BASIC ASSESSMENT REPORT

Appendix D.5: Geohydrological Assessment

GEOHYDROLOGICAL ASSESSMENT

Basic Assessment for the Proposed Development of a 132 kV Transmission Line to service the proposed 75 MW Solar Photovoltaic Facility (KENHARDT PV 1 - Transmission Line) on the remaining extent of Onder Rugzeer Farm 168 and remaining extent of Portion 3 of Gemsbok Bult Farm 120, north-east of Kenhardt, Northern Cape Province

Report prepared for:

CSIR – Environmental Management Services

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Report prepared by:

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South Africa

June 2016

SPECIALIST EXPERTISE

CURRICULUM VITAE - Julian Edward Conrad

GENERAL

Nationality:	South African
Profession:	Geohydrologist
Specialization:	Groundwater exploration, development, management and monitoring and the application of spatial technologies for geohydrological assessment and management purposes
Position in firm:	Director: GEOSS -Geohydrological and Spatial Solutions International (Pty) Ltd
Language skills:	English (mother tongue), Afrikaans (average).

Key skills

- Project leadership and management for the delivery of contract projects on brief, budget and time.
- Groundwater Resource Directed Measures (RDM) projects, including Reserve determinations; Classification; and Resource Quality Objectives. Groundwater Catchment Management Strategies as well as groundwater Validation and Verification. Legal compliance of groundwater use.
- Groundwater management and monitoring – database design, development and analysis of groundwater level and quality data.
- Groundwater development - borehole drilling and test pumping supervision and analysis.
- Groundwater exploration - (aerial photo interpretation, resistivity, magnetic and EM34 geophysical surveys for borehole siting purposes)
- Specialization in Geographical Information Systems (GIS) for geohydrological application.

Educational and professional status
Qualifications
1995: M.Sc. (Hydrogeology and GIS) University of Rhode Island, United States of America.
1985: B.Sc. (Hon) (Engineering geology) University of Natal, Durban, South Africa.
1984: B.Sc. (Geology) University of Natal, Durban, South Africa.

Courses

2010	Introduction to QGIS (GISSA) / Skills Presentation (Elsabé Daneel Productions cc)
2006	South African Groundwater Decision Tool (SAGDT)
2004	Fractured Rock Aquifer Assessment / 2001 Isotope Techniques in Catchment Management
2000	Groundwater Recharge
1999	Remote Sensing and Geohydrology / Applied 3D Groundwater Modelling (MODFLOW)
1997	Avenue Programming / 1995 ArcView (GIMS)
1991	Advanced training on Arc/Info (DWA&F) / 1990 Pump test analysis (IGS-UOFS).

Memberships

- International Association of Hydrogeologists (IAH)
- Geological Society of South Africa (GSSA) / Groundwater Division of the Geological Society of South Africa
- Water Institute of South Africa (WISA)
- Geo-Information Society of South Africa (GISSA)
- South African Council for Natural Scientific Professions (SACNASP)

EMPLOYMENT RECORD

- 1 March 2001 – present: Founded GEOSS – a company specializing in geohydrology
- 1 May 1990 – 28 Feb. 2001 Hydrogeologist with Environmentek, Groundwater Group, CSIR
- Jan. 1986 – Dec. 1988 Geotechnical geologist with Rőssing Uranium Limited, Namibia

RELEVANT EXPERIENCE

- 25 years' experience in geohydrology, including the development of the GRDM and Water Resources Classification methodologies. This includes work in Validation and Verification projects and the development of the groundwater component of Catchment Management Strategies.
- Numerous groundwater exploration; development; monitoring and management projects have been completed.
- Numerous Environmental Impact Assessment (EIA) projects have been completed, that have triggered groundwater studies, both at the Scoping and EIA phases.
- Project management of numerous groundwater projects and large projects that have included many sub-consultants and specialists, especially RDM studies.

PUBLICATIONS (DETAILS ON REQUEST)

CURRICULUM VITAE - Charles Peek

GENERAL

Nationality:	South African
Profession:	Geohydrologist
Specialization:	Groundwater exploration, development, monitoring and management including GIS and Remote Sensing expertise.
Position in firm:	Geohydrologist at GEOSS - Geohydrological and Spatial Solutions International (Pty) Ltd
Date commenced:	4th February 2013
Language skills:	English (good – speaking, reading and writing) Afrikaans (fair - speaking, reading and writing).

Key skills

- Groundwater exploration, development, monitoring and management.
- Arc GIS software (ESRI products)
- Proficient in working with and analysis of SPOT and Landsat imagery, using ERDAS, PCI Geoinformatica, eCognition, and ENVI

RELEVANT EXPERIENCE

- Numerous groundwater exploration, development, monitoring and management projects.
- Extensive satellite image data processing (including geo-referencing) for the Validation and Verification projects within the Breede-Overberg Catchment Management Agency.

EDUCATIONAL AND PROFESSIONAL STATUS

Qualifications

2012	BSc Hon – Geoinformatics University of the Stellenbosch, South Africa
2011	BSc - Earth Science Degree: University of the Stellenbosch, South Africa

Memberships

- South African Council for National Scientific Professions (SACNASP) Mem. No. 500030/13

EMPLOYMENT RECORD

February 2013 to present:	GEOSS – Geohydrological and Spatial Solutions International (Pty) Ltd, Stellenbosch
April 2011 to November 2011:	Central Analytical Facilities, Geography and Geo-environmental Science, University of Stellenbosch.

SPECIALIST DECLARATION

I, **Julian Conrad**, as the appointed independent specialist, in terms of the 2014 EIA Regulations, hereby declare that I:

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

Signature of the specialist

Name of company: GEOSS - Geohydrological & Spatial Solutions International (Pty) Ltd.

Professional Registration (including number): SACNASP - 400159/05

Date: 21 February 2016

EXECUTIVE SUMMARY

Scatec Solar is proposing to develop a 75 Megawatt (MW) Solar Photovoltaic (PV) power generation facility (referred to as Kenhardt PV 1) along with associated electrical infrastructure (including a 132 kV transmission line for the proposed 75 MW facility). The Eskom Nieuwehoop Substation and associated connection points to the substation are located on the remaining extent of Portion 3 of Gemsbok Bult Farm 120. The 75 MW Solar PV facility will cover an approximate area of 250 hectares (ha) and will be constructed in the vicinity of two other proposed 75 MW Solar PV facilities (with a collective footprint of approximately 750 ha and a combined power generation capacity of 225 MW), also proposed by Scatec Solar. Each 75 MW Solar PV Facility has been assessed separately as part of an Environmental Impact Assessment (EIA) process. Each transmission line and associated electrical infrastructure required to connect the proposed 75 MW Solar PV Facilities to the national grid are also assessed separately as part of a Basic Assessment (BA) Process. This Geohydrological Assessment is being conducted as part of the BA Process for the proposed 132 kV transmission line required for the proposed Kenhardt PV 1 project (referred to as Kenhardt PV 1 – Transmission Line). All the transmission lines are included within a corridor which will range from 300 m wide to 1 000 m wide extending from the Kenhardt PV 3 area all the way to the Eskom Nieuwehoop Substation. The corridor widens towards the Eskom Nieuwehoop Substation.

The study area receives approximately 71 mm of rainfall per year and it receives most of its rainfall during autumn and has a semi-arid to arid climate. It receives the lowest rainfall between July to September (i.e. winter) and the highest in March.

Geologically, the study area for the proposed Kenhardt PV 1 transmission line corridor is overlain by wind-blown sand (Qg) of the Gordonia Formation. Bedrock is expected to be Jacomyns Pan Formation (which consists of weathered metamorphic rock types). According to regional groundwater maps the entire study area does host an “intergranular and fractured” aquifer (i.e. the wind-blown sands and river alluvium as well as fractures within the bedrock constitute an aquifer) with an average borehole yield of 0.1 L/s to 0.5 L/s. Using Electrical Conductivity (EC) as a groundwater quality indicator, the regional groundwater maps indicate that the EC ranges from 300 – 1 000 mS/m within the study area and the area is classified as having a low vulnerability to surface based contaminants.

The potential impacts on the groundwater can be from the construction of storage yards and labour accommodation, as well as accidental oil spillages and fuel leakages during construction. All of these sources need to be managed and potential impacts minimised. However, none of these sources are considered a direct or indirect threat geohydrologically as the upper geological layers contain highly metamorphic rock types with limited fracture networks which host very little groundwater and the groundwater present in the area is saline. Protection measures are required to ensure the groundwater recharge and shallow groundwater is not negatively impacted and that the current groundwater can still be used as a source of water supply for livestock. Thus a precautionary approach needs to be taken and the existing groundwater levels and quality must not be negatively impacted.

If groundwater is to be considered for use at the site then abstraction of groundwater from the aquifer will need to undergo treatment prior to use. A separate study (outside of the BA Process) will be required to investigate the feasibility and financial viability of such a project.

