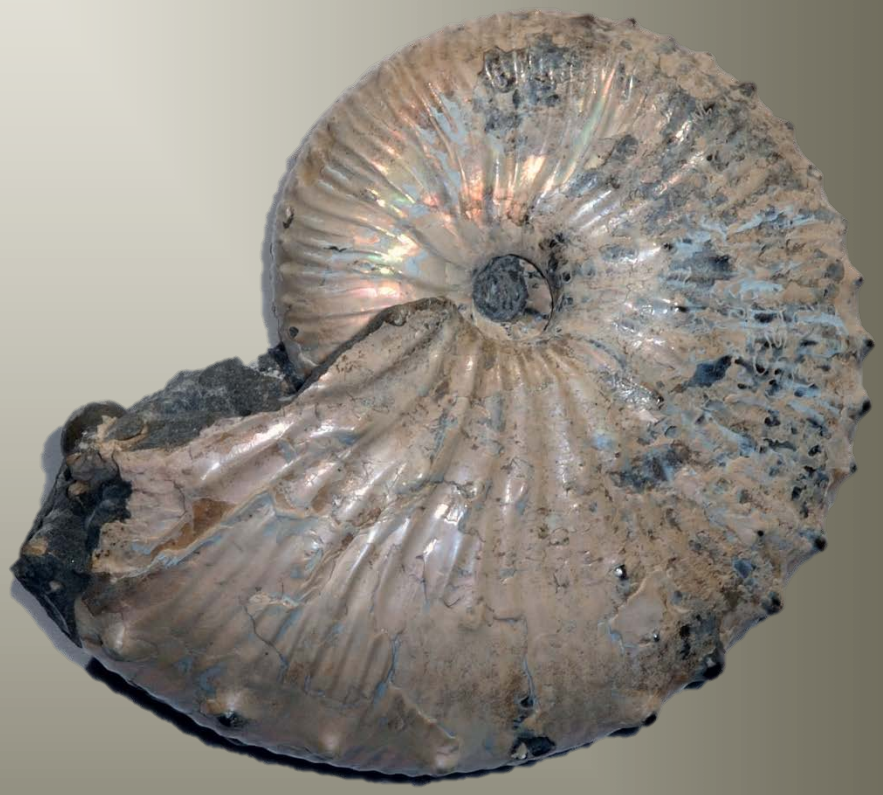
PALAEONTOLOGICAL IMPACT ASSESSMENT FOR THE PROPOSED UPGRADE OF EXISTING WATER SUPPLY INFRASTRUCTURE AT NOUPOORT, NORTHERN CAPE PROVINCE



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EXECUTIVE SUMMARY

The Umsobomvu Municipality proposes the upgrade of the existing water supply infrastructure around the area of Noupoort, Northern Cape Province. The project will consist of the improvement of Noupoort bulk water supply network and the installation of a fibre optic communication network as part of the required maintenance to the water supply network. The improvements will be focused on the Carolus Poort, Klipheuwel and Barredeel areas. Due to Section 35 of the National Heritage Resources Act, a palaeontological impact assessment is required to detect the presence of fossil material at the proposed development site.

The proposed water supply area consists of Late Permian to Earliest Triassic sediments as well as Quaternary sediments. The area covered in Quaternary alluvium is not considered to be palaeontologically sensitive. The low-lying relief and absence of potentially fossiliferous gulleys and appropriate exposures on most areas of the proposed upgrade area strongly suggest that fossils are absent in these areas. However, fragmentary fossils were located on the small hill to the south west of the town (Late Permian to Earliest Triassic sediments), where the existing Main Supply Reservoir is situated. Should fossil remains be discovered during any phase of construction, either on the surface or exposed by excavations in progress, the ECO responsible for these developments should be alerted. Such discoveries ought to be protected (preferably *in situ*) and the ECO should alert SAHRA (South African Heritage Research Agency) so that appropriate mitigation (*e.g.* recording, sampling or collection) can be taken by a professional paleontologist.

It is recommended that the construction team should be made aware of the possibility of uncovering important bone or plant fossils on the hill southwest of the town. It is recommended that no further palaeontological heritage studies, ground truthing and/or specialist mitigation are required for the commencement of this development, pending the discovery or exposure of any fossil remains during the construction phase.

Contents

1. INTRODUCTION

WSP Environmental (Pty) Ltd was appointed by the Umsobomvu Municipality, Noupoort, Northern Cape Province to conduct a Palaeontological impact assessment for the upgrade of the existing water supply infrastructure. The project entails the upgrading of the existing Noupoort bulk water supply network and installation of a fibre optic communication network as part of the required maintenance to the water supply network.

