EXXARO COAL MPUMALANGA (PTY) LTD

PROPOSED BELFAST COAL MINE EXPANSION PROJECT

Site Visit (Phase 2) Palaeontological Impact Assessment in the Mpumalanga Province

For

Nsovo Environmental Consulting

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Expertise of Specialist

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Qualifications: PhD (Wits Univ, 1990); FRSSAf, ASSAf
Experience: 31 years research; 23 years PIA studies

Declaration of Independence

This report has been compiled by Professor Marion Bamford, of the University of the Witwatersrand, sub-contracted by Nsovo Environmental Consulting, Midrand, 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.

Specialist: Prof Marion Bamford

Signature: 

Executive Summary

A palaeontological Impact Assessment was requested for the proposed expansion of the Exxaro Belfast coal mine and it is collectively known as the Belfast Expansion Project (BEP). The proposed facilities include but not limited to five conveyor route options, two shaft options, one Mine Residue Facility (MRF) with two lobes and the main mining area.

To comply with 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 Palaeontological Impact Assessment (PIA) was completed for the proposed project.

Phase 2 (Site visit 28 September 2020) – this report.
The land is covered by soils and there were no rocky outcrops. No fossils were found and no potentially fossiliferous shales were found. Based on the site survey and the lack of any previously recorded fossils from the area, it is extremely unlikely that any fossils would be preserved in the overlying soils. There is a small chance that fossils may occur below ground in the shales of the early Permian Vryheid Formation so a Fossil Chance Find Protocol should be added to the EMPr. As far as the palaeontology is concerned:

- The whole mining area (open cast and underground) could have fossils in the partings between the coal seams BUT their occurrence and distribution are impossible to predict. It is more advantageous to science if the mining project takes place as this will reveal the presence or absence of fossils (as long as partings are frequently examined for fossils by the responsible person/environmental officer) than to leave them all buried and unknown to science.
- All four above ground conveyor route options are the same as far as the palaeontology is concerned. These will be above ground so their impact on any fossils in the partings would be most unlikely.
- The below-ground conveyor linked to Shaft 1 is along an unspecified level (mined-out coal seam, or shale parting, or a combination) so the impact is unknown.
- Shaft 2 is the preferred option because it is in moderately sensitive rocks of the Dwyka Group. Shaft 1 is in the very highly sensitive Vryheid Formation but its footprint is much smaller than that of the general mining area.
- Both options for the MRF are the same as far as the palaeontology is concerned so no preference can be given.
- Since there is a small to moderate chance that fossils occur in all of these rocks, a FCFP must be implemented for all activities.

If fossils are found once drilling or excavations for the mining operations and proposed infrastructure, they should be rescued and a palaeontologist contacted to investigate their scientific worth, and make a representative collection (see section 9). Any fossils found during the collection visit by a palaeontologist, can only be collected with a SAHRA permit and a representative sample collected must be housed in a recognised repository. The *Glossopteris* flora fossils are common and only of scientific interest if well preserved. Thereafter, the project and construction can continue.

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1. Background

The Exxaro Belfast Mining Right (Ref No. MP 30/5/1/2/2/431 MR) is situated in the Mpumalanga Province and is located south of Belfast along the N4. In 2018 the Belfast Implementation Project (BIP) commenced with mining activities and the construction of the associated plant and infrastructure to process 3 Mtpa of Run of Mine (ROM) with a life of mine (LOM) of 17 years. The first coal was produced at the processing plant during September 2019.

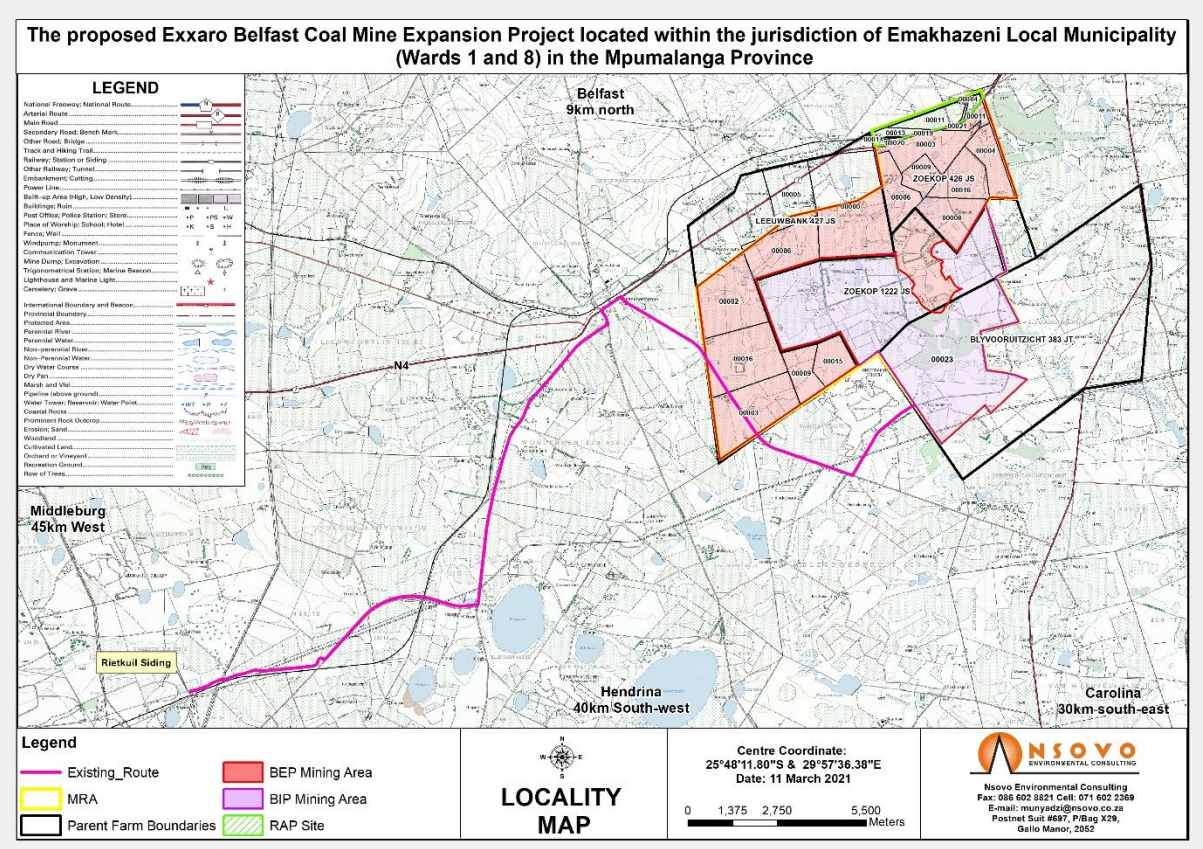

Figure 1: Mining Rights Area (MRA)

The Belfast Expansion Project (BEP) area falls within the Belfast mining right area and subsequently forms part of the resource pertaining to Belfast, however, it falls outside the current mining layout. A desktop study and site visit study were done to assess the potential impact to the Palaeontological Heritage. The three activities considered for this updated scope of work are described briefly below.

