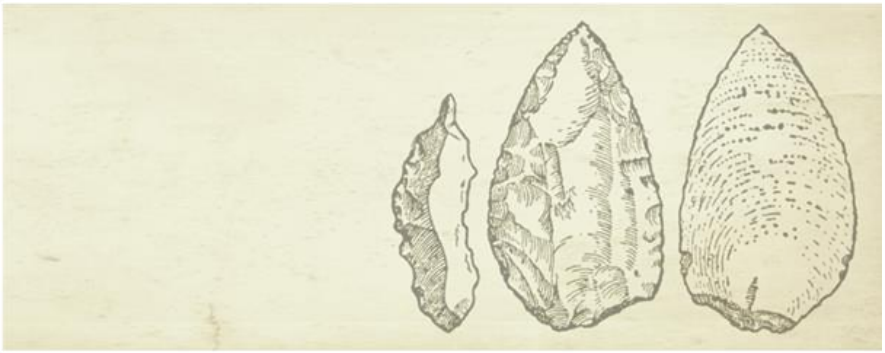

PHASE 1 HIA SKA SCIENCE EXPLORATORIUM, CARNARVON, NORTHERN CAPE

PHASE 1 HERITAGE IMPACT ASSESSMENT REPORT FOR THE PROPOSED SKA DEVELOPMENT OF A NEW SCIENCE EXPLORATORIUM/ SARAO SCIENCE CENTRE ON ERF 431 CARNARVON KAREEBERG LOCAL MUNICIPALITY, PIXLEY KA SEME DISTRICT MUNICIPALITY NORTHERN CAPE PROVINCE.

PREPARED FOR:

ENVIRO AFRICA CC

PREPARED BY:

SKY-LEE FAIRHURST-BOOYSE & JAN ENGELBRECHT
ELIZE BUTLER & HEIDI FIVAZ
UBIQUE HERITAGE CONSULTANTS

23 AUGUST 2024

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Declaration of Independence:

UBIQUE Heritage Consultants hereby, as the appointed independent specialists, declare that:

- We act as independent specialists in this application;
- We perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant;
- We regard the information contained in this report as it relates to our specialist input/study to be accurate and correct, and do not have and will not have any financial interest in the undertaking of the activity other than remuneration for work performed in terms of the NEMA, the Environmental Impact Assessment Regulations, 2014 (as amended) and any specific environmental management Act;
- We declare that there are no circumstances that may compromise my objectivity in performing such work;
- We have expertise in conducting the specialist report relevant to this application, including knowledge of the Act, Regulations and any guidelines that have relevance to the proposed activity;
- We will comply with the Act, Regulations and all other applicable legislation;
- We have no, and will not engage in, conflicting interests in the undertaking of the activity;
- We have no vested interest in the proposed activity proceeding;
- We undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the application by the competent authority and the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- We have ensured that information containing all relevant facts in respect of the specialist input/study was distributed or made available to interested and affected parties and the public and that participation by interested and affected parties was facilitated in such a manner that all interested and affected parties were provided with a reasonable opportunity to participate and to provide comments on the specialist input/study;
- We have ensured that the comments of all interested and affected parties on the specialist input/study were considered, recorded and submitted to the competent authority in respect of the application;
- All the particulars furnished by me in this specialist input/study are true and correct, and
- We realise that a false declaration is an offence in terms of regulation 48 and is punishable in terms of section 24F of the Act.
-

Signed: **Date: 2024-08-23**
J.A.C. Engelbrecht, H. Fivaz & S. Fairhurst-Booyse
UBIQUE Heritage Consultants

SUMMARY OF SPECIALIST EXPERTISE

SKY-LEE FAIRHURST-BOOYSE

ARCHAEOLOGIST

Sky-Lee Fairhurst-Booyse has been part of UBIQUE Heritage Consultants since 2019. Mrs Fairhurst-Booyse obtained her BA in Archaeology and Biblical archaeology in 2016 and her BA Hons in Archaeology (cum laude) at the University of South Africa (UNISA) in 2018, focussing on research themes of gender, households and Late Iron Age settlements. She successfully attained her MA in Archaeology from UNISA in 2023. She is skilled at artefacts and archaeological illustrations. Over the past ten years, she has obtained considerable excavation and survey experience and worked on various sites, including historical, Iron Age, and Paleontological sites.

HEIDI FIVAZ

CRM ARCHAEOLOGIST & OBJECT CONSERVATOR

Heidi Fivaz has been a part of UBIQUE Heritage Consultants since 2016. She holds a B.Tech. Fine Arts degree (2000) from the Tshwane University of Technology, a BA in Culture and Arts Historical Studies degree (2012) from UNISA and received her BA (Hons) in Archaeology in 2015 (UNISA). She has received extensive training in object conservation from the South African Institute of Object Conservation and specialises in glass and ceramics conservation. Ms Fivaz was awarded her MA in Archaeology (with distinction) in 2021 by the University of South Africa (UNISA), focusing on historical and industrial archaeology. She is a professional member of the Association of South African Archaeologists and has worked on numerous archaeological excavation and surveying projects over the past thirteen years. Ms Fivaz is an accredited CRM Field Director.

JAN ENGELBRECHT

CRM ARCHAEOLOGIST

Jan Engelbrecht is accredited by the Cultural Resources Management section of the Association of Southern African Professional Archaeologists (ASAPA) to undertake Phase 1 AIAs and HIAs in South Africa. He is also a member of the Association for Professional Archaeologists (ASAPA). Mr Engelbrecht holds an honours degree in archaeology (specialising in the history of early farmers in southern Africa (Iron Age) and the Colonial period) from the University of South Africa. He has over 12 years of experience in heritage management. Mr Engelbrecht established Ubique Heritage Consultants in 2012. He is currently studying for his MA Degree in Archaeology.

EXECUTIVE SUMMARY

Project description

EnviroAfrica CC appointed UBIQUE Heritage Consultants as independent heritage specialists following Section 38 of the NHRA and Section 24(5) of the National Environmental Management Act[1] (NEMA) 107 of 1998 to conduct a cultural heritage assessment to determine the impact of the proposed SKA Development of a New Science Exploratorium/ Sarao Science Centre on Erf 431 Carnarvon in the Pixley Ka Seme District Municipality and within the Kareeberg Local Municipality, Northern Cape Province.

Findings and Impact on Heritage Resources

UBIQUE Heritage Consultants assessed the development footprint on the **29th of June 2024**. Three instances of Historical Period resources were identified. This includes a midden (C/431-010) and two random scatters of cultural material (C/431-011 and C/431-012). These resources are without substantial archaeological context or matrix and are therefore deemed of minor scientific importance and not conservation-worthy (NCW). The expected direct impact on these resources would be NEGATIVE LOW before and after mitigation during the construction and operational phases. **The impact is negligible.**

A cemetery (C/431-013) was identified outside of the proposed footprint. All graves/cemeteries are of high significance and, therefore, worthy of conservation, and they should be mitigated. In the improbable event that impact occurs, it would be negative. However, since the municipal cemetery is well outside the proposed development, it **will thus not be impacted by development**. Therefore, the impact on this resource would be a NEGATIVE LOW before and after mitigation during the construction and operational phases, a NEGATIVE LOW before mitigation and a POSITIVE LOW after mitigation during the decommissioning phases.

Regarding the Palaeontological resources, the Desktop research (National Database and published data) concluded that **fossil heritage of scientific and conservational interest in the development area is relatively rare and of low scientific and conservational value**. Data indicates that fossil sites are generally rare, sporadic and unpredictable. A **low significance** has thus been allocated to the Construction phase of the development footprint. **This is in disagreement with the Moderate Sensitivity allocated to the development area by the SAHRIS Palaeontological Sensitivity Map and Medium Sensitivity allocated by the DFFE Screening Tool**. Due to the mapped Palaeontological Sensitivity, no site investigation was conducted, and thus, the actual Palaeontological Sensitivity of the development was not verified, but the desktop research confirmed that the area has a LOW sensitivity for paleo resources.

[1] NEMA is the national legislation that provides for the authorisation of certain controlled activities known as "listed activities".

In terms of palaeontological impacts, **a Low Palaeontological Significance has been allocated for the study area pre- and post-mitigation**. Therefore, the proposed development will not have damaging impacts on the area's palaeontological resources. **The development may thus be permitted to its whole extent, as the development footprint is not considered sensitive in terms of palaeontological resources.** It is consequently recommended that **no further palaeontological heritage studies, ground truthing, or specialist mitigation be required pending the discovery of newly discovered fossils.** (Appendix A, Butler 2024).

Recommendations

Based on the assessment of the potential impact of the development on the identified heritage, the following recommendations are made, taking into consideration any existing or potential sustainable social and economic benefits:

1. The scatters of Historical Period material and the midden feature (C/431-010, 011, 012), given a field rating of IVC, are of low cultural and historical significance and are thus considered **non-conservation worthy. No further mitigation is recommended concerning these resources.**

2. The cemetery (C/431-013) is well outside the proposed development and **will not be impacted by development**. Therefore, **no further mitigation is recommended concerning this resource.**

3. In terms of palaeontological impacts, **a Low Palaeontological Significance has been allocated for the study area pre- and post-mitigation**. Therefore, the proposed development will not have damaging impacts on the area's palaeontological resources. **The development may thus be permitted to its whole extent, as the development footprint is not considered sensitive in terms of palaeontological resources.** It is consequently recommended that **no further palaeontological heritage studies, ground truthing, or specialist mitigation be required pending the discovery of newly discovered fossils. However, in the event that fossil remains or trace fossils are discovered** either on the surface or exposed by excavations, it is recommended that:
   - the Environmental Control Officer (ECO) in charge of these developments must be informed. These discoveries ought to be protected, and the ECO must report to SAHRA (Contact details: SAHRA, 111 Harrington Street, Cape Town. PO Box 4637, Cape Town 8000, South Africa. Tel: 021 462 4502. Fax: +27 (0)21 462 4509. Web: www.sahra.org.za) so that mitigation can be carried out by a palaeontologist.
   - Before any fossil material can be collected from the development site, the specialist involved would need to apply for a collection permit from SAHRA. Fossil material must be housed in an official collection (museum or university), while all reports and fieldwork should meet the minimum standards for palaeontological impact studies proposed by SAHRA (2012).
   - These recommendations should be incorporated into the Environmental Management Programme (EMPr) for the Project (Appendix A).

4. Although all possible care has been taken to identify sites of cultural importance during the investigation of study areas, it is always possible that hidden or sub-surface sites could be overlooked during the assessment. If during construction, any evidence of archaeological sites or remains (e.g. remnants of stone-made structures, indigenous ceramics, bones, stone artefacts, ostrich eggshell fragments, charcoal and ash concentrations), fossils or other categories of heritage resources are found during the proposed development, SAHRA must be alerted as per section 35(3) of the NHRA. If unmarked human burials are uncovered, the SAHRA must be alerted immediately as per section 36(6) of the NHRA. Depending on the nature of the finds, a professional archaeologist or palaeontologist must be contacted as soon as possible to inspect the findings. If the newly discovered heritage resources are of archaeological or palaeontological significance, a Phase 2 rescue operation may be required, subject to permits issued by SAHRA. UBIQUE Heritage Consultants and its personnel will not be held liable for such oversights or costs incurred due to such oversights.

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ABBREVIATIONS

AIA:	Archaeological Impact Assessment
ASAPA:	Association of South African Professional Archaeologists
CRM:	Cultural Resource Management
EIA:	Early Iron Age
EMP:	Environmental Management Plan
ESA:	Earlier Stone Age
GPS:	Global Positioning System
HIA:	Heritage Impact Assessment
HWC:	Heritage Western Cape
IA:	Iron Age
IMP:	Integrated Management Plan
LSA:	Later Stone Age
MIA:	Middle Iron Age
MSA:	Middle Stone Age
NEMA:	National Environmental Management Act
NHRA:	National Heritage Resources Act
PHRA:	Provincial Heritage Resource Agency
PIA:	Palaeontological Impact Assessment
SADC:	Southern African Development Community
SAHRA:	South African Heritage Resources Agency
SAHRIS:	South African Heritage Resources Information System

1. INTRODUCTION

1.1 Scope of Study

The project involves the proposed SKA Development of a New Science Exploratorium/Sarao Science Centre on Erf 431 Carnarvon in the Kareeberg Local Municipality, Pixley Ka Seme District Municipality, Northern Cape Province. UBIQUE Heritage Consultants was appointed by EnviroAfrica CC as independent heritage specialists in compliance with Section 38 of the National Heritage Resources Act 25 of 1999 (NHRA) to conduct a cultural heritage assessment (AIA/HIA) of the development area.

The assessment aims to identify and report any heritage resources that may fall within the development footprint; to determine the impact of the proposed development on any sites, features, or objects of cultural heritage significance; to assess the significance of any identified resources; and to assist the developer in managing the documented heritage resources in an accountable manner, within the framework provided by the National Heritage Resources Act (Act 25 of 1999) (NHRA).

South Africa's heritage resources are rich and widely diverse, encompassing sites from all periods of human history. Resources may be tangible, such as buildings and archaeological artefacts, or intangible, such as landscapes and living heritage. Their significance is based on their aesthetic, architectural, historical, scientific, social, spiritual, linguistic, economic or technological values; their representation of a time or group; their rarity; and their sphere of influence.

Natural (e.g. erosion) and human (e.g. development) activities can jeopardise the integrity and significance of heritage resources. In the case of human activities, a range of legislation exists to ensure the timely and accurate identification and effective management of heritage resources for present and future generations.

The result of this investigation is presented in this archaeological impact assessment report. It comprises the recording of present/ absent heritage resources and offers recommendations for managing them within the proposed development context.

Depending on SAHRA's acceptance of this report, the developer will receive permission to proceed with the proposed development, considering any proposed mitigation measures.

1.2 Assumptions and Limitations

It is assumed that the description of the proposed project, as provided by the client, is accurate. Furthermore, it is assumed that the public consultation process undertaken as part of the Environmental Impact Assessment (EIA) is comprehensive and does not have to be repeated as part of the heritage/archaeological impact assessment.

The significance of the sites, structures, and artefacts is determined by their historical, social, aesthetic, technological, and scientific value in relation to their uniqueness, condition of preservation, and research potential. The various aspects are not mutually exclusive, and any site is evaluated with reference to any of these aspects. Cultural significance is site-specific and relates to the content and context of the site.

The comprehensive field survey and intensive desktop study have taken all possible care to identify sites of cultural importance within the development areas. However, it is essential to note that some heritage sites may have been missed due to their subterranean nature or dense vegetation cover. No subsurface investigation (i.e. excavations or sampling) was undertaken since an SAHRA permit is required for such activities. Therefore, should any heritage features and/or objects, such as architectural features, stone tool scatters, artefacts, human remains, or fossils, be uncovered or observed during construction, operations must be stopped, and a qualified archaeologist must be contacted to assess the find. Observed or located heritage features and/or objects may not be disturbed or removed in any way until the heritage specialist has been able to assess the significance of the site (or material) in question.

2. STUDY APPROACH AND METHODOLOGY

2.1 Desktop Study

The first step in the methodology was to conduct a desktop study of the heritage background of the area and the proposed development site. This entailed scoping and scanning historical texts/records, previous heritage studies, and research around the study area.

The study area is contextualised by incorporating data from previous HIA/AIA reports and a digital archival search. The objective is to extract data and information on the area in question, looking at archaeological sites, historical sites and graves.

No archaeological site data was available for the project area. A concise account of the archaeology and history of the broader study area was compiled (sources listed in the bibliography).

2.1.1 Literature Review

A literature survey was undertaken to obtain background information regarding the area. Through researching the SAHRA APM Report Mapping Project records and the SAHRIS online database (http://www.sahra.org.za/sahris), it was determined that several other archaeological or historical studies had been performed within the broader vicinity of the study area. Sources consulted in this regard are indicated in the bibliography.

2.2 Field Study

Phase 1 (AIA/HIA) requires the completion of a field study to establish and ensure the following:

2.2.1 Systematic Survey

A systematic survey of the proposed project area was completed to locate, identify, record, photograph, and describe archaeological, historical or cultural interest sites.

2.2.2 Recording Significant Areas

The survey was tracked, and GPS points of identified significant areas were recorded with a handheld GPS and an Android smartphone using a Locus Map application. Photographs of the environment and identified heritage resources were taken, and detailed field notes were taken to describe observations. The layout of the area and plotted GPS points, tracks and coordinates were transferred to Google Earth, and QGIS and maps were created.

2.2.3 Definitions of Heritage Resources

The NHRA defines a heritage resource as any place or object of cultural significance, i.e., aesthetic, architectural, historical, scientific, social, spiritual, linguistic, or technological value or significance. These include, but are not limited to, the following wide range of places and objects:

- Living heritage as defined in the National Heritage Council Act No 11 of 1999 (cultural tradition; oral history; performance; ritual; popular memory; skills and techniques; indigenous knowledge systems; and the holistic approach to nature, society and social relationships);
- Ecofacts (non-artefactual organic or environmental remains that may reveal aspects of past human activity; definition used in KwaZulu-Natal Heritage Act 2008);
- places, buildings, structures and equipment;
- places to which oral traditions are attached or which are associated with living heritage;
- historical settlements and townscapes;
- landscapes and natural features;
- geological sites of scientific or cultural importance;
- archaeological and palaeontological sites;
- graves and burial grounds;
- public monuments and memorials;
- sites of significance relating to the history of slavery in South Africa;
- movable objects, but excluding any object made by a living person; and
- battlefields.

2.3 Determining Significance

Heritage resources are considered of value if the following criteria apply:

a.	It is important in the community or pattern of South Africa's history;
b.	It has uncommon, rare or endangered aspects of South Africa's natural or cultural heritage;
c.	It has the potential to yield information that will contribute to an understanding of South Africa's natural or cultural heritage;
d.	It is vital in demonstrating the principal characteristics of a particular class of South Africa's natural or cultural places or objects;
e.	It exhibits particular aesthetic characteristics valued by a community or cultural group;
f.	It is essential in demonstrating a high degree of creative or technical achievement at a particular period;
g.	It has a strong or unique association with a particular community or cultural group for social, cultural or spiritual reasons;
h.	It has a strong or special association with the life or work of a person, group or organisation of importance in the history of South Africa;
i.	It is of significance relating to the history of slavery in South Africa.

Levels of significance of the various types of heritage resources observed and recorded are determined by the following criteria:

CULTURAL & HERITAGE SIGNIFICANCE	
LOW	A cultural object found out of context, not part of a site or without any related feature/structure in its surroundings.
MEDIUM	Any site, structure or feature is regarded as less important due to several factors, such as date, frequency and uniqueness. Likewise, any important object found out of context.
HIGH	Any site, structure or feature is regarded as important because of its age or uniqueness. Graves are always categorised as of a high importance. Likewise, any important object found within a specific context.

Field Ratings or Gradings are assigned to indicate the level of protection required and who is responsible for national, provincial, or local protection.

FIELD RATINGS & GRADINGS	
National Grade I	Heritage resources with exceptional qualities to the extent that they are of national significance and should therefore be managed as part of the national estate.
Provincial Grade II	Heritage resources with qualities provincial or regional importance, although it may form part of the national estate, it should be managed as part of the provincial estate.
Local Grade IIIA	Heritage resources are of local importance and worthy of conservation. Therefore, it should be included in the heritage register and not be mitigated (high significance).
Local Grade IIIB	Heritage resources are of local importance and worthy of conservation. Therefore, it should be included in the heritage register and mitigated (high/ medium significance).
General Protection Grade IVA	The site/resource should be mitigated before destruction (high/ medium significance).
General protection Grade IVB	The site/resource should be recorded before destruction (medium significance).
General protection Grade IVC	Phase 1 is considered sufficient recording and may be demolished (low significance).