The construction of approximately 20 km of uPVC pipelines, valve chambers, fibre optic sleeves, draw boxes, pump stations, boreholes and renovation of two collection reservoirs is planned. Developments will include substantial excavations into the superficial sediment cover as well as locally into the underlying bedrock. These developments will modify the existing topography and may disturb, damage or destroy scientific valuable fossil heritage exposed at the surface or buried below ground. Palaeontological material is unique and non-renewable and is protected by the National Heritage Resources Act (Act No. 25 of 1999, section 35; see Appendix 1). A Palaeontological Impact Assessment of the proposed development is therefore necessary to certify that palaeontological material is either removed, or is not present.

1.1.Objective

To conduct a desktop study for the upgrade of the existing water supply infrastructure at Noupoort, Northern Cape and determine the impact on potential palaeontological material at this site.

When a palaeontological desktop study is conducted, the potentially fossiliferous rocks (i.e. groups, formations, members, etc) represented within the study area are determined from geological maps. The known fossil heritage within each rock unit is collected from published scientific literature; Fossil sensitivity map; consultations with professional colleagues, previous palaeontological impact studies in the same region and the databases of various

institutions may be consulted. This data is then used to assess the palaeontological sensitivity of each rock unit of the development area. The likely impact of the proposed development on local fossil heritage is subsequently established on the basis of

- the palaeontological sensitivity of the rocks concerned and
- the nature and scale of the development itself (extent of new bedrock excavated)

When rocks of moderate to high palaeontological sensitivity are present within the development area, a field-based assessment by a professional palaeontologist is necessary. Based on this desktop data as well as a field examination of representative exposures of all major sedimentary rock present, the impact significance of the planned development is considered with recommendations for any further studies or mitigation.

2. BACKGROUND TO THE GEOLOGICAL AND PALAEONTOLOGICAL HISTORY

The existing water supply infrastructure as well as the proposed upgrade at Noupoort, Northern Cape (Fig. 1) is situated on an area of low relief with no steep river gulleys or sharp outcrops except for a low hill to the southwest of the town (Fig. 2). The proposed water supply area consists of Late Permian to Earliest Triassic sediments as well as Quaternary sediments (Fig.3).

