PEER REVIEW

PROPONENT

South African Radio Astronomy Observatory (SARAO)

INDEPENDENT VISUAL IMPACT ASSESMENT CONSULTANT

Digby Wells Environmental

VISUAL IMPACT PEER REVIEW CONSULTANT
ON BEHALF OF
NEWTOWN LANDSCAPE ARCHITECTS

Menno Klapwijk

DATE: JULY 2018

1. INTRODUCTION AND BACKGROUND

Bapela Cave Klapwijk (BCK) Landscape Architects & Environmental Planners were requested by Newtown Landscape Architects (NLA) to assist them with reviewing the above mentioned report. NLA were appointed by Digby Wells Environmental in July 2018 to review the Visual Impact Assessment specialist report on the proposed **Phase 1 of the Square Kilometre Array (SKA) Project**.

The Terms of Reference (ToR) for the Specialist Study are to compile a Visual Impact Assessment (VIA) to determine the expected visual impact of the Project on the visual and aesthetic character of the receiving environment. The ToR indicated that the VIA must include a lighting plan that details how to minimise the negative visual impact of light pollution (night glow) on the regional nightscape

2. QUALIFICATIONS & EXPERIENCE OF THE PEER REVIEWER

Menno Klapwijk has specialised for 33 years in environmental planning, construction rehabilitation and control, visual impact assessment, and landscape site design. Significant visual impact projects and involvement include:
Peer reviewer of several VIA studies such as the recent Aquaculture SEA on behalf of the CSIR (Environmental Management Services)
Member of the CSIR panel of experts to assist in the development of visual impact guidelines for the Western Cape (ed. Oberholzer B);
Co-author on Chapter Visual, Aesthetic and Scenic Resources – Shale Gas development in the Central Karoo (ed. CSIR);
Aggeneys Solar Park; 75 MW Photovoltaic Solar Facility Zeerust; Mzimvubu Water Project Eastern Cape; Makapan Valley World Heritage Site; Cradle of Humankind World Heritage Site; Taung Child Skull world Heritage Site; N3 De Beers Pass ; N2 Wild Coast Toll Highway; Moatise Power Plant (Tete Mozambique), Transnet Multi-product Fuel Pipeline Pump stations (Durban to Heidelberg), Saldanha Steel, Mozal (Alusaf – Mozambique), Letsibogo Dam (Botswana), Blue Circle Cement Factory (East London), Phlogopite Factory (Phalaborwa), Iscor Heavy Minerals Smelter (Empangeni), many VIA's for Eskom 765kV and 400kV transmission lines and substations; West Coast Combined Cycle Gas Turbine Power Plant (CCGT), De Hoop Dam and Pipeline (Sekhukuneland), Tugela Water Project (KwaZulu-Natal), Vodacom Tower Mast (Delportshoop, Northern Cape), N3 Toll Road, Cedara (KwaZulu-Natal) to Heidelberg (Gauteng), Maputo Steel Project (Maputo, Mozambique), Ga-Pila Village (Potgietersrus, Limpopo Province) and Pom Pom Camp (Okavango, Botswana).
He has more than 100 publications and reports dealing mostly with environmental planning, environmental rehabilitations and control specification, environmental impact assessment and visual impact assessment

1983:	B.Sc (Land Arch), Texas A & M
1986:	Environmental Impact Assessment, Graduate School of Business, UCT

Registered: South African Council for Landscape Architecture Practitioners (SACLAP)
Member: Institute of Landscape Architects of South Africa (ILASA)
Member: American Society of Landscape Architects (ASLA)
Member: International Association of Impact Assessors (SA)

3. TERMS OF REFERENCE

The Terms of Reference for the Peer Reviewer were also not provided to the Reviewer. However, in the absence of such this review is based on the following:

- Does the work as reported meet the requirements of what would typically be the terms of reference of such as study?
- Is the work of the requisite quality as per current industry standards, is the study scientifically sound and are the interpretations supported by the data presented?
- Are the terms of reference adequate and do they cover all relevant aspects to be addressed in a study of this nature?

4. FINDING OF THE PEER REVIEWER

4.1 It has been found that the VIA specialist consultant has adequately met the terms of reference that would typically be set for such a study. The guidelines that have been set for specialists are addressed in NEMA (Integrated Environmental Management) of the National Environmental Management Act, 1998 (Act No. 107 of 1998). The consultant has followed the "Guideline for involving visual and aesthetic specialists in Environmental Impact Assessment (EIA) processes" document that had been set for the Western Cape as the Best Practice guideline for this VIA.

Other documents and guidelines have been consulted such as national legislation and policy documents such as Section 23(1)(d) of the Mineral and Petroleum Resources Development Act, 2002 (Act No. 28 of 2002) (MPRDA), The National Heritage Resources Act, 1999 (Act No. 25 of 1999) (NHRA), Section 17 of the National Environmental Management: Protected Areas Act, 2003 (Act No. 57 of 2003) (NEM: PAA), the Astronomy Geographic Advantage Act, 2007 (Act No. 21 of 2007) (AGA Act). The IFC Performance Standards (IFC, 2012a) and the Equator Principles (EPFI, 2013) have been used as best practice guidelines as well.

4.2 The VIA study does follow accepted practice and methodologies. The methodology is sound in that both theoretical and practical viewshed models were developed by ground-thruthing the theoretical model in the field for both day and night time.

4.3 The specialist consultant needs to explain how the Visual Absorption Capacity (VAC) was determined as ‘moderate (page 43). It was stated in the report that this is due to the partial screening of the topography. An explanation of this in the report would assist the reader. The VAC should be based on a combination of values such as slope (topography), vegetation pattern and height and visual diversity. My instinct tells me, based on my limited knowledge of the area, that the VAC should be rated ‘Low’ rather than ‘Moderate’

4.4 Mitigation measures to reduce the visual intrusion are, as stated, difficult in this sparse environment. Vegetative screening is almost impossible and the only remaining real option is to address the colour of the installations as the white colour stands out in high contrast to the surrounding landscape. The Specialist has recommended that these be toned down by using muted colours that blend in with the landscape. Has the Specialist determined whether this is a viable option as there may be technical reasons why these installations are painted white? If it is not possible to change the colour then the conclusion that with the proposed mitigation measures, the visual impact significance rating from the visual assessment will be reduced to moderate or minor in most instances will need to be reviewed.

5. GENERAL COMMENTS

5.1 It is good practice to state what visual/aesthetic comments have been raised by I&AP’s during the Scoping/EIA process (if available at the time of the study).

5. CONCLUSIONS AND RECOMMENDATIONS

It is concluded that the study has adequately met the terms of reference of the lead consultant and that the methodology, limitations, assumptions, findings and conclusions are consistent with current best practice

Menno Klapwijk Pr.L.Arch.
13 July 2018

The South African Radio Astronomy Observatory Square Kilometre Array Heritage Impact Assessment and Conservation Management Plan Project

Visual Impact Assessment

Project Number:

NRF4874

Prepared for:

SARAO

May 2018

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This document has been prepared by Digby Wells Environmental.

Report Type:	**Visual Impact Assessment**
Project Name:	**The South African Radio Astronomy Observatory Square Kilometre Array Heritage Impact Assessment and Conservation Management Plan Project**
Project Code:	**NRF4874**

Name	**Responsibility**	**Signature**	**Date**
Stephanie Mulder	Report Writer		May 2018
Barbara Wessels	Reviewer		May 2018

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DECLARATION OF INDEPENDENCE

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I, Stephanie Claire Mulder as duly authorised representative of Digby Wells and Associates (South Africa) (Pty) Ltd., hereby confirm my independence (as well as that of Digby Wells and Associates (South Africa) (Pty) Ltd.) and declare that neither I nor Digby Wells and Associates (South Africa) (Pty) Ltd. have any interest, be it business, financial, personal or other, in any proposed activity, application or appeal in respect of the South African Radio Astronomy Observatory (SARAO), other than fair remuneration for work performed, specifically in connection with the proposed development of Phase 1 of the Square Kilometre Array (SKA) Project, located near Carnarvon, Northern Cape Province.

Full Name:	Stephanie Claire Mulder
Title/ Position:	Manager: GIS
Qualification(s):	BSc Honours in Geography
Experience (Years):	11.5 years
Registration(s):	GISSA

EXECUTIVE SUMMARY

Introduction

Digby Wells Environmental (hereafter Digby Wells) was appointed by the South African Radio Astronomy Observatory (SARAO) as the specialist service provider for the Heritage Resources Management (HRM) process in support of Phase 1 of the Square Kilometre Array (SKA) Project (the Project).

The Project comprises two primary components, namely the ‘core’ (36 land parcels) and three ‘spiral arms’ (73 land parcels) covering an approximate areal extent of 460,000 hectares (ha). This land makes provision for the SKA Radio Telescope site, KAT-7 radio telescope, MeerKAT, HIRAX and HERA instruments. During Phase 1 of the SKA Project the international SKA Organisation (SKAO) proposes to establish an additional 133 dish-antennas to the 64-dish MeerKAT radio telescope and various ancillary infrastructures.

The significance of the long term visual impacts of a proposed development will determine the acceptability of the development to receptors. An understanding of the visual/aesthetic character of a landscape allows the sensitivity of the landscape to be determined. This in turn indicates the ability of the landscape to accommodate visual change. A Visual Impact Assessment (VIA) is performed to identify the potential visual impacts of a proposed project on the receiving environment.

This report constitutes the VIA required as part of the HRM process and describes the visual/aesthetic character of the receiving environment and the expected visual impacts of the proposed Project. The impacts are described and rated, and mitigation/management actions proposed to reduce the negative visual impacts of the Project.

Methodology

A desktop study was conducted to evaluate the topography of the receiving environment and aerial photography of the area was examined to determine the surface features. Available vector GIS data was used to determine the relative location of the features surrounding the Project area.

A topographical model was created using ArcGIS 3D Analyst Extension. The resultant topographical model was then used to create slope intensity and slope aspect models using the Slope and Aspect tools of ArcGIS 3D Analyst Extension. The slope model indicates the slope degree.

The topographical model was used to create viewshed models using the Viewshed Tool of the ArcGIS 3D Analyst Extension. These viewshed models illustrate the areas from which the Project will potentially be visible, taking into account the estimated height of the proposed infrastructure.

Theoretical and practical viewshed models were created for the Project for daytime and night time scenarios. These viewshed models are based on the topography only and do not take the screening effect of vegetation into account. The viewshed models depict worst case scenarios and show the areas from which the Project may potentially be visible.

The information gathered from the above desktop study was verified with a site visit. The combined information from the desktop study and the site visit forms the basis of this report.

Baseline and Findings

The Project area is situated in the Bo-Karoo region of the Great Karoo, a semi-arid area in the Northern Cape Province of South Africa (Oberholzer & Lawson, 2016). The Project area and surrounds are characterised by vast expanses of open land (some of which is used for sheep farming) interspersed with isolated farmsteads and the occasional small town/settlement.

The Project area consists of the core and three spiral arms namely:

- Brandvlei spiral arm;
- Carnarvon spiral arm; and
- Williston spiral arm.

Residential areas and road users in the Project area and surrounds are all potential visual receptors of the Project. The Project area and surrounds have a largely rural, farming sense of place.

According to Mucina and Rutherford (2012) the dominant vegetation types in the Project area and surrounds are Bushmanland Arid Grassland, Bushmanland Basin Shrubland, Bushmanland Sandy Grassland, Northern Upper Karoo, Upper Karoo Hardeveld and Western Upper Karoo interspersed with Bushmanland Vloere. Most of the natural Shrubland and Grassland vegetation is intact but this low, sparse vegetation is not expected to provide screening of the Project. There are existing rows of alien invasive plants/trees planted near some farm residences as windbreaks/vegetation screens. It is anticipated that these alien invasive plants/trees will have a screening effect and will reduce the visual impact of the Project on these farm residences.

The visibility of the existing MeerKAT and KAT-7 radio telescope dish-antennas was used to determine the expected visibility of the dish-antennas during the day. The visibility of the night time lighting of the Meysdam construction camp was used to determine the expected visibility of the proposed construction camps at night. Based on the findings of the site visit it is likely that the Project will be visible from a maximum distance of 20 km during the day and 8 km at night. It is noted that beyond these distances the visual exposure is expected to be negligible.

The potential visual receptors within the daytime practical viewshed include residents of the Brandvlei and Swartkop settlements, residents of the 194 farmsteads on the surrounding farms, road users and 82 heritage sites outside the core area. The potential visual receptors within the night time practical viewshed include road users and five heritage sites outside the core area.

The receiving environment of the Project has a high visual sensitivity as there are highly visible and potentially sensitive areas in the landscape. The Project area and surrounds are characterised by vast expanses of open land interspersed with isolated farmsteads and the occasional small town/settlement. The receiving environment has a largely rural, farming sense of place.

The Project has a high visibility and a high visual exposure as it is visible from a large area (defined by Oberholzer (2005) as several square kilometres), dominant in the landscape and clearly noticeable to receptors. The Project has a high visual intrusion as it is likely to result in a noticeable change and is discordant with the surroundings.

The identified receptors (residents of the farmsteads on the surrounding farms, road users and heritage sites) of the Project have a high sensitivity as they include residential areas and heritage sites.

The receiving environment of the Project has a moderate Visual Absorption Capacity (VAC) because there is partial screening by the topography.

Impacts

Change of land use from natural vegetation and agriculture to industry/scientific research will have a negative visual impact on the receiving environment. This change of land use will change the sense of place of the Project area and surrounds from a rural, farming sense of place to a more industrial/scientific sense of place resulting in a loss of scenic character and increased visual disturbance.

The SKA radio telescope and associated infrastructure will remain indefinitely resulting in a permanent negative visual impact on the receiving environment.

Mitigation

General mitigation/management actions that should be implemented where possible include:

- As much existing natural vegetation as possible should be retained, specifically bushes and trees if present. This will assist to conceal the development;
- Areas susceptible to dust should be frequently wetted by means of a water bowser during the construction phase. It is extremely important to suppress the visual aspects of dust to avoid creating the impression of a polluting industry;
- Surface infrastructure should be painted natural hues so as to blend into the surrounding landscape where possible;
- Pylons and metal structures should be galvanised so as to weather to a matt grey finish rather than be painted silver. If the pylons and metal structures are painted, it is recommended that a neutral matt finish be used;
- Where possible avoid construction and operational activities at night. If construction and operational activities take place at night, then only areas where these activities are taking place should be lit and the number of lights and brightness must not exceed the minimum requirements for safety and security. Down lighting and low-

pressure sodium light sources must be implemented to minimise light pollution. Lights should be directed inwards towards the Project area and not outwards from the Project area;

- Educate receptors on the benefits of the Project to change their perceptions of the visual impact; and
- An appropriate grievance mechanism should be developed to respond to grievances from receptors that relate to visual aspects.

Conclusion

The "Guideline for involving visual and aesthetic specialists in Environmental Impact Assessment (EIA) processes" document by Oberholzer (2005) identifies large-scale infrastructure as a Category 5 development. The receiving environment of the Project is an area of high scenic, cultural or historical significance as the Project area has a largely rural, farming sense of place. The Project area and surrounds are characterised by vast expanses of open land (some of which is used for sheep farming) interspersed with isolated farmsteads and the occasional small town/settlement. A Category 5 development in this area is expected to have a very high visual impact. The findings of this VIA concur with this categorisation. However, with the mitigation proposed, the visual impact significance rating from the visual impact assessment is reduced to moderate or minor in most instances. (It should be noted that Oberholzer's categorisation differs from the impact assessment methodology and as a result the expected visual impact according to Oberholzer and the visual impact significance ratings from the visual impact assessment may differ).

The SKA radio telescope Project is of international scientific importance. For some receptors, the visibility of the Project may be viewed positively as it signifies advances in scientific research.

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LIST OF ACRONYMS & ABBREVIATIONS

3D	Three-Dimensional
AGA Act	Astronomy Geographic Advantage Act, 2007 (Act No. 21 of 2007)
CD:NGI	Chief Directorate: National Geospatial Information
CMP	Conservation Management Plan
CSIR	Council for Scientific and Industrial Research
CV	Curriculum Vitae
DEA	Department of Environmental Affairs
DEM	Digital Elevation Model
Digby Wells	Digby Wells Environmental
EHS	Environmental, Health and Safety
EIA	Environmental Impact Assessment
EPFI	Equator Principles Financial Institution
ESRI	Environmental Systems Research Institute
GHG	Greenhouse Gas
GIS	Geographical Information System
GISSA	Geo-Information Society of South Africa
ha	hectares
HIA	Heritage Impact Assessment
HRM	Heritage Resources Management
IFC	International Finance Corporation
km	kilometres
km^2	kilometres squared
m	metres
m.a.m.s.l.	metres above mean sea level
MPRDA	Mineral and Petroleum Resources Development Act, 2002 (Act No. 28 of 2002)
NEMA	National Environmental Management Act, 1998 (Act No. 107 of 1998)
NEM: PAA	National Environmental Management: Protected Areas Act, 2003 (Act No. 57 of 2003)
NHRA	National Heritage Resources Act, 1999 (Act No. 25 of 1999)
Project	SKA Project
PV	Photovoltaic

REEA	South African Renewable Energy EIA Application Database
RFI	Radio Frequency Interference
SACAA	South African Civil Aviation Authority
SAHRA	South African Heritage Resources Agency
SAPAD	South African Protected Areas Database
SARAO	South African Radio Astronomy Observatory
SEA	Strategic Environmental Assessment
SKA	Square Kilometre Array
SKAO	SKA Organisation
ToR	Terms of Reference
VAC	Visual Absorption Capacity
VIA	Visual Impact Assessment
WBG	World Bank Group

1 Introduction

The South African Radio Astronomy Observatory (SARAO) provided a brief (*BID SKA PEP 6 001/2017*) for the full execution/implementation of services to complete a Heritage Impact Assessment (HIA) and Conservation Management Plan (CMP) in support of Phase 1 of the Square Kilometre Array (SKA) Project (the Project). The prerequisite for the HIA and CMP was to satisfy the requirements of Section 38(3) of the National Heritage Resources Act, 1999 (Act No. 25 of 1999) (NHRA) and Statutory Comment issued by the South African Heritage Resources Agency (SAHRA) on Case ID: 10314.

Digby Wells Environmental (hereinafter Digby Wells) was the successful bidder and subsequently appointed by SARAO as the specialist service provider in support of the aforementioned Heritage Resources Management (HRM) process.

This report constitutes the Visual Impact Assessment (VIA) as part of the HRM process and describes the visual/aesthetic character of the receiving environment and the expected visual impacts of the proposed Project. The impacts are described and rated, and mitigation/management actions proposed to reduce the negative visual impacts of the Project.

1.1 General

"Visual, scenic and cultural components of the environment can be seen as a resource, much like any other resource, which has a value to individuals, to society and to the economy of the region. In addition, this resource may have a scarcity value, be easily degraded, and is usually not replaceable" (Oberholzer, 2005).

The significance of the long term visual impacts of a proposed development will determine the acceptability of the development to receptors. An understanding of the visual/aesthetic character of a landscape allows the sensitivity of the landscape to be determined. This in turn indicates the ability of the landscape to accommodate visual change. A VIA is performed to identify the potential visual impacts of a proposed project on the receiving environment.

1.2 Project Background

The Project comprises two primary components, namely the 'core' (36 land parcels) and three 'spiral arms' (73 land parcels) covering an approximate areal extent of 460,000 hectares (ha). This land makes provision for the SKA Radio Telescope site, KAT-7 radio telescope, MeerKAT, HIRAX and HERA instruments.

In support of obtaining environmental exclusion in terms of Section 24(2)(e) for the Project, the Department of Environmental Affairs (DEA) commissioned the Council for Scientific and Industrial Research (CSIR) to complete a Strategic Environmental Assessment (SEA) (CSIR, 2016) in accordance with the principles of the National Environmental Management

Act, 1998 (Act No. 107 of 1998) (NEMA). The SEA is interpreted as the first step in the development of management principles into environmental decision making processes.

The Project area was investigated by various specialists through desktop Geographic Information System (GIS) analysis and site visits from November 2015 to May 2016. The SEA included a strategic level assessment of the visual/landscape aspects "to establish a baseline against which the potential impacts of the SKA can be measured" (Oberholzer & Lawson, 2016).

1.3 Project Description

The international SKA Organisation (SKAO) proposes to establish an additional 133 dish-antennas to the 64-dish MeerKAT radio telescope, including various ancillary infrastructures comprising:

- Establishment of approximately 115 km new access gravel roads;
- Upgrading of approximately 320 km of existing roads;
- Development of electrical infrastructure including:
  - Above ground and underground (trenched) powerlines; and
  - Mini substations and distribution kiosks.
- Development of fibre optic network including:
  - Above ground and underground (trenched) fibre optic cables.
- Establishment of 15 small-scale solar photovoltaic (PV) plants;
- Establishment of approximately 20 borrow pits;
- Establishment of four stone quarries;
- Expansion of the existing Losberg construction camp; and
- Establishment of two new construction camps at Bergsig and Swartfontein.

Current planning estimates that construction activities associated with SKA Phase 1 will commence in the latter part of 2019, continuing to 2024. The lifespan of SKA Phase 1 is expected to be 40 to 50 years from the completion of construction.

1.4 Terms of Reference

The Terms of Reference (ToR) for this study are to compile a VIA to determine the expected visual impact of the Project on the receiving environment. The ToR indicated that the VIA must include a lighting plan that details how to minimise the negative visual impact of light pollution (night glow) on the regional nightscape.

2 Details of Specialist

A Curriculum Vitae (CV) is attached in Appendix A.

Stephanie Mulder is the manager of the Geographical Information System (GIS) department at Digby Wells. Stephanie joined the company in September 2009 as an Environmental GIS Specialist and was subsequently made GIS Manager in July 2012. She obtained her Bachelor of Science (BSc) Honours degree in Geography from the University of Johannesburg in 2006. Stephanie is responsible for managing the GIS team and overseeing all GIS and Visual work.

Since starting at Digby Wells, Stephanie has developed and refined the methodology for assessing topographical and visual impacts, including the visual impact of night time lighting. She has conducted numerous VIAs to both local and international best practice guidelines including International Finance Corporation (IFC) Performance Standards and Equator Principles and the World Bank Group (WBG) Environmental, Health and Safety (EHS) Guidelines. Her skills include 3D topographical and visibility modelling, visualisation/mapping, and impact prediction and mitigation.

She has experience managing GIS specific projects and has also managed several social survey projects. Stephanie has a strong technical GIS background and has experience using GIS as a digital cartographic and spatial analytical tool. She also has experience with interactive mapping, sensitivity analysis, site selection and remote sensing projects. Stephanie is a registered member of GISSA (Geo-Information Society of South Africa).

3 Relevant Legislation

The following international, national and regional documents form part of the legislative and policy framework of the visual assessment.

3.1 National Legislation and Policy

At a national level, the following legislative documents potentially apply to the visual assessment:

- Regulations in Chapter 5 (Integrated Environmental Management) of the National Environmental Management Act, 1998 (Act No. 107 of 1998) (NEMA) and the Act in its entirety. The Act states that “the State must respect, protect, promote and fulfil the social, economic and environmental right of everyone…” Landscape is both moulded by, and moulds, social and environmental features;
- Section 23(1)(d) of the Mineral and Petroleum Resources Development Act, 2002 (Act No. 28 of 2002) (MPRDA), where it is mentioned that a mining right will be granted if “the mining will not result in unacceptable pollution, ecological degradation or damage to the environment”. Visual pollution is a form of environmental pollution and therefore needs to be considered under this section. Holders of rights granted in terms of the MPRDA must at all times give effect to the general objectives of integrated environmental management laid down in Chapter 5 of the NEMA. The Regulations promulgated in terms of the NEMA, with which holders of rights must

comply, provide for the assessment and evaluation of potential impacts, and the setting of management plans to mitigate such impacts.

- The National Heritage Resources Act, 1999 (Act No. 25 of 1999) (NHRA) and related provincial regulations – in some instances there are policies or legislative documents that give rise to the protection of listed sites. The NHRA states that it aims to promote "good management of the national estate, and to enable and encourage communities to nurture and conserve their legacy so that it may be bequeathed for future generations". A holistic landscape whose character is a result of the action and interaction and/or human factors has strong cultural associations as societies and the landscape in which they live are affected by one another in many ways;
- Section 17 of the National Environmental Management: Protected Areas Act, 2003 (Act No. 57 of 2003) (NEM: PAA) sets out the purposes of the declaration of areas as protected areas which includes the protection of natural landscapes. Landscapes are defined by the natural, visual and subjectively perceived landscape; these aspects of a landscape are intertwined to form a holistic landscape context; and
- The objectives of the Astronomy Geographic Advantage Act, 2007 (Act No. 21 of 2007) (AGA Act) include:
  - "to identify and protect areas in which astronomy projects of national strategic importance can be undertaken;
  - to provide a framework for the establishment of a national system of astronomy advantage areas in the Republic, to ensure that the geographic areas in the Republic which are highly suitable for astronomy and related scientific endeavours due to, for example, high atmospheric transparency, low levels of light pollution, low population density or minimal radio frequency interference are protected, preserved and properly maintained; and
  - to regulate activities which cause or could cause light pollution or radio frequency interference or interfere in any other way with astronomy and related scientific endeavours in those areas".

3.2 IFC Performance Standards and Equator Principles

Visual assessments are relevant to the IFC Performance Standards (IFC, 2012a) and the Equator Principles (EPFI, 2013). These standards will be treated as a best practice guideline.

Equator Principle 3: Applicable Environmental and Social Standards states that "the Equator Principles Financial Institution (EPFI) will require that the Assessment process evaluates the compliance with the applicable standards as follows:

- For Projects located in Non-Designated Countries, the Assessment process evaluates compliance with the then applicable IFC Performance Standards on Environmental and Social Sustainability (Performance Standards) and the World Bank Group (WBG) Environmental, Health and Safety (EHS) Guidelines; and

- For Projects located in Designated Countries, the Assessment process evaluates compliance with relevant host country laws, regulations and permits that pertain to environmental and social issues. Host country laws meet the requirements of environmental and/or social assessments (Principle 2), management systems (Principle 4), Stakeholder Engagement (Principle 5) and, grievance mechanisms (Principle 6)."

The Equator Principles Association defines Designated Countries as "those countries deemed to have robust environmental and social governance, legislation and institutional capacity designed to protect their people and the natural environment." South Africa is not on the Equator Principles Association's list of Designated Countries and therefore the IFC Performance Standards are applicable to this Project (EPFI, 2013).

IFC Performance Standard 1: Assessment and Management of Environmental and Social Risks and Impacts is applicable to an EIA and all specialist studies including the visual assessment. "Performance Standard 1 underscores the importance of managing environmental and social performance throughout the life of a project" (IFC, 2012a). The objectives of this Performance Standard are:

- "To identify and evaluate environmental and social risks and impacts of the project;
- To adopt a mitigation hierarchy to anticipate and avoid, or where avoidance is not possible, minimise, and, where residual impacts remain, compensate/offset for risks and impacts to workers, Affected Communities and the environment;
- To promote improved environmental and social performance of clients through the effective use of management systems;
- To ensure that grievances from Affected Communities and external communications from other stakeholders are responded to and managed appropriately; and
- To promote and provide means for adequate engagement with Affected Communities throughout the project cycle issues that could potentially affect them and to ensure that the relevant environmental and social information is disclosed and disseminated" (IFC, 2012a).

IFC Performance Standard 3: Resource Efficiency and Pollution Prevention is applicable to the visual assessment. "Performance Standard 3 recognises that increased economic activity and urbanisation often generate increased levels of pollution to air, water and land,

and consume finite resources in a manner that may threaten people and the environment at the local, regional and global levels[1]" (IFC, 2012a).

IFC Performance Standard 6: Biodiversity Conservation and Sustainable Management of Living Natural Resources is applicable to the visual assessment. "Performance Standard 6 recognises that protecting and conserving biodiversity, maintaining ecosystem services, and sustainably managing living natural resources are fundamental to sustainable development" (IFC, 2012a). "Ecosystem services are the benefits that people, including businesses, derive from ecosystem services. Ecosystem services are organised into four types: (i) provisioning services, which are the products people obtain from ecosystems; (ii) regulating services, which are the benefits people obtain from the regulation of ecosystem processes; (iii) cultural services, which are the nonmaterial benefits people obtain from ecosystems; and (iv) supporting services, which are the natural processes that maintain the other services[2]" (IFC, 2012a).