2.4 Determining Impact

A heritage resource impact may be defined broadly as the net change, either beneficial or adverse, between the integrity of a heritage site with and without the proposed development. Beneficial impacts occur wherever a proposed development actively protects, preserves, or enhances a heritage resource by minimising natural site erosion or facilitating non-destructive public use. More commonly, development impacts are of an adverse nature and can include:

- destruction or alteration of all or part of a heritage site;
- isolation of a site from its natural setting and/or
- introduction of physical, chemical or visual elements out of character with the heritage resource and its setting.

Beneficial and adverse impacts can be direct or indirect and cumulative, as implied by the examples. Although indirect impacts may be more difficult to foresee, assess and quantify, they must form part of the assessment process.

2.4.1 Impact Rating System

Impact assessment must take account of the nature, scale, and duration of impacts on the environment, whether such impacts are positive or negative. Impact assessment is completed according to the project phases:

- planning
- construction
- operation
- decommissioning

Where necessary, the proposal for mitigation or optimisation of an impact is detailed. A brief discussion of the impact and the rationale behind assessing its significance is included. The rating system is applied to the potential impacts on the receiving environment and includes an objective evaluation of the impact mitigation. In assessing the significance of each impact, the following criteria are used:

NATURE		
Loss of Archaeological & Cultural Heritage		
GEOGRAPHICAL EXTENT		
This is defined as the area over which the impact will be experienced.		
1	Site	The impact will only affect the site.
2	Local/district	Will affect the local area or district.
3	Province/region	Will affect the entire province or region.

4	International and National	Will affect the entire country.
PROBABILITY		
This describes the chance of occurrence of an impact.		
1	Unlikely	The chance of the impact occurring is extremely low (Less than a 25% chance of occurrence).
2	Possible	The impact may occur (Between a 25% to 50% chance of occurrence).
3	Probable	The impact will likely occur (Between a 50% to 75% chance of occurrence).
4	Definite	The impact will undoubtedly occur (Greater than a 75% chance of occurrence).
DURATION		
This describes the duration of the impacts. Duration indicates the lifetime of the impact as a result of the proposed activity.		
1	Short term	The impact will either disappear with mitigation or will be mitigated through natural processes in a span shorter than the construction phase (0 – 1 years), or the impact will last for the period of a relatively short construction period and a limited recovery time after construction, thereafter it will be entirely negated (0 – 2 years).
2	Medium term	The impact will continue or last for some time after the construction phase but will be mitigated by direct human action or by natural processes thereafter (2 – 10 years).
3	Long term	The impact and its effects will continue or last for the entire operational life of the development. However, they will be mitigated by direct human action or by natural processes thereafter (10 – 30 years).
4	Permanent	The only class of impact that will be non-transitory. Mitigation either by man or natural process, will not occur in such a way or such a period that the impact can be considered indefinite.
INTENSITY/ MAGNITUDE		
Describes the severity of an impact.		
1	Low	Impact affects the quality, use and integrity of the system/component in a way that is barely perceptible.
2	Medium	Impact alters the quality, use and integrity of the system/component, but the system/component still continues to function in a moderately modified way and maintains general integrity (some impact on integrity).
3	High	The impact affects the continued viability of the system/ component, and the quality, use, integrity and functionality of the system or component is severely impaired and may temporarily cease—high costs of rehabilitation and remediation.
4	Very high	The impact affects the continued viability of the system/component, and the quality, use, integrity and functionality of the system or component permanently ceases and is irreversibly impaired. Rehabilitation and remediation are often impossible. If possible, rehabilitation and remediation are often unfeasible due to extremely high costs.

REVERSIBILITY		
This describes the degree to which an impact can be successfully reversed upon completion of the proposed activity.		
1	Completely reversible	The impact is reversible with the implementation of minor mitigation measures.
2	Partly reversible	The impact is partly reversible, but more intense mitigation measures are required.
3	Barely reversible	The impact is unlikely to be reversed even with intense mitigation measures.
4	Irreversible	The impact is irreversible, and no mitigation measures exist.

IRREPLACEABLE LOSS OF RESOURCES		
This describes the degree to which resources will be irreplaceably lost as a result of a proposed activity.		
1	No loss of resource	The impact will not result in the loss of any resources.
2	Marginal loss of resource	The impact will result in a marginal loss of resources.
3	Significant loss of resources	The impact will result in a significant loss of resources.
4	Complete loss of resources	The impact results in a complete loss of all resources.

CUMULATIVE EFFECT		
This describes the cumulative effect of the impacts. A cumulative impact is an effect which in itself may not be significant. However, it may become significant if added to other existing or potential impacts emanating from similar or diverse activities due to the project activity in question.		
1	Negligible cumulative impact	The impact would result in negligible to no cumulative effects.
2	Low cumulative impact	The impact would result in insignificant cumulative effects.
3	Medium cumulative impact	The impact would result in minor cumulative effects.
4	High cumulative impact	The impact would result in significant cumulative effects.

SIGNIFICANCE
Significance is determined through a synthesis of impact characteristics. Significance is an indication of the importance of the impact in terms of both physical extent and time scale and, therefore, indicates the level of mitigation required. The calculation of the significance of an impact uses the following formula:
(Extent + probability + reversibility + irreplaceability + duration + cumulative effect) x magnitude/intensity.
The summation of the different criteria will produce a non-weighted value. By multiplying this value with the magnitude/intensity, the resultant value acquires a weighted characteristic which can be measured and assigned a significance rating.

POINTS	IMPACT SIGNIFICANCE RATING	DESCRIPTION
6 to 28	Negative low impact	The anticipated impact will have negligible negative effects and will require little to no mitigation.
6 to 28	Positive low impact	The anticipated impact will have minor positive effects.
29 to 50	Negative medium impact	The anticipated impact will have moderate negative effects and will require moderate mitigation measures.
29 to 50	Positive medium impact	The anticipated impact will have moderate positive effects.
51 to 73	Negative high impact	The anticipated impact will have significant effects and will require significant mitigation measures to achieve an acceptable level of impact.
51 to 73	Positive high impact	The anticipated impact will have significant positive effects.
74 to 96	Negative very high impact	The anticipated impact will have highly significant effects and are unlikely to be able to be mitigated adequately. These impacts could be considered "fatal flaws".
74 to 96	Positive very high impact	The anticipated impact will have highly significant positive effects.

2.5 Report

The desktop research and field survey results are compiled in this report. The identified heritage resources and anticipated direct, indirect, and cumulative impacts of the proposed project's development on the identified heritage resources will be presented objectively. Alternatives are offered if any significant sites are impacted adversely by the proposed project. All efforts will be made to ensure that all studies, assessments, and results comply with the relevant legislation, code of ethics, and Association of South African Professional Archaeologists (ASAPA) guidelines. The report aims to assist the developer in managing the documented heritage resources in a responsible manner and protecting, preserving, and developing them within the framework provided by the National Heritage Resources Act of 1999 (Act 25 of 1999).

3. PROJECT OVERVIEW

UBIQUE Heritage Consultants were appointed by EnviroAfrica CC as independent heritage specialists in accordance with Section 38 of the NHRA to conduct a cultural heritage assessment to determine the impact of the SKA Development of a New Science Exploratorium/ Sarao Science Centre on Erf 431 Carnarvon in the Pixley Ka Seme District Municipality and within the Kareeberg Local Municipality, Northern Cape Province.

The SKA radio telescope is used to observe and research the galaxies of the Milky Way, and the proposed project plans to build an information centre on the outskirts of Carnarvon in the Northern Cape. The aim is to inform residents about the SKA and establish an interest in science and the universe. The information centre is designed to draw local and international tourists. The information centre would put the SKA in the middle of the local and wider community.

The information centre is planned on a site on the outskirts of but adjacent to the town, on a proclaimed municipal plot. The centre will consist of two buildings, two vehicle parking areas and stalls for selling merchandise. Apart from awareness and education, the aim is to provide opportunities for local people to improve their circumstances in an isolated area where livelihoods are hard to come by.

3.1 Technical Information

PROJECT DESCRIPTION	
Project name	Proposed New Science Exploratorium, Carnarvon, Northern Cape
Description	Proposed SKA Development of a New Science Exploratorium/ Sarao Science Centre on Erf 431 Carnarvon in the Pixley Ka Seme District Municipality and within the Kareeberg Local Municipality, Northern Cape Province.
DEVELOPER	
South African Radio Astronomy Observatory (SARAO)	
Development type	Transformation of Land => Indigenous vegetation
PROPERTY DETAILS	
Province	Northern Cape
District municipality	Pixley ka Seme District Municipality
Local municipality	Karoo Highlands/Karoo Hoogland Local Municipality
Topo-cadastral map	1:50 000 3022CC
Farm name	Erf 431
Closest town	Carnarvon
GPS Coordinates	**30° 58' 01" S** **22° 07' 25" E**
PROPERTY SIZE	N/A

DEVELOPMENT FOOTPRINT SIZE	Approximately 4,5ha
LAND US	
Previous	Municipal
Current	Municipal
Rezoning required	Yes
Sub-division of land	No

DEVELOPMENT CRITERIA IN TERMS OF SECTION 38(1) NHRA	YES/NO
Construction of a road, wall, power line, pipeline, canal or other linear forms of development or barrier exceeding 300 m in length.	Yes
Construction of bridge or similar structure exceeding 50 m in length.	Yes
Construction exceeding 5000m ².	Yes
Development involving three or more existing erven or subdivisions.	No
Development involving three or more erven or divisions that have been consolidated within the past five years.	Yes
Rezoning of site exceeding 10 000 m ².	Yes
Any other development category, public open space, squares, parks, recreation grounds.	Yes

Figure 1 *Locality of the development footprint, indicated on Google Earth Satellite imagery.*

Figure 2 *Locality of the development footprint, indicated on Google Earth Satellite imagery.*

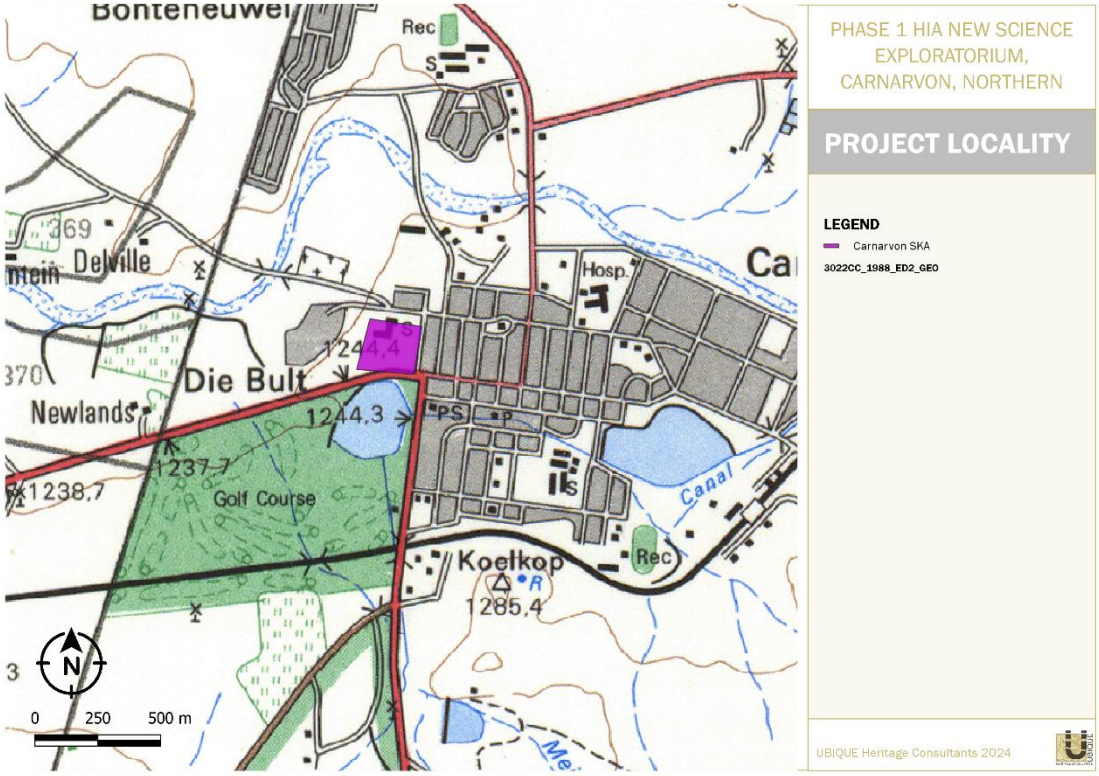

Figure 3 *Locality of the development footprint, indicated on 1: 50 000 2920BD map.*

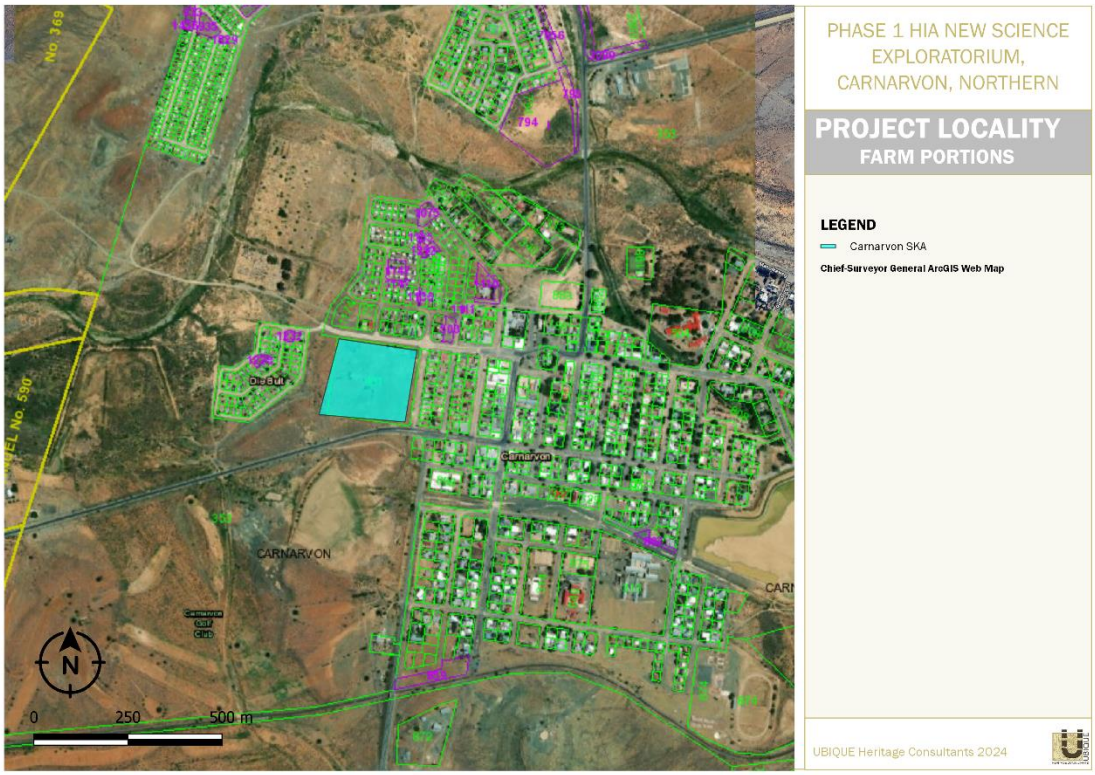

Figure 4 shows the regional locality of the development footprint, indicated on the Chief-Surveyor General ArcGIS Web Map (https://csggis.drdlr.gov.za/psv/).

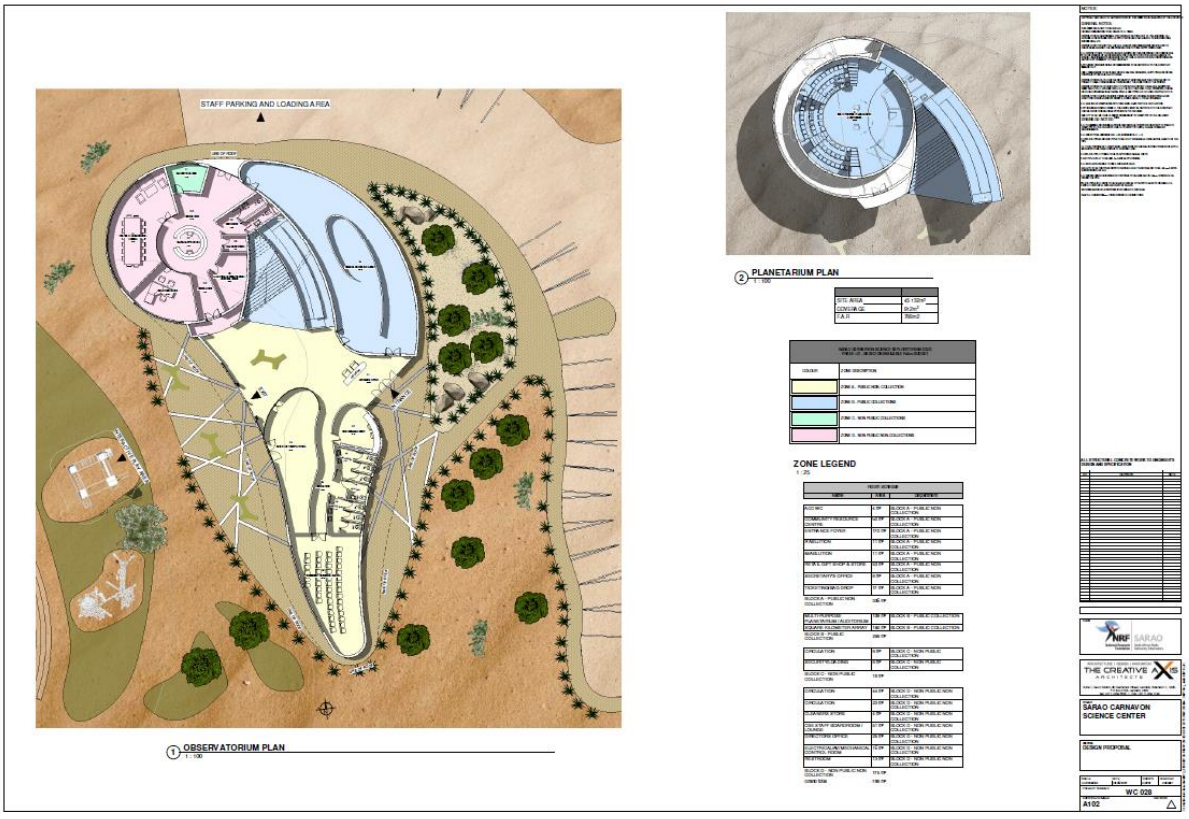

Figure 5 Observatorium Plan. Image provided by Client.

Figure 6 *Proposed development layout. Image provided by client.*

4. HISTORICAL AND ARCHAEOLOGICAL BACKGROUND

4.1 Region: Northern Cape

South Africa has a long and varied history of human occupation (Deacon & Deacon 1999). This occupation dates to approximately 2mya (million years ago) (Mitchell 2002). Briefly, the archaeology of South Africa can be divided into three "major" periods: the Stone Age, the Iron Age and the Historical Period. In addition, various archaeological and historical sites have been identified and documented throughout South Africa, including the Northern Cape provinces.