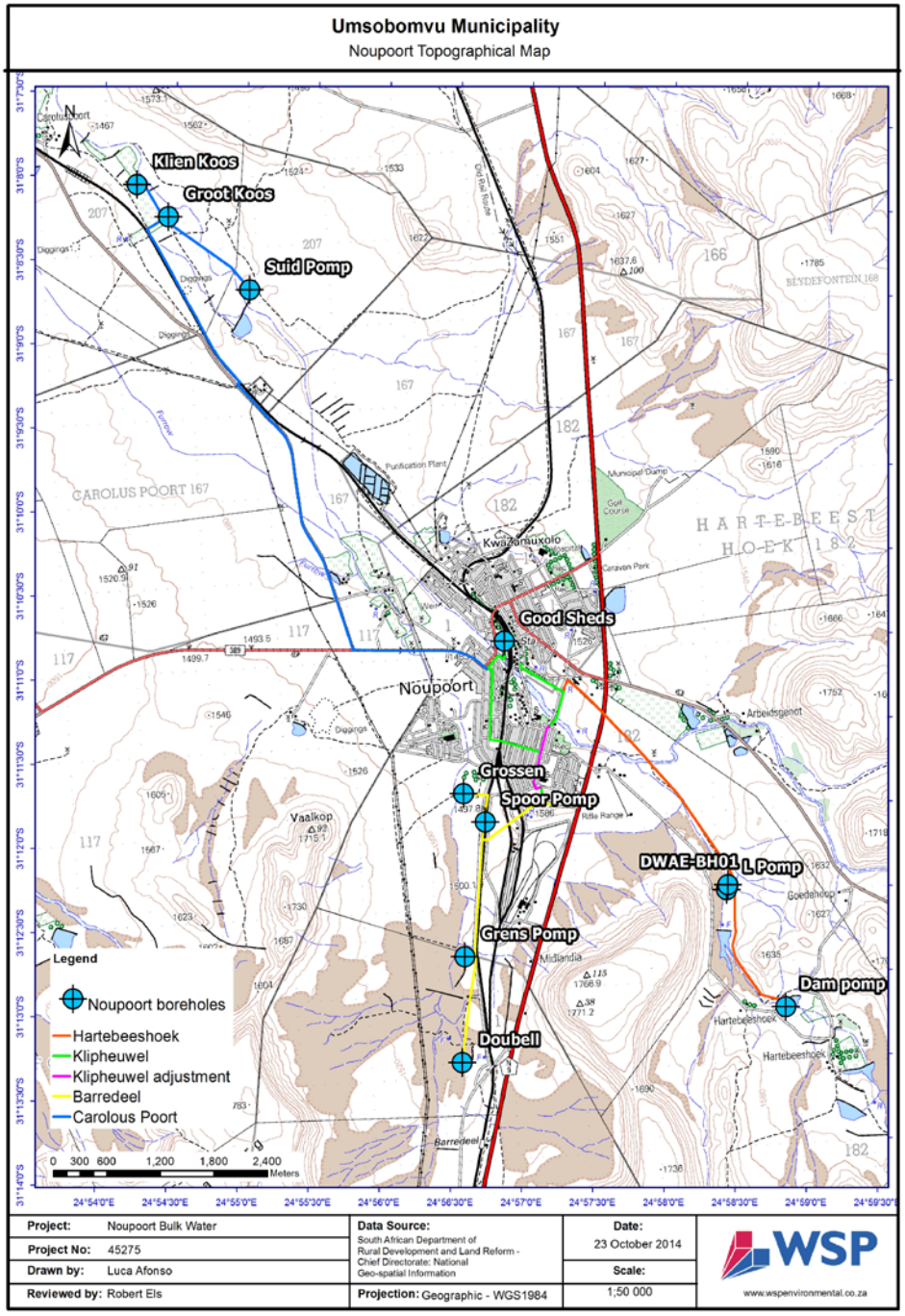

Figure 1. The upgrade of Noupoort (Northern Cape) bulk water supply network. Areas surveyed included Klipheuwel, Barredeel and Carolous Poort, while Hartebeeshoek was excluded from the assessment. (Map provided by WSP Environmental Pty Ltd.

Figure 2. Low relief of Noupoort, Umsobomvu Municipality, Northern Cape Province as indicated by a satelite image. (Modified from Google Earth, 2014).