COMPLIANCE WITH THE APPENDIX 6 OF THE 2014 EIA REGULATIONS

Requirements of Appendix 6 – GN R982	Addressed in the Specialist Report
1. (1) A specialist report prepared in terms of these Regulations must contain- a) details of- i. the specialist who prepared the report; and ii. the expertise of that specialist to compile a specialist report including a curriculum vitae;	Preliminary sections of this report
b) a declaration that the specialist is independent in a form as may be specified by the competent authority;	Appendix I of the BA Report, Preliminary sections of this report, and Section 1.1.7 of this Report
c) an indication of the scope of, and the purpose for which, the report was prepared;	Section 1.1.2 and Section 1.1.3
d) the date and season of the site investigation and the relevance of the season to the outcome of the assessment;	Section 1.6.1
e) a description of the methodology adopted in preparing the report or carrying out the specialised process;	Section 1.1.2, Section 1.1.3 and Section 1.6.1
f) the specific identified sensitivity of the site related to the activity and its associated structures and infrastructure;	Section 1.2 and Section 1.3
g) an identification of any areas to be avoided, including buffers;	There are no areas to be avoided.
h) a map superimposing the activity including the associated structures and infrastructure on the environmental sensitivities of the site including areas to be avoided, including buffers;	Appendix A of this report
i) a description of any assumptions made and any uncertainties or gaps in knowledge;	Section 1.1.5
j) a description of the findings and potential implications of such findings on the impact of the proposed activity, including identified alternatives on the environment;	Section 1.6
k) any mitigation measures for inclusion in the EMPr;	Section 1.6, Section 1.7 and Section 1.8
l) any conditions for inclusion in the environmental authorisation;	Section 1.9
m) any monitoring requirements for inclusion in the EMPr or environmental authorisation;	Section 1.6, Section 1.7 and Section 1.8
n) a reasoned opinion- i. as to whether the proposed activity or portions thereof should be authorised; and ii. if the opinion is that the proposed activity or portions thereof should be authorised, any avoidance, management and mitigation measures that should be included in the EMPr, and where applicable, the closure plan;	Section 1.9
o) a description of any consultation process that was undertaken during the course of preparing the specialist report;	Section 1.6.1
p) a summary and copies of any comments received during any consultation process and where applicable all responses thereto; and	Section 1.6.1
q) any other information requested by the competent authority.	Not applicable at this stage

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LIST OF ABBREVIATIONS

Bh	Borehole
EC	Electrical Conductivity
ET	Evapotranspiration
GEOSS	Trading name for Geohydrological & Spatial Solutions International (Pty) Ltd.
GIS	Geographical Information Systems
Ha	Hectare
L/s	Litres per second
m	Meters
mS/m	milliSiemens per meter
MAP	Mean Annual Precipitation
mbgl	metres below ground level
mg/L	milligrams per litre
NGA	National Groundwater Archive
^{o}C	degrees Celsius
ORP	Oxygen Reduction Potential
TDS	Total Dissolved Solids
Temp	Temperature
WL	Water Level

GLOSSARY

Definitions	
Aquifer	A geological formation that has structures or textures that hold water or permit appreciable water movement through them.
Borehole	includes a well, excavation, or any other artificially constructed or improved groundwater cavity which can be used for the purpose of intercepting, collecting or storing water from an aquifer; observing or collecting data and information on water in an aquifer; or recharging an aquifer [from National Water Act (Act No. 36 of 1998)].
DRASTIC	An acronym for a groundwater vulnerability assessment methodology: D = depth to groundwater / R = recharge/ A = aquifer media type / S = soil type / T = topography / I = impact of the unsaturated zone / C = hydraulic conductivity. The methodology uses a rating and weighting approach and was developed by the Environmental Protection Agency (USA)
Fractured Aquifer	Fissured and fractured bedrock resulting from decompression and/or tectonic action. Groundwater occurs predominantly within fissures and fractures.
Groundwater	Water found in the subsurface in the saturated zone below the water table or piezometric surface i.e. the water table marks the upper surface of groundwater systems.
Intergranular Aquifer	Generally unconsolidated but occasionally semi-consolidated aquifers. Groundwater occurs within intergranular interstices in porous medium. Typically occur as alluvial deposits along river terraces.
Intergranular and Fractured Aquifer	Largely medium to coarse grained granite, weathered to varying thicknesses, with groundwater contained in intergranular interstices in the saturated zone, and in jointed and occasionally fractured bedrock.

GEOHYDROLOGICAL ASSESSMENT

This report presents the findings of the Geohydrological Assessment that was prepared by Mr. Julian Conrad and Mr. Charles Peek (of Geohydrological and Spatial Solutions International (PTY) Ltd (GEOSS)) as part of the Basic Assessment (BA) for the proposed Kenhardt PV 1 – Transmission Line project within the Northern Cape Province.

1.1 INTRODUCTION AND METHODOLOGY

1.1.1 Introduction

The proposed project includes the development of a 75 MW Solar Photovoltaic (PV) Facility (referred to as Kenhardt PV 1) along with associated electrical infrastructure on the remaining extent of Onder Rugzeer Farm 168. The farm Onder Rugzeer 168 is situated alongside the farm Boven Rugzeer (Remaining Extent of Farm 169) and the proposed Eskom Nieuwehoop Substation, currently under construction. The proposed Kenhardt PV 1 project will be linked to the Eskom Nieuwehoop Substation by means of a 132 kV transmission line. The proposed transmission line corridor will extend from the proposed Kenhardt PV 1 project to Portion 3 of farm Gemsbok Bult 120. The proposed transmission line will also traverse (aboveground) the Remainder of Boven Rugzeer 169 and Portion 4 of Onder Rugzeer 168. The study area is located approximately 30 km north-east of Kenhardt and 80 km south of Upington within the Kheis Local Municipality, Northern Cape Province (**Map 1, Appendix A**).

Each 75 MW Solar PV Facility has been assessed separately as part of an Environmental Impact Assessment (EIA) process. Each transmission line required to connect the proposed 75 MW Solar PV Facilities to the national grid have also been assessed separately as part of a BA Process. This Geohydrological Assessment is being conducted as part of the BA Process for the proposed 132 kV transmission line (referred to as Kenhardt PV 1 – Transmission Line), which will serve the Kenhardt PV 1 facility (assessed as part of the separate EIA Process). The maps provided in this report show the Kenhardt PV 1 facility for contextual purposes.

The proposed transmission line is expected to be overhead, with concrete and steel tower structures. All transmission lines for the Kenhardt PV 1, PV 2 and PV 3 transmission line projects will be constructed within an electrical infrastructure corridor (as shown in **Map 2, Appendix A**), which has been assessed in this report. All the transmission lines will be included within a corridor which will range from 300 m wide to 1 000 m wide extending from the Kenhardt PV 3 area to the Eskom Nieuwehoop Substation. The corridor widens towards the Eskom Nieuwehoop Substation.

1.1.2 Scope and Objectives

As explained in Section A of the BA Report, the Project Applicant intends to make use of existing boreholes to source groundwater (if available and if suitable) for the construction phase. One of the objectives of this Geohydrological Assessment is to confirm whether the groundwater is in fact sufficient and suitable for use (i.e. in terms of quality and quantity (i.e. borehole yields)). This study is therefore aimed at providing a clear indication of groundwater availability and suitability from existing boreholes.

The overall scope of this Geohydrological Assessment is to determine the impact of the proposed project on the surrounding geohydrology and any geohydrological features, as well as to recommend mitigation measures to reduce the significance of potential negative impacts.

For this specialist study, a desktop study was conducted based on existing maps and reports of the geology and geohydrology. Groundwater data, including groundwater level and groundwater quality data, was obtained from the National Groundwater Archive (NGA) for the area surrounding the proposed area. This was followed by a detailed fieldwork component to inform this Geohydrological Assessment.

1.1.3 Terms of Reference

The Scope of Work is based on the following broad Terms of Reference (TOR), which have been specified for this specialist study on groundwater (i.e. this Geohydrological Assessment):

- Identify significant features or disturbances within the proposed project area and define any environmental risks in terms of geohydrology and the proposed project infrastructure;
- Conduct a desktop study and describe the existing environment in terms of geohydrology (including hydrogeological characterisation of aquifers (types, sensitivity, vulnerability), and groundwater (quality, quantity, use, potential for industrial or domestic use) in the area surrounding the proposed development;
- Conduct a fieldwork assessment to determine the location of any boreholes and to collect groundwater samples (where possible) to ascertain the water quality;
- Develop a sensitivity map indicating the presence of sensitive areas, "no-go" areas, setbacks/buffers, as well as the identification of red flags or risks associated with geohydrological impacts;
- Highlight any gaps in baseline data and provide a description of confidence levels;
- Assess potential direct, indirect and cumulative impacts resulting from the construction, operational and decommissioning phases of the proposed project on the surrounding geohydrology;
- Identify any relevant legal and permit requirements that may be required in terms of groundwater/geohydrological impacts likely to be generated as a result of the proposed project;
- Provide mitigation, monitoring and management measures in order to minimize any negative geohydrological impacts and enhance the positive impacts;
- Assess the consequences and significance of potential groundwater contamination; and
- If necessary recommend groundwater management and monitoring for the proposed site.

