

**Palaeontological Impact Assessment for the proposed
Macclesfield Project for Chelmsford Colliery,
KwaZulu Natal Province**

Desktop Study

For

Cabanga Environmental

10 June 2018

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Expertise of Specialist

The Palaeontologist Consultant is: Prof Marion Bamford

Qualifications: PhD (Wits Univ, 1990); FRSSAf, ASSAf

Experience: 30 years research; 22 years PIA studies

Declaration of Independence

This report has been compiled by Professor Marion Bamford, of the University of the Witwatersrand, sub-contracted by Cabanga Environmental, Johannesburg, 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:

A handwritten signature in blue ink, appearing to read 'MKBamford', with a horizontal line underneath it.

Executive Summary

A desktop palaeontological Impact Assessment was completed for the Macclesfield section of Chelmsford Colliery which is an existing, operational mine with an approved Mining Right (30/5/1/2/2/10006MR and 30/5/1/2/2/196 MR) and associated Environmental Management Plan (EMP). The next proposed development is the Macclesfield Section that comprises three opencast mine areas, a temporary small in-pit ROM coal stockpile areas in the boxcut; and a container to serve as a workshop in the boxcuts.

The coal mine is in the Ecca Group Vryheid Formation which has fossil plants in some regions. Based on the geology and records of fossil plants from sediments of the same age from other areas, it is moderately likely that they would occur in the shales and mudstones within, above and below the coal seams. It is recommended that a responsible person (mine geologist, environmental officer or other designated person) monitor the rocks from the coal seam levels that will be dumped, according to the included Chance Find Protocol. This protocol should be added to the EMP: if fossils are found once mining has commenced then they should be rescued and a palaeontologist called to assess and collect a representative sample.

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1. Background

Chelmsford Colliery is an existing, operational mine with an approved Mining Right (30/5/1/2/2/10006MR and 30/5/1/2/2/196 MR) and associated Environmental Management Plan (EMP) (Van Hoven & Needham, May 2012). The mineral boundary encompasses a total area of 5138.238ha.

The operation is divided into five sections:

- Ashley Section (Active):
 - Opencast mine areas;
 - Underground mine through highwall adits which will eventually join to the underground reserves on the southern extreme of Macclesfield farm (considered part of the Ashley Mine operational area) and access the Exmoor Mine underground reserves (considered part of the Exmoor Mine operational area);
 - Temporary small in-pit ROM coal stockpile area in the adit boxcut;
 - Container to serve as workshop in the adit boxcut;
 - Beneficiation and wash plant area;
 - The crushing and screening of coal;
 - Washing and processing area;
 - Coal stockpiling area;
 - Central mining support infrastructure area;
 - Administrative area and central offices; and
 - Magazine.
- Shelley Mine (Active):
 - Opencast mine area with PCD to contain surface runoff;
 - Highwall adit to access the Exmoor Mine underground reserves (considered part of the Exmoor Mine operational area);
 - Temporary small in-pit ROM coal stockpile area in the adit boxcut; and
 - Container to serve as workshop in the adit boxcut.
- Macclesfield Section (the next development):
 - Opencast mine areas (x3);
 - Temporary small in-pit ROM coal stockpile areas in the boxcut; and
 - Container to serve as workshop in the boxcuts.
- Mooikrantz Mine:
 - Underground mining areas;
 - Accessed by horizontal adit;
 - Temporary small ROM coal stockpile area; and
 - Container to serve as workshop.
- Exmoor Mine:
 - Underground mining which will be accessed through Ashley Mine and Shelley Mine (no other infrastructure).

This application relates specifically to Macclesfield Section, which was targeted for underground mining in the approved EMP (2012) (Van Hoven & Needham, May 2012). However, the coal resource will be mined via opencast methods (approximately 281Ha in extent at Macclesfield) as per the recent Integrated Water Use License (IWUL) (2017) (Kasl, 14 December 2016).

Opencast mining will be conducted through roll-over mining with successive cuts opened as old mined cuts are rehabilitated. Access to open pits will be via a low wall ramp. These access ramps will progress with the roll-over mining.

