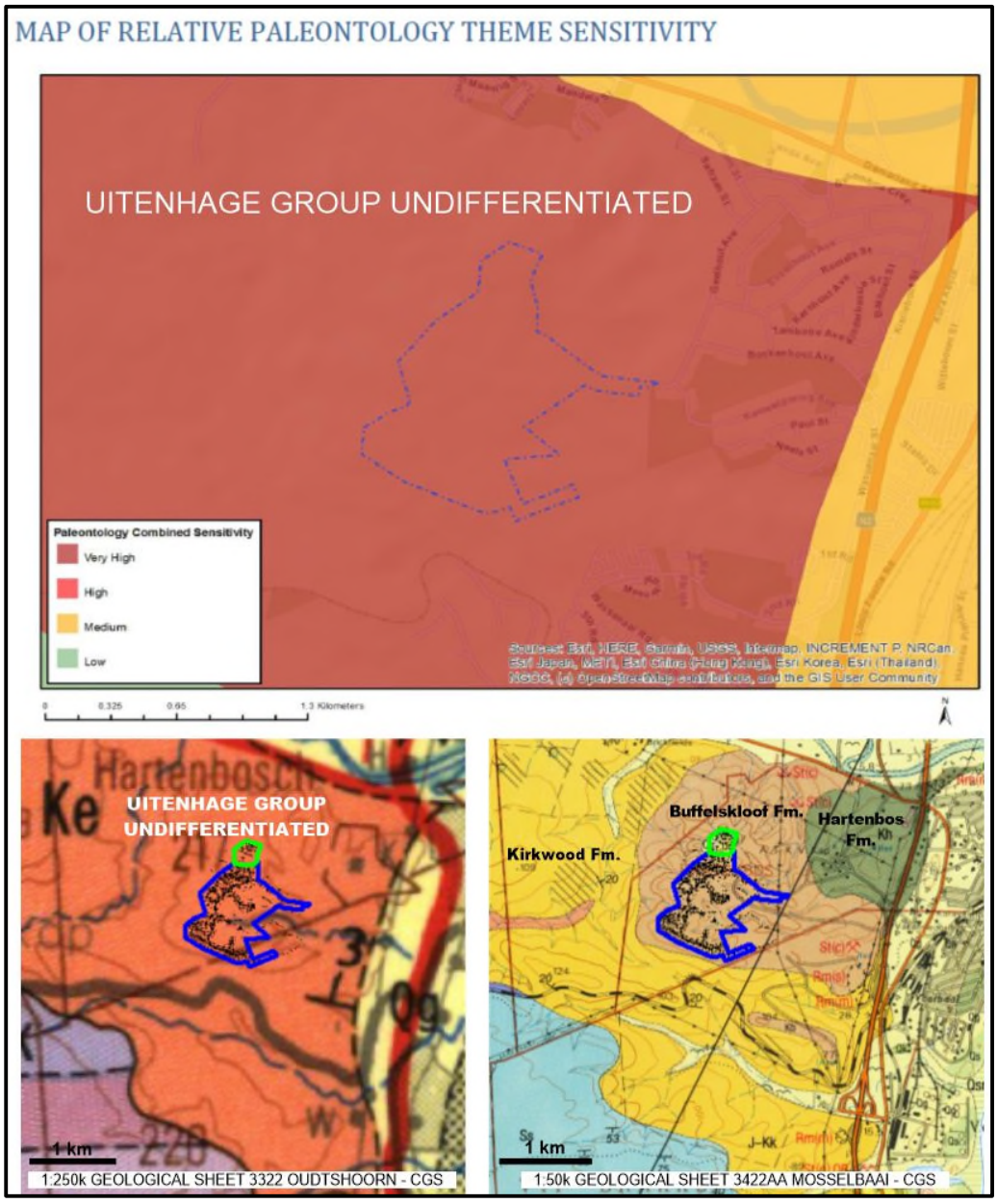


FFP Figure 1. A: Geological map and palaeontological sensitivities in the Project Area. B: Detail of area of Moderate sensitivity.

---oooOOOooo---

FOSSIL DISCOVERIES: HWC PRELIMINARY RECORDING FORM		
Name of project:		
Name of fossil location:		
Date of discovery:		
Description of situation in which the fossil was found:		
Description of context in which the fossil was found:		
Description and condition of fossil identified:		
GPS coordinates:	Lat:	Long:
If no co-ordinates available then please describe the location:		
Time of discovery:		
Depth of find in hole		
Photographs (tick as appropriate and indicate number of the photograph)	Digital image of vertical section (side)	
	Fossil from different angles	
	Wider context of the find	
Temporary storage (where it is located and how it is conserved)		
Person identifying the fossil	Name: Contact:	
Recorder	Name: Contact:	
Photographer	Name: Contact:	

13 APPENDIX 4 – NOTE ON SCREENING REPORT - PALAEONTOLOGY



The Screening Report Palaeontological Sensitivity Theme map is based on the SAHRIS PalaeoMap which is based on the 1:250 000 Geological Sheets. In this area the relevant geological map is 3322 OUDTSHOORN, published in 1979. In this map the various, late Jurassic to early Cretaceous faulted basin formations were not yet differentiated and are depicted combined as the Uitenhage Group. Due to the occurrence of important fossils in certain of the constituent formations (*e.g.* the Kirkwood Fm.), the widely enclosing polygon is cautiously rated Very High.

The subsequent map at 1:50 000 scale depicted these formations (Viljoen & Malan, 1993), which differ in their palaeontological sensitivities, as described in this report.