Palaeontological Impact Assessment for the proposed diamond Prospecting Rights Application on Portion 3 of Farm Lanyon Vale 376, southwest of Douglas, Northern Cape Province

Site Visit Report (Phase 2)

For

Archaeological & Heritage Services Africa (Pty) Ltd

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Declaration of Independence

This report has been compiled by Professor Marion Bamford, of the University of the Witwatersrand, sub-contracted by Archaeological & Heritage Services Africa (Pty) Ltd, Pretoria, South Africa. The views expressed in this report are entirely those of the author and no other interest was displayed during the decision making process for the Project.

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Executive Summary

A Palaeontological Impact Assessment was requested for the proposed Prospecting Right Application by Kimswa Mining (Pty) Ltd on Portion 3 (Beatrys) of the Farm Lanyon Vale 376. The site is southwest of Douglas in the Hay Administrative District, Northern Cape Province. The extent of the area is approximately 8241 Ha.

To comply with the regulations of the South African Heritage Resources Agency (SAHRA) in terms of Section 38(8) of the National Heritage Resources Act, 1999 (Act No. 25 of 1999) (NHRA), a site visit (Phase 2) Palaeontological Impact Assessment (PIA) was completed for the proposed development.

The site lies on three different and potentially fossiliferous strata. The very highly fossiliferous Boomplaas Formation (Ghaap Group, Transvaal Supergroup) adjacent to the eastern part of the Orange River could have trace fossils such as stromatolites or oolites. The highly fossiliferous Quaternary Calcretes and the moderately fossiliferous Quaternary alluvium could have trapped bones or wood, and the Dwyka Group could have fragmented fossils plants or invertebrates.

The site visit and walk through in late September 2022 by the palaeontologist confirmed that there are NO FOSSILS in any of the strata. Cobbles and pebbles are abundant on the surface and in the naturally exposed profiles. It is not known what lies below the surface, therefore, a Fossil Chance Find Protocol should be added to the EMPr. Based on this information it is recommended that no further palaeontological impact assessment is required unless fossils are found by the prospectors, contractor, environmental officer or other designated responsible person once excavations, drilling or sampling activities have commenced. Since the impact will be low, as far as the palaeontology is concerned, the project should be authorised.

Table of Contents

1. Background

The proposed Prospecting Right Application for diamonds by Kimswa Mining (Pty) Ltd on the Portion 3 (Beatrys) of the Farm Lanyon Vale 376, requires an EIA. The site is southwest of Douglas in the Hay Administrative District, Northern Cape Province. The extent of the area is approximately 8241 Ha. Location of the site and farm boundaries are provided in Figure 1. The project area is on the northern bank of the Orange River about 55km southwest of the Town of Douglas. There is no evidence of agriculture near the river. Farther north the land is gently sloping towards the river.

A Palaeontological Impact Assessment was requested for the Beatrys / Portion 3 of Lanyon Vale 376 Prospecting Right Application (PRA) project. To comply with the regulations of the South African Heritage Resources Agency (SAHRA) in terms of Section 38(8) of the National Heritage Resources Act, 1999 (Act No. 25 of 1999) (NHRA), a site visit and walkthrough (Phase 2) Palaeontological Impact Assessment (PIA) was completed for the proposed development and is reported herein.

Table 1: National Environmental Management Act, 1998 (Act No. 107 of 1998) (NEMA) and Environmental Impact Assessment (EIA) Regulations, 2014 (as amended) - Requirements for Specialist Reports (Appendix 6).

	A specialist report prepared in terms of the Environmental Impact Regulations of 2017 must contain:	**Relevant section in report**
ai	Details of the specialist who prepared the report,	Appendix B
aii	The expertise of that person to compile a specialist report including a curriculum vitae	Appendix B
b	A declaration that the person is independent in a form as may be specified by the competent authority	Page 1
c	An indication of the scope of, and the purpose for which, the report was prepared	Section 1
ci	An indication of the quality and age of the base data used for the specialist report: SAHRIS palaeosensitivity map accessed – date of this report	Yes
cii	A description of existing impacts on the site, cumulative impacts of the proposed development and levels of acceptable change	Section 5
d	The date and season of the site investigation and the relevance of the season to the outcome of the assessment	N/A
e	A description of the methodology adopted in preparing the report or carrying out the specialised process	Section 2
f	The specific identified sensitivity of the site related to the activity and its associated structures and infrastructure	Section 4
g	An identification of any areas to be avoided, including buffers	N/A

	A specialist report prepared in terms of the Environmental Impact Regulations of 2017 must contain:	Relevant section in report
h	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
i	A description of any assumptions made and any uncertainties or gaps in knowledge;	Section 5
j	A description of the findings and potential implications of such findings on the impact of the proposed activity, including identified alternatives, on the environment	Section 4
k	Any mitigation measures for inclusion in the EMPr	Section 8, Appendix A
l	Any conditions for inclusion in the environmental authorisation	N/A
m	Any monitoring requirements for inclusion in the EMPr or environmental authorisation	Section 8, Appendix A
ni	A reasoned opinion as to whether the proposed activity or portions thereof should be authorised	Section 6
nii	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	Sections 6, 8
o	A description of any consultation process that was undertaken during the course of carrying out the study	N/A
p	A summary and copies of any comments that were received during any consultation process	N/A
q	Any other information requested by the competent authority.	N/A
2	Where a government notice gazetted by the Minister provides for any protocol or minimum information requirement to be applied to a specialist report, the requirements as indicated in such notice will apply.	N/A