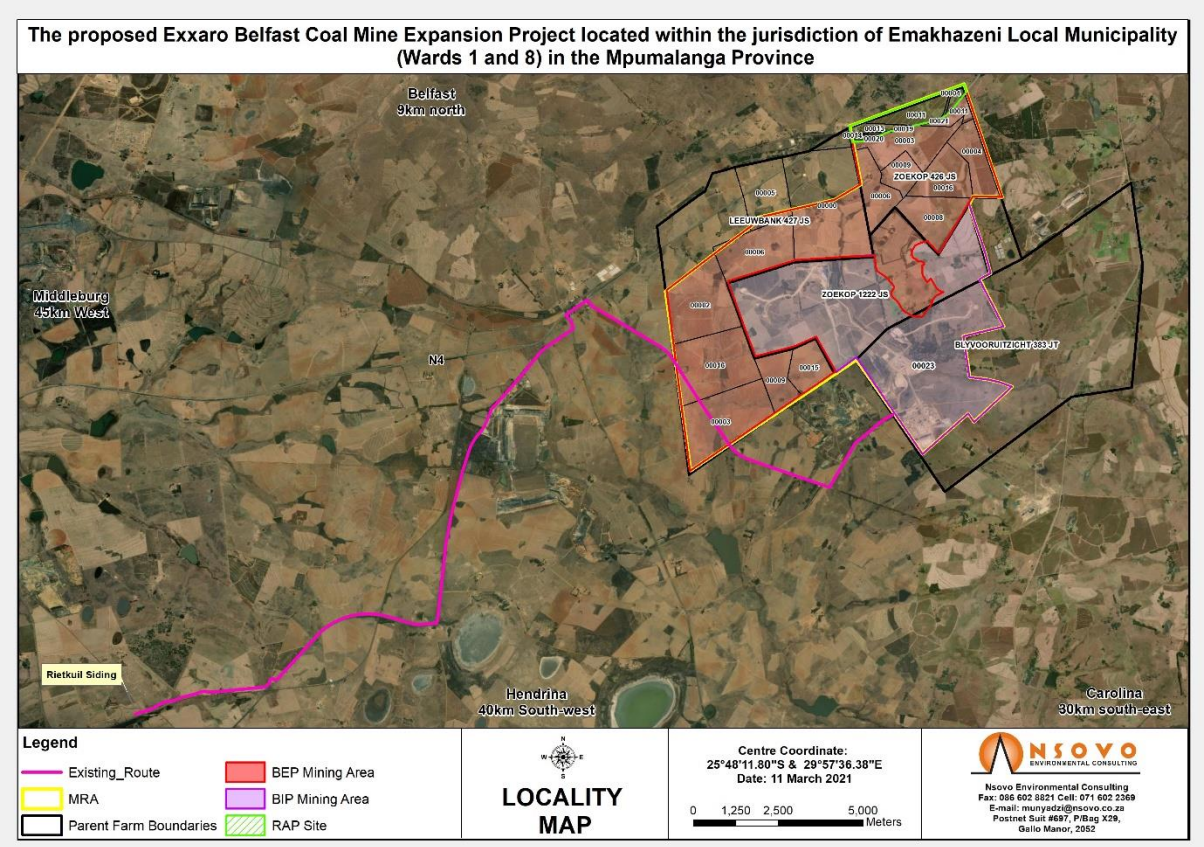

Figure 2: Mining Rights Area indicated on a Google Earth Map.

A Palaeontological Impact Assessment was requested for the BEP project. In order 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 desktop and site visit Palaeontological Impact Assessment (PIA) were completed for the proposed development by Rick Tolchard (PhD candidate) on 28th September 2020. The Site visit (phase 2) study is reported herein.

Table 1: Specialist report requirements in terms of appendix 6 of the EIA Regulations (amended 2017)

	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	None
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	Figure 5
i	A description of any assumptions made and any uncertainties or gaps in knowledge;	Section 6
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	Table 3, Section 0
k	Any mitigation measures for inclusion in the EMPr	Section 9, Appendix A
l	Any conditions for inclusion in the environmental authorisation	Section 6
m	Any monitoring requirements for inclusion in the EMPr or environmental authorisation	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	Section 6
o	A description of any consultation process that was undertaken during the course of carrying out the study	None
p	A summary and copies if any comments that were received during any consultation process	N/A
q	Any other information requested by the competent authority.	N/A

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 (*done for this assessment*);
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. Scope of work

The proposed project will entail the following scope of work.

