Palaeontological Impact Assessment for the proposed Construction of a low level bridge at Ezingadeni, Mondlo, KwaZulu Natal Province

Desktop Study

For

SA Sheq Consultants

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Expertise of Specialist

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Qualifications: PhD (Wits Univ, 1990); FRSSAf, ASSAf
Experience: 30 years research; 20 year PIA studies

Declaration of Independence

This report has been compiled by Professor Marion Bamford, of the University of the Witwatersrand, sub-contracted by Jean Beater on behalf of SA Sheq Consultants. The views expressed in this report are entirely those of the author and EIA consultant and no other interest was displayed during the decision making process for the project.

Specialist: …….. Prof Marion Bamford……..

Signature: ……  …….

Executive Summary

The desktop Palaeontological Impact Assessment for the proposed construction of a low level bridge at Ezingadeni, Mondlo, KwaZulu Natal, has been completed. The site is in the Permian Pietermaritzburg and Vryheid Formations, Ecca Group and Jurassic dolerite dykes. There is a chance of finding fossils of the *Glossopteris* flora in the Vryheid Formation only. It is possible that some fossil plants could be destroyed in the construction process but they have not been reported from this area and would be very sparsely distributed if present. Since there is a small chance that fossil plants could be discovered when excavations or construction commences a Chance Find protocol and monitoring programme have been added to the report. It is concluded that the project may continue as far as the palaeontology is concerned.

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1. Background

The proposed construction of a low level bridge at Ezingadeni, Mondlo, will be situated at 27°58'19.83"S and 30°41'4.44"E. The SAHRIS palaeosensitivity map shows that the area is moderately to highly sensitive (red on the map in Figure 1), so a desktop palaeontological study is reported here.

The National Heritage Resources Act (Act 25 of 1999) and the National Environmental Management Act (Act 107 of 1998) requires that the proposed development must be preceded by the relevant impact assessment, in this case for palaeontology.

This report complies with the requirements of the NEMA and environmental impact assessment (EIA) regulations (GNR 982 of 2014). The table below provides a summary of the requirements, with cross references to the report sections where these requirements have been addressed.

Table 1: Specialist report requirements in terms of Appendix 6 of the EIA Regulations (2014)

A specialist report prepared in terms of the Environmental Impact Regulations of 2014 must contain:	**Relevant section in report**
Details of the specialist who prepared the report	Prof Marion Bamford
The expertise of that person to compile a specialist report including a curriculum vitae	Palaeontologist (PhD Wits 1990) CV attached
A declaration that the person is independent in a form as may be specified by the competent authority	Page 2
An indication of the scope of, and the purpose for which, the report was prepared	Section 1, page 3
The date and season of the site investigation and the relevance of the season to the outcome of the assessment	n/a Seasons make no difference to fossils
A description of the methodology adopted in preparing the report or carrying out the specialised process	Section 2, page 4
The specific identified sensitivity of the site related to the activity and its associated structures and infrastructure	See table 2
An identification of any areas to be avoided, including buffers	n/a
A map superimposing the activity including the associated structures and infrastructure on the environmental sensitivities of the site including areas to be avoided, including buffers;	n/a
A description of any assumptions made and any uncertainties or gaps in knowledge;	Section 6, page 8
A description of the findings and potential implications of such findings on the impact of the proposed activity, including identified alternatives, on the environment	n/a
Any mitigation measures for inclusion in the EMPr	n/a
Any conditions for inclusion in the environmental authorisation	n/a
Any monitoring requirements for inclusion in the EMPr or environmental authorisation	Section 8, page 9
A reasoned opinion as to whether the proposed activity or portions thereof should be authorised and	n/a

If the opinion is that the proposed activity or portions thereof should be authorised, any avoidance, management and mitigation measures that should be included in the EMPr, and where applicable, the closure plan	n/a
A description of any consultation process that was undertaken during the course of carrying out the study	Section 3 page 4
A summary and copies if any comments that were received during any consultation process	n/a
Any other information requested by the competent authority.	n/a

2. Methods and Terms of Reference

1. In order to determine the likelihood of fossils occurring in the affected area geological maps, literature, palaeontological databases and published and unpublished records must be consulted.