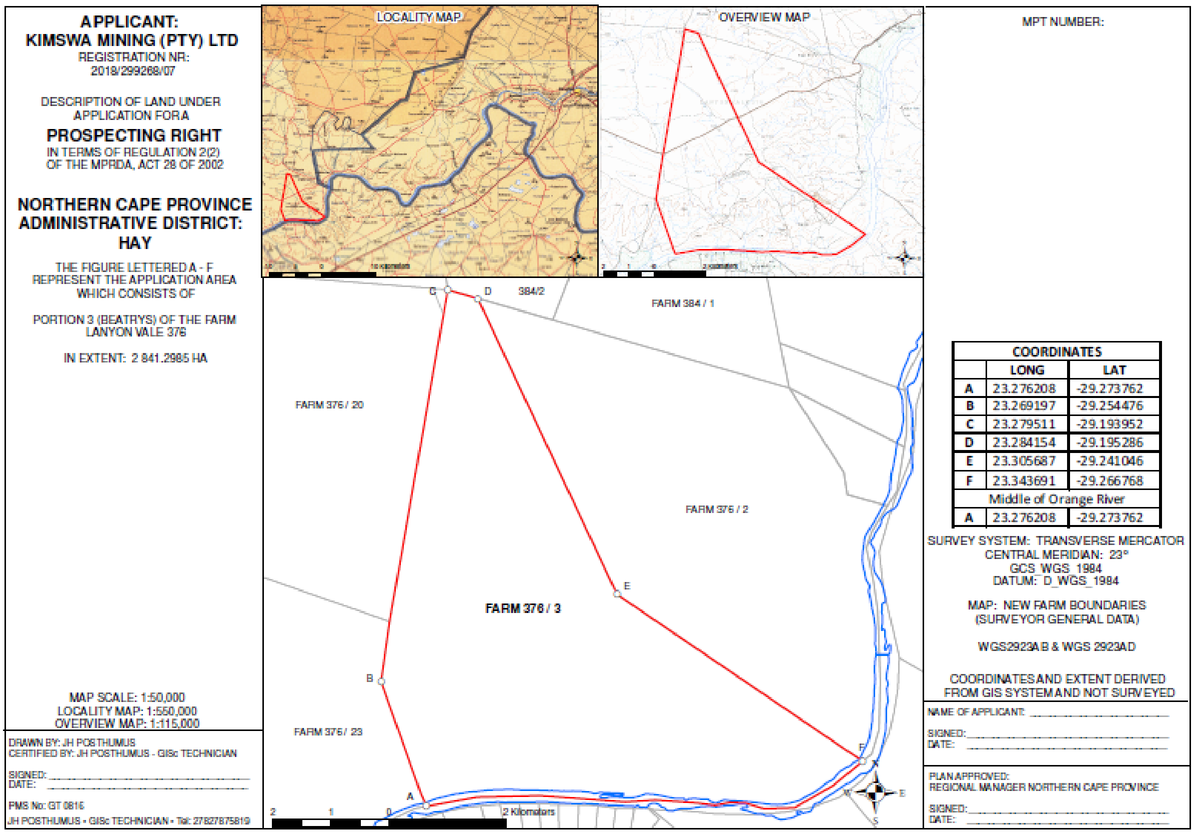

Figure 1: Area and locality maps for the Beatrys / Ptn 3 Lanyon Vale 376 PRA.

2. Methods and Terms of Reference

The Terms of Reference (ToR) for this study were to undertake a PIA and provide feasible management measures to comply with the requirements of SAHRA.
The methods employed to address the ToR included:

1. Consultation of geological maps, literature, palaeontological databases, published and unpublished records to determine the likelihood of fossils occurring in the affected areas. Sources included records housed at the Evolutionary Studies Institute at the University of the Witwatersrand and SAHRA databases;
2. Where necessary, site visits by a qualified palaeontologist to locate any fossils and assess their importance, as is the case here;
3. Where appropriate, collection of unique or rare fossils with the necessary permits for storage and curation at an appropriate facility (*not applicable to this assessment*); and
4. Determination of fossils' representivity or scientific importance to decide if the fossils can be destroyed or a representative sample collected (*not applicable to this assessment*).

