

**PHASE 1 PALAEOLOGICAL ASSESSMENT
FOR THE PROPOSED UPGRADING OF DEBE
WATER SUPPLY SCHEME, AMATOLA WATER
(AW 2013/14/04) INFRASTRUCTURE,
NKONKOBÉ LOCAL MUNICIPALITY,
AMATHOLE DISTRICT MUNICIPALITY,
EASTERN CAPE PROVINCE**

For:

EOH Coastal & Environmental Services

DATE: 11 July 2015

By

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EXECUTIVE SUMMARY

Gideon Groenewald was appointed by EOH Coastal & Environmental Services to undertake a Phase 1 survey, assessing the potential palaeontological impact of the proposed Upgrading of the Debe-nek Water Supply Scheme, Amatola Water (AW 2013/14/04) Infrastructure, Nkonkobe Local Municipality, Amathole District Municipality, Eastern Cape Province.

The purpose of this Palaeontological Impact Assessment is to identify exposed and potential palaeontological heritage on the site of the proposed development, to assess the impact the development may have on this resource, and to make recommendations as to how this impact might be mitigated.

This report forms part of the Basic Environmental Impact Assessment for proposed Upgrading of the Debe-nek Water Supply Scheme, Amatola Water (AW 2013/14/04) Infrastructure, Nkonkobe Local Municipality, Amathole District Municipality, Eastern Cape Province and complies with the requirements for the South African National Heritage Resource Act No 25 of 1999. In accordance with Section 38 (Heritage Resources Management), a Palaeontological Impact Assessment is required to assess any potential impacts to palaeontological heritage within the development footprint of the proposed Upgrading of the Debe-nek Water Supply Scheme, Amatola Water (AW 2013/14/04) Infrastructure, Nkonkobe Local Municipality, Amathole District Municipality, Eastern Cape Province.

The development site for the proposed Upgrading of the Debe-nek Water Supply Scheme is underlain by Permian aged sedimentary rocks of the Adelaide Subgroup, Karoo Supergroup.

The development sites are underlain by shallow soils and several areas are eroded with good outcrops of sediments of the Middleton and Balfour Formations of the Adelaide Subgroup. Although no fossils were observed during the field investigation, the potential for finding significant fossils in slightly weathered sandstone and mudstone of the Adelaide Subgroup is high. Due to the fact that no fossils were observed in the outcrop areas of the Adelaide Subgroup, the Very High Palaeontological Sensitivity of the development sites are lowered to a High Sensitivity and the developer must be notified of the possibility of exposing significant fossils during excavation of the trenches for the installation of pipelines. A qualified palaeontologist must be appointed to inspect all exposure of bedrock and where fossils are recorded, the palaeontologist must apply for a permit to collect the fossils according to SAHRA specifications. The fact that all the development sites are underlain by rocks with a High Palaeontological Sensitivity and that trenching might expose significant fossils, must be noted in the EMP of the project.

It is recommended that:

- The EAP and ECO must be informed of the fact that a High Palaeontological Sensitivity is allocated to the proposed upgrading of the Debe-nek Water Supply Scheme.
- A qualified palaeontologist must be appointed to apply for a permit to record and collect any fossils found as part of a Phase II PIA for the project according to SAHRA specifications.
- These recommendations must form part of the EMP of the project.

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1. INTRODUCTION

Gideon Groenewald was appointed by EOH Coastal & Environmental Services to undertake a Phase 1 survey, assessing the potential palaeontological impact of the proposed Upgrading of the Debe-nek Water Supply Scheme, Amatola Water (AW 2013/14/04) Infrastructure, Nkonkobe Local Municipality, Amathole District Municipality, Eastern Cape Province.

The purpose of this Palaeontological Impact Assessment is to identify exposed and potential palaeontological heritage on the site of the proposed development, to assess the impact the development may have on this resource, and to make recommendations as to how this impact might be mitigated.