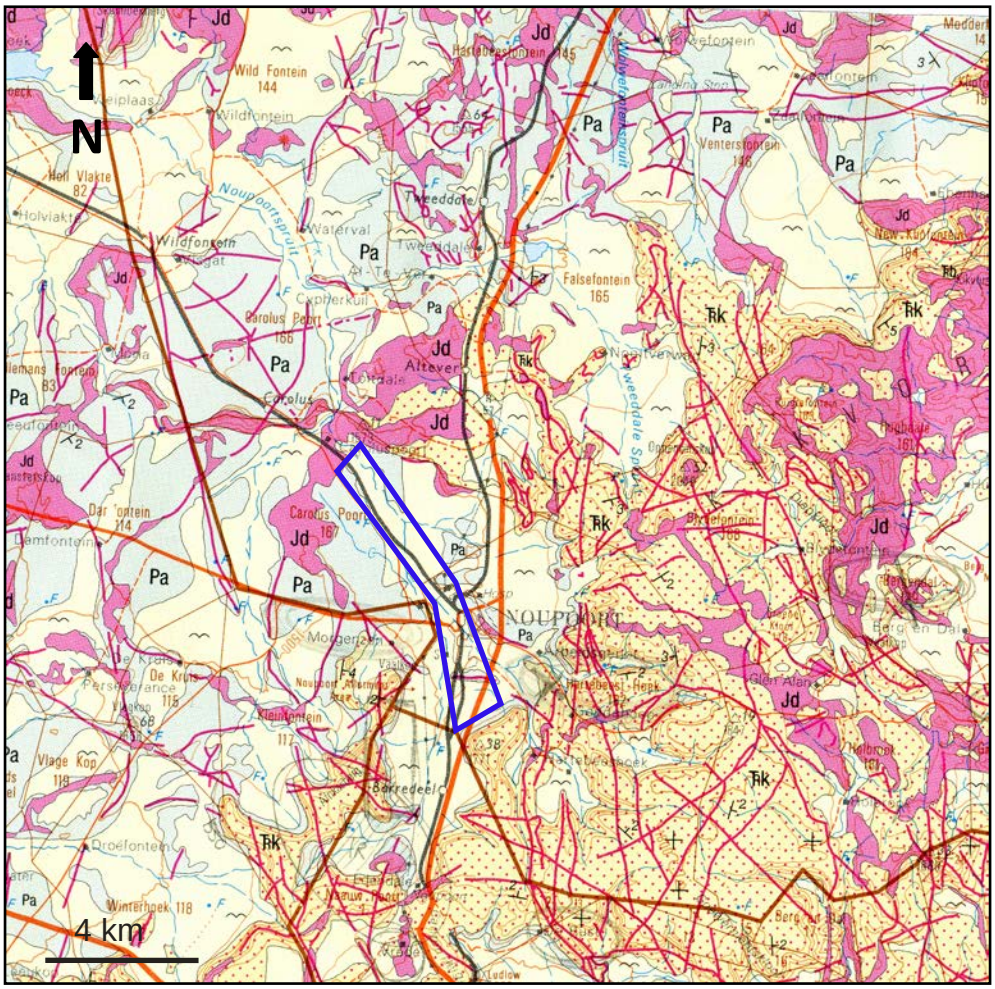

Figure 3: Proximate outline of the study area (**Blue**) in Noupoort extracted from 1: 250 000 geology sheet 3124 Middelburg (Council for Geoscience, Pretoria). The main geological units represented here are: **Pa (pale blue)** = Late Permian to Earliest Triassic Adelaide Subgroup (Lower Beaufort Group, Karoo Supergroup). **Pale yellow** = Quaternary sediments.

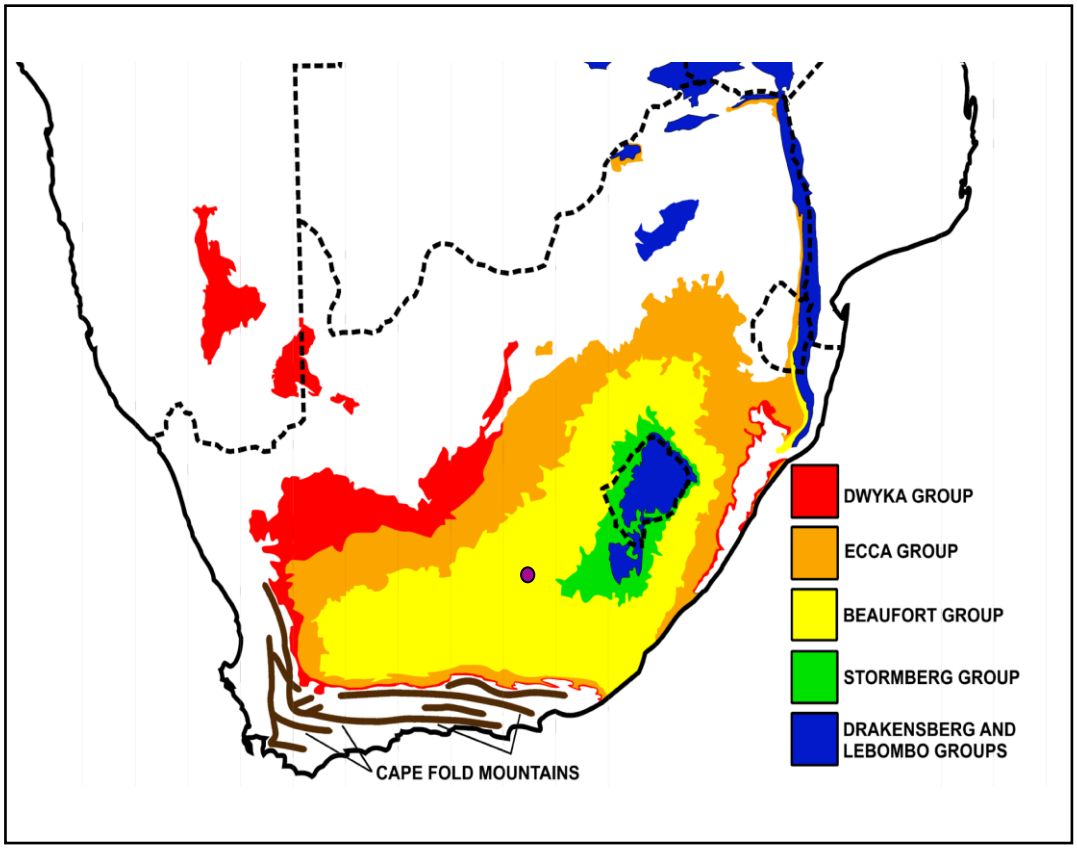

Figure 4. The position of Noupoort (Northern Cape) in the Lower Beaufort Group (Karoo Supergroup).