3. Geology and Palaeontology

i. Project location and geological context

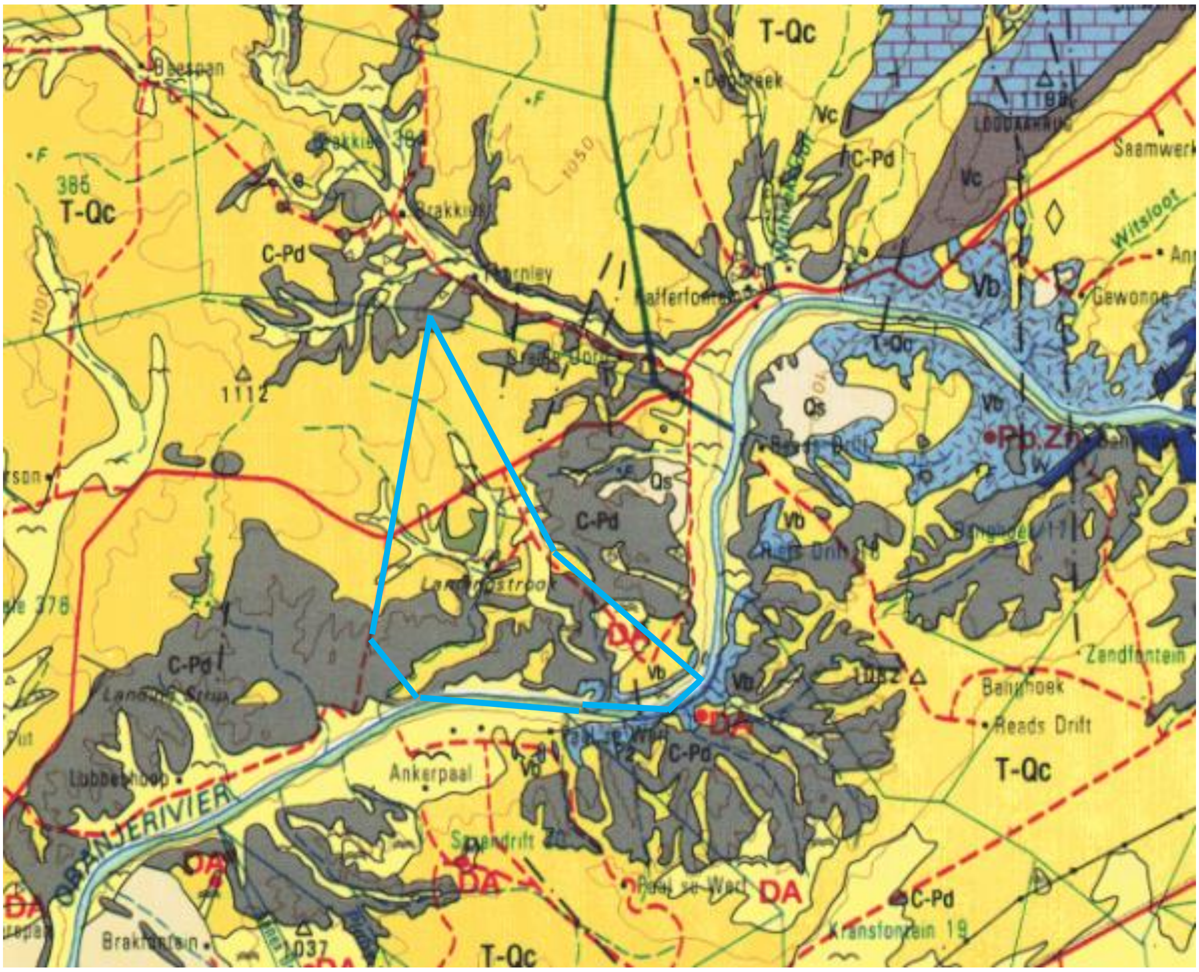

Figure 2: Geological map of the area around Portion 3 (Beatrys) of Farm Lanyon Vale 376 with the PRA area shown within the turquoise polygon. Abbreviations of the rock types are explained in Table 2. Map enlarged from the Geological Survey 1: 250 000 map 2922 Prieska.

Table 2: Explanation of symbols for the geological map and approximate ages (Johnson et al., 2006; Partridge et al., 2006; Zeh. 2020). SG = Supergroup; Fm = Formation; Ma = million years; grey shading = formations impacted by the project.

Symbol	Group/Formation	Lithology	Approximate Age
Q	Kalahari Group sands	Alluvium	Quaternary, ca 1.0 Ma to present
Qs	Kalahari Group sands	Sand and sandy soil	Quaternary, ca 1.0 Ma to present
T-Qc	Undifferentiated Tertiary and Quaternary sediments	Calcrete	Tertiary to Quaternary, last 65 million years
C-Pd	Dwyka Group, Karoo SG	Diamictites, tillites, sandstone, mudstone, shale	Late Carboniferous to Early Permian
Vb	Bomplaas Fm, Schmidtsdrift Subgroup, Ghaap Group, Transvaal	Oolitic, stromatolitic and algal-mat limestone;	Palaeoproterozoic, Ca 2620-2600 Ma

Symbol	Group/Formation	Lithology	Approximate Age
	SG (Griqualand West Sequence)	interbedded with flag-stone and quartzite	

The site lies in the north western part of the Karoo basin where the basal rocks of the Transvaal Supergroup are unconformable overlain by early Karoo Supergroup strata (Figure 2). Along the rivers and streams much younger reworked sands and alluvium overly the older strata.

The Late Archaean to early Proterozoic Transvaal Supergroup is preserved in three structural basins on the Kaapvaal Craton (Eriksson et al., 2006). In South Africa are the Transvaal and Griqualand West Basins, and the Kanye Basin is in southern Botswana. The Griqualand West Basin is divided into the Ghaap Plateau sub-basin and the Prieska sub-basin. Sediments in the lower parts of the basins are very similar but they differ somewhat higher up the sequences. Several tectonic events have greatly deformed the south western portion of the Griqualand West Basin between the two sub-basins

The Transvaal Supergroup comprises one of world’s earliest carbonate platform successions (Beukes, 1987; Eriksson et al., 2006; Zeh et al., 2020). In some areas there are well preserved stromatolites that are evidence of the photosynthetic activity of blue green bacteria and green algae. These microbes formed colonies in warm, shallow seas.