IFC Performance Standard 8: Cultural Heritage applies to the visual assessment. "Performance Standard 8 recognises the importance of cultural heritage for current and future generations" (IFC, 2012a). "For the purposes of this Performance Standard, cultural heritage refers to: (i) tangible forms of cultural heritage, such as tangible movable or immovable objects, property, sites, structures, or groups of structures, having archaeological (prehistoric), paleontological, historical, cultural, artistic and religious values; (ii) unique natural features or tangible objects that embody cultural values, such as sacred groves, rocks, lakes, and waterfalls; and (iii) certain instances of intangible forms of culture that are proposed to be used for commercial purposes, such as cultural knowledge, innovations, and practices of communities embodying traditional lifestyles" (IFC, 2012a).

"Tangible cultural heritage is considered a unique and often non-renewable resource that possesses cultural, scientific, spiritual, or religious value and includes moveable or immovable objects, sites, structures, groups of structures, natural features, or landscapes that have archaeological, paleontological, historical, architectural, religious, aesthetic, or other cultural value" (IFC, 2012b). The requirements of Performance Standard 8 do not apply to the cultural heritage of Indigenous Peoples which is covered under Performance Standard 7 (IFC 2012a).

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[1] "For the purposes of this Performance Standard, the term 'pollution' is used to refer to both hazardous and non-hazardous chemical pollutants in the solid, liquid, or gaseous phases, and includes other components such as pests, pathogens, thermal discharge to water, Greenhouse Gas (GHG) emissions, nuisance odours, noise, vibration, radiation, electromagnetic energy and the creation of potential visual impacts including light" (IFC, 2012a).

[2] "Examples are as follows: (i) provisioning services may include food freshwater, timber, fibres, medicinal plants; (ii) regulating services may include surface water purification, carbon storage and sequestration, climate regulation, protection from natural hazards; (iii) cultural services may include natural areas that re sacred sites and areas of importance for recreation and aesthetic enjoyment; and (iv) supporting services may include soil formation, nutrient cycling, primary production" (IFC, 2012a).

3.3 World Bank Group Environmental, Health and Safety Guidelines

Although not specifically related to radio telescopes, aspects of both the WBG EHS Guidelines for Telecommunications (WBG, 2007b) and the WBG EHS Guidelines for Wind Energy (WBG, 2015) may be relevant.

The WBG EHS Guidelines for Telecommunications (WBG, 2007b) "are applicable to telecommunications infrastructure such as fixed line and wireless voice and data transmission infrastructure, including long distance terrestrial and submarine cables (e.g. fibre optic cables), as well as radio and television broadcasting, and associated telecommunications and broadcasting installations and equipment. Associated installations and equipment include cellular, micro wave, and other radio-based systems; satellite receivers; wire line and wireless receiving, transmitting, and switching stations, and related equipment such as masts and towers, cables and connectors, equipment housing such as shelters and cabinets, backup batteries, and auxiliary power units (generators)" (WBG, 2007b).

The section relevant to visual impacts in WBG EHS Guidelines for Telecommunications (WBG, 2007b) can be summarised as follows:

"The visual impacts from tower and antennae equipment may depend on the perception of the local community as well as the aesthetic value assigned to the scenery (e.g. scenic and tourism areas). Recommendations to prevent, minimise and control the visual impacts include:

- Minimising construction of additional towers through co-location of proposed antennae in existing towers or existing structures such as building or power transmission towers;
- Use of tower and antennae camouflaging or disguising alternatives (e.g. masts or towers designed to look as tress); and
- Taking into account public perception about aesthetic issues by consulting with the local community during the siting phase of antennae towers" (WBG, 2007b).

The WBG EHS Guidelines for Wind Energy (WBG, 2015) provide "a summary of EHS issues associated with wind energy facilities along with recommendations for their management" (WBG, 2015).

"Construction activities for wind energy facilities typically include land clearing for site preparation and access routes; excavation, blasting, and filling; transportation of supply materials and fuels; construction of foundations involving excavations and placement of concrete; operating cranes for unloading and installation of equipment; construction and installation of associated infrastructure; installation of overhead conductors or cable routes (above ground and underground); and commissioning of new equipment. Decommissioning activities may include removal of project infrastructure and site rehabilitation. Environmental impacts associated with the construction, operation, and decommissioning of wind energy facilities activities may include, among others, impacts on the physical environment (such as noise or visual impact) and biodiversity (affecting birds and bats, for instance)" (WBG, 2015).

The section relevant to landscape, seascape, and visual impacts in WBG EHS Guidelines for Wind Energy (WBG, 2015) can be summarised as follows:

"Depending on the location, a wind energy facility may have an impact on viewscapes, especially if visible from or located near residential areas or tourism sites. Visual impacts associated with wind energy projects typically concern the installed and operational turbines themselves (e.g. colour, height, and number of turbines).

Impacts may also arise in relation to operational wind facilities' interaction with the character of the surrounding landscape and/or seascape. Impacts on Legally Protected and Internationally Recognised Areas of importance to biodiversity[3] and cultural heritage features[4] are also a consideration. Preparing zone of influence maps and preparing wire-frame images and photomontages from key viewpoints is recommended to inform both the assessment and the consultation process.

Avoidance and minimisation measure to address landscape, seascape, and visual impacts are largely associated with the siting and layout of wind turbines and associated infrastructure, such as meteorological towers, onshore access tracks, and substations.

Consideration should be given to turbine layout, size and scale in relation to the surrounding landscape and seascape character and surrounding visual receptors (e.g. residential properties, users of recreational areas/routes).

Consideration should also be given to the proximity of turbines to settlements, residential areas, and other visual receptors to minimise visual impacts and impacts on residential amenity, where possible. All relevant viewing angles should be considered when considering turbine locations, including viewpoints from nearby settlements.

Other factors can be considered in relation to minimising visual impacts:

- Incorporate community input into wind energy facility layout and siting;
- Maintain a uniform size and design of turbines (e.g. type of turbine and tower, as well as height);
- Adhere to country-specific standards for marking turbines, including aviation/navigational and environmental requirements, where available;
- Minimise presence of ancillary structures on the site by minimising site infrastructure, including the number of roads, as well as by burying collector system power lines, avoiding stockpiling of excavated material or construction debris, and removing inoperative turbines; and

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[3] See paragraph 20 in IFC Performance Standard 6 (IFC, 2012a) for the definition of "Legally Protected and Internationally Recognised Areas."

[4] Sites with archaeological, palaeontological, historical, cultural, artistic, and religious values.

- Erosion measures should be implemented and cleared land should be promptly re-vegetated with local seed stock of native species" (WBG, 2015).

The WBG EHS Guidelines for Mining provide "a summary of EHS issues associated with mining activities which may occur during the exploration, development and construction, operation, closure and decommissioning, and post-closure phase, along with recommendations for their management" (WBG, 2007a). These guidelines are applicable to the borrow pits and quarries.

"Mining operations, and in particular surface mining activities, may result in negative visual impacts to resources associated with other landscape uses such as recreation or tourism. Potential contributors to visual impacts include highwalls, erosion, discoloured water, haul roads, waste dumps, slurry ponds, abandoned mining equipment and structures, garbage and refuse dumps, open pits, and deforestation.

Mining operations should prevent and minimise negative visual impacts through consultation with local communities about potential post-closure land use, incorporating visual impact assessment into the mine reclamation process. Reclaimed lands should, to the extent feasible, conform to the visual aspects of the surrounding landscape. The reclamation design and procedures should take into consideration the proximity to public viewpoints and the visual impact within the context of the viewing distance. Mitigation measures may include strategic placement of screening materials including trees and use of appropriate plant species in the reclamation phase as well as modification in the placement of ancillary facilities and access roads" (WBG, 2007a).

3.4 Guidelines

The "Guideline for involving visual and aesthetic specialists in Environmental Impact Assessment (EIA) processes" document by Oberholzer (2005) has been used as a best practice guideline for this VIA. Although these guidelines were developed for the Western Cape province of South Africa they are relevant for this VIA as "the guidelines promote the principles of EIA best practice without being tied to specific legislated national or provincial EIA terms and requirements" (Oberholzer, 2005).

4 Aims and Objectives

The aims of this VIA are to determine the nature of the Project area and the impact of the proposed Project on the visual/aesthetic character of the surrounding landscape. The following objectives were identified to achieve these aims:

- Examine aerial photography available for the Project area;
- Create and analyse topographical, slope intensity and slope aspect models in ArcGIS 3D Analyst Extension;
- Create and analyse viewshed models in ArcGIS 3D Analyst Extension for daytime and night time scenarios;

- Visit the Project area to verify these models;
- Describe the topography and visual/aesthetic character of the receiving environment;
- Describe the current and post development visual aspects of the Project area;
- Create photomontages to illustrate the current and potential future views of the Project area;
- Identify sensitive visual receptors and key public viewpoints that will be impacted on by the proposed Project, taking into account visibility aspects;
- Identify the impacts, pre- and post-mitigation that the proposed infrastructure will have on the topographical and visual landscape, by rating the scale, duration, severity and probability of the impacts occurring; and
- Provide mitigation measures and recommendations in an attempt to reduce the potential visual impacts.

5 Assumptions and Limitations

A VIA is open to subjectivity. This subjectivity is due to the different opinions receptors may have of a proposed project. Oberholzer (2005) defines receptors as "individuals, groups or communities who are subject to the visual influence of a particular project". A receptor may be partial to the fact that a proposed project is occurring in an area, which becomes a source of economic upliftment for a community, whereas another receptor may view a proposed project as a negative factor which could hamper tourism or recreational activities.

Many factors can enhance or reduce the visual impact of a proposed project. Vegetation near a receptor's viewpoint can greatly reduce that receptor's view of a proposed project. Other factors such as weather/climatic conditions and seasonal change can also affect a receptor's view of a proposed project.

It is, therefore, difficult to determine the visual impact of the Project from the viewpoint, as well as perspective, of each individual receptor. Consequently, this report focuses on the size of the viewshed area as an indication of the significance of the visual impacts of the Project. Five (5) key viewpoints were selected for the photomontages to provide an example of the expected views of the Project (refer to Section 8.5 below).

Lidar contours with a 0.5 metre contour interval are available for the Project area but only 20 metre contour relief data is available for the surrounding area. The topographical model was created using the available 20 metre contour relief data from Chief Directorate: National Geo-Spatial Information (CD: NGI). This data is generalised and some of the topography detail is lost. Ideally contour relief data with a higher resolution is desired to increase the accuracy of the topographical and viewshed models but the Lidar data is too detailed for the model extent.

At the time of the study only limited information was available for some of the ancillary infrastructure. The location and extent of the mini substations and distribution kiosks as well as the extent of the solar PV plants, borrow pits and quarries, was not known. The construction camps will remain and be maintained until commencement of the construction for Phase 2 of the SKA Project (CSIR, 2016). If Phase 2 does not materialise these camps will be decommissioned.

The site visit took place from 27 February to 1 March 2018. The weather conditions for the site visit were mainly clear sunny skies with the exception of 27 February when some scattered small clouds were present. These weather conditions were suitable to obtain sufficient visual observations and photographs for the VIA.

To prevent Radio Frequency Interference (RFI) from electronic equipment several restriction zones exist near the operational radio telescopes. All electronic equipment was sent for testing prior to the site visit and the camera used to take photographs for the VIA was only permitted to be operated at a certain distance from any operational telescope (1.4 km from the nearest MeerKAT dish-antenna and 1.6 km from the nearest HERA antenna). This meant that no close up photographs of the dish-antennas could be obtained. The image of the dish-antenna that has been overlaid in the photomontages is a photograph of the proto-type dish-antenna obtained from the internet.

6 Project Area

The Project area is situated in the Bo-Karoo region of the Great Karoo, a semi-arid area in the Northern Cape Province of South Africa (Oberholzer & Lawson, 2016). The Project area and surrounds are characterised by vast expanses of open land (some of which is used for sheep farming) interspersed with isolated farmsteads and the occasional small town/settlement. Plan 1 (Appendix B) illustrates the regional setting of the Project.

The Project area consists of the core and three spiral arms namely:

- Brandvlei spiral arm;
- Carnarvon spiral arm; and
- Williston spiral arm.

The Project area falls within the Hantam and Karoo Hoogland Local Municipalities of the Namakwa District and the Kareeberg Local Municipality of the Pixley ka Seme District. The Project covers an area of approximately 460,000 ha or 4,600 km² (the core is approximately 1,230.1 km², the Brandvlei spiral arm is approximately 1,023.6 km², the Carnarvon spiral arm is approximately 1,199.4 km² and the Williston spiral arm is approximately 1,145.6 km²). The coordinates of the centre of the Project are 30° 41' 27.557" S and 21° 25' 31.477" E.

The nearest large town is Carnarvon located 74.2 km east-south-east of the centre of the Project area and 28.9 km south-east of the nearest proposed dish-antenna (SKA120). The residential areas in the surrounding area are potential visual receptors of the Project. The towns/settlements within 20 km of the proposed infrastructure, as well as their direct distance and direction from the proposed infrastructure, are summarised in Table 1. All distances are straight line distances measured from the centre of the towns/settlements to the closest edge of the proposed infrastructure (i.e. the shortest distance).

Table 1: Closest Towns and Settlements

Name	Type	Direct Distance	Infrastructure	Direction
Onderstedorings	Settlement	10.6 km	SKA008	N
Swartkop	Settlement	15 km	SKA006	NNW
Sterling	Settlement	18.5 km	SKA132	ENE

Road and railway users in the Project area and surrounds are also potential visual receptors. The R63 regional road between Carnarvon and Williston runs through the Williston spiral arm, the R357 regional road between Brandvlei and Van Wyksvlei runs through the Brandvlei spiral arm and both the R361 regional road between Carnarvon and Van Wyksvlei and the R386 regional road between Carnarvon and Prieska run through the Carnarvon spiral arm. There are also numerous minor roads and farm roads within the Project area and surrounds. The Carnarvon-Williston railway line runs in an east-west direction through the Williston spiral arm approximately 4.3 km south of the nearest proposed dish-antenna (SKA132). Plan 2 (Appendix B) illustrates the local setting of the Project.

The Project area and surrounds have a rich heritage with numerous archaeological, historical, palaeontological and rock art sites as well as burial grounds and graves (Digby Wells, 2018). These heritage sites are located on privately owned farms and therefore not accessible to the public. Should any of these heritage sites be developed into tourism attractions then visitors to these developed sites would be potential visual receptors of the Project.

Protected areas[5] such as nature reserves, and recreational and tourism areas are considered sensitive visual receptors. There are no protected areas within the Project area. The nearest protected area is the Dr Appie van Heerden Nature Reserve (DEA, 2018a) located on the southern edge of the town of Carnarvon. This nature reserve is approximately 29.1 km south-east of the nearest proposed dish-antenna (SKA120). All distances are straight line distances measured from the closest edge of the protected area to the closest edge of the proposed infrastructure (i.e. the shortest distance).

Oberholzer (2005) defines sense of place as “the unique quality or character of a place, whether natural, rural or urban”. Sense of place “relates to uniqueness, distinctiveness or strong identity” and is “sometimes referred to as *genius loci* meaning *spirit of the place*” (Oberholzer, 2005). The Project area and surrounds have a largely rural, farming sense of place. Oberholzer and Lawson (2016) use the words “vastness, serenity, quietness and dark skies at night” to describe the sense of place.

[5] SARAO are applying to have the core area declared a protected area. Access to this protected area will be restricted and any visitors will not be sensitive visual receptors of the Project as it is assumed that they will be visiting the area out of scientific interest.

The affected visual receptors will be determined in the investigation to follow (refer to Section 8.3).

7 Methodology

The VIA was performed using surveyed geographically referenced information and aerial photography, together with the professional opinion of an experienced visual impact assessor.

The study identified and evaluated the surface features using ArcGIS 3D Analyst Extension to create a topographical model, and the resultant slope intensity, slope aspect and viewshed models.

7.1 Characterisation of Visual Impacts

The expected visual impact of the Project was categorised based on the type of receiving environment and the type of development as detailed in Table 3 (Oberholzer, 2005). This table provides an indication of the visual impacts that can be expected for different types of developments in relation to the nature of the receiving environment. Following the classification system of Oberholzer (2005), the Project is classed as a **Category 5 development** (Table 2). The receiving environment can be described as having **high scenic, cultural or historical significance** due to the largely rural, farming sense of place of the Project area. The Project area and surrounds are characterised by vast expanses of open land (some of which is used for sheep farming) interspersed with isolated farmsteads and the occasional small town/settlement. It is therefore expected that the Project will have a **very high visual impact** on the receiving environment. This will be verified in the investigation to follow.

Table 2: Key to Categorisation of Development (adapted from Oberholzer, 2005)

Type of Development	Examples of Development
Category 1	Nature reserves, nature related recreation, camping, picnicking, trails and minimal visitor facilities.
Category 2	Low-key recreation/resort/residential type development, small-scale agriculture/nurseries, narrow roads and small-scale infrastructure.
Category 3	Low density resort/residential type development, golf or polo estates, low to medium-scale infrastructure.
Category 4	Medium density residential development, sports facilities, small-scale commercial facilities/office parks, one-stop petrol stations, light industry, medium-scale infrastructure.

Type of Development	Examples of Development
Category 5	High density township/residential development, retail and office complexes, industrial facilities, refineries, treatment plants, power stations, wind energy farms, power lines, freeways, toll roads, **large-scale infrastructure** generally. Large-scale development of agricultural land and commercial tree plantations. Quarrying and mining activities with related processing plants.

Table 3: Categorisation of Expected Visual Impact (adapted from Oberholzer, 2005)

Type of Environment	Type of Development (Low to High Intensity)				
	Category 1 Development	**Category 2 Development**	**Category 3 Development**	**Category 4 Development**	**Category 5 Development**
Protected/wild areas of international, national or regional significance	Moderate visual impact expected	High visual impact expected	High visual impact expected	Very high visual impact expected	Very high visual impact expected
Areas or routes of high, scenic, cultural or historical significance	Minimal visual impact expected	Moderate visual impact expected	High visual impact expected	High visual impact expected	**Very high visual impact expected**
Areas or routes of medium scenic, cultural or historical significance	Little or no visual impact expected	Minimal visual impact expected	Moderate visual impact expected	High visual impact expected	High visual impact expected
Areas or routes of low scenic, cultural or historical significance	Little or no visual impact expected. Possible benefits	Little or no visual impact expected	Minimal visual impact expected	Moderate visual impact expected	High visual impact expected
Disturbed or degraded sites/run down urban areas/wasteland	Little or no visual impact expected. Possible benefits	Little or no visual impact expected. Possible benefits	Little or no visual impact expected	Minimal visual impact expected	Moderate visual impact expected

For projects where a high or very high visual impact is expected, Oberholzer (2005) recommends that a Level 4 visual assessment be conducted. A Level 4 visual assessment includes the following:

- Identification of issues raised in the scoping phase, and site visit;
- Description of the receiving environment and the proposed project;
- Establishment of view catchment area, view corridors, viewpoints and receptors;
- Indication of potential visual impacts using established criteria;
- Inclusion of potential lighting impacts at night;
- Description of alternatives, mitigation measures and monitoring programmes; and
- Complete 3D modelling and simulations, with and without mitigation.

7.2 Visual/Aesthetic Character and Topography

A desktop study was conducted to evaluate the topography of the receiving environment and aerial photography of the area was examined to determine the surface features. Available vector GIS data was used to determine the relative location of the features surrounding the Project area.

A topographical model (Plan 3, Appendix B) was created using ArcGIS 3D Analyst Extension. The model was created using the 20 metre contour relief data available from CD:NGI.

The resultant topographical model was then used to create slope intensity (Plan 4, Appendix B) and slope aspect (Plan 5, Appendix B) models using the Slope and Aspect tools of ArcGIS 3D Analyst Extension. The slope model indicates the slope degree and was classified using the Natural Breaks (Jenks)[6] classification method.

The information gathered from the above desktop study was verified with a site visit. The combined information from the desktop study and the site visit forms the basis of this report.

7.3 Viewshed Analysis

The resultant topographical model was used to create a viewshed model using the Viewshed Tool of the ArcGIS 3D Analyst Extension. This viewshed model illustrates the areas from which the Project will potentially be visible, taking into account the estimated height of the proposed infrastructure (Table 4). The infrastructure is illustrated on Plan 6 (Appendix B).

Table 4: Infrastructure Heights for Viewshed Modelling

[6] The Natural Breaks (Jenks) classification method splits data into classes based on natural groupings within the data. Natural breaks occur at low points on the histogram and are used to identify classes that group similar values together while maximising the differences between classes. This method accurately depicts trends in the data (Cartographica, 2010 and ESRI, 2016).

Infrastructure	Height	Source
Dish-antennas	21.5 m	Provided (CSIR, 2016)
Construction camp night time lighting	10 m	Assumed based on height of existing lighting masts at Losberg and Meysdam construction camps
Above ground powerlines	8 m	Assumed based on height of other powerlines in the area
Above ground fibre optic cables	8 m	Fibre optic cables will make use of the same poles as the powerlines to reduce impacts (CSIR, 2016)
Construction camp buildings	5 m	Average height of single storey building with pitched roof
Solar PV plants	3 m	Assumed based on height of other small-scale solar PV plants
Access roads	0 m	Ground level
Borrow pits	0 m	Below ground
Stone quarries	0 m	Below ground

The concept of viewshed modelling is depicted in Figure 1. The topography denotes whether or not a development will be visible from a receptor. In Figure 1 the development is only visible from the receptors within the valley and on the slopes of the hills facing it. The development will be hidden from all receptors beyond the first hills.

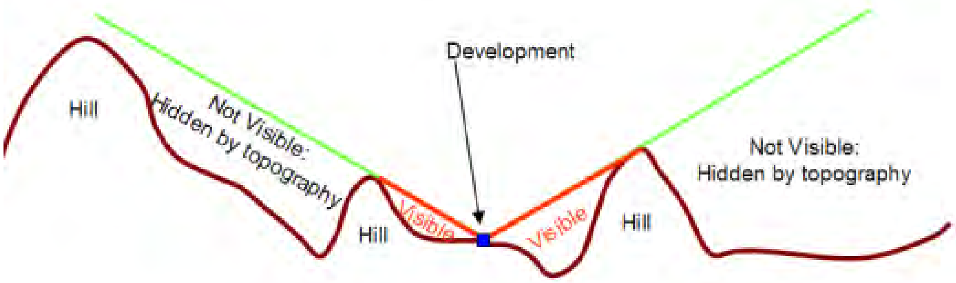

Figure 1: Theoretical Background of Viewshed Modelling

Both theoretical and practical viewshed models were created for daytime and night time conditions. These viewshed models are based on the topography only and do not take the screening effect of vegetation into account. The viewshed models depict worst case scenarios and show the areas from which the Project may potentially be visible. Most of the natural Shrubland and Grassland vegetation of the Project area and surrounds is intact but this low, sparse vegetation is not expected to provide any screening of the Project. There are existing rows of alien invasive plants/trees planted near some farm residences as windbreaks/vegetation screens. It is anticipated that these alien invasive plants/trees will have a screening effect and will reduce the visual impact of the Project on these farm residences.

The theoretical viewshed models were refined to practical viewshed models by dividing the viewshed area into areas that are likely to experience different categories of visual exposure. Visual exposure and the visual impact of a development diminish exponentially with distance (Oberholzer, 2005).

The findings of the site visit from 27 February to 1 March 2018 were used to determine these categories. This site visit took place during the day and evening in summer and the weather conditions were mainly sunny skies.

7.3.1 Daytime

All the infrastructure will be visible during the day to varying degrees but the dish-antennas will be more visible than any of the other infrastructure. The visibility of the existing MeerKAT and KAT-7 radio telescope dish-antennas in the core were used as a reference to determine the expected visibility of the Project. These dish-antennas are a similar design and height to the proposed dish-antennas for the Project. Due to the slightly hazy conditions the reference dish-antennas were sometimes more visible to the naked eye than in the photographs. The photographs were taken with a focal length of 50 mm. All distances are measured from the photograph point to the centre of the respective radio telescope.

Figure 2 illustrates the daytime view of MeerKAT from a distance of 17.6 km and KAT-7 from a distance of 17.2 km. The photograph was taken from the unnamed road that runs along the northern boundary of the MeerKAT and KAT-7 radio telescope area. The photograph was taken looking in a south-easterly direction towards the dish-antennas which are visible at the foot of the mountains. The white dishes stand out against the darker background. Both the concentration of dish-antennas at the centre of the MeerKAT radio telescope and the isolated individual dish-antennas are visible.

Based on the findings of the site visit it is likely that the Project will be visible from a maximum distance of 20 km. It is noted that after 20 km the visual exposure is expected to be negligible. This distance of 20 km is a worst case scenario and may be reduced by the screening effect of the topography and vegetation.

Figure 3 illustrates the daytime view of MeerKAT from a distance of 12.8 km and KAT-7 from a distance of 13 km. This photograph was also taken looking in a south-easterly direction from the unnamed road that runs along the northern boundary of the MeerKAT and KAT-7 radio telescope area. The dish-antennas almost fill the view of this photograph.

Figure 4 illustrates the daytime view of MeerKAT from a distance of 8.6 km and KAT-7 from a distance of 10.1 km. The photograph was taken looking in a southerly direction from the unnamed road that runs along the northern boundary of the MeerKAT and KAT-7 radio telescope area. The dish-antennas are spread out over a large area and from this distance they cannot all be seen in one photograph.

Figure 5 illustrates the daytime view of MeerKAT from a distance of 5 km. The photograph was taken from a farm road within the core area looking in an easterly direction. The nearest dish-antenna in the foreground is M049 at a distance of 1.4 km. Only some of the MeerKAT dish-antenna are visible in this photograph. The photograph illustrates that the angle of the dish-antennas affects their visibility, i.e. those dish-antenna facing towards the camera are more visible than those facing away or upwards.

Figure 6 illustrates the daytime view of KAT-7 from a distance of 2.4 km. This photograph was taken from the same location as the photograph in Figure 5 looking in a south-easterly direction directly towards KAT-7. The dish-antenna on the right side of the photograph is M063 at a distance of 2.7 km.