Geology

The upgrade of the existing water supply infrastructure consists of Late Permian and Caenozoic (Quaternary) sediments. The largest area of the project is underlain by Late Permian sediments of the Adelaide Subgroup, Karoo Supergroup (Fig. 4). These rocks include the Palingkloof Member of Latest Permian to Earliest Triassic age. The Adelaide Subgroup consists of mudstones [greenish or blue grey and greyish-red mudstones, and has a thickness of approximately 20m in the Noupoort area (Carlton Siding)], siltstones as well as sandstones (South African Committee for Stratigraphy, 1980). The Adelaide Subgroup is divided into two distinct stratigraphic sequences (Fig.5) which are positioned either side of the 24^{o} eastern longitude. To the east of that dividing line the Adelaide Subgroup consists of the Koonap, Middelton and Balfour Formations (in order of decreasing stratigraphic age). To the west of 24^{o} east the Adelaide subgroup is subdivided into a lower Abrahamskraal and upper Teekloof Formations. The project area lies east of 24^{o} and the Adelaide Subgroup sediments are thus those of the Balfour Formation.

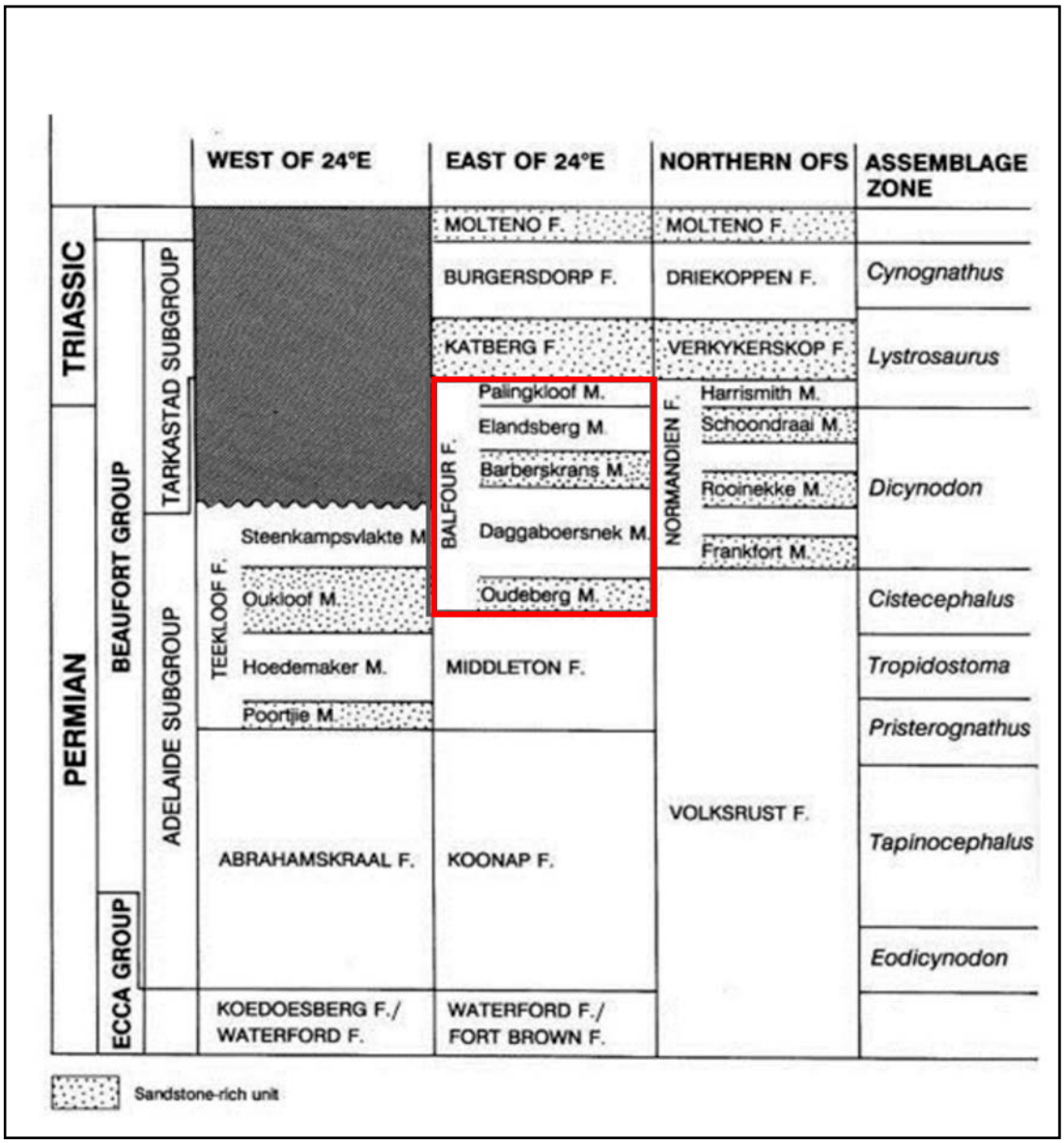

Figure 5. Lithostratigraphic (rock-based) and biostratigraphic (fossil-based) subdivisions of the Beaufort Group with rock units and fossil assemblage zones relevant to the present study outlined in red (Modified from Rubidge 1995). The subdivisions of the Beaufort Group include the Adelaide and Tarkastad Subgroups and range in age from Late Permian to Middle Triassic.