There are two Formations in the Schmidtsdrift Subgroup and occur in both of the sub-basins of the Griqualand West Basin. The lower **Boomplaas Formation** comprises stromatolitic and oolitic platform carbonates. Only the upper 100m is visible in surface outcrops but it extends another 185m in borehole core (Beukes, 1979, 1983). They represent deep lagoonal deposits, transported oolites and carbonate shelf rocks. The upper Clearwater Formation comprises shales, tuffites and BIF-like cherts and is interpreted as a transgressive deposit over the Boomplaas Formation (ibid; Eriksson et al., 2006).

The Karoo Supergroup rocks cover a very large proportion of South Africa and extend from the northeast (east of Pretoria) to the southwest and across to almost the KwaZulu Natal south coast. It is bounded along the southern margin by the Cape Fold Belt and along the northern margin by the much older Transvaal Supergroup rocks. Representing some 120 million years (300 – 183Ma), the Karoo Supergroup rocks have preserved a diversity of fossil plants, insects, vertebrates and invertebrates.

During the Carboniferous Period South Africa was part of the huge continental landmass known as Gondwanaland and it was positioned over the South Pole. As a result, there were several ice sheets that formed and melted, and covered most of South Africa (Visser, 1986, 1989; Isbell et al., 2012). Gradual melting of the ice as the continental mass moved northwards and the earth warmed, formed fine-grained sediments in the large inland sea. These are the oldest rocks in the system and are exposed around the outer part of the ancient Karoo Basin, and are known as the Dwyka Group. They comprise tillites, diamictites, mudstones, siltstones and sandstones that were deposited as the basin filled. This group has been divided into two formations with Elandsvlei Formation occurring throughout the basin and the upper Mbizane Formation occurring only in the Free State and KwaZulu Natal (Johnson et al., 2006).

The **Quaternary Kalahari sands** form an extensive cover of much younger deposits over much of the Northern Cape Province and Botswana. Haddon and McCarthy (2005) proposed that the Kalahari basin formed as a response to down-warp of the interior of the southern Africa, probably in the Late Cretaceous. This, along with possible uplift along epeirogenic axes, back-tilted rivers into the newly formed Kalahari basin and deposition of the Kalahari Group sediments began. Sediments included basal gravels in river channels, sand and finer sediments. A period of relative tectonic stability during the mid-Miocene saw the silcretisation and calcretisation of older Kalahari Group lithologies, and this was followed in the Late Miocene by relatively minor uplift of the eastern side of southern Africa and along certain epeirogenic axes in the interior. More uplift during the Pliocene caused erosion of the sand that was then reworked and redeposited by aeolian processes during drier periods, resulting in the extensive dune fields that are preserved today.

There are numerous pans in the Kalahari, generally 3–4 km in diameter (Haddon and McCarthy, 2005). Most pans in the Kalahari Basin are filled by a layer of clayey sand or calcareous clays and are flanked by lunette dunes formed as a result of deflation of the pan floor during arid periods (Lancaster, 1978a, b; Haddon and McCarthy, 2005). At some localities in the south western Kalahari spring-fed tufas have formed at the margins of pans during periods where groundwater discharge was high (Lancaster, 1986). Associated with some palaeo-pans and palaeo-springs are fossil bones, root casts, pollen and archaeological artefacts. Well-known sites are Florisbad and Deelpan in the Free State, Wonderkrater in Limpopo and Bosluispan in the Northern Cape.

Tertiary calcretes cover large parts of the Northern Cape but they are difficult to date and there are several schools of thought (see Partridge et al., 2006). Nonetheless, it is accepted that calcretes form under alternating cycles humid and arid climatic conditions in strata that have calcium carbonate (Netterberg, 1969). More recent research using geophysical techniques to measure uplift of the continent during the Cretaceous and tertiary, combined with the fossil record (Braun et al., 2014) suggest that there were two predominant humid periods during the Tertiary. The whole of the Eocene (56-33 Ma) and a short period during the early Miocene (ca 20-19 Ma) were humid according to their estimation. It is possible that the Northern Cape calcretes formed during one of these periods.

Overlying many of these rocks are loose sands and sand dunes of the Gordonia Formation, Kalahari Group of Neogene Age. The Gordonia Formation is the youngest of six formations and is the most extensive, stretching from the northern Karoo, Botswana, Namibia to the Congo River (Partridge et al., 2006). It is considered to be the biggest palaeo-erg in the world (ibid). The sands have been derived from local sources with some additional material transported into the basin (Partridge et al., 2006). Much of the Gordonia Formation comprises linear dunes that were reworked a number of times before being stabilised by vegetation (ibid).

ii. Palaeontological context

The palaeontological sensitivity of the area under consideration is presented in Figure 3. The site for mining is on the moderately fossiliferous Dwyka Group and the Tertiary-Quaternary sands and calcretes. Along the river are alluvial sand deposits.

The lower Boomplaas Formation comprises stromatolitic and oolitic platform carbonates. These are trace fossils of algal activity. Stromatolites are layer upon layer of minerals precipitated by the photosynthesising algal colonies and form domes or flat laminae. Oolitic limestone is composed up of small spheres called ooiliths that are cemented together by lime mud. They form when calcium carbonate is deposited on the surface of sand grains rolled around by wave action on a shallow sea floor. The original algal cells, however, are not preserved.

The Dwyka Group is made up of seven facies that were deposited in a marine basin under differing environmental settings of glacial formation and retreat (Visser, 1986, 1989; Johnson et al., 2006). The mudrock facies consists of dark-coloured, commonly carbonaceous mudstone, shale or silty rhythmite that was formed when the mud or silt in suspension settled. This is the only fossiliferous facies of the Dwyka Group.