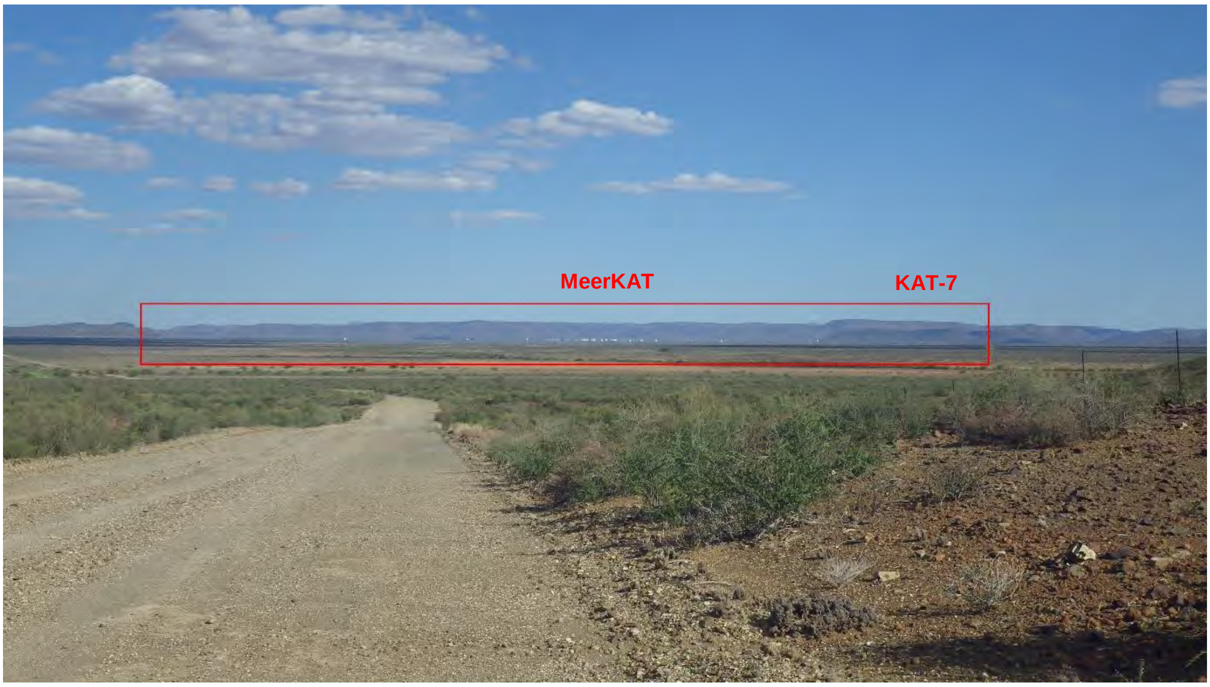

Figure 2: Daytime View of MeerKAT and KAT-7 in a South-Easterly Direction from 17.6 km and 17.2 km

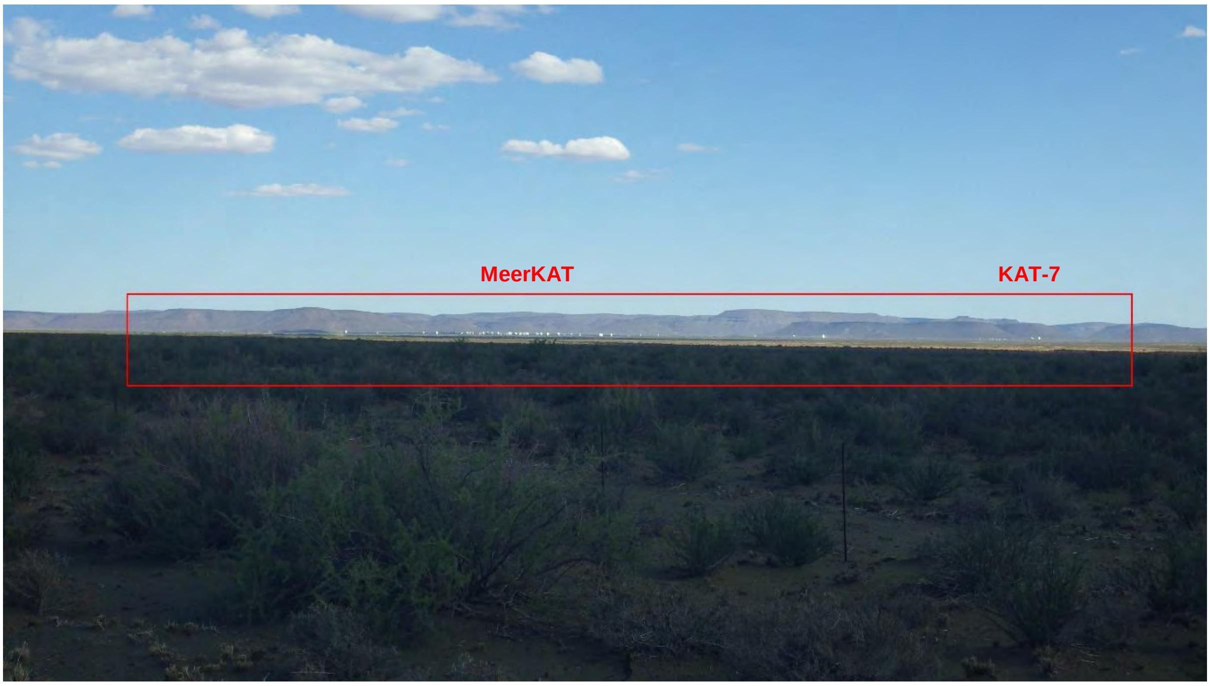

Figure 3: Daytime View of MeerKAT and KAT-7 in a South-Easterly Direction from 12.8 km and 13 km

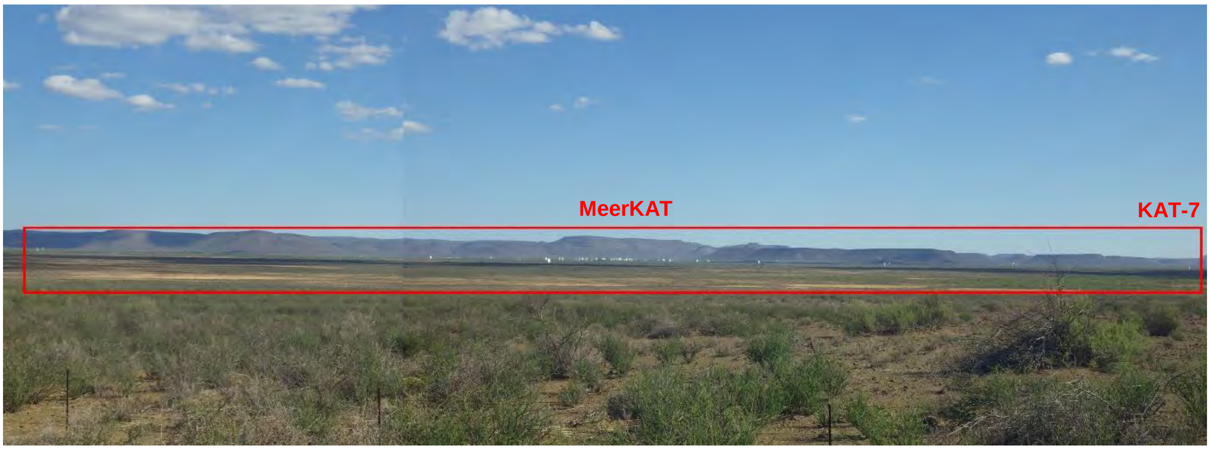

Figure 4: Daytime View of MeerKAT and KAT-7 in a Southerly Direction from 8.6 km and 10.1 km

Figure 5: Daytime View of MeerKAT in an Easterly Direction from 5km

Figure 6: Daytime View of KAT-7 in a South-Easterly Direction from 2.4 km

Based on the findings of the site visit the following categories were used for the daytime practical viewshed model:

- 0 – 2 km: Potentially very high visual exposure;

- 2 – 5 km: Potentially high visual exposure;
- 5 – 9 km: Potentially moderate visual exposure;
- 9 – 14 km: Potentially low visual exposure; and
- 14 – 20 km: Potentially very low visual exposure.

7.3.2 Night Time

The construction camps are the only infrastructure that will be visible at night as there is no lighting in any of the other infrastructure areas. The visibility of the night time lighting of the Meysdam construction camp was used to determine the expected visibility of the proposed construction camps at night. The photographs were taken with a focal length of 50 mm. A longer exposure time was used to capture the night time photographs.

The MeerKAT and KAT-7 radio telescopes and the HIRAX and HERA instruments are completely dark at night. The only light is from the Meysdam and Losberg construction camps and the Losberg site complex. The Meysdam construction camp is the only area visible from outside of the MeerKAT and KAT-7 radio telescope area.

Figure 7 illustrates the night time view of the Meysdam construction camp from the road running along the northern boundary of the MeerKAT and KAT-7 radio telescope area. The photograph was taken looking in a south-south-westerly direction from a distance of 8.6 km. Only a very faint light is visible from this camp (circled in yellow) if you know where to look. There is no sky glow visible. Figure 7 also illustrates that there is no light visible from the dish-antennas located on the right side of the photograph.

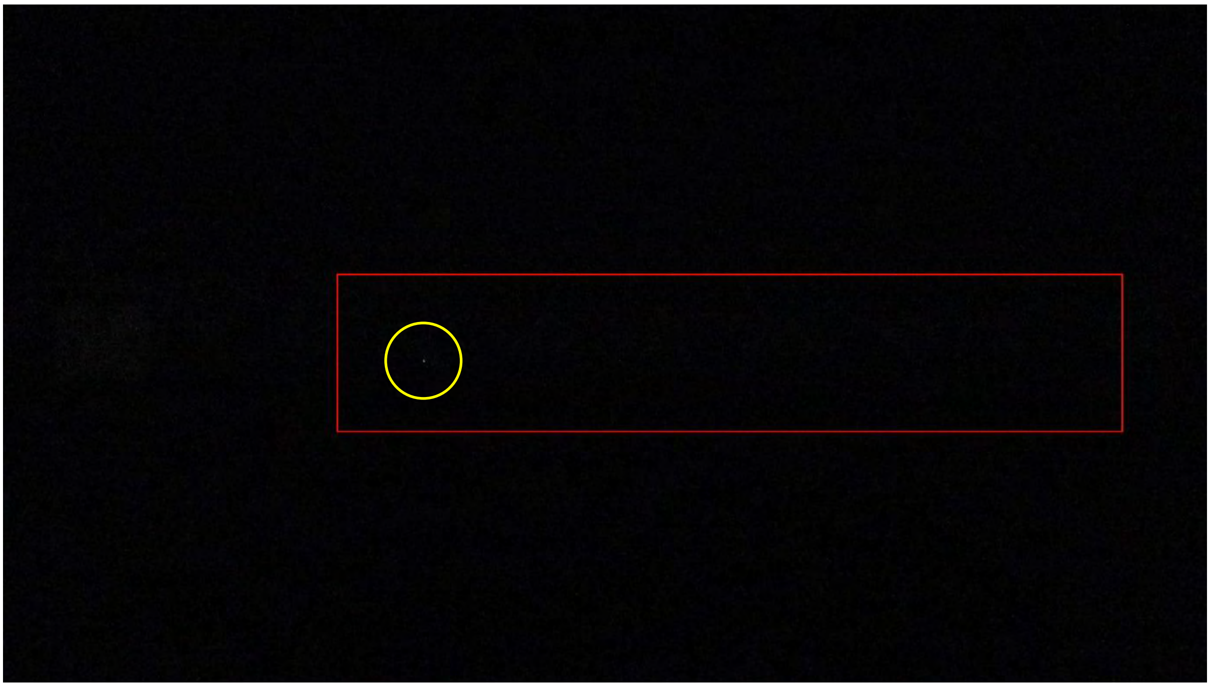

Figure 7: Night Time View of Meysdam Construction Camp in a South-South-Westerly Direction from 8.7 km

Based on the findings of the site visit the following categories were used for the night time practical viewshed model:

- 0 – 2 km: Potentially high visual exposure;
- 2 – 4 km: Potentially moderate visual exposure; and
- 4 – 8 km: Potentially low visual exposure.

Only three categories were used for the night time practical viewshed model as there is less distinction in visual exposure at night.

8 Findings

The findings include a description of the visual/aesthetic character and topography, the results of the viewshed analysis, identification of the sensitive receptors, and photomontages illustrating the current and potential future views of the Project area.

8.1 Visual/Aesthetic Character and Topography

This section provides the results obtained from the analysis of the topographical, slope and aspect models created in ArcGIS.

The Project area and surrounds are relatively flat with the exception of the dolerite outcrops and mountainous area that runs through the southern part of the core area. The flat open plains are expected to provide minimal screening of the proposed development while the dolerite outcrops are expected to provide some screening of the proposed development.

The topographical model indicates that the elevation of the Project area increases from 896 metres above mean sea level (m.a.m.s.l.) in the northern part of the Brandvlei spiral arm to 1,551 m.a.m.s.l. in the southern part of the Carnarvon spiral arm. The elevation in the core increases from 954 m.a.m.s.l. on the northern flat plain to 1,420 m.a.m.s.l. on the dolerite outcrops in the south. The elevation in the Brandvlei spiral arm increases from 896 m.a.m.s.l. to 1,092 m.a.m.s.l. on the dolerite outcrops. The elevation in the Carnarvon spiral arm increases from 1,014 m.a.m.s.l. in the north to 1,551 m.a.m.s.l. on the dolerite outcrops in the south. The elevation in the Williston spiral arm increases from 1,038 m.a.m.s.l. to 1,408 m.a.m.s.l. on the dolerite outcrops. Plan 3 (Appendix B) illustrates the topographical model and features of the Project area and surrounds.

The majority of the Project area is flat with slopes of between 0° and 3.5°. The lower slopes of the dolerite outcrops are slightly steeper with slopes of between 3.5° and 11.5° while the upper slopes of the dolerite outcrops have steeper slopes of between 11.5° and 37°[7]. The dolerite outcrops are generally flat on top. Plan 4 (Appendix B) illustrates the slope model of

[7] The topographical, slope and aspect models were created using the available 20 metre contour relief data from CD: NGI. It should be noted that this data is generalised and some of the topography detail is lost. As a result the slopes on site are steeper than what is depicted by the slope model.

the Project area. Plan 5 (Appendix B) illustrates the slope aspect/direction of the Project area.

Figure 8 and Figure 9 illustrate the landscape and vegetation in the north-western part of the Brandvlei spiral arm SKA008. Figure 8 was taken looking in a westerly direction from SKA008 across the open plains with the mountains in the distance on the horizon. Figure 9 was taken from the same location as Figure 8 but looking in a south-westerly direction. The natural vegetation in this area is sparse and limited in height to between 30 and 40 cm.

Figure 10 and Figure 11 illustrate the landscape and vegetation in the core. Figure 10 was taken looking in a southerly direction from the unnamed road that runs along the northern boundary of the MeerKAT and KAT-7 radio telescope area. The photograph illustrates the vast open plain in the north and the mountains in the south of the core area. The natural vegetation in the core is sparse and has a maximum height of 1 m.

Figure 12 illustrates the landscape and vegetation in the Williston spiral arm. This photograph was taken from an unnamed road looking in a north-easterly direction across the plains to the mountains in the distance. The natural vegetation in this part of the Williston arm is sparse and small reaching heights of only 20 to 30 cm.

Figure 13 illustrates the landscape in the Carnarvon spiral arm. The photograph was taken from an unnamed road looking in a south-westerly direction. The natural vegetation in the Carnarvon spiral arm is denser and taller than in the rest of the Project area reaching heights of more than 1 m in places.

Figure 14 illustrates the view from SKA128 looking in a northerly direction. The farmstead is located approximately 2.4 km from SKA128 and because the farmstead is visible from this location it is likely that the dish-antenna will be visible from the farmstead.

Figure 8: View from SKA008 in the Brandvlei Spiral Arm in a Westerly Direction

Figure 9: Vegetation in the Brandvlei Spiral Arm near SKA008

Figure 10: View from Unnamed Road in the Core across Flat Plains towards Mountains in Southerly Direction

Figure 11: Vegetation in the Core

Figure 12: View along Unnamed Road in the Williston Spiral Arm in a North-Easterly Direction

Figure 13: View from Unnamed Road in the Carnarvon Spiral Arm in a South-Westerly Direction

Figure 14: View from SKA128 in the Carnarvon Spiral Arm in a Northerly Direction

According to Mucina and Rutherford (2012) the dominant vegetation types in the Project area and surrounds are Bushmanland Arid Grassland, Bushmanland Basin Shrubland, Bushmanland Sandy Grassland, Northern Upper Karoo, Upper Karoo Hardeveld and

Western Upper Karoo interspersed with Bushmanland Vloere (Plan 7, Appendix B). Table 5 provides a description of the vegetation and landscape features for each of these vegetation types.

Table 5: Vegetation and Landscape Features (Mucina & Rutherford, 2012)

Vegetation Type	Vegetation and Landscape Features
Bushmanland Arid Grassland	Extensive to irregular plains on a slightly sloping plateau sparsely vegetated by grassland dominated by white grasses (*Stipagrostis* species) giving this vegetation type the character of semidesert 'steppe'. In places low shrubs of *Salsola* change the vegetation structure. In years of abundant rainfall rich displays of annual herbs can be expected.
Bushmanland Basin Shrubland	Slightly irregular plains with dwarf shrubland dominated by a mixture of low sturdy and spiny (and sometimes also succulent) shrubs (*Rhigozum*, *Salsola*, *Pentzia*, *Eriocephalus*), 'white' grasses (*Stipagrostis*) and in years of high rainfall also by abundant annuals such as species of *Gazania* and *Leysera*.
Bushmanland Sandy Grassland	Dense, sandy grassland plains with dominating white grasses (*Stipagrostis, Schmidtia*) and abundant drought-resistant shrubs. After rainy winters rich displays of ephemeral spring flora (*Grielum humifusum, Gazania lichtensteinii*) can occur.
Bushmanland Vloere	Flat and very even surfaces of pans and broad bottoms of intermittent rivers. The centre of a pan (or the river drainage channel itself) is usually devoid of vegetation; loosely patterned scrub dominated by *Rhigozum trichotomum* and various species of *Salsola* and *Lycium*, with a mixture of nonsucculent dwarf shrubs of Nama-Karoo relationship. In places loose thickets of *Parkinsonia africana*, *Lebeckia lineariifolia* and *Acacia karroo* can be found.
Northern Upper Karoo	Shrubland dominated by dwarf karoo shrubs, grasses and *Acacia mellifera* subsp. *detinens* and some other low trees (especially on sandy soils in the northern parts and vicinity of the Orange River). Flat to gently sloping, with isolated hills of Upper Karoo Hardeveld in the south and Vaalbos Rocky Shrubland in the northeast and with many interspersed pans.
Upper Karoo Hardeveld	Steep slopes of koppies, butts, mesas and parts of the Great Escarpment covered with large boulders and stones supporting sparse dwarf Karoo scrub with drought-tolerant grasses of genera such as *Aristida, Eragrostis* and *Stipagrostis*.
Western Upper Karoo	Much dissected landscape in the southwest associated with the tributaries of the upper catchment of the Sak River (e.g. Renoster River, Riet River, Klein Sak River), often rocky. Mixture of small-leaved shrubs and shrubby succulents (*Brownanthus*, *Drosanthemum*, *Ruschia* etc.) with drought-resistant (mostly 'white') grasses is the determinant feature of the vegetation structure.

Most of the natural Shrubland and Grassland vegetation is intact but this low, sparse vegetation is not expected to provide screening of the Project. There are existing rows of alien invasive plants/trees planted near some farm residences as windbreaks/vegetation screens. It is anticipated that these alien invasive plants/trees will have a screening effect and will reduce the visual impact of the Project on these farm residences. Figure 15 was taken from in front of the farmstead on the farm Oest 107 looking in a south-south-westerly direction towards SKA130. The view of SKA130 from the farmstead is screened by the vegetation and a small earth berm located behind it.

Figure 15: View from Farmstead in a South-South-Westerly Direction towards SKA130 Screened by Vegetation and Earth Berm

The Karoo scenery is "characterised by flat-topped koppies, extensive sandy to gravelly vlaktes (flats) and water courses that flow only in response to summer rain storms" (CSIR, 2016). The landforms and rock formations in the Karoo are more pronounced than in the rest of South Africa as they stand out above the low, sparse vegetation. The landscape of the Project area consists mainly of flat plains interspersed with low sandstone and doleritic mountains (CSIR, 2016). "The main scenic resources are concentrated in the mountainous terrain across the middle of the study area, where peaks, ridgelines, scarp edges, steep side slopes and dolerite rock outcrops are potentially visually sensitive, particularly in terms of structures on the skyline" (CSIR, 2016). Oberholzer and Lawson (2016) used a geomorphological approach to identify three broad landscape types within the Project area and surrounds. The scenic characteristics of these landscape types are detailed in Table 6.

Table 6: Landscape Types (Oberholzer & Lawson, 2016)

Landscape Type	Characteristics	Significant Visual Features

Landscape Type	Characteristics	Significant Visual Features
A. Southern plain: Beaufort Group, Adelaide Formation mudstones, sandstones and shales.	Broad plain intruded in places by dolerites, and incised in the south-west corner of the study area by the Sak River and the Brak River. The elevation varies from 1 100 to 1 400 metres.	Generally dry river courses and minor dolerite koppies. Koppies are visually sensitive, and the plains are visually exposed. Travelers on the R63 Route and a number of farmsteads are the main visual receptors.
B. Mountainous terrain: Ecca Group, Canarvon Formation sandstones and shales with dolerite intrusions.	The harder, more weather-resistant sandstones and dolerites are responsible for the koppies and ridges, including the Kareeberge, with elevations ranging from 1 300 to 1 500 metres. This is the most scenic part of the study area.	Scenic dolerite ridges and koppies, with a few small ports. The ridge skylines are visually sensitive, while the varied topography is more visually absorptive than the plains. There are a small number of farmsteads, mainly in the more fertile valleys near sources of water.
C. Northern plain: Ecca Group, Tierberg Formation shales.	Broad and largely featureless plain at an elevation of 1000 metres, with some dolerite outcrops and several pans. Patches of alluvium, sand and calcrete occur to the north.	Fairly featureless, except for minor dolerite koppies and a series of linked pans, and dry river courses. Visually exposed. A number of farmsteads are widely spread in the area.

8.2 Viewshed Model

The daytime theoretical viewshed model is illustrated in Plan 8 (Appendix B) and the night time theoretical viewshed model is illustrated in Plan 9 (Appendix B). These theoretical viewshed models were based on the topography only and do not take the screening effect of vegetation into account. This viewshed model depicts the worst case scenario and shows the areas from which the Project may potentially be visible.

8.2.1 Daytime

The daytime theoretical viewshed model was refined to a daytime practical viewshed model (Plan 10, Appendix B) with a buffer of 20 km around the proposed dish-antennas and divided into areas that are likely to experience different categories of visual exposure. Due to the nature of the receiving environment it is unlikely that the proposed dish-antennas will be noticeable beyond this 20 km buffer. The daytime practical viewshed model depicts the area from which the Project may potentially be visible during the day. This daytime practical viewshed model covers an area of approximately 13,639.32 km². The viewshed areas for the categories are listed in Table 7 below.

Table 7: Daytime Viewshed Area per Category

Category	Impact	Viewshed Area

Category	Impact	Viewshed Area
0 – 2 km	Potentially Very High Visual Exposure	568.40 km²
2 – 5 km	Potentially High Visual Exposure	1,802.96 km²
5 – 9 km	Potentially Moderate Visual Exposure	3,194.36 km²
9 – 14 km	Potentially Low Visual Exposure	4,038.44 km²
14 – 20 km	Potentially Very Low Visual Exposure	4,035.17 km²

8.2.2 Night Time

The night time theoretical viewshed was refined to a night time practical viewshed model (Plan 11, Appendix B) with a buffer of 8 km around the proposed construction camps and divided into areas that are likely to experience different categories of visual exposure. Due to the nature of the receiving environment it is unlikely that the night time lighting of the proposed construction camps will be visible beyond this 8 km buffer. The night time practical viewshed model depicts the area from which the Project may potentially be visible at night. This night time practical viewshed model covers an area of approximately 220.39 km². The viewshed areas for the categories are listed in Table 8 below.

Table 8: Night Time Viewshed Area per Category

Category	Impact	Viewshed Area
0 – 2 km	Potentially High Visual Exposure	27.57 km²
2 – 4 km	Potentially Moderate Visual Exposure	47.10 km²
4 – 8 km	Potentially Low Visual Exposure	145.72 km²

8.3 Sensitive Receptors

The visual sensitivity of receptors is dependent on the nature of the receptors (Oberholzer, 2005). Receptors in residential areas or nature reserves have a high sensitivity while receptors in industrial or mining areas have a low sensitivity. This section identifies the sensitive visual receptors in each category of the daytime and night time practical viewshed models.

8.3.1 Daytime

The potential visual receptors identified within the daytime practical viewshed model of the Project include residents of the Brandvlei and Swartkop settlements, residents of the farmsteads on the surrounding farms, road users and heritage sites. The daytime visual receptors are indicated on Plan 10 (Appendix B).

The farmsteads in each category of the daytime practical viewshed model are listed in Table 10 below. SARAO has purchased all the farms within the core. By the time construction commences the farmers will have moved off these farms and the existing buildings will either be incorporated into the proposed construction camps or demolished. Therefore only the 194 farmsteads outside the core area will be potential visual receptors of the Project.

Table 9: Farmsteads per Category (Daytime)

Category	Impact	Number of Farmsteads	Location
0 – 2 km	Potentially Very High Visual Exposure	8	Within core
		4	Outside core
2 – 5 km	Potentially High Visual Exposure	5	Within core
		23	Outside core
5 – 9 km	Potentially Moderate Visual Exposure	8	Within core
		44	Outside core
9 – 14 km	Potentially Low Visual Exposure	1	Within core
		65	Outside core
14 – 20 km	Potentially Very Low Visual Exposure	None	Within core
		58	Outside core

Road users within the daytime practical viewshed area are potential visual receptors of the Project (Plan 10, Appendix B). When construction commences the secondary roads running through the core area will be boomed off but secondary roads outside the core area will be potential visual receptors. The following regional roads are also potential visual receptors of the Project: the R27 and small parts of the R353 near Brandvlei as well as the R63 between Williston and Sterling, the R357 near Van Wyksvlei, the R386 near Carnarvon and the R361 between Carnarvon and Williston.

Currently the heritage sites within the daytime practical viewshed area are located on privately owned farms and therefore not accessible to the public. Should any of these heritage sites be developed into tourism attractions then visitors to these developed sites would be potential visual receptors of the Project. There are 159 heritage sites within the daytime practical viewshed area (Plan 10, Appendix B). The heritage sites in each category of the daytime practical viewshed model are listed in Table 10 below. A detailed list of the site names of the affected heritage sites is included in Appendix C.

Table 10: Heritage Sites per Category (Daytime)

Category	Impact	Number of Heritage Sites	Location
0 – 2 km	Potentially Very High Visual Exposure	53	Within core
		18	Outside core
2 – 5 km	Potentially High Visual Exposure	17	Within core

Category	Impact	Number of Heritage Sites	Location
		17	Outside core
5 – 9 km	Potentially Moderate Visual Exposure	7	Within core
		11	Outside core
9 – 14 km	Potentially Low Visual Exposure	None	Within core
		15	Outside core
14 – 20 km	Potentially Very Low Visual Exposure	None	Within core
		21	Outside core

8.3.2 Night Time

The potential visual receptors identified within the night time practical viewshed model of the Project include residents of the farmsteads on the surrounding farms, road users and heritage sites. The night time visual receptors are indicated on Plan 11 (Appendix B).

The farmsteads in each category of the night time practical viewshed model are listed in Table 11 below. SARAO has purchased all the farms within the core. By the time construction commences the farmers will have moved off these farms and the existing buildings will either be incorporated into the proposed construction camps or demolished. The farmsteads on the farms Bergsig and Swartfontein are directly adjacent to the proposed construction camps with the same names. All three farmsteads within the night time viewshed model are within the core and therefore not sensitive receptors of the proposed construction camps.

Table 11: Farmsteads per Category (Night Time)

Category	Impact	Farm	Location
0 – 2 km	Potentially High Visual Exposure	Bergsig	Adjacent to proposed construction camp – Within core
		Swartfontein	
2 – 4 km	Potentially Moderate Visual Exposure	Vissers Kloof	Within core
4 – 8 km	Potentially Low Visual Exposure	None	n/a

Road users of the two secondary roads running through the core area within the night time practical viewshed area are potential visual receptors of the Project (Plan 11, Appendix B). Access to the north-south road is already restricted and when construction commences the east-west road will also be boomed off. The night time lighting may potentially be visible to road users travelling on this road outside of the core area.

Currently the heritage sites within the night time practical viewshed area are located on privately owned farms and therefore not accessible to the public. Should any of these heritage sites be developed into tourism attractions then visitors to these developed sites would be potential visual receptors of the Project. There are 33 heritage sites within the night time practical viewshed area (Plan 11, Appendix B). The heritage sites in each category of the night time practical viewshed model are listed in Table 12 below. Only five of these heritage sites (all within the potentially low visual exposure category) are outside the core area. A detailed list of the site names of the affected heritage sites is included in Appendix C.

Table 12: Heritage Sites per Category (Night Time)

Category	Impact	Number of Heritage Sites	Location
0 – 2 km	Potentially High Visual Exposure	11	Within core
2 – 4 km	Potentially Moderate Visual Exposure	10	Within core
4 – 8 km	Potentially Low Visual Exposure	7	Within core
		5	Outside core

From the above the potential visual receptors within the night time practical viewshed only include road users and five heritage sites on privately owned farms outside the core area. It can therefore be deduced that the night time visual impact of the Project is largely muted.

8.4 Lighting Plan

The night time practical viewshed model indicates that the night time lighting of the proposed construction camps will be visible for a distance of up to 8 km (refer to Section 8.2.2). The potential visual receptors identified within the night time practical viewshed model of the Project include residents of the farmsteads on the surrounding farms, road users and heritage sites. SARAO has purchased all the farms within the core and access to this area will be restricted. The only potential visual receptors within the night time practical viewshed model that are located outside the core are five heritage sites located on privately owned farms (access to these sites is restricted) and road users accessing the surrounding farms. Based on the findings of this VIA it is not deemed necessary to compile a lighting plan.

