Palaeontological Impact Assessment for the Copper Sunset sand mining operation near Viljoensdrif, northern Free State Province

COP6679

Site Visit Report (Phase 2)

For

Digby Wells

18 March 2021

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Expertise of Specialist

The Palaeontologist Consultant: Prof Marion Bamford
Qualifications: PhD (Wits Univ, 1990); FRSSAf, ASSAf
Experience: 32 years research; 24 years PIA studies

Declaration of Independence

This report has been compiled by Professor Marion Bamford, of the University of the Witwatersrand, sub-contracted by Digby Wells, 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

Executive Summary

A Phase 2 Palaeontological Impact Assessment was requested by Copper Sunset (Pty) Ltd for a sand-mining operation near Viljoensdrif in the Free State. Copper Sunset holds an approved Mining Right but is looking to extend their mining right to include the areas indicated in Figure 1. There are two proposed phases for this project.

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

No fossils of any kind were seen during the site visit. The farmlands have been ploughed and planted for many years, and currently most lie fallow with deep soils and grassland cover.

The proposed sites lie on the aeolian sands and soils of the Quaternary that are unlikely to preserve fossils, and on the shales and sandstones of the Vryheid Formation (Ecca Group, Karoo Supergroup) that is potentially fossiliferous. Potential fossils would be impressions of the Glossopteris flora (Glossopteris leaves, lycopods, sphenophytes, ferns and early gymnosperms. Although no fossils were seen during the site visit, a Fossil Chance Find Protocol should be added to the EMPr. Based on this information it is recommended that no further palaeontological site visit is required. If fossils are found once sand mining commences then they should be rescued and a palaeontologist called to collect a representative sample.).

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1. Background

A Palaeontological Impact Assessment site visit was requested for the proposed Copper Sunset (Pty) Ltd sand-mining operation near Viljoensdrif in the Free State. Copper Sunset holds an approved Mining Right but is looking to extend their mining right to include the two areas indicated in the Google Earth Map (both the purple and the red areas, Figure 1).

A Phase 2 (site visit) Palaeontological Impact Assessment is required for the project boreholes and this was done by Rick Tolchard on 11 May 2021. 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 Palaeontological Impact Assessment (PIA) was completed for the proposed project and is presented herein.