The Dwyka *Glossopteris* flora outcrops are very sporadic and rare. Of the seven facies that have been recognised in the Dwyka Group fossil plant fragments have only been recognised from the mudrock facies. They have been recorded from around Douglas only (Johnson et al., 2006; Anderson and McLachlan 1976) although the Dwyka Group exposures are very extensive.

The Tertiary calcretes can trap fossils and artefacts when associated with palaeo-pans or palaeo-springs (Partridge et al., 2006). Where deflation has occurred, for example along the west coast of South Africa, any trapped materials in the different levels can be concentrated in the depo-centre of the pan or dune and thus it can be challenging to interpret the deposit (Felix-Henningsen et al., 2003).

The Aeolian sands of the Gordonia Formation do not preserve fossils because they have been transported and reworked. Conditions required for the preservation of organic material and formation of fossils are burial in a low energy, anoxic environment such as overbank deposits, lake muds or clays (Briggs and McMahon, 2016). Aeolian sands are high energy, well-oxygenated environments. In some regions, the sands may have covered pan or spring deposits and these can trap fossils, and more frequently archaeological artefacts. Usually these geomorphological features can be detected using satellite imagery. No such features are visible.

Exploration and research along the palaeo-rivers of Southern Africa, now only present as abandoned palaeochannels, or captured by the present day rivers, the Vaal and Orange Rivers in this case, the gravels and sands might include transported robust and fragmentary fossils. Examples of these are heavy bone fragments and silicified wood fragments, as well as diamonds (de Wit, 1999; de Wit et al., 2000).

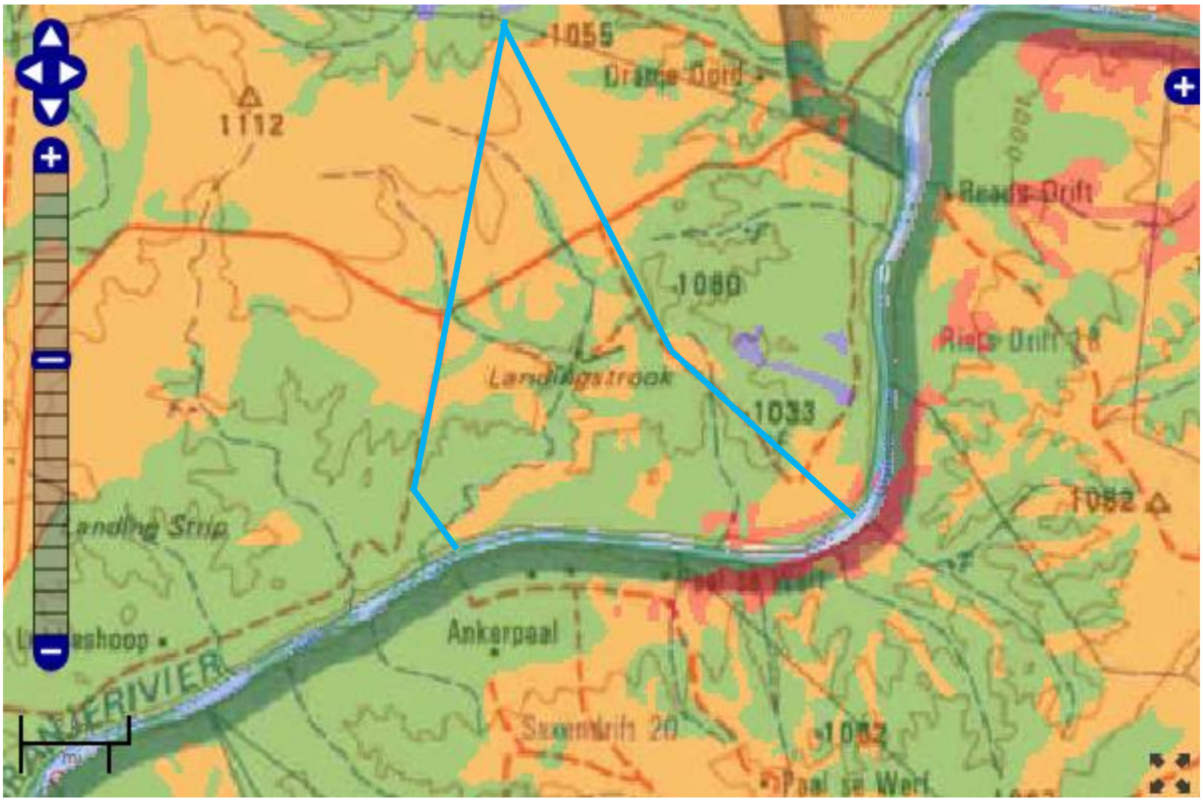

Figure 3: SAHRIS palaeosensitivity map for the site for the proposed Beatrys /Lanyon Vale 376 PRA shown within the blue polygon. Background colours indicate the following degrees of sensitivity: red = very highly sensitive; orange/yellow = high; green = moderate; blue = low; grey = insignificant/zero.

iii. Site visit observations

The site was walked through and visibility was good as the vegetation was fairly sparse. Photographs and observations were made at representative sites for the geology and palaeontology. Although there were many transported boulders, cobbles and pebbles, none of them was a fossil. No fossils of any kind were seen on the land surface or in the existing trenches or erosion gullies (Note, no new excavations were done). Although it was expected to find outcrops of the Boomplaas Formation stromatolitic and oolitic limestone alongside the river, as indicated on the geology map, no dolomite or limestones were recognised.