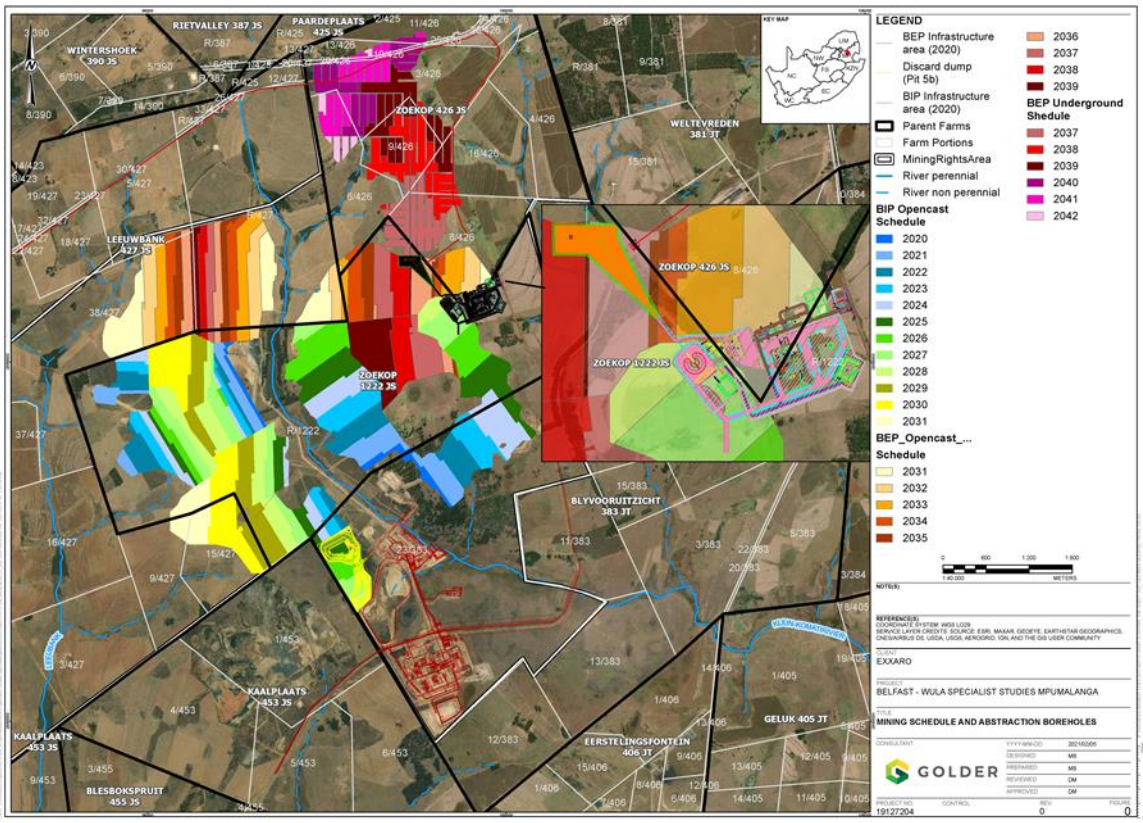

Figure 3: Proposed Open Pit And Underground Mining Operations (for scope of work 3.1)

3.1. Main Mining Area (open pit and underground)

3.1.1. Open Pit

For the open pit areas at BEP, a similar mining method will be employed as with BIP. The BIP site is currently using strip mining with a mixed hybrid of benching and doze-over.

Strip mining as a basis is used as it has been proven as the method of choice for relatively shallow coal seams in the Witbank coal region. The reason it is so successful is that the waste is moved as short a distance as possible, minimizing the cost impact of the mining process.

To further reduce the waste mining costs, doze-over mining is used, as the cost per unit moved over a relatively small distance is cheaper than loading and hauling.
An example of the benching and doze-over method is illustrated below.
It consists of:

- Topsoil – Load and haul topsoil to the low-wall side where backfilling has already been completed where the topsoil is spread and re-vegetated.
- Soft Overburden – Load and haul to the low-wall side where backfilling of hard overburden and parting has already been completed.
- Hard Overburden – Drill, blast, load, and haul to the low-wall side where backfilling of parting and parting has already been completed.
- Top Coal Seam – Drill, blast, load, and haul to the crusher or where required.
- Parting – Drill, cast blast, doze, load and haul towards the low-wall side.
- Bottom Coal Seam – Drill, blast, load, and haul to the crusher or where required.

3.1.2. Underground Mining and Infrastructure

For the identified underground areas at BEP, a traditional board and pillar (B&P) mining method was decided upon. The B&P method allows for medium to high extraction of underground coal seams while being able to navigate difficult and varying ground conditions. It also requires less initial capital investment than the longwall method with smaller increments in production.
Other aspects that will form part of the design of all civil infrastructure for the BEP underground mine that includes the following:

- Earthworks / Platforms, including cut and fill embankments.
- Roads and traffic design; including LDV and haul roads.
- Stormwater management, including clean and dirty water separation and pollution control dams.
- Cable ducts.
- Sewer system.
- Fencing.
- Water supply, i.e. potable, fire and wash water.

3.2. Conveyor Belt underground

3.2.1. Conveyor Belt and Shaft

The link between the surface infrastructure and the underground mine is the incline conveyor that will feed the ROM stockpile on surface from the main underground conveyor, approximately 3km long.

3.3. Conveyor belt overland (4 options)

Various options will be possible to reclaim from the stockpile and to transfer the ROM material to the overland conveyor belt to enter the plant.

The reclaim options are:
a) Option 1: FEL to road truck 30t side tipper;
b) Option 2: FEL via few ramps to haul road truck, Cat 773 or similar 50t;
c) Option 3: stockpile tunnel with reclaim conveyor feeding surge truck loading bin; and

d) Option 4: stockpile tunnel with reclaim / sacrificial conveyor feeding new overland conveyor.

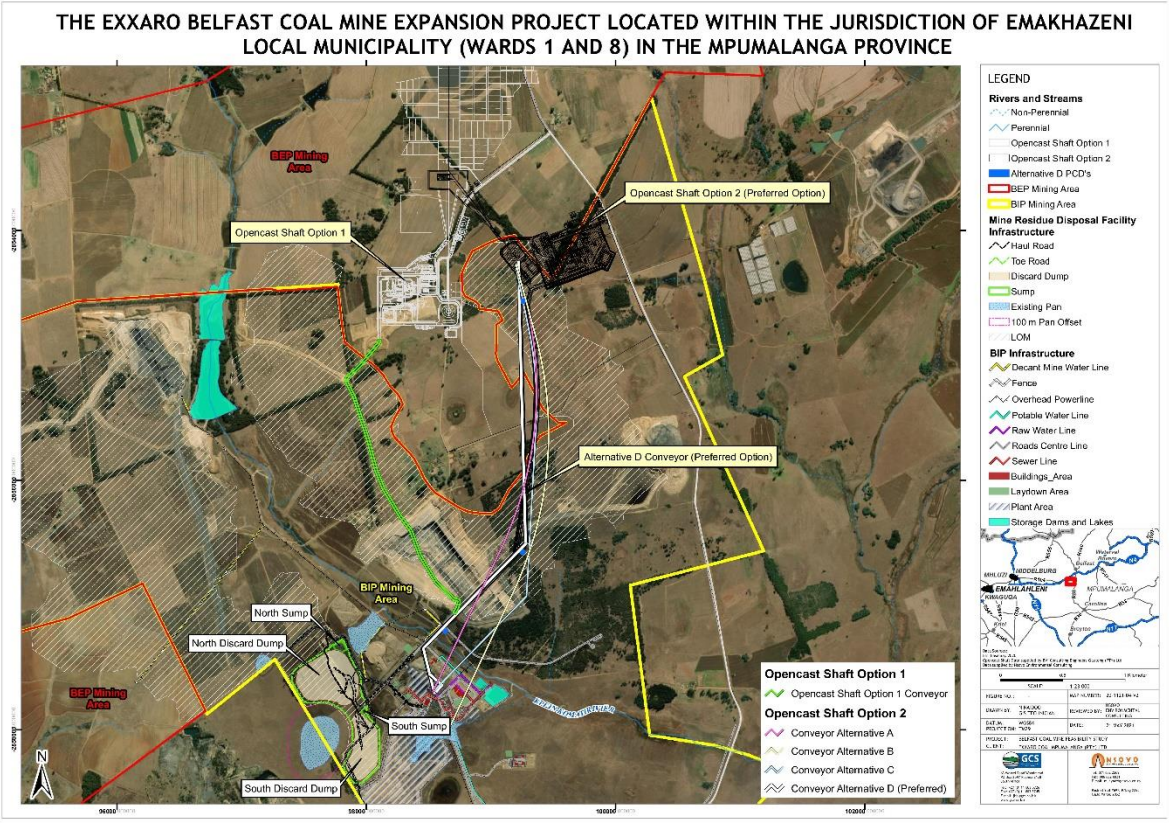

Figure 4: BEP Overland Conveyor Systems And Inclined Shaft Options (for Scope of work 3.2 and 3.3)

3.4. Inclined Shafts (2 options)

Road transport options from ROM stockpile at inclined shaft to existing plant:

a) Option 1: Haul truck to existing tip (most probably modifications will be required to bypass primary crusher to reduce generation of fines).
b) Option 2: Side tipper (road truck) to new tip next to existing tip (via district road)..