1.1. Legal Requirements

This report forms part of the Basic Environmental Impact Assessment for proposed Upgrading of the Debe-nek Water Supply Scheme, Amatola Water (AW 2013/14/04) Infrastructure, Nkonkobe Local Municipality, Amathole District Municipality, Eastern Cape Province. and complies with the requirements for the South African National Heritage Resource Act No 25 of 1999. In accordance with Section 38 (Heritage Resources Management), a Palaeontological Impact Assessment is required to assess any potential impacts to palaeontological heritage within the development footprint of the proposed Upgrading of the Debe-nek Water Supply Scheme, Amatola Water (AW 2013/14/04) Infrastructure.

Categories of heritage resources recognised as part of the National Estate in Section 3 of the Heritage Resources Act, and which therefore fall under its protection, include:

- geological sites of scientific or cultural importance;
- objects recovered from the soil or waters of South Africa, including archaeological and palaeontological objects and material, meteorites and rare geological specimens; and
- objects with the potential to yield information that will contribute to an understanding of South Africa's natural or cultural heritage.

2. AIMS AND METHODOLOGY

A Phase 1 investigation is often the last opportunity to record the fossil heritage within the development footprint. These records are very important to understand the past and form an important part of South Africa's National Estate.

Following the "SAHRA APM Guidelines: Minimum Standards for the Archaeological & Palaeontological Components of Impact Assessment Reports" the aims of the palaeontological impact assessment are:

- to identifying exposed and subsurface rock formations that are considered to be palaeontologically significant;
- to assessing the level of palaeontological significance of these formations;
- to comment on the impact of the development on these exposed and/or potential fossil resources and
- to make recommendations as to how the developer should conserve or mitigate damage to these resources.

Prior to the field investigation a preliminary assessment (desktop study) of the topography and geology of the study area was made using appropriate 1:250 000 geological maps (3226 King Williams' Town and 3326 Grahamstown) in conjunction with Google Earth. Potential fossiliferous

rock units (groups, formations etc) were identified within the study area and the known fossil heritage within each rock unit was inventoried from the published scientific literature, previous palaeontological impact studies in the same region and the author’s field experience.

Priority palaeontological areas were identified within the development footprint to focus the field investigator’s time and resources. The aim of the fieldwork was to document any exposed fossil material and to assess the palaeontological potential of the region in terms of the type and extent of rock outcrop in the area.

The likely impact of the proposed development on local fossil heritage was determined on the basis of the palaeontological sensitivity of the rock units concerned and the nature and scale of the development itself, most notably the minimal extent of fresh bedrock excavation envisaged. The different sensitivity classes used are explained in Table 2.1 below.

Table 2.1 Colour Coding for Palaeontological Sensitivity Classes

PALAEONTOLOGICAL SIGNIFICANCE/VULNERABILITY OF ROCK UNITS	
The following colour scheme is proposed for the indication of palaeontological sensitivity classes. This classification of sensitivity is adapted from that of Almond et al (2008).	
RED	Very High Palaeontological sensitivity/vulnerability. Development will most likely have a very significant impact on the Palaeontological Heritage of the region. Very high possibility that significant fossil assemblages will be present in all outcrops of the unit. Appointment of professional palaeontologist, desktop survey, phase I Palaeontological Impact Assessment (PIA) (field survey and recording of fossils) and phase II PIA (rescue of fossils during construction) as well as application for collection and destruction permit compulsory.
ORANGE	High Palaeontological sensitivity/vulnerability. High possibility that significant fossil assemblages will be present in most of the outcrop areas of the unit. Fossils most likely to occur in associated sediments or underlying units, for example in the areas underlain by Transvaal Supergroup dolomite where Cenozoic cave deposits are likely to occur. Appointment of professional palaeontologist, desktop survey and phase I Palaeontological Impact Assessment (field survey and collection of fossils) compulsory. Early application for collection permit recommended. Highly likely that a Phase II PIA will be applicable during the construction phase of projects.
GREEN	Moderate Palaeontological sensitivity/vulnerability. High possibility that fossils will be present in the outcrop areas of the unit or in associated sediments that underlie the unit. For example areas underlain by the Gordonia Formation or undifferentiated soils and alluvium. Fossils described in the literature are visible with the naked eye and development can have a significant impact on the Palaeontological Heritage of the area. Recording of fossils will contribute significantly to the present knowledge of the development of life in the geological record of the region. Appointment of a professional palaeontologist, desktop survey and phase I PIA (ground proofing of desktop survey) recommended.