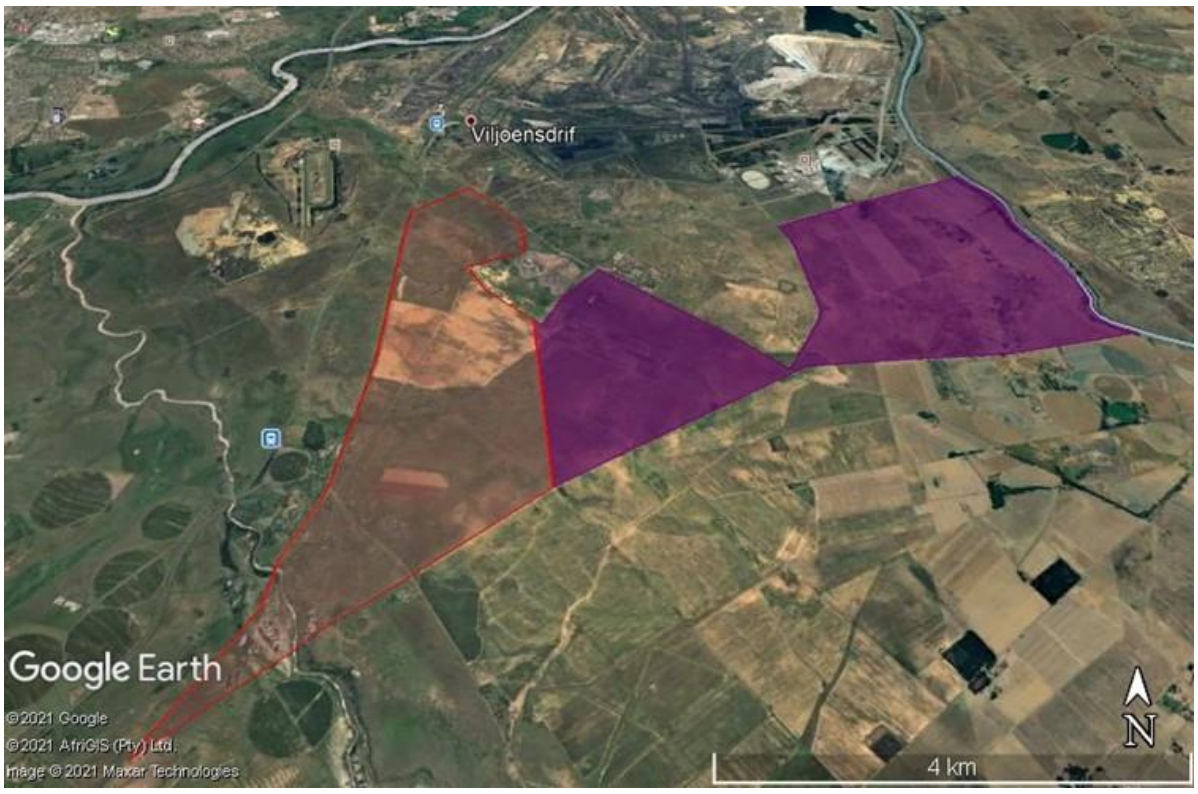

Figure 1: Google Earth map of proposed sand mining area for Copper sunset, south of Viljoensdrif indicated in purple (area 1) and pink (area 2)

Map data supplied by Digby Wells.

Table 1: Specialist Report Requirements in terms of Appendix 6 of the EIA Regulations (2017)

	A specialist report prepared in terms of the Environmental Impact Regulations of 2017 must contain:	**Relevant section**
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 i
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 4
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
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 6 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 6 Appendix A
ni	A reasoned opinion as to whether the proposed activity or portions thereof should be authorised	N/A

	A specialist report prepared in terms of the Environmental Impact Regulations of 2017 must contain:	Relevant section
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	N/A
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 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 (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 site lies in the eastern sector of the Karoo Basin with Karoo Supergroup rocks intruded by dolerite dykes and unconformably overlain much younger aeolian sands and soils of Quaternary age (Figure 2).

The Main Karoo Basin and Karoo Supergroup rocks cover a very large proportion of South Africa. 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 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 sediments in the large inland sea. These are the oldest rocks in the Karoo 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 (Johnson et al., 2006).

Overlying the Dwyka Group rocks are rocks of the Ecca Group that are Early Permian in age. There are eleven formations recognised in this group but they do not all extend throughout the Karoo Basin. In the Free State and KwaZulu Natal, from the base upwards are the Pietermaritzburg Formation, Vryheid Formation and the Volksrust Formation. All of these sediments have varying proportions of sandstones, mudstones, shales and siltstones and represent shallow to deep water settings, deltas, rivers, streams and overbank depositional environments.

Overlying the Ecca Group rocks are the Beaufort Group Rocks that are late Permian and early Triassic in age. There are six formations in the Beaufort Group but their distribution is not throughout the basin. East of the 24°E line of latitude there are three formations: the basal Koonap Formation, Middleton Formation and the Balfour Formation. In The Free State and KwaZulu Natal the equivalent of the Balfour Formation is the Normandien Formation (previously called the Estcourt Formation). Four members are recognised in the Normandien Formation: the Frankfort Member, Rooinekke Member, Schoondraai Member and Harrismith Member.

Intruding through all these sediments are dolerite dykes that formed during the Jurassic Drakensberg basaltic eruptions. Unconformably overlying the older rocks are the considerably younger Quaternary or Kalahari sands. As the continent dried out during the Late Quaternary period windblown sands from the Kalahari Basin were redeposited farther to the east, and together with fluvially borne sands from the major rivers such as the Vaal River, the sands covered some of the lower lying areas (Partridge et al., 2006).