4.1.1 Stone Age

The history of the Northern Cape Province is reflected in a rich archaeological landscape with a wealth of pre-colonial archaeological sites. Numerous sites have been identified and documented across the region, dating to the earlier, middle, and later Stone Ages.

In southern Africa, the Stone Age can be divided into three periods. It is, however, critical to note that dates are relative and only provide a broad framework for interpretation. The division of the Stone Age, according to Lombard et al. (2012), is as follows:

- Earlier Stone Age (ESA): >2 000 000 - >200 000 years ago
- Middle Stone Age (MSA): <300 000 - >20 000 years ago
- Later Stone Age (LSA): <40 000 - until the historical period

In short, the Stone Age refers to humans mainly utilising stone as a technological marker. Each sub-division is formed by industries where the assemblages share attributes or common traditions (Lombard et al. 2012). The ESA is characterised by flakes produced from pebbles, cobbles, percussive tools, and objects created later during this period, such as large hand axes, cleavers, and other bifacial tools (Klein 2000). The MSA is associated with small flakes, blades and points. It is generally suggested that the aforementioned was made and utilised for hunting activities and had numerous functions (Wurz 2013). Hunter-gatherer lifeways are attested to in the Middle Stone Age record for at least the last 100,000 years (Wadley 2015). Such foraging groups continued to occupy the landscape throughout the Later Stone Age between 40,000 and 20,000 years ago, lasting until a couple of centuries.

About 2000 years ago, during the final ceramic Later Stone Age, the first evidence for goats/sheep was found in southern Africa, possibly associated with Khoekhoe herding groups (e.g., Sadr 2008). These groups came into being as a combination of the migration of East African pastoralists who mixed with local hunter-gatherers (e.g., Choudhury et al. 2021). However, it is almost impossible to differentiate between the San and Khoekhoe groups based on archaeological or genetic records. Presently, these populations are referred to as Khoisan (Barnard 1992). Furthermore, the LSA is characterised by microlithic stone tools, scrapers and flakes (Binneman 1995; Lombard et al.

2012). The LSA is also associated with rock art. These sites are commonly found on slopes, hilltops, rocky outcrops and occasionally in river beds (Kruger 2018).

4.1.2 Iron Age

Archaeologically, the arrival of African farming communities from West Africa about 1700 years ago and their subsequent settlement, first in the northeastern parts and later in much of southern Africa, is known as the Iron Age (Huffman 2007). These farmers encountered Khoisan communities (Mitchell 2002). The archaeology of farming communities of southern Africa encompasses three phases. The Early Iron Age, dated 200 – 900 CE, represents the arrival of farmers in southern Africa. The Middle Iron Age (900 – 1300 CE) is best associated with the onset of state formation in the Limpopo Valley of South Africa. Finally, the Late Iron Age (1300 – 1840 CE) marked the arrival and spread of ancestral Nguni- and Sotho-Tswana communities into southern Africa and the development of state-level societies, such as Great Zimbabwe and Mutapa (Huffman 2007; Badenhorst 2010).

The Iron Age (IA) is characterised by the use of metal (Coertze & Coertze 1996: 346). There is some controversy about the periods within the IA. Van der Ryst & Meyer (1999) have suggested that there are two phases within the IA, namely:

- Early Iron Age (EIA) 200 – 1000 A.D
- Late Iron Age (LIA) 1000 – 1850 A.D

However, Huffman (2007) suggests instead that there are three periods within the Iron Age, these periods are:

- Early Iron Age (EIA) 250 – 900 A.D
- Middle Iron Age (MIA) 900 – 1300 A.D
- Late Iron Age (LIA) 1300 – 1840 A.D

Thomas Huffman believes that the Middle Iron Age should be included within this period; his dates have been widely accepted in the IA field of archaeology.

The South African Iron Age is generally characterised by farming communities with domesticated animals, cultivated plants, manufactured and used ceramics and beads, and smelted iron for weapons and manufactured tools (Hall 1987). Iron Age people were often mixed farmers/agropastoralists. These agropastoralists generally lived in areas with sufficient water for domestic use and arable soil that could be cultivated with an iron hoe. Most Iron Age (IA) settlements built by agropastoralists were permanent settlements (with a few exceptions). They comprised houses, raised grain bins, storage pits and animal kraals/byres, contrasting with pastoralists' and hunter-gatherers' temporary camps (Huffman 2007). It is evident in the archaeological record that IA groups had migrated with their material culture (Huffman 2002).

4.1.3 Historical Period

The Historical/Colonial period generally refers to the last 500+ years when European settlers and colonialism entered southern Africa (Binneman et al. 2011). During the colonial frontier period, place names started becoming fixed on maps and farm names, specifically in a cadastral sense. As an archaeological period, the Late Iron Age ended by the 1840s. By then, the ongoing Mfecane caused major socio-political disruptions in southern Africa. During the late 1600s and 1700s, Dutch settlers subjugated the Khoisan and established the Cape Colony. By the 1800s, a culmination of preceding tensions rooted in competition amongst local chiefdoms for trade at Delagoa Bay, increased demand for ivory by European traders, and droughts severely impacted maise-dependent communities. The steady rise of chiefdoms, such as the Mabhudu, Ndwande, Qwabe and Mtethwa, meant rulers expanded their patronage networks by conquering a competitor's land and people. Smaller chiefdoms caught up in the conflict fled and either attacked or merged with neighbouring populations. This political unrest would be followed by a similar uprising, the Mfecane (ca. 1818-1840 CE) (Ross 1999; Bonner 2002; Chewins 2016). European traders, travellers, and missionaries encountered Khoisan and African farmers during this time. Subsequent relations, with negative and positive impacts, continued into the 20th century (e.g., Hall 1987).

The development of a rich colonial frontier can be seen in the archaeological record (Kruger 2018). However, it was not until relatively recently (because of its distance from the Cape Colony) that this arid part of South Africa's interior was colonised. The historical period of the Northern Cape coincides with the incursion of white traders, hunters, explorers, and missionaries into the interior of South Africa (Engelbrecht & Fivaz 2019). The documented records of this region dating from the 18th- and 19th- centuries mainly pertain to areas south of and along the Orange River (Morris 2018a, b & c). The Swedish travellers Hendrick Wikar and Robert Gordon, two of the earliest travellers, had followed the river as far as and beyond the region during the 1770s. Wikar and Gordon provided descriptions of the terrain and the communities living along the river (Morris 2018a, b & c; Morris & Beaumont 1991). Some other early travellers, traders, and missionaries who arrived in the region during the 19th century include PJ Truter, William Somerville, Cowan, Donovan, Burchell and Campbell (De Jong 2010). The London Mission Society (LMS) station near Kuruman was established in 1817 by James Read (De Jong 2010; Van Vollenhoven 2014). Various buildings and structures that have been documented and recorded can be associated with early travellers, traders, and missionaries. There is also evidence of the settlements of the first white farmers and towns in the Northern Cape. These historical buildings and structures have been captured on the SAHRIS database in areas such as Kakamas, Kenhardt, Keimoes and Upington.

The surveying, division, and transference of government-owned land to farmers marked the initial distribution of land to colonial farmers from the 1880s onward (De Jong 2010). It is believed that most farms were still government farms and were leased to farmers in 1875. The farms were only later sold to individuals (Van Vollenhoven 2014). During the late 1920s, more permanent and large-scale settlements and possibly some of the first farmsteads started to appear in the region.

The region has been the backdrop to various incidents of conflict. Numerous factors such as population growth, increasing pressure on natural resources, the emergence of power blocs'

attempts to control trade, the emergence of the Griquas, and penetration of the Korana and early white communities from the southwest resulted in a period of instability in South Africa. Furthermore, with the introduction of loan farms in the second half of the 18th century, an influx of newcomers such as trekboers, European game hunters and livestock thieves contributed to the region's volatility and sociocultural stress and transformation (Mlilo 2019).

The period known as the Difaqane/Mfecane began in the late 18th century and effectively ended with the settlement of white farmers in the interior (De Jong 2010; Mlilo 2019). The Difaqane/Mfecane period also affected the Northern Cape Province around the 1820s, relatively later than the rest of southern Africa. This period was prompted by the incursion of displaced refugees associated with the Fokeng, Tlokwa, Hlakwana and Phuting groups (De Jong 2010).

Moreover, during the 1830s, the Voortrekkers started migrating northwards from the Cape Colony. This migration was due to their dissatisfaction with British rule (Eldredge 1987). The Voortrekkers' migration is known as the "Groot Trek" (Great Trek). The Voortrekkers had conflict with Tswana and missionary groups who had settled near Bechuanaland and Griqualand West (Van Vollenhoven 2014). A series of wars and battles between the Voortrekkers, Zulu and Sotho-Tswana communities eventually arose due to the migrations (De Bruyn 2019).

Between 1879 and 1880, the region was also caught up in the Koranna War. Further military activity in the area included the rise of the 'rebels' during the Anglo-Boer War and again in 1915 with the incursion of German troops (Morris 2018a, b & c). Numerous graves can be linked to the battles fought during the 1914 Rebellion (Engelbrecht & Fivaz 2019). It is believed that any military settlement related to the Koranna Wars would have been closer to the Orange River (Webley & Halkett 2014).

With the arrival of the Dutch settlers in the Cape in the mid-17th century, clashes between the Europeans and Khoi tribes in the Cape Peninsula resulted in the Goringhaiqua and Goraxouqua migrating north towards the Gariep/Orange River in 1680. These tribes became known as the Korannas, living as small tribal entities in separate areas (Penn 2005).

Bushmanland was one of the last regions of the Cape Province to be settled by early European farmers. This was because the region was very arid and far from Cape Town and the produce markets. Many of the farms in the Bushmanland area were only allocated after the introduction of the windpump to South Africa in the 1870s. In other words, the windpump made the arid lands accessible and suitable for grazing (Webley & Halkett 2012a). Historical literature also confirms that San hunter-gatherers occupied Bushmanland early in the 19th century. During the 19th century, Basters of mixed descent lived around the salt pans in Bushmanland. They were, however, driven away from the land as the farms were surveyed and made available to European farmers (Webley & Halkett 2012a). In the late 18th and early 19th centuries, with the introduction and implementation of the commando system, the Karoo 'Bushmen' were eventually destroyed or indentured into farm labour (Kaplan 2015).

4.2 Local

Briefly, Carnarvon was a Rhenish mission station dating back to the 1940s. The town was originally known as Harmsfontein (History of Carnarvon 2019). Harmsfontein (Carnarvon) was established in 1853 along a route between Cape Town and Botswana that early explorers and traders used. Harmsfontein was later renamed Carnarvon in 1874, in honour of the British Colonial Secretary Lord Carnarvon (Wikipedia Carnarvon 2024).

The town is well-known for its Corbelled houses. Corbelled houses are domed-roof houses constructed from flat stones. These were built between 1811 and 1815. Afrikaans poet A.G. Visser had significant ties to Carnarvon, and his former residence in the town is still standing (Wikipedia Carnarvon 2024). Moreover, the Carnarvon Museum, established in 1907, was initially the community hall for the Dutch Reformed Church. It was later donated to the municipality when a new community centre was built in 1973. The museum features regional cultural exhibits, including antiques such as an old hearse from the Dutch Reformed Church. A corbelled house relocated from a nearby farm is preserved outside the museum (Wikipedia Carnarvon 2024).

During the Second Boer War, the Cape administration constructed a fort on a hill overlooking Carnarvon. The hill, now called Koeëlkop (from the Afrikaans word for bullet, *koeël*), now hosts a water reservoir, and the fort's remains were later reconstructed (Wikipedia Carnarvon 2024).

During the early 1900s, following a geologist report in 1907 that reported the presence of a vast lake of oil beneath the surface of the Upper Karoo, considerable efforts were made to strike oil and to turn Carnarvon into a thriving crude oil production. However, after repeated attempts, the search for oil was abandoned in 1921 (History of Carnarvon 2019).

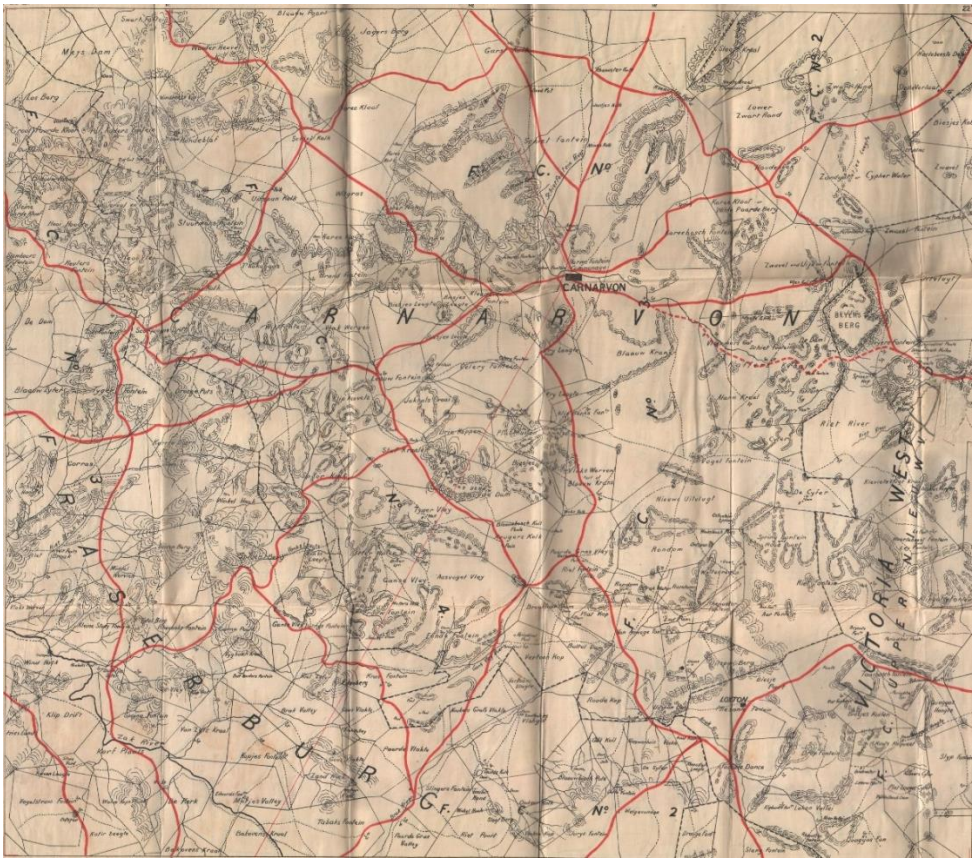

Figure 7 *Imperial Map of Carnarvon and surrounds. Image from UCT digital collections, https://exhibits.stanford.edu/*

Figure 8 *Imperial Map of Carnarvon and surrounds. Image from UCT digital collections, https://exhibits.stanford.edu/*

5. SITE SENSITIVITY: ARCHAEOLOGICAL AND CULTURAL HERITAGE THEME

5.1 Site Verification

The site sensitivity verification was completed through a desktop analysis, satellite imagery and literature research, and on-site inspection.

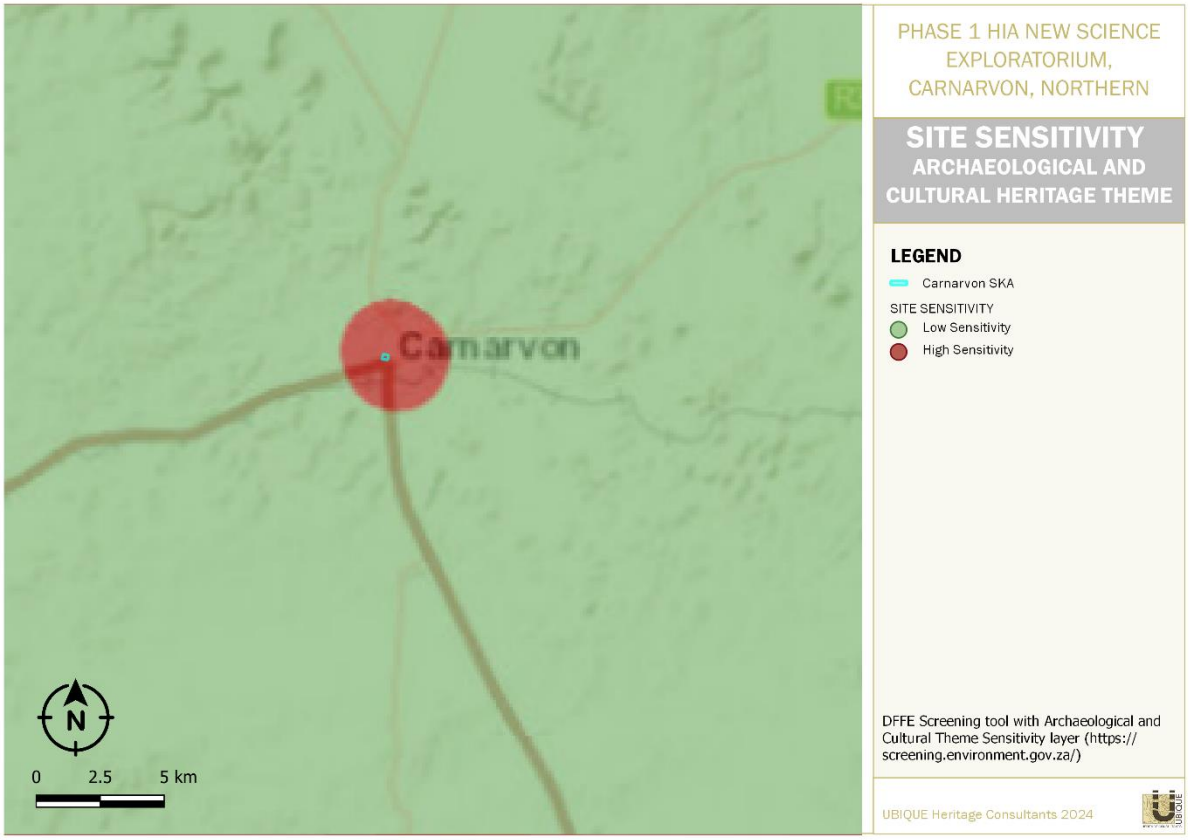

Figure 9 *The Project area indicated on the DFFE Screening tool with Archaeological and Cultural Theme Sensitivity layer (https://screening.environment.gov.za/)*

***Figure* 10** *The Project area indicated on the DFFE Screening tool with Archaeological and Cultural Theme Sensitivity layer (https://screening.environment.gov.za/)*

Our findings disagree with the site sensitivity of the project footprint as indicated by the DFFE Screening Tool. The DFFE Screening Tool (https://screening.environment.gov.za/) shows a High Archaeological and Cultural Theme Sensitivity within and around the proposed development footprint (Figures 9 and 10). However, the footprint itself has a **predominately Low Sensitivity. T**he instances of cultural material identified are considered NCW and thus have a low significance. The study area's consulted HIA and AIA reports predominantly reported on low significant resources, with few instances of medium to high significant resources. The Archaeological and Cultural Heritage Theme (DFFE Screening Tool) shows areas of high significance, mainly within the town of Carnarvon. The high sensitivity corresponds with the instances of Grade II sites on the SAHRA database.

5.2 Site Sensitivity Desktop Results

Due to the wide range of HIA/AIA reports completed in the region, this desktop study does not include all the reports. However, most reports recorded artefacts and features relating to the Stone Age and the Historical Period. These reports were obtained from the SAHRA database.

A handful of impact assessments were conducted near the proposed development in and around Carnarvon, consulted HIAs that identified cultural resources reported on material and features

relating to the Stone Ages and the Historical/Colonial period (e.g. Dreyer 2007b, c, 2008; Rossouw 2015; Van der Walt 2014).