1.1.4 Approach and Methodology

The specialist study was completed as follows:

Task 1: A desktop study and relevant literature review pertaining to the site was completed. Borehole data was searched for on the NGA and a project GIS was established.

Task 2: A site visit was completed on 28th and 29th September 2015. The field work included a hydrocensus, which extended to 1 km from the outline of the property boundaries. The objective of this task was three-fold:

1. To locate the NGA boreholes and complete a borehole assessment.
2. To locate boreholes not yet recorded on the NGA and complete assessments.
3. To collect anecdotal information from the land owners in the area as well as from discussions with the Department of Water and Sanitation (DWS)

geohydrologists. It was essential to collect as much information as possible relating to groundwater quality, groundwater levels and borehole yields.

Task 3: All the data obtained from the desktop review and fieldwork was assessed and the impacts relating to the site evaluated.

Task 4: The findings of the investigation, potential risks, any potential mitigation measures, monitoring requirements as well as relevant recommendations have been included in a report. The impacts were assessed based on the methodology indicated in Section D of the BA Report.

1.1.5 Assumptions and Limitations

The geohydrological appraisal is based on previous studies and available literature for the study area. The main assumptions are based on 1: 500 000 national scale Geographic Information System (GIS) datasets and that the previous geohydrological work completed was correct. The main limitation is that no drill records or yield test data exists for boreholes drilled or wells constructed within the study area. In addition it was determined that the proposed project will have no cumulative impacts on the geohydrology of the area (as this assessment recommends that groundwater is not suitable or sufficient for use) and this also takes into account other related projects in the area.

1.1.6 Source of Information

The geological information has been obtained from geological maps of the Council for Geoscience and Slabbert *et al*, 1999.

The groundwater related data and maps have been obtained from the 1: 500 000 Hydrogeological map series of the Republic of South Africa, (Department of Water Affairs and Forestry (DWAF) 2002). The report compiled by GEOSS (2014) as part of the EIA for the adjacent Nieuwehoop Development was also reviewed and relevant information has been used in this report, as applicable.

The field data obtained from the site visit completed on the 28th and 29th September 2015 was useful as it enabled the assessment of the more regional existing data sets and provides valuable insights into the geohydrology of the area.

1.1.7 Declaration of Independence of Specialists

Refer to preliminary section of this specialist report for the Curriculum Vitae of Mr. Julian Conrad and Mr. Charles Peek, which highlights their experience and expertise. The declaration of independence by the specialist is provided in Box 1.1 below and included in **Appendix I** of this BA Report.

BOX 1.1: DECLARATION OF INDEPENDENCE

I, Julian Conrad, declare that I am an independent consultant and have no business, financial, personal or other interest in the proposed Kenhardt PV 1 – Transmission Line Project, application or appeal in respect of which I was appointed, other than fair remuneration for work performed in connection with the activity, application or appeal. There are no circumstances that compromise the objectivity of my performing such work.

JULIAN CONRAD

1.2 DESCRIPTION OF PROJECT ASPECTS RELEVANT TO GEOHYDROLOGICAL IMPACTS

The Project Applicant is considering the use of existing boreholes to source groundwater (if available and suitable) for the construction activities.

Broadly speaking groundwater can theoretically be impacted two ways, namely:

- Over-abstraction (where groundwater abstraction exceeds recharge rates) and can result in the alteration of groundwater levels, flow directions and gradients; and
- Quality deterioration (i.e. anthropogenic activities negatively impacting groundwater quality).

There is currently abstraction taking place within the study area in the form of shallow boreholes installed with wind pumps. One borehole is equipped with a solar pump. The groundwater is being used for livestock watering only, as it is saline. The low rainfall and high evapotranspiration within the study area is a limiting factor for the recharge of the aquifer underling the study area (which is described in Section 1.3 of this report).

Therefore, the groundwater within the study area is not suitable for use (i.e. in terms of quality and quantity). As such, pipelines do not need to be constructed for the transfer of water from the boreholes to the site.

For the proposed project, it is recommended that the **groundwater not be used (i.e. abstracted) within the study area.** This recommendation is based on reasoning that the groundwater is saline and does not meet guidelines for construction use. The alternative source of water is that water tanks can be used to store the water from the municipality. In this regard, there will be generally about 5 to 10 (10,000 liter) tanks required per site. If the Municipality supplies water then during construction there is expected to be 1 trip every 2 days for 7 months.

The proposed construction of the transmission line can potentially impact the groundwater quality of the aquifer, although it is extremely unlikely. Possible contamination sources include: oil spillage and fuel leakages from construction vehicles and during the construction of the storage yards and temporary labour accommodation site camps.

It is important to note that a complete, detailed project description is provided in Section A of the BA Report.

If the Project Applicant still wants to explore the use of groundwater, the groundwater exploration and cost benefit study will have to be addressed as a separate study to this one.

1.3 DESCRIPTION OF THE AFFECTED ENVIRONMENT

1.3.1 Rainfall and Temperature

Kenhardt normally receives approximately 70 mm of rain per year, with most rainfall occurring mainly during autumn. Figure 1a shows the average rainfall values for Kenhardt per month. It typically receives the lowest rainfall (0 mm) in June and the highest (23 mm) in March. The monthly distribution of average daily maximum temperatures (Figure 1b) shows that the average midday temperatures for Upington range from 19°C in June to 33°C in January. The region is the coldest during June and July.

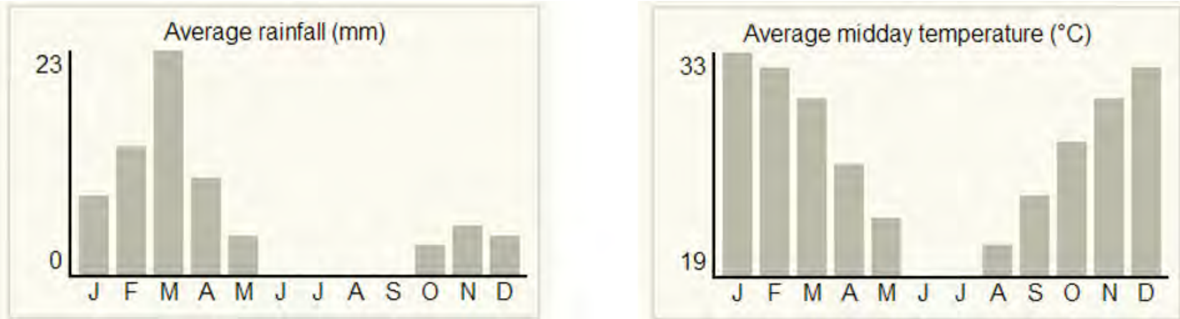

Figure 1a and 1b: Rainfall and Average Midday Temperature for Kenhardt (www.saexplorer.co.za)

The monthly distribution of rainfall and evaporation for the remaining extent of Onder Rugzeer Farm 168 is shown in Figure 2. The area receives approximately 71 mm of rainfall per year and because it receives most of its rainfall during autumn it has a semi-arid to arid climate. It receives the lowest rainfall between July to September (0 mm) and the highest in March. The relevance of this information is that the rainfall occurs whilst temperatures are quite high and therefore associated evaporation rates will be high. This implies that groundwater recharge will be very low. Figure 2 show the long term monthly rainfall and evaporation distribution respectively.

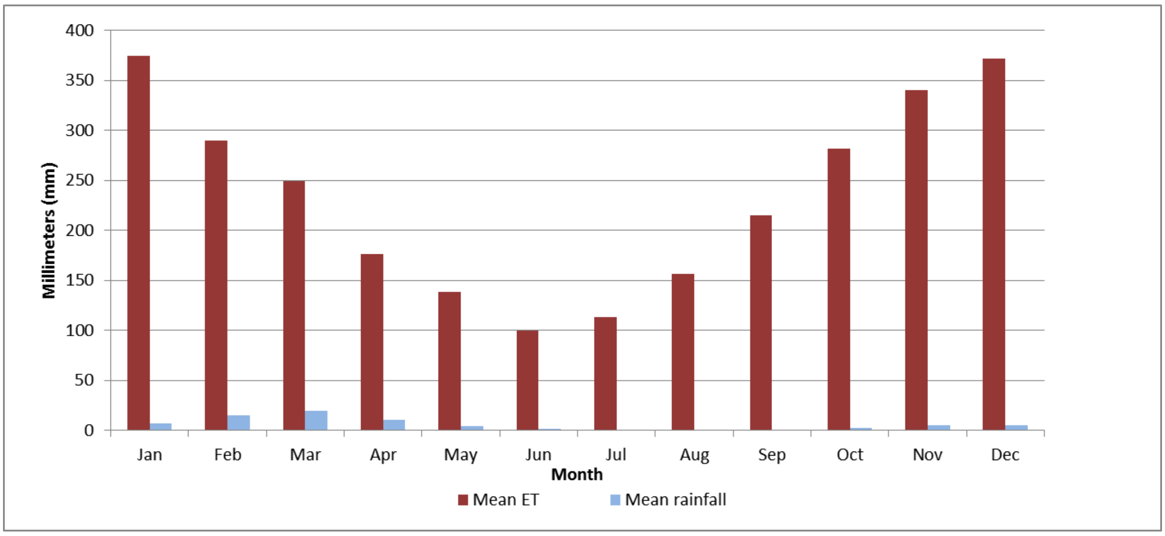

Figure 2: Long term average rainfall and evapotranspiration (ET) (Schulze et al., 2008)

1.3.2 Regional Geology

The Geological Survey of South Africa (now the Council for Geoscience) has mapped the area at 1:250 000 scale (2920 - Kenhardt). The geological setting is shown in **Map 3** (**Appendix A**). The main geology of the area is listed in **Table 1**. The formations occurring within the study area are indicated in bold (and shaded) in **Table 1**.