Figure 2 presents the regional geology within which the Project is located. The Project area is shown in the blue polygons. Table 2 includes an explanation of the abbreviations of the rock types. In this table, SG refers to Supergroup, Fm refers to Formation and Ma refers to million years. Geological features impacted by the Project are highlighted through grey shading.

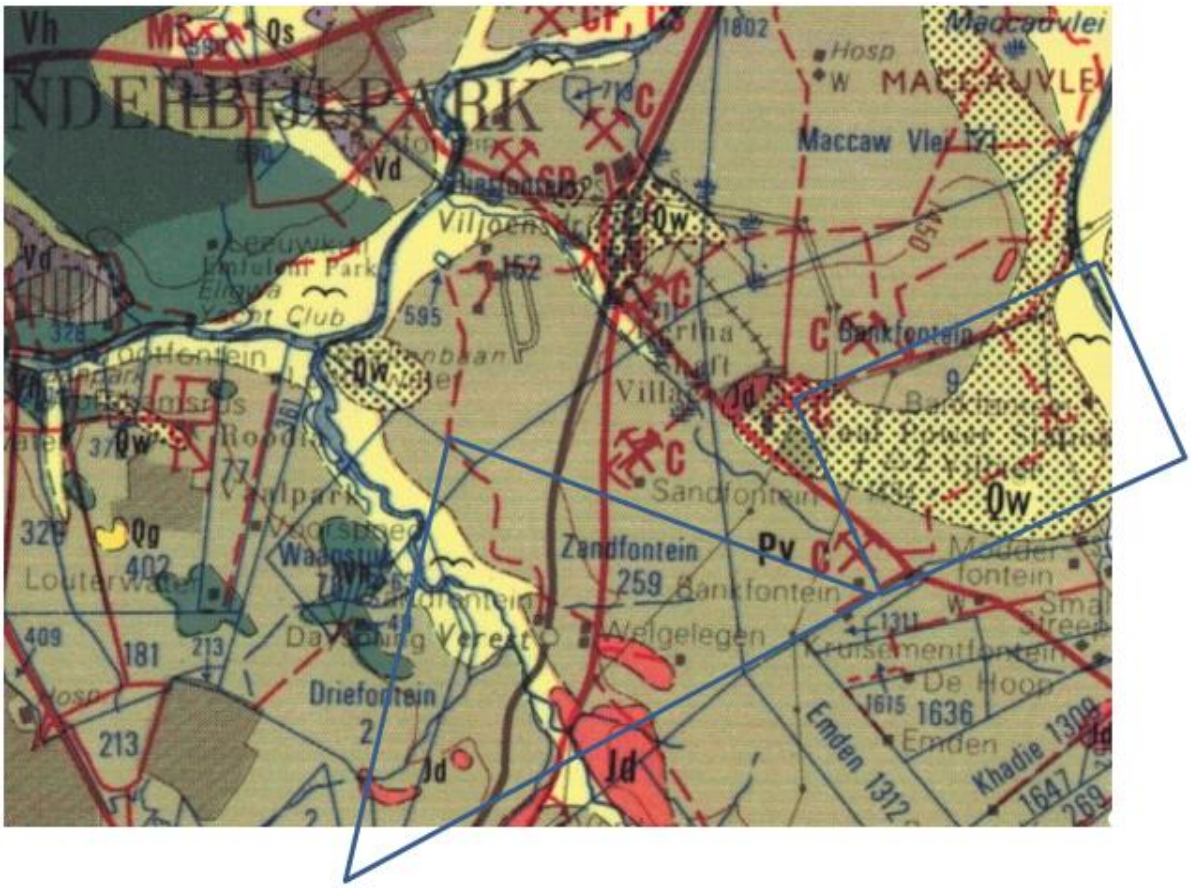

Figure 2: Geological map of the area south of Viljoendrif with the proposed sand mining areas within the blue outlines.