Table 3: Site observations, GPS points and relevant figures (Figures 4-5).

GPS points	Observations	Figure
Stop 1: 29°15'31.35"S 23°16'7.49"E	General view photo taken from start of survey. Note gently rolling topography and sparse vegetation that enables good visibility of the rocks and soils	4A
Stop 2:	A stream incised through a deep deposit of silt. There is evidence of active erosion during the rainy season. C –	4B-C

29°13'49.70"S 23°17'58.9"E	close-up of the sediments showing gypsum infilling of the mud cracks, indicating alternating wet-dry cycles. No fossils, no trace fossils.	
Stop3: 29°14'28.3"S 23°17'57.9"E	Profile of streambank shows unconsolidated calcrete, and sparse inclusion of pebbles. No fossils	4D
Stop 4: 29°14'46.9"S 23°18'42.20"E	Streambank shows several deposition episodes of the gravels. No fossils included in the gravels.	
Stop 5: 29°15'01.10"S 23°18'52.80"E	Rooikoppie gravels (Quaternary) sitting on top of glacial tillite deposit (Dwyka) on the shoulder of a stream. No fossils, no silicified wood.	5A
Stop 6: 29°15'15.50"S 23°19'11.2"E	Streambank profile shows several depositional layers – at the bottom unconsolidated shale/clay, shale with a concentration of pebbles, and a topsoil horizon composed of brown silt and fine gravel.	5B
Stop 7: 29°15'15.5"S 23°19'11.2"E	Stop 9: Surface exposure of shale below superficial Rooikoppie gravels, larger than at previous site. No fossils	
Stop 8: 29°15'17.7"S 23°19'12.0"E	Calcrete mantle on the shoulder of a stream. No inclusions in the calrete and no fossils.	5C
Stop 9: 29°14'52.20"S 23°17'39.20"E	Streambank profile shows shale at the bottom, calcrete crumps, pebbles and a calcrete mantle. These stream cuttings are common close to the river. Note, no limestone or stromatolites were seen adjacent to the river as would be expected according to the geology map.	5D

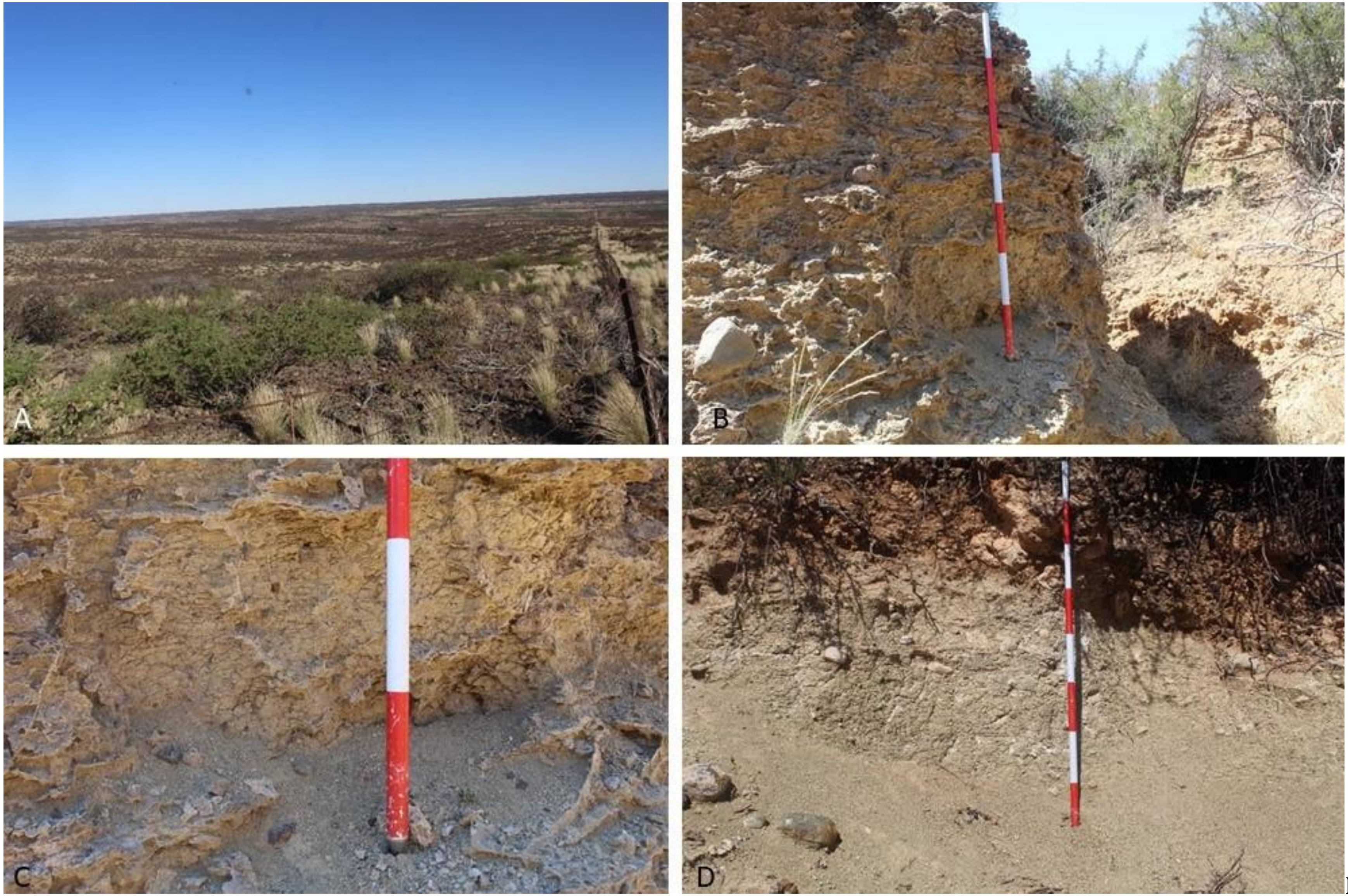

Figure 4

Figure 5.