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	Appendix B
The expertise of that person to compile a specialist report including a curriculum vitae	Appendix B
A declaration that the person is independent in a form as may be specified by the competent authority	Page 1
An indication of the scope of, and the purpose for which, the report was prepared	Section 1
The date and season of the site investigation and the relevance of the season to the outcome of the assessment	N/A
A description of the methodology adopted in preparing the report or carrying out the specialised process	Section 2
The specific identified sensitivity of the site related to the activity and its associated structures and infrastructure	Section ii Error! Reference source not found.
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 5
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
Any mitigation measures for inclusion in the EMPr	N/A
Any conditions for inclusion in the environmental authorisation	Section 8
Any monitoring requirements for inclusion in the EMPr or environmental authorisation	Section 8

A reasoned opinion as to whether the proposed activity or portions thereof should be authorised	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	N/A
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

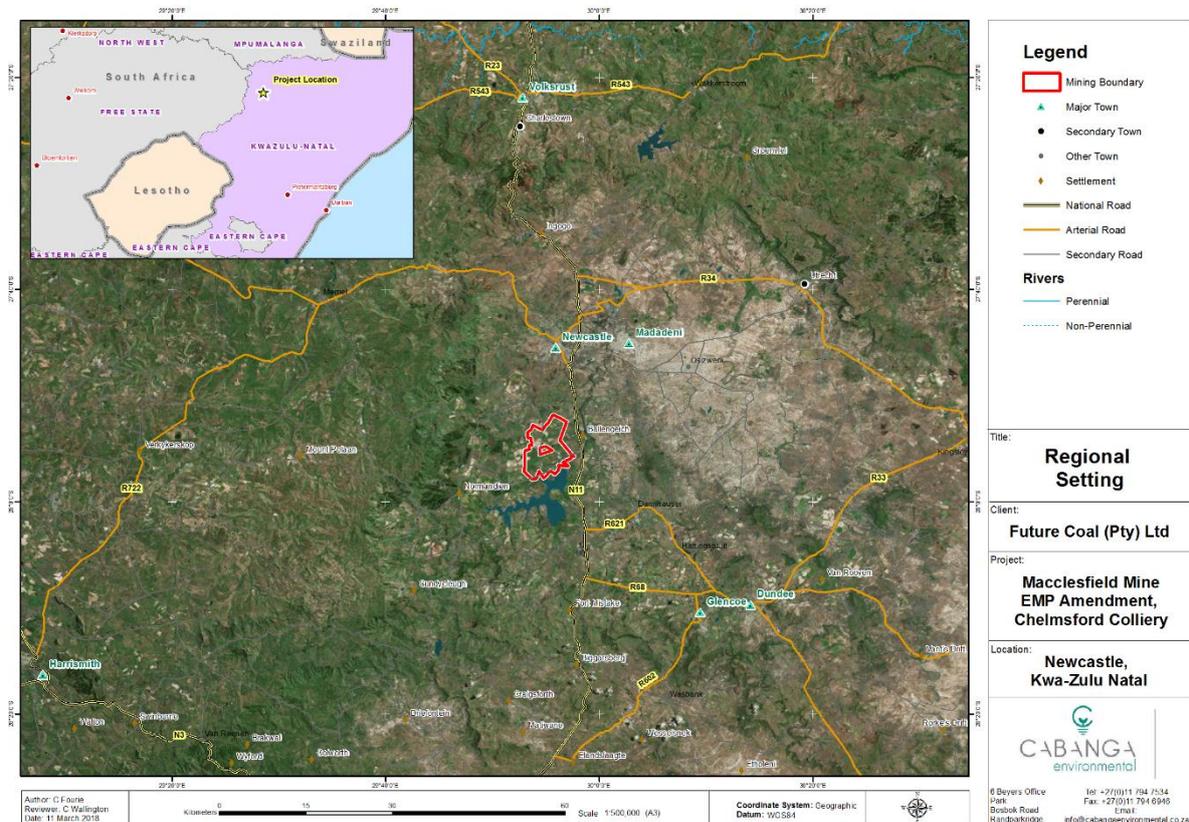


Figure 1: Google Earth map of the Chelmsford Colliery and Macclesfield Section outlined in red, south of Newcastle and north of the Chelmsford Dam, KwaZulu-Natal. Map supplied by Cabanga.