BLUE	<p>Low Palaeontological sensitivity/vulnerability. Low possibility that fossils that are described in the literature will be visible to the naked eye or be recognized as fossils by untrained persons. Fossils of for example small domal Stromatolites as well as micro-bacteria are associated with these rock units. Fossils of micro-bacteria are extremely important for our understanding of the development of Life, but are only visible under large magnification. Recording of the fossils will contribute significantly to the present knowledge and understanding of the development of Life in the region. Where geological units are allocated a blue colour of significance, and the geological unit is surrounded by highly significant geological units (red or orange coloured units), a palaeontologist must be appointed to do a desktop survey and to make professional recommendations on the impact of development on significant palaeontological finds that might occur in the unit that is allocated a blue colour. An example of this scenario will be where the scale of mapping on the 1:250 000 scale maps excludes small outcrops of highly significant sedimentary rock units occurring in larger alluvium deposits. Collection of a representative sample of potential fossiliferous material is recommended.</p>
GREY	<p>Very Low Palaeontological sensitivity/vulnerability. Very low possibility that significant fossils will be present in the bedrock of these geological units. The rock units are associated with intrusive igneous activities and no life would have been possible during emplacement of the rocks. It is however essential to note that the geological units mapped out on the geological maps are invariably overlain by Cenozoic aged sediments that might contain significant fossil assemblages and archaeological material. Examples of significant finds occur in areas underlain by granite, just to the west of Hoedspruit in the Limpopo Province, where significant assemblages of fossils and clay-pot fragments are associated with large termite mounds. Where geological units are allocated a grey colour of significance, and the geological unit is surrounded by very high and highly significant geological units (red or orange coloured units), a palaeontologist must be appointed to do a desktop survey and to make professional recommendations on the impact of development on significant palaeontological finds that might occur in the unit that is allocated a grey colour. An example of this scenario will be where the scale of mapping on the 1:250 000 scale maps excludes small outcrops of highly significant sedimentary rock units occurring in dolerite sill outcrops. It is important that the report should also refer to archaeological reports and possible descriptions of palaeontological finds in Cenozoic aged surface deposits.</p>

When rock units of Moderate to Very High palaeontological sensitivity are present within the development footprint, palaeontological mitigation measures should be incorporated into the Environmental Management Plan.

2.1. Scope and Limitations of the Phase 1 Investigation

The scope of a phase 1 Investigation includes:

- an analysis of the area's stratigraphy, age and depositional setting of fossil-bearing units;
- a review of all relevant palaeontological and geological literature, including geological maps, and previous palaeontological impact reports;
- data on the proposed development provided by the developer (e.g. location of footprint, depth and volume of bedrock excavation envisaged) and
- where feasible, location and examination of any fossil collections from the study area (e.g. museums).
- an on-site investigation to assess the identified palaeontological sensitive areas within the development footprint/study area rather than formal palaeontological collection. The

investigation focussed on the bedrock exposure where excavations would most probably require palaeontological monitoring.

The results of the field investigation are then used to predict the potential of buried fossil heritage within the development footprint. In some investigations this involves the examination of similar accessible bedrock exposures, such as road cuttings and quarries, along roads that run parallel to or across the development footprint.

3. LOCALITY AND PROPOSED DEVELOPMENT



Figure 3.1 Locality of the Debe-nek pipeline upgrades

The Project area is located west, south-west and south of Debe. The sites are located in areas with gentle to rugged hills and river valleys that cut the topography of the region. The project proposes to upgrade the water reticulation system for the Debe-nek region through the construction of a new and upgraded water distribution pipelines, reservoirs and pumping stations at localities refer to as Gravity Main 1 to 4 (Figure 3.1).