The oldest rocks in the area comprise of metamorphic gneisses (altered granite) which belong to the Jacomyns Pan Formation (Mja). The Jacomyns Pan Formation is also part of the Jacomyns Pan Group. These rocks mainly occur in the northern and central portion of the study area and are presumed to be bedrock. The study area is overlain by wind-blown sand (Qg) of the Gordonia Formation, the Gordonia Formation forms part of the Kalahari Group. The stream channels are filled with alluvial material.

Table 1: Geological Description of the Geological Formations found within the Study Area

Symbol	Name	Group	Description
Qg	**Gordonia Formation**	**Kalahari**	**Wind-blown dunes**
Mks	Klip koppies granite	Keimoes suite	Grey, fine to medium grained porphyritic granite
Mb	Brussel granite	Keimoes suite	Grey, fine to medium grained porphyritic granite
Me	Elsie se goria granite	Keimoes suite	Grey, medium grained granite, well-foliated.
Mva	Valsvei	Biesje poort	Yellow weathered, medium grained quarzitic gneiss with lenses of calc-silcate politic gneiss
Msa	Sandputs	Biesje poort	Grey to brown, fine grained weather calc-bearing quartzite
Mja	**Jacomyns pan**	**Jacomyns pan**	**Pelitic gneisses with quartzite, leuco-gneiss, amphibolite and calc-silcate rocks.**
Mke	Kenhardt migmatiet	Metamorphic suite	Migmatitic biotite gneiss, amphibolite, leucogneiss and porphyroblastic biotite.

1.3.3 Regional Hydrogeology

As mentioned previously, according to the 1:500 000 scale groundwater map of Prieska (2920) the entire study area does host an intergranular and fractured aquifer (i.e. the wind-blown sands and river alluvium as well as fractures within the bedrock constitutes an aquifer) with an average borehole yield of 0.1 L/s to 0.5 L/s (**Map 4**, **Appendix A**).

With such a low rainfall in the area, and thus associated low groundwater recharge conditions, it is anticipated that the groundwater quality will be poor. The regional 1:500 000 groundwater quality map (**Map 5**, **Appendix A**) indicates that the groundwater is of poor quality. Using Electrical Conductivity (EC) as a groundwater quality indicator, the EC ranges from 300 – 1 000 milliSiemens per meter (mS/m). In terms of domestic supply this is classified as “poor” and cannot be used for consumption or irrigation. As shown in Map 5 in Appendix A, the EC for the preferred site (Kenhardt PV 1) and the Kenhardt PV 1 transmission line corridor ranges from 300 mS/m to 1 000 mS/m. However, overall it is recommended that the groundwater not be used (i.e. abstracted) within the study area as a result of its saline nature and unsuitable quality. This is not considered a fatal flaw, as it simply means that alternate water supply needs to be sourced to fulfil the construction water requirements. As noted in Section A of the BA Report, if the groundwater is not sufficient or suitable for use, water will then be sourced from the municipal supply (i.e. delivery via water tankers).

The national scale groundwater vulnerability map, which was developed according to the DRASTIC methodology (Aller *et al*, 1987) classifies the area as having a “medium” groundwater vulnerability to surface based contaminants index whilst the corridor zone has a “low” vulnerability index (DWAF, 2005), (**Map 6**, **Appendix A**). The DRASTIC method takes into account the following factors:

D	=	depth to groundwater	(5)
R	=	recharge	(4)
A	=	aquifer media	(3)
S	=	soil type	(2)
T	=	topography	(1)
I	=	impact of the vadose zone	(5)
C	=	conductivity (hydraulic)	(3)

The vulnerability index is based on a rating and weighting approach. The number indicated in parenthesis at the end of each factor description is the weighting or relative importance of that factor. However this assessment is based on national scale mapping. Based on the local conditions at the study area there is a very low risk of groundwater contamination in this area as the groundwater level is relatively deep and the unsaturated as well as saturated zone has a very low hydraulic conductivity.

1.4 APPLICABLE LEGISLATION AND PERMIT REQUIREMENTS

If a more detailed study, which includes borehole drilling, pumping tests and water chemistry analysis (which is outside the current scope of this specialist study) concludes that groundwater abstraction should be pursued and successful boreholes are drilled, a Water Use Licence will be required from the DWS (in terms of Section 21 (a) of the National Water Act (Act 36 of 1998)) if the General Authorisation is exceeded. However if no groundwater abstraction is planned no approvals or legislation is required in terms of this specific water use.

1.5 KEY ISSUES

1.5.1 Key Issues Identified

The potential groundwater issues identified as part of this BA Process included:

- Limited groundwater availability and potential usage;
- Poor groundwater quality; and
- Low groundwater vulnerability to surface based contaminants as a result of construction activities.

The BA (and EIA) Reports were released for a 30-day comment period which extended from 3 March 2016 to 5 April 2016. All comments raised and responses thereto are included in Appendix E.3 of the finalised BA Report. To date, no comments and issues have been raised by I&APs specifically in relation to groundwater resources or geohydrological impacts. The issues noted above were included for consideration in the BA Phase.

1.5.2 Identification of Potential Impacts

The following potential impacts (stated in no particular order) of the proposed project activities on groundwater and geohydrological resources are listed below and predicted and assessed in Section 1.6 of this report:

- Potential impact on groundwater quality as a result of accidental oil spillages or fuel leakages; and

- Potential impact on the groundwater as a result of the construction of the storage yards and temporary construction labour accommodation site camps.

1.5.3 Construction Phase

- Potential impact on groundwater quality as a result of accidental oil spillages or fuel leakages; and
- Potential impact on the groundwater as a result of the construction of the storage yards and temporary construction labour accommodation site camps.

1.5.4 Operational Phase

- There are no potential groundwater impacts during this phase.

1.5.5 Decommissioning Phase

- Potential impact on groundwater quality as a result of accidental oil spillages or fuel leakages.

1.5.6 Cumulative impacts

- There are no potential cumulative impacts on groundwater.

1.6 ASSESSMENT OF IMPACTS AND IDENTIFICATION OF MANAGEMENT ACTIONS

1.6.1 Results of the Field Study

The initial desktop study, which included a search of the NGA for boreholes within the corridor and for a distance of 1 km from the corridor outline, resulted in no boreholes being located.

Also please note that GEOSS has previously worked in the area and groundwater data from that work (GEOSS, 2014) is also applicable to this project. Relevant information regarding borehole yields, borehole and groundwater depths and groundwater quality was also obtained from the landowner/farm manager during the previous site visit (GEOSS, 2014). GEOSS (2014) reported that borehole depths are typically between 60 – 120 m deep and fractures occur within the highly metamorphic rocks between two zones of 15 – 30 m and 100 – 120 m below ground level. Please note that the GEOSS (2014) boreholes located are referred to as "HBH" (i.e. hydrocensus borehole).

The desktop study informed the preparation for the field work in that groundwater is unlikely to be of socio-economic or ecological importance to any large degree in the area.

Nonetheless a site visit is always very informative and a hydrocensus was completed on 28th and 29th September 2015. The site visit was completed a dry time of the year and in the spring season. Please note that groundwater conditions do not vary significantly in this region and a once-off visit is sufficient to characterize the groundwater conditions of the area. Consultation with the land owners is always important for site specific data and anecdotal information. Mr Strauss (the occupier of the site) was very helpful in this regard. No further comments have been received regarding the geohydrological study. The locations of ten boreholes identified within this study area are listed in **Table 2**. The borehole positions are shown in **Map 2 (Appendix A**). Please note that the boreholes located during the September 2015 visit are referred to as "BH" (i.e. borehole) and not "HBH" to differentiate the data from the two visits. Nine of the ten boreholes where found to be wind pumps and the groundwater is piped into storage dams from the wind pumps. A Solar Pump was found to be installed at BH7 and the groundwater piped to a storage dam. Groundwater levels where measured, where possible, and water samples were collected and tested in the field to characterise the groundwater quality. The boreholes were found to be dry or to have very low yields (hence the use of wind pumps). For the boreholes that could be sampled the EC measurements exceed 300 mS/m and the groundwater quality is thus classified as "poor" according to the DWAF (1998) drinking water guidelines. Borehole BH7 was found to contain an EC of 1 030.8 mS/m, which classifies the groundwater as "completely unacceptable".

A list of the boreholes locations and field chemistry from the 28th and 29th September 2015 visit is provided in **Table 2**.