Palaeontological potential

The sediments of the Balfour Formation underlying the project form part of the *Dicynodon* Assemblage Zone (Fig. 5). The sediments of the Beaufort Formation are relatively rich in fossils, especially vertebrate fossils. Fossils from the Beaufort Formation may include *(*Kitching, 1977):

- Dicynodonta: *Aulacephalodon*, *Dicynodon*, *Diictodon*, *Dinanomodon*, *Emydops*, *Lystrosaurus, Oudenodon*, *Palemydops*, *Pelanomodon* and *Pristerodon*
- Biarmosuchia: *Burnettia*, *Ictidorhinus*, *Lemurosaurus* and *Rubidgina*)
- Gorgonopsida: *Broomicephalus*, *Cielandina*, *Cyonosaurus*, *Dinogorgon*, *Lycaenops*, *Prorubidgea*, *Rubidgea*, *Paragalerhinus* and *Leontocephalus*
- Therocephalia: *Akidnognathus*, *Cerdops*, *Homodontosaurus*, *Ictidosuchoides*, *Lycideops*, *Moschorinus*, *Nanictidops*, *Promoschorhynchus*, *Scaloporhinus*, *Tetracynodon* and *Theriognathus*
- Cynodontia: *Cynosaurus*, *Nanictosaurus* and *Procynosuchus*
- Captorhinida: *Anthodon*, *Milleretta*, *Millerosaurus*, *Owenetta*, *Pareiasaurus* and *Spondylolestes*
- Eosuchia: *Saurosternon* and *Youngi*
- Amphibians: *Laccocephalus*, and *Rhinesuchus*
- Fish: *Athestonia* and *Namaicthy*.
- freshwater mollusk: *Palaeomutella* and
- Fossil plants of the Balfour Formation are relatively rare compared to the vertebrate fossil assemblages. The presence of the wood genera, *Agathoxylon* and *Australoxylon,* was described by Bamford (2004).

The Katberg Formation, Early Triassic, includes the Palingkloof member (Fig. 5) (Groenewald & Kitching 1995, Rubidge 2005). The Palingkloof Member form part of the latest Permian *Lystrosaurus* Assemblage Zone and is named after the medium sized, dicynodont *Lystrosaurus* (the most abundant fossil in this biozone contributing up to 95% of fossils found) (Smith & Botha 2005, Botha & Smith 2007). Other fossils present in this biozone are the small captorhinid parareptile *Procolophon*, the crocodile-like early archosaur *Proterosuchus*, and small to large armour-plated "labyrinthodont" amphibians e.g.

Lydekkerina, small-bodied true reptiles (owenettids), therocephalians, and early cynodonts (*e.g. Galesaurus, Thrinaxodon*). Various aquatic and land-living invertebrates burrowed e.g. arthropods. Burrowing tetrapods include various cynodonts, procolophonids and L*ystrosaurus* (Groenewald 1991, Groenewald and Kitching, 1995, Damiani *et al.* 2003b, Abdala *et al.* 2006, Modesto & Brink 2010). Vascular plant fossils are in general rare in this biozone, but include petrified wood ("*Dadoxylon*") as well as leaves of glossopterid progymnosperms and arthrophyte ferns (*Schizoneura*, *Phyllotheca*).

Fossils from the Katberg Formation are relatively rare but palaeontologically of great importance because they document the recovery phase of terrestrial ecosystems following the catastrophic end-Permian Mass Extinction (approximately 251.4 million years ago) (Smith & Botha 2005, Botha & Smith 2007). Vertebrate fossils are usually found in mudrock facies instead of sandstones. Articulated skeletons are enclosed by calcareous pedogenic nodules while intact procolophonids, dicynodonts and cynodonts have been recovered from burrow infills. These fossils are of worldwide palaeontological importance because they document the recovery of terrestrial biotas following the catastrophic end-Permian Mass Extinction event (251 million years ago). Several Early Triassic vertebrate fossil localities have already been recorded in close proximity to the Noupoort district and are represented in museum collections (*e.g.* Centre of Evolutionary Studies, School of Geosciences, University of the Witwatersrand Johannesburg; Iziko Museums, Cape Town; National Museum, Bloemfontein).