5.2.1 Stone Age

Very few of the consulted impact assessments reported on lithic material within the Carnarvon area. Lithic occurrences dating to the MSA and LSA periods were identified. Most of the occurrences were surface scatters of low significance – these scatters mainly consisted of flakes and informal stone tools, some of which were highly patinated (e.g. Dreyer 2007b; Rossouw 2015).

However, most of the reports conducted in the wider region around areas such as Upington, Kakamas, Keimoes, and Kenhardt reported on lithic material dating from the ESA, MSA, and LSA. These include but are not limited to Beaumont (2008b), Dreyer (2006), Engelbrecht & Fivaz (2018, 2019 a), Fivaz & Engelbrecht (2019, 2020a, b and c, 2021 a and b), Kaplan (2011, 2016a, b and c, 2017), Morris (2010, 2011, 2013d, 2017b), Orton (2013, 2014, 2016, 2020), Van der Walt (2020), Van Schalkwyk (2010, 2011, 2013, 2014) and Webley & Halkett (2010, 2014). Most lithic occurrences recorded ranged from cores, flakes, blades, chunks, and scrapers. Some sites also yielded fragments of OES and grindstones. Most of which were of low significance.

5.2.2 Rock Art

Only one of the consulted HIAs reported on a rock engraving site (black boulders with engravings in both Afrikaans / Dutch as well as English). It is located approximately 55km NW of Carnarvon, near Klerkshoop (Van der Walt 2014).

5.2.3 Iron Age

None of the consulted HIAs/AIAs reported on any cultural material or features relating to the Iron Age near the proposed development area.

5.2.4 Historical/Colonial Period

Some consulted HIAs reported on cultural material and features dating to the Historical/Colonial period. The historical period resources identified mainly included farmhouses with associated features such as labourers' dwellings (made from mudbrick) and several stone-packed kraals (e.g. Dreyer 2007c, 2008, Van der Walt 2014). In addition, some houses from the historical period are still in use (Rossouw 2015). Interestingly, two farmhouses and two corbelled huts that form the centre of the farmhouse were declared national monuments (Dreyer 2007c, 2008).

Numerous sites have been documented in the Carnarvon area. Some of these sites have been graded as Grade IIIa, IIIc with or Grade II. The sites range from buildings, stonewalling, artefacts, rock art, and burial grounds to graves. These can all be found on the SAHRA database:

SITES IDENTIFIED ON THE SAHRA DATABASE				
FullSiteName	SiteReference	SiteType	Grading	Coordinates
Old Parsonage, Union Square, Carnarvon	9/2/019/0002-023	Building	Grade II	-30.966640, 22.128706
Standard Bank, Alheit Street, Carnarvon	9/2/019/0002-077	Building		-30.966848, 22.133041
10 Daniel Street, Carnarvon	9/2/019/0002-080	Building		-30.967645, 22.129526
Erf 330, Hanau Street, Carnarvon	9/2/019/0002-085	Building		-30.969875, 22.130719
17 Daniel Street, Carnarvon	9/2/019/0002-086	Building		-30.967311, 22.129118
Erf 328, Hanau Street, Carnarvon	9/2/019/0002-087	Building		-30.969741, 22.129436
22 Grey Street, Carnarvon	9/2/019/0002-125	Building		-30.967155, 22.130480
19 Church Street, Carnarvon	9/2/019/0002-128	Building		-30.967148, 22.128376
22 Zahn Street, Carnarvon	9/2/019/0002-129	Building		-30.968333, 22.132980
11 Sterrenberg Street, Carnarvon	9/2/019/0002-130	Building		-30.967203, 22.125782
7 Sterrenberg Street, Carnarvon	9/2/019/0002-131	Building		-30.967063, 22.125781
2 Victoria Street, Carnarvon	9/2/019/0002-134	Building		-30.973373, 22.126400
8 Sterrenberg Street, Carnarvon	9/2/019/0002-135	Building		-30.967652, 22.125990
24 Daniel Street, Carnarvon	9/2/019/0002-136	Building		-30.965967, 22.129758
4 Daniel Street, Carnarvon	9/2/019/0002-137	Building		-30.968060, 22.129478
19 Grey Street, Carnarvon	9/2/019/0002-138	Building		-30.966957, 22.129953
17 Grey Street, Carnarvon	9/2/019/0002-139	Building		-30.967155, 22.129910
13 Van Riebeeck Street, Carnarvon	9/2/019/0002-140	Building		-30.969234, 22.131505
9 Kronkel Road, Carnarvon	9/2/019/0002-141	Building		-30.968119, 22.133233
5 Kronkel Road, Carnarvon	9/2/019/0002-142	Building		-30.968452, 22.133901
14 Alheit Street, Carnarvon	9/2/019/0002-143	Building		-30.966431, 22.131400
16 Zahn Street, Carnarvon	9/2/019/0002-144	Building		-30.968935, 22.132873
1 End Street, Carnarvon	9/2/019/0002-145	Building		-30.967901, 22.125134
9-11 Grey Street, Carnarvon	9/2/019/0002-146	Building		-30.967779, 22.129992
5 End Street, Carnarvon	9/2/019/0002-147	Building		-30.967638, 22.125168
10 Church Street, Carnarvon	9/2/019/0002-148	Building		-30.968222, 22.128641

SITES IDENTIFIED ON THE SAHRA DATABASE				
FullSiteName	SiteReference	SiteType	Grading	Coordinates
12 Grey Street, Carnarvon	9/2/019/0002-149	Building		-30.968033, 22.130331
Johanna Street, Carnarvon	9/2/019/0002-150	Building		-30.969064, 22.131775
14 Johanna Street, Carnarvon	9/2/019/0002-151	Building		-30.968098, 22.132148
9 River Street, Carnarvon	9/2/019/0002-152	Building		-30.967974, 22.130844
5 River Street, Carnarvon	9/2/019/0002-153	Building		-30.968379, 22.130807
20 Daniel Street, Carnarvon	9/2/019/0002-154	Building		-30.966899, 22.129601
6 River Street, Carnarvon	9/2/019/0002-155	Building		-30.968196, 22.131204
7 Johanna Street, Carnarvon	9/2/019/0002-156	Building		-30.968834, 22.131635
5 Daniel Street, Carnarvon	9/2/019/0002-157	Building		-30.968102, 22.129047
1 Grey Street, Carnarvon	9/2/019/0002-158	Building		-30.969337, 22.129663
Dutch Reformed Mission Church Complex, Union Square, Carnarvon	9/2/019/0003	Building	Grade II	-30.966383, 22.128712
Corbelled house complex, Stuurmansfontein, Carnarvon District	9/2/019/0004	Building	Grade II	-30.915783, 21.663084
Svenskbo, 11 Church Street, Carnarvon	9/2/019/0005	Building	Grade II	-30.967814, 22.128230
14 New Street, Carnarvon	9/2/019/0007	Building	Grade II	-30.967506, 22.126903
Corbelled Buildings, T'Kokoboos, Carnarvon District	9/2/019/0009	Building	Grade II	-30.932599, 21.692141
Corbelled House Complex, Konka, Carnarvon District	9/2/019/0011	Building	Grade II	-30.912655, 21.907487
De Bult, Carnarvon	9/2/019/0014	Conservation Area		-30.964511, 22.125462
Carnarvon Masonic Lodge, 57 Russel Street, Richmond	9/2/440/0007	Building	Grade II	-29.869259, 30.272940
(Carnarvon/DR2996/01)	CARN/DR2996/01	Burial Grounds & Graves	Grade IIIa	-30.802778, 21.767500
Carnarvon 001	CARNA001	Rock Art	Grade IIIb	-30.723950, 21.604020
Carnarvon 002	CARNA002	Building, Stone walling	Grade IIIa	-30.723100, 21.605930
Carnarvon 003	CARNA003	Building	Grade IIIc	-30.721670, 21.604830
Carnarvon 004	CARNA004	Burial Grounds & Graves	Grade IIIa	-30.719130, 21.602630
Carnarvon & Williston 001	CWN001	Artefacts	Grade IIIc	-30.710833, 21.613611

5.2.5 Graves/Burials

Graves are readily found throughout the landscape. However, very few of the consulted HIAs reported on graves/burials. Some of the consulted impact assessments reported on a family cemetery (Van der Walt 2014) and graves belonging to former farm owners and on farmland (Dreyer 2007, 2008). Some of the identified graves were covered by inscribed concrete slabs, one

of which was decorated with a wreath made from a pair of rear side windows of a motor vehicle, more over an instance of a grave marked by a natural headstone without any inscriptions, contained a small figurine as decoration, with a single row of stones on its western side has also been noted (Dreyer 2008).

5.2.6 Palaeontological Sensitivity

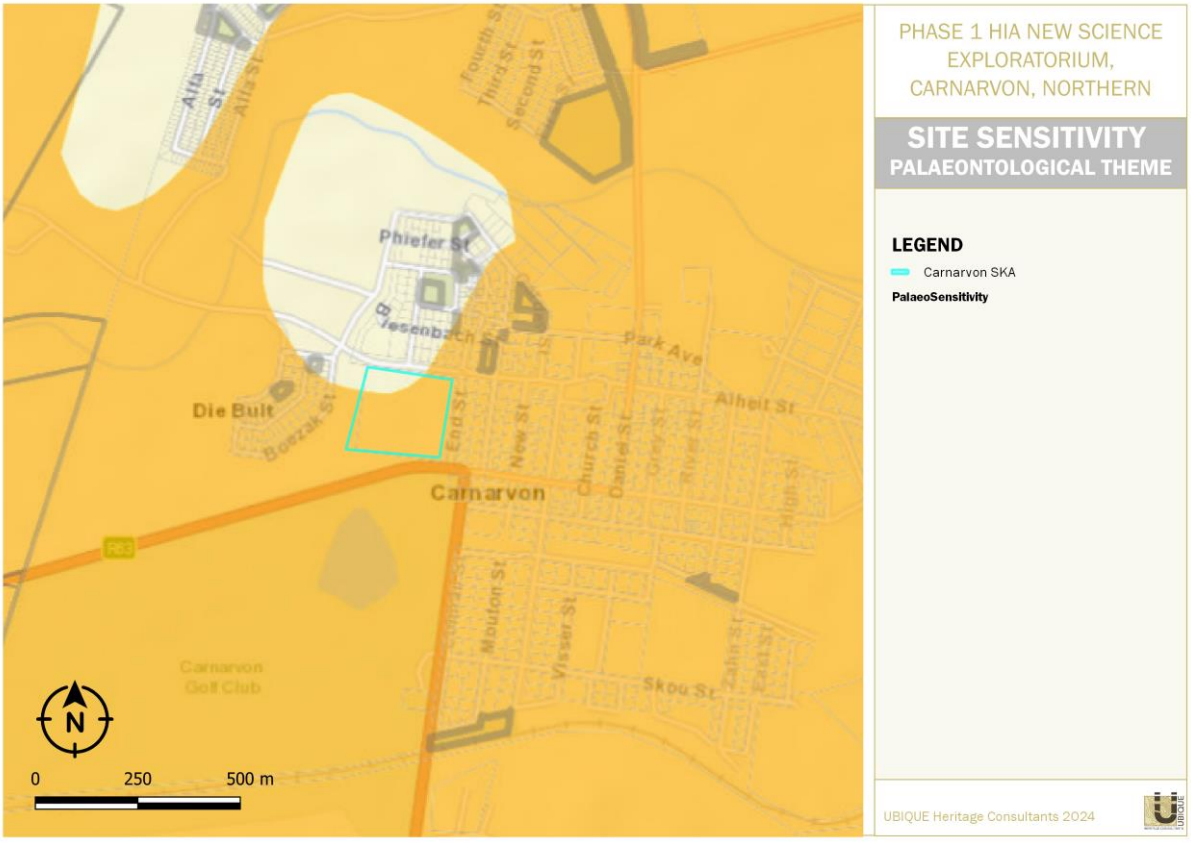

Figure 11 *The DFFE Screening tool Palaeontological Theme and SAHRIS PalaeoSensitivity Map, indicating Medium (Orange) palaeontological significance in the study area (https://screening.environment.gov.za/).*

According to the PalaeoMap of the South African Heritage Resources Information System (SAHRIS), the Palaeontological Sensitivity of the Jurassic Dolerite is Zero, while that of the Carnarvon Formation (Ecca Group) is Moderate (Almond and Pether, 2009; Almond et al., 2013, Groenewald et al. 2014). However, the suggested location is classified as having a Medium Palaeontology Theme Sensitivity in the DFFE (Department of Forestry Fisheries and the Environment) Screening Report. At the same time, areas with an unknown Sensitivity are also crossed. Updated Geology (Council of Geosciences) indicates that the Waterford Formation of the Ecca Group entirely underlies the proposed development.

Desktop research (National Database and published data) concluded that **fossil heritage of scientific and conservational interest in the development area is relatively rare and of low scientific and conservational value**. Data indicates that fossil sites are generally rare, sporadic and

unpredictable. A **low significance** has thus been allocated to the Construction phase of the development footprint. **This is in disagreement with the Moderate Sensitivity allocated to the development area by the SAHRIS Palaeontological Sensitivity Map and the Medium Sensitivity allocated by the DFFE Screening Tool**. Due to the mapped Palaeontological Sensitivity, no site investigation was conducted, and thus, the actual Palaeontological Sensitivity of the development was not verified, but the desktop research confirmed that the area has a LOW sensitivity for paleo resources (Butler 2024, Appendix A).

5.3 Digital Survey

The Google satellite imagery and the topo maps (3022CC 2003) indicate that the proposed Science Exploratorium development will be located in an open area within Carnarvon. A review of aerial photos dating from 2006, 2013, and 2020 taken around the larger landscape of the footprint shows a predominately developed landscape.

Figure 12 *Aerial Photographs and Google Earth Satelite imagery taken in 2006, 2013, and 2020 of the larger landscape around the proposed footprint. (*http://www.cdngiportal.co.za/CDNGIPortal/ and https://earth.google.com/).

5.4 Description of the Affected Environment

The site visit was conducted during mid-winter on the **29th of June 2024** by UBIQUE Heritage Consultants. The dry terrain with sparse vegetation translated into good ground surface visibility. The development area mainly falls within the Northern Upper Karoo Vegetation Type and is surrounded by instances of the Upper Karoo Hardeveld and Western Upper Karoo vegetation types (Mucina & Rutherford 2006).

The proposed development footprint has scattered small to medium indigenous trees and sparse karoo-type veld grass. An empty space to the site's northeast is used as an informal sports (soccer) field. At the northwest corner of the site's central area, the concrete foundations of demolished structures are visible on the surface. The site slopes moderately steeply from the west to east but flattening towards the central area. The central and eastern parts of the site are generally flat to very gently sloping. The surface consists of rocky areas with solid reddish ground and a few rocky outcrops on the site. Excavations and previous construction or development also cause disturbed areas.

The primary geology observed on the ground surface includes Dolerite, Quartzite, Shale and, CCS. Moreover, the dominant (Primary) vegetation observed includes Tumble weed (*Salsola kali*), Three-Thorn tree (*Rhigozum trichotomum*), and Prosopis trees (*Prosopis glandulosa*).

One drainage trench is outside the footprint and towards the site's southwest. There are no prominent rivers or dry river/riverine beds—minor erosion trenches due to water erosion and flooding towards the site's southwest corner. Two-track roads and footpaths lend accessibility to the site. Previous disturbances created some trenches at certain places due to water erosion. The development is bound by residential areas to the north, east and west, the R63 secondary road to the south, and the Pofadder gravel road to the north, an open veld to the south.

Figure 13 *Views of the affected development area.*

6. SURVEY AND IDENTIFIED HERITAGE RESOURCES

6.1 Surveyed Area

UBIQUE Heritage Consultants inspected the remaining area of the proposed development and surrounding areas on the **29th of June 2024** and completed a controlled-exclusive, pre-planned pedestrian and vehicular survey. We inspected the ground's surface, wherever the surface was visible. This was done with no substantial attempt to clear brush, sand, deadfall, leaves or other material that may cover the surface and with no effort to look beneath the surface beyond inspecting rodent burrows, cut banks and other exposures fortuitously observed. Seasonality has no bearing on the study, and the fieldwork we conducted for the development footprint is deemed sufficient for the nature of the project.

The areas surveyed for the impact assessment were dictated by the Google Earth map of the development footprints provided by the client. The proposed development areas were surveyed by vehicle and on foot.

Figure 14 *Survey tracks across the development footprint.*

6.2 Identified Heritage Resources

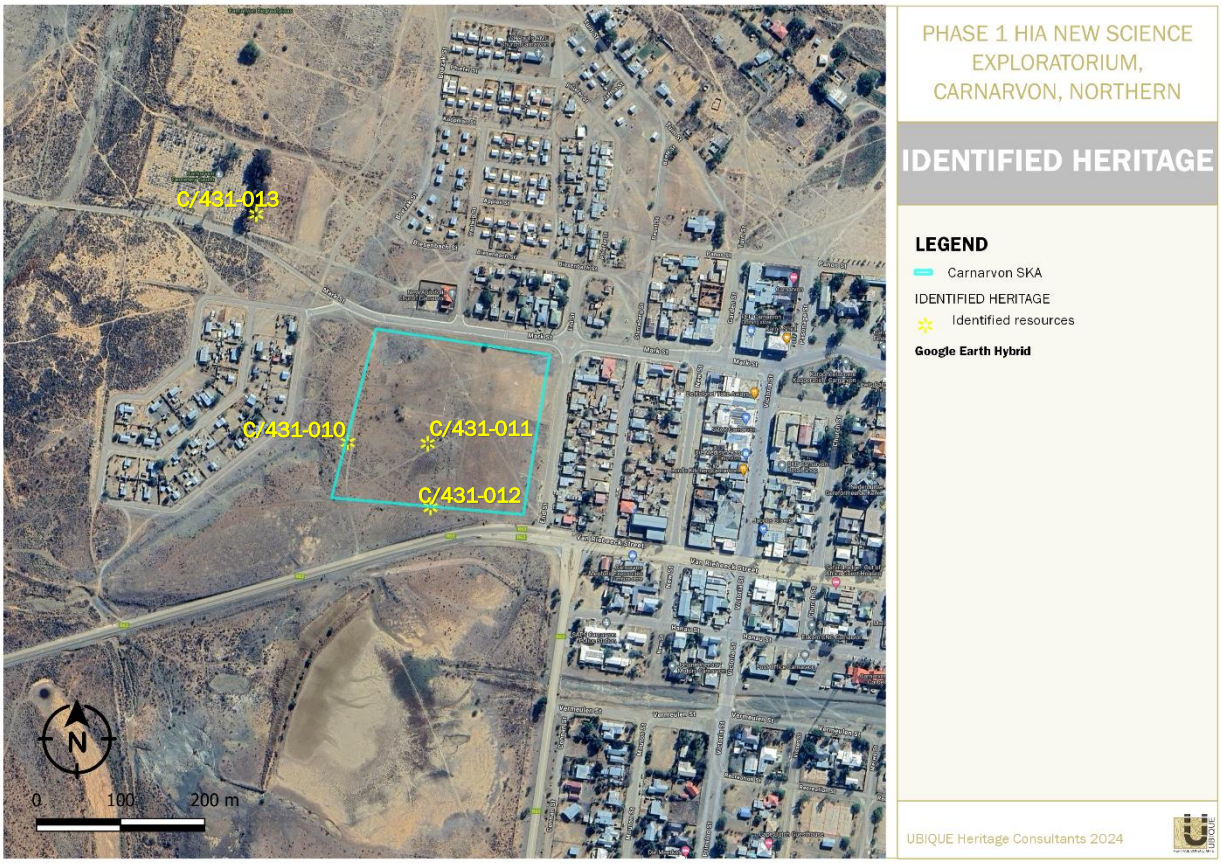

Figure 15 *Distribution of identified heritage resources at the proposed development area.*

6.2.1 Stone Age Identified

No cultural material or features attributed to the Stone Age period were recorded within the development footprint.