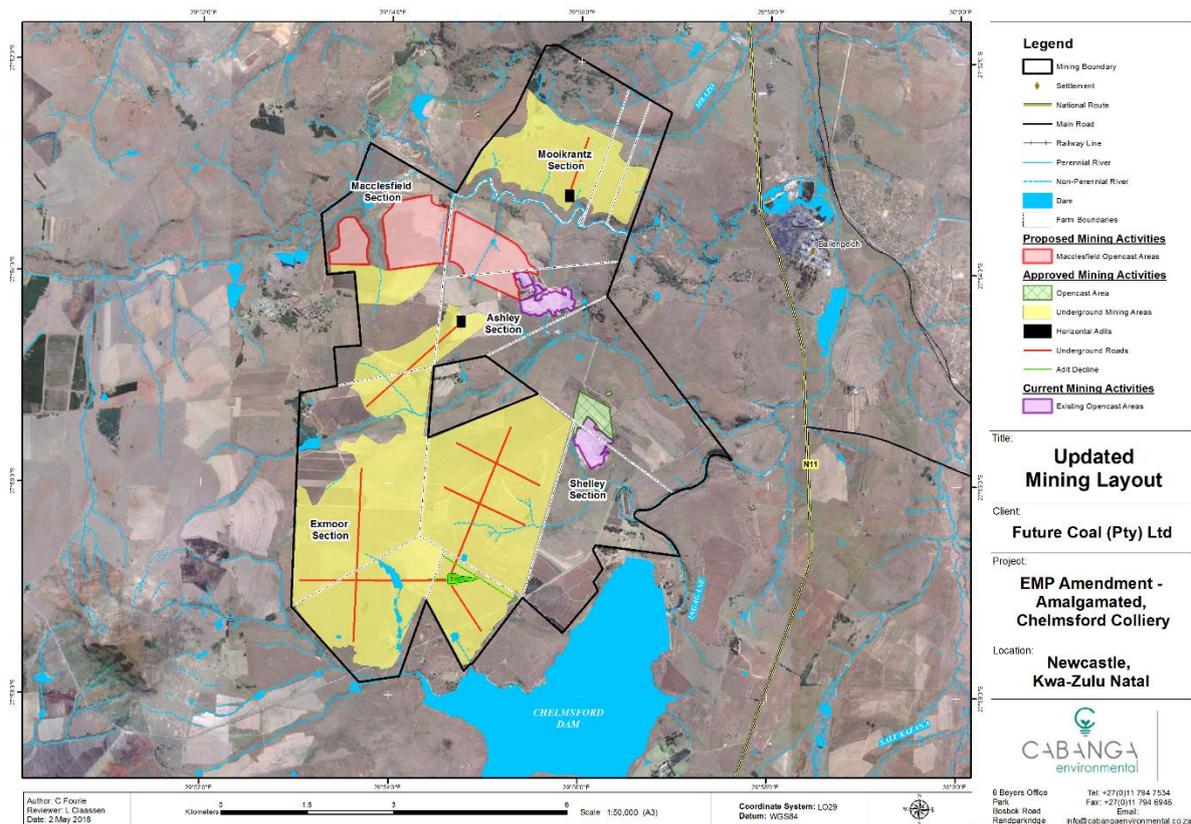


Figure 2: details of the mining layout for Macclesfield Section (red outline), Chelmsford Colliery, KwaZulu Natal. Map provided by Cabanga Environmental.