2. If fossils are likely to occur then a site visit must be made by a qualified palaeontologist to locate and assess the fossils and their importance.

3. Unique or rare fossils should either be collected (with the relevant South African Heritage Resources Agency (SAHRA) permit) and removed to a suitable storage and curation facility, for example a Museum or University palaeontology department or protected on site.

4. Common fossils can be sacrificed if they are of minimal or no scientific importance but a representative collection could be made if deemed necessary.

The published geological and palaeontological literature, unpublished records of fossil sites, catalogues and reports housed in the Evolutionary Studies Institute, University of the Witwatersrand, and SAHRA databases were consulted to determine if there are any records of fossils from the sites and the likelihood of any fossils occurring there.

3. Consultation Process

No consultations were carried out during the palaeontological desktop study.

4. Geology and Palaeontology

<u>Project location and geological setting</u>

As indicated on the geological map (Figure 2) Mondlo lies on the sediments of the Pietermaritzburg and Vryheid Formations and close to dolerites of the Jurassic period. There are a large number of settlements in this area and many roads.

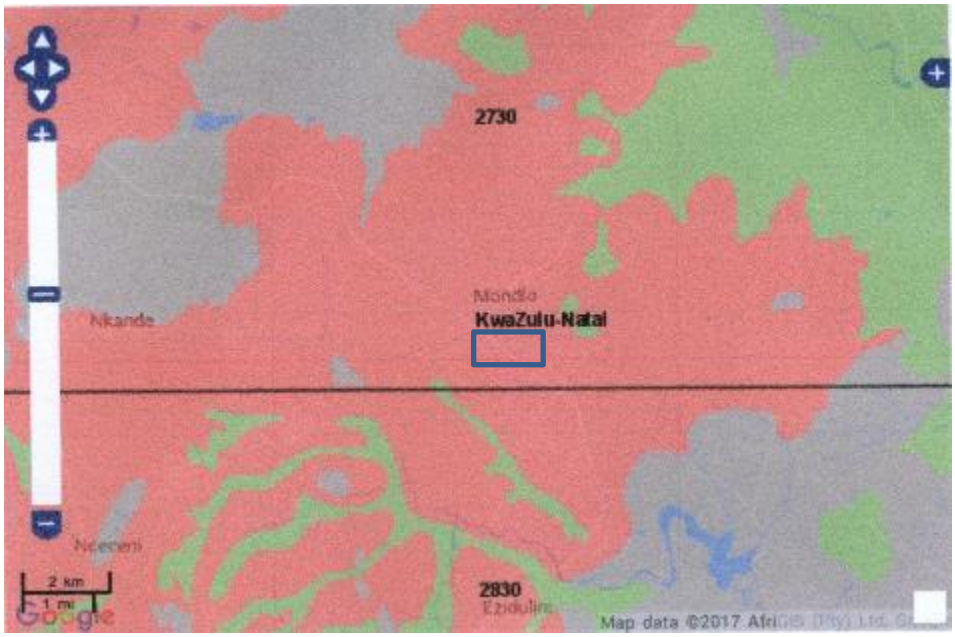

Figure 1: SAHRIS Palaeosensitivity map for the area around Mondlo. The proposed low level bridge is within blue rectangle. Colours indicate the following degrees of sensitivity: red = very highly sensitive; orange/yellow = high; green = moderate; blue = low; grey = insignificant/zero

Geology

The sediments of the underlying Pietermaritzburg Formation (Fm) are deep water deposits and do not contain fossils (Johnson et al., 2006). In the northeastern part of the Karoo Basin they immediately overlie the Dwyka Group. The Pietermaritzburg Fm comprises dark silty mudrock that coarsens upwards and becomes mixed with sandy and silty beds that are heavily bioturbated. These invertebrate trace fossils are sometimes present on the bedding planes. The palaeoenvironment was that of shallow water from melting Carboniferous glaciers (Johnson et al., 2006). The Pietermaritzburg Fm is overlain by the Ecca Vryheid Formation which comprises shales, sandstones and coal seams of deltaic origin in the main basin. In this area, the eastern part of the Karoo Basin, it represents a series of coarsening upward deltaic cycles in the lower parts but shifts to more fluvially dominated deltaic sequences. Coal is mined in the Vryheid Fm in this area and a number of borehole cores have been extracted to investigate the coal seams. Seams are not continuous over long distances so each mine has a different complement, usually incomplete, of the total of thirteen seams. Little research, however, has been done on the palaeontology of this region.