Map enlarged from the Geological Survey 1: 250 000 map 2626 West Rand.

Table 2: Explanation of symbols for the geological map and approximate ages (Eriksson et al., 2006, 2012; Johnson et al., 2006).

Symbol	Group/Formation	Lithology	Approximate Age
Qs	Quaternary sands and soils	Partly consolidated fine-grained sediments with silcrete nodules	Last 2.5 Ma
Qw	Quaternary sands	Aeolian sand	Last 2.5 Ma
Jd	Jurassic dykes	Dolerite dykes, intrusive	Jurassic, approx. 180 Ma

Symbol	Group/Formation	Lithology	Approximate Age
Pv	Vryheid Fm, Ecca Group, Karoo SG	Shales, sandstone, coal	Early Permian, Middle Ecca

ii. Palaeontological context

The palaeontological sensitivity of the area under consideration is presented in Figure 3. The Permian Vryheid Formation sediments could have preserved fossil plants of the Glossopteris Flora, including leaf impressions and fructifications of Glossopteris, and other extinct groups like the cordaitaleans, some lycopods, sphenophytes, wood and ferns, as well as early gymnosperms. Fossil plants have been recorded from other regions but they are sporadic and hard to predict.

The Glossopteris flora fossils are of interest to palaeobotanists but in general they are widely scattered and difficult to locate. This flora is well known but there is always a very small chance that some new taxa may be discovered (Plumstead, 1969; Anderson and Anderson, 1985).

Jurassic dolerite dykes do not preserve fossils as the heat and intrusive action tends to destroy any fossils in the host rock.

Quaternary sands seldom preserve fossils as they are either aeolian in origin or from recent fluvial activity, in other words they are not in primary context. Fossil pans, spring mounds or stabilised sand dunes may preserve fossils but these features are not indicated on the Google Earth map that shows the land has been modified by agricultural practices.

From the SAHRIS map (Figure 3) the area is indicated as moderately sensitive (green) for the eastern section, and this applies to the overlying Quaternary sands, and very highly sensitive (red) for parts of the western area. Therefore, a site visit and survey are required. This was completed.