2. Methods and Terms of Reference

The Terms of Reference (ToR) for this study were to undertake a Palaeontological Impact Assessment (PIA) and provide feasible management measures to comply with the requirements of the South African Heritage Resources Agency (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 (not applicable to 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. Geology and Palaeontology

i. Project location and geological context

The proposed mine amendment is in the Klip River Coal Field which is the most important coal field in KwaZulu Natal (Snyman, 1998). It has only two economic coal seams, the Top and Bottom seams, and on average, they are overlain by at least 100m of dolerite, shale and sandstone.

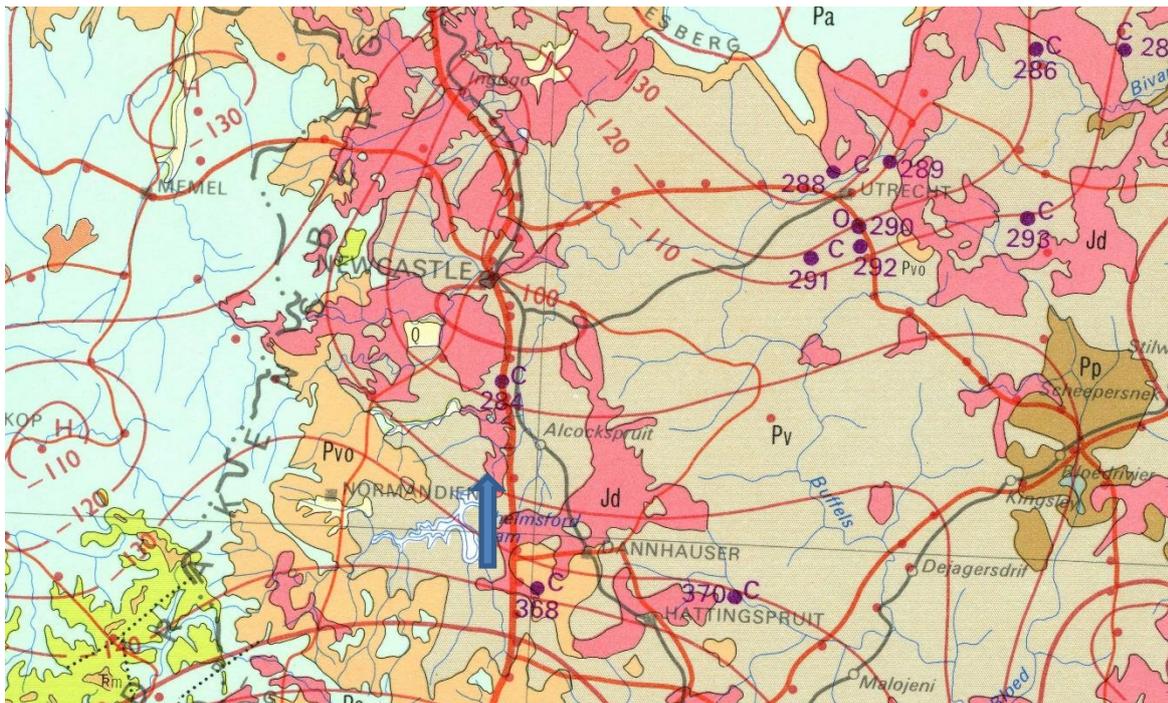


Figure 3: Geological map of the area around Chelmsford Colliery with the arrow indicating the position of the Macclesfield Section. Abbreviations of the rock types are explained in Table 2. Map enlarged from the Geological Survey 1: 1 000 000 map 1984.

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
Q	Quaternary	Alluvium, sand, calcrete	Neogene, ca 25 Ma to present
Jd	Jurassic dykes	Dolerite dykes, intrusive	Jurassic, approx. 180 Ma
Q	Quaternary	Alluvium, sands, calcrete	Last 2.5 Ma
Jd	Jurassic dolerite dykes	dolerite	Jurassic ca 180 Ma
Tr-m	Molteno Fm, Stormberg Group	Sandstone, mudstone, shale	Late Triassic 227-208 Ma
Pa	Adelaide subgroup & Estcourt Fm, Beaufort Group, (upper Permian) Lopingian Epoch	Mudstone, sandstone	“middle” Permian, Late Ecca Ca 260 Ma