The Volksrust Fm overlies the Vryheid Fm and is predominantly argillaceous (deep water deposited grey to black silty shale) with sometimes bioturbated lenses of siltsone or sandstone. Overlying the Volksrust Fm is the Adelaide Subgroup (Beaufort Group, upper Permian) and intruding into these formations are the dolerite dykes of Early Jurassic age which have cut through the sediments and baked them, destroying any fossils that may have been present. In the Utrecht area some of these dolerites are substantive, for example over 100m thick at Vaalbank (Snyman, 1998).

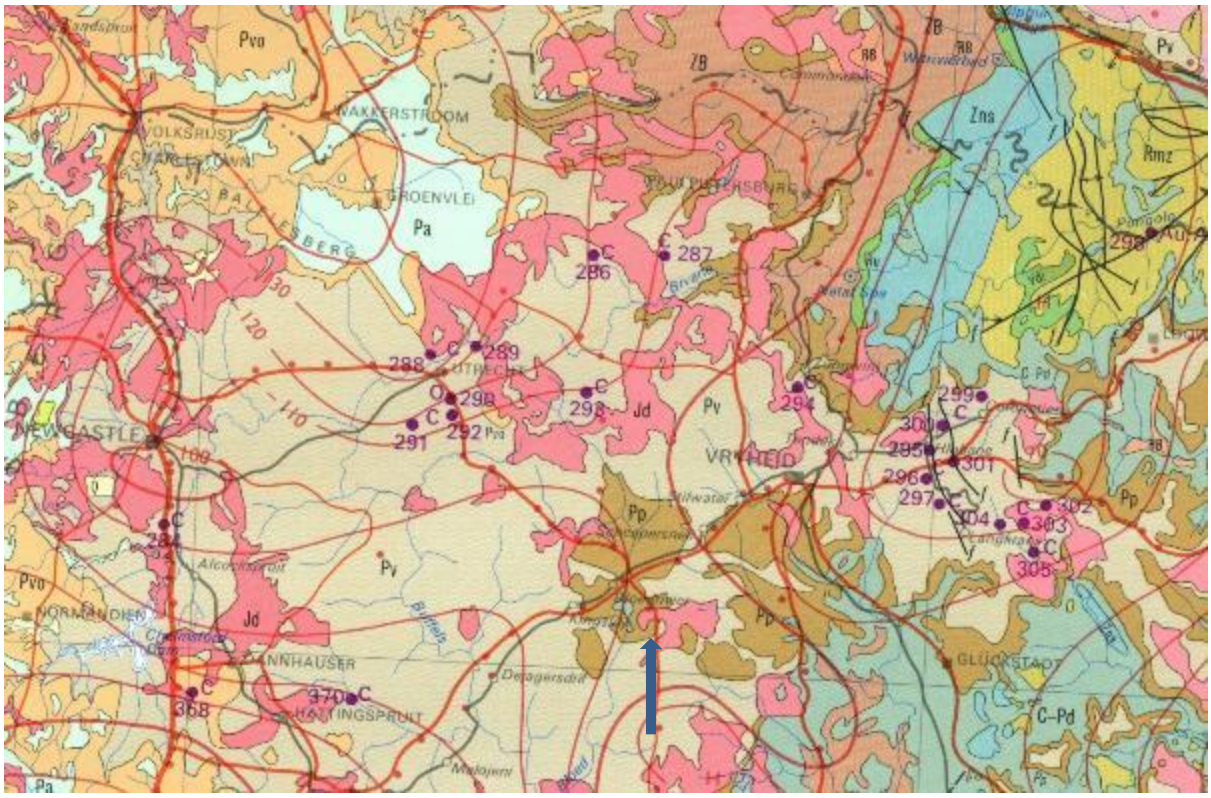

Figure 2: Geological map of the area around Mondlo The approximate location of the proposed project is indicated with the arrow. Abbreviations of the rock types are explained in Table 2. Map enlarged from the Geological Survey 1: 1 000 000 map 1984