6.2.2 Iron Age Identified

No cultural material, features or structures attributed to the Iron Age period were recorded within the development footprint.

6.2.3 Historical/Colonial Period Identified

HISTORICAL PERIOD RESOURCES IDENTIFIED					
SITE ID #	DESCRIPTION		PERIOD	LOCATION	FIELD RATING/ SIGNIFICANCE/ RECOMMENDED MITIGATION
C/431-010	Type of feature	Midden with historical material (garbage)	1890-1950	30º 58' 02.0" S 22º 07' 21.0" E	Field Rating IVC Low significance No mitigation
	Material	Glass, metal, ceramics			
	N in m².	20/m²			
	Context	Midden, possibly in context with a previous settlement.			
	Additional	No structures or other evidence visible in context with the midden. The Midden was also disturbed and some context was destroyed.			
C/431-011	Type of feature	Surface scatter	1890-1950	30º 58' 02.0" S 22º 07' 24.6" E	Field Rating IVC Low significance
	Material	Glass, ceramics, metal			
	N in m².	5/m²			
	Context	No context			
	Additional	Random surface scatter of historical material in an area of approximately 50m²			
C/431-012	Type of feature	Surface scatter	1890-1950	30º 58' 04.46" S 22º 07' 24.7" E	Field Rating IVC
	Material	Glass, ceramics, metal			
	N in m².	5/m²			
	Context	No context			
	Additional	Random surface scatter of historical material in an area of approximately 50m²			

6.2.3.1 Discussion: Historical Period Resources

A midden (C/431-010) was identified. It is possible that this midden may be in context with a previous settlement. However, no structures older than 60 years were identified near the midden. The midden and the context have been disturbed, with minimal surface material remaining. The cultural material identified dates between ca. 1890s to 1950s. In addition, two isolated surface scatters of historical period material were identified (C/431-012 and C/431-011). These resources do not have substantial archaeological context or matrix and are deemed of minor scientific importance and not conservation-worthy (NCW). **The material is given a 'General' Protection C (Field Rating IV C). This means that it has been sufficiently recorded (in Phase 1). It requires no further action.**

C/431-010

C/431-012

C/431-011

Figure 16 *Sample images of Historical Period resources identified*

6.2.4 Graves

Graves RESOURCES IDENTIFIED					
SITE ID #	DESCRIPTION		PERIOD	LOCATION	FIELD RATING/ SIGNIFICANCE/ RECOMMENDED MITIGATION
C/431-013	Grave marker	Various	1700's to 2024	**30º 57' 53.2" S 22º 07' 16.9" E**	Local Grade IIIA Medium to high significance No-go/buffer zone
	Inscription	Various – historical to modern			
	Grave Orientation	East-West			
	Dimensions/extent	Approx. 5ha			
	Additional	Graves located dated from 1700's and later—municipal cemetery.			

6.2.4.1 Discussion: Graves

A municipal cemetery was identified (C/431-013). However, this cemetery is situated outside of the proposed development footprint. **All graves/cemeteries are of High significance. The grave is given a 'Local' Grade A (Field Rating III A).** Since it is outside of the proposed footprint, **no further mitigation is recommended.**

C/431-013

C/431-013

C/431-013

C/431-013

Figure 17 *Sample images of the graves identified at the cemetery (C/431-013) Palaeontological Resources*

6.2.5 Palaeontological Resources

The proposed new Science Exploratorium site in Carnarvon in the Pixley ka Seme District Municipality of the Northern Cape Province is underlain by Jurassic dolerite as well as the Carnarvon Formation (not yet SACS accredited). According to the PalaeoMap of the South African Heritage Resources Information System (SAHRIS), the Palaeontological Sensitivity of the Jurassic Dolerite is Zero, while that of the Carnarvon Formation (Ecca Group) is Moderate (Almond and Pether, 2009; Almond et al., 2013, Groenewald et al. 2014). However, the suggested location is classified as having a Medium Palaeontology Theme Sensitivity in the DFFE (Department of Forestry Fisheries and the Environment) Screening Report. At the same time, areas with an

unknown Sensitivity are also crossed. Updated Geology (Council of Geosciences) indicates that the Waterford Formation of the Ecca Group entirely underlies the proposed development.

No site investigation was undertaken due to the mapped Palaeontological Sensitivity. However, the desktop research (National Database and published data) concluded that **fossil heritage of scientific and conservational interest in the development area is relatively rare and of low scientific and conservational value**. Data indicates that fossil sites are generally rare, sporadic and unpredictable. A **low significance** has thus been allocated to the Construction phase of the development footprint. **This is in disagreement with the Moderate Sensitivity allocated to the development area by the SAHRIS Palaeontological Sensitivity Map and the Medium Sensitivity allocated by the DFFE Screening Tool** (Butler 2024, Appendix A).

7. IMPACT ASSESSMENT OF THE DEVELOPMENT

7.1 Impact Assessment Tables

ARCHAEOLOGICAL, HISTORICAL, & CULTURAL

NATURE	HERITAGE AND CULTURAL RESOURCES IDENTIFIED SITE(S): Low Significance Sites **(C/431-011, C/431-012, C/431-013)**							
DEVELOPMENT PHASE	DEVELOPMENT IMPACT			IMPACT RATING		RECOMMENDED MITIGATION	IS IMPACT ACCEPTABLE?	
	CRITERIA	*BM	**AM	BEFORE MITIGATION	AFTER MITIGATION		*BM	**AM
PLANNING PHASE	Extent	1	1	Positive low impact	Positive low impact	NONE	YES	YES
	Probability	1	1					
	Reversibility	1	1					
	Irreplaceability	1	1					
	Duration	1	1					
	Cumulative Effect	1	1					
	Magnitude	1	1					
	Impact Significance	6	6					
CONSTRUCTION PHASE	Extent	1	1	Negative Low Impact	Negative Low Impact	NONE	YES	YES
	Probability	3	1					
	Reversibility	2	1					
	Irreplaceability	1	1					
	Duration	1	1					
	Cumulative Effect	1	1					
	Magnitude	1	1					
	Impact Significance	9	6					
OPERATIONAL PHASE	Extent	1	1	Negative Low Impact	Negative Low Impact	NONE	YES	YES
	Probability	2	1					
	Reversibility	1	1					
	Irreplaceability	1	1					
	Duration	1	1					
	Cumulative Effect	1	1					
	Magnitude	1	1					
	Impact Significance	7	6					
DECOMMISSIONING PHASE	Extent	1	1	Positive low impact	Positive low impact	NONE	YES	YES
	Probability	1	1					
	Reversibility	1	1					
	Irreplaceability	1	1					
	Duration	1	1					
	Cumulative Effect	1	1					
	Magnitude	1	1					
	Impact Significance	6	6					

*BM = BEFORE MITIGATION =; **AM = AFTER MITIGATION

IMPACT: The resources identified at Erf 431 Carnarvon (C/431-011, 010, 012) are considered to be of low significance, as they are without substantial archaeological context or matrix and are therefore deemed of minor scientific importance and not conservation-worthy (NCW). Thus, any impact would be Negligible. The impact on these resources would be NEGATIVE LOW before and after mitigation during the construction and operational phases. The impact is negligible.

MITIGATION: These resources have been sufficiently recorded (in Phase 1). No further mitigation measures are recommended.

ARCHAEOLOGICAL, HISTORICAL, & CULTURAL								
NATURE	HERITAGE AND CULTURAL RESOURCES IDENTIFIED SITE(S): High Significance **(C/431-013)**							
DEVELOPMENT PHASE	DEVELOPMENT IMPACT			IMPACT RATING		RECOMMENDED MITIGATION	IS IMPACT ACCEPTABLE?	
	CRITERIA	*BM	**AM	BEFORE MITIGATION	AFTER MITIGATION		*BM	**AM
PLANNING PHASE	Extent	2	2	Positive low impact	Positive low impact	NONE	YES	YES
	Probability	1	1					
	Reversibility	1	1					
	Irreplaceability	1	1					
	Duration	1	1					
	Cumulative Effect	1	1					
	Magnitude	1	1					
	Impact Significance	7	7					
CONSTRUCTION PHASE	Extent	2	2	Negative Low Impact	Negative Low Impact	NONE	NO	YES
	Probability	1	1					
	Reversibility	2	1					
	Irreplaceability	3	1					
	Duration	2	1					
	Cumulative Effect	3	1					
	Magnitude	2	1					
	Impact Significance	26	7					
OPERATIONAL PHASE	Extent	2	2	Negative Low Impact	Negative Low Impact	NONE	NO	YES
	Probability	1	1					
	Reversibility	1	1					
	Irreplaceability	1	1					
	Duration	1	1					
	Cumulative Effect	1	1					
	Magnitude	1	1					
	Impact Significance	7	7					
DECOMMISSIONING PHASE	Extent	2	2	Negative Low Impact	Positive low impact	NONE	NO	YES
	Probability	1	1					
	Reversibility	1	1					
	Irreplaceability	1	1					
	Duration	1	1					
	Cumulative Effect	1	1					
	Magnitude	1	1					
	Impact Significance	7	7					

*BM = BEFORE MITIGATION =; **AM = AFTER MITIGATION

IMPACT: All graves/cemeteries are highly significant and worthy of conservation and should be mitigated. In the very unlikely event that impact occurs, it would be negative. However, since the municipal cemetery is well outside the proposed development, it will thus not be impacted by development. Therefore, the impact on this resource would be NEGATIVE LOW before and after mitigation during the construction and operational phases and NEGATIVE LOW before mitigation and POSITIVE LOW after mitigation during the decommissioning phases.

MITIGATION: The cemetery is well outside of the proposed development. No further mitigation is recommended.

PALAEONTOLOGICAL								
NATURE	PALAEONTOLOGICAL RESOURCES IDENTIFIED SITE(S):							
DEVELOPMENT PHASE	DEVELOPMENT IMPACT			IMPACT RATING		RECOMMENDED MITIGATION	IS IMPACT ACCEPTABLE?	
	CRITERIA	*BM	**AM	BEFORE MITIGATION	AFTER MITIGATION		*BM	**AM
PLANNING PHASE	Extent	1	1	Positive low impact	Positive low impact	NONE	YES	YES
	Probability	1	1					
	Reversibility	1	1					
	Irreplaceability	1	1					
	Duration	1	1					
	Cumulative Effect	1	1					
	Magnitude	1	1					
	Impact Significance	6	6					
CONSTRUCTION PHASE	Extent	1	1	Negative Low impact	Negative low impact	NONE	NO	YES
	Probability							
	Reversibility	4	4					
	Irreplaceability	4	4					
	Duration	4	4					
	Cumulative Effect	2	1					
	Magnitude	1	1					
	Impact Significance	15	14					
OPERATIONAL PHASE	Extent	1	1	Negative low impact	Negative low impact	NONE	NO	YES
	Probability	1	1					
	Reversibility	1	1					
	Irreplaceability	1	1					
	Duration	1	1					
	Cumulative Effect	1	1					
	Magnitude	1	1					
	Impact Significance	6	6					
DECOMMISSIONING PHASE	Extent	1	1	Positive low impact	Positive low impact	NONE	NO	YES
	Probability	1	1					
	Reversibility	1	1					
	Irreplaceability	1	1					
	Duration	1	1					
	Cumulative Effect	1	1					
	Magnitude	1	1					
	Impact Significance	6	6					

IMPACT: In terms of palaeontological impacts, a Low Palaeontological Significance has been allocated for the study area pre- and post-mitigation. It is therefore considered that the proposed development will not lead to damaging impacts on the palaeontological resources of the area.

MITIGATION: No further mitigation is recommended.

7.2 Cumulative Impact

The EIA Regulations 2014 (as amended in 2017) determine that cumulative impacts, "*in relation to an activity, means the past, current and reasonably foreseeable future impact of an activity, considered together with the impact of activities associated with that activity, that in itself may not*

be significant, but may become significant when added to the existing and reasonably foreseeable impacts eventuating from similar or diverse activities."

The term "Cumulative Effect" has, for the purpose of this report, been defined as the summation of effects over time which can be attributed to the operation of the project itself and the overall effects on the heritage significance of the site and within a 30 km radius, that can be attributed to the project and other existing and planned future projects.

The proposed SKA project's impact cannot be compared to similar projects within the broader landscape. However, even if similar projects are launched within the broader landscape, the nature of the project means the cumulative impact of the development on heritage is localised and should be low. In addition, graves and burial grounds can be found anywhere in Southern Africa. However, the impact on graves would be site-specific. Thus, it is considered that if mitigation recommendations are followed for the identified heritage resources, no cumulative impact is expected. The impact of the proposed development will only result in minimal additional impact, as it will be site-specific and rated as **LOW NEGATIVE AFTER MITIGATION.**

New developments proposed within the study area can not potentially negatively impact the significant archaeological resources in the larger geographical area or vice versa. The impact is considered positive, as each new development that requires an HIA assessment allows for a more thorough investigation of the broader landscape and contributes to our understanding of the landscape.

The general Palaeontological Sensitivity of the area is Zero to Moderate. However, it is important to note that the quality of preservation of these different sites will most probably vary, and it is thus difficult to allocate a Cumulative Sensitivity to the projects. **If all the mitigation measures are carried out, a conservative estimate of the cumulative impacts on fossil heritage will vary between low and medium levels.**

RESOURCE TYPE	DEVELOPMENT IMPACT			IMPACT RATING	
	CRITERIA	*BM	**AM	BEFORE MITIGATION	AFTER MITIGATION
ARCHAEOLOGICAL, HISTORICAL, CULTURAL	Extent	2	2	Negative low impact	Negative low impact
	Probability	2	2		
	Reversibility	2	2		
	Irreplaceability	3	2		
	Duration	4	3		
	Magnitude	2	2		
	Impact Significance	26	22		
PALAEONTOLOGICAL	Extent	2	2	Negative low impact	Positive low impact
	Probability	2	2		
	Reversibility	2	2		
	Irreplaceability	2	2		
	Duration	3	3		
	Magnitude	2	2		
	Impact Significance	22	22		

8. RECOMMENDATIONS

Based on the assessment of the potential impact of the development on the identified heritage, the following recommendations are made, taking into consideration any existing or potential sustainable social and economic benefits:

1. The scatters of Historical Period material and the midden feature (C/431-010, 011, 012), given a field rating of IVC, are of low cultural and historical significance and are thus considered **non-conservation worthy. No further mitigation is recommended concerning these resources.**

2. The cemetery (C/431-013) is well outside the proposed development and **will not be impacted by development**. Therefore, **no further mitigation is recommended concerning this resource.**

3. In terms of palaeontological impacts, **a Low Palaeontological Significance has been allocated for the study area pre-and post-mitigation**. It is therefore considered that the proposed development will not have damaging impacts on the area's palaeontological resources. **The development may thus be permitted to its whole extent, as the development footprint is not considered sensitive in terms of palaeontological resources.** It is consequently recommended that **no further palaeontological heritage studies, ground truthing, or specialist mitigation be required, pending the discovery of newly discovered fossils. However, in the event that fossil remains or trace fossils are discovered** either on the surface or exposed by excavations, it is recommended that:
   - the Environmental Control Officer (ECO) in charge of these developments must be informed. These discoveries ought to be protected, and the ECO must report to SAHRA (Contact details: SAHRA, 111 Harrington Street, Cape Town. PO Box 4637, Cape Town 8000, South Africa. Tel: 021 462 4502. Fax: +27 (0)21 462 4509. Web: www.sahra.org.za) so that mitigation can be carried out by a palaeontologist.
   - Before any fossil material can be collected from the development site, the specialist involved would need to apply for a collection permit from SAHRA. Fossil material must be housed in an official collection (museum or university), while all reports and fieldwork should meet the minimum standards for palaeontological impact studies proposed by SAHRA (2012).
   - These recommendations should be incorporated into the Environmental Management Programme (EMPr) for the Project (Appendix A).

4. Although all possible care has been taken to identify sites of cultural importance during the investigation of study areas, it is always possible that hidden or sub-surface sites could be overlooked during the assessment. If during construction, any evidence of archaeological sites or remains (e.g. remnants of stone-made structures, indigenous ceramics, bones, stone artefacts, ostrich eggshell fragments, charcoal and ash concentrations), fossils or other

categories of heritage resources are found during the proposed development, SAHRA must be alerted as per section 35(3) of the NHRA. If unmarked human burials are uncovered, the SAHRA must be alerted immediately as per section 36(6) of the NHRA. Depending on the nature of the finds, a professional archaeologist or palaeontologist must be contacted as soon as possible to inspect the findings. If the newly discovered heritage resources are of archaeological or palaeontological significance, a Phase 2 rescue operation may be required, subject to permits issued by SAHRA. UBIQUE Heritage Consultants and its personnel will not be held liable for such oversights or costs incurred due to such oversights.

9. CONCLUSION

The HIA identified historical and cultural resources within the development footprint. Three instances of Historical Period resources were identified. This includes a midden (C/431-010) and two random scatters of cultural material (C/431-011, C/431-012). These resources are without substantial archaeological context or matrix and are therefore deemed of minor scientific importance and not conservation-worthy (NCW). The impact is negligible. No further mitigation is recommended.

A cemetery (C/431-013) was identified outside of the proposed footprint. All graves/cemeteries are of high significance and, therefore, worthy of conservation, and they should be mitigated. In the improbable event that impact occurs, it would be negative. However, since the municipal cemetery is well outside the proposed development, it will thus not be impacted by development. No further mitigation is recommended.

Regarding the Palaeontological resources, a Low Palaeontological Significance has been allocated for the study area pre- and post-mitigation. It is therefore considered that the proposed development will not have damaging impacts on the area's palaeontological resources. The development may thus be permitted to its whole extent, as the development footprint is not considered sensitive in terms of palaeontological resources. It is consequently recommended that no further palaeontological heritage studies, ground truthing, or specialist mitigation be required, pending the discovery of newly discovered fossils.

The proposed SKA development of a new Science Exploratorium/Sarao Science Centre on Erf 431 Carnarvon in the Pixley Ka Seme District Municipality and within the Kareeberg Local Municipality, Northern Cape Province, may continue, provided the recommendations stipulated within this report and the subsequent SAHRA decision are followed.

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11. TERMS OF REFERENCE

11.1 Statutory Requirements

11.1.1 General

The principle is that the environment should be protected for present and future generations by preventing pollution, promoting conservation and practising ecologically sustainable development. With regard to spatial planning and related legislation at national and provincial levels, the following legislation may be relevant:

- Physical Planning Act 125 of 1991
- Municipal Structures Act 117 of 1998
- Municipal Systems Act 32 of 2000
- Development Facilitation Act 67 of 1995 (DFA)

The identification, evaluation and management of heritage resources in South Africa are required and governed by the following legislation:

- National Environmental Management Act 107 of 1998 (NEMA)
- KwaZulu-Natal Heritage Act 4 of 2008 (KZNHA)
- National Heritage Resources Act 25 of 1999 (NHRA)
- Minerals and Petroleum Resources Development Act 28 of 2002 (MPRDA)

11.1.2 National Heritage Resources Act 25 of 1999

The NHRA established the South African Heritage Resources Agency (SAHRA) together with its Council to fulfil the following functions:

- coordinate and promote the management of heritage resources at the national level;
- set norms and maintain essential national standards for the management of heritage resources in the Republic and to protect heritage resources of national significance;
- control the export of nationally significant heritage objects and the import into the Republic of cultural property illegally exported from foreign countries;
- enable the provinces to establish heritage authorities which must adopt powers to protect and manage certain categories of heritage resources; and
- provide for local authorities' protection and management of conservation-worthy places and areas.