Symbol	Group/Formation	Lithology	Approximate Age
Pvo	Volkstrust Fm	Shale	Ca 260 Ma
Pv	Vryheid Fm	Shales, sandstone, coal	Early Permian, Middle Ecca 269-265 Ma
Pp	Pietermaritzburg Fm	Shale	Early Permian, Early Ecca, 286-269 Ma

The various formations of the Ecca Group are exposed in this region, from the basal Pietermaritzburg Formation that is composed of shales and dark silty mudrock that is bioturbated and has some trace fossils. This formation represents a major post-glacial transgression with carbonate concretions, lenses and beds that indicate a shallow water environment (Johnson et al., 2006). The overlying Vryheid Formation comprises upward-coarsening cycles of sediments that represent a variety of deltaic environments from delta fronts to rivers, meandering rivers, interfluvies and backswamps. Important coal deposits are from the fluvial settings.

Above the Vryheid Formation is the Volkstrust Formation that is predominantly argillaceous. It represents a transgressive open shelf sequence comprising muds that were suspended and then deposited. There is still some debate about whether there was some marine influence or if it was lacustrine to lagoonal and coastal in origin (Johnson et al., 2006). Notwithstanding, it does not contain coal seams. The Adelaide subgroup is divided into a number of formations and members based on the lithostratigraphy and faunal ranges; of this subgroup the Normandien Formation preserves fossil plants and the other formations have a faunal record.

ii. Palaeontological context

While coal is composed of plants that have been deposited as peat and then altered by heat and pressure over time to produce coal, the original plant material is not distinguishable. Coal itself is of very limited interest to palaeontology but plant impressions can be preserved in the shales and mudstones that are closely associated with the coal seams. Vertebrates are very rarely found to occur with fossil plants because the conditions for preservation are different.

Plants of the coal flora are mainly the glossopterids (a large group of extinct seed ferns), lycopods, sphenophytes, ferns and very rare gymnosperms (see Appendix A and Figure 5). This flora has been fairly well studied and can vary from basin to basin. The overwhelming factor is that the occurrence of the preserved plants is very scattered and unpredictable and there is no way of predicting where well preserved outcrops will be.

From the South African Heritage Resources Information System (SAHRIS) map below the area is indicated as highly sensitive (red) because of the coal seams occurring below ground.