Table 2: Hydrocensus boreholes (28 - 29 September 2015)

ID	Latitude	Longitude	WL (mbgl)	pH	Temp (C°)	EC (mS/m)	TDS (mg/L)	Salinity (mg/L)	ORP (mV)	Type	Comment
BH1	-29.20409	21.29679	Closed	7.49	19.3	300.2	2 203	1 780	145.6	WP	-
BH2	-29.20409	21.29679	Closed	7.78	17.8	300.1	2 281	1 850	147.9	WP	-
BH3	-29.223047	21.32389	Closed	7.8	17.9	350.2	2 632	2 160	118.1	WP	-
BH4	-29.233219	21.3153	Closed	7.99	18.5	296.3	2 197	1 780	73.9	WP	-
BH5	-29.270519	21.31655	Closed	-	-	-	-	-	-	WP	Pipe disappears underground – cannot find outlet
BH6	-29.27061	21.31848	Closed	-	-	-	-	-	-	WP	Pipe disappears underground – cannot find outlet
BH7	-29.27132	21.31855	12.102	7.13	25	1 030.8	6 669	5 700	90.2	BH	Solar Panel
BH8	-29.268721	21.32003	Closed	-	-	-	-	-	-	WP	Abandoned
BH9	-29.22345	21.26583	Closed	7.65	27	390.1	2 385	1 950	299	WP	Livestock
BH10	-29.187158	21.27478	Closed	-	-	-	-	-	-	WP	Inaccessible

1.6.2 Construction and Decommissioning Phases: Potential Impact on Groundwater Quality as a result of Accidental Oil Spillages or Fuel Leakages

If there is an accidental oil spill or fuel leakage during the construction, or decommissioning phases, then the low permeability of the vadose zone will provide significant attenuation capacity. The potential impact ratings have been listed in **Table 3** in Section 1.7.

The status of this impact, which is considered a direct impact, is rated as negative with a site specific spatial extent and short-term duration (i.e. the impact and risk will be experienced for less than 1 year). The consequence and probability of the impact are respectively rated as moderate and very unlikely. The reversibility of the impact is rated as high and the irreplaceability is rated as low. The significance of the impact without the implementation of mitigation measures is rated as low and with mitigation measures as very low.

Management Actions

A precautionary approach should be taken and reasonable measures should be undertaken to prevent oil spillages and fuel leakages from occurring. During the construction phase, vehicles must be regularly serviced and maintained to check and ensure there are no leakages. Any engines that stand in one place for a significant length of time must have drip trays. Fuel storage tanks should be above ground on an impermeable surface and within a bunded area. Construction vehicles and equipment should also be refuelled on an impermeable surface. If spillages occur, they should be contained and removed as rapidly as possible, with correct disposal practices of the spilled material. Proof of disposal (waste disposal slips or waybills) should be obtained and retained on file for auditing purposes.

During the operational phase the filling and servicing of vehicles should take place off-site.

With effective implementation of these mitigation actions, the impact of the project on groundwater as a consequence of the presence of accidental oil spillages and fuel leakages is predicted to be of very low significance.

1.6.3 Construction Phase: Potential Impact on the Groundwater as a result of the Construction of the Storage Yards and Temporary Construction Labour Accommodation Site Camps

The status of this impact is rated as negative and direct with a site specific spatial extent and short-term duration (i.e. the impact and risk will be experienced for less than 1 year). The consequence and probability of the impact is respectively rated as moderate and very unlikely. The reversibility of the impact is rated as high and the irreplaceability is rated as low. The significance of the impact without the implementation of mitigation measures is rated as low and if mitigation measures are implemented the rating is very low.

Even if different positions are selected for the storage yards and housing sites across the study area the ratings will remain the same. The reason for this is that the groundwater conditions across the site are essentially homogeneous across the area for the proposed transmission line corridor.

These potential impacts are only applicable during the construction phase and possibly the decommissioning phase; however they are not applicable to the operational phase. However, this potential impact for the decommissioning phase has not been rated as it is believed to be of a very low significance and extremely unlikely in terms of probability.

Management Actions

During the construction phase, all reasonable measures must be taken to prevent soil and groundwater contamination. The main source of contamination will be from construction vehicles leaking oil or fuel, fuel storage and spillages may occur whilst refuelling vehicles and machinery. During the construction phase, vehicles must be regularly serviced and maintained to check and ensure there are no leakages.

With effective implementation of these mitigation actions, the impact of the proposed project on groundwater as a consequence of the temporary storage yards and temporary site camp areas (required for the proposed transmission line) is predicted to be of very low significance.

1.6.4 Cumulative Impacts

There are no potential cumulative impacts with regard to the groundwater of the area from the construction, operation or decommissioning of the transmission lines (as groundwater is not recommended for use).

1.7 IMPACT ASSESSMENT SUMMARY

Impact assessment summary tables for direct and indirect impacts for the Construction and Decommissioning Phases have been included (see **Tables 3 and 4**). A Cumulative Impacts table has not been included as no cumulative impacts are applicable to the geohydrology for the proposed project.

Table 3: Impact assessment summary table for the Construction Phase

Construction Phase													
Direct and Indirect Impacts													
Aspect/ Impact Pathway	Nature of Potential Impact/ Risk	Status	Spatial Extent	Duration	Consequence	Probability	Reversibility of Impact	Irreplaceability	Potential Mitigation Measures	Significance of Impact and Risk		Ranking of Residual Impact/ Risk	Confidence Level
										Without Mitigation/ Management	With Mitigation/ Management (Residual Impact/ Risk)		
Construction of storage yards and labour accommodation sites	Groundwater contamination	Negative	Site	Short- term	Moderate	Very unlikely	High	Low	Vehicles to be correctly serviced	Low	Very low	5	High
Accidental oil spillage / fuel leakage	Groundwater contamination	Negative	Site	Short -term	Moderate	Very unlikely	High	Low	Storage tanks and filling areas to be on an impermeable surface. Storage tanks in a bunded area. Vehicles to be correctly serviced	Low	Very low	5	High

Table 4: Impact assessment summary table for the Decommissioning Phase

Decommissioning Phase													
Direct and Indirect Impacts													
Aspect/ Impact Pathway	Nature of Potential Impact/ Risk	Status	Spatial Extent	Duration	Consequence	Probability	Reversibility of Impact	Irreplaceability	Potential Mitigation Measures	Significance of Impact and Risk		Ranking of Residual Impact/ Risk	Confidence Level
										Without Mitigation/ Management	With Mitigation/ Management (Residual Impact/ Risk)		
Accidental oil spillage / fuel leakage	Groundwater contamination	Negative	Site	Short-term	Moderate	Very unlikely	High	Low	Storage tanks and filling areas to be on an impermeable surface. Storage tanks in a bunded area. Vehicles to be correctly serviced	Low	Very low	5	High

1.8 INPUT TO THE ENVIRONMENTAL MANAGEMENT PROGRAMME

Measures need to be put in place to ensure that the groundwater is not contaminated. The following aspects are considered important during the construction and possibly the decommissioning phase:

- All vehicles and other equipment (generators etc.) must be regularly serviced to ensure they do not spill oil. Vehicles should be refuelled and parked on paved (impervious) areas. If liquid product is being transported it must be ensured this does not spill during transit.
- Emergency measures and plans must be put in place and rehearsed in order to prepare for accidental spillage.
- Diesel fuel storage tanks must be above ground in a bunded area.
- Vehicle and washing areas must also be on paved surfaces and the by-products correctly managed.

1.9 CONCLUSION AND RECOMMENDATIONS

The groundwater in the area is saline and not fit for human consumption or recommended for the use in construction. There is limited abstraction occurring in the study area and groundwater is being used for livestock watering only. The study area is located in a highly metamorphosed geological setting. Metamorphic rocks rarely host sufficient groundwater and are considered an effective barrier to groundwater flow. The poor potential for groundwater development is related to the low occurrence of fractured networks within the formations and low rainfall.

The proposed activities have a very low significance of impact with respect to groundwater (with the implementation of mitigation measures).

From a geohydrological perspective there are no inclusions required for the environmental authorisation other than all reasonable measures must be taken to ensure fuel or oil spillage from site vehicles is limited during the construction phase. The proposed activity can proceed from a geohydrological perspective.

There are no areas that need to be avoided. However if a borehole is in the pathway of the power line, the replacement of the borehole needs to be discussed with the land owner.

If the Project Applicant considers the use of municipal water too expensive to use during the construction phase then a pilot groundwater exploration study and associated cost-benefit study needs to be completed (outside of this BA Process). Boreholes or additional boreholes being considered to be used for industrial use should be properly tested according to SANS guideline for borehole testing to assess their sustainable yield. A desalination plant is recommended for the removal of minerals from the saline groundwater. In addition a Water Use Licence will be required for the use of the groundwater if the use exceeds the General Authorisation. The possible use of groundwater will have to be addressed as an entirely separate project, however all indications at this stage are that groundwater will not be used in the construction, operational or decommissioning phases of the proposed transmission lines.

1.10 REFERENCES

Aller L., Bennet T., Lehr J.H. and Petty R.J. (1987). DRASTIC – A standardised system for evaluating groundwater pollution potential using hydrogeological setting. US EPA Report EPA/600/2-87/035, United States Environmental Protection Agency.