Interface and battery limit with Plant operations:
Conveyor options from the ROM stockpile at inclined shaft to existing plant:

a) Option 1: New curved overland conveyor from underground section ROM stockpile across the existing Klein Komati crossing, with transfer stations and then onto existing overland conveyor.
b) Option 2: New overland curved conveyor crossing the Klein Komati at a new position and then onto the overland belt before the secondary crusher without a transfer station. This solution might cross environmentally sensitive areas.

Option 3: New overland curved conveyor crossing the Klein Komati at a new position and then onto the overland belt after the secondary crusher without a transfer station. This solution might cross environmentally sensitive areas.

3.5. Discard Dump

3.5.1. Mine Residue Facility (MRF)

A Trade-off was undertaken to decide on the location of the proposed MRF which considered the following locations:

- A Greenfields site across the Klein Komati River on the Eastern side of the current MRF;
- Adjoining the current facility; and
- Adjacent to the current facility over a backfilled opencast pit (Pit 5 – proposed).

4. Geology and Palaeontology

i. Project location and geological context

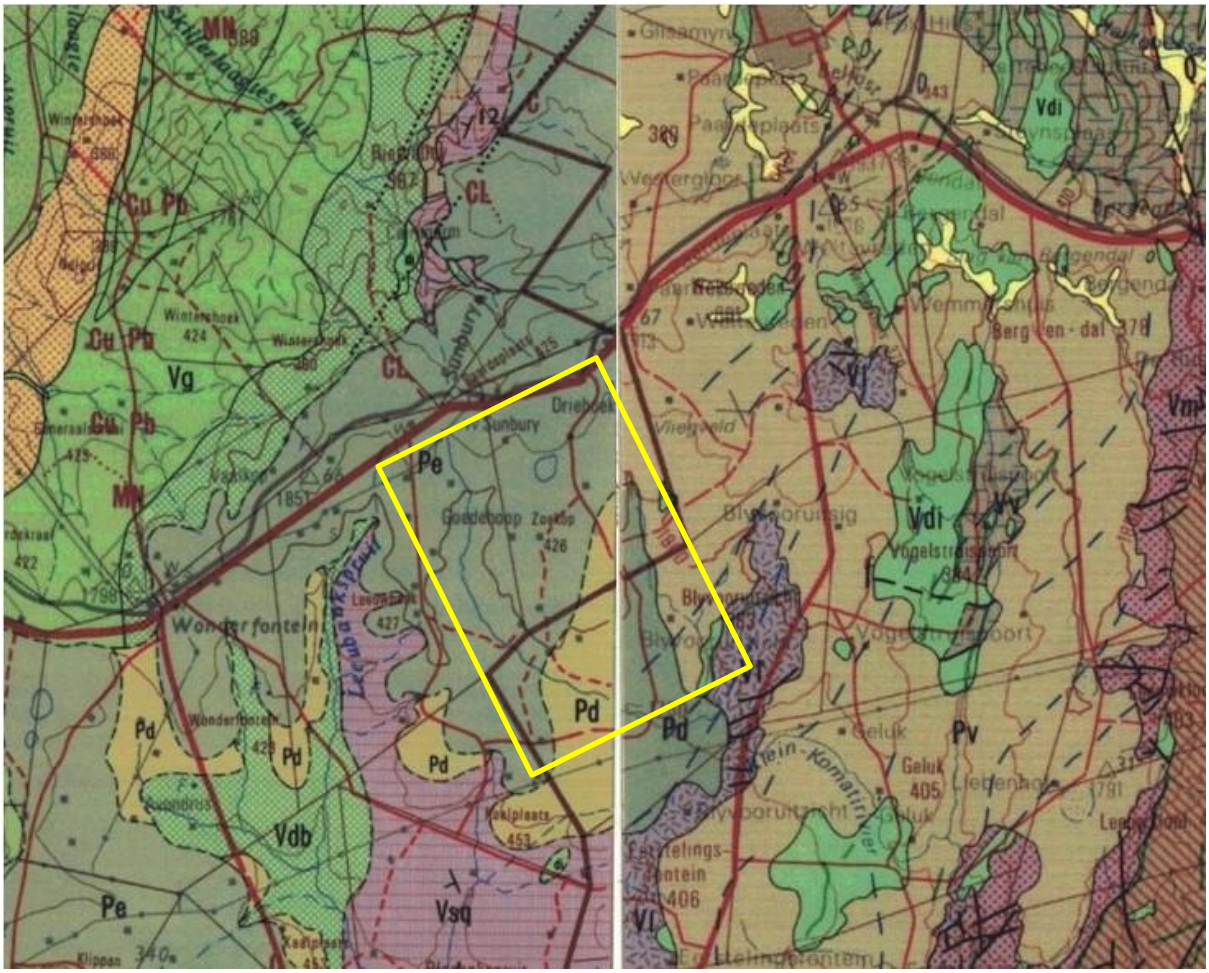

Figure 5: Geological map of the area around the BIP and BEP. Abbreviations of the rock types are explained in Table 2. Map enlarged from the Geological Survey 1: 250 000 maps 2528 Pretoria 1978 (left) and 2530 Barberton (right).

Table 2: Explanation of symbols for the geological map and approximate ages (Buchanan, 2006; Eriksson et al., 2006, 2012; Johnson et al., 2006). SG = Supergroup; Fm = Formation; Ma = million years; grey shading = formations impacted by the project.

Symbol	Group/Formation	Lithology	Approximate Age
Pe	Ecca Group, Karoo SG	Shale, shaley sandstone, grit, sandstone, coal	Early Permian ca 280-260 Ma
Pd	Dwyka Group, Karoo SG	Tillite, shale	Late Carboniferous to early Permian
Vg	Main Zone, Rustenberg Layered Suite	Gabbro	<2050 Ma
Vdb	Dullstroom Fm, Rooiberg Group	Volcanic rocks, pyroxene, hornfels	<2050 Ma
Vsq	Steenkampsberg Fm, Pretoria Group, Transvaal SG	Quartzite, subordinate shales	2100-2050 Ma

The oldest rocks in the area are those of the Steenkampsberg Formation (Pretoria Group, Transvaal Supergroup that are composed of quartzite with subordinate shales (Figure 5, Table 2). Overlying these are volcanic rocks of the Dullstroom Formation (Rooiberg Group). To the northwest are some outcrops of the Rustenburg Layered Suite that is also volcanic in origin. All three formations are very old and not the correct type of rocks to preserve fossils so they will not be considered further.