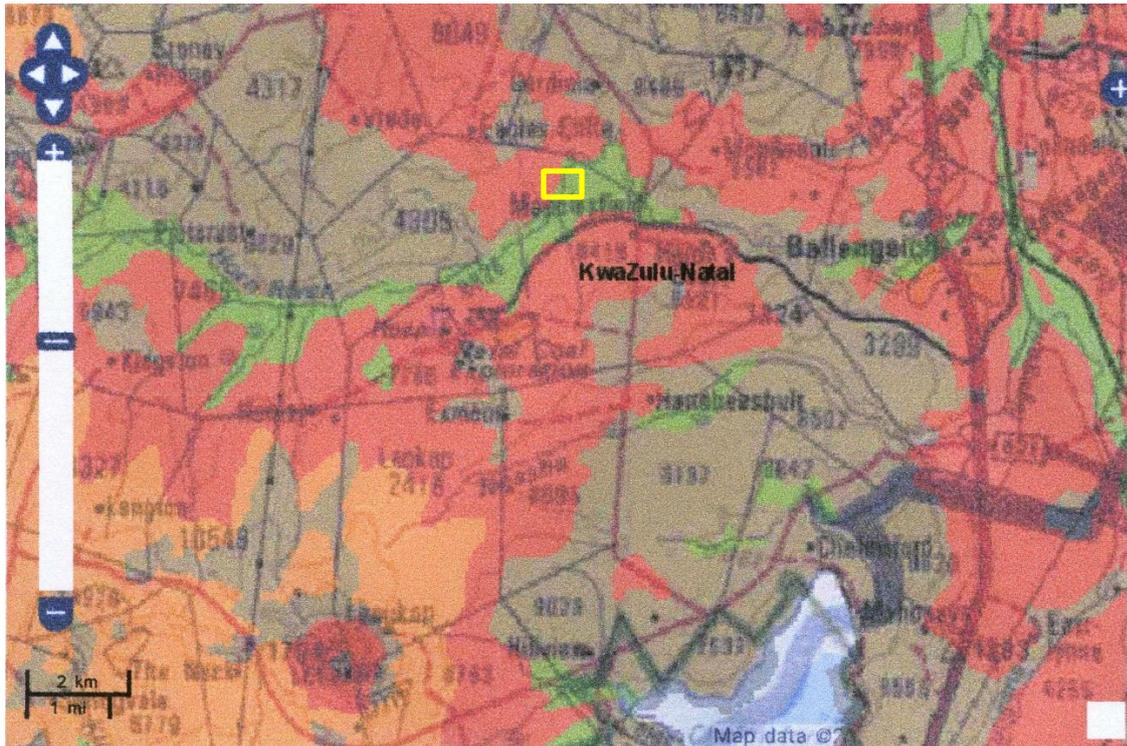


Figure 4: SAHRIS palaeosensitivity map for the site for the proposed Macclesfield Section, Chelmsford Colliery shown within the yellow rectangle. Colours indicate the following degrees of sensitivity: red = very highly sensitive; orange/yellow = high; green = moderate; blue = low; grey = insignificant/zero.

4. Impact assessment

An assessment of the potential impacts to possible palaeontological resources considers the criteria encapsulated in Table 3A:

TABLE 3A: 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 3B: IMPACT ASSESSMENT

PART B: ASSESSMENT		
SEVERITY/NATURE	H	-
	M	-the Vryheid Fm contains coal seams and possibly associated fossil plant impressions in the shales
	L	-
	L+	-
	M+	-
	H+	-
DURATION	L	-
	M	-
	H	Where manifest, the impact will be permanent.
SPATIAL SCALE	L	Since only the possible fossils within the area would be fossil plants from the <i>Glossopteris</i> flora in the shales, the spatial scale will be localised within the site boundary.
	M	-
	H	-
PROBABILITY	H	-
	M	It is possible that fossil plant impressions will be found in the shales associated with the coal seams
	L	-

Based on the nature of the project, surface activities will NOT impact on the palaeontological heritage as the coal seams and associated shales are far below ground. Open cast mining of the coal seams may impact upon the fossil heritage if preserved in the development footprint. The geological structures suggest that the rocks are likely to contain impressions of fossil plants but not of vertebrates. Since

there is a moderate chance that fossils from the Vryheid Formation may be disturbed a Chance find protocol has been added to this report. Taking account of the defined criteria, the potential impact to fossil heritage resources is moderate because the distribution of the flora is scattered and of unknown quality (scientific importance).

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 do contain fossil plant material of the Glossopteris flora. It is uncertain how widespread or abundant the fossil plant impressions would be and if they are sufficiently well preserved to be of any scientific value.

6. Recommendation

Based on the geology and records of fossil plants from sediments of the same age from other areas, it is moderately likely that they would occur in the shales and mudstones within, above and below the coal seams. It is highly impractical for a professional palaeontologist to be present throughout the mining operation (and there is insufficient expertise in south Africa at this stage) so it is recommended that a responsible person (mine geologist, environmental officer or other designated person) monitor the rocks from the coal seam levels that will be dumped, according to the Chance Find Protocol. This protocol should be added to the EMP: if fossils are found once mining has commenced then they should be rescued and a palaeontologist called to assess and collect a representative sample.

7. References

Adendorff, R. Bamford, M.K., McLoughlin, S. 2003. Liknopetalon: a review of a rare Gondwanan Permian pteridophyte. *Review of Palaeobotany and Palynology*. 126, 83-101.