4. Impact assessment

An assessment of the potential impacts to possible palaeontological resources considers the criteria encapsulated in Table :

Table 4a: 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

Table 4b: Impact Assessment

PART B: Assessment		
SEVERITY/NATURE	**H**	-
	M	-
	L	Alluvium and gravels do not preserve plant or animal fossils; calcrete might trap fossils; so far there are no records from the Dwyka Group or Tertiary calcrete of plant or animal fossils in this region so it is very unlikely that fossils occur on the site. The impact would be very unlikely.
	L+	-

PART B: Assessment		
	M+	-
	H+	-
DURATION	**L**	-
	M	-
	H	Where manifest, the impact will be permanent.
SPATIAL SCALE	**L**	Since the only possible fossils within the area would be trace fossils (stromatolites, oolites), fossil plants from the early *Glossopteris* flora in the shales, or trapped fossils in the calcrete, the spatial scale will be localised within the site boundary.
	M	-
	H	-
PROBABILITY	**H**	-
	M	It is possible that trace fossils will be found in the Boomplaas Fm; plant and invertebrates fossils would be found in Dwyka tillites because they have been recorded from Douglas; the loose sand and calcrete might have trapped fossils, therefore, a Fossil Chance Find Protocol should be added to the eventual EMPr
	L	.

Based on the nature of the project, surface activities may impact upon the fossil heritage if preserved in the development footprint. The geological structures suggest that the rocks are the correct age and type to preserve fossils. The site visit and walk through confirmed that there were NO TRACE FOSSILS in the Boomplaas Formation, NO FOSSILS in the Dwyka Group tillites, in NO TRAPPED FOSILS in the calcretes or in Quaternary sand along the river. Since there is a very small chance that fossils from below the ground surface may be disturbed a Fossil Chance Find Protocol has been added to this report. Taking account of the defined criteria, the potential impact to fossil heritage resources is low.

5. 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 dolomites, sandstones, shales and sands are typical for the country and some do contain trace fossils, fossil plant, insect, invertebrate and vertebrate material. The site visit and walk through by the palaeontologist confirmed that there are no fossils on the surface and none in the profiles of the stream cuttings. It is not known what is below the ground surface but the occurrence of fossils seems very unlikely based on the site visit observations.

6. Recommendation

Based on the fossil record for guidance but confirmed by the site visit and walk through there are NO FOSSILS of any kind although three types/ages of fossils could be expected. There was no stromatolitic or oolitic limestone (Boomplaas Formation in the eastern section close to the Orange River). There were no plant fossils of the the early *Glossopteris* flora even though fossils have been recorded from rocks of a similar age and type in South Africa about 50 km northwest along the Orange River at Blaaukranz (McLachlan and Anderson, 1973b). It is extremely unlikely that any fossils would be preserved in the overlying soils and sands of the Quaternary unless there are traps such as palaeo-pans or palaeo-springs. There is a very small chance that fossils may occur below the ground surface, but based on the erosion profiles the pebble and cobble layers are not fossiliferous. Nonetheless, a Fossil Chance Find Protocol should be added to the EMPr. If fossils are found by the prospectors, contractors, environmental officer or other responsible person once excavations and drilling have commenced, then they should be rescued and a palaeontologist called to assess and collect a representative sample.

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8. Chance Find Protocol

Monitoring Programme for Palaeontology – to commence once the excavations / drilling activities begin.

1. The following procedure is only required if fossils are seen on the surface and when drilling/excavations commence.
2. When excavations begin the rocks and discard must be given a cursory inspection by the environmental officer or designated person. Any

fossiliferous material (trace fossils, fossils of plants, insects, bone or coalified material) should be put aside in a suitably protected place. This way the project activities will not be interrupted.

3. Photographs of similar fossils must be provided to the developer to assist in recognizing the trace fossils, fossil plants, vertebrates, invertebrates or trace fossils in the shales and mudstones (for example see Figure 6-8). This information will be built into the EMP's training and awareness plan and procedures.
4. Photographs of the putative fossils can be sent to the palaeontologist for a preliminary assessment.
5. If there is any possible fossil material found by the developer/environmental officer/miners then the qualified palaeontologist sub-contracted for this project, should visit the site to inspect the selected material and check the dumps where feasible.
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 by the palaeontologist will be necessary. A final report by the palaeontologist must be sent to SAHRA once the project has been completed and only if there are fossils.
8. If no fossils are found and the excavations have finished then no further monitoring is required.

9. Appendix A – Examples of fossils from the Ghaap Group, Dwyka Group and the Quaternary Group.

Figure 6: Photographs of stromatolites and oolites as seen in the field.