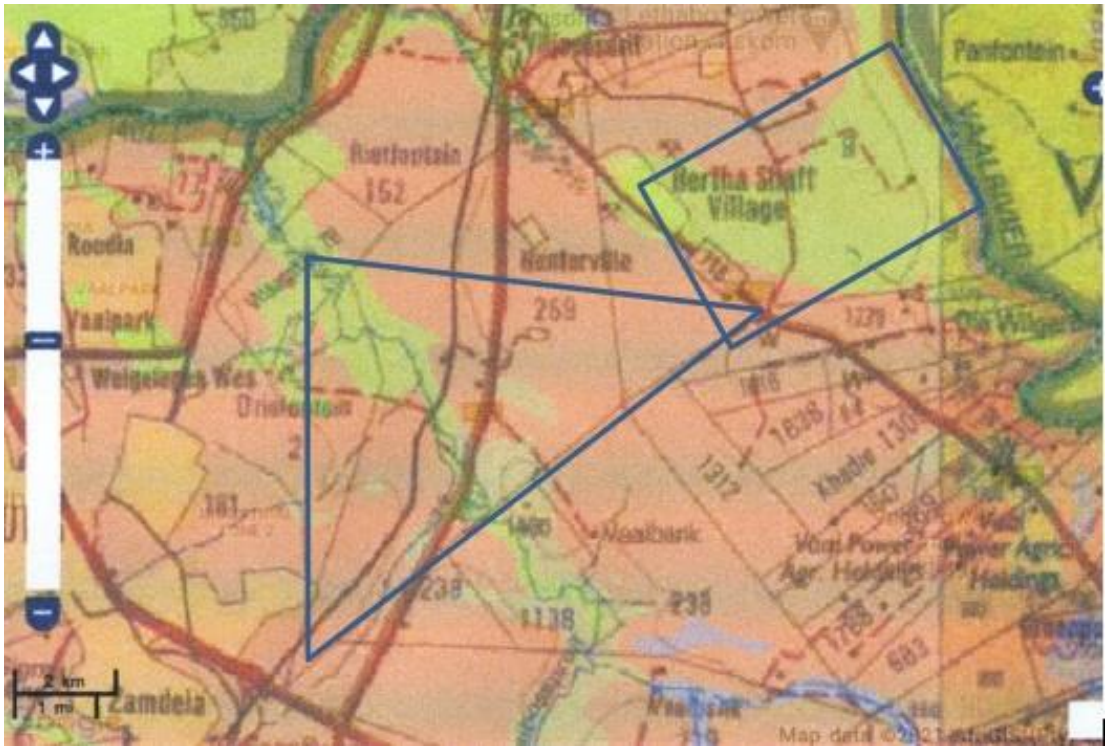

Figure 3: SAHRIS palaeosensitivity map for the site for the proposed sand mining project shown within the blue outlines.

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

A site visit was completed on 11th May by Rick Tolchard and the survey observations are given below. Photographs were taken by him and are shown in Figure 5 to Figure 12 below.

Table 3: GPS Points and Site Observations from the Paleontological Survey

Point No.	GPS coordinates	Observations	Figure
Stop 1	S26°45”18.77’ E27°55”36.70’ 1494m	Area 2, northern part. Flat previously ploughed and planted fields. Deep soils, no rocky outcrops and no fossils	5
Stop 2	S26°46”43.2875’ E27°58”02.47954’ 1525m	Area 2, southern part. Previously ploughed and planted fields.	6
Stop 3	S26°46”43.29304’ E27°58”02.46747’ 1523m	Southern border of eastern section of Area 1. Gate locked and no access.	7

Point No.	GPS coordinates	Observations	Figure
Stop 4	S26°46”55.25978’ E27°57”40.8309’ 1532m	Previously ploughed and planted field. Flat topography and no rocky outcrops	-
Stop 5	S26°47”06.67’ E27°55”46.07’ 1517m	Previously ploughed and planted field. Flat topography and no rocky outcrops	-
Stop 6	S26°46”44.61319’ E27°57”08.39806’ 1512m	Previously ploughed and planted field. Flat topography and no rocky outcrops	-
Stop 7	S26°46”40.31236’ E27°57”10.7867’ 1520m	Ploughed and planted field. Rare displaced sandstone rocks	8
Stop 8	S26°46”38.26907’ E27°57”12.32592’ 1517m	Cleared field with a furrow exposing the sandy soils	9
Stop 9	S26°44”38.01324’ E27°59”28.15077’ 1472m	Northern border of eastern section of Area 1. Ploughed and revegetated field, relatively flat and no rocky exposures. No fossils	10
Stop 10	S26°46”32.64’ E27°59”10.30’ 1494m	Ploughed and abandoned fields. No fossils	-
Stop 11	S26°47”24.62’ E27°58”08.35’ 1517m	Abandoned field; furrow shows sandy soils and some pieces of dolerite. No fossils	11, 12