Aitken, G. 1994. Permian palynomorphs from the Number 5 Seam, Ecca Group, Witbank Highveld Coalfields, South Africa. *Palaeontologia africana* 31: 97-109.

Anderson, J.M., Anderson, H.M., 1985. *Palaeoflora of Southern Africa: Prodrum of South African megaflores, Devonian to Lower Cretaceous*. A.A. Balkema, Rotterdam. 423 pp.

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.

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.

Kasl, B. (14 December 2016). *Integrated Water and Waste Management Plan for the opencast and underground mining at Chelmsford Colliery*. Johannesburg: Canganga Environmental.

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.

Rubidge BS (ed). 1995. Biostratigraphy of the Beaufort Group (Karoo Supergroup). South African Committee for Stratigraphy Biostratigraphic Series 1. Council for Geoscience, South Africa.

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.

Van Hoven, P. W., & Needham, R. (May 2012). Future Coal (Pty) Ltd Chelmsford Colliery II Environmental Impact Assessment + Environmental Management Plan. Pretoria: Prodigy Trading (Pty) Ltd.

8. Chance Find Protocol

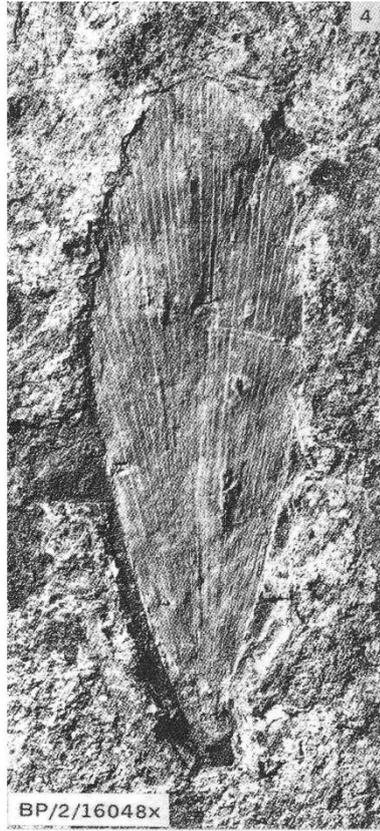
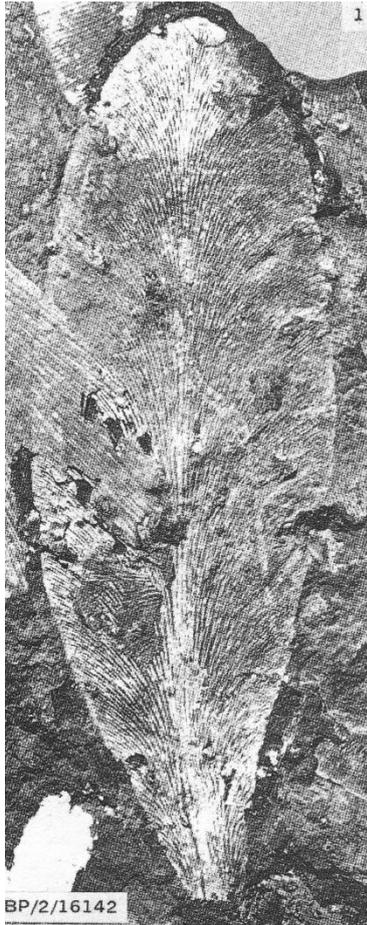
Monitoring Programme for Palaeontology – to commence once the open cast mining begins.

The following procedure is required once the open cast mining operations have reached the coal seams.

1. When excavations begin the rocks and carbonaceous material must be given a cursory inspection by the geologist, environmental officer or designated person. Any fossiliferous material such as leaf impressions, stems, seeds, wood, insect wings, should be put aside in a suitably protected place. This way the mining activities will not be interrupted.
2. 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 5). This information will be built into the EMP's training and awareness plan and procedures.
3. Photographs of the putative fossils can be sent to the palaeontologist for a preliminary assessment.
4. If there is any possible fossil material found by the developer/environmental officer/miners then a qualified palaeontologist sub-contracted for this project, should visit the site to inspect the selected material and check the dumps where feasible.
5. Fossil plants or invertebrates 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 an AMAFA permit must be obtained. Annual reports must be submitted to SAHRA as required by the relevant permits.
6. If no good fossil material is recovered then the site inspections by the palaeontologist will not be necessary. Annual reports by the palaeontologist must be sent to SAHRA.
7. If no fossils are found and the excavations have finished then no further monitoring is required.