12.1.3 Heritage Impact Assessments/Archaeological Impact Assessments

Section 38(1) of the NHRA of 1999 requires **the responsible heritage resources authority to notify the person who intends to undertake a development that fulfils the following criteria to submit an impact assessment report if there is reason to believe that heritage resources will be affected by such event:**

- the construction of a road, wall, power line, pipeline, canal or other similar form of linear development or barrier exceeding 300m in length;
- the construction of a bridge or similar structure exceeding 50m in length;
- any development or other activity that will change the character of a site—
    - exceeding 5000m² in extent; or
    - involving three or more existing erven or subdivisions thereof; or
    - involving three or more erven or divisions thereof which have been consolidated within the past five years; or
    - the costs of which will exceed a sum set in terms of regulations by SAHRA or a provincial heritage resources authority;
- the rezoning of a site exceeding 10 000m² in extent; or
- any other category of development provided for in regulations by SAHRA or a provincial heritage resources authority.

11.1.4 Management of Graves and Burial Grounds

- **Graves younger than 60 years** are protected in terms of the Graves and Dead Bodies Ordinance (Ord 7) of 1925 (re-instituted by the Proclamation 109 of June 17 1994), the Exhumations Ordinance (Ord 12 of 1980), as well as either the Human Tissues Act (Act 65 of 1983 as Amended) or the National Health Act (Act 61 of 2003).

- **Graves older than 60 years, situated outside a formal cemetery administered by a local Authority are** protected in terms of Section 36 of the NHRA as well as the Human Tissues Act of 1983. Accordingly, such graves are under the jurisdiction of SAHRA. The procedure for Consultation Regarding Burial Grounds and Graves (Section 36(5) of NHRA) is applicable to graves older than 60 years that are situated outside a formal cemetery administrated by a local authority. Graves in the category located inside a formal cemetery administrated by a local authority will also require the same authorisation as set out for graves younger than 60 years over and above SAHRA authorisation.

The **protocol for the management of graves older than 60 years situated outside a formal cemetery administered by a local authority** is detailed in Section 36 of the NHRA:

> (3) *(a)* No person may, without a permit issued by SAHRA or a provincial heritage resources authority—
>
> *(a)* destroy, damage, alter, exhume or remove from its original position or otherwise disturb the grave of a victim of conflict, or any burial ground or part thereof which contains such graves;
>
> *(b)* destroy, damage, alter, exhume, remove from its original position or otherwise disturb any grave or burial ground older than 60 years which is situated outside a formal cemetery administered by a local authority; or
>
> *(c)* bring onto or use at a burial ground or grave referred to in paragraph *(a)* or *(b)* any excavation equipment, or any equipment which assists in the detection or recovery of metals.
>
> (4) SAHRA or a provincial heritage resources authority may not issue a permit for the destruction or damage of any burial ground or grave referred to in subsection (3)*(a)* unless

it is satisfied that the applicant has made satisfactory arrangements for the exhumation and re-interment of the contents of such graves, at the cost of the applicant and in accordance with any regulations made by the responsible heritage resources authority.

(5) SAHRA or a provincial heritage resources authority may not issue a permit for any activity under subsection (3)*(b)* unless it is satisfied that the applicant has, in accordance with regulations made by the responsible heritage resources authority—

(a) made a concerted effort to contact and consult communities and individuals who by tradition have an interest in such grave or burial ground; and

(b) reached agreements with such communities and individuals regarding the future of such grave or burial ground.

(6) Subject to the provision of any other law, any person who in the course of development or any other activity discovers the location of a grave, the existence of which was previously unknown, must immediately cease such activity and report the discovery to the responsible heritage resources authority which must, in cooperation with the South African Police Service and in accordance with regulations of the responsible heritage resources authority—

(a) carry out an investigation for the purpose of obtaining information on whether or not such grave is protected in terms of this Act or is of significance to any community; and

(b) if such grave is protected or is of significance, assist any person who or community which is a direct descendant to make arrangements for the exhumation and re-interment of the contents of such grave or, in the absence of such person or community, make any such arrangements as it deems fit.

APPENDIX A

PALAEONTOLOGICAL DESKTOP ASSESSMENT PROPOSED NEW SCIENCE EXPLORATORIUM, CARNARVON, NORTHERN CAPE.

BANZAI ENVIRONMENTAL

PALAEONTOLOGICAL DESKTOP ASSESSMENT

PROPOSED NEW SCIENCE EXPLORATORIUM, CARNARVON, NORTHERN CAPE.

August 2024

COMPILED FOR: Ubique Heritage Consultants

Declaration of Independence

I, Elize Butler, declare that –

General declaration:

- I act as the independent palaeontological specialist in this application
- I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favorable to the applicant
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting palaeontological impact assessments, including knowledge of the Act, Regulations and any guidelines that have relevance to the proposed activity;
- I will comply with the Act, Regulations, and all other applicable legislation;
- I will take into account, to the extent possible, the matters listed in section 38 of the NHRA when preparing the application and any report relating to the application;
- I have no, and will not engage in, conflicting interests in the undertaking of the activity;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the application by the competent authority; and - the objectivity of any report, plan, or document to be prepared by myself for submission to the competent authority;
- I will ensure that information containing all relevant facts in respect of the application is distributed or made available to interested and affected parties and the public and that participation by interested and affected parties is facilitated in such a manner that all interested and affected parties will be provided with a reasonable opportunity to participate and to provide comments on documents that are produced to support the application;
- I will provide the competent authority with access to all information at my disposal regarding the application, whether such information is favorable to the applicant or not
- All the particulars furnished by me in this form are true and correct;

- I will perform all other obligations as expected a palaeontological specialist in terms of the Act and the constitutions of my affiliated professional bodies; and
- I realize that a false declaration is an offense in terms of regulation 71 of the Regulations and is punishable in terms of section 24F of the NEMA.

Disclosure of Vested Interest

I do not have and will not have any vested interest (either business, financial, personal, or other) in the proposed activity proceeding other than remuneration for work performed in terms of the Regulations.

PALAEONTOLOGICAL CONSULTANT: Banzai Environmental (Pty) Ltd

CONTACT PERSON: Elize Butler

Tel: +27 844478759

Email: info@banzai-group.com

SIGNATURE: 

The heritage impact assessment report has been compiled considering the National Environmental Management Act 1998 (NEMA) and Environmental Impact Regulations 2014 as amended, requirements for specialist reports, Appendix 6, as indicated in the table below.

Table 1: Checklist for Specialist studies conformance with Appendix 6 of the EIA Regulations of 2014 (as amended).

Requirements of Appendix 6 – GN R326 EIA Regulations of 7 April 2017	**The relevant section in the report**	**Comment where not applicable.**
1.(1) (a) (i) Details of the specialist who prepared the report	Page ii and Section 2 of Report – Contact details and company and Appendix A	-
(ii) The expertise of that person to compile a specialist report including a curriculum vita	Section 2 – refer to **Appendix A**	-
(b) A declaration that the person is independent in a form as may be specified by the competent authority	Page ii of the report	-
(c) An indication of the scope of, and the purpose for which, the report was prepared	Section 4 – Methods and Terms of Reference	-
(cA) An indication of the quality and age of base data used for the specialist report	Section 5 – Geological and Palaeontological history	-
(cB) a description of existing impacts on the site, cumulative impacts of the proposed development and levels of acceptable change;	Section 7	-
(d) The duration, date and season of the site investigation and the relevance of the season to the outcome of the assessment		Desktop Assessment

Requirements of Appendix 6 – GN R326 EIA Regulations of 7 April 2017	**The relevant section in the report**	**Comment where not applicable.**
(e) a description of the methodology adopted in preparing the report or carrying out the specialised process inclusive of equipment and modelling used	Section 4 Approach and Methodology	-
(f) details of an assessment of the specifically identified sensitivity of the site related to the proposed activity or activities and its associated structures and infrastructure, inclusive of a site plan identifying site alternatives;	Executive Summary and Section 8	
(g) An identification of any areas to be avoided, including buffers	Executive Summary and Section 8	
(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;	Section 5 – Geological and Palaeontological history	
(i) A description of any assumptions made and any uncertainties or gaps in knowledge;	Section 4.1 – Assumptions and Limitation	-
(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	Executive Summary and 8	
(k) Any mitigation measures for inclusion in the EMPr	Executive Summary and 8	
(l) Any conditions for inclusion in the environmental authorisation	Executive Summary and 8	
(m) Any monitoring requirements for inclusion in the EMPr or environmental authorisation	Executive Summary and 8	
(n)(i) A reasoned opinion as to whether the proposed activity, activities or portions thereof should be authorised and	Executive Summary and 8	

Requirements of Appendix 6 – GN R326 EIA Regulations of 7 April 2017	**The relevant section in the report**	**Comment where not applicable.**
(n)(iA) A reasoned opinion regarding the acceptability of the proposed activity or activities; and		
(n)(ii) If the opinion is that the proposed activity, activities 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	Executive Summary and 8	-
(o) A description of any consultation process that was undertaken during the course of carrying out the study	N/A	Not applicable. A public consultation process was handled as part of the Environmental Impact Assessment (EIA) and Environmental Management Plan (EMP) process.
(p) A summary and copies of any comments that were received during any consultation process	N/A	Not applicable. To date, no comments regarding heritage resources that require input from a specialist have been raised.

Requirements of Appendix 6 – GN R326 EIA Regulations of 7 April 2017	**The relevant section in the report**	**Comment where not applicable.**
(q) Any other information requested by the competent authority.	N/A	Not applicable.
(2) Where a government notice by the Minister provides for any protocol or minimum information requirement to be applied to a specialist report, the requirements as indicated in such notice will apply.	Section 3 compliance with SAHRA guidelines	

EXECUTIVE SUMMARY

Banzai Environmental was appointed by Ubique Heritage Consultants to conduct the Desktop Assessment (PDA) to assess the Palaeontology of the **Proposed New Science Exploratorium, Carnarvon, Northern Cape**. In accordance with the National Environmental Management Act No 107 of 1998 (NEMA) and to comply with the National Heritage Resources Act (No 25 of 1999, section 38) (NHRA), this PDA is necessary to confirm if fossil material could potentially be present in the planned development area, to evaluate the potential impact of the proposed development on the Palaeontological Heritage and to mitigate possible damage to fossil resources.

The proposed new Science Exploratorium site in Carnarvon in the Pixley ka Seme District Municipality of the Northern Cape Province is underlain by Jurassic dolerite as well as the Carnarvon Formation (not yet SACS accredited). According to the PalaeoMap of the South African Heritage Resources Information System (SAHRIS) the Palaeontological Sensitivity of the Jurassic Dolerite is Zero, while that of the Carnarvon Formation (Ecca Group) is Moderate (Almond and Pether, 2009; Almond et al., 2013, Groenewald et al. 2014). However, the suggested location is classified as having a Medium Palaeontology Theme Sensitivity in the DFFE (Department of Forestry Fisheries and the Environment) Screening Report, while areas with an unknown Sensitivity are also crossed. Updated Geology (Council of Geosciences) indicates that the proposed development is entirely underlain by the Waterford Formation of the Ecca Group.

Desktop research (National Database and published data) concluded that **fossil heritage of scientific and conservational interest in the development area is relatively rare and of low scientific and conservational value**. Data indicates that fossil sites are generally rare, sporadic and unpredictable. A **low significance** has thus been allocated to the Construction phase of the development footprint. **This is in disagreement with the Moderate Sensitivity allocated to the development area by the SAHRIS Palaeontological Sensitivity Map and Medium Sensitivity allocated by the DFFE Screening Tool**. Due to the mapped Palaeontological Sensitivity, no site investigation was conducted, and thus, the actual Palaeontological Sensitivity of the development was not verified, but the desktop research confirmed that the area has a LOW sensitivity for paleo resources.

In terms of palaeontological impacts, **a Low Palaeontological Significance has been allocated for the study area pre- and post-mitigation**. It is therefore considered that the proposed development will not lead to damaging impacts on the palaeontological resources of the area. **The development may thus be permitted in its whole extent, as the development footprint is not**

considered sensitive in terms of palaeontological resources. It is consequently recommended that no further palaeontological heritage studies, ground truthing, or specialist mitigation be required, pending the discovery of newly discovered fossils.

However, if fossil remains or trace fossils are discovered, either on the surface or exposed by excavations, the Environmental Control Officer (ECO) in charge of these developments must be informed. These discoveries ought to be protected, and the ECO must report to SAHRA (Contact details: SAHRA, 111 Harrington Street, Cape Town. PO Box 4637, Cape Town 8000, South Africa. Tel: 021 462 4502. Fax: +27 (0)21 462 4509. Web: www.sahra.org.za) so that mitigation can be carried out by a palaeontologist.

Before any fossil material can be collected from the development site, the specialist involved would need to apply for a collection permit from SAHRA. Fossil material must be housed in an official collection (museum or university), while all reports and fieldwork should meet the minimum standards for palaeontological impact studies proposed by SAHRA (2012).

These recommendations should be incorporated into the Environmental Management Programme (EMPr) for the Project.

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APPENDIX A: CURRICULUM VITAE

GLOSSARY OF TERMS

Fossil

A fossil is the preserved remnants or vestiges of a long-dead organism, generally from millions of years ago. Fossils can be mineralized skeletons, shells, or other hard pieces of ancient animals and plants, as well as impressions, moulds, and casts left in sedimentary rock when the organism's remains decomposed and left an impression. Fossils provide valuable insights into the evolution and biodiversity of ancient species, allowing scientists to study and understand their evolution and biodiversity.

Heritage

That which is inherited and forms part of the National Estate (historical places, objects, fossils as defined by the National Heritage Resources Act No 25 of 1999).

Heritage resources

This means any place or object of cultural significance and can include (but not limited to) as stated under Section 3 of the NHRA,

- places, buildings, structures, and equipment of cultural significance.
- places to which oral traditions are attached or which are associated with living heritage.
- historical settlements and townscapes.
- landscapes and natural features of cultural significance.
- geological sites of scientific or cultural importance.
- archaeological and palaeontological sites.
- graves and burial grounds, and
- sites of significance relating to the history of slavery in South Africa.

Palaeontology

Palaeontology, also referred to as "palaeontology" in American English, is the scientific study of ancient life and the history of life on Earth as recorded in the fossil record. Palaeontologists are scientists who study and analyse the remnants of plants, animals, and other species from the distant past, as well as traces of their activity such as footprints and burrows. Palaeontologists attempt to understand the evolution, diversity, and interactions of life forms throughout Earth's history by researching fossils and the geological environment in which they are found, which can provide vital insights into the planet's geological and biological past.

LIST OF ABBREVIATIONS

BA	Basic Assessment
DEA	Department of Environmental Affairs
DFFE	Department of Forestry, Fisheries and the Environment
CA	National Competent Authority
DA	Diamonds alluvial
D	Diamonds General
DK	Diamonds in Kimberlite
ECO	Environmental Control Officer
EMPr	Environmental Management Programme
ESO	Environmental Site Officer
HIA	Heritage Impact Assessment
Ma	Millions of years ago
NEMA	National Environmental Management Act
NHRA	National Heritage Resources Act
NW	North-West
PIA	Palaeontological Impact Assessment
PSSA	Palaeontological Society of South Africa
SAHRA	South African Heritage Resources Agency
SAHRIS	South African Heritage Resources Information System
S&EIA	Scoping & Environmental Impact Assessment
ToR	Terms of Reference

1 INTRODUCTION

The proposed new Science Exploratorium site is located in Carnarvon, Pixley ka Seme District Municipality, Northern Cape Province. It is located west of Carnarvon's central business district and may be accessed via End Street. Streets bordering the proposed site is Mark Street to the north, End Street to the east, Van Riebeeck Street to the south and open land to the west.

2 QUALIFICATIONS AND EXPERIENCE OF THE AUTHOR

Please refer to Appendix A (Specialist CV).

This study has been conducted by Mrs. Elize Butler of Banzai Environmental (Pty) Ltd. She has conducted approximately 700 palaeontological impact assessments (PIA) for developments in the Free State, KwaZulu-Natal, Eastern and Northern Cape, Northwest, Gauteng, Limpopo, and Mpumalanga. She has an MSc (*cum laude*) in Zoology (specializing in Palaeontology) from the University of the Free State, South Africa and has been working in Palaeontology for more than thirty years. She has experience in locating, collecting, and curating fossils, including exploration field trips in search of new localities in the Karoo Basin. She has been a member of the Palaeontological Society of South Africa (PSSA) since 2006 and has been conducting PIAs since 2014.

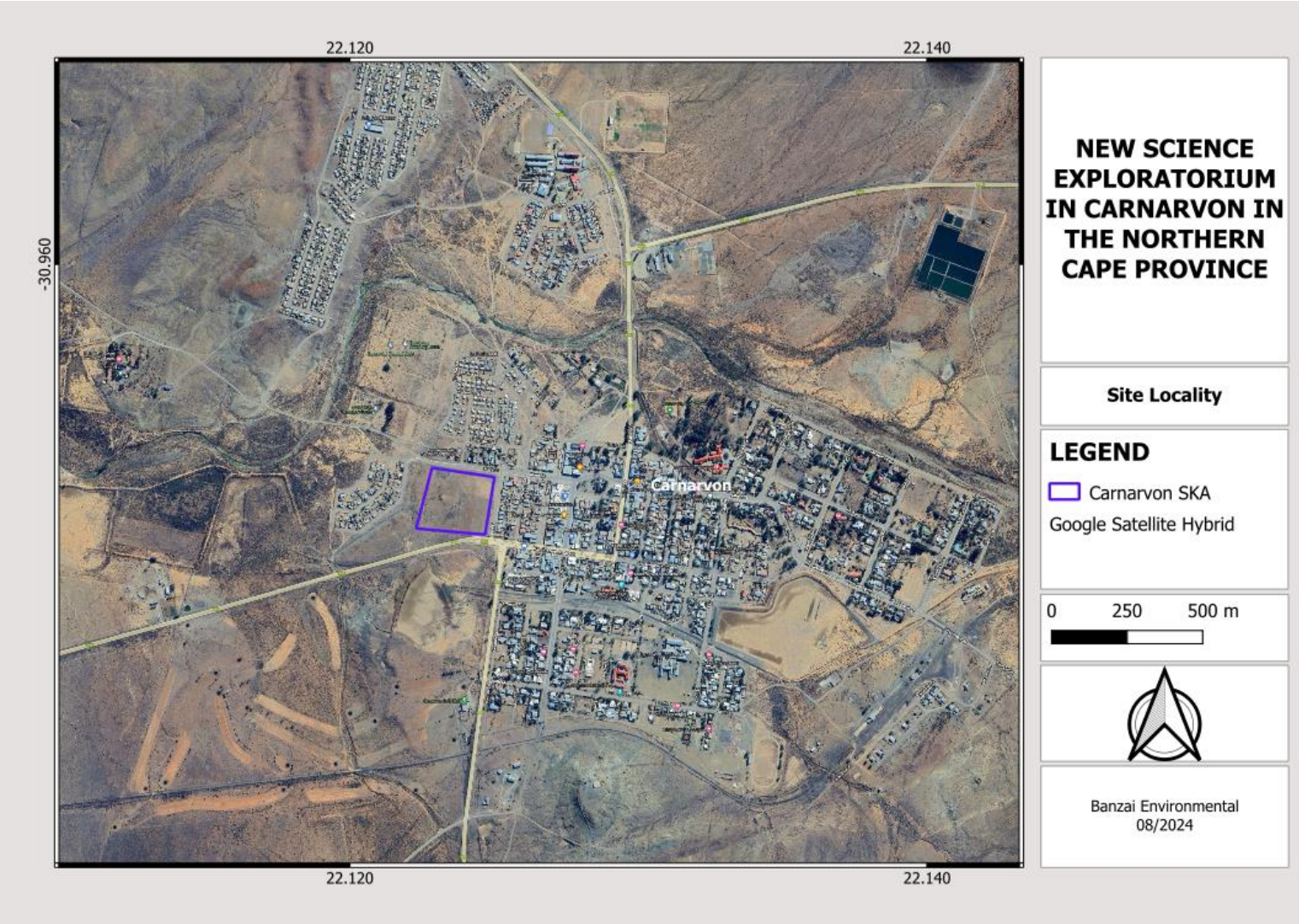


***Figure 1: Regional locality of the proposed new Science Exploratorium** site located **in** Carnarvon in the Northern Cape Province.*

3 LEGISLATION

3.1 National Heritage Resources Act (25 of 1999)

Cultural Heritage in South Africa, includes all heritage resources, is protected by the National Heritage Resources Act (Act No. 25 of 1999) (NHRA). Heritage resources as defined in Section 3 of the Act include "all objects recovered from the soil or waters of South Africa, including archaeological and palaeontological objects and material, meteorites and rare geological specimens".