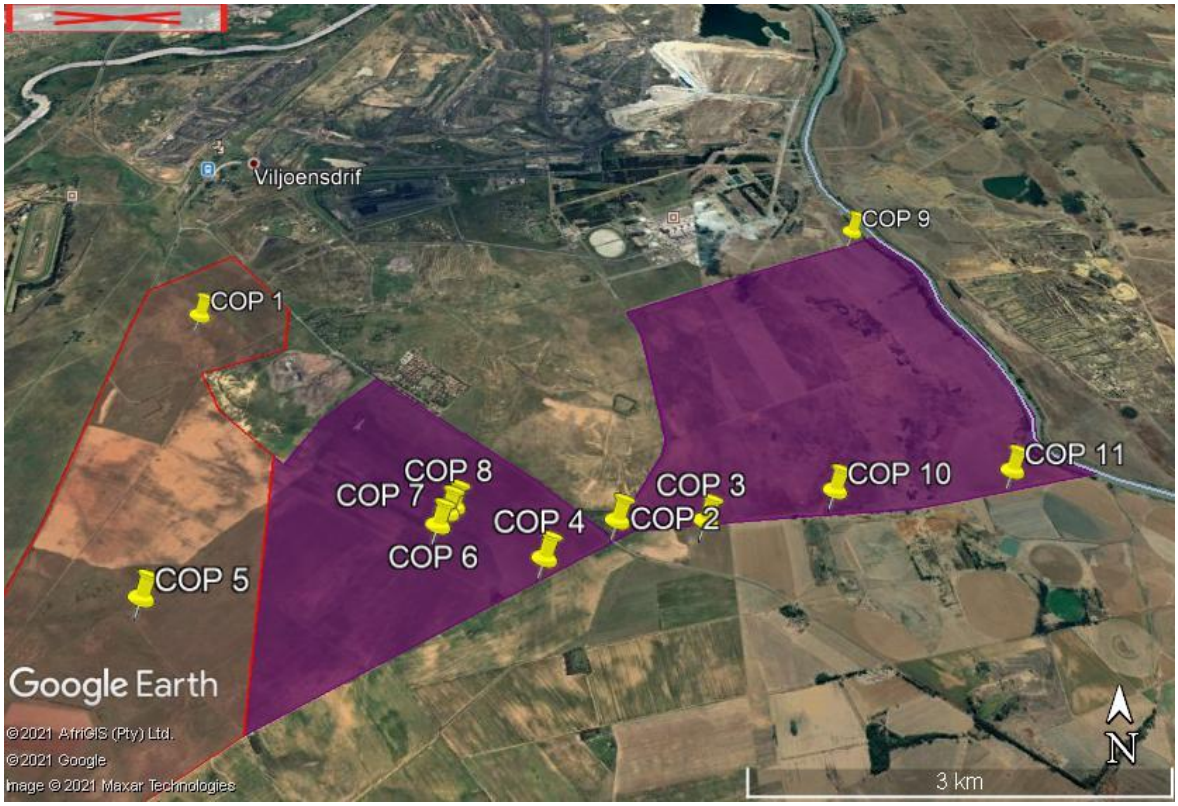

Figure 4: Google Earth map showing site visit stops (COP 1 to COP 11) for the Copper Sunset sand mining project. COP 1 and 5 are in Area 2; the rest are in Area 1

Figure 5: Stop 1 – note flat topography and previously ploughed and planted fields

Figure 6: Stop 2 – flat topography, deep soils with dry mealie crop that has not yet been cleared.

Figure 7: Stop 3 – no access. Flat topography, sandy soils covered with grass

Figure 8: Stop 7. Rare sandstone at the edge of a field, probably displaced. Coarse-grained and no fossils are preserved.

Figure 9: Stop 8: furrow in a field showing the sandy soil.

Figure 10: Stop 9 – abandoned field to the south, and to the north (this view) with a coal-fired power station in the distance.

Figure 11: Stop 11 – view into the field showing vegetation cover and relatively flat topography.

Figure 12: Stop 11 – furrow showing sandy soils and some pieces of dolerite.

4. Impact assessment

Table 4 presents the criteria used to assess the potential impacts to palaeontological resources. Table 5 presents the results of the impact assessment.