Figure 7: Photographs of fossils from the Dwyka Group comprising early glossopterids and silicified woods.

A – leaf impression in sandstone; B – silicified wood fragments in a stream bed; C – fossil bone fragments in the shales.

Figure 8: Photographs of fossils from the Quaternary sands and alluvium.

10. Appendix B – Details of specialists

Marion Bamford (PhD)

Short CV for PIAs – July 2022

I) **Personal details**

Present employment: Professor; Director of the Evolutionary Studies Institute.
Member Management Committee of the NRF/DST Centre of
Excellence Palaeosciences, University of the Witwatersrand,
Johannesburg, South Africa

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Fax	:	+27 11 717 6694
Cell	:	082 555 6937
E-mail	:	marion.bamford@wits.ac.za ; marionbamford12@gmail.com

ii) **Academic qualifications**

Tertiary Education: All at the University of the Witwatersrand:
1980-1982: BSc, majors in Botany and Microbiology. Graduated April 1983.
1983: BSc Honours, Botany and Palaeobotany. Graduated April 1984.
1984-1986: MSc in Palaeobotany. Graduated with Distinction, November 1986.
1986-1989: PhD in Palaeobotany. Graduated in June 1990.

iii) **Professional qualifications**

Wood Anatomy Training (overseas as nothing was available in South Africa):
1994 - Service d'Anatomie des Bois, Musée Royal de l'Afrique Centrale, Tervuren, Belgium, by Roger Dechamps
1997 - Université Pierre et Marie Curie, Paris, France, by Dr Jean-Claude Koeniguer
1997 - Université Claude Bernard, Lyon, France by Prof Georges Barale, Dr Jean-Pierre Gros, and Dr Marc Philippe

iv) **Membership of professional bodies/associations**

Palaeontological Society of Southern Africa
Royal Society of Southern Africa - Fellow: 2006 onwards
Academy of Sciences of South Africa - Member: Oct 2014 onwards
International Association of Wood Anatomists - First enrolled: January 1991
International Organization of Palaeobotany – 1993+
Botanical Society of South Africa
South African Committee on Stratigraphy – Biostratigraphy - 1997 - 2016
SASQUA (South African Society for Quaternary Research) – 1997+
PAGES - 2008 –onwards: South African representative
ROCEEH / WAVE – 2008+
INQUA – PALCOMM – 2011+onwards

vii) **Supervision of Higher Degrees**

All at Wits University

Degree	Graduated/completed	Current
Honours	11	0
Masters	14	1
PhD	11	6
Postdoctoral fellows	12	2

viii) **Undergraduate teaching**
Geology II – Palaeobotany GEOL2008 – average 65 students per year
Biology III – Palaeobotany APES3029 – average 25 students per year
Honours – Evolution of Terrestrial Ecosystems; African Plio-Pleistocene Palaeoecology; Micropalaeontology – average 12 - 20 students per year.

ix) **Editing and reviewing**
Editor: Palaeontologia africana: 2003 to 2013; 2014 – Assistant editor
Guest Editor: Quaternary International: 2005 volume
Member of Board of Review: Review of Palaeobotany and Palynology: 2010 –
Associate Editor: Cretaceous Research: 2018-2020
Associate Editor: Royal Society Open: 2021 -
Review of manuscripts for ISI-listed journals: 25 local and international journals

x) **Palaeontological Impact Assessments**

Selected from recent project only – list not complete:

- Mala Mala 2017 for Henwood
- Modimolle 2017 for Green Vision
- Klipoortjie and Finaalspan 2017 for Delta BEC
- Ledjadja borrow pits 2018 for Digby Wells
- Lungile poultry farm 2018 for CTS
- Olienhout Dam 2018 for JP Celliers
- Isondlo and Kwasobabili 2018 for GCS
- Kanakies Gypsum 2018 for Cabanga
- Nababeep Copper mine 2018
- Glencore-Mbali pipeline 2018 for Digby Wells
- Remhoogte PR 2019 for A&HAS
- Bospoort Agriculture 2019 for Kudzala
- Overlooked Quarry 2019 for Cabanga
- Richards Bay Powerline 2019 for NGT
- Eilandia dam 2019 for ACO
- Eastlands Residential 2019 for HCAC
- Fairview MR 2019 for Cabanga
- Graspan project 2019 for HCAC
- Lieliefontein N&D 2019 for Enviropro
- Skeerpoort Farm Mast 2020 for HCAC
- Vulindlela Eco village 2020 for 1World
- KwaZamakhule Township 2020 for Kudzala
- Sunset Copper 2020 for Digby Wells
- McCarthy-Salene 2020 for Prescali
- VLNR Lodge 2020 for HCAC
- Madadeni mixed use 2020 for Enviropro

- Frankfort-Windfield Eskom Powerline 2020 for 1World
- Beaufort West PV Facility 2021 for ACO Associates
- Copper Sunset MR 2021 for Digby Wells
- Sannaspos PV facility 2021 for CTS Heritage
- Smithfield-Rouxville-Zastron PL 2021 for TheroServe
- Glosam Mine 2021 for AHSA

Xi) **Research Output**

Publications by M K Bamford up to July 2022 peer-reviewed journals or scholarly books: over 165 articles published; 5 submitted/in press; 10 book chapters.
Scopus h-index = 30; Google Scholar h-index = 36; -i10-index = 95
Conferences: numerous presentations at local and international conferences.