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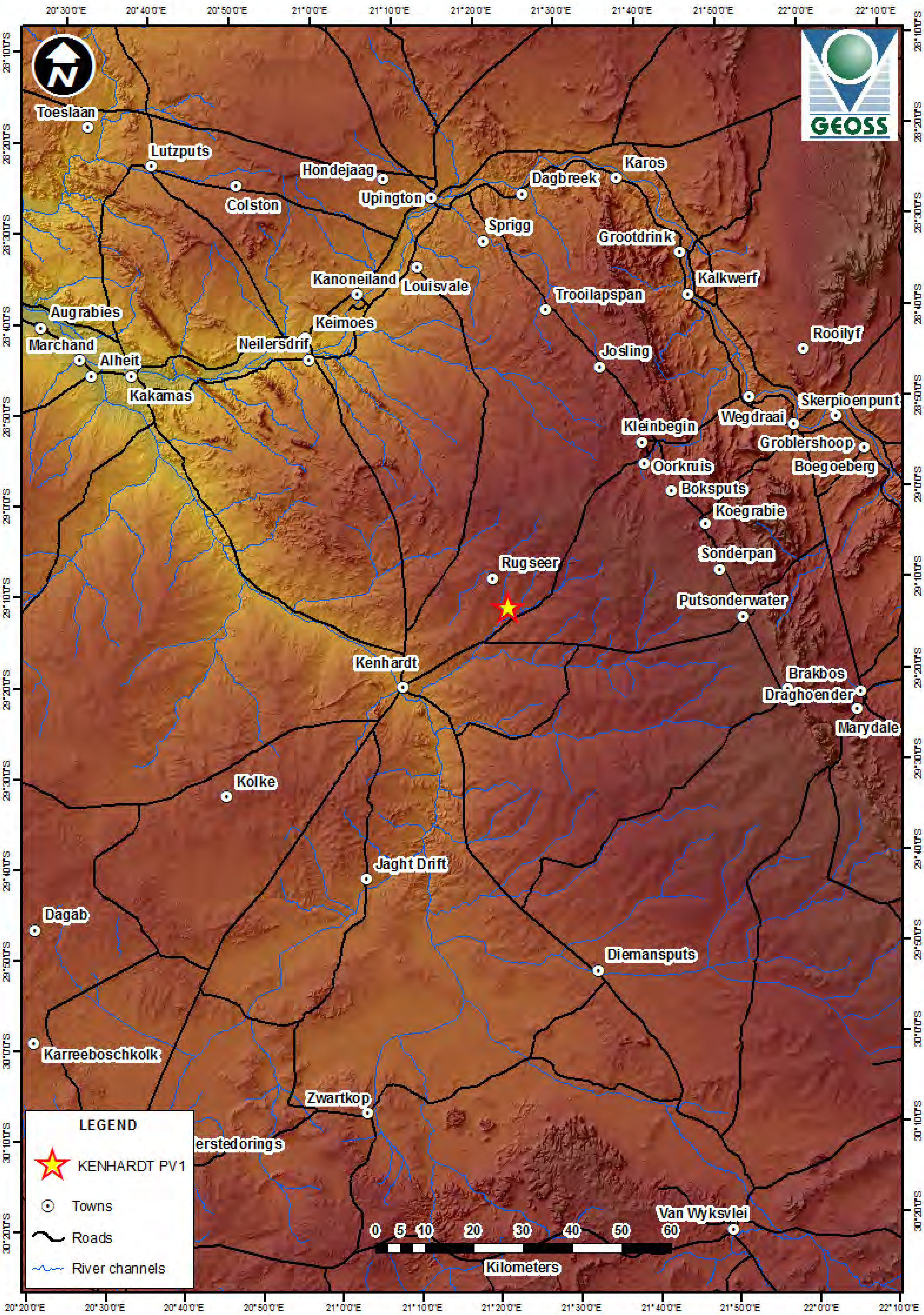
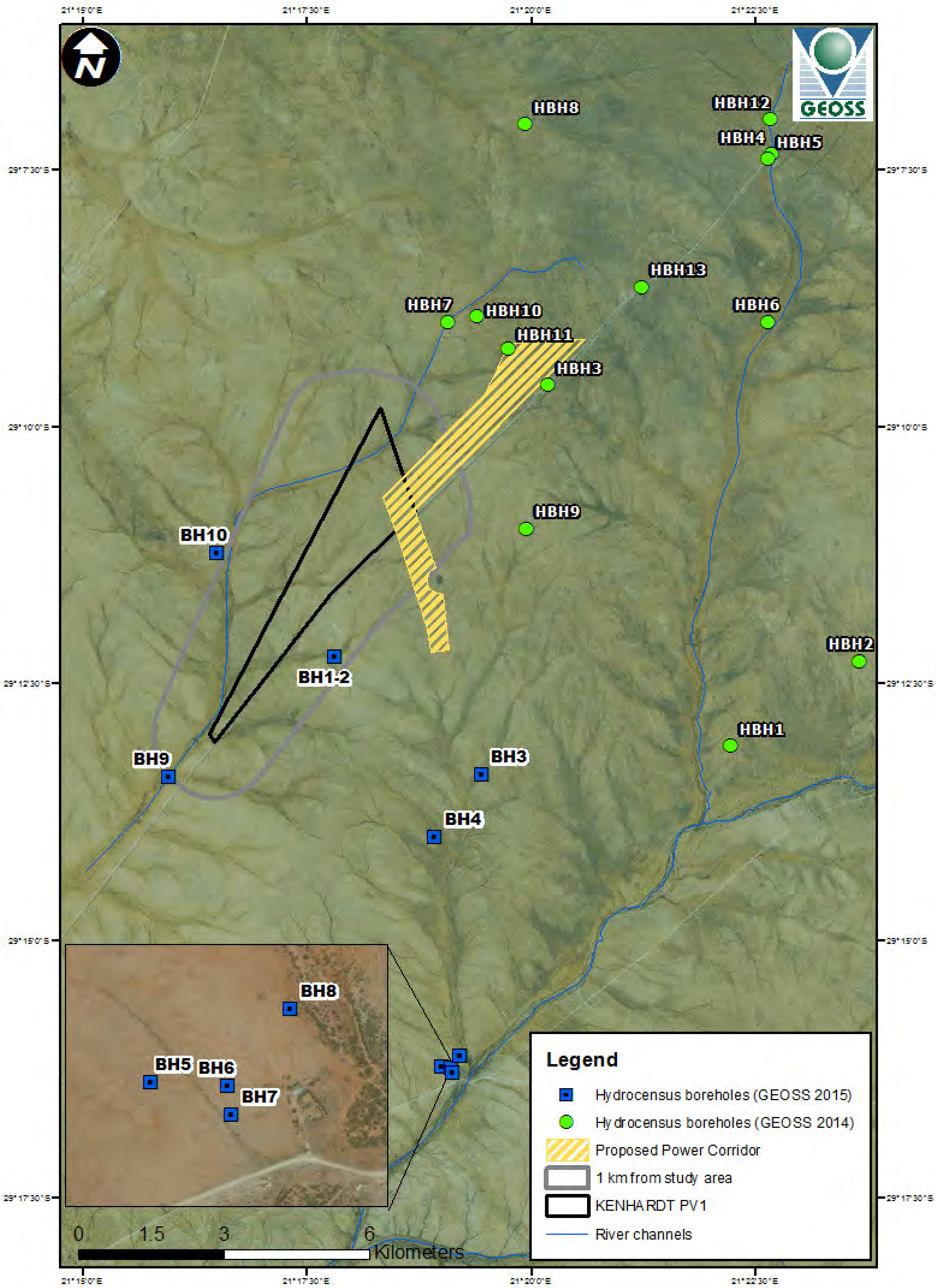
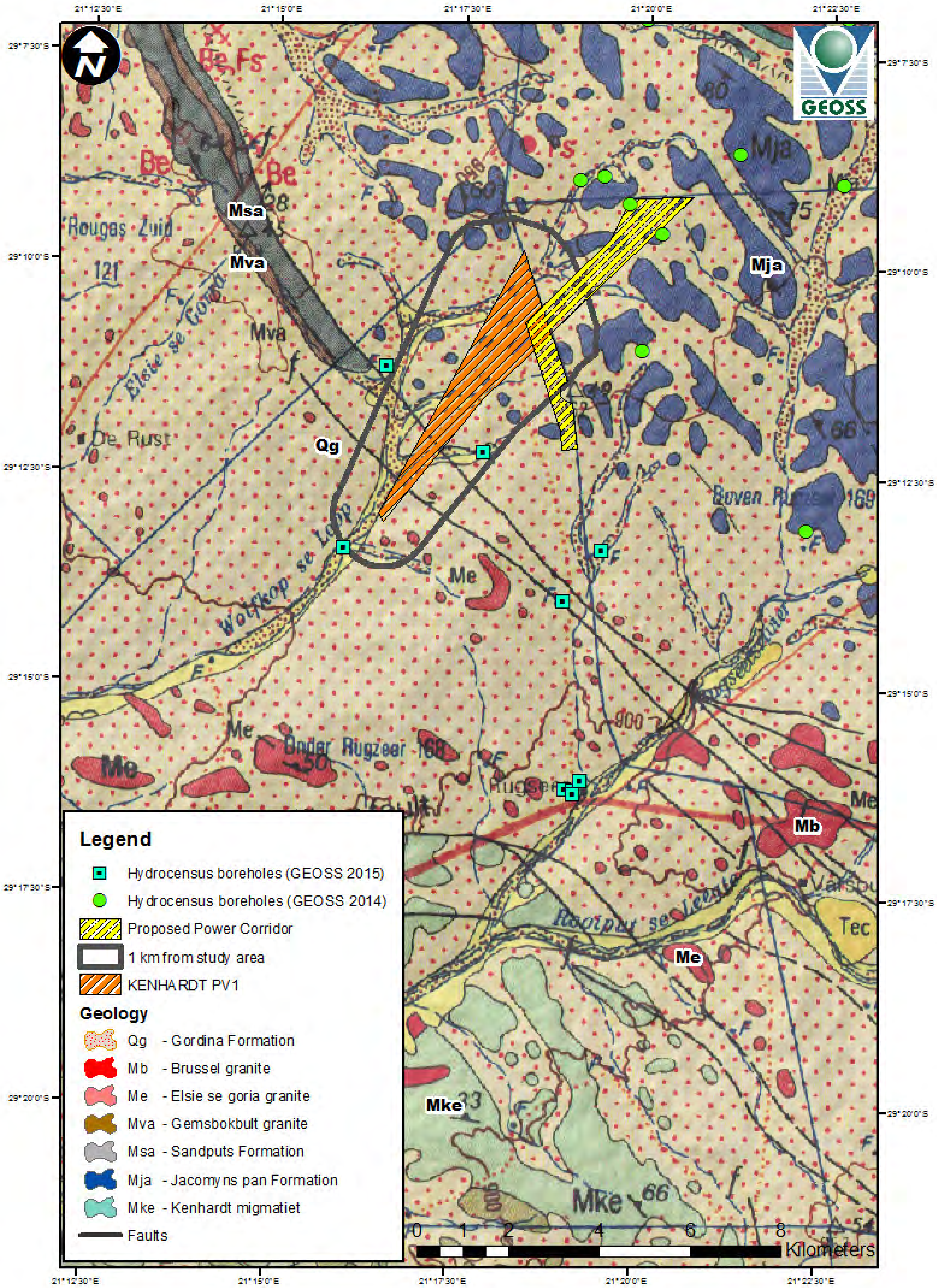
1.11 APPENDICES A: MAPS