4. GEOLOGY OF THE AREA

Following a desktop survey it was established that the site of the proposed upgrading of the Debe-nek Water Supply Scheme is underlain by Permian aged sedimentary rocks of the Middleton and Balfour Formations of the Adelaide Subgroup, Karoo Supergroup (Figure 4.1).

4.1. Karoo Supergroup

4.1.1. Adelaide Subgroup [Middleton Formation (Pum); Balfour Formation (Pub)]

The Permian aged Adelaide Subgroup is a thick sequence of sedimentary rocks dominated by light grey to yellow coloured fine-grained sandstones with interbedded green, grey and red coloured shale. These sandstones and mudstones were deposited in ancient meandering rivers alongside which lay vast swamplands. Burial of plant and animal remains lead to a wealth of fossils preserved in these sediments (Johnson et al, 2009).

The southern part of the study area is underlain by sedimentary rocks of the Permian aged Middleton Formation (Pum), characterised by red mudstone units, whilst the northern region is underlain by Permian aged sediments of the Balfour Formation (Pub), dominated by grey-green coloured mudstone units (Figure 4.1).

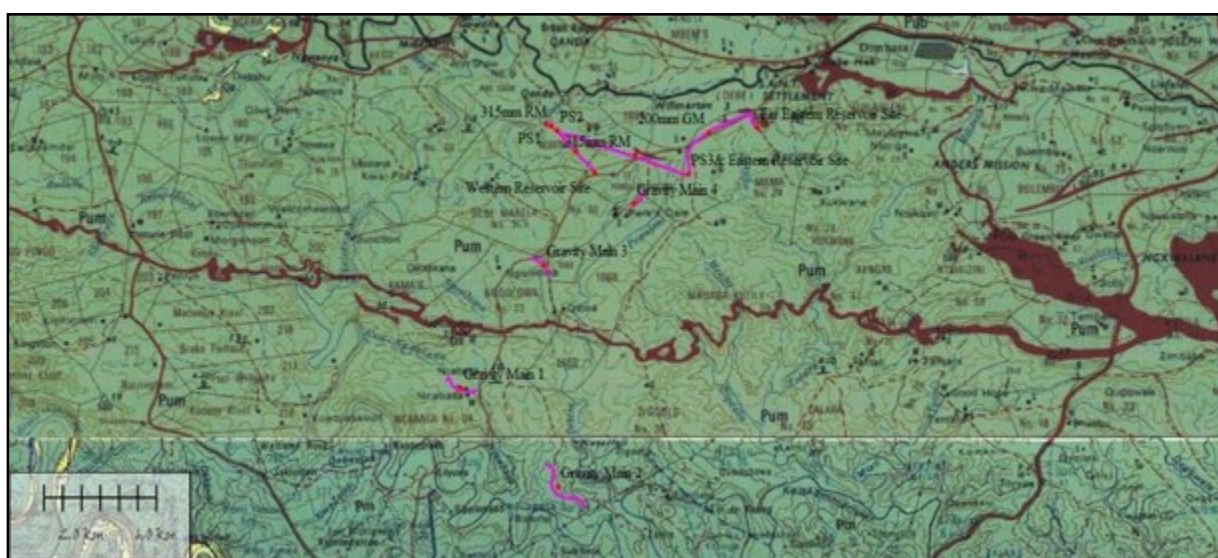


Figure 4.1 The entire study site falls on the underlying sedimentary rocks of the Adelaide Subgroup (Pa). Study sites are shown in purple.

5. PALAEOLOGY OF THE AREA

5.1. Karoo Supergroup (Adelaide Subgroup)

This sequence of sediments is rated as some of the most productive deposits of Permian aged plant fossils of *Glossopteris* assemblages in South Africa. At their peak development during the Permian these plants inhabited a variety of ecological niches, including riverine forests and was dominated by cycadeoids, ginkos and conifers. Rich assemblages of insects are also recorded from these sequences. From the Desktop survey it is concluded that the study area falls in the middle to upper part of the Adelaide Subgroup and is underlain by rocks of both the Middleton and Balfour Formations.