Table 4: 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 5: Impact Assessment

PART B: Assessment		
SEVERITY/NATURE	**H**	-
	M	-
	L	Soils and sands of the Quaternary do not preserve fossils; the Vryheid Fm might preserve fossil plants; so far there are no records of fossils in this region so it is very unlikely that fossils occur on the site. The impact would be very unlikely.
	L+	-
	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 fossil plants from the Glossopteris flora in the shales, the spatial scale will be localised within the site boundary.
	M	-
	H	-

PART B: Assessment		
PROBABILITY	H	-
	M	-
	L	It is extremely unlikely that any fossils would be found in the loose sand that will be mined, but there might be Vryheid Fm plants underneath the sands. Therefore, a Fossil Chance Find Protocol should be added to the eventual EMPr.

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 contain fossils, i.e. fossil plant impressions of the Glossopteris flora but the rocks are covered by soils, sandy soils and vegetation. Furthermore, the material to be targeted (sand) does not preserve fossils. Since there is a small chance that fossils from the below ground Vryheid Formation 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 extremely 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 dolorites, sandstones, shales and sands are typical for the country and could contain fossil plant, insect, invertebrate and vertebrate material. The aeolian sands of the Quaternary period would not preserve fossils. The site visit confirmed that there were no fossils in the sandy soils that are overlying the Vryheid Formation and no fossils were in the Quaternary sands.

6. Recommendation

Based on experience and the lack of any previously recorded fossils from the area, it is extremely unlikely that any fossils would be preserved in the aeolian sands and soils of the Quaternary. There is a very small chance that fossil plants of the *Glossopteris* flora may occur in the adjacent and underground shales of the Vryheid Formation. The site visit showed that there are NO FOSSILS visible on the surface. Nonetheless, a Fossil Chance Find Protocol should be added to the EMPr: if fossils are found once mining for sand has commenced then they should be rescued and a palaeontologist called to assess and collect a representative sample.

7. References

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

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.

Isbell, J.L., Henry, L.C., Gulbranson, E.L., Limarino, C.O., Fraiser, F.L., Koch, Z.J., Ciccioli, P.l., Dineen, A.A., 2012. Glacial paradoxes during the late Paleozoic ice age: Evaluating the equilibrium line altitude as a control on glaciation. Gondwana Research 22, 1-19..

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.

Visser, J.N.J., 1986. Lateral lithofacies relationship sin the glacigene Dwyka Formationin the western and central parts of the Karoo Basin. Transactions of the Geological Society of South Africa 89, 373-383.

Visser, J.N.J., 1989. The Permo-Carboniferous Dwyka Formation of southern Africa: deposition by a predominantly subpolar marine icesheet. Palaeogeography, Palaeoclimatology, Palaeoecology 70, 377-391

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8. Chance Find Protocol

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

1. The following procedure is only required if fossils are seen on the surface and when drilling/excavations/mining commence.
2. When excavations begin the rocks and 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 fossils must be provided to the developer to assist in recognizing the fossil plants, vertebrates, invertebrates or trace fossils in the shales and mudstones (for example see Figure 13). 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.

Appendix A: Examples of fossils from the Adelaide Subgroup (Beaufort Group, Karoo Supergroup)