Unconformably overlying the ancient rocks are the basal rocks of the Karoo Supergroup, namely the basal-most Dwyka Group and the Ecca Group.

The Belfast coal mine lies in the Witbank Coalfield and the uppermost coal seam, number 5, is about 12m below the surface (Snyman, 1998). Seam 5 is overlain by sandstone shale and soil, the latter about 5m deep. While coal is the product of heat and pressure altered organic matter from the buried peats formed in the Ecca swamps, coal itself is of no interest to palaeontologists because no original plant taxa can be recognised. The shales between coals seams is of interest to palaeobotanists because in this less altered medium one can find impressions of the original plants, such as leaves and reproductive structures of the glossopterid group of plants, lycopods, sphenophytes, ferns early gymnosperms and a number of *incertae sedis* (not classified) plants (Plumstead, 1969; Anderson and Anderson, 1985).

In this area, the Ecca Group rocks have not been subdivided into the three formations that comprise this group, the Pietermaritzburg, Vryheid and Volksrust Formations, probably based on lack of distinct lithologies and lack of fossils. Based on the presence of the coal seams, it is likely that the Ecca Group rocks are Vryheid Formation rocks. The slightly older Dwyka Group tillites and diamictites might have fragments of the early *Glossopteris* flora, silicified wood and marine fossils. The Dwyka Group is not known to have coal seams.

Vertebrate bones very seldom occur with the fossil plants, probably because the plants are well preserved in more acidic environments and bones in more alkaline environments. It would not be expected to find any fossil fauna in this area.

ii. 4ii Palaeontological context

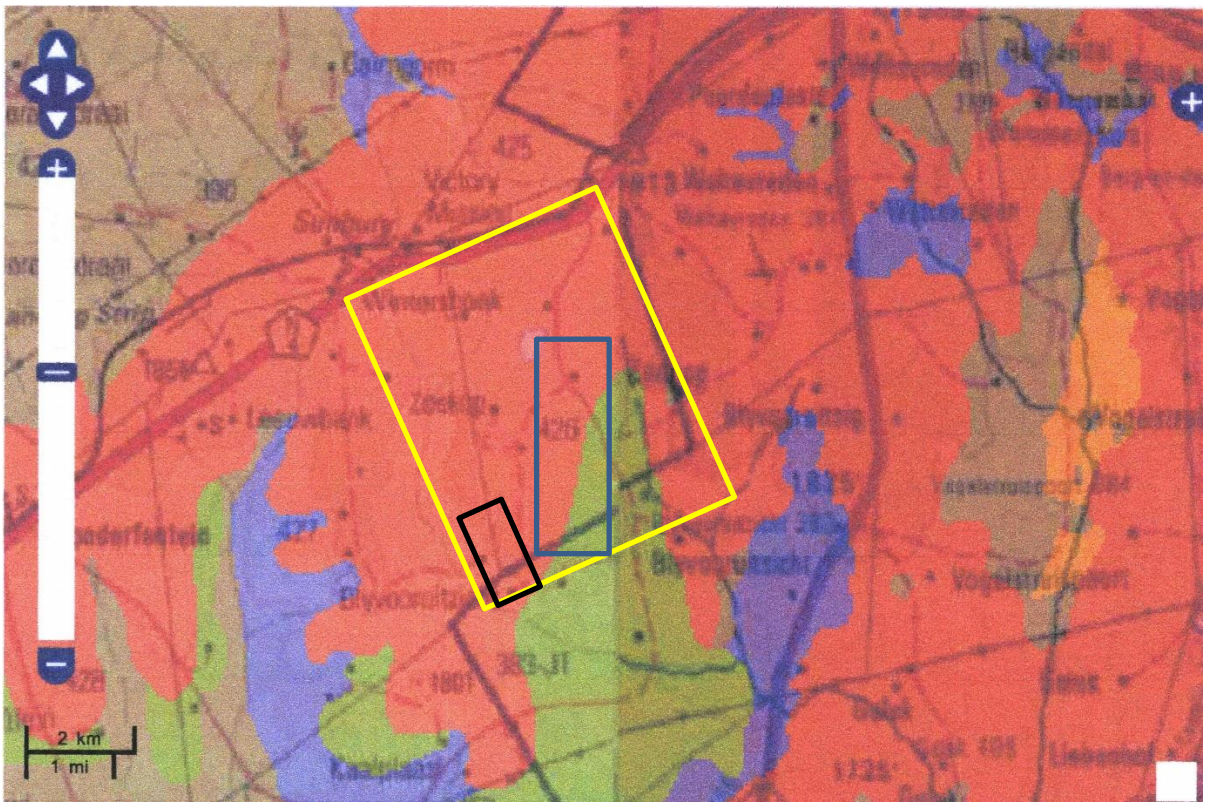

Figure 6**:** SAHRIS Palaeosensitivity map for the site for the proposed BEP mining and associated conveyor belts and shaft options. Yellow rectangle = greater mining area; blue rectangle = conveyors and shafts; black rectangle = mrf (discard dump). Background colours indicate the following degrees of sensitivity: red = very highly sensitive; orange/yellow = high; green = moderate; blue = low; grey = insignificant/zero.

From the SAHRIS map in Figure 6, the area is indicated as ranging from highly sensitive to no sensitivity. For this area the very highly sensitive rocks (red) are those of the Ecca Group, while the moderately sensitive rocks (green) are those of the Dwyka Group. Non-fossiliferous rocks, the Dullstroom Formation volcanics (grey) and Steenkampsberg Formation quartzites (blue), will not be considered further.

Referring to the Scope of Work (Section 3A – 3E):
The mining area (open cast and underground) falls in the very highly sensitive Vryheid Formation because this is where the coal seams occur (3A).
It is not known in which level the underground conveyor will be placed. If it is in a mined-out coal seam then it will have no impact on the palaeontology. If it is in a shale layer, it will have a high impact on the palaeontology (3B).
The four options for the above-ground conveyor belt are close together and lie along the margin of the moderately sensitive Dwyka Group and the very highly sensitive Vryheid Formation. From the palaeontological perspective, there is no difference among the above ground conveyors so no preferred route can be specified (3C).

Shaft options 1 lies in the very highly sensitive Vryheid Formation and Option 2 lies in the moderately sensitive Dwyka Group, Option is the preference (3D).
For the proposed discard dump or Mine Residue Facility, all options lie on the very highly sensitive Vryheid Formation rocks, so there is no preference. However, it should be noted that area is already highly disturbed.