Table 2: Explanation of symbols for the geological map and approximate ages (Barbolini et al., 2016; Johnson et al., 2006). SG = Supergroup; Fm = Formation

Symbol	Group/Formation	Lithology	Approximate Age
Jd	Jurassic	Dolerite dykes, intrusive	Jurassic, approx. 180 Ma
Pa	Adelaide & Estcourt Fms	Mudstones, shales	Upper Permian, Lower Beaufort
Pvo	Volksrust Fm	Deep water shale	Middle Permian, Upper Ecca 266 – 255 Ma
Pv	Vryheid Fm	Shales, sandstone, coal	Lower Permian, Middle Ecca <269 - 266 Ma268 Ma
Pp	Pietermaritzburg Fm	Deep water shale	Lower Permian, Lower Ecca 287 - 269 Ma
C-Pd	Dwyka Fm	Tillites	Carboniferous – Permian >290 Ma

Palaeontology

(Refer to Figure 1 for SAHRIS palaeosensitivity)

Shales, and shale lenses between coal seams, of the Vryheid Fm are likely to preserve leaf impressions of the *Glossopteris* flora (lycopods, sphenophytes, ferns, cordaitaleans, ginkgophytes and early conifers), but none has yet been reported from this area.

The Pietermaritzburg and Volksrust formations are unlikely to contain any fossils.

The *Glossopteris* flora fossils are of interest to palaeobotanists but in general they are widely scattered and difficult to locate. This flora is well known but there is always a very small chance that some new taxa may be discovered. To date no fossils have been reported from the Ezingadeni/Mondlo area. Fossil vertebrates of this age are extremely rare and there are no known occurrences of vertebrate fossils associated with coals in southern Africa. Insect wings can occur with the leaves but are extremely rare and difficult to find.

The area is disturbed from previous urban and agricultural activities. Any surface fossils are likely to be very weathered (naturally) or destroyed by previous activities. Along the river there could be downcutting into underlying sediments that contain fossil plants. There is however a very small chance that fossil plants could be found where new excavations are made for the bridge foundations and access roads.

5. Impact assessment

Using the criteria in the table below, the impact of the relatively shallow excavations for the bridge foundations and access roads has been assessed.

The surface activities would impact on the fossil heritage, only if preserved in this area, as the rocks are sedimentary and the correct age, however the intact shales, coal seams and associated shales are well below ground level. The IMPACT is very low (according to the scheme in Table 3).

TABLE 3: CRITERIA FOR ASSESSING IMPACTS

PART A: DEFINITION AND CRITERIA		
Criteria for ranking of the SEVERITY/NATURE of environmental impacts	**H**	Substantial deterioration (death, illness or injury). Recommended level will often be violated. Vigorous community action.
	M	Moderate/ measurable deterioration (discomfort). Recommended level will occasionally be violated. Widespread complaints.
	L	Minor deterioration (nuisance or minor deterioration). Change not measurable/ will remain in the current range. Recommended level will never be violated. Sporadic complaints.
	L+	Minor improvement. Change not measurable/ will remain in the current range. Recommended level will never be violated. Sporadic complaints.
	M+	Moderate improvement. Will be within or better than the recommended level. No observed reaction.
	H+	Substantial improvement. Will be within or better than the recommended level. Favourable publicity.
Criteria for ranking the DURATION of impacts	**L**	Quickly reversible. Less than the project life. Short term
	M	Reversible over time. Life of the project. Medium term
	H	Permanent. Beyond closure. Long term.
Criteria for ranking the SPATIAL SCALE of impacts	**L**	Localised - Within the site boundary.
	M	Fairly widespread – Beyond the site boundary. Local
	H	Widespread – Far beyond site boundary. Regional/ national
PROBABILITY (of exposure to impacts)	**H**	Definite/ Continuous
	M	Possible/ frequent
	L	Unlikely/ seldom

Excavation for bridge, foundations, road access and infrastructure would not penetrate much below 2-3 m below the ground surface. If good fossils occur at depth, this will only be revealed once excavations have commenced. The chance of finding fossil plants would be very small prior to this so there would be minor deterioration of the surface of sites and a minor impact on any potential fossils. Therefore the SEVERITY/NATURE of the environmental impact would be L.