8.5 Photomontages

This section presents the photomontages created from photographs taken during the site visit from 27 February to 1 March 2018. Plan 12 (Appendix B) indicates the viewpoint (position) and view direction in which the photographs were taken. The photomontages were created using GIMP version 2 software.

The photomontages were created by adding the proposed infrastructure to photographs of the current views. The scale of the images was measured by comparing the length of an object in the photo to the length of the object in reality. This scale was then used to calculate the size of the proposed infrastructure based on the estimated heights of the proposed infrastructure (Table 4).

The infrastructure is then overlaid onto the original photograph in their respective locations (based on the line of sight from the point the photograph was taken) to give an approximation of what the view will look like before and during the operation of the Project. The foreground of the photograph was extracted from the original photograph and replaced on top of the infrastructure to give a realistic representation of the view from the viewpoint.

The infrastructure overlaid on the photographs is an example and does not reflect accurate depictions of the proposed infrastructure, i.e. the dish-antennas depicted are based on an image of the proto-type dish-antenna but will be of equivalent height and footprint area. The photomontages provide an indication of what the landscape might potentially look like in the future.

8.5.1 Viewpoint 1

Viewpoint 1 is located on an unnamed road in the Brandvlei spiral arm. The photograph was taken looking in a south-easterly direction towards SKA008. Figure 16 illustrates the current view from Viewpoint 1. Figure 17 illustrates the potential future view from Viewpoint 1. The dish-antenna is approximately 300 m from Viewpoint 1. The dish-antenna at SKA008 is located on an area that is slightly elevated above the surrounding topography. The dish-antenna will dominate the view from Viewpoint 1 and will be visible on the skyline from all directions. The Project is expected to have a negative visual impact on Viewpoint 1.

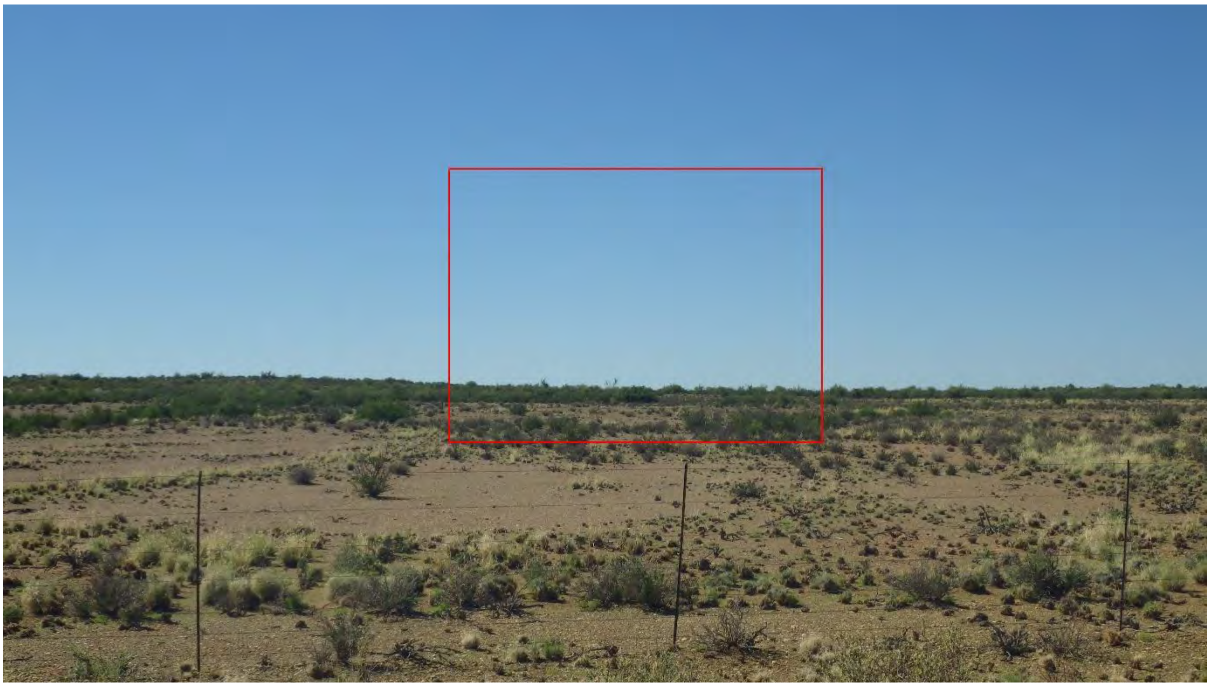

Figure 16: Current View from Viewpoint 1 in a South-Easterly Direction towards SKA008

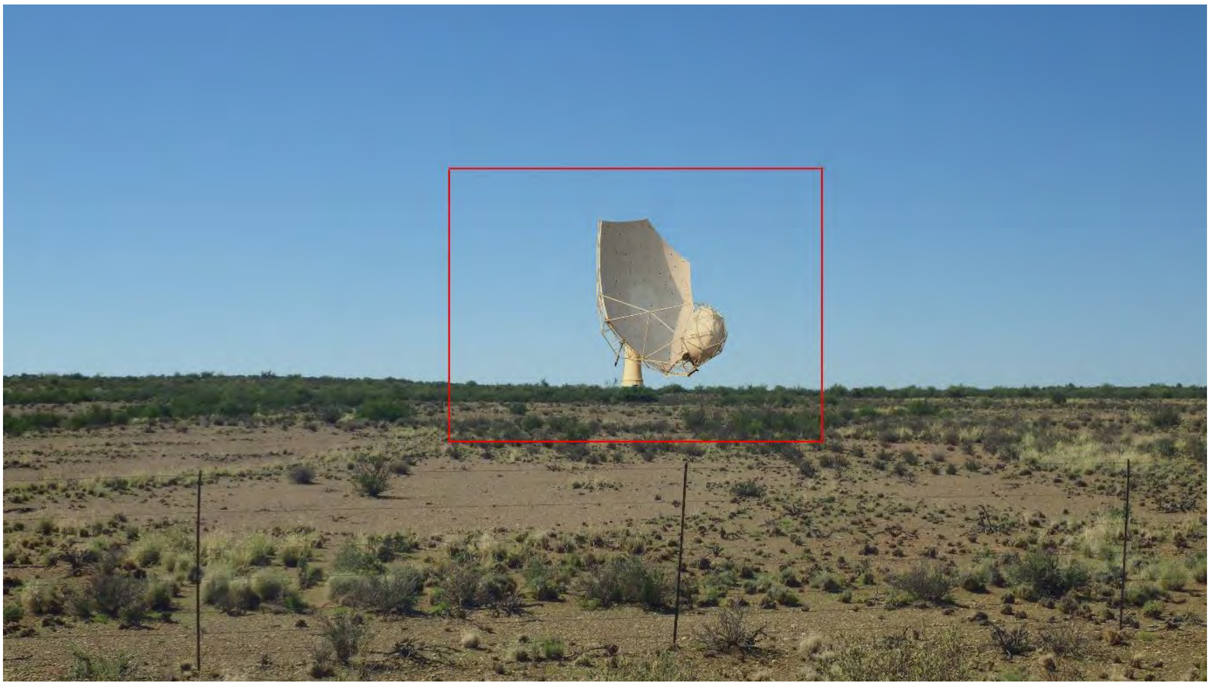

Figure 17: Potential Future View from Viewpoint 1 in a South- Easterly Direction towards SKA008

8.5.2 Viewpoint 2

Viewpoint 2 is located on an unnamed road in the core that runs along the northern boundary of the MeerKAT and KAT-7 radio telescope area. The photograph was taken looking in southerly direction towards the MeerKAT and KAT-7 radio telescopes. The core area extends beyond the view that is visible in this photograph. The centre of MeerKAT is located 8.6 km from Viewpoint 1 and the centre of KAT-7 is located 10.1 km from Viewpoint 2. Figure 18 illustrates the current view from Viewpoint 2. Figure 19 illustrates the potential future view from Viewpoint 2. The majority of the 133 dish-antennas that will be added to the MeerKAT radio telescope during Phase 1 of the SKA Project will be located within the core. The current 64-dish MeerKAT radio telescope already dominates the view from Viewpoint 2 and the addition of new dish-antennas will add to this visual disturbance. The Project is expected to have a negative visual impact on Viewpoint 2.

Figure 18: Current View from Viewpoint 2 in a Southerly Direction towards the Dish-Antennas in the Core

Figure 19: Potential Future View from Viewpoint 2 in a Southerly Direction towards the Dish-Antennas in the Core

8.5.3 Viewpoint 3

Viewpoint 3 is located just outside the farmstead on the farm Oest 107. The vegetation and earth berm illustrated in Figure 15 is located behind the photographer in this photograph. The photograph was taken looking in a south-south-westerly direction towards SKA130 in the Williston spiral arm. Figure 20 illustrates the current view from Viewpoint 3. Figure 21 illustrates the potential future view from Viewpoint 3. The dish-antenna is approximately 3.7 km from Viewpoint 3. The dish-antenna is located on the flat plain in front of the mountains in the background of the photograph. The white dish-antenna stands out against the dark backdrop but it is below the skyline. SKA130 will not be visible from the farmstead itself but it will be visible from the immediate surrounding area. The dish-antenna will be noticeable from Viewpoint 3 but will not dominate the view. The Project is expected to have a negative visual impact on Viewpoint 3.

Figure 20: Current View from Viewpoint 3 in a South-South-Westerly Direction towards SKA130

Figure 21: Potential Future View from Viewpoint 3 in a South-South-Westerly Direction towards SKA130

8.5.4 Viewpoint 4

Viewpoint 4 is located on an unnamed road in the Williston spiral arm. The photograph was taken looking in a south-easterly direction towards SKA130. Figure 22 illustrates the current view from Viewpoint 4. Figure 23 illustrates the potential future view from Viewpoint 4. The dish-antenna is approximately 600 m from Viewpoint 4. The dish-antenna at SKA130 is located on a flat plain in front of the low hills in the background. The dish-antenna will dominate the view from Viewpoint 4 and will be visible on the skyline from this view direction. The Project is expected to have a negative visual impact on Viewpoint 4.

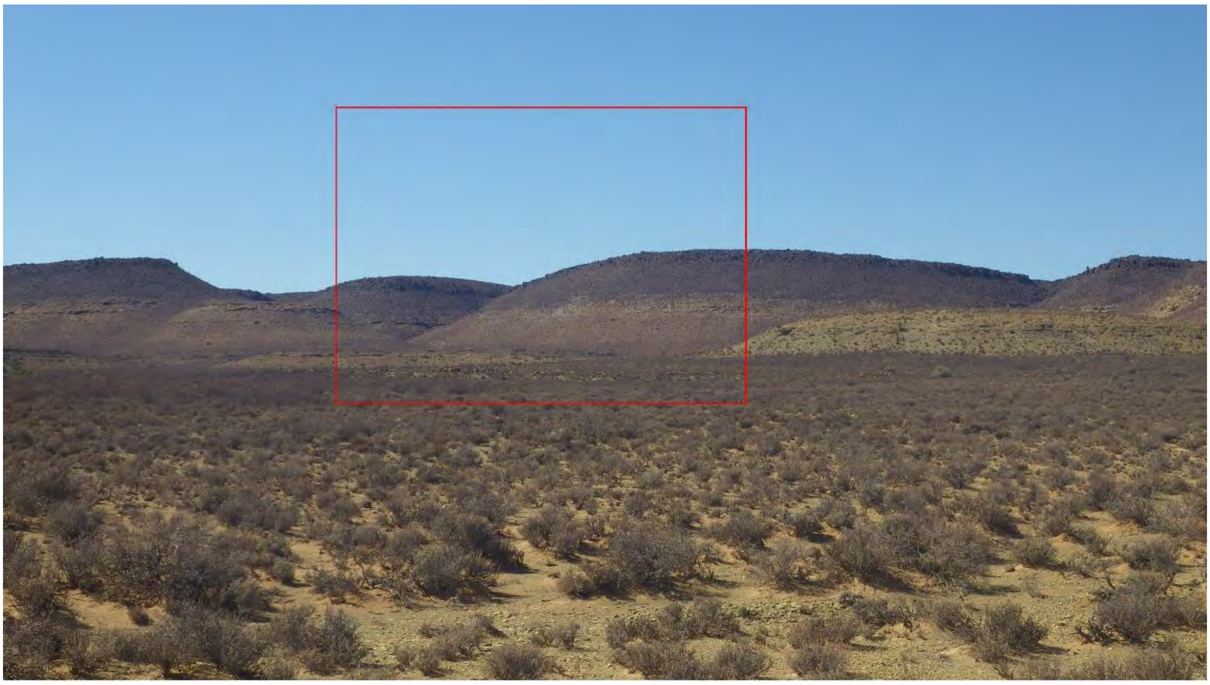

Figure 22: Current View from Viewpoint 4 in a in a South-Easterly Direction towards SKA130

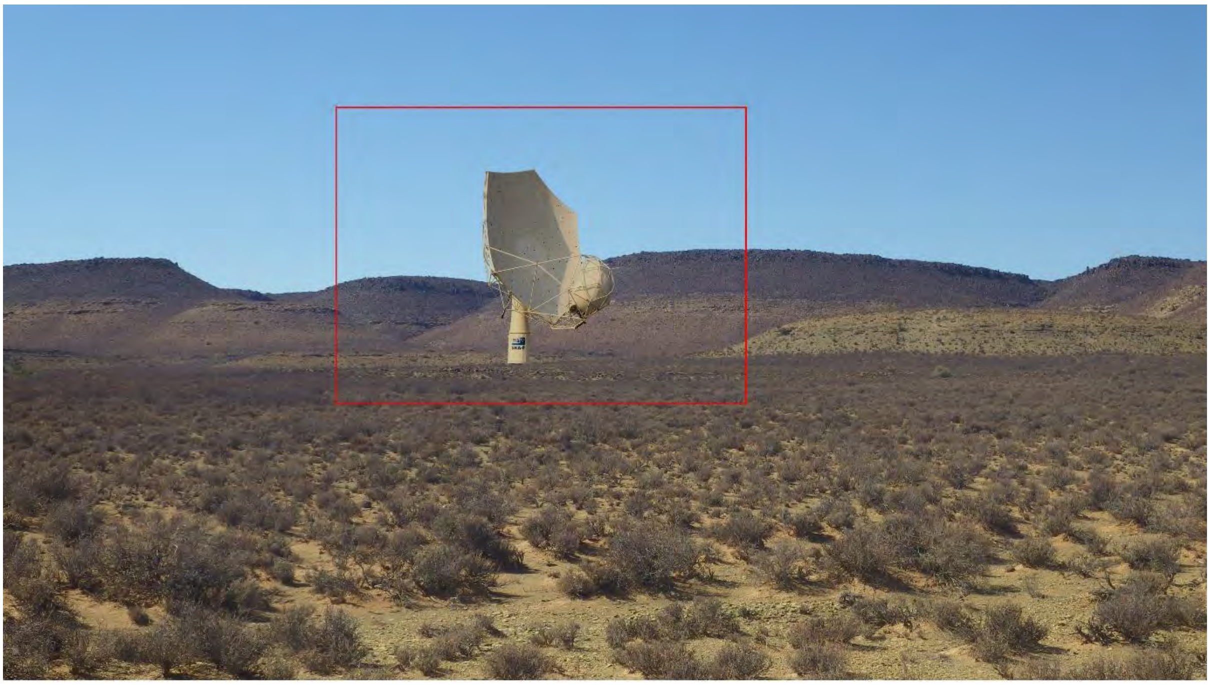

Figure 23: Potential Future View from Viewpoint 4 in a South-Easterly Direction towards SKA130

8.5.5 Viewpoint 5

Viewpoint 5 is located on an unnamed road in the Carnarvon spiral arm near the entrance to the farmstead on the farm Honde Blaf 493. The photograph was taken looking in a southerly direction Towards SKA128. Figure 24 illustrates the current view from Viewpoint 5. Figure 25 illustrates the potential future view from Viewpoint 5. The dish-antenna is approximately 2.3 km from Viewpoint 5. SKA128 is not expected to be visible from Viewpoint 5. This is due to the screening effect of the vegetation. The Project is not expected to have a negative visual impact on Viewpoint 5.

Figure 24: Current View from Viewpoint 5 in a Southerly Direction towards SKA128

Figure 25: Potential Future View from Viewpoint 5 in a Southerly Direction towards SKA128

9 Discussion

The Project will have a negative visual impact on the receiving environment. The most significant daytime visual impact will be from the dish-antennas. The white dish-antennas will be spread over a large area and will stand out against the surrounding landscape. The only night time visual impact will be from the night time lighting of the proposed construction camps. This visual impact is largely limited to the core.

The SKA radio telescope Project is of international scientific importance. For some receptors, the visibility of the Project may be viewed positively as it signifies advances in scientific research.

Oberholzer (2005) provides a number of criteria related specifically to VIAs (Table 13) and suggests that a proposed project should be assessed against these criteria before conducting the impact assessment. Table 13 provides a summary of the criteria and they are discussed in more detail in Sections 9.1 to 9.6 below.

Table 13: Specific Criteria for VIAs (adapted from Oberholzer, 2005)

Criteria	Rating	Description
Visibility of the project	**High visibility**	**Visible from a large area (e.g. several square kilometres)**
	Moderate visibility	Visible from an intermediate area (e.g. several hectares)

Criteria	Rating	Description
	Low visibility	Visible from a small area around the project site
Visual exposure	**High exposure**	**Dominant or clearly noticeable**
	Moderate exposure	Recognisable to the viewer
	Low exposure	Not particularly noticeable to the viewer
Visual sensitivity of the area	**High visual sensitivity**	**Highly visible and potentially sensitive areas in the landscape**
	Moderate visual sensitivity	Moderately visible areas in the landscape
	Low visual sensitivity	Minimally visible areas in the landscape
Visual sensitivity of receptors	**High sensitivity**	**Residential areas, nature reserves and scenic routes or trails**
	Moderate sensitivity	Sporting or recreational areas, or places of work
	Low sensitivity	Industrial, mining or degraded areas
Visual absorption capacity (VAC)	High VAC	Effective screening by topography and vegetation
	Moderate VAC	**Partial screening by topography and vegetation**
	Low VAC	Little screening by topography or vegetation
Visual intrusion	**High visual intrusion**	**Results in a noticeable change or is discordant with the surroundings**
	Moderate visual intrusion	Partially fits into the surroundings, but clearly noticeable
	Low visual intrusion	Minimal change or blends in well with the surroundings

9.1 Visibility of the Project

The visibility of the project refers to the viewshed area and is also related to the number of receptors affected (Oberholzer, 2005). The Project has a **high visibility** as it is visible from a large area (defined by Oberholzer (2005) as several square kilometres) with numerous visual receptors.

The daytime practical viewshed model covers an area of approximately 13,639.32 km². The potential visual receptors within the daytime practical viewshed include residents of the Brandvlei and Swartkop settlements, residents of the 194 farmsteads on the surrounding farms, road users and 82 heritage sites outside the core area (refer to Section 8.3.1 for details). The night time practical viewshed model covers an area of approximately 220.39 km². The potential visual receptors within the night time practical viewshed include road users and five heritage sites outside the core area (refer to Section 8.3.2 for details).

9.2 Visual Exposure

Visual exposure is “based on the distance from the infrastructure area to selected viewpoints” and “tends to diminish exponentially with distance” (Oberholzer, 2005). The Project has a **high exposure** as it will be dominant in the landscape and clearly noticeable to receptors within the viewshed area. This is illustrated by the photomontages in Section 8.5 above.

9.3 Visual Sensitivity of the Area

The visual sensitivity of the area refers to “the inherent visibility of the landscape, usually determined by a combination of topography, landform, vegetation cover and settlement pattern” (Oberholzer, 2005). The receiving environment of the Project has a **high visual sensitivity** as there are highly visible and potentially sensitive areas in the landscape.

The Project area and surrounds are characterised by vast expanses of open land interspersed with isolated farmsteads and the occasional small town/settlement. The receiving environment has a largely rural, farming sense of place. The undulating topography is expected to provide partial screening of the proposed infrastructure while the natural Shrubland and Grassland vegetation of the Project area and surrounds is not expected to provide any screening of the Project.

9.4 Visual Sensitivity of Receptors

The visual sensitivity of receptors is dependent on the nature of the receptors (Oberholzer, 2005). Receptors in residential areas or nature reserves have a high sensitivity while receptors in industrial or mining areas have a low sensitivity. The identified receptors (residents of the farmsteads on the surrounding farms, road users and heritage sites) of the Project have a **high sensitivity** as they include residential areas and heritage sites.

9.5 Visual Absorption Capacity

The Visual Absorption Capacity (VAC) refers to “the potential of the landscape to conceal the proposed project” (Oberholzer, 2005). The receiving environment of the Project has a **moderate VAC** because there is partial screening by the topography.

9.6 Visual Intrusion

The visual intrusion of the project refers to “the level of compatibility or congruence of the project with the particular qualities of the area, or its sense of place”. Visual intrusion is “related to the idea of context and maintaining the integrity of the landscape or townscape” (Oberholzer, 2005). The Project has a **high visual intrusion** as it results in a noticeable change and is discordant with the surroundings.

10 Impact Assessment

10.1 Impact Assessment Methodology

Details of the impact assessment methodology used to determine the significance of physical, bio-physical and socio-economic impacts are provided below.

The significance rating process follows the established impact/risk assessment formula:

Significance = Consequence x Probability x Nature

Where

Consequence = Intensity + Extent + Duration

And

Probability = Likelihood of an impact occurring

And

Nature = Positive (+1) or negative (-1) impact

Note: In the formula for calculating consequence, the type of impact is multiplied by +1 for positive impacts and -1 for negative impacts.

The matrix calculates the rating out of 147, whereby intensity, extent, duration and probability are each rated out of seven as indicated in Table 14. The weight assigned to the various parameters is then multiplied by +1 for positive and -1 for negative impacts.

Impacts are rated prior to mitigation and again after consideration of the mitigation has been applied; post-mitigation is referred to as the residual impact. The significance of an impact is determined and categorised into one of eight categories (Table 15). The description of the significance ratings is presented in Table 16.

It is important to note that the pre-mitigation rating takes into consideration the activity as proposed, (i.e. there may already be some mitigation included in the engineering design). If the specialist determines the potential impact is still too high, additional mitigation measures are proposed.

Table 14: Impact Assessment Parameter Ratings

Rating	Intensity		Extent	Duration/Reversibility	Probability
	Negative Impacts (Nature = -1)	Positive Impacts (Nature = +1)			
7	Major negative change to receiving environment with high to very high value.	Major positive change to receiving environment with high to very high value.	International The effect will occur across international borders.	Permanent The impact will permanently alter or change the receiving environment.	Certain/Definite Happens frequently. The impact will occur regardless of the implementation of any preventative or corrective actions.
6	Moderate negative change to receiving environment with high to very high value.	Moderate positive change to receiving environment with high to very high value.	National Will affect the entire country.	Beyond Project Life The impact will reduce over time after project life.	Highly Probability Happens often. It is most likely that the impact will occur.
5	Minor negative change to receiving environment with high to very high value.	Minor positive change to receiving environment with high to very high value.	Province/Region Will affect the entire province of region.	Project Life The impact will cease after project life.	Likely Could easily happen. The impact may occur.
4	Major negative change to receiving environment with medium to medium high value.	Major positive change to receiving environment with medium to medium high value.	Municipal Area Will affect the whole municipal area.	Long Term The impact will remain for more than 50% of the project life.	Probable Could occur. Has occurred here or elsewhere.
3	Moderate negative change to receiving environment with medium to medium high value.	Moderate positive change to receiving environment with medium to medium high value.	Local Local extending only as far as the development site area.	Medium Term The impact will remain for between 10% and 50% of the project life.	Unlikely/Low Probability Has not happened yet but could happen once in the lifetime of the project. There is a possibility that the impact will occur.

Rating	Intensity		Extent	Duration/Reversibility	Probability
	Negative Impacts (Nature = -1)	**Positive Impacts (Nature = +1)**			
2	Minor negative change to receiving environment with medium to medium high value.	Minor positive change to receiving environment with medium to medium high value.	Limited Limited to the site and its immediate surroundings.	Short Term The impact will remain for less than 10% of the project life.	Rare/Improbable Conceivable, but only in extreme circumstances. Has not happened during the lifetime of the project but has happened elsewhere. The possibility of the impact materialising is very low as a result of design, historic experience or implementation of adequate mitigation measures.
1	No change to receiving environment with values of medium of higher, or any negative change to receiving environment with low value.	No change to receiving environment with values of medium of higher, or any positive change to receiving environment with low value.	Site Specific Limited to specific isolated parts of the site.	Immediate The impact may be sporadic/limited in duration and can occur at any time.	Highly Unlikely/None Expected never to happen. Impact will not occur

Table 15: Probability/Consequence Matrix

Probability	Significance																																					
7	-147	-140	-133	-126	-119	-112	-105	-98	-91	-84	-77	-70	-63	-56	-49	-42	-35	-28	-21	21	28	35	42	49	56	63	70	77	84	91	98	105	112	119	126	133	140	147
6	-126	-120	-114	-108	-102	-96	-90	-84	-78	-72	-66	-60	-54	-48	-42	-36	-30	-24	-18	18	24	30	36	42	48	54	60	66	72	78	84	90	96	102	108	114	120	126
5	-105	-100	-95	-90	-85	-80	-75	-70	-65	-60	-55	-50	-45	-40	-35	-30	-25	-20	-15	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100	105
4	-84	-80	-76	-72	-68	-64	-60	-56	-52	-48	-44	-40	-36	-32	-28	-24	-20	-16	-12	12	16	20	24	28	32	36	40	44	48	52	56	60	64	68	72	76	80	84
3	-63	-60	-57	-54	-51	-48	-45	-42	-39	-36	-33	-30	-27	-24	-21	-18	-15	-12	-9	9	12	15	18	21	24	27	30	33	36	39	42	45	48	51	54	57	60	63
2	-42	-40	-38	-36	-34	-32	-30	-28	-26	-24	-22	-20	-18	-16	-14	-12	-10	-8	-6	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40	42
1	-21	-20	-19	-18	-17	-16	-15	-14	-13	-12	-11	-10	-9	-8	-7	-6	-5	-4	-3	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
	-21	**-20**	**-19**	**-18**	**-17**	**-16**	**-15**	**-14**	**-13**	**-12**	**-11**	**-10**	**-9**	**-8**	**-7**	**-6**	**-5**	**-4**	**-3**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**
	Consequence																																					

Table 16: Significance Rating Description

Score	Description	Rating
109 to 147	A very beneficial impact which may be sufficient by itself to justify implementation of the project. The impact may result in permanent positive change.	Major (positive) (+)
73 to 108	A beneficial impact which may help to justify the implementation of the project. These impacts would be considered by society as constituting a major and usually a long term positive change to the (natural and/or social) environment.	Major (positive) (+)
36 to 72	A positive impact. These impacts will usually result in positive medium to long term effects on the natural and/or social environment.	Minor (positive) (+)
3 to 35	A small positive impact. The impact will result in medium to short term effects on the natural and/or social environment.	Negligible (positive) (+)
-3 to -35	An acceptable negative impact for which mitigation is desirable. The impact by itself is insufficient even in combination with other low impacts to prevent the development being approved. These impacts will result in negative medium to short term effects on the natural and/or social environment.	Negligible (negative) (-)
-36 to -72	A minor negative impact which requires mitigation. The impact is insufficient by itself to prevent the implementation of the project but which in conjunction with other impacts may prevent its implementation. These impacts will usually result in negative medium to long term effects on the natural and/or social environment.	Minor (negative) (-)
-73 to -108	A moderate negative impact which may prevent the implementation of the project. These impacts would be considered as constituting a major and usually a long term change to the (natural and/or social) environment and result in severe changes.	Moderate (negative) (-)
-109 to -147	A major negative impact which may be sufficient by itself to prevent implementation of the project. The impact may result in permanent change. Very often these impacts are immitigable and usually result in very severe effects. The impacts are likely to be irreversible and/or irreplaceable.	Major (negative) (-)

10.2 Project Activities and Infrastructure

The activities or items of infrastructure associated with the Project and applicable to this VIA are listed in Table 17 below.