The identification, evaluation and assessment of any cultural heritage site, artefact or finds in the South African context is required and governed by the following legislation:

- National Environmental Management Act (NEMA) Act No. 107 of 1998
- National Heritage Resources Act (NHRA) Act No. 25 of 1999
- Minerals and Petroleum Resources Development Act (MPRDA) Act No. 28 of 2002
- Notice 648 of the Government Gazette 45421- general requirements for undertaking an initial site sensitivity verification where no specific assessment protocol has been identified.

The next section in each Act is directly applicable to the identification, assessment, and evaluation of cultural heritage resources.

GNR 982 (Government Gazette 38282, 14 December 2014) promulgated under the National Environmental Management Act (NEMA) Act No. 107 of 1998

- Basic Assessment Report (BAR) – Regulations 19 and 23
- Environmental Impacts Assessment (EIA) – Regulation 23
- Environmental Scoping Report (ESR) – Regulation 21
- Environmental Management Programme (EMPr) – Regulations 19 and 23

National Heritage Resources Act (NHRA) Act No. 25 of 1999

- Protection of Heritage Resources – Sections 34 to 36
- Heritage Resources Management – Section 38

The NEMA (No. 107 of 1998) states that an integrated EMP should (23:2 (b)) "*…identify, predict and evaluate the actual and potential impact on the environment, socio-economic conditions and cultural heritage*".

In agreement with legislative requirements, EIA rating standards as well as SAHRA policies a comprehensive and legally compatible PIA report has been compiled.

Palaeontological heritage is exceptional and non-renewable and is protected by the NHRA. Palaeontological resources and may not be unearthed, broken moved, or destroyed by any development without prior assessment and without a permit from the relevant heritage resources authority as per section 35 of the NHRA.

This Palaeontological Impact assessment forms part of the Heritage Impact Assessment (HIA) and adhere to the conditions of the Act. According to Section 38 (1), an HIA is required to assess any potential impacts to palaeontological heritage within the development footprint where:

- the construction of a road, wall, power line, pipeline, canal or other similar form of linear development or barrier exceeding 300 m in length.
- the construction of a bridge or similar structure exceeding 50 m in length.
- any development or other activity which will change the character of a site—
    - exceeding 5 000 m^2 in extent; or
    - involving three or more existing erven or subdivisions thereof; or
    - involving three or more erven or divisions thereof which have been consolidated within the past five years; or
    - the costs of which will exceed a sum set in terms of regulations by SAHRA or a provincial heritage resources authority or
    - the re-zoning of a site exceeding 10 000 m² in extent or

any other category of development provided for in regulations by SAHRA or a Provincial heritage resources authority.

4 METHODS AND TERMS OF REFERENCE

This Palaeontological Assessment is part of the HIA Report. The PIA's goals are to: 1) identify the palaeontological significance of the rock formations in the footprint; 2) evaluate the palaeontological magnitude of the formations; 3) clarify the impact on fossil heritage; and 4) make recommendations for how the developer might protect and minimize potential harm to fossil heritage, according to the "SAHRA APM Guidelines: Minimum Standards for the Archaeological and Palaeontological Components of Impact Assessment Reports".

Calculations of the palaeontological state of each rock segment and the potential impact of development on fossil history take into account the palaeontological status of the rocks, the type of development, and the amount of bedrock removed.

The Provisional DFFE Screening Tool, the SAHRIS Palaeosensitivity map, all Palaeontological Impact Assessment reports for the same area, Google Earth images, topographical and geological maps, as well as academic articles about specimens from the development area and Assemblage Zones, are all used to create scoping reports.

When the development footprint has a moderate to high palaeontological sensitivity, a field-based assessment is necessary. A desktop or field assessment of the exposed rock is used to evaluate the significance of the proposed development's impact, and recommendations for more research or mitigation are made. Excavations for the project often only take place during

the building phase, changing the terrain and destroying or permanently encasing fossils at or below the ground surface. Then, access to Fossil Heritage will no longer be available for academic study.

When doing a site investigation, a palaeontologist examines the local development as well as the quantity and variety of fossils found there. This can be demonstrated by looking at representative fossiliferous rock exposures (most igneous and metamorphic rocks are not fossiliferous, whereas sedimentary rocks contain fossil heritage). Examined rock exposures frequently contain a sizeable portion of the stratigraphic unit, which is primarily made up of recently exposed (unweathered) rock. These exposures may be man-made (such as quarries, open building excavations, even railway and road cuttings) or natural (such as cliffs, and dongas as well as rocky outcrops along stream or river banks). It is usual practice for palaeontologists to record well-preserved fossils (GPS, and stratigraphic data) during field assessment examinations.

Although mitigation is often done prior to construction, it may take place if potentially fossiliferous bedrock is revealed. Fossil collection and documentation are examples of mitigation. A permit from SAHRA must be obtained before beginning any fossil excavation, and the material must be stored at an authorized facility. When mitigation is properly used, it is possible to have a positive impact by raising awareness of the palaeontological past of the area.

By physically evaluating bedrock outcrops to determine their lithology and fossil richness and crisscrossing the development footprint, one can assess an area's fossil potential. Because the presence of fossils at the surface is so unexpected, an average sample size of the region is investigated. To be clear, however, the lack of fossils in a development footprint does not automatically suggest that there is no paleontologically important material present on the site (on or below the ground surface).

The terms of reference of a PIA are as follows:

General Requirements:

- Adherence to the content requirements for specialist reports in accordance with Appendix 6 of the EIA Regulations 2014, as amended;
- Adherence to all applicable best practice recommendations, appropriate legislation and authority requirements;
- Submit a comprehensive overview of all appropriate legislation, guidelines;
- Describe of the proposed project and provide information regarding the developer and consultant who commissioned the study;
- Describe location of the proposed development and provide geological and topographical maps
- Provide palaeontological and geological history of the affected area;
- Identify sensitive areas to be avoided (providing shapefiles/kmls) in the proposed development;
- Evaluate the significance of the planned development during the Pre-construction, Construction, Operation, Decommissioning Phases and Cumulative impacts. Potential impacts should be rated in terms of the direct, indirect and cumulative:
    a. Direct impacts are impacts that are caused directly by the activity and generally occur at the same time and at the place of the activity.
    b. Indirect impacts of an activity are indirect or induced changes that may occur as a result of the activity.
    c. Cumulative impacts are impacts that result from the incremental impact of the proposed activity on a common resource when added to the impacts of other past, present or reasonably foreseeable future activities.
- Fair assessment of alternatives (infrastructure alternatives have been provided);
- Recommend mitigation measures to minimise the impact of the proposed development; and
- Detail the implications of specialist findings for the proposed development (such as permits, licenses etc).

4.1 Assumptions and Limitations

The geology of the area is the focal point of geological maps, and the sheet explanations of the Geological Maps were not intended to focus on palaeontological heritage. Many inaccessible areas of South Africa have never been examined by palaeontologists, and data is typically dependent solely on aerial pictures. Locality and geological information in museums and university databases is out of date, and data acquired in the past is not always adequately documented.

Comparable Assemblage Zones in other places are also used to provide information on the existence of fossils in areas that have not before been recorded. When similar Assemblage Zones and geological formations are used for Desktop studies, it is commonly assumed that exposed fossil exists within the footprint.

5 GEOLOGICAL AND PALAEONTOLOGICAL HISTORY

The proposed new Science Exploratorium site in Carnarvon is depicted on the 1:250 000 Britstown 3022 (1991) Geological Map (Council for Geosciences, Pretoria) (Figure 2; Table 2). The study area is underlain by Jurassic dolerite (Jd, red) as well as the Carnarvon Formation (Pc, orange-red, not yet accredited by SACS). According to the PalaeoMap of the South African Heritage Resources Information System (SAHRIS) the Palaeontological Sensitivity of the Jurassic Dolerite) is Zero (grey), while that of the Carnarvon Formation (Ecca Group) is Moderate (green) (Almond and Pether, 2009; Almond et al., 2013, Groenewald et al 2014) (Figure 3, Table 3). However, the suggested location is classified as having a Medium (yellow) Palaeontology Theme Sensitivity in the DFFE (Department of Forestry Fisheries and the Environment) Screening Report, while areas with an unknown (white) Sensitivity is also crossed (Figure 5). Updated Geology (Council of Geosciences) indicates that the proposed development is entirely underlain by the Waterford Formation of the Ecca Group (Figure 5).

The Karoo igneous province is one of the worlds classic continental basalt (CFB) provinces. This province consists of intrusive and extrusive rocks that occur over a large area (Duncan et al, 2006). Generally, the flood basalts do not contribute to prominent volcanic structures, but instead are formed by successive eruptions from a set of fissures that form sub-horizontal lava flows (sills and dykes) varying in thickness. This lava caps the landscape on which they erupted. As the Karoo is an old flood basalt province it is today preserved as erosional fragments of a more extensive lava cap that covered much of southern Africa in the geological past. It is estimated that the Karoo lava outcrop currently covered at least 140 000 km^2 while it was larger in the past [~2 000 000 km^2 (Cox 1970, 1972)].

The Karoo Igneous Province contains a large volume of flood basalts as well as silicic volcanic rocks. These units are comprised of rhyodacite and rhyolitic magma and crops out along the Lebombo monocline. Individual units span up to 60 km and sometimes show massive pyroclastic structures and are thus classified as rheoignimbrites. The basal lavas lie conformable on the Clarens Formation but in specific localities sandstone erosion occurred before the volcanic eruptions took place. Lock *et al* (1974) found evidence in the Eastern Cape that in the early stages of volcanism magma interacted with ground water to produce volcaniclastic deposits as well as phreatic and phreatomagmatic diatremes. Eales *et al* (1984) also found evidence of aqueous environments during early volcanism by the existence of pillow lavas and

associated hyaloclastite breccias and thin lenses of fluviatile sandstones interbedded with the lowermost magmas.

The arenaceous Waterford Formation overlies the Fort Brown Formation. The formation comprises alternating very fine-grained, lithofeldspathic sandstone and mudrock or clastic rhythmite units. The Waterford Formation, consists of fine- to medium-grained sandstone, siltstone, shale and rhythmite. The lower part of the Formation is characterized by upward-coarsening cycles of sediments, which are capped by extensive sheet-like sandstones and alternating chaotic, slump and slide deposits. The upper portion of the Formation consists of sandstone (±8m thick), siltstone, ball-and-pillow layers and channel-fill deposits.

The Ecca group is widely- known for its trace fossils, recovered from deep-water deposits while fossil plants are abundantly found in the sandstones of the northern parts of the Basin. The bivalve *Megadesmus* has been recovered from the upper Volksrust shale Formation in the in the north-eastern Karoo Basin. This is the first find of this genus in Africa while it is known from other continents (Australia, Siberia, India, Tasmania and South America). The presence of this bivalve indicates a marine environment. Cairncross et al, (2005) came to the conclusion that the marine enclave still existed and that terrestrial conditions did not occur in the north-eastern portion of the Karoo Basin during the Late Permian.

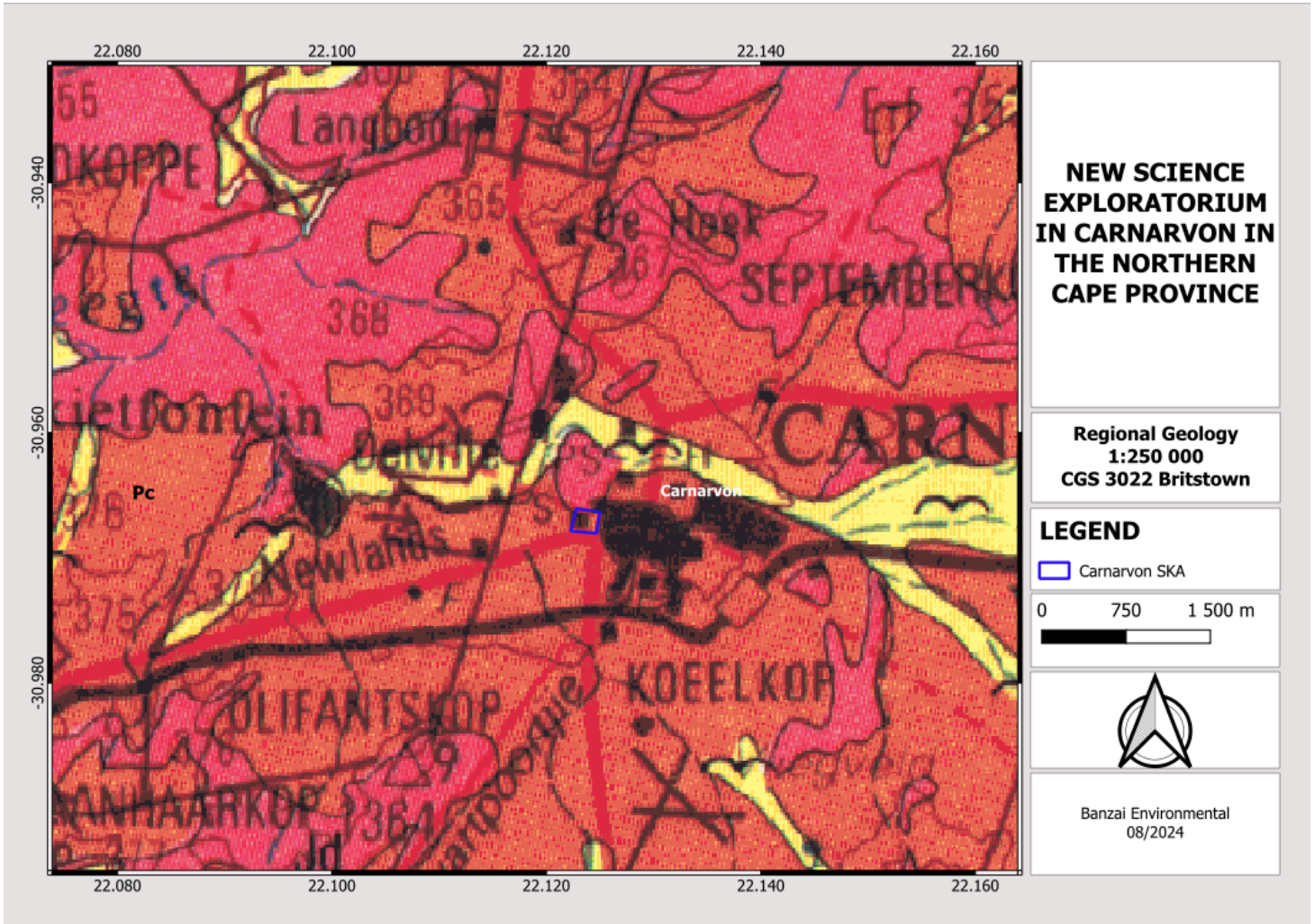


Figure 2. Extract of the 1:250 000 Britstown 3022 (1991) Geological Map (Council for Geosciences, Pretoria) indicates that the study area is underlain by Jurassic dolerite (Jd, red) as well as Carnarvon Formation (Pc, orange red, not yet SACS accredited).

Table 2: Legend to the Britstown 3022 (1991) Geological Map (Council for Geosciences, Pretoria).