DURATION of the impact would be permanent: H.

Since only the possible fossils within the area would be fossil plants such as leaf impressions from the *Glossopteris* flora in the shales, the SPATIAL SCALE will be localised within the site boundary: L.

There is a very small chance of finding leaf fossils in the shales between coal seams because these have been reported from the same formations but not in this particular area. However, the PROBABILITY of affecting any fossils is unlikely or seldom: L

6. Assumptions and uncertainties

Based on the geology of the area and the palaeontological record as we know it, it can be assumed that the formation and layout of the basement rocks, dolomites, sandstones, shales, coals, quartzites, basalts and volcanic rocks are typical for the country and do not contain any fossil material. The shales of the Vryheid Formation could contain impression fossils of plants of the *Glossopteris* flora, however, they have yet to be recorded from the proposed site for the low level bridge at Ezingadeni, Mondlo.

7. Recommendation

It is unlikely that any well preserved fossils occur in the proposed building and infrastructure sites in the shales and mudstones. Furthermore, no fossils have been recorded from this area. Nonetheless rocks of this type and age are potentially fossiliferous, as indicated in the SAHRIS palaeosensitivity map (Fig 1). As there is a chance find, a monitoring protocol is recommended.

As far as the palaeontology is concerned the proposed development can go ahead. Any further palaeontological assessment would only be required after excavations and building have commenced and if fossils are found by the geologist or environmental personnel. The procedure can be added to the EMPr.

8. Monitoring Programme for Palaeontology – to commence once the excavations begin.

1. The following procedure is only required if fossils are seen on the surface and when excavations commence.
2. When excavations begin the rocks and must be given a cursory inspection by the environmental officer or designated person. Any fossiliferous material (trace fossils, plants, insects, bone, and coal) should be put aside in a suitably protected place. This way the construction activities will not be interrupted.
3. Photographs of similar fossil plants must be provided to the developer to assist in recognizing the fossil plants in the shales and mudstones (for example see Figure 3). This information will be built into the EMPr's training and awareness plan and procedures.
4. Photographs of the putative fossils can be sent to the palaeontologist for a preliminary assessment.
5. A qualified palaeontologist sub-contracted for this project, should visit the site to inspect the selected material and check the dumps where feasible. The frequency of inspections should be dependent on the finding of any potentially important fossil material.
6. Fossil plants or vertebrates that are considered to be of good quality or scientific interest by the palaeontologist must be removed, catalogued and housed in a suitable institution where they can be made available for further study. Before the fossils are removed from the site a SAHRA permit must be obtained. Annual reports must be submitted to SAHRA as required by the relevant permits.
7. If no good fossil material is recovered then no site inspections would be necessary and a final report by the palaeontologist can be sent to SAHRA.
8. If no fossils are found and the excavations have finished then no further monitoring is required.

9. References

Barbolini, N., Bamford, M.K., Rubidge, B., 2016. Radiometric dating demonstrates that Permian spore-pollen zones of Australia and South Africa are diachronous. Gondwana Research 37, 241-251.

Groenewald, G. 2012. Palaeontological Technical Report for KwaZulu Natal. Report for Heritage KwaZulu Natal. AMAFA. 61pp.

Johnson, M.R., van Vuuren, C.J., Visser, J.N.J., Cole, D.I., Wickens, H.deV., Christie, A.D.M., Roberts, D.L., Brandl, G., 2006. Sedimentary rocks of the Karoo Supergroup. 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. Pp 461 – 499.

Plumstead, E.P., 1969. Three thousand million years of plant life in Africa. Geological Society of southern Africa, Annexure to Volume LXXII. 72pp + 25 plates.

Snyman, C.P., 1998. Coal. In: Wilson, M.G.C., and Anhaeusser, C.P., (Eds) The Mineral Resources of South Africa: Handbook, Council for Geosciences 16, 136-205.

Figure 3: Examples of fossil leaf impressions and compressions of the *Glossopteris* flora (Ecca Group) that could possibly be found