For the very highly sensitive rocks (red) it is possible that fossil plants of the *Glossopteris* flora could occur in the shales below ground, but not in the surface soils. For the moderately sensitive parts (green) there might be early glossopterid fossils, wood fragments and marine fossils because these have been found (but only very rarely, McLachlan and Anderson, 1976) near Douglas in Dwyka sediments. No vertebrate fossils have been recorded from these Ecca rocks. However, in all cases the fossils will not be found in the surface soils that are about 5m deep.

Table 3: Palaeosensitivity for BEP project mining area, conveyor routes, shafts and mine residue facility – refer to Figures 5 and 6. Colours are those of the SAHRIS palaeosensitivity map (see Figure 6). FCFP = Fossil Chance Find Protocol (see Section 9 and Appendix A).

Facility	Palaeosensitivity	Recommendation	
3A: Mining area – open; underground	Very highly sensitive – Vryheid Fm	100% red; Site visit done – proceed with FCFP	
3B: Conveyor (Green) for Shaft Option 1	Within a mined-out shaft – no impact; If within a shale parting – very high impact	Unknown	
3C: Conveyor option A Conveyor option B Conveyor option C Conveyor option D	Border of very highly sensitive – Vryheid Fm, and moderately sensitive – Dwyka Group.	50% red Site visit done; FCFP	50% green; FCFP
3D: Shaft option 1 Shaft option 2	1 = Very highly sensitive – Vryheid Fm; 2 = moderate sensitivity = preferred option	1 = 100% red; Site visit done	2 = preferred FCFP
3E: Mine Residue Facility (discard dump)	Moderately sensitive – Dwyka Group	100% red but very disturbed already – proceed; FCFP	

The Mining Area unavoidably is confined to the Vryheid Formation. Fossils do not occur in the coal itself but might occur in the partings between the seams. A Fossil Chance Find Protocol (FCFP) should be applied to the partings when they are dumped or before they are covered by soils.

Shaft option 2 is in the Dwyka Group so is the preference. When the selected shaft (either one) is excavated an FCFP should be applied to the partings.

There is no difference between the four above ground conveyor route options and they are very close together. They are along the border of the two rock types so a FCFP must be done when the foundations are excavated.

The two options for the Mine Residue Facility are close together and all are on the Vryheid Formation but the area is very disturbed. If new ground is broken, a FCFP should be applied. No further site visit is required but a Fossil Chance Find Protocol should be included in the EMPr.

Iii Site visit Observations.

Rick Tolchard attended the orientation meeting on Monday 28th September and then surveyed from the mine offices carpark and generally surveyed the proposed mining area (Figure 7).

Table 4: Survey points with GPS coordinates. Refer to Figure 7 for the map and points.

Survey Points and GPS co-ords	Observations	Figure
Pal 12 25:50:4.9038S 29:59:18.4446E 1812m	Beginning of survey, starting from the mine head offices and moving generally south westwards. Previously ploughed field, now covered in grass. No rocky outcrops. No fossils.	8
Pal 11 25:50:7.31719S 29:58:59.60222E 1813	Previously ploughed field, now covered in grass. No rocky outcrops. No fossils, only dolerite pieces.	9, 10
Pal 10 25:50:16.37915S 29:58:38.08815E 1815m	Previously ploughed field, now covered in grass. No rocky outcrops. Sandstone fragments and no fossils	11
Pal 9 25:50:33.34541S 29:58:17.56925E 1782m	Previously ploughed field, now covered in grass. No rocky outcrops. No fossils.	12

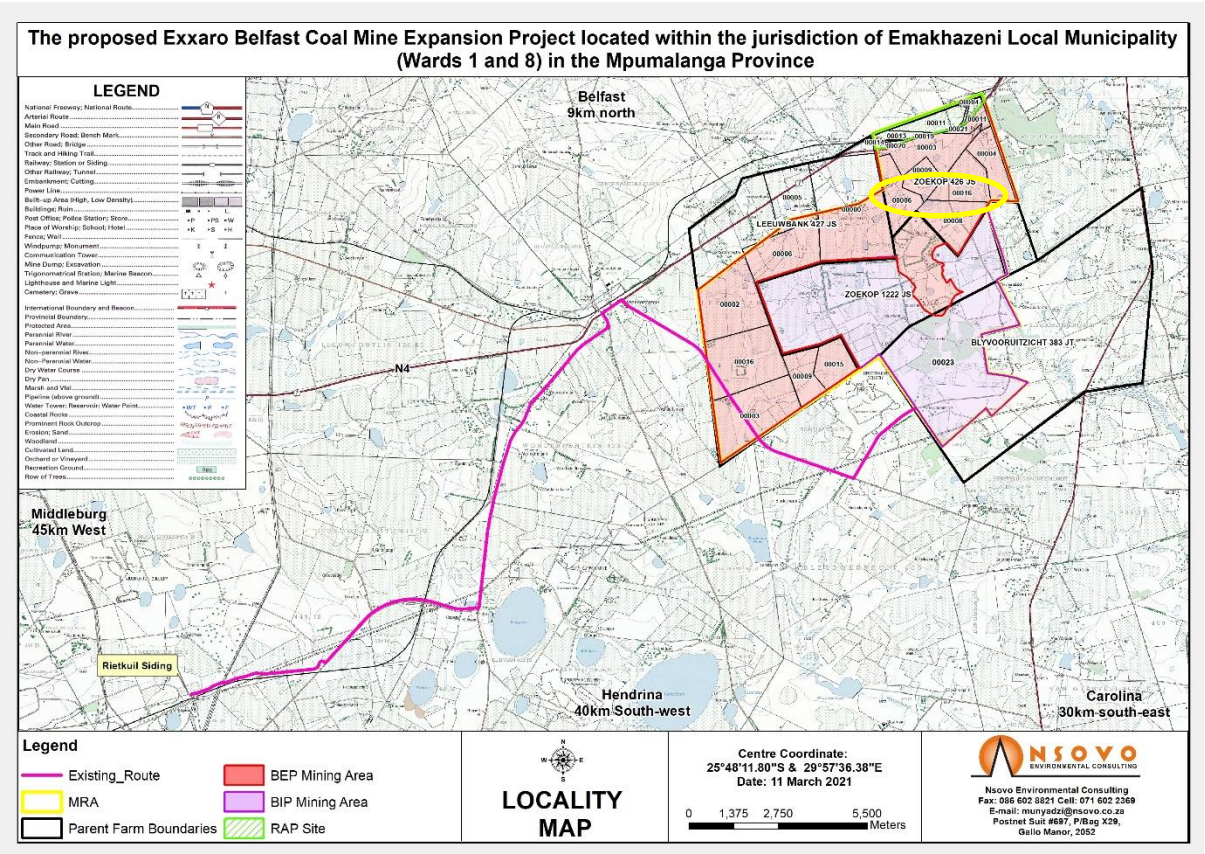

Figure 7: Survey points/stops are within the yellow outline (Table 5 and Photos in Figures 8 – 12) marked on a section of the locality map in Figure 1.