Various types of surface deposits of Late Caenozoic (Miocene/Pliocene to Recent) age commonly occur throughout the Karoo region. They include calcretes, colluvial slope deposits, river alluvium, and spring and pan sediments. Surface exposure of fresh Beaufort Group rocks (particularly mudrocks) is generally poor, except in stream beds, dongas and steep slopes as well as road and railway cuttings. Hill slopes are typically covered with a thin layer of colluvium or slope deposits. Thicker accumulations of sandy, gravelly and bouldery alluvium of Late Caenozoic age (< 5million years ago) are found in stream and river beds. These colluvial and alluvial deposits may be calcretised (*i.e.* cemented with soil limestone or

calcrete), particularly near dolerite intrusions where groundwaters are enriched in dissolved solids.

Fossil heritage within the Late Caenozoic

The Quaternary represents a time span of approximately 2.5 million years ago to present (Walker *et. al*., 2009; Gradstein *et al*., 2012). These alluvium sediments may also contain fossil remains which might include rolled bones, intact or fragmented vertebrate skeletons, vertebrate teeth, invertebrates such as molluscs and crustaceans, trace fossils of fossilised termite heaps (termitaria) and burrows of both vertebrates and invertebrates. Furthermore, fossilised plant remains such as wood, peats or pollens and roots might also be present in these sediments. All the above mentioned fossils however tend to be low in variety as well as in abundance in these cover soils which obscure the underlying bedrock.

3. GEOGRAPHICAL LOCATION OF THE SITE

The topography of the area is generally flat except for a small mountain to the southwest of the town, where existing water reservoirs are situated. The vegetation in the surveyed area mostly consists of low grass and shrubs, with patches of soil. The vegetation includes current agricultural fields and old fields. The proposed routes mostly follow existing roads, railway tracks and pipe lines and consequently are planned in existing disturbed areas.

The sections surveyed are:

Carolous Poort (North of Noupoort)

Kilpheuwel (central Noupoort)

Barredeel (south east)

Originally the upgrade of the water system included the above mentioned three areas as well as the farm Hartebeeshoek to the west of the town. However this farm was excluded from this phase of the project and therefore not assessed in this PIA.

4. METHODS

A desktop study was conducted to assess the potential risk to palaeontological material (fossils, trace fossils) in the proposed areas of development. The author's experience, aerial photos (using Google, 2014), topographical and geological maps were used to assess the proposed area of development. GIS based programme used is WHISH (Windows Interpretation Software for Hydrogeologists.

4.1 Assumptions and Limitations

The accuracy and reliability of desktop Palaeontological Impact Assessments as components of heritage impact assessments are normally limited by the following restrictions:

- Old fossil databases that have not been kept up-to-date or are not computerized. These databases do not always include relevant locality or geological information. South Africa has a limited number of professional palaeontologists that carry out fieldwork and most development study areas have never been surveyed by a palaeontologist.
- The accuracy of geological maps where information may be based solely on aerial photographs and small areas of significant geology have been ignored. The sheet explanations for geological maps are inadequate and little to no attention is paid to palaeontological material.
- Impact studies and other reports (*e.g*. of commercial mining companies) - is not readily available for desktop studies.

Large areas of South Africa have not been studied palaeontologically. Fossil data collected from different areas but in similar Assemblage Zones might however provide insight on possible occurrence of fossils in an unexplored area. Desktop studies of this nature therefore usually assume the presence of unexposed fossil heritage within study areas of similar geological formations. Where considerable exposures of bedrocks or potentially fossiliferous superficial sediments are present in the study area, the reliability of a

palaeontological impact assessment may be significantly improved through field assessment by a professional palaeontologist.

5. SITE VISIT

A site visit was conducted on the 23 rd of October 2014. The site was crossed extensively by foot and motor vehicle to determine the palaeontological importance of the area and to quantify the impact that the proposed construction activities would have on the palaeontological heritage site. The site is an area of low relief with no steep river gulleys or sharp outcrops, with the exception of a small hill in the south western section where the Noupoort Main Supply Reservoir is situated. This is the only area where fragmented fossils were found. Isolated, badly weathered post cranial fragments as well as 2 poorly preserved *Lystrosaurus* skulls were identified. These fragments was severely weathered and not considered for collecting.