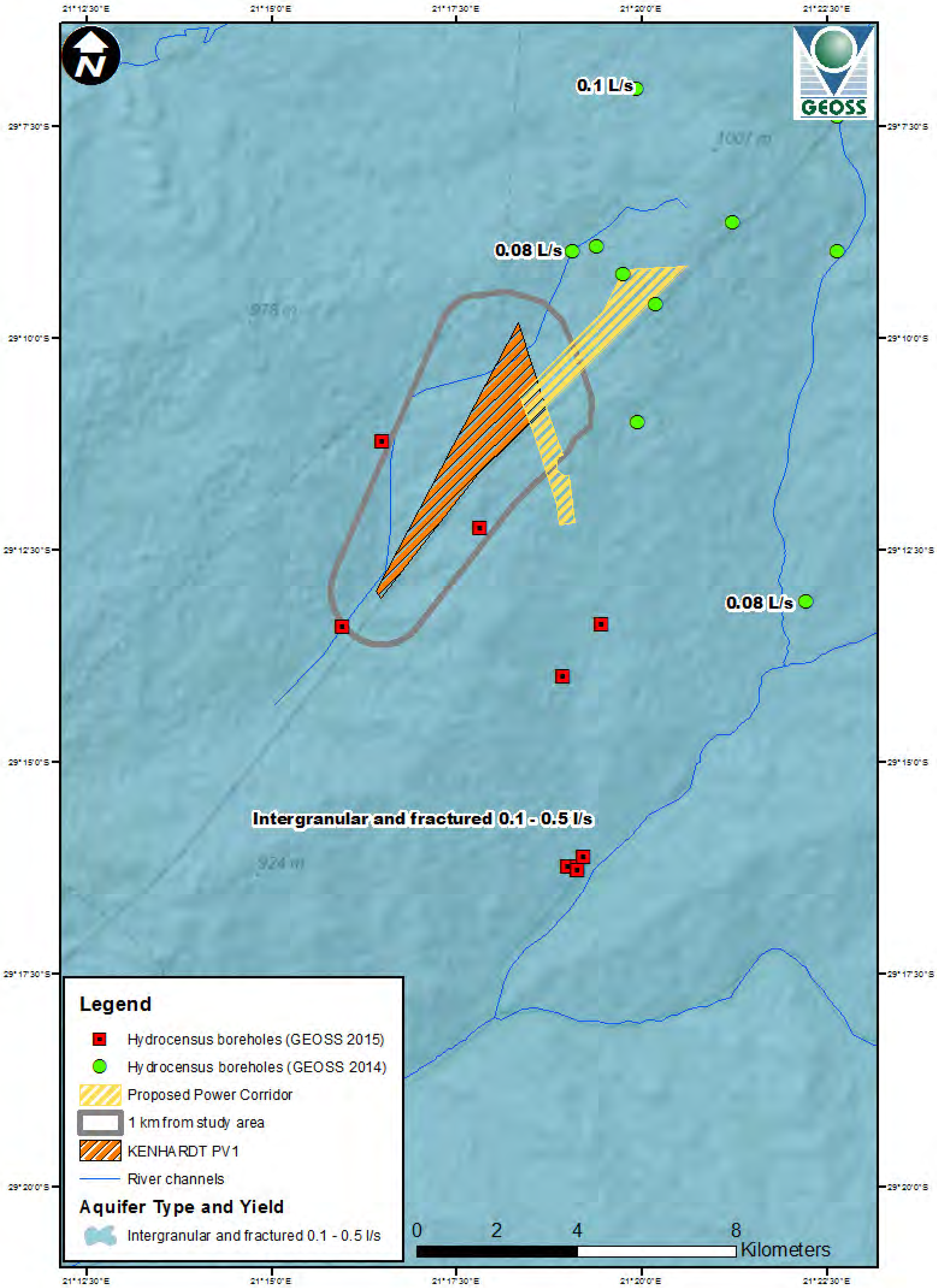
Map 1: Locality Map of the Study Area within a Regional Setting



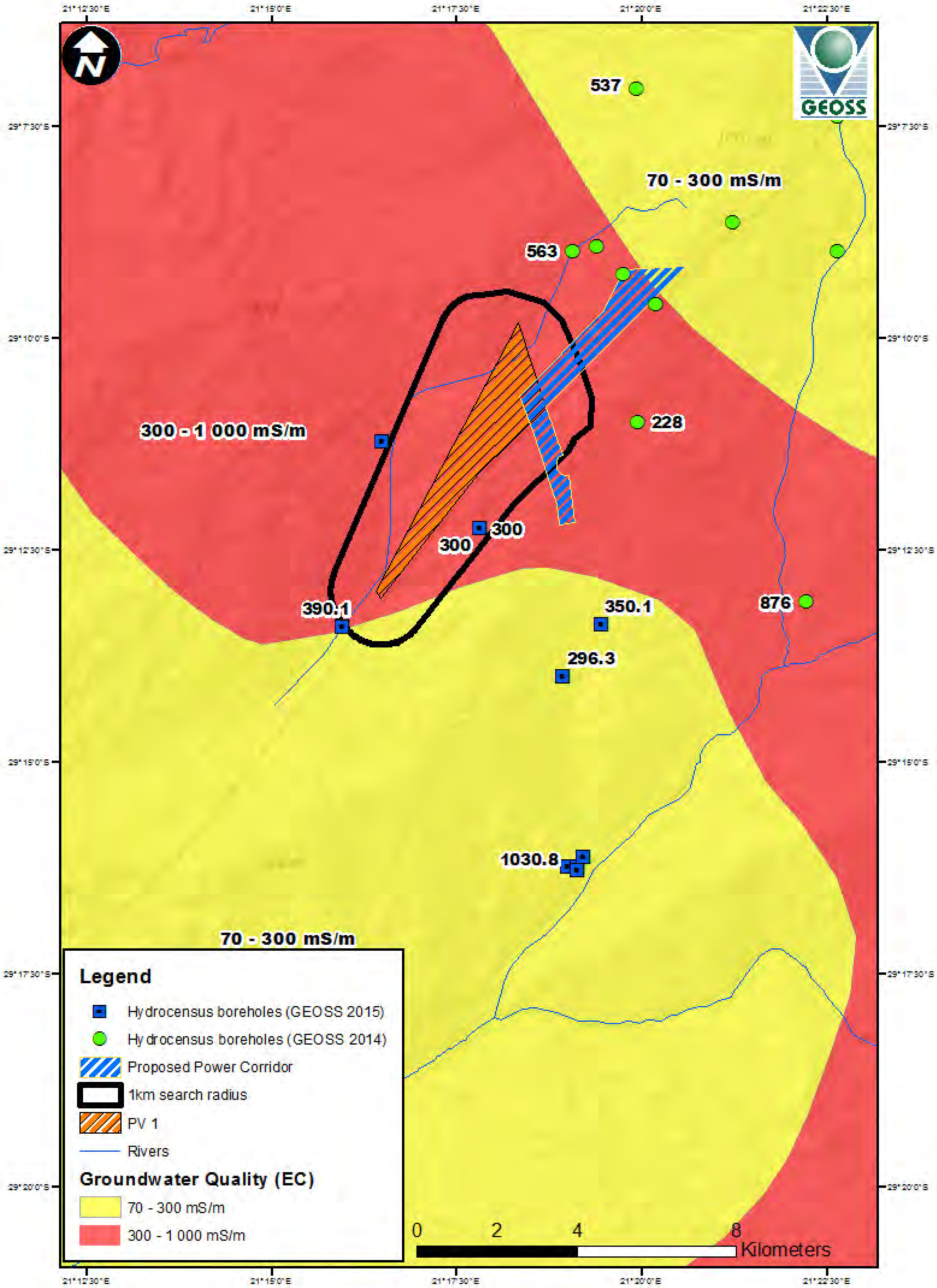
Map 2: Setting of the Study Area Superimposed on an Aerial Photograph (source ESRI), showing Hydrocensus Boreholes.