Figure 8: Survey point 12 - only rocks in evidence are fragments of coarse sandstone.

Figure 9: Survey point 11: ploughed field with burned grass in the background. No fossils.

Figure 10: Dolerite fragments at Survey point 11.

Figure 11: Very weathered sandstone at Survey point 10.

Figure 12: Survey point 9. Previously ploughed field and no rocky outcrops

Figure 13: Survey point 8. Sand road (imported material) and ploughed field in the background.

5. Impact assessment

An assessment of the potential impacts to possible palaeontological resources considers the criteria encapsulated in Table 55:

TABLE 5A: 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 6B: IMPACT ASSESSMENT

PART B: ASSESSMENT			FACILITY
SEVERITY/NATURE	**H**	-	
	M	Vryheid Fm rocks often preserve fossils but soils do not	Mining area; shafts
	L	Volcanic rocks do not preserve plant fossils; Dwyka Group rocks rarely preserve fossils and but it is unlikely that fossils occur on the disturbed surface. The impact would be unlikely.	All conveyor options and MRF
	L+	-	
	M+	-	
	H+	-	
DURATION	**L**	-	
	M	-	
	H	Where manifest, the impact will be permanent.	All
SPATIAL SCALE	**L**	Since the only possible fossils within the area would be fossil plants from the *Glossopteris* flora in the shales, the spatial scale will be localised within the site boundary.	All
	M	-	
	H	-	
PROBABILITY	**H**	**-**	
	M	It is unlikely that any fossils would be found in the surface soils and sands but may be present below ground.. No fossils were found.	All
	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 right age and type to contain fossils. However, the potentially fossiliferous shales

overlying and between the coal seams, are covered by about 5m of soils and this does not preserve fossils. Since there is a small chance that fossils from the Vryheid Formation (Ecca Group) 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 medium to low.

6. Assumptions and uncertainties

Based on the site visit survey of the BEP mining area (surface), geology of the area and the palaeontological record as we know it, it can be assumed that the formation and layout of the coal shales, sandstones and shales are typical for the country and do contain fossil plant and insect material. The overlying soils would not preserve fossils. Fossiliferous shales are not present in the ploughed field in the proposed mining area and NO FOSSILS were found. The MRF site was not visited as this lies on Dwyka Group rocks of moderate sensitivity.

7. Recommendation

Based on the site survey and the lack of any previously recorded fossils from the area, it is extremely unlikely that any fossils would be preserved in the overlying soils. There is a small chance that fossils may occur below ground in the shales of the early Permian Vryheid Formation so a Fossil Chance Find Protocol should be added to the EMPr. As far as the palaeontology is concerned:

- The whole mining area (open cast and underground) could have fossils in the partings between the coal seams BUT their occurrence and distribution are impossible to predict. Glossopterid fossils have been well-studied but there is always a small chance that new taxa could be found. It is more advantageous to science if the mining project takes place as this will reveal the presence or absence of fossils– as long as partings are frequently examined for fossils by the responsible person/environmental officer – than to leave them all buried and unknown to science.
- All four above ground conveyor route options are the same as far as the palaeontology is concerned. These will be above ground so their impact on any fossils in the partings would be most unlikely.
- The below-ground conveyor linked to Shaft 1 is along an unspecified level (mined-out coal seam, or shale parting, or a combination) so the impact is unknown.
- Shaft 2 is the preferred option because it is in moderately sensitive rocks of the Dwyka Group. Shaft 1 is in the very highly sensitive Vryheid Formation but its footprint is much smaller than that of the general mining area.
- Both options for the MRF are the same as far as the palaeontology is concerned so no preference can be given.
- Since there is a small to moderate chance that fossils occur in all of these rocks, a FCFP must be implemented for all activities.

If fossils are found once drilling or excavations for the mining operations and proposed infrastructure, they should be rescued and a palaeontologist contacted to investigate their scientific worth, and make a representative collection (see section 9). Any fossils found during

the collection visit by a palaeontologist, can only be collected with a SAHRA permit and a representative sample collected must be housed in a recognised repository. The *Glossopteris* flora fossils are common and only of scientific interest if well preserved. Thereafter, the project and construction can continue.

8. References

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Eriksson, P.G., Bartman, R., Catuneanu, O., Mazumder, R., Lenhardt, N., 2012. A case study of microbial mats-related features in coastal epeiric sandstones from the Palaeoproterozoic Pretoria Group, Transvaal Supergroup, Kaapvaal craton, South Africa; the effect of preservation (reflecting sequence stratigraphic models) on the relationship between mat features and inferred palaeoenvironment. Sedimentary Geology 263, 67-75.

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.

9. Chance Find Protocol

Monitoring Programme for Palaeontology – to commence once the excavation or construction 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 sediments must be given a cursory inspection by the environmental officer or designated person. Any fossiliferous material (plants, insects, bone, coal) should be put aside in a suitably protected place. This way the project 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 14). 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. 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 site inspections by the palaeontologist will not 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.