Table 17: Project Activities

Category	Activity or Item of Infrastructure
Infrastructure	▪ Dish-antennas; ▪ Construction Camps; ▪ Access roads; ▪ Solar PV plants; ▪ Powerlines (above ground and underground (trenched)); ▪ Fibre optic network (above ground and underground (trenched)); and ▪ Borrow pits and quarries.
Processes	▪ Operation of SKA radio telescope; and ▪ Operation of construction camps.

10.3 Visual Impact Assessment

The Project activities and items of infrastructure listed in Table 17 will be rated according to the visual impact they will have on the receiving environment, i.e. the environment before development. Negative visual impacts decrease the visual character of the pre-development environment. Neutral visual impacts assist to minimise the negative visual impacts of a development but do not result in a positive visual impact. A positive visual impact only occurs when an area is rehabilitated to a state that is better than the state of the pre-development environment, e.g. an infrastructure project area on previously agricultural land is rehabilitated to an area of natural vegetation and all visible signs of agriculture and infrastructure are removed. Positive visual impacts may only occur during the decommissioning and closure phase.

10.3.1 Construction Phase

The construction phase is characterised by site development and infrastructure construction. This includes site clearing, vegetation removal, topsoil removal and spoiling, construction of dish-antennas, construction camps, access roads, solar PV plants, powerlines and fibre optic network, and development of borrow pits and quarries. The establishment of infrastructure and the related site clearing and construction activities will draw attention to the Project area making receptors aware of the Project. The construction phase will have negative visual impacts on the receiving environment.

10.3.1.1 Activity 1: Site Clearing

Site clearing including the removal of vegetation and topsoil is expected to have a negative visual impact on the receiving environment. Change of land use from natural vegetation and agriculture to industry/scientific research will have a negative visual impact on the receiving environment. This change of land use will change the sense of place of the Project area and surrounds from a rural, farming sense of place to a more industrial/scientific sense of place resulting in a loss of scenic character and increased visual disturbance. The change of land use will contribute to the cumulative impacts of industry and development on the regional environment.

The receiving environment is characterised by vast open areas of natural vegetation. Site clearing and vegetation removal will have a negative visual impact on the receiving environment. The natural vegetation will be cleared to make way for the Project. The Project area will become noticeable to nearby receptors as it will contrast the surrounding areas. Topsoil removal and spoiling will have a negative visual impact on the receiving environment. Dust from the spoil piles will also have a negative visual impact. The impacts of site clearing are summarised in Table 18 and Table 19.

Table 18: Potential Impacts of Change of Land Use on the Receiving Environment

IMPACT DESCRIPTION: Change of land use from natural vegetation and agriculture to industry/scientific research will have a negative visual impact on the receiving environment.				
Dimension	**Rating**	**Motivation**		
PRE-MITIGATION				
Duration	Permanent (7)	There will be a permanent and irreversible negative visual impact on the receiving environment. The SKA radio telescope and associated infrastructure will remain indefinitely.	Consequence: Highly detrimental (-16)	Significance: Major – negative (-112)
Extent	Province/ Region (5)	The daytime practical viewshed model indicates that the Project will be visible from a maximum distance of 20 km during the day. The night time practical viewshed model indicates that the Project will be visible from a maximum distance of 8 km at night.		
Intensity x	Moderately high -	Change of land use will		

IMPACT DESCRIPTION: Change of land use from natural vegetation and agriculture to industry/scientific research will have a negative visual impact on the receiving environment.				
Dimension	**Rating**	**Motivation**		
type of impact	negative (-4)	result in a permanent change in the sense of place of the Project area and surrounds.		
Probability	Certain (7)	The impact will definitely occur.		
MITIGATION:				
▪ All mitigation/management actions in the VIA are applicable.				
POST-MITIGATION				
Duration	Permanent (7)	There will be a permanent and irreversible negative visual impact on the receiving environment. The SKA radio telescope and associated infrastructure will remain indefinitely.	Consequence: Highly detrimental (-14)	Significance: Moderate – negative (-98)
Extent	Municipal Area (4)	The extent of the impact will be reduced by implementing the mitigation actions listed above.		
Intensity x type of impact	Moderate – negative (-3)	The visual disturbance will be reduced by implementing the mitigation measures above.		
Probability	Certain (7)	The impact will definitely occur.		

Table 19: Potential Impacts of Site Clearing on the Receiving Environment

<table>
<tr><td colspan="5">IMPACT DESCRIPTION: Site clearing and vegetation removal will have a negative visual impact on the receiving environment.</td></tr>
<tr><td>Dimension</td><td>Rating</td><td colspan="3">Motivation</td></tr>
<tr><td colspan="5">PRE-MITIGATION</td></tr>
<tr><td>Duration</td><td>Medium term (3)</td><td>The impact will occur during the construction phase.</td><td rowspan="3">Consequence: Moderately detrimental
(-9)</td><td rowspan="4">Significance: Moderate – negative
(-63)</td></tr>
<tr><td>Extent</td><td>Local (3)</td><td>Site clearing activities will be visible from the area surrounding the construction site.</td></tr>
<tr><td>Intensity x type of impact</td><td>Moderate - negative (-3)</td><td>Site clearing is expected to cause a moderate visual disturbance. The natural vegetation will be cleared to make way for the Project. The Project area will become noticeable to the nearby receptors as it will contrast the surrounding areas.</td></tr>
<tr><td>Probability</td><td>Certain (7)</td><td colspan="2">The impact will definitely occur.</td></tr>
<tr><td colspan="5">MITIGATION:</td></tr>
<tr><td colspan="5">Only remove vegetation within the infrastructure areas;
Only remove topsoil within the infrastructure areas;
Vegetate the topsoil spoils with indigenous species so that they blend into the surrounding landscape;
Limit the footprint area and height of the topsoil spoils; and
Apply dust suppression techniques to limit dust generated from the topsoil spoils.</td></tr>
<tr><td colspan="5">POST-MITIGATION</td></tr>
<tr><td>Duration</td><td>Medium term (3)</td><td>The impact will occur during the construction phase.</td><td rowspan="2">Consequence: Slightly detrimental
(-7)</td><td rowspan="2">Significance: Minor – negative
(-42)</td></tr>
<tr><td>Extent</td><td>Limited (2)</td><td>The extent of the impact will be reduced by implementing the mitigation actions listed</td></tr>
</table>

IMPACT DESCRIPTION: Site clearing and vegetation removal will have a negative visual impact on the receiving environment.				
Dimension	**Rating**	**Motivation**		
		above.		
Intensity x type of impact	Low - negative (-2)	The visual disturbance will be reduced by implementing the mitigation measures above.		
Probability	Highly probable (6)	It is most likely that the impact will occur.		

10.3.1.2 Activity 2: Construction of infrastructure

The Project consists of the following components:

- Dish-antennas;
- Construction camps;
- Access roads;
- Solar PV plants; and
- Powerline and fibre optic cable network.

Construction of infrastructure is expected to have a negative visual impact on the receiving environment. The surface infrastructure will change the sense of place of the Project area from a rural, farming sense of place to a more industrial/scientific sense of place. Construction activities are not expected to take place at night. The impacts of construction of infrastructure are summarised in Table 20, Table 21, Table 22, Table 23 and Table 24.

Table 20: Potential Impacts of Construction of Dish-Antennas on the Receiving Environment

IMPACT DESCRIPTION: Construction of dish-antennas is expected to have a negative visual impact on the receiving environment.				
Dimension	**Rating**	**Motivation**		
PRE-MITIGATION				
Duration	Permanent (7)	There will be a permanent and irreversible negative visual impact on the receiving environment. The SKA radio telescope and associated infrastructure will remain	Consequence: Highly detrimental (-16)	Significance: Major – negative (-112)

IMPACT DESCRIPTION: Construction of dish-antennas is expected to have a negative visual impact on the receiving environment.

Dimension	Rating	Motivation		
		indefinitely.		
Extent	Province/ Region (5)	The daytime practical viewshed model indicates that the Project will be visible from a maximum distance of 20 km during the day.		
Intensity x type of impact	Moderately high - negative (-4)	Construction of the dish-antennas is expected to cause a moderately high visual disturbance.		
Probability	Certain (7)	The impact will definitely occur.		

MITIGATION:

- Ensure the dish-antennas do not exceed the proposed heights;
- Where possible, surface infrastructure must be painted natural hues so that it blends into the surrounding landscape;
- Limit the footprint area of the surface infrastructure;
- Pylons and metal structures must be galvanised so as to weather to a matt grey finish rather than be painted silver. If the pylons and metal structures are painted, a neutral matt finish must be used; and
- Avoid construction activities at night. If construction activities take place at night then only areas where these activities are taking place should be lit and the number of lights and brightness must not exceed the minimum requirements for safety and security. Down lighting and low-pressure sodium light sources must be implemented to minimise light pollution. Lights should be directed inwards towards the Project area and not outwards from the Project area.

POST-MITIGATION

Dimension	Rating	Motivation		
Duration	Permanent (7)	There will be a permanent and irreversible negative visual impact on the receiving environment. The SKA radio telescope and associated infrastructure will remain indefinitely.	Consequence: Highly detrimental (-14)	Significance: Moderate – negative (-84)
Extent	Municipal Area (4)	The extent of the impact will be reduced by		

IMPACT DESCRIPTION: Construction of dish-antennas is expected to have a negative visual impact on the receiving environment.				
Dimension	**Rating**	**Motivation**		
		implementing the mitigation actions listed above.		
Intensity x type of impact	Moderate – negative (-3)	The visual disturbance will be reduced by implementing the mitigation measures above.		
Probability	Highly probable (6)	It is most likely that the impact will occur.		

Table 21: Potential Impacts of Expansion of Losberg Construction Camp and Construction of Bergsig and Swartfontein Construction Camps on the Receiving Environment

IMPACT DESCRIPTION: Expansion of Losberg Construction Camp and Construction of Bergsig and Swartfontein Construction Camps is expected to have a negative visual impact on the receiving environment.				
Dimension	**Rating**	**Motivation**		
PRE-MITIGATION				
Duration	Permanent (7)	There will be a permanent and irreversible negative visual impact on the receiving environment. The SKA radio telescope and associated infrastructure will remain indefinitely.	Consequence: Highly detrimental (-13)	Significance: Moderate - negative (-91)
Extent	Local (3)	The night time practical viewshed model indicates that the Project will be visible from a maximum distance of 8 km at night.		

<table>
<tr><td colspan="5">IMPACT DESCRIPTION: Expansion of Losberg Construction Camp and Construction of Bergsig and Swartfontein Construction Camps is expected to have a negative visual impact on the receiving environment.</td></tr>
<tr><td>Dimension</td><td>Rating</td><td colspan="3">Motivation</td></tr>
<tr><td>Intensity x type of impact</td><td>Moderate – negative (-3)</td><td>Expansion of the Losberg construction camp and construction of the Bergsig and Swartfontein construction camps is expected to cause a moderate visual disturbance.</td><td></td><td rowspan="2"></td></tr>
<tr><td>Probability</td><td>Certain (7)</td><td colspan="2">The impact will definitely occur.</td></tr>
<tr><td colspan="5">MITIGATION:</td></tr>
<tr><td colspan="5">

Ensure the construction camps do not exceed the proposed heights;
Where possible, surface infrastructure must be painted natural hues so that it blends into the surrounding landscape;
Limit the footprint area of the surface infrastructure;
Pylons and metal structures must be galvanised so as to weather to a matt grey finish rather than be painted silver. If the pylons and metal structures are painted, a neutral matt finish must be used; and
Avoid construction activities at night. If construction activities take place at night then only areas where these activities are taking place should be lit and the number of lights and brightness must not exceed the minimum requirements for safety and security. Down lighting and low-pressure sodium light sources must be implemented to minimise light pollution. Lights should be directed inwards towards the Project area and not outwards from the Project area.

</td></tr>
<tr><td colspan="5">POST-MITIGATION</td></tr>
<tr><td>Duration</td><td>Beyond project life (6)</td><td>The impact will occur during the construction phase and remain for some time after the Project.</td><td rowspan="3">Consequence: Moderately detrimental
(-10)</td><td rowspan="3">Significance: Minor - negative
(-60)</td></tr>
<tr><td>Extent</td><td>Limited (2)</td><td>The extent of the impact will be reduced by implementing the mitigation actions listed above.</td></tr>
<tr><td>Intensity x type of impact</td><td>Low - negative (-2)</td><td>The visual disturbance will be reduced by implementing the mitigation measures</td></tr>
</table>

IMPACT DESCRIPTION: Expansion of Losberg Construction Camp and Construction of Bergsig and Swartfontein Construction Camps is expected to have a negative visual impact on the receiving environment.				
Dimension	**Rating**	**Motivation**		
		above.		
Probability	Highly probable (6)	It is most likely that the impact will occur.		

Table 22: Potential Impacts of Upgrade of Existing Roads and Construction of New Roads on the Receiving Environment

IMPACT DESCRIPTION: Upgrade of Existing Roads and Construction of New Roads is expected to have a negative visual impact on the receiving environment.				
Dimension	**Rating**	**Motivation**		
PRE-MITIGATION				
Duration	Permanent (7)	There will be a permanent and irreversible negative visual impact on the receiving environment. The SKA radio telescope and associated infrastructure will remain indefinitely.	Consequence: Highly detrimental (-13)	Significance: Moderate - negative (-91)
Extent	Local (3)	The roads will be visible from the surrounding area.		
Intensity x type of impact	Moderate - negative (-3)	Upgrade of the existing roads and construction of new roads is expected to cause a moderate visual disturbance.		
Probability	Certain (7)	The impact will definitely occur.		
MITIGATION:				
▪ Limit the footprint area of roads where possible; ▪ Construct sealed roads where possible; ▪ Limit the speed of vehicles travelling on gravel roads to reduce dust; and ▪ Apply dust suppression techniques to limit dust generated from the gravel roads.				

<table>
<tr><td colspan="5">IMPACT DESCRIPTION: Upgrade of Existing Roads and Construction of New Roads is expected to have a negative visual impact on the receiving environment.</td></tr>
<tr><th>Dimension</th><th>Rating</th><th colspan="3">Motivation</th></tr>
<tr><td colspan="5">POST-MITIGATION</td></tr>
<tr><td>Duration</td><td>Beyond project life (6)</td><td>The impact will occur during the construction phase and remain for some time after the Project.</td><td rowspan="3">Consequence: Moderately detrimental (-10)</td><td rowspan="4">Significance: Minor - negative (-60)</td></tr>
<tr><td>Extent</td><td>Limited (2)</td><td>The extent of the impact will be reduced by implementing the mitigation actions listed above.</td></tr>
<tr><td>Intensity x type of impact</td><td>Low - negative (-2)</td><td>The visual disturbance will be reduced by implementing the mitigation measures above.</td></tr>
<tr><td>Probability</td><td>Highly probable (6)</td><td colspan="2">It is most likely that the impact will occur.</td></tr>
</table>

Table 23: Potential Impacts of Construction of Solar PV Plants on the Receiving Environment

<table>
<tr><td colspan="5">IMPACT DESCRIPTION: Construction of Solar PV Plants is expected to have a negative visual impact on the receiving environment.</td></tr>
<tr><th>Dimension</th><th>Rating</th><th colspan="3">Motivation</th></tr>
<tr><td colspan="5">PRE-MITIGATION</td></tr>
<tr><td>Duration</td><td>Permanent (7)</td><td>There will be a permanent and irreversible negative visual impact on the receiving environment. The SKA radio telescope and associated infrastructure will remain indefinitely.</td><td rowspan="2">Consequence: Highly detrimental (-13)</td><td rowspan="2">Significance: Moderate - negative (-91)</td></tr>
<tr><td>Extent</td><td>Local (3)</td><td>The solar PV plants will be visible from the surrounding area.</td></tr>
</table>

<table>
<tr><td colspan="5">IMPACT DESCRIPTION: Construction of Solar PV Plants is expected to have a negative visual impact on the receiving environment.</td></tr>
<tr><td>Dimension</td><td>Rating</td><td colspan="3">Motivation</td></tr>
<tr><td>Intensity x type of impact</td><td>Moderate - negative (-3)</td><td>Construction of the solar PV plants is expected to cause a moderate visual disturbance.</td><td></td><td rowspan="2"></td></tr>
<tr><td>Probability</td><td>Certain (7)</td><td colspan="2">The impact will definitely occur.</td></tr>
<tr><td colspan="5">MITIGATION:</td></tr>
<tr><td colspan="5">
Ensure the solar PV plants do not exceed the proposed heights;
Where possible, surface infrastructure must be painted natural hues so that it blends into the surrounding landscape;
Limit the footprint area of the surface infrastructure;
Pylons and metal structures must be galvanised so as to weather to a matt grey finish rather than be painted silver. If the pylons and metal structures are painted, a neutral matt finish must be used;
Avoid construction activities at night. If construction activities take place at night then only areas where these activities are taking place should be lit and the number of lights and brightness must not exceed the minimum requirements for safety and security. Down lighting and low-pressure sodium light sources must be implemented to minimise light pollution. Lights should be directed inwards towards the Project area and not outwards from the Project area; and
Ensure that a Glint and Glare Impact Assessment is conducted to meet the new South African Civil Aviation Authority (SACAA) regulations for solar projects (SACAA, 2017).
</td></tr>
<tr><td colspan="5">POST-MITIGATION</td></tr>
<tr><td>Duration</td><td>Beyond project life (6)</td><td>The impact will occur during the construction phase and remain for some time after the Project.</td><td rowspan="3">Consequence: Moderately detrimental (-10)</td><td rowspan="3">Significance: Minor - negative (-60)</td></tr>
<tr><td>Extent</td><td>Limited (2)</td><td>The extent of the impact will be reduced by implementing the mitigation actions listed above.</td></tr>
<tr><td>Intensity x type of impact</td><td>Low - negative (-2)</td><td>The visual disturbance will be reduced by implementing the mitigation measures above.</td></tr>
</table>

IMPACT DESCRIPTION: Construction of Solar PV Plants is expected to have a negative visual impact on the receiving environment.			
Dimension	**Rating**	**Motivation**	
Probability	Highly probable (6)	It is most likely that the impact will occur.	

Table 24: Potential Impacts of Development of the Powerline and Fibre Optic Cable Networks on the Receiving Environment

IMPACT DESCRIPTION: Development of the Powerline and Fibre Optic Cable Networks is expected to have a negative visual impact on the receiving environment.				
Dimension	**Rating**	**Motivation**		
PRE-MITIGATION				
Duration	Permanent (7)	There will be a permanent and irreversible negative visual impact on the receiving environment. The SKA radio telescope and associated infrastructure will remain indefinitely.	Consequence: Highly detrimental (-13)	Significance: Moderate - negative (-91)
Extent	Local (3)	The powerline and fibre optic cable networks will be visible from the surrounding area.		
Intensity x type of impact	Moderate - negative (-3)	Development of the powerline and fibre optic cable networks is expected to cause a moderate visual disturbance.		
Probability	Certain (7)	The impact will definitely occur.		
MITIGATION:				

- Ensure the above ground powerlines and fibre optic cables do not exceed the proposed heights;
- Spread topsoil and re-vegetate the servitude areas of underground (trenched) powerlines and fibre optic cables with indigenous species;
- Where possible, surface infrastructure must be painted natural hues so that it blends into the surrounding landscape;
- Limit the footprint area of the surface infrastructure;

<table>
<tr><td colspan="5">IMPACT DESCRIPTION: Development of the Powerline and Fibre Optic Cable Networks is expected to have a negative visual impact on the receiving environment.</td></tr>
<tr><td>Dimension</td><td>Rating</td><td colspan="3">Motivation</td></tr>
<tr><td colspan="5">Pylons and metal structures must be galvanised so as to weather to a matt grey finish rather than be painted silver. If the pylons and metal structures are painted, a neutral matt finish must be used; and
If construction activities take place at night then only areas where these activities are taking place should be lit and the number of lights and brightness must not exceed the minimum requirements for safety and security. Down lighting and low-pressure sodium light sources must be implemented to minimise light pollution. Lights should be directed inwards towards the Project area and not outwards from the Project area.</td></tr>
<tr><td colspan="5">POST-MITIGATION</td></tr>
<tr><td>Duration</td><td>Beyond project life (6)</td><td>The impact will occur during the construction phase and remain for some time after the Project.</td><td rowspan="3">Consequence: Moderately detrimental (-10)</td><td rowspan="4">Significance: Minor – negative (-60)</td></tr>
<tr><td>Extent</td><td>Limited (2)</td><td>The extent of the impact will be reduced by implementing the mitigation actions listed above.</td></tr>
<tr><td>Intensity x type of impact</td><td>Low - negative (-2)</td><td>The visual disturbance will be reduced by implementing the mitigation measures above.</td></tr>
<tr><td>Probability</td><td>Highly probable (6)</td><td colspan="2">It is most likely that the impact will occur.</td></tr>
</table>

10.3.1.3 Activity 3: Development of Borrow Pits and Quarries

Development of borrow pits and quarries is expected to have a negative visual impact on the receiving environment. The impacts of development of borrow pits and quarries are summarised in

Table 25: Potential Impacts of Development of Borrow Pits and Quarries on the Receiving Environment

<table>
<tr><td colspan="3">IMPACT DESCRIPTION: Development of Borrow Pits and Quarries is expected to have a negative visual impact on the receiving environment.</td></tr>
<tr><td>Dimension</td><td>Rating</td><td>Motivation</td></tr>
<tr><td colspan="3">PRE-MITIGATION</td></tr>
</table>

IMPACT DESCRIPTION: Development of Borrow Pits and Quarries is expected to have a negative visual impact on the receiving environment.				
Dimension	**Rating**	**Motivation**		
Duration	Permanent (7)	There will be a permanent and irreversible negative visual impact on the receiving environment. The SKA radio telescope and associated infrastructure will remain indefinitely.	Consequence: Highly detrimental (-14)	Significance: Moderate – negative (-98)
Extent	Local (3)	The borrow pits and quarries will be visible from the surrounding area.		
Intensity x type of impact	Moderately high - negative (-4)	Development of borrow pits and quarries will cause a moderately high visual disturbance.		
Probability	Certain (7)	The impact will definitely occur.		
MITIGATION:				
▪ Only remove borrow material from within the borrow pit and quarry areas; ▪ Apply dust suppression techniques to limit dust generated from blasting; ▪ Do not blast when the wind speed exceeds 5.4 m/s; ▪ Rehabilitate and establish natural vegetation on all disturbed areas as detailed in the Ecological Report and Rehabilitation Plan; and ▪ Ensure that the rehabilitated area is re-contoured and profiled.				
POST-MITIGATION				
Duration	Beyond project life (6)	The impact will occur during the construction phase and remain until the borrow pits and quarries have been rehabilitated.	Consequence: Moderately detrimental (-11)	Significance: Minor - negative (-66)
Extent	Limited (2)	The extent of the impact will be reduced by implementing the mitigation actions listed above.		

IMPACT DESCRIPTION: Development of Borrow Pits and Quarries is expected to have a negative visual impact on the receiving environment.				
Dimension	**Rating**	**Motivation**		
Intensity x type of impact	Moderate – negative (-3)	The visual disturbance will be reduced by implementing the mitigation measures above.		
Probability	Highly probable (6)	It is most likely that the impact will occur.		

10.3.2 Operational Phase

The operational phase is characterised by operation of the SKA radio telescope and construction camps. The operational phase is expected to have negative visual impacts on the receiving environment.

10.3.2.1 Activity 4: Operation of the SKA Radio Telescope

Operation of the SKA radio telescope is expected to have a negative visual impact on the receiving environment during the day. The impacts of operation of the SKA radio telescope are summarised in Table 27.

Table 26: Potential Impacts of Operation of the SKA Radio Telescope on the Receiving Environment

IMPACT DESCRIPTION: Change of land use from natural vegetation and agriculture to industry/scientific research will have a positive visual impact on the receiving environment.				
Dimension	**Rating**	**Motivation**		
PRE-MITIGATION				
Duration	Permanent (7)	There will be a permanent positive visual impact on the receiving environment. The removal of alien and invasive vegetation and revegetation of indigenous vegetation will remain indefinitely.	Consequence: Highly detrimental (14)	Significance: Major – positive (98)
Extent	Municipal Area (4)	The daytime practical viewshed model indicates that the Project will be		

IMPACT DESCRIPTION: Change of land use from natural vegetation and agriculture to industry/scientific research will have a positive visual impact on the receiving environment.				
Dimension	**Rating**	**Motivation**		
		visible from a maximum distance of 20 km during the day. The night time practical viewshed model indicates that the Project will be visible from a maximum distance of 8 km at night.		
Intensity x type of impact	Moderate – positive (3)	Change of land use will result in a permanent change in the sense of place of the Project area and surrounds.		
Probability	Certain (7)	The impact will definitely occur.		
MITIGATION:				
■ Mitigation will not be required as the activity will have have a positive impact on the receiving environment.				

Table 27: Potential Impacts of Operation of the SKA Radio Telescope on the Receiving Environment

IMPACT DESCRIPTION: Operation of the SKA radio telescope is expected to have a negative visual impact on the receiving environment during the day.				
Dimension	**Rating**	**Motivation**		
PRE-MITIGATION				
Duration	Permanent (7)	There will be a permanent and irreversible negative visual impact on the receiving environment. The SKA radio telescope and associated infrastructure will remain indefinitely.	Consequence: Highly detrimental (-16)	Significance: Major – negative (-112)
Extent	Province/ Region (5)	The daytime practical viewshed model indicates that the Project will be visible from a		

IMPACT DESCRIPTION: Operation of the SKA radio telescope is expected to have a negative visual impact on the receiving environment during the day.				
Dimension	**Rating**	**Motivation**		
		maximum distance of 20 km during the day.		
Intensity x type of impact	Moderately high - negative (-4)	Operation of the SKA radio telescope is expected to cause a moderately high visual disturbance.		
Probability	Certain (7)	The impact will definitely occur.		
MITIGATION:				

- Where possible, surface infrastructure must be maintained by painting it with natural hues so that it blends into the surrounding landscape;
- When maintenance occurs pylons and metal structures must be galvanised so as to weather to a matt grey finish rather than be painted silver. If the pylons and metal structures are painted, a neutral matt finish must be used; and
- Educate receptors on the benefits of the Project to change their perceptions of the visual impact.

POST-MITIGATION				
Duration	Permanent (7)	There will be a permanent and irreversible negative visual impact on the receiving environment. The SKA radio telescope and associated infrastructure will remain indefinitely.	Consequence: Highly detrimental (-14)	Significance: Moderate – negative (-84)
Extent	Municipal Area (4)	The extent of the impact will be reduced by implementing the mitigation actions listed above.		
Intensity x type of impact	Moderate - negative (-3)	The visual disturbance will be reduced by implementing the mitigation measures above.		
Probability	Highly probable (6)	It is most likely that the impact will occur.		

10.3.2.2 Activity 5: Operation of the Construction Camps

Operation of the construction camps is expected to have a negative visual impact on the receiving environment at night. The impacts of operation of the construction camps are summarised in Table 28.

Table 28: Potential Impacts of Operation of the Construction Camps on the Receiving Environment

IMPACT DESCRIPTION: Operation of the construction camps is expected to have a negative visual impact on the receiving environment at night.				
Dimension	**Rating**	**Motivation**		
PRE-MITIGATION				
Duration	Permanent (7)	There will be a permanent and irreversible negative visual impact on the receiving environment. The SKA radio telescope and associated infrastructure will remain indefinitely.	Consequence: Highly detrimental (-13)	Significance: Moderate - negative (-91)
Extent	Local (3)	The night time practical viewshed model indicates that the Project will be visible from a maximum distance of 8 km at night.		
Intensity x type of impact	Moderate - negative (-3)	Operation of the construction camps is expected to cause a moderate visual disturbance.		
Probability	Certain (7)	The impact will definitely occur.		
MITIGATION:				
▪ Where possible avoid operational activities at night. If operational activities take place at night, then only areas where these activities are taking place should be lit and the number of lights and brightness must not exceed the minimum requirements for safety and security. Down lighting and low-pressure sodium light sources must be implemented to minimise light pollution. Lights should be directed inwards towards the Project area and not outwards from the Project area.				