5.1.1. Middleton Formation (Pum)

A rich assemblage of vertebrates, including some of the most important Mammal-like Reptiles in the World, associated with the *Pristyerognathus*, *Tropidostoma* and *Cistecephalus* Assemblage Zones of the Karoo Basin, are found in these rock sequences (Rubidge et al, 1995; MacRae, 1999; McCarthy and Rubidge, 2005).

5.1.2. Balfour Formation (Pub)

As with the Middleton Formation, rich assemblage of vertebrates, including some of the more advanced Mammal-like Reptiles, are associated with these rock sequences. Fossils associated with the Balfour Formation includes vertebrates from the *Dicynodon* Assemblage Zone and *Lystrosaurus* Assemblage Zone (Rubidge et al, 1995; MacRae, 1999; McCarthy and Rubidge, 2005; Johnson et al, 2009). Several important trace fossil assemblages, including vertebrate tracks and casts of vertebrate burrows have been described from the Formation (Groenewald, 1996; Johnson *et al.*, 2009).

6. PRELIMINARY ASSESSMENT RESULTS

The palaeontological sensitivity was predicted after identifying potentially fossiliferous rock units; ascertaining the fossil heritage from the literature and evaluating the nature and scale of the development itself. The palaeontological sensitivity was predicted as highly significant, due to the potential abundance of Permian aged fossils, including plant fossils, in the Adelaide Subgroup (Figure 6.1).



Figure 6.1 Predicted Palaeosensitivity for the Debe-nek development sites. For explanation of red colour coding see Table 2.1

7. FIELD INVESTIGATION

Dr Gideon Groenewald, experienced fieldworker, visited the site of the proposed the proposed Upgrading of the Debe-nek Water Supply Scheme on Monday 8 June 2015 and Wednesday 10 June 2015. The topography of the area is mostly gentle undulating to relatively rugged in the river valleys, with rolling hills of grassland away from the deeper valleys. The soil cover vary from deep (>1.5m) soils in the valley floors, to relatively shallow (<1.0m) soils on slightly weathered sandstone and mudstone of the Adelaide Subgroup.





Excavations for the construction of the proposed Upgrading of the Debe-nek Water Supply Scheme will be restricted to areas close to the roads, mostly underlain by deep soils or slightly weathered bedrock of the Adelaide Subgroup. The proposed sites of the upgrading of the Debe-nek Water Supply Scheme were investigated and possible impacts on palaeontological heritage were recorded at specific GPS stations (Figure 7.1).





Photographic records were kept for different GPS stations (Table 7.1).













Figure 7.1 GPS Stations (698 to 791) where field observations were made. See Table 7.1 for photographic record of observations.






Table 7.1 Photographic record of observations

Photo	GPS station no (Fig. 7-1) and coordinates	Description	Picture
1	(698) -32° 52' 12.5" 27° 07' 46.8"	General view of the environment at the site of the new layout for the proposed Debe-nek water reticulation works. Excavation into weathered mudstone of the Balfour Formation. No fossils observed.	
2	(699) -32° 52' 03.3" 27° 07' 40.9"	Shallow soil with outcrop of slightly weathered mudstone of the Balfour Formation. No fossils observed.	
3	(700) -32° 51' 43.9" 27° 07' 35.6"	Site underlain by weathered mudstone of the Adelaide Subgroup. No fossils observed in excavated mudstone.	
4	(701) -32° 51' 41.5" 27° 07' 21.4"	Shallow soils on slightly weathered mudstone of the Adelaide Subgroup. No outcrop. No fossils expected or observed.	