Appendix A – Examples of fossils from the Dwyka and Ecca Groups

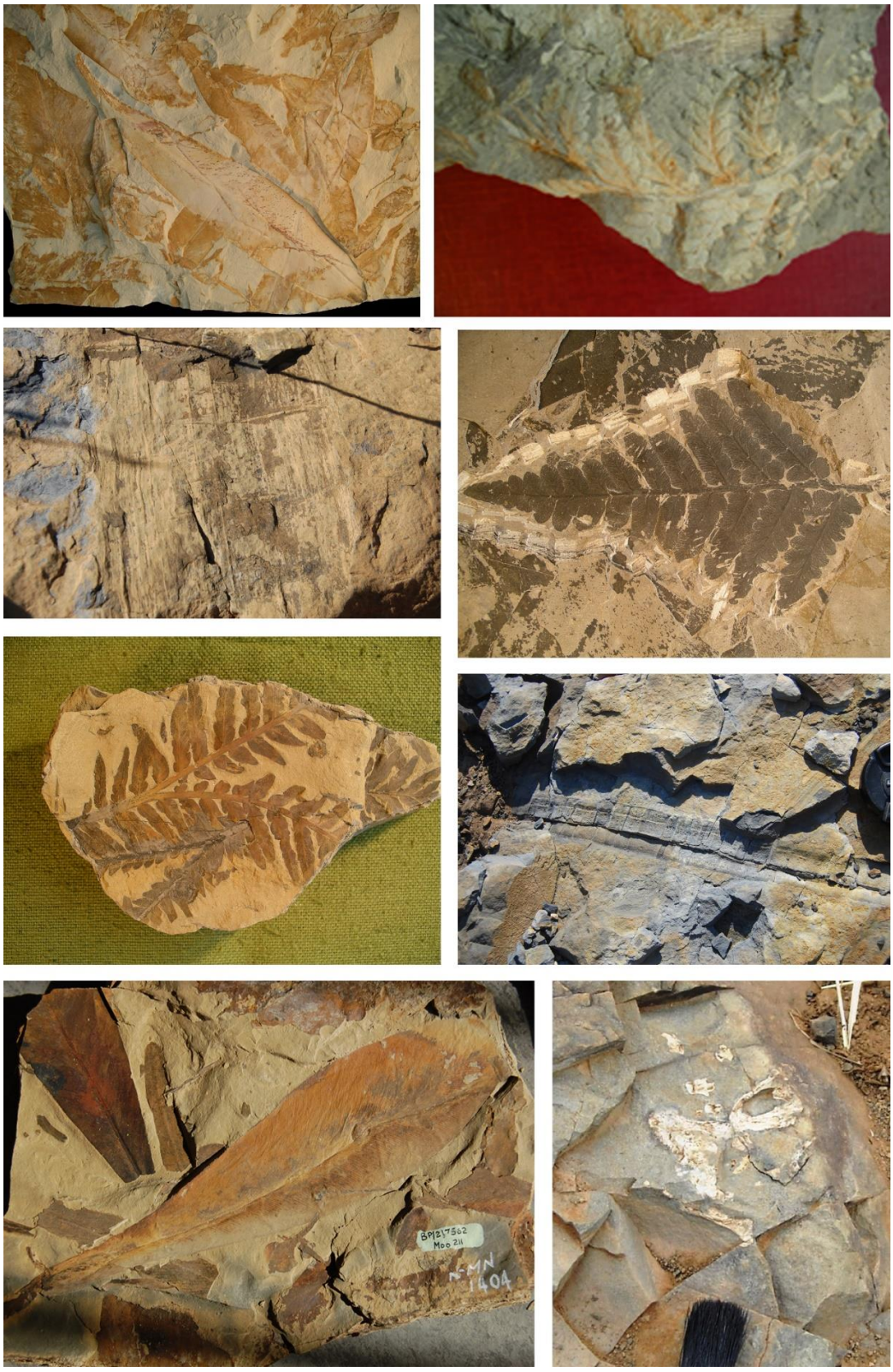

Figure 14: Examples of fossils from the Dwyka and Ecca groups, *Glossopteris*, ferns and sphenophytes.

Appendix B – Details of specialist

Curriculum vitae (short) - Marion Bamford PhD
July 2020

I) Personal details

Surname	:	**Bamford**
First names	:	**Marion Kathleen**
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-
Telephone	:	+27 11 717 6690
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	7	0
Masters	10	4
PhD	12	5
Postdoctoral fellows	10	3

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 2-8 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 –
Cretaceous Research: 2014 –
Journal of African Earth Sciences: 2020 -

Review of manuscripts for ISI-listed journals: 25 local and international journals

x) Palaeontological Impact Assessments

Selected – list not complete:

- Thukela Biosphere Conservancy 1996; 2002 for DWAF
- Vioolsdrift 2007 for Xibula Exploration
- Rietfontein 2009 for Zitholele Consulting
- Bloeddrift-Baken 2010 for TransHex
- New Kleinfontein Gold Mine 2012 for Prime Resources (Pty) Ltd.
- Thabazimbi Iron Cave 2012 for Professional Grave Solutions (Pty) Ltd
- Delmas 2013 for Jones and Wagener
- Klipfontein 2013 for Jones and Wagener
- Platinum mine 2013 for Lonmin
- Syferfontein 2014 for Digby Wells
- Canyon Springs 2014 for Prime Resources
- Kimberley Eskom 2014 for Landscape Dynamics
- Yzermyne 2014 for Digby Wells
- Matimba 2015 for Royal HaskoningDV
- Commissiekraal 2015 for SLR
- Harmony PV 2015 for Savannah Environmental

- Glencore-Tweefontein 2015 for Digby Wells
- Umkomazi 2015 for JLB Consulting
- Ixia coal 2016 for Digby Wells
- Lambda Eskom for Digby Wells
- Alexander Scoping for SLR
- Perseus-Kronos-Aries Eskom 2016 for NGT
- 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

xi) Research Output

Publications by M K Bamford up to December 2019 peer-reviewed journals or scholarly books: over 150 articles published; 5 submitted/in press; 8 book chapters.
Scopus h-index = 29; Google scholar h-index = 35; -i10-index = 80
Conferences: numerous presentations at local and international conferences.

xii) NRF Rating

NRF Rating: B-2 (2016-2020)
NRF Rating: B-3 (2010-2015)
NRF Rating: B-3 (2005-2009)
NRF Rating: C-2 (1999-2004)

Mr Frederick Tolchard
Brief Curriculum Vitae – September 2020

Academic training

BA Archaeology – University of the Witwatersrand, graduated 2015
BSc (Honours) Palaeontology – University of the Witwatersrand, 2017 with distinction
MSc Palaeontology – University of the Witwatersrand, 2018 – 2019. Graduated 2020 with Distinction
PhD Palaeontology – Wits – 2020 - current

Field Experience

Honours Fieldtrip – Karoo biostratigraphy – April 2017
Research fieldwork – Elliot Formation with Prof Choiniere – April 2018, November 2018; April 2019

Publications

Tolchard, F., Nesbitt, S.J., Desojo, J.B., Viglietti, P.A., Butler, R.J. and Choiniere, J.N., 2019. 'Rauisuchian' material from the lower Elliot Formation of South Africa: Implications for late Triassic biogeography and biostratigraphy. Journal of African Earth Sciences, 160, 103610.

Viglietti, P.A., McPhee, B.W., Bordy, E.M., Sciscio, L., Barrett, P.M., Benson, R.B.J., Wills, F., Tolchard, F., Choiniere, J.N., 2020. Biostratigraphy of the Scalenodontoides Assemblage Zone (Stormberg Group, Karoo Supergroup), South Africa. South African Journal of Geology 123, 239-248.

PIA fieldwork projects

2018 May – Williston area – SARAO project, Digby Wells
2018 September – Lichtenburg PVs – CTS Heritage
2018 November – Nomalanga farming – Digby Wells
2019 January – Thubelisha coal – Digby Wells
2019 March – Matla coal – Digby Wells
2019 March – Musina-Machado SEZ – Digby Wells
2019 June – Temo coal – Digby Wells
2019 September – Makapanstad Agripark – Plantago
2020 January – Hendrina, Kwazamakuhle – Kudzala
2020 February – Hartebeestpoort Dam - Prescali
2020 March – Twyfelaar Coal mine – Digby Wells
2020 March – Ceres Borrow Pits – ACO Associates
2020 March – Copper Sunset Sand – Digby Wells