<table>
<tr><td colspan="5">IMPACT DESCRIPTION: Operation of the construction camps is expected to have a negative visual impact on the receiving environment at night.</td></tr>
<tr><td>Dimension</td><td>Rating</td><td colspan="3">Motivation</td></tr>
<tr><td colspan="5">POST-MITIGATION</td></tr>
<tr><td>Duration</td><td>Project Life (5)</td><td>The visual impact will remain as long as the construction camps are operational.</td><td rowspan="3">Consequence: Moderately detrimental (-9)</td><td rowspan="4">Significance: Minor - negative (-54)</td></tr>
<tr><td>Extent</td><td>Local (3)</td><td>The extent of the impact will be reduced by implementing the mitigation actions listed above.</td></tr>
<tr><td>Intensity x type of impact</td><td>Low - negative (-2)</td><td>The visual disturbance will be reduced by implementing the mitigation measures above.</td></tr>
<tr><td>Probability</td><td>Highly probable (6)</td><td colspan="2">It is most likely that the impact will occur.</td></tr>
</table>

11 Cumulative Impacts

The receiving environment is characterised by vast expanses of open land (some of which is used for sheep farming) interspersed with isolated farmsteads and the occasional small town/settlement. The Project area and surrounds have a largely rural, farming sense of place which is described by Oberholzer and Lawson (2016) with the words “vastness, serenity, quietness and dark skies at night”.

The SKA Project will be developed in a phased approach and at this stage only the details of Phase 1 are confirmed. “It is however planned that the highest density of dish-antennas will be located in the SKA core (i.e. Meysdam and Losberg farms) and that the remote SKA stations will extend to other African countries” (CSIR, 2016).

Although the SKA radio telescope Project is one of a kind, the South African Renewable Energy EIA Application Database (REEA) indicates that there are numerous approved and proposed solar PV and wind energy projects in the surrounding area (DEA, 2018b). Plan 13 (Appendix B) illustrates the proposed Project in relation to the nearby approved and proposed solar PV and wind energy projects.

The development of the SKA Project and other large-scale infrastructure projects in the region will cumulatively result in a loss of scenic character and increased visual disturbance. Over time the sense of place will change from a rural, farming sense of place to a more industrial/scientific sense of place.

12 General Mitigation/Management

According to Brush *et al*. (1979), vegetation screening is the best mitigation/management action to conceal a development. Figure 26 illustrates the screening effect of vegetation. It is recommended that any natural vegetation which may potentially conceal the proposed development be left undisturbed, especially on the Project boundary. Vegetation left undisturbed along the perimeter of the Project has the ability to conceal the proposed infrastructure from nearby receptors. Figure 27 illustrates the effect of cleared vegetation allowing direct views of the proposed infrastructure.

The natural vegetation of the Project area and surrounds is Shrubland and Grassland and does not contain tree species. The existing rows of plants/trees planted near some farm residences as windbreaks/vegetation screens are alien invasive species. It is therefore not possible to recommend tree species for vegetation screens as there are no indigenous trees in the Shrubland and Grassland vegetation.

Figure 26: Screening Effect of Vegetation

Figure 27: Effect of Cleared Vegetation

Other general mitigation/management actions that should be implemented where possible include:

- As much existing natural vegetation as possible should be retained, specifically bushes and trees if present. This will assist to conceal the development;
- Areas susceptible to dust should be frequently wetted by means of a water bowser during the construction phase. It is extremely important to suppress the visual aspects of dust to avoid creating the impression of a polluting industry;
- Surface infrastructure should be painted natural hues so as to blend into the surrounding landscape where possible;
- Pylons and metal structures should be galvanised so as to weather to a matt grey finish rather than be painted silver. If the pylons and metal structures are painted, it is recommended that a neutral matt finish be used;
- Where possible avoid construction and operational activities at night. If construction and operational activities take place at night, then only areas where these activities are taking place should be lit and the number of lights and brightness must not exceed the minimum requirements for safety and security. Down lighting and low-pressure sodium light sources must be implemented to minimise light pollution. Lights should be directed inwards towards the Project area and not outwards from the Project area;
- Educate receptors on the benefits of the Project to change their perceptions of the visual impact; and
- An appropriate grievance mechanism should be developed to respond to grievances from receptors that relate to visual aspects.

13 Monitoring Plan

SARAO will be responsible for the implementation of all monitoring actions. The recommended monitoring actions for the identified impacts are detailed below. SARAO will also be responsible for keeping a record of all environmental monitoring undertaken for the Project.

The following monitoring activities should be undertaken on a monthly basis for the life of the Project:

- Dust monitoring and management as per the Air Quality Monitoring Plan (reducing the dust on site will reduce the visual impact of dust);
- The existing rows of trees planted near some farm residences as windbreaks/ vegetation screens need to be maintained and protected against fire and utilisation of the vegetation for fire wood, etc.; and
- Grievances from visual receptors must be monitored and addressed through a Grievance Mechanism.

14 Unplanned Events and Low Risks

There are no unplanned events and low risks expected for the Project that will result in visual impacts.

15 Consultation Undertaken

Digby Wells completed a public participation process as part of the Heritage Resources Management Process. No specific comments were recorded relevant to this VIA.

16 Recommendations

It is recommended that the mitigation/management actions in Sections 10.3, 12 and 13 are implemented to reduce the impact that the Project will have on the visual character of the receiving environment. The Project will have a very high visual impact on the receiving environment and will be visible for a maximum distance of 20 km during the day and 8 km at night. This visual impact will be permanent as the SKA radio telescope and associated infrastructure will remain indefinitely.

Due to the uncertainty of the location and extent of some of the ancillary infrastructure, it is recommended that the visual impact be re-assessed and the VIA updated when these details are determined.

The new SACAA regulations require that all new solar project applications are "accompanied by a Glint and Glare Impact Assessment with specific relevance to aviation and aircraft operations" (SACAA, 2017). It is therefore recommended that a Glint and Glare Impact Assessment be conducted for the proposed solar PV plants.

17 Conclusion

Digby Wells Environmental was appointed by SARAO as the specialist service provider for the Heritage HRM process in support of Phase 1 of the SKA Project. The HRM process also required the compilation of a VIA.

The Project comprises two primary components, namely the 'core' (36 land parcels) and three 'spiral arms' (73 land parcels) covering an approximate areal extent of 460,000 ha. This land makes provision for the SKA Radio Telescope site, KAT-7 radio telescope, MeerKAT, HIRAX and HERA instruments. During Phase 1 of the SKA Project the international SKAO proposes to establish an additional 133 dish-antennas to the 64-dish MeerKAT radio telescope and various ancillary infrastructures.

Theoretical and practical viewshed models were created for the Project. These viewshed models are based on the topography only and do not take the screening effect of vegetation into account. The viewshed models depict worst case scenarios and show the areas from which the Project may potentially be visible.

The potential visual receptors within the daytime practical viewshed include residents of the Brandvlei and Swartkop settlements, residents of the 194 farmsteads on the surrounding farms, road users and 82 heritage sites outside the core area. The potential visual receptors within the night time practical viewshed include road users and five heritage sites outside the core area.

The "Guideline for involving visual and aesthetic specialists in EIA processes" document by Oberholzer (2005) identifies large-scale infrastructure as a Category 5 development. The receiving environment of the Project is an area of high scenic, cultural or historical significance as the Project area has a largely rural, farming sense of place. The Project area and surrounds are characterised by vast expanses of open land (some of which is used for sheep farming) interspersed with isolated farmsteads and the occasional small town/settlement. A Category 5 development in this area is expected to have a very high visual impact. The findings of this VIA concur with this categorisation. However, with the mitigation proposed, the visual impact significance rating from the visual impact assessment is reduced to moderate or minor in most instances. (It should be noted that Oberholzer's categorisation differs from the impact assessment methodology and as a result the expected visual impact according to Oberholzer and the visual impact significance ratings from the visual impact assessment may differ).

Change of land use from natural vegetation and agriculture to industry/scientific research will have a negative visual impact on the receiving environment. This change of land use will change the sense of place of the Project area and surrounds from a rural, farming sense of place to a more industrial/scientific sense of place resulting in a loss of scenic character and increased visual disturbance.

The SKA radio telescope and associated infrastructure will remain indefinitely resulting in a permanent negative visual impact on the receiving environment. However, with the proposed mitigation measures, the visual impact significance rating from the visual impact assessment will be reduced to moderate or minor in most instances. The SKA radio telescope Project is of international scientific importance. For some receptors, the visibility of the Project may be viewed positively as it signifies advances in scientific research.

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Appendix A: Specialist CV

Mrs. Stephanie Mulder

Unit Manager: GIS & Visual Services

Digby Wells Environmental

1 Education

Year	Qualification
2006	BSc (Hons) Geography (cum laude) at University of Johannesburg Major subjects: Philosophy and Research Methodology; Strategic Environmental Planning; Geographic Information Systems (GIS); Urban Geography and Geomorphology
2003 to 2005	BSc Geography and Informatics with Financial Orientation at University of Johannesburg Major subjects: Geography and Informatics Ancillary subjects: Mathematics; Analytical Techniques; Financial Management; Accounting and Business Management

2 Training

Year	Course
2012	Diplôme D'Études en Langue Française – DELF A1 (La Commission Nationale du DELF et du DALF)
2011	ArcPad for ArcGIS (ESRI)
2011	Mining for Non-Miners (Snowden)
2009	Emerging Management Development Programme (EMDP) (University of Pretoria in association with the Public Administration Leadership and Management academy (PALAMA) and the School of Public Management and Administration)
2008	Building Geodatabases (ESRI)
2008	Geodatabase Design Concepts (ESRI)
2007	Introduction to ArcGIS I (ESRI)

3 Language Skills

Language	Level
English	Excellent
Afrikaans	Good
French	Intermediate

4 Employment

Date	Company	Position
1 July 2012 to Present	Digby Wells Environmental	Unit Manager: GIS & Visual Services
1 September 2009 to 30 June 2012	Digby Wells Environmental	Environmental GIS Specialist
1 January 2008 to 31 August 2009	Statistics South Africa, Geography Division	GIS Specialist – Geo-Database and Application Development
1 January 2007 to 31 December 2007	Statistics South Africa, Geography Division	Intern Professional
February 2006 to October 2006	Department of Geography, Environmental Management and Energy Studies, University of Johannesburg	Demonstrator for the First Year Geography Practical Lectures

5 Experience

I have experience in using Geographic Information Systems (GIS) as a digital cartographic and spatial analytical tool. As a GIS Specialist at Statistics South Africa I was responsible for maintaining the geodatabase and I gained experience working with vector data, aerial photography and satellite imagery. I was responsible for the data preparation and mapping for the Community Survey 2007 Digital Atlas CD. I assisted with map production for surveys and user requests for spatial data. I also worked on the Dwelling Frame Project, Placename and Enumerator Area Demarcation.

My responsibilities at Digby Wells currently include but are not limited to:

- Management of the GIS and Visual Services Unit;

- Generation of maps for projects;
- Conducting Topography and Visual Impact Assessments (T&VIAs);
- Review of GIS maps and T&VIA Reports;
- Assisting with the maintenance of the GIS databases by storing all electronic files in a well organised structure;
- Expanding and improving the GIS databases by identifying gaps and sources of additional mapping data;
- The production of spatial information in map format;
- Application of GPS technology, aerial photo and satellite images.
- Assessing digital databases to ensure a high level of accuracy of data available at all times;
- Spatial analyses relating to environmental projects;
- Compilation of interactive maps and document management systems; and
- Conducting sensitivity analyses and site selection.

6 Project Experience

My project experience at Digby Wells includes but is not limited to:

Year	Client	Project	Responsibility	Location
2017	Canyon Coal	Palmietkuilen Mining Project EIA	Visual Impact Assessment Supervise mapping	Mpumalanga, South Africa
2017	Ergo	Grootvlei Cluster Reclamation EIA	Visual Impact Assessment Supervise mapping	Gauteng, South Africa
2016	Glencore	Hendrina Coal Mine EIA	Visual Impact Assessment Supervise mapping	Mpumalanga, South Africa
2016	Namane Generation	IPP EIA	Visual Impact Assessment Supervise mapping	Limpopo, South Africa
2016	Natural Habitats	HCV Assessment	Mapping	Sierra Leone

Year	Client	Project	Responsibility	Location
2016	Platreef Resources	Platreef EIA Amendment	Visual Impact Assessment Mapping	Limpopo, South Africa
2016	Rand Gold	Closure Cost Assessment 2016	3D modelling and closure calculations Supervise mapping	DRC, Ivory Coast and Mali
2016	Sasol Mining	Brandspruit Interactive Map and Document Management System	Project Manager Interactive map	Mpumalanga, South Africa
2016	Sasol Mining	Middelbult Interactive Map and Document Management System	Project Manager Interactive map	Mpumalanga, South Africa
2016	Sasol Mining	Mooikraal Interactive Map and Document Management System	Project Manager Interactive map	Free State, South Africa
2016	Sasol Mining	Twistdraai Interactive Map and Document Management System	Project Manager Interactive map	Mpumalanga, South Africa
2016	Uranex	Nachu Graphite Mine ESIA	Mapping	Tanzania
2015	Anker Coal	Elandsfontein and Golfview Baseline Studies	Mapping	Mpumalanga, South Africa
2015	Anker Coal	Elandsfontein and Golfview Closure Cost Assessments	3D modelling and closure calculations Mapping	Mpumalanga, South Africa
2015	Anker Coal	Elandsfontein and Golfview IWULAs	Mapping	Mpumalanga, South Africa
2015	Anker Coal	Golfview Rehabilitation Plan	3D modelling and volume calculations Mapping	Mpumalanga, South Africa

Year	Client	Project	Responsibility	Location
2015	BECSA (South 32)	KPSX: Weltevreden EIA	Topography and Visual Impact Assessment Supervise mapping	Mpumalanga, South Africa
2015	CDC Group	Fauna and Flora, and Social Studies	Data compilation Mapping	DRC
2015	Fountain Capital	Oakleaf Open Pit Coal Mine EIA	Assist with Topography and Visual Impact Assessment Supervise mapping	Gauteng, South Africa
2015	Gold One	Sibanye WRTRP EIA	Topography and Visual Impact Assessment Supervise mapping	Gauteng, South Africa
2015	Harmony Gold	Closure Cost Assessment 2015	3D modelling and closure calculations Supervise mapping	Free State, Gauteng and North West, South Africa
2015	Lanxess Mining	Lanxess Chrome Mine Section 102 EMP Amendment	Topography and Visual Impact Assessment Mapping	North West, South Africa
2015	Pamish Investments	Magnetite EIA	Topography and Visual Impact Assessment Mapping	Limpopo, South Africa
2015	Rand Gold	Closure Cost Assessment 2015	3D modelling and closure calculations Supervise mapping	DRC, Ivory Coast and Mali
2015	Sasol Mining	Sigma Interactive Map and Document Management System	Project Manager Interactive map	Free State, South Africa
2014	AECOM	EIA for Management of AMD from the Eastern Basin	Assist with Topography and Visual Impact Assessment Supervise mapping	Gauteng, South Africa

Year	Client	Project	Responsibility	Location
2014	BECSA (South 32)	KPSX: South EIA	Topography and Visual Impact Assessment Supervise mapping	Mpumalanga, South Africa
2014	Ergo	Pipeline GIS Audit	Project Manager	Gauteng, South Africa
2014	Exxaro	Tshikondeni Closure Plan	Mapping	Limpopo, South Africa
2014	Genesis Analytics	Evaluation of Environmental Governance	Interviews, Research and Report Compilation	South Africa
2014	Glencore Xstrata	Tavistock EMP	Mapping	Mpumalanga, South Africa
2014	Harmony Gold	Closure Cost Assessment 2014	3D modelling and closure calculations Supervise mapping	Free State, Gauteng and North West, South Africa
2013	Amara Sega	Cluff Sega RAP	Data compilation Mapping	Burkina Faso
2013	Anglo American Thermal Coal	Dalyshope Coal Mine EIA	Topography and Visual Impact Assessment Mapping	Limpopo, South Africa
2013	Aureus Mining Inc	New Liberty Gold Mine RAP	Questionnaire design Data compilation and analysis Mapping	Liberia
2013	Glencore Xstrata	GIS Phase 2 Project	Project Manager	Mpumalanga, South Africa
2013	Glencore Xstrata	Closure Cost Assessment 2013	3D modelling and closure calculations Supervise mapping	Mpumalanga, South Africa

Year	Client	Project	Responsibility	Location
2013	Harmony Gold	Closure Cost Assessment 2013	3D modelling and closure calculations Supervise mapping	Free State, Gauteng and North West, South Africa
2013	Platreef Resources	Platreef EIA	Topography and Visual Impact Assessment Mapping	Limpopo, South Africa
2013	Rhodium Reefs	Rhodium Reefs EIA	Topography and Visual Impact Assessment	Limpopo, South Africa
2013	Vedanta	Vedanta IPP EIA	Topography and Visual Scoping Study Mapping	Limpopo, South Africa
2012	Bokoni Platinum Mine	Bokoni Water Balance	Mapping	Limpopo, South Africa
2012	Platreef Resources	Platreef Agricultural Survey	Project Manager Data compilation Mapping	Limpopo, South Africa
2012	Platreef Resources	Platreef Skills and Business Survey	Project Manager Digital survey methodology Data compilation and analysis	Limpopo, South Africa
2012	Xstrata Coal	Closure Cost Assessment 2012	3D modelling and closure calculations Supervise mapping	Mpumalanga, South Africa
2012	Xstrata Coal	Consolidated EIA EMP for Tavistock	Mapping	Mpumalanga, South Africa
2011	DRD Gold	Crown Knights Reclamation of Sand Dump 4/A/6 (Lycaste) EIA	Topography and Visual Impact Assessment Mapping	Gauteng, South Africa

Year	Client	Project	Responsibility	Location
2011	DRD Gold	Crown Pipeline Audit	Mapping	Gauteng South Africa
2011	DRD Gold	Crown Consolidated EMP	Mapping	Gauteng, South Africa
2011	Koidu	Koidu RAP	Questionnaire design Data compilation and analysis	Sierra Leone
2011	Rand Gold	Gounkoto RAP	Fieldwork Mapping	Mali
2011	ResGen	Boikarabelo Railway EIA	Topography and Visual Impact Assessments	Limpopo, South Africa
2011	ResGen	Boikarabelo Power Station EIA	Topography Impact Assessment Mapping	Limpopo, South Africa
2011	Temo Coal	Temo Coal Mine EIA	Topography and Visual Impact Assessments	Limpopo, South Africa
2011	Universal Coal	Brakfontein Social and Environmental Screening Study	Mapping	Mpumalanga, South Africa
2011	Universal Coal	Roodekop EIA	Mapping	Mpumalanga, South Africa
2011	Xstrata Coal	Closure Cost Assessment 2011	3D modelling and closure calculations Mapping	Mpumalanga, South Africa
2011	Xstrata Alloys	Lesedi Power Station EIA	Topography Impact Assessment Mapping	Mpumalanga, South Africa
2010	DRD Gold	Crown Pipeline EIA	Mapping	Gauteng, South Africa

Year	Client	Project	Responsibility	Location
2010	DRD Gold	Crown City Deep Reclamation of Slimes Dam 4/L/2 EIA	Mapping	Gauteng, South Africa
2010	DRD Gold	Crown City Deep Reclamation of Slimes Dams 3/L/40 & 3/L/42 EIA	Mapping	Gauteng, South Africa
2010	Galaxy Gold	Galaxy Gold Mine EIA	Topography and Visual Impact Assessments Mapping	Mpumalanga, South Africa
2010	HCI Coal	Nokuhle Colliery EIA	Topography Impact Assessment Mapping	Mpumalanga, South Africa
2010	HCI Coal	Palesa Extension EIA	Topography and Visual Impact Assessments Mapping	Mpumalanga, South Africa
2010	Mmamabula	Mookane Domestic Power Project	Mapping	Botswana
2010	ResGen	Boikarabelo Coal Mine EIA	Mapping	Limpopo South Africa
2010	Xstrata Coal	Closure Cost Assessment 2010	3D modelling and closure calculations Mapping	Mpumalanga, South Africa
2010	Xstrata Coal	Zonnebloem Colliery EIA	Mapping	Mpumalanga, South Africa
2009	BHP Billiton	Naudesbank & Vaalbank Baseline Studies	Mapping	Mpumalanga, South Africa
2009	MSA	Nkwe Social Survey	Mapping	Limpopo, South Africa
2009	Sasol Mining	Syferfontein Colliery EIA	Mapping	Mpumalanga, South Africa

Year	Client	Project	Responsibility	Location
2009	Universal Coal	Kangala Coal Mine EIA	Mapping	Mpumalanga, South Africa
2009	Xstrata Coal	Community Baseline Survey	Data analysis Mapping	Mpumalanga, South Africa
2009	Xstrata Coal	Tavistock EMPR	Mapping	Mpumalanga, South Africa

7 Professional Affiliations

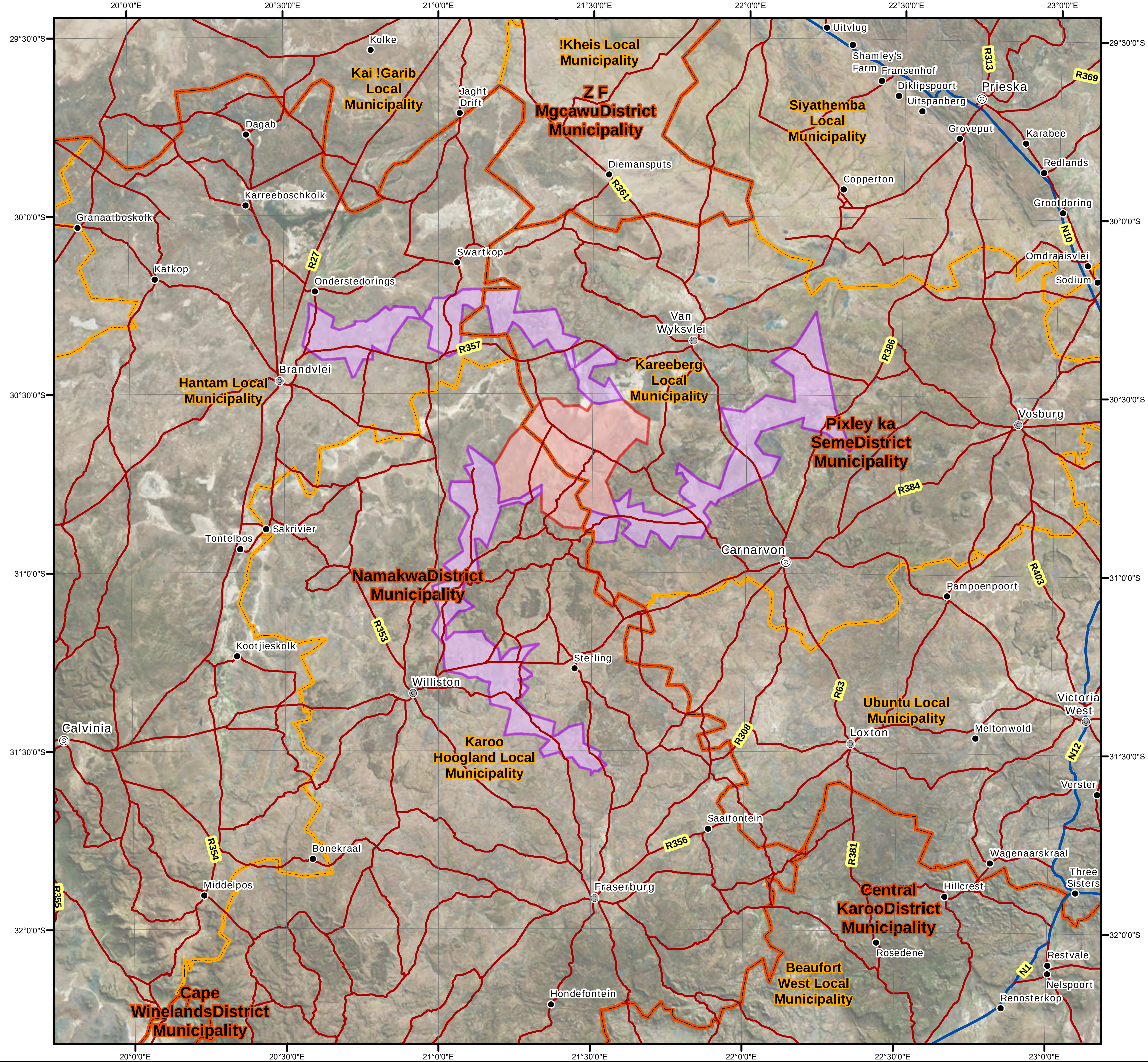
Geographic Information Society of South Africa (GISSA)

Appendix B: Plans

Plan 1

SKA Project

Regional Setting



Legend

Project Area

- SKA Phase 1 Core
- SKA Phase 1 Spiral Arms
- Secondary Town
- Other Town
- Settlement
- Main Road
- National Road
- District Municipality Boundary
- Local Municipality Boundary

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Projection: Transverse Mercator
Datum: WGS 1984
Central Meridian: 21°E

Ref #: scm.NRF4874.201805.063
Revision Number: 1
Date: 09/05/2018

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Kilometres
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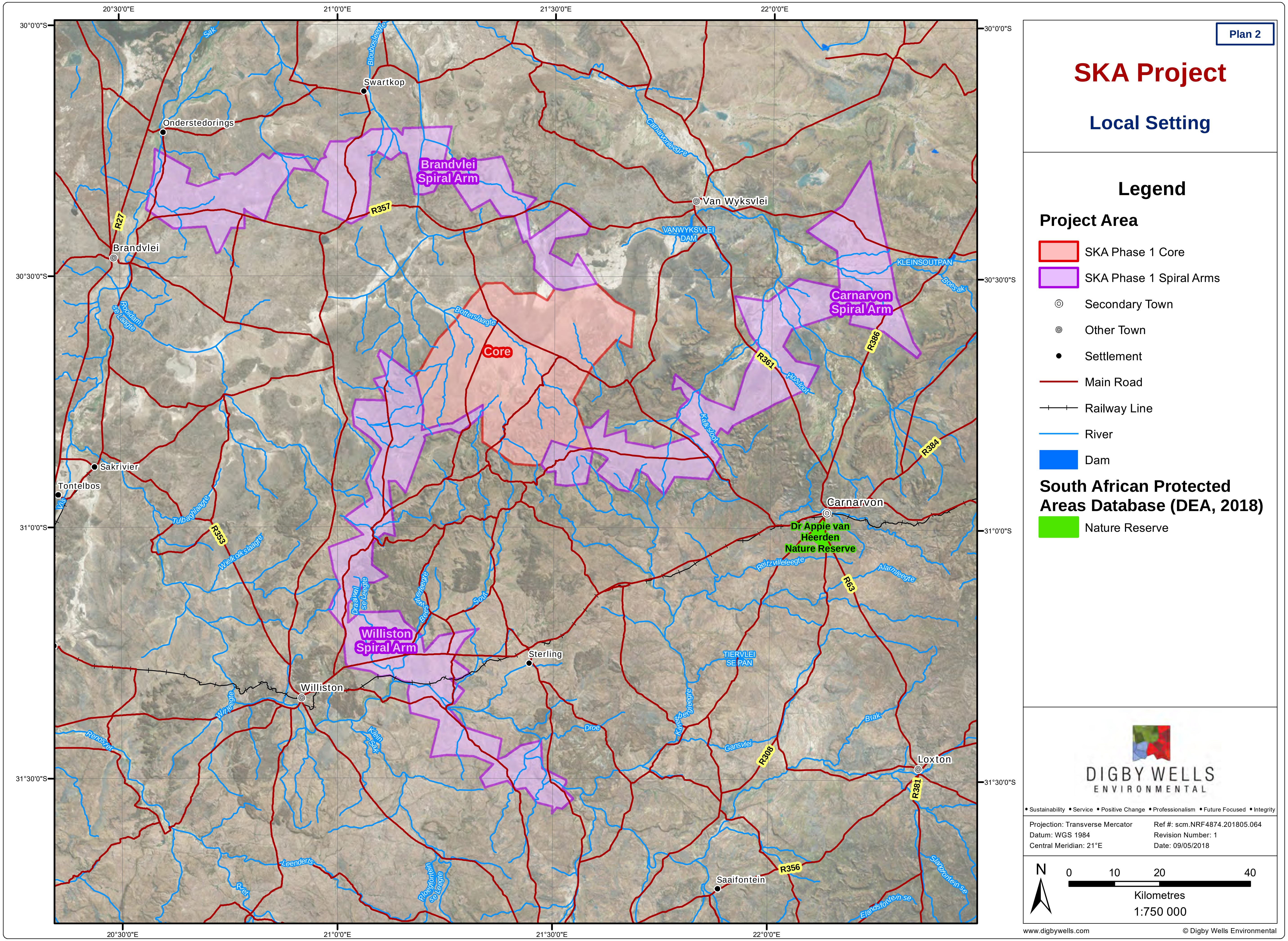