Appendix A – Vryheid Formation flora and Fauna (Aitken, 1994; Anderson & Anderson, 1985; Adendorff et al., 2003; Barbolini et al., 2016; Plumstead, 1969; Rubidge et al., 1995).

Flora - macroplants	Flora – microfossils	Fauna
<i>Azaniodendron fertile</i> , <i>Cyclodendron leslii</i> , <i>Sphenophyllum hammanskraalensis</i> , <i>Annularia sp.</i> , <i>Raniganjia sp.</i> , <i>Asterotheca spp.</i> , <i>Liknopetalon enigmata</i> , Glossopteris > 20 species, <i>Hirsutum 4 spp.</i> , <i>Scutum 4 spp.</i> , <i>Ottokaria 3 spp.</i> , <i>Estcourtia sp.</i> , <i>Arberia 4 spp.</i> , <i>Lidgettonia sp.</i> , <i>Noeggerathiopsis sp.</i> <i>Podocarpidites sp</i>	<i>Protohaploxypinus microcarpus</i> <i>Praecolpatities sinuous</i> <i>Microbaculispora trisina</i> <i>Striatopodocarpites cancellatus</i> <i>Striatopodocarpites fusus</i> <i>Pseudoreticulatispora pseudoreticulata</i> <i>Pseudoreticulatispora confluens</i> Taeniate bisaccate pollen	<i>Mesosaurus ??</i>



Noeggerathiopsis and
Glossopteris leaves

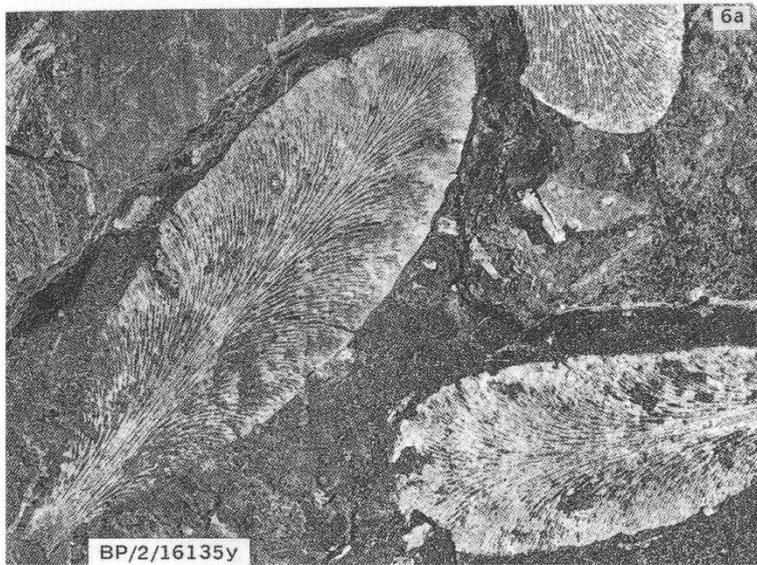


Figure 5: Examples of fossil leaf impressions of *Glossopteris* that are likely to occur in the shales within, above or below the coals seams of the Vryheid Formation.

Appendix B – Details of specialist

Curriculum vitae (short) - Marion Bamford PhD June 2018

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 – 1990+
 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	6	1
Masters	8	1
PhD	10	2
Postdoctoral fellows	9	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 -

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

xi) Research Output

Publications by M K Bamford up to June 2018 peer-reviewed journals or scholarly books: over 120 articles published; 5 submitted/in press; 8 book chapters.

Scopus h index = 26; Google scholar h index = 28;

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)