6. FINDINGS AND RECOMMENDATIONS

The Balfour Formation that underlies the project area form part of the *Dicynodon* Assemblage Zone. This biostratigraphic zone includes a rich and diverse vertebrate fauna of exceptionally high scientific significance due to their part in recording the evolutionary transition from reptiles to mammals. Regardless of the sparse and sporadic occurrence of fossils in this biozone a single fossil can have a huge scientific importance as many vertebrate fossil taxa are known from a single fossil. The potential for significant loss to the palaeontological heritage thus remains. Any damage to fossil material that may occur during the excavation and construction phase of the project is permanent and irreversible.

The area covered in Quaternary alluvium is not considered to be palaeontologically sensitive. The low-lying relief and absence of potentially fossiliferous gulleys and appropriate exposures on most areas of the proposed upgrade area strongly suggest that fossils are absent in these areas. However, fragmentary fossils were located on the small hill to the southwest of the town where the existing Main Supply Reservoir is situated.

Should fossil remains be discovered during any phase of construction, either on the surface or exposed by excavations in progress, the ECO responsible for these developments should be alerted. Such discoveries ought to be protected (preferably *in situ*) and the ECO should alert SAHRA (South African Heritage Research Agency) so that appropriate mitigation (*e.g.* recording, sampling or collection) can be taken by a professional paleontologist.

It is recommended that the construction team should be made aware of the possibility of uncovering important bone or plant fossils on the hill southwest of the town. It is recommended that no further palaeontological heritage studies, ground truthing and/or specialist mitigation are required for the commencement of this development, pending the discovery or exposure of any fossil remains during the construction phase.

The specialist involved would require a collection permit from SAHRA (Contact details: Mrs. Colette Scheermeyer, P.O. Box 4637, Cape Town 8000; Tel: 021 462 4502; Email: cscheermeyer@sahra.org.za). Fossil material must be curated in an approved collection (*e.g.* museum or university collection) and all fieldwork and reports should meet the minimum standards for palaeontological impact studies developed by SAHRA.

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QUALIFICATIONS AND EXPERIENCE OF THE AUTHOR

Elize Butler has a MSc in Palaeontology from the University of the Free State, Bloemfontein, South Africa. She has been working at the National Museum for the past 22 years and currently holds the position of Collection Manager of the Karoo Vertebrate Collection, Palaeontology Department at the National Museum in Bloemfontein. Her current research interests comprise of Permo-Triassic vertebrate palaeobiology, with a special focus on gorgonopsians at the end-Permian mass extinction.

Declaration of Independence

I, Elize Butler, declare that I am an independent consultant and have no business, financial, personal or other interest in the proposed project, application or appeal in respect of which I was appointed other than fair remuneration for work performed in connection with the activity, application or appeal. There are no circumstances that compromise my objectivity in this work.

Sincerely,

Mrs. Elize Butler

Appendix 1.Section 25 of the National Heritage Resources Act 1999.

Heritage resources

The various categories of heritage resources are recognised as part of the National Estate in Section 3 of The National Heritage Resources Act. This include among others:

- geological sites of scientific or cultural importance;
- palaeontological sites;
- palaeontological objects and material, meteorites and rare geological specimens.

According to Section 25 of the National Heritage Resources Act 1999, dealing with archaeology, palaeontology and meteorites:

- The protection of archaeological and palaeontological sites and material and meteorites is the responsibility of a provincial heritage resources authority.
- All archaeological objects, palaeontological material and meteorites are the property of the State.
- Any person who discovers archaeological or palaeontological objects or material or a meteorite in the course of development or agricultural activity must immediately report the find to the responsible heritage resources authority, or to the nearest local authority offices or museum, which must immediately notify such heritage resources authority.
- No person may, without a permit issued by the responsible heritage resources authority—
    - destroy, damage, excavate, alter, deface or otherwise disturb any archaeological or palaeontological site or any meteorite;
    - destroy, damage, excavate, remove from its original position, collect or own any archaeological or palaeontological material or object or any meteorite;
    - trade in, sell for private gain, export or attempt to export from the Republic any category of archaeological or palaeontological material or object, or any meteorite; or

- bring onto or use at an archaeological or palaeontological site any excavation equipment or any equipment which assist in the detection or recovery of metals or archaeological and palaeontological material or objects, or use such equipment for the recovery of meteorites.

- When the responsible heritage resources authority has reasonable cause to believe that any activity or development which will destroy, damage or alter any archaeological or palaeontological site is under way, and where no application for a permit has been submitted and no heritage resources management procedure in terms of section 38 has been followed, it may—
    - serve on the owner or occupier of the site or on the person undertaking such development an order for the development to cease immediately for such period as is specified in the order;
    - carry out an investigation for the purpose of obtaining information on whether or not an archaeological or palaeontological site exists and whether mitigation is necessary.