Relevant lithology is indicated in red polygons

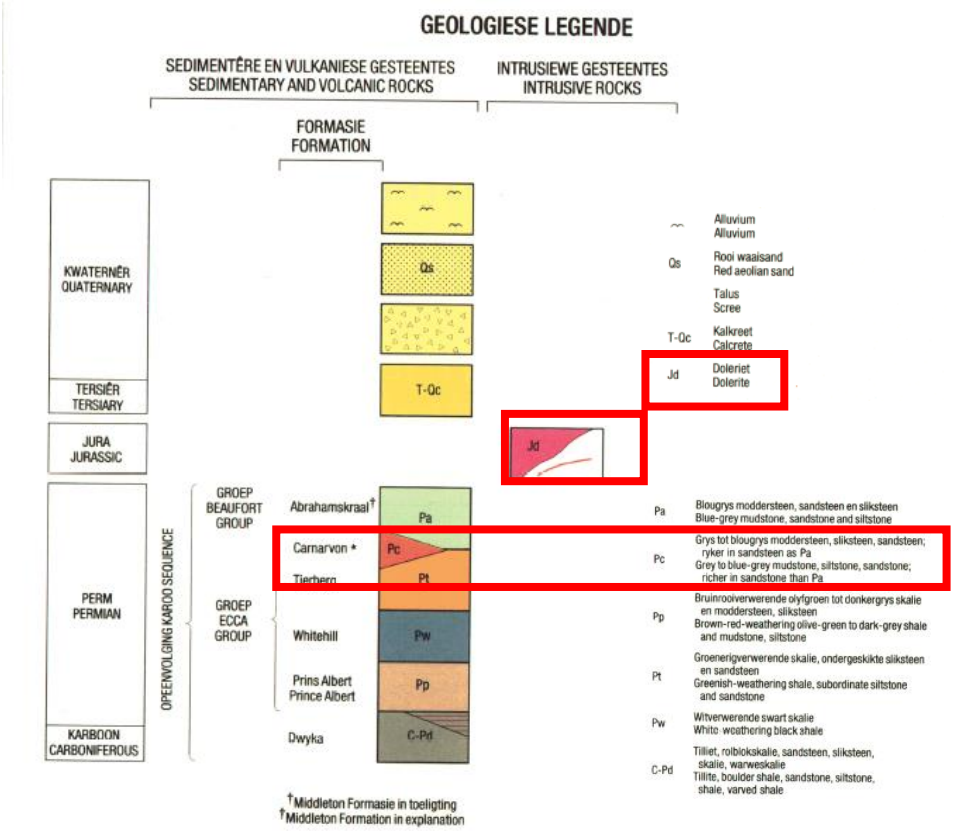
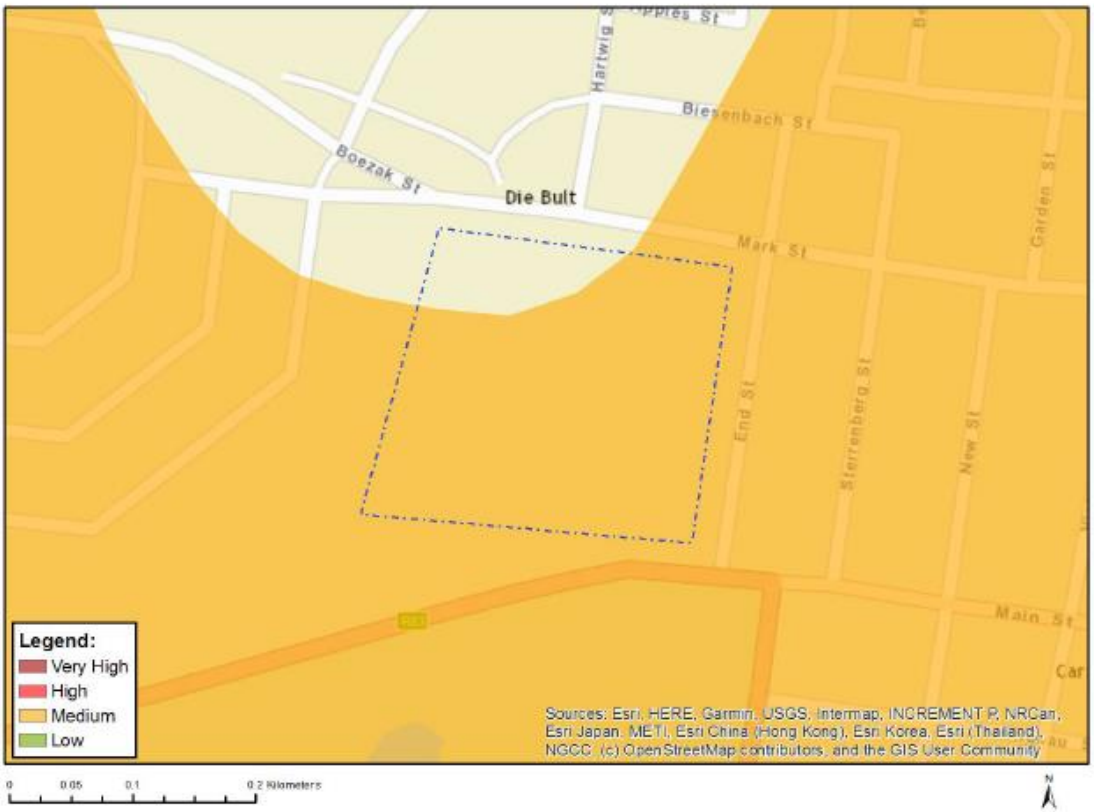


Figure 3: Extract of the SAHRIS PalaeoMap map (Council of Geosciences) indicates that the study area is underlain with sediments with a Zero (grey) and Moderate (green) Palaeontological Sensitivity.

Table 3: Palaeontological Sensitivity according to the SAHRIS PalaeoMap (Almond et al, 2013; SAHRIS website.

Colour	***Sensitivity***	***Required Action***
RED	VERY HIGH	Field assessment and protocol for finds is required
ORANGE/YELLOW	HIGH	Desktop study is required and based on the outcome of the desktop study; a field assessment is likely
GREEN	**MODERATE**	**Desktop study is required**
BLUE	LOW	No palaeontological studies are required however a protocol for finds is required
GREY	**INSIGNIFICANT/ZERO**	**No palaeontological studies are required**
WHITE/CLEAR	UNKNOWN	These areas will require a minimum of a desktop study. As more information comes to light, SAHRA will continue to populate the map.

MAP OF RELATIVE PALEONTOLOGY THEME SENSITIVITY



Very High sensitivity	High sensitivity	Medium sensitivity	Low sensitivity
		X	

Sensitivity Features:

Sensitivity	Feature(s)
Medium	Features with a Medium paleontological sensitivity

Figure 4: Palaeontological Sensitivity generated by the DFFE National Environmental Web-Based Screening Report indicates a Medium (orange) Palaeontological Sensitivity, while an area with an Unknown (white) Sensitivity is also crossed.

The mapped Palaeontological Sensitivity of the SAHRIS PalaeoMap (Figure 3) indicates a Medium (green) and Zero (grey) Sensitivity for the study site while the DFFE Screening Report indicates (Figure 4)

a Medium (yellow) Sensitivity. An area with an unknown (white) Sensitivity is also crossed. Due to the mapped Palaeontological Sensitivity no site investigation was conducted and thus the actual Palaeontological Sensitivity of the development was not verified, but the desktop research confirmed that the area has a LOW sensitivity for paleo resources.

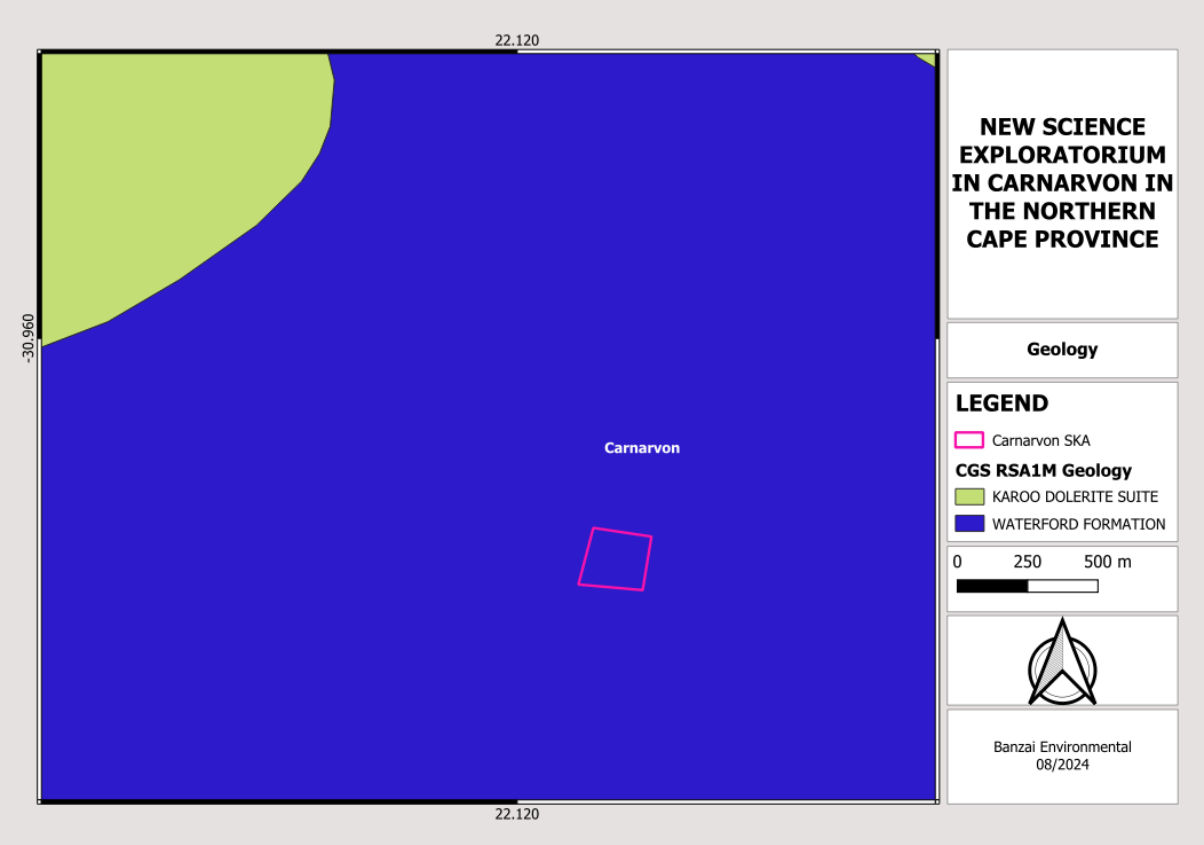


Figure 5: Updated Geology (2014, Council of Geosciences, Pretoria) indicates that the proposed new Science Exploratorium site located in Carnarvon in the Northern Cape Province is entirely underlain by the Waterford Formation of the Ecca Group.

6 ADDITIONAL INFORMATION CONSULTED

In compiling this report the following sources were consulted:

- Geological map 1:100 000, Geology of the Republic of South Africa (Visser 1984)
- A Google Earth map with polygons of the proposed development was obtained from Ubique
- Google Earth© satellite imagery.
- 1:250 000 Britstown 3022 (1991) Geological Map (Council for Geosciences, Pretoria)
- Updated geology of the proposed development (2014, Council for Geosciences, Pretoria).

- Palaeosensitivity map on SAHRIS (South African Heritage Resources Information System) website
- Department of Forestry, Fisheries and the Environment Screening tool report
- The combined National Palaeontological Databases of the Museums and Universities of Southern Africa.

7 ASSESSMENT METHODOLOGY

7.1 Method of Environmental Assessment

The environmental assessment aims to identify the various possible environmental impacts that could results from the proposed activity. Different impacts need to be evaluated in terms of its significance and in doing so highlight the most critical issues to be addressed.

Significance is determined through a synthesis of impact characteristics which include context and intensity of an impact. Context refers to the geographical scale i.e., site, local, national, or global whereas intensity is defined by the severity of the impact e.g., the magnitude of deviation from background conditions, the size of the area affected, the duration of the impact and the overall probability of occurrence. Significance is calculated as shown in Table 4.1.

Significance is an indication of the importance of the impact in terms of both physical extent and time scale, and therefore indicates the level of mitigation required. The total number of points scored for each impact indicates the level of significance of the impact.

7.2 Impact Rating System

Impact assessment must take account of the nature, scale, and duration of impacts on the environment whether such impacts are positive or negative. Each impact is also assessed according to the project phases:

- planning
- construction
- operation
- decommissioning

Where necessary, the proposal for mitigation or optimisation of an impact should be detailed. A brief discussion of the impact and the rationale behind the assessment of its significance should also be included. The rating system is applied to the potential impacts on the receiving environment and includes

an objective evaluation of the mitigation of the impact. In assessing the significance of each impact, the following criteria is used:

Table 4:The rating system

NATURE		
Include a brief description of the impact of environmental parameter being assessed in the context of the project. This criterion includes a brief written statement of the environmental aspect being impacted upon by a particular action or activity.		
GEOGRAPHICAL EXTENT		
This is defined as the area over which the impact will be experienced.		
1	Site	The impact will only affect the site.
2	Local/district	Will affect the local area or district.
3	Province/region	Will affect the entire province or region.
4	International and National	Will affect the entire country.
PROBABILITY		
This describes the chance of occurrence of an impact.		
1	Unlikely	The chance of the impact occurring is extremely low (Less than a 25% chance of occurrence).
2	Possible	The impact may occur (Between a 25% to 50% chance of occurrence).
3	Probable	The impact will likely occur (Between a 50% to 75% chance of occurrence).
4	Definite	Impact will certainly occur (Greater than a 75% chance of occurrence).
DURATION		
This describes the duration of the impacts. Duration indicates the lifetime of the impact as a result of the proposed activity.		
1	Short term	The impact will either disappear with mitigation or will be mitigated through natural processes in a span shorter than the construction phase (0 – 1 years), or the impact will last for the

		period of a relatively short construction period and a limited recovery time after construction, thereafter it will be entirely negated (0 – 2 years).
2	Medium term	The impact will continue or last for some time after the construction phase but will be mitigated by direct human action or by natural processes thereafter (2 – 10 years).
3	Long term	The impact and its effects will continue or last for the entire operational life of the development, but will be mitigated by direct human action or by natural processes thereafter (10 – 30 years).
4	Permanent	The only class of impact that will be non-transitory. Mitigation either by man or natural process will not occur in such a way or such a time span that the impact can be considered indefinite.
INTENSITY/ MAGNITUDE		
Describes the severity of an impact.		
1	Low	Impact affects the quality, use and integrity of the system/component in a way that is barely perceptible.
2	Medium	Impact alters the quality, use and integrity of the system/component but system/component still continues to function in a moderately modified way and maintains general integrity (some impact on integrity).
3	High	Impact affects the continued viability of the system/ component and the quality, use, integrity and functionality of the system or component is severely impaired and may temporarily cease. High costs of rehabilitation and remediation.
4	Very high	Impact affects the continued viability of the system/component and the quality, use, integrity and functionality of the system or component permanently ceases and is irreversibly impaired. Rehabilitation and remediation often impossible. If possible rehabilitation and remediation often unfeasible due to extremely high costs of rehabilitation and remediation.
REVERSIBILITY		

This describes the degree to which an impact can be successfully reversed upon completion of the proposed activity.		
1	Completely reversible	The impact is reversible with implementation of minor mitigation measures.
2	Partly reversible	The impact is partly reversible but more intense mitigation measures are required.
3	Barely reversible	The impact is unlikely to be reversed even with intense mitigation measures.
4	Irreversible	The impact is irreversible and no mitigation measures exist.
IRREPLACEABLE LOSS OF RESOURCES		
This describes the degree to which resources will be irreplaceably lost as a result of a proposed activity.		
1	No loss of resource	The impact will not result in the loss of any resources.
2	Marginal loss of resource	The impact will result in marginal loss of resources.
3	Significant loss of resources	The impact will result in significant loss of resources.
4	Complete loss of resources	The impact is result in a complete loss of all resources.
CUMULATIVE EFFECT		
This describes the cumulative effect of the impacts. A cumulative impact is an effect which in itself may not be significant but may become significant if added to other existing or potential impacts emanating from other similar or diverse activities as a result of the project activity in question.		
1	Negligible cumulative impact	The impact would result in negligible to no cumulative effects.
2	Low cumulative impact	The impact would result in insignificant cumulative effects.
3	Medium cumulative impact	The impact would result in minor cumulative effects.
4	High cumulative impact	The impact would result in significant cumulative effects
SIGNIFICANCE		
Significance is determined through a synthesis of impact characteristics. Significance is an indication of the importance of the impact in terms of both physical extent and time scale, and therefore indicates the level of mitigation required. The calculation of the significance of an impact uses the following formula: (Extent + probability + reversibility + irreplaceability + duration + cumulative effect) x magnitude/intensity.		

The summation of the different criteria will produce a non-weighted value. By multiplying this value with the magnitude/intensity, the resultant value acquires a weighted characteristic which can be measured and assigned a significance rating.		
Points	Impact significance rating	Description
6 to 28	Negative low impact	The anticipated impact will have negligible negative effects and will require little to no mitigation.
6 to 28	Positive low impact	The anticipated impact will have minor positive effects.
29 to 50	Negative medium impact	The anticipated impact will have moderate negative effects and will require moderate mitigation measures.
29 to 50	Positive medium impact	The anticipated impact will have moderate positive effects.
51 to 73	Negative high impact	The anticipated impact will have significant effects and will require significant mitigation measures to achieve an acceptable level of impact.
51 to 73	Positive high impact	The anticipated impact will have significant positive effects.
74 to 96	Negative very high impact	The anticipated impact will have highly significant effects and are unlikely to be able to be mitigated adequately. These impacts could be considered "fatal flaws".
74 to 96	Positive very high impact	The anticipated impact will have highly significant positive effects.

(Extent + probability + reversibility + irreplaceability + duration + cumulative effect) x magnitude/intensity

Table 5: Summary of Impacts

Impacts	Extent	Duration	Magnitude	Reversibility	Irreplaceable loss	Cumulative effect	Impact Significance
Pre-mitigation	1	4	1	4	4	2	15 LOW
Post mitigation	1	4	1	4	4	1	14 LOW

8 FINDINGS AND RECOMMENDATIONS

The proposed new Science Exploratorium site in Carnarvon, in the Pixley ka Seme District Municipality of the Northern Cape Province, is underlain by Jurassic dolerite as well as the Carnarvon Formation (not yet SACS accredited). According to the PalaeoMap of the South African Heritage Resources Information System (SAHRIS) the Palaeontological Sensitivity of the Jurassic Dolerite is Zero, while that of the Carnarvon Formation (Ecca Group) is Moderate (Almond and Pether, 2009; Almond et al., 2013, Groenewald et al 2014). However, the suggested location is classified as having a Medium Palaeontology Theme Sensitivity in the DFFE (Department of Forestry Fisheries and the Environment) Screening Report, while areas with an unknown Sensitivity are also crossed. Updated Geology (Council of Geosciences) indicates that the proposed development is entirely underlain by the Waterford Formation of the Ecca Group.

Desktop research (National Database and published data) concluded that fossil heritage of scientific and conservational interest in the development area is relatively rare and of low scientific and conservational value. Data indicates that fossil sites are generally rare, sporadic and unpredictable. A low significance has thus been allocated to the development footprint. This is in disagreement with the Moderate Sensitivity allocated to the development area by the SAHRIS Palaeontological Sensitivity Map and Medium Sensitivity allocated by the DFFE Screening Tool. Due to the mapped Palaeontological Sensitivity, no site investigation was conducted, and thus, the actual Palaeontological Sensitivity of the development was not verified, but the desktop research confirmed that the area has a LOW sensitivity for paleo resources.

In terms of palaeontological impacts, a Low Palaeontological Significance has been allocated for the study area pre- and post-mitigation. It is therefore considered that the proposed development will not

lead to damaging impacts on the palaeontological resources of the area. **The development may thus be permitted in its whole extent, as the development footprint is not considered sensitive in terms of palaeontological resources.** It is consequently recommended that **no further palaeontological heritage studies, ground truthing, or specialist mitigation be required pending the discovery of newly discovered fossils.**

However, if fossil remains or trace fossils are discovered, either on the surface or exposed by excavations, the Environmental Control Officer (ECO) in charge of these developments must be informed. These discoveries ought to be protected, and the ECO must report to SAHRA (Contact details: SAHRA, 111 Harrington Street, Cape Town. PO Box 4637, Cape Town 8000, South Africa. Tel: 021 462 4502. Fax: +27 (0)21 462 4509. Web: www.sahra.org.za) so that mitigation can be carried out by a palaeontologist.

Before any fossil material can be collected from the development site, the specialist involved would need to apply for a collection permit from SAHRA. Fossil material must be housed in an official collection (museum or university), while all reports and fieldwork should meet the minimum standards for palaeontological impact studies proposed by SAHRA (2012).

These recommendations should be incorporated into the Environmental Management Programme (EMPr) for the Project.

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APPENDIX A: CURRICULUM VITAE

PROFESSION:	Palaeontologist
YEARS' EXPERIENCE:	30 years in Palaeontology
EDUCATION:	B.Sc. Botany and Zoology, 1988 University of the Orange Free State
	B. Sc (Hons) Zoology, 1991 University of the Orange Free State
	Management Course, 1991 University of the Orange Free State
	M.Sc. *Cum laude* (Zoology), 2009 University of the Free State

Dissertation title: The postcranial skeleton of the Early Triassic non-mammalian Cynodont *Galesaurus planiceps*: implications for biology and lifestyle

MEMBERSHIP

Palaeontological Society of South Africa (PSSA) 2006-currently

EMPLOYMENT HISTORY

Part time Laboratory assistant	Department of Zoology & Entomology University of the Free State Zoology 1989-1992
Part time laboratory assistant	Department of Virology University of the Free State Zoology 1992
Research Assistant	National Museum, Bloemfontein 1993 – 1997
Principal Research Assistant and Collection Manager	National Museum, Bloemfontein 1998–2022

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