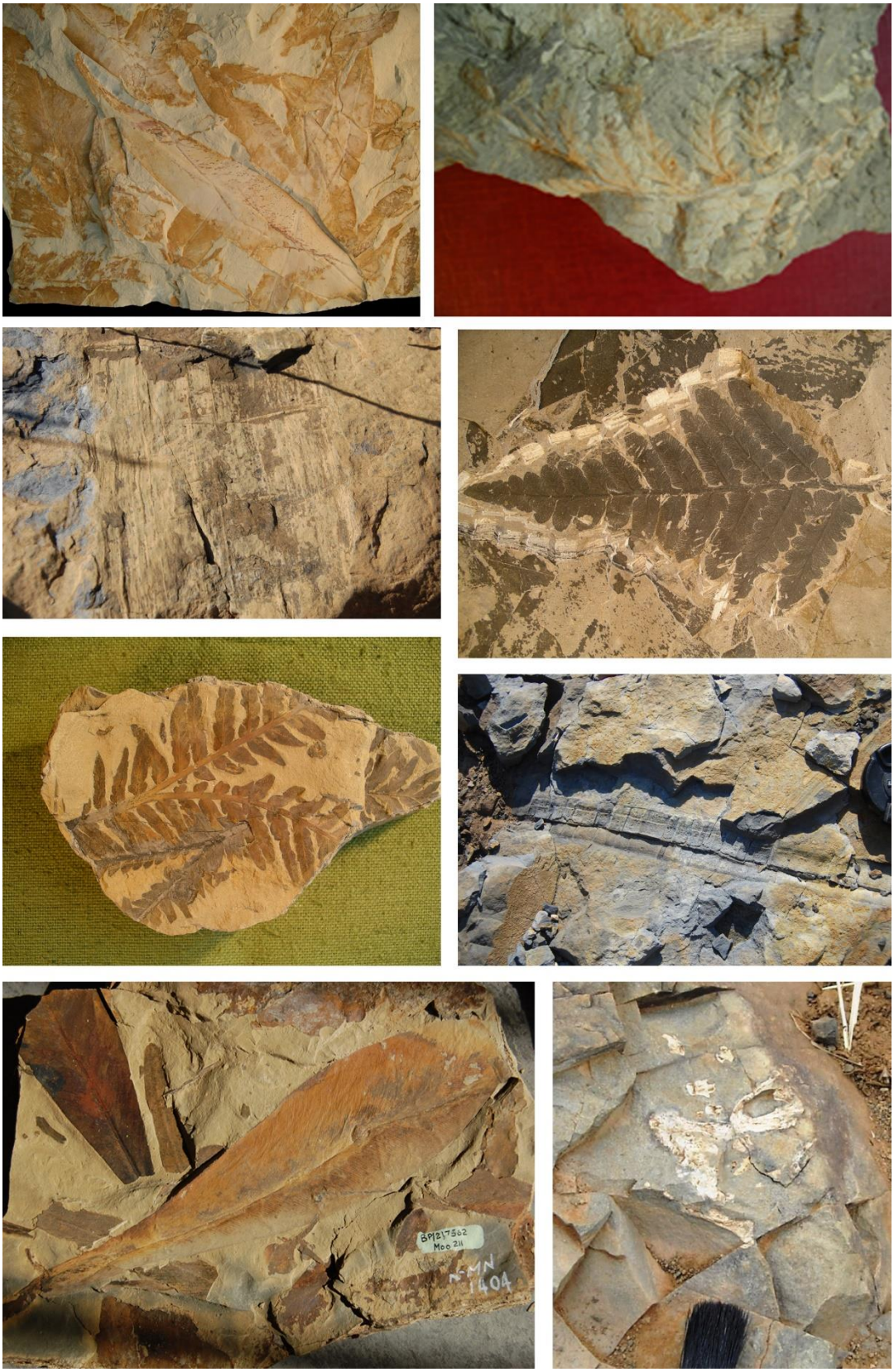

Figure 13: Photographs of a selection of plants from the Glossopteris flora from the Ecca Vryheid Formation. Bottom right - an example of the appearance fossil bones in the rock.

Appendix B: Details of specialists

Curriculum vitae (short) - Marion Bamford PhD
January 2021

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	11	0
Masters	10	4
PhD	11	4
Postdoctoral fellows	10	5

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 –

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
- 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

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; 10 book chapters.
Scopus h-index = 29; Google scholar h-index = 35; -i10-index = 92
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 – January 2021

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
2020 October – Belfast loop and Expansion – Nsovo
2020 October – VLNR lodge Mapungubwe – HCAC
2020 November – Delmore Park BWSS - HCAC
2020 December – Kromdraai commercial – HCAC
2021 January – Welgedacht Siding – Elemental Sustainability