5	(702) -32° 52' 22.0" 27° 05' 55.7"	Relatively shallow soils with outcrop of Adelaide Subgroup mudstone. No fossils were observed. Excavation might expose fossil bearing mudstone.	
6	(703) -32° 52' 30.5" 27° 05' 51.7"	Weathered mudstone of the Adelaide Subgroup. Shallow soils. No fossils were observed and excavation will probably be into shallow soils, with slight chance of exposure of fossils.	
7	(704) -32° 52' 40.4" 27° 05' 48.6"	Deep soils exposed during excavation for a burrow pit. Weathered mudstone exposed. No fossils observed.	
8	(705) -32° 53' 12.2" 27° 05' 48.7"	Reservoir at GPS station 705. PS3 & Eastern Reservoir Site. No outcrop and no fossils observed.	
9	(772) -32° 53' 24.8" 27° 04' 33.5"	Sandy shale of the Adelaide Subgroup. No fossils observed.	

10	(773) -32° 53' 44.9" 27° 04' 29.2"	No outcrop. Excavation will be into sandstone of the Adelaide Subgroup. No fossils expected or observed.	
11	(774) -32° 52' 42.1" 27° 04' 17.2"	Relatively shallow soils on sandstone and mudstone of the Adelaide Subgroup. Excavation will probably expose bedrock with slight chance of exposing fossils. No outcrop and fossils observed during fieldwork.	
12	(764) -32° 53' 19.0" 27° 02' 45.6"	Relatively deep soil on weathered mudstone of the Adelaide Subgroup. No outcrop, no fossils observed.	
13	(775) -32° 52' 22.7" 27° 03' 06.5"	Deep soils on Adelaide Subgroup sediments. No outcrop and no fossils expected or observed.	
14	(777) -32° 52' 52.8" 27° 02' 54.2"	Relatively deep soils along route of planned construction. Deeper weathering of mudstone of the Adelaide Subgroup. No outcrop, no fossils observed. Excavation for pipeline might expose fossils.	

15	(779) -32° 51' 55.3" 27° 01' 56.2"	Debe Dam site. No outcrop, no fossils observed. Excavation of trenches might expose fossils.	
16	(780) -32° 51' 54.0" 27° 02' 01.4"	Exposure of sandstone boulders. No fossils expected, no fossils observed.	
17	(783) -32° 52' 08.7" 27° 03' 03.8"	General view of environment along the route of the development. Relatively deep soils and no outcrop.	
18	(786) -32° 59' 08.2" 26° 59' 50.8"	Outcrop of red mudstone of the Middleton Formation, Adelaide Subgroup. Excavation will expose this mudstone with potential to find fossils. No fossils were observed during fieldwork.	
19	(786) -32° 59' 08.2" 26° 59' 50.8"	Shallow soil with large exposures of Adelaide Subgroup mudstone. No fossils observed during fieldwork. Fossils might be exposed during excavation for infrastructure.	

20	(788) -33° 01' 21.9" 27° 01' 55.4"	Red mudstone outcrops of the Middleton Formation, Adelaide Subgroup. Excavation will expose mudstone with potential to expose fossils. No fossils observed during field investigation.	
21	(789) -33° 01' 40.7" 27° 02' 47.8"	Reservoir on exposure of Middleton Formation mudstone and very shallow soils. Excavation will expose mudstone with potential to expose fossils. No fossils observed during field investigation.	
22	(790) -33° 01' 33.0" 27° 02' 10.2"	Red mudstone of the Middleton Formation, Adelaide Subgroup exposed along the route of the pipeline. Excavation will expose mudstone with potential fossils. No fossils were observed during field investigation.	
23	(791) -33° 01' 36.9" 27° 02' 41.4"	Shallow soil and outcrop of red mudstone of the Middleton Formation, Adelaide Subgroup. Fossils might be exposed during excavation of trenches. No fossils were observed during field investigation.	
24	(791) -33° 01' 36.9" 27° 02' 41.4"	Shallow soils on mudstone of the Middleton Formation, Adelaide Subgroup. No fossils were observed during the field investigation but might be exposed during excavation of trenches.	