Plan 2
SKA Project
Local Setting
Legend
Project Area
SKA Phase 1 Core
SKA Phase 1 Spiral Arms
Secondary Town
Other Town
Settlement
Main Road
Railway Line
River
Dam
South African Protected Areas Database (DEA, 2018)
Nature Reserve
Brandvlei Spiral Arm
Carnarvon Spiral Arm
Williston Spiral Arm
Core
Dr Appie van Heerden Nature Reserve
Swartkop
Onderstedorings
Brandvlei
Van Wyksvlei
VANWYKSVLEI DAM
KLEINSOUTPAN
Sakrivier
Tontelbos
Carnarvon
Sterling
Williston
TIERVLEI SE PAN
Loxton
Saaifontein
R27
R357
R361
R386
R384
R353
R63
R308
R381
R356
20°30'0"E
21°0'0"E
21°30'0"E
22°0'0"E
30°0'0"S
30°30'0"S
31°0'0"S
31°30'0"S
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Revision Number: 1
Date: 09/05/2018
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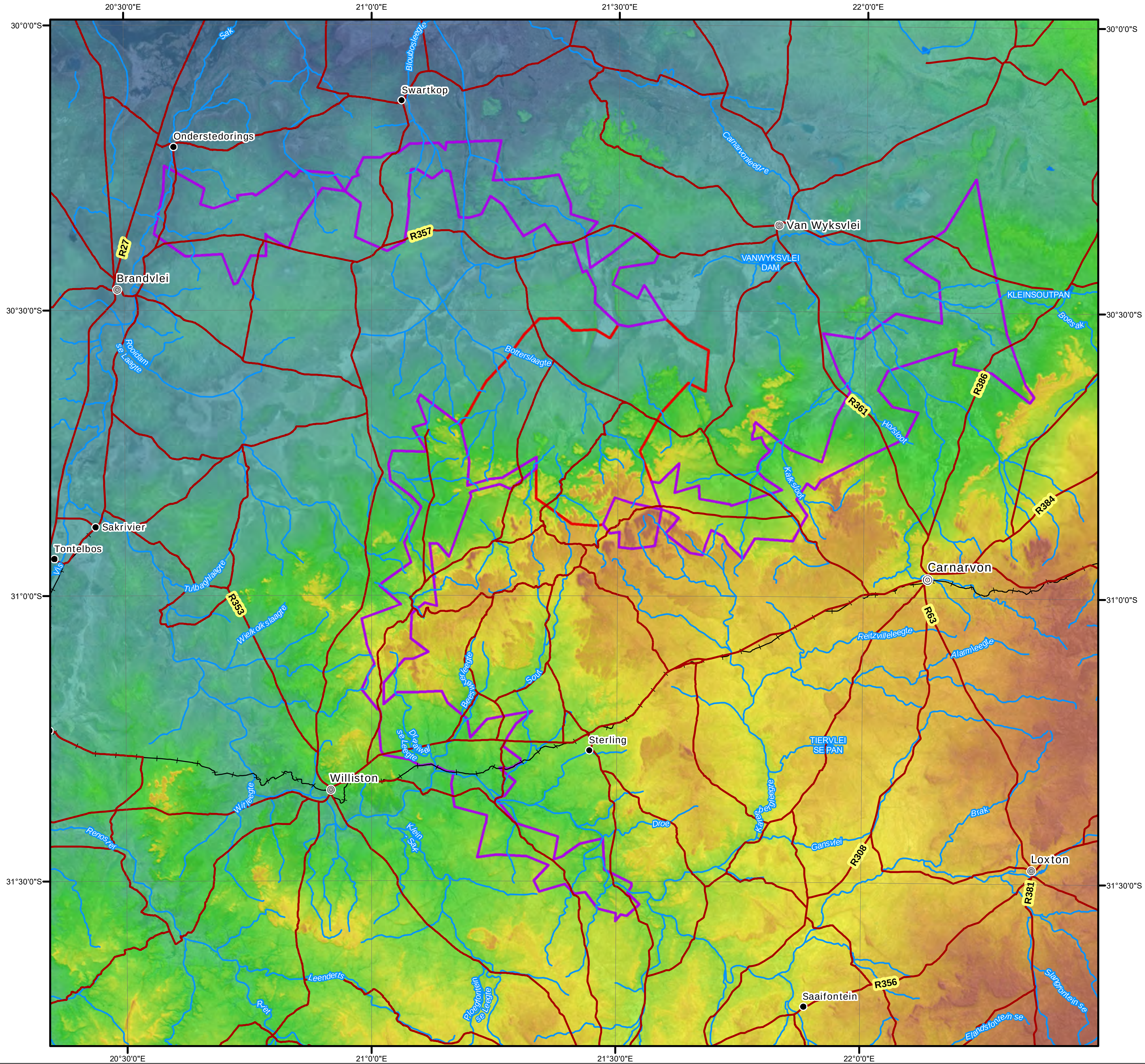

Plan 3

SKA Project

Topographical Model

Legend

Project Area

- SKA Phase 1 Core
- SKA Phase 1 Spiral Arms
- Secondary Town
- Other Town
- Settlement
- Main Road
- Railway Line
- River
- Dam

Topographical Model

Elevation (m.a.m.s.l.)

High : 1671

Low : 848

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Date: 09/05/2018

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Kilometres

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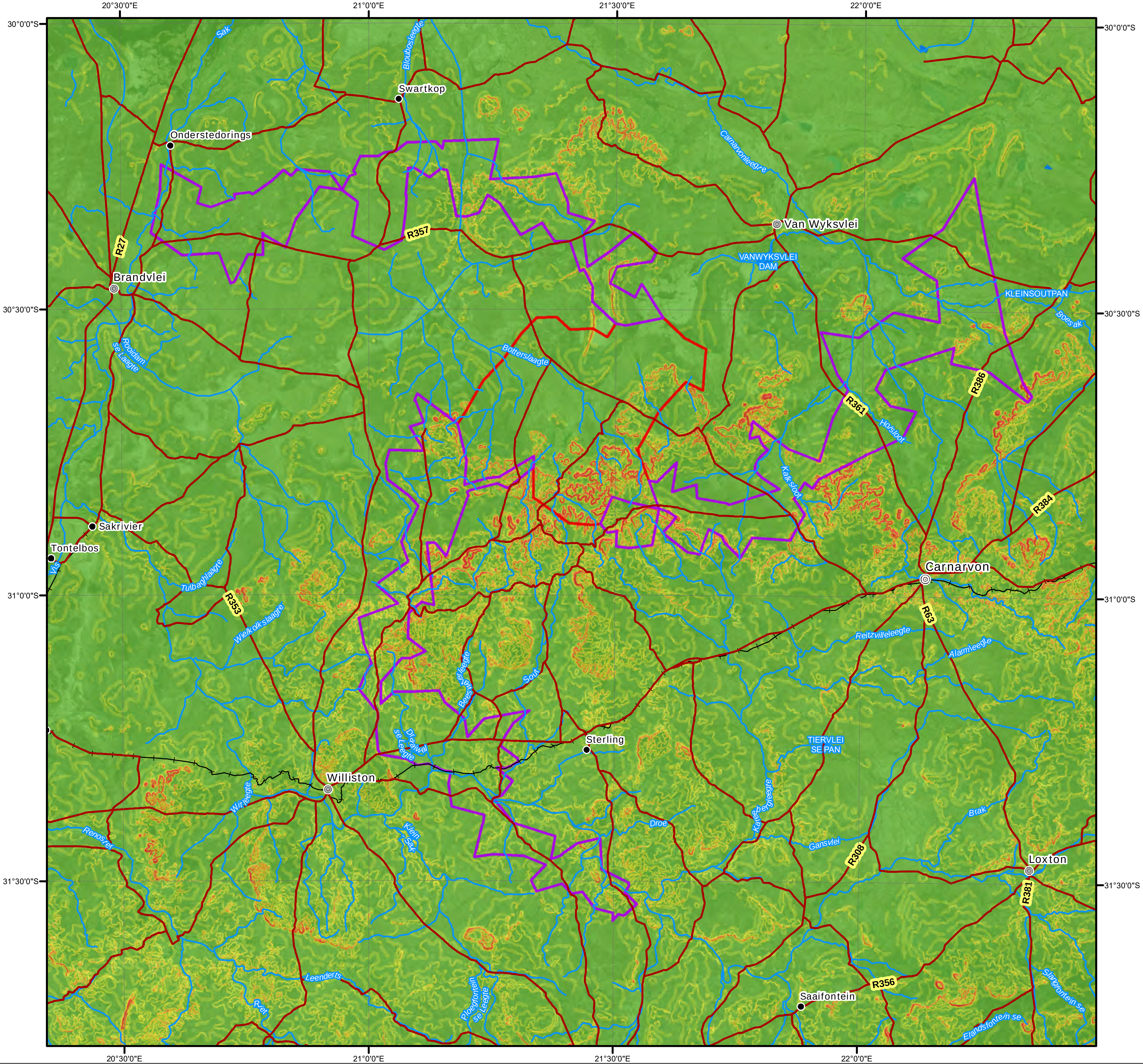
Plan 4

SKA Project

Slope Model



Legend

Project Area

- SKA Phase 1 Core
- SKA Phase 1 Spiral Arms
- Secondary Town
- Other Town
- Settlement
- Main Road
- Railway Line
- River
- Dam

Slope Model

Degrees (°)

- 0 - 0.9
- 1 - 2.8
- 2.9 - 5.7
- 5.8 - 9.6
- 9.7 - 14.5
- 14.6 - 20.6
- 20.7 - 37

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Date: 09/05/2018

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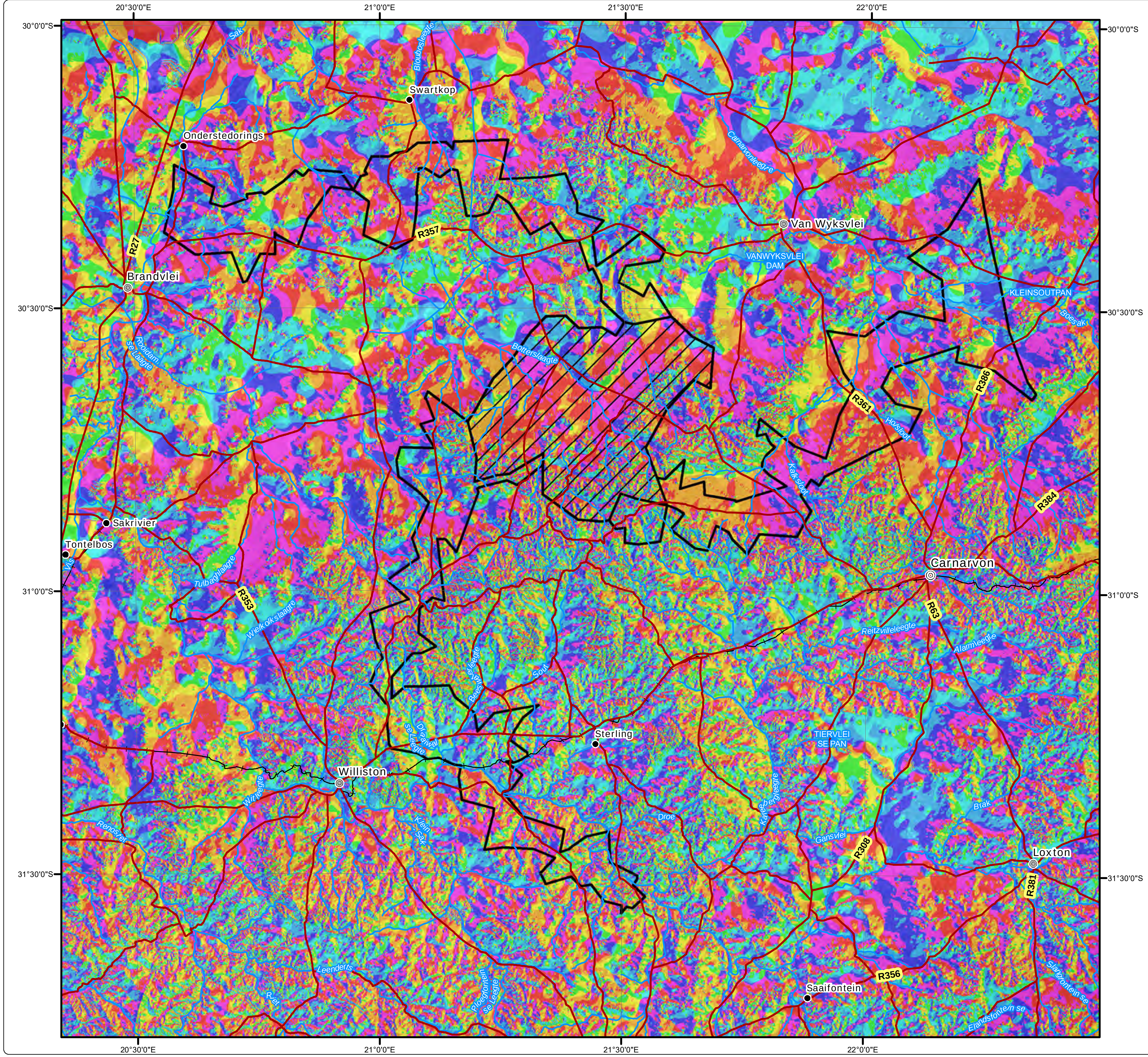

Plan 5

SKA Project

Aspect Model

Legend

Project Area

- SKA Phase 1 Core
- SKA Phase 1 Spiral Arms
- Secondary Town
- Other Town
- Settlement
- Main Road
- Railway Line
- River
- Dam

Aspect Model

- Flat (-1)
- North (0-22.5)
- Northeast (22.5-67.5)
- East (67.5-112.5)
- Southeast (112.5-157.5)
- South (157.5-202.5)
- Southwest (202.5-247.5)
- West (247.5-292.5)
- Northwest (292.5-337.5)
- North (337.5-360)

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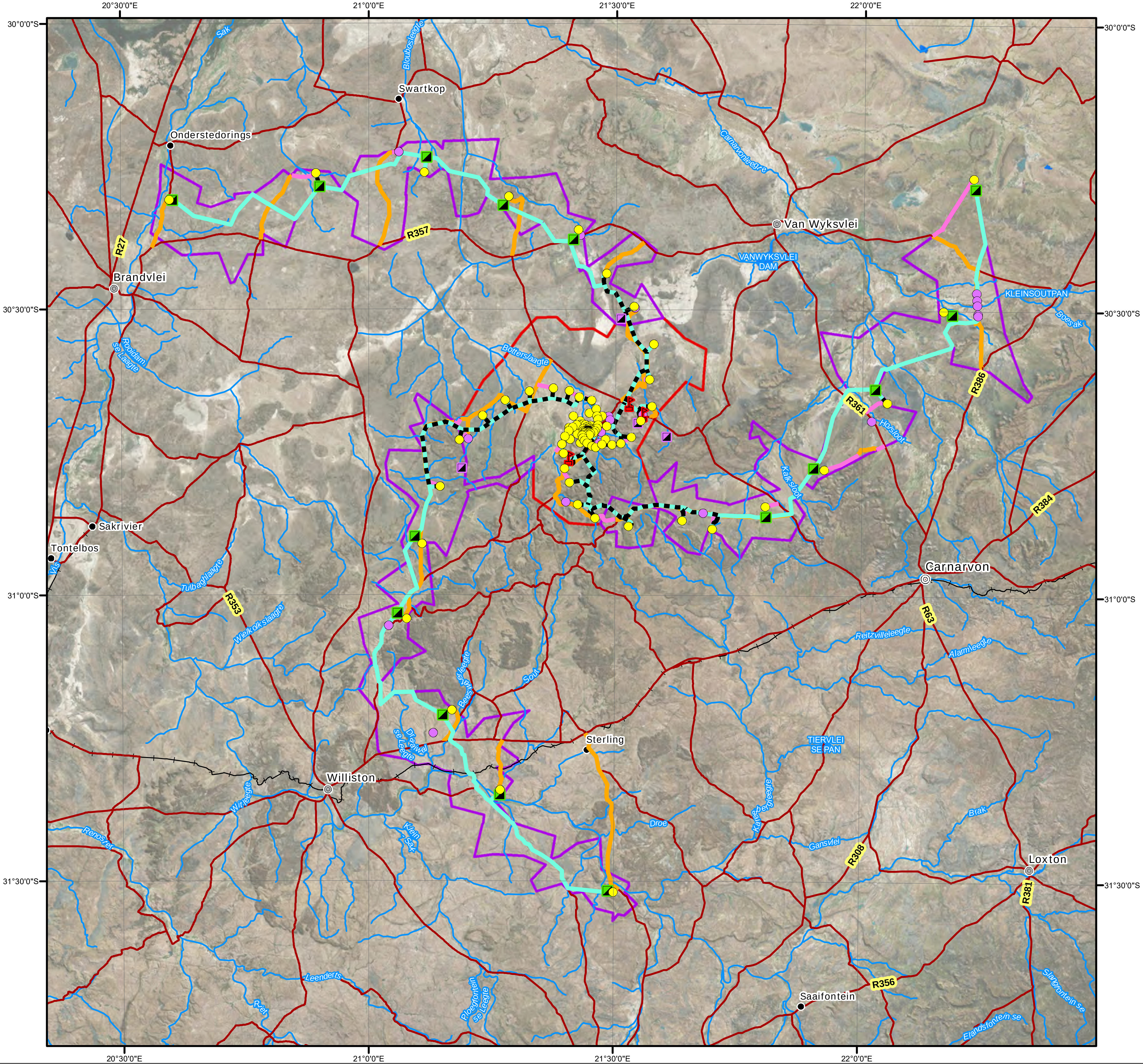

Plan 6

SKA Project

Infrastructure Layout

Legend

Project Area

- SKA Phase 1 Core
- SKA Phase 1 Spiral Arms
- Secondary Town
- Other Town
- Settlement
- Main Road
- Railway Line
- River
- Dam

Infrastructure

- Dish-Antenna
- Construction Camp
- PV Site
- Borrow Pit
- Quarry
- Powerline
- Fibre Optic Cable
- Existing Road to be Upgraded
- New Road

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Central Meridian: 21°E

Ref #: scm.NRF4874.201805.068
Revision Number: 1
Date: 09/05/2018

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Kilometres
1:750 000

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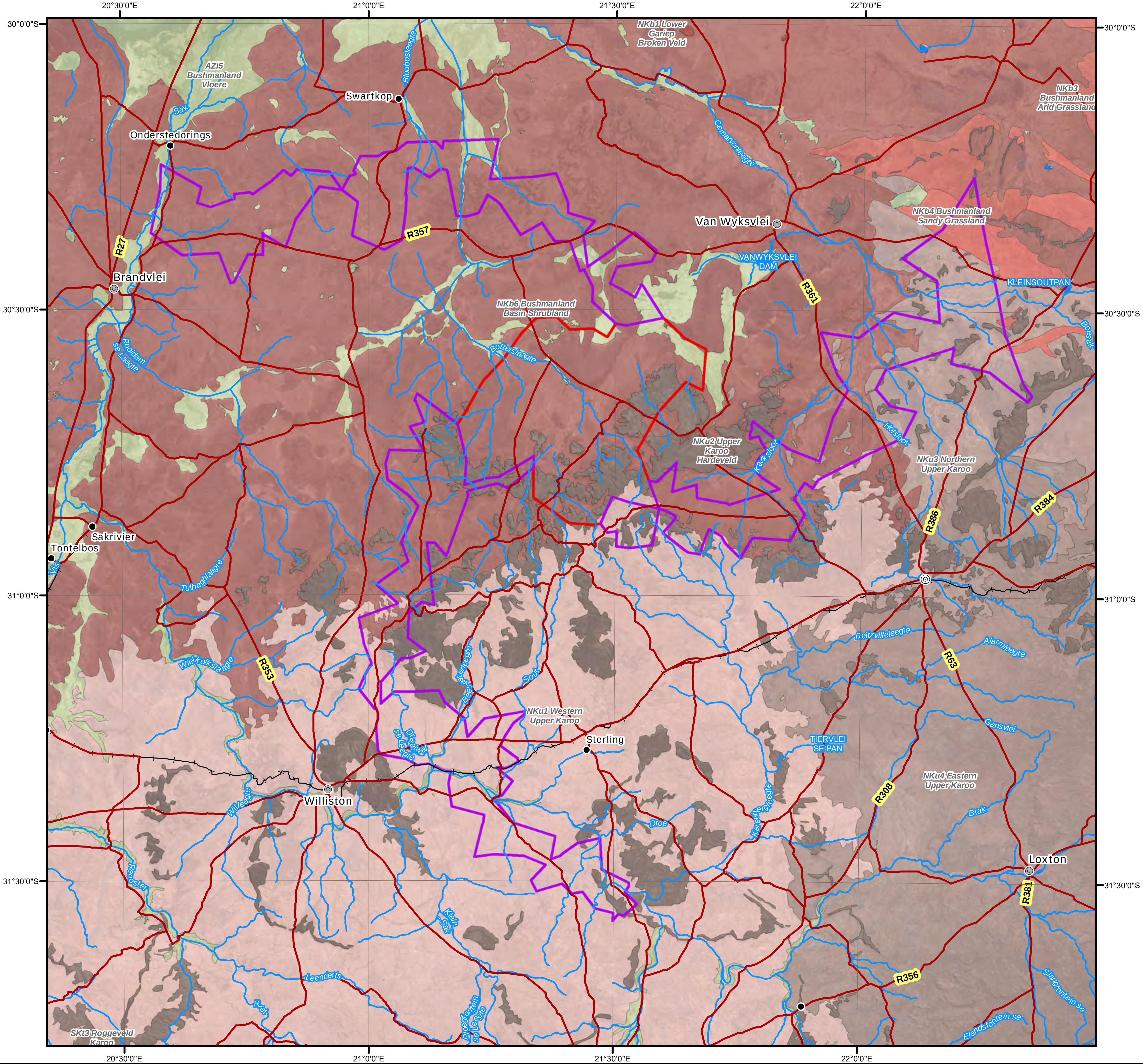
Plan 7

SKA Project

Regional Vegetation



Legend

Project Area

- SKA Phase 1 Core
- SKA Phase 1 Spiral Arms
- Secondary Town
- Other Town
- Settlement
- Main Road
- Railway Line
- River
- Dam

Regional Vegetation (Mucina & Rutherford, 2012)

- SKt 3 Roggeveld Karoo
- NKb 1 Lower Gariep Broken Veld
- NKb 3 Bushmanland Arid Grassland
- NKb 4 Bushmanland Sandy Grassland
- NKb 6 Bushmanland Basin Shrubland
- NKu 1 Western Upper Karoo
- NKu 2 Upper Karoo Hardeveld
- NKu 3 Northern Upper Karoo
- NKu 4 Eastern Upper Karoo
- AZi 5 Bushmanland Vloere

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Projection: Transverse Mercator
Datum: WGS 1984
Central Meridian: 21°E

Ref #: scm.NRF4874.201805.069
Revision Number: 1
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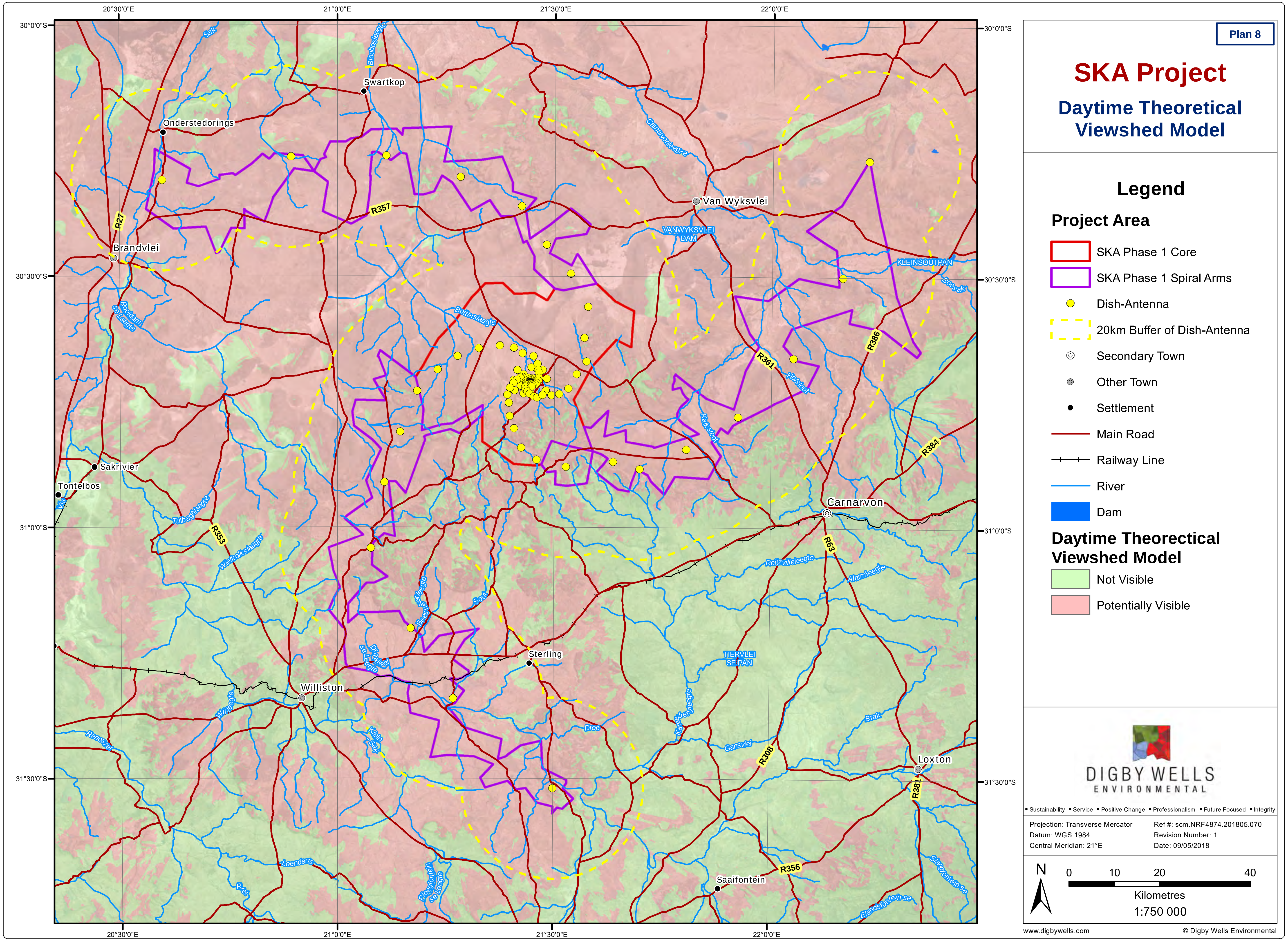