8. PALAEOLOGICAL IMPACT AND MITIGATION

The predicted palaeontological impact of the development is based on the initial mapping assessment and literature reviews as well as information gathered during the field investigation. The field investigation confirms that the study area is underlain by medium-grained sandstone and green to grey and red-coloured mudstone beds of the Adelaide Subgroup, Karoo Supergroup.

The excavations at the new layout for the Upgrading of the Debe-nek Water Supply Scheme will most probably be into shallow soils and partly weathered sediments of the Adelaide Subgroup. Due to expected weathering of the sediments of the Adelaide Subgroup and the observation that a large part of the proposed sites is underlain by soil and partly weathered sandstone and mudstone, fossils will be poorly preserved. No fossils were observed during the field investigation, leading to a lowering of the significance values for Palaeontological Heritage. Exposure of bedrock during excavation is highly likely and might have a significant impact on the palaeontology of the sites. The fact that no fossils were observed during the field investigation leads to the reduction of the Palaeontological Sensitivity from Very High to a High Palaeontological Significance for all the sites (Figure 8.1). If fossils are observed they must be recorded and collected according to SAHRA specifications.



Figure 8.1 Schematic presentation of Palaeontological Sensitivity of the site of the proposed construction of the Debe-nek water reticulation system. (For Geo-referenced file see attached KMZ file). For explanation of colour coding see Table 2.1.

9. CONCLUSION

The development site for the proposed Upgrading of the Debe-nek Water Supply Scheme, Amatola Water (AW 2013/14/04) Infrastructure, Nkonkobe Local Municipality, Amathole District Municipality, Eastern Cape Province, is underlain by Permian aged sedimentary rocks of the Adelaide Subgroup, Karoo Supergroup.

The development sites are underlain by shallow soils and several areas are eroded with good outcrops of sediments of the Middleton and Balfour Formations of the Adelaide Subgroup. Although no fossils were observed during the field investigation, the potential for finding significant fossils in slightly weathered sandstone and mudstone of the Adelaide Subgroup is high. Due to the fact that no fossils were observed in the outcrop areas of the Adelaide Subgroup, the Very High Palaeontological Sensitivity of the development sites are lowered to a High Sensitivity and the developer must be notified of the possibility of exposing significant fossils during excavation of the trenches for the installation of pipelines. A qualified palaeontologist must be appointed to inspect all exposure of bedrock and where fossils are recorded, the palaeontologist must apply for a permit to collect the fossils according to SAHRA specifications. The fact that all the development sites are underlain by rocks with a High Palaeontological Sensitivity and that trenching might expose significant fossils, must be noted in the EMP of the project.

It is recommended that:

- The EAP and ECO must be informed of the fact that a High Palaeontological Sensitivity is allocated to the proposed upgrading of the Debe-nek Water Supply Scheme.
- A qualified palaeontologist must be appointed to apply for a permit to record and collect any fossils found as part of a Phase II PIA for the project according to SAHRA specifications.
- These recommendations must form part of the EMP of the project.

10. REFERENCES

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11. QUALIFICATIONS AND EXPERIENCE OF THE AUTHOR

Dr Gideon Groenewald has a PhD in Geology from the University of Port Elizabeth (Nelson Mandela Metropolitan University) (1996) and the National Diploma in Nature Conservation from Technicon RSA (the University of South Africa) (1989). He specialises in research on South African Permian and Triassic sedimentology and macrofossils with an interest in biostratigraphy, and palaeoecological aspects. He has extensive experience in the locating of fossil material in the Karoo Supergroup and exploration field trips in search of new localities in the southern, western, eastern and north-eastern parts of the country. His publication record includes multiple articles in internationally recognized journals. Dr Groenewald is accredited by the Palaeontological Society of Southern Africa (society member for 25 years).

12. DECLARATION OF INDEPENDENCE

I, Gideon Groenewald, declare that I am an independent specialist consultant and have no financial, personal or other interest in the proposed development, nor the developers or any of their subsidiaries, apart from fair remuneration for work performed in the delivery of palaeontological heritage assessment services. There are no circumstances that compromise the objectivity of my performing such work.



Dr Gideon Groenewald
Geologist