Plan 8
SKA Project
Daytime Theoretical Viewshed Model
Legend
Project Area
SKA Phase 1 Core
SKA Phase 1 Spiral Arms
Dish-Antenna
20km Buffer of Dish-Antenna
Secondary Town
Other Town
Settlement
Main Road
Railway Line
River
Dam
Daytime Theoretical Viewshed Model
Not Visible
Potentially Visible
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Projection: Transverse Mercator
Datum: WGS 1984
Central Meridian: 21°E
Ref #: scm.NRF4874.201805.070
Revision Number: 1
Date: 09/05/2018
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Kilometres
1:750 000
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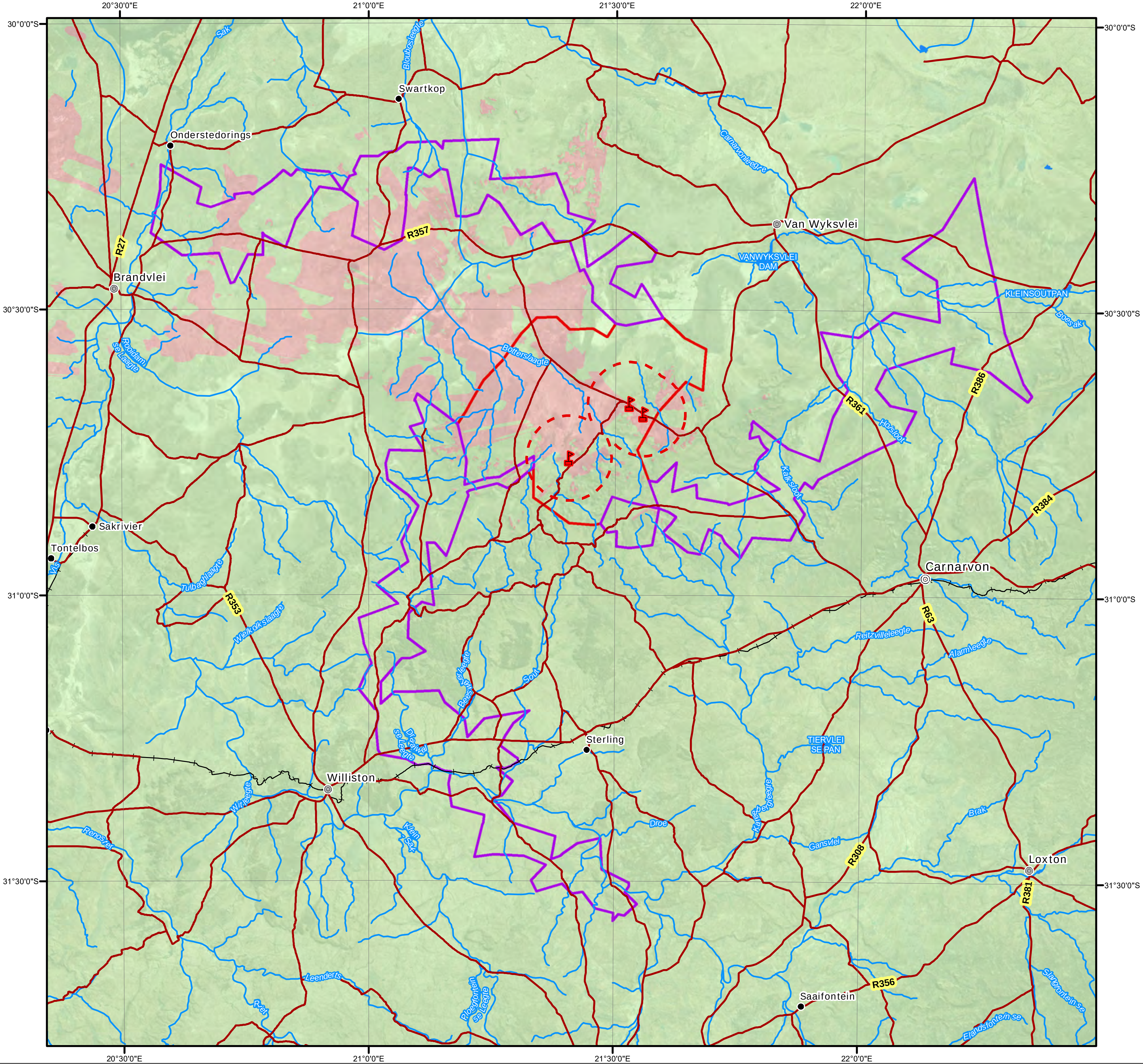
© Digby Wells Environmental
20°30'0"E
21°0'0"E
21°30'0"E
22°0'0"E
30°0'0"S
30°30'0"S
31°0'0"S
31°30'0"S
Swartkop
Onderstedorings
Brandvlei
Van Wyksvlei
VANWYKSVLEI DAM
KLEINSOUTPAN
Sakrivier
Tontelbos
Carnarvon
Sterling
Williston
Loxton
Saaifontein
TIERVLEI SE PAN
R27
R357
R353
R361
R386
R384
R63
R308
R381
R356



Plan 9

SKA Project

Night Time Theoretical Viewshed Model

Legend

Project Area

- SKA Phase 1 Core
- SKA Phase 1 Spiral Arms
- Construction Camp
- 8km Buffer of Construction Camp
- Secondary Town
- Other Town
- Settlement
- Main Road
- Railway Line
- River
- Dam

Night Time Theoretical Viewshed Model

- Not Visible
- Potentially Visible

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Ref #: scm.NRF4874.201805.071
Revision Number: 1
Date: 09/05/2018

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Kilometres
1:750 000

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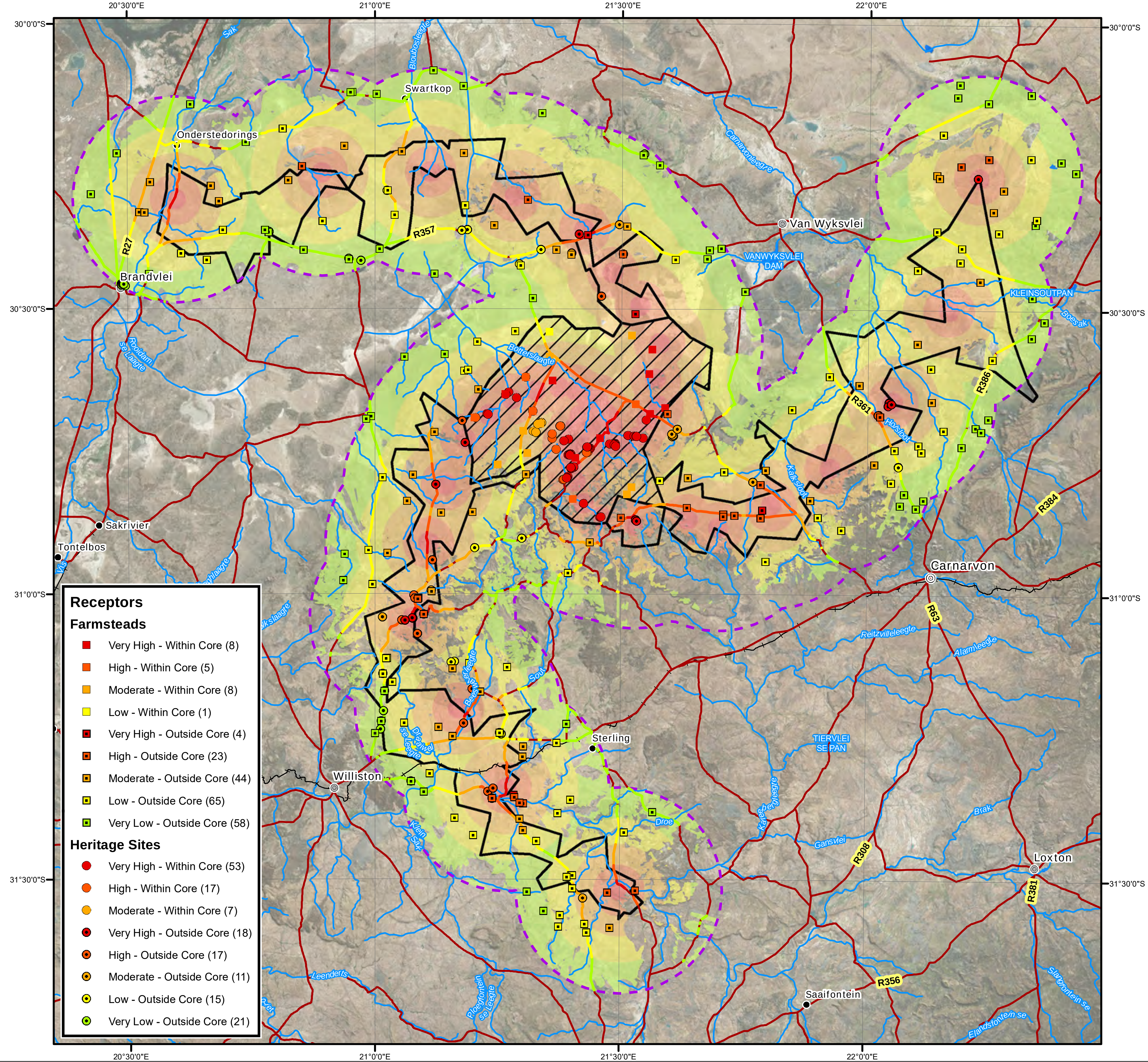
Plan 10

SKA Project

Daytime Practical Viewshed Model



Legend

Project Area

- SKA Phase 1 Core
- SKA Phase 1 Spiral Arms
- 20km Buffer of Dish-Antenna
- Secondary Town
- Other Town
- Settlement
- Main Road
- Railway Line
- River
- Dam

Daytime Practical Viewshed Model

- 0 - 2 km: Potentially Very High Visual Exposure
- 2 - 5 km: Potentially High Visual Exposure
- 5 - 9 km: Potentially Moderate Visual Exposure
- 9 - 14 km: Potentially Low Visual Exposure
- 14 - 20 km: Potentially Very Low Visual Exposure

Receptors

Road Users

- Very High
- High
- Moderate
- Low
- Very Low

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Projection: Transverse Mercator
Datum: WGS 1984
Central Meridian: 21°E

Ref #: scm.NRF4874.201805.072
Revision Number: 1
Date: 15/05/2018

N
0 10 20 40
Kilometres
1:750 000

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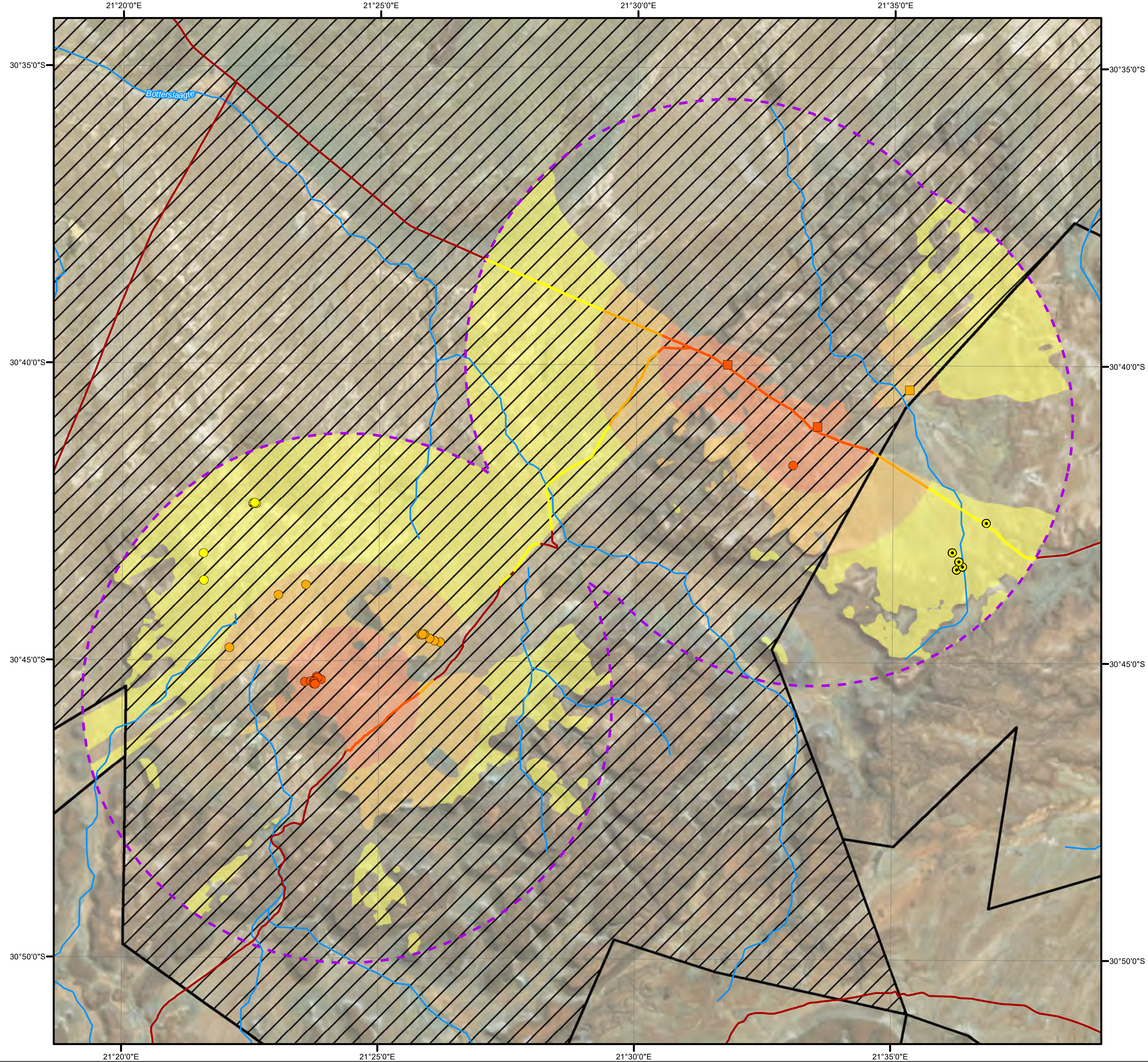
Plan 11

SKA Project

Night Time Practical Viewshed Model



Legend

Project Area
- SKA Phase 1 Core
- SKA Phase 1 Spiral Arms
- 8km Buffer of Construction Camp
- Main Road
- River

Night Time Practical Viewshed Model
- 0 - 2 km: Potentially High Visual Exposure
- 2 - 4 km: Potentially Moderate Visual Exposure
- 4 - 8 km: Potentially Low Visual Exposure

Receptors

Farmsteads
- High - Within Core (2)
- Moderate - Within Core (1)

Heritage Sites
- High - Within Core (11)
- Moderate - Within Core (10)
- Low - Within Core (7)
- Low - Outside Core (5)

Road Users
- High
- Moderate
- Low

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Projection: Transverse Mercator
Datum: WGS 1984
Central Meridian: 21°E

Ref #: scm.NRF4874.201805.073
Revision Number: 1
Date: 15/05/2018

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Kilometres
1:120 000

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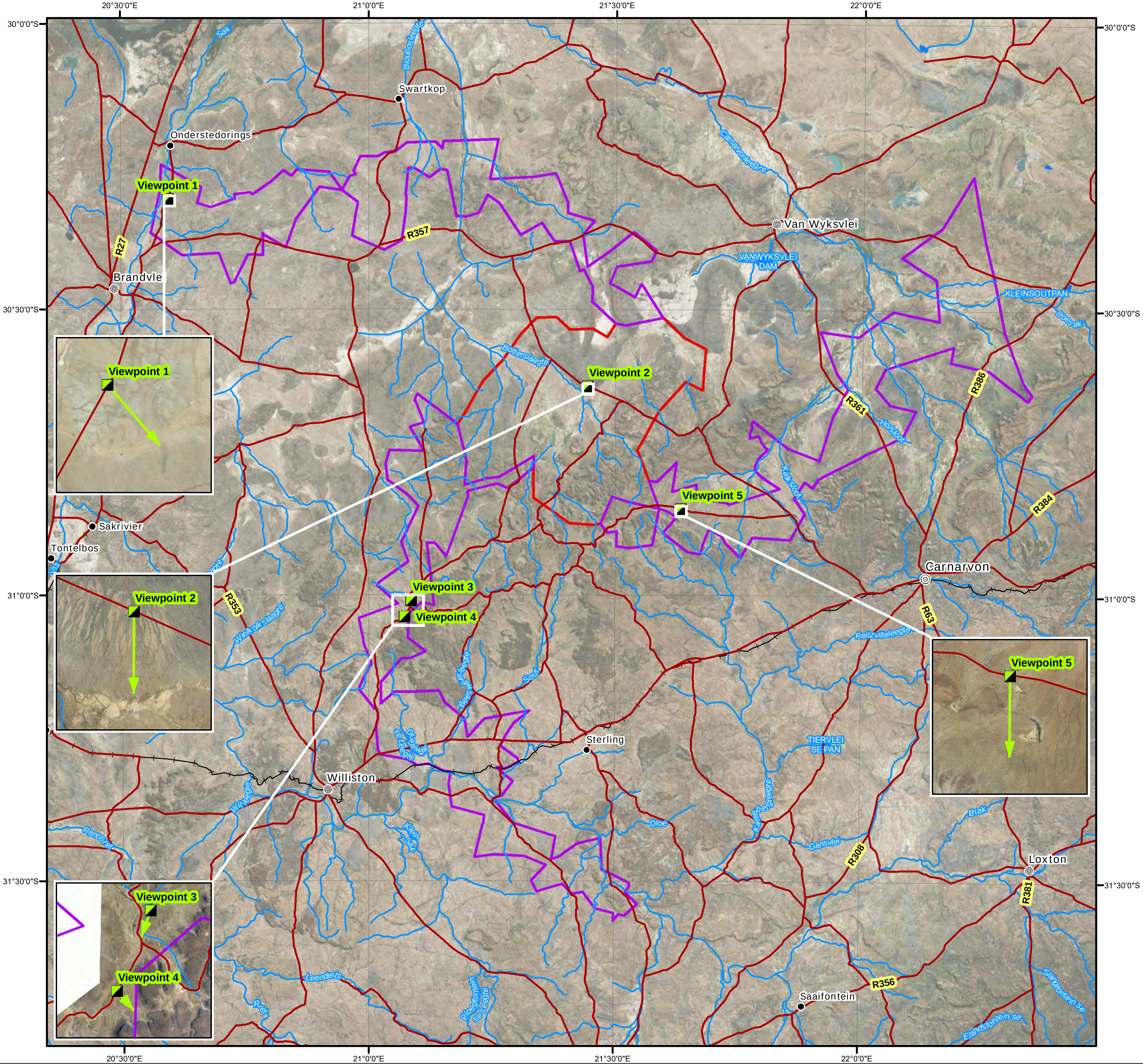

Plan 12

SKA Project

Viewpoints for Photomontages

Legend

Project Area

- SKA Phase 1 Core
- SKA Phase 1 Spiral Arms
- Photomontage Viewpoints
- View Direction
- Secondary Town
- Other Town
- Settlement
- Main Road
- Railway Line
- River
- Dam

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Projection: Transverse Mercator
Datum: WGS 1984
Central Meridian: 21°E

Ref #: scm.NRF4874.201805.074
Revision Number: 1
Date: 09/05/2018

N

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Kilometres
1:750 000

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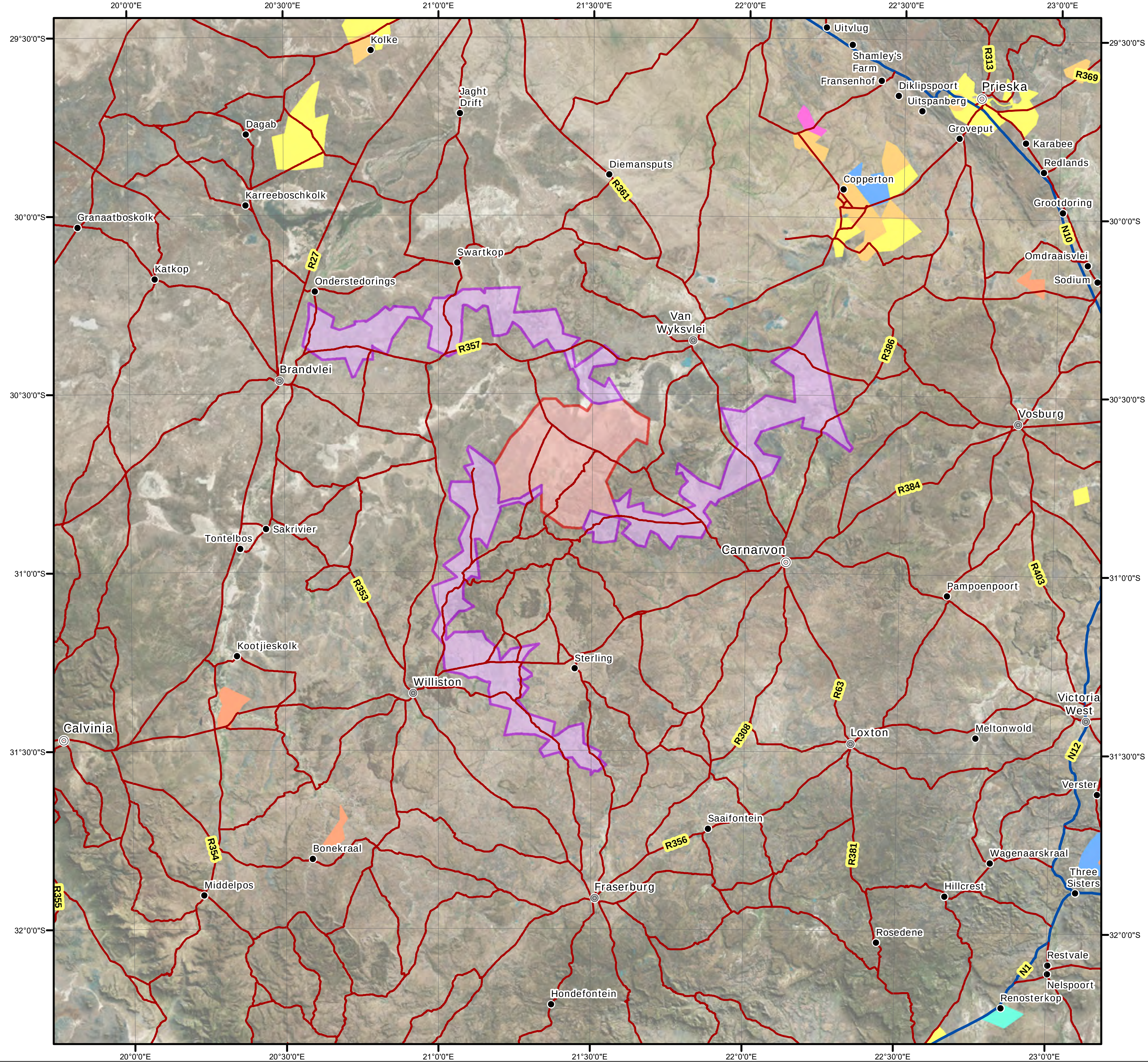

Plan 13

SKA Project

Cumulative Impacts

Legend

Project Area

- SKA Phase 1 Core
- SKA Phase 1 Spiral Arms
- Secondary Town
- Other Town
- Settlement
- Main Road
- National Road

South African Renewable Energy EIA Application Database (DEA, 2018)

- Solar PV, Approved
- Solar PV, In process
- Solar PV, Withdrawn/Lapsed
- Wind, Approved
- Wind, Withdrawn/Lapsed
- Unknown, Withdrawn/Lapsed

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Datum: WGS 1984
Central Meridian: 21°E

Ref #: scm.NRF4874.201805.075
Revision Number: 1
Date: 09/05/2018

N

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Kilometres
1:1 200 000

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Appendix C: Sensitive Receptors

List of Heritage Sites per Category (Daytime)

Category	Impact	Heritage Site	Location
0 – 2 km	Potentially Very High Visual Exposure	BGG-001	Within core
		BGG-002	
		HER-SKA009	
		HER-SKA010	
		HER-SKA011	
		HER-SKA012	
		HER-SKA043	
		HER-SKA044	
		HER-SKA045	
		HER-SKA046	
		HER-SKA049	
		HER-SKA053	
		HER-SKA054	
		HER-SKA055	
		HER-SKA067	
		HER-SKA071	
		HER-SKA072	
		HER-SKA073	
		HER-SKA074	
		HER-SKA075	
		HER-SKA076	
		KAT_Morris_004.1	
		KAT003	
		KAT004	
		KAT005	
		KAT005.1	
		MXD-001	
		MXD-002	
		MXD-003	
		RA-001	

Category	Impact	Heritage Site	Location
		RA-002	
		RA-003	
		RA-004	
		RA-005	
		RA-006	
		RA-007	
		RA-008	
		SA-001	
		SA-002	
		SA-004	
		SA-005	
		SA-006	
		SA-007	
		SA-008	
		SA-009	
		SA-010	
		SA-012	
		SA-013	
		SA-014	
		SA-015	
		SA-016	
		SA-018	
		WILLIS009	
		HER-SKA002	Outside core
		HER-SKA003	
		HER-SKA004	
		HER-SKA005	
		HER-SKA006	
		HER-SKA028	
		HER-SKA029	
		HER-SKA057	

Category	Impact	Heritage Site	Location
		HER-SKA063	
		HER-SKA064	
		HER-SKA066	
		HER-SKA082	
		HER-SKA083	
		HER-SKA084	
		HST-001	
		RA-009	
		RA-010	
		SA-017	
2 – 5 km	Potentially High Visual Exposure	HER-SKA013	Within core
		HER-SKA014	
		HER-SKA047	
		HER-SKA048	
		HER-SKA050	
		HER-SKA051	
		HER-SKA052	
		HER-SKA056	
		HER-SKA068	
		HER-SKA069	
		HER-SKA077	
		HER-SKA078	
		HER-SKA079	
		HER-SKA080	
		KAT001	
		KAT002	
		WILLIS008	
		GTK 001	Outside core
		HER-SKA001	
		HER-SKA026	
		HER-SKA027	

Category	Impact	Heritage Site	Location
		HER-SKA030	
		HER-SKA038	
		HER-SKA039	
		HER-SKA040	
		HER-SKA065	
		HER-SKA081	
		HRA 12-13	
		HRA 17-18	
		HRA 20	
		HRA 21-43	
		HRA 7	
		JTP001	
		PAL-002	
5 – 9 km	Potentially Moderate Visual Exposure	WILLIS001	Within core
		WILLIS003	
		WILLIS003	
		WILLIS004	
		WILLIS005	
		WILLIS006	
		WILLIS007	
		CARN/DR2996/01	Outside core
		CARNA001	
		CARNA002	
		CARNA003	
		CARNA004	
		CWN001	
		DSK001	
		HER-SKA061	
		HRA 14-16	
		MSD001	
		PAL-001	

Category	Impact	Heritage Site	Location
9 – 14 km	Potentially Low Visual Exposure	None	Within core
		8334/Location 869	Outside core
		8334/Location 870	
		8334/Location 872	
		9/2/107/0003	
		Hartogskloof	
		HER-SKA007	
		HER-SKA008	
		HER-SKA022	
		HER-SKA025	
		HER-SKA041	
		HER-SKA042	
		HER-SKA060	
		HER-SKA062	
		HRA 10	
		HRA 8	
14 – 20 km	Potentially Very Low Visual Exposure	None	Within core
		Abiquaputs	Outside core
		Brandvlei	
		BRNDV001	
		BRNDV002	
		BRNDV003	
		BRNDV004	
		BRNDV005	
		BRNDV006	
		BRNDV007	
		BROTP001	
		BROTP002	
		BROTP003	
		BROTP004	
		HER-SKA031	

Category	Impact	Heritage Site	Location
		HER-SKA032	
		HER-SKA033	
		HER-SKA034	
		HER-SKA037	
		HER-SKA058	
		HER-SKA059	
		SBO	

List of Heritage Sites per Category (Night Time)

Category	Impact	Heritage Site	Location
0 – 2 km	Potentially High Visual Exposure	HER-SKA043	Within core
		HER-SKA044	
		HER-SKA045	
		HER-SKA046	
		HER-SKA071	
		HER-SKA072	
		HER-SKA073	
		HER-SKA074	
		HER-SKA075	
		HER-SKA076	
		SA-016	
2 – 4 km	Potentially Moderate Visual Exposure	HER-SKA047	Within core
		HER-SKA049	
		KAT_Morris_004.1	
		KAT003	
		KAT004	
		KAT005	
		KAT005.1	
		RA-001	
		RA-002	

Category	Impact	Heritage Site	Location
		WILLIS009	
4 – 8 km	Potentially Low Visual Exposure	HER-SKA048	Within core
		HER-SKA050	
		HER-SKA077	
		HER-SKA078	
		HER-SKA079	
		HER-SKA080	
		WILLIS008	
		CARNA001	Outside core
		CARNA002	
		CARNA003	
		CARNA004	
		CWN001	