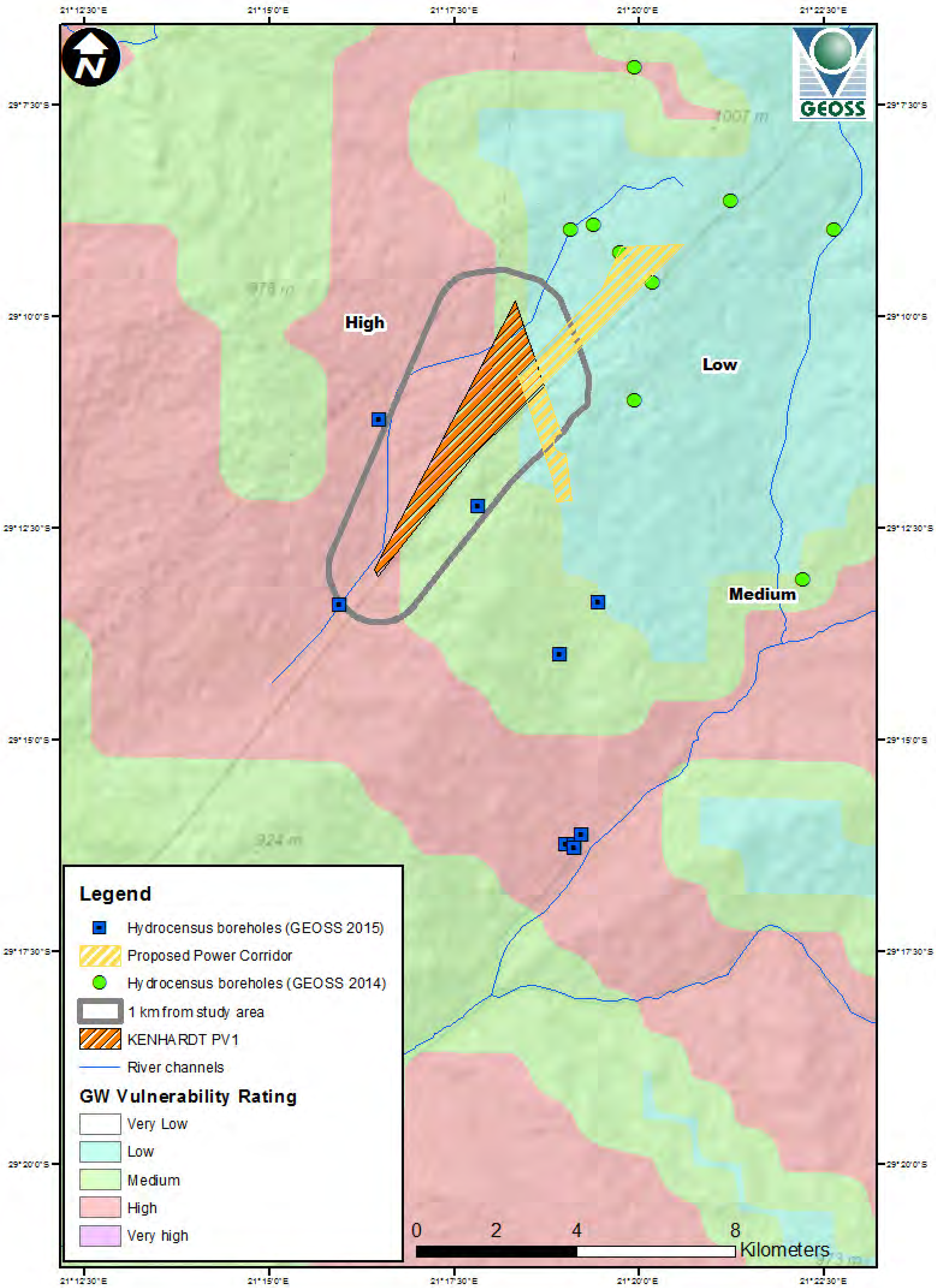
Map 3: The Geological Setting of the Study Area and NGA Boreholes (Council for Geoscience Map: 1:250 000 scale 2920 – Kenhardt)



Map 4: Aquifer Type and Yield (Department of Water Affairs Groundwater Map: 1:500 000 Scale 2920 - Prieska)



Map 5: Regional Groundwater Quality (Department of Water Affairs Groundwater Map: 1:500 000 scale 2920 - Prieska)



Map 6: Regional Groundwater Vulnerability (calculated according to the DRASTIC Methodology) and Boreholes (DWAF, 2005).

1.12 APPENDICES B: SITE PHOTOS

BH1 – wind pump

BH2 – wind pump

BH3 – wind pump

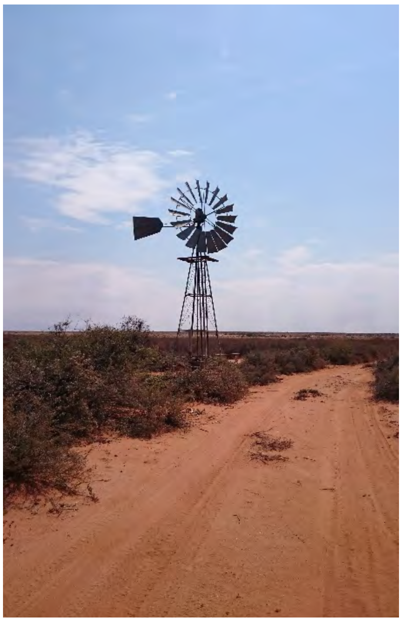
BH4 – wind pump

BH5 – wind pump

BH6 – wind pump

BH7 – solar pump borehole

BH8 – wind pump



BH9 – wind pump

No photo available
(site not accessible)

BH10 – wind pump

BASIC ASSESSMENT REPORT

Appendix D.6:
Soils and Agricultural Potential Assessment

SOILS AND AGRICULTURAL POTENTIAL ASSESSMENT:

Basic Assessment for the proposed development of a 132 kV Transmission Line to connect to the proposed 75 MW Solar PV Facility (Kenhardt PV 1) on the Remaining Extent of Onder Rugzeer Farm 168, and the Remaining Extent of Portion 3 of Gemsbok Bult Farm 120, north-east of Kenhardt, Northern Cape.

Report prepared for:

CSIR – Environmental Management Services

P O Box 17001

Congella, Durban, 4013

South Africa

Report prepared by:

Johann Lanz – Soil Scientist

P.O. Box 6209

Stellenbosch, 7599

South Africa

June 2016

SPECIALIST EXPERTISE

Curriculum Vitae – Johann Lanz

Education

- M.Sc. (Environmental Geochemistry) — University of Cape Town — 1996 - June 1997
- B.Sc. Agriculture (Soil Science, Chemistry) — University of Stellenbosch — 1992 - 1995
- BA (English, Environmental & Geographical Science) — University of Cape Town — 1989 - 1991
- Matric Exemption — Wynberg Boy's High School — 1983

Professional work experience

I am registered as a Professional Natural Scientist (Pri.Sci.Nat.) in the field of soil science, registration number 400268/12.

- **Soil Science Consultant** — **Self employed** — **2002 - present**

I run a soil science consulting business, servicing clients in both the environmental and agricultural industries. Typical consulting projects involve:

- Soil specialist study inputs to EIA's, SEA's and EMPR's. These have focused on impact assessments and rehabilitation on agricultural land, rehabilitation and re-vegetation of mining and industrially disturbed and contaminated soils, as well as more general aspects of soil resource management. Recent clients include: CSIR; SiVEST; Savannah Environmental; Aurecon; Subsolar; Red Cap Investments; MBB Consulting Engineers; Enviroworks; Sharples Environmental Services; Mainstream Renewable Power; Haw & Inglis; BioTherm Energy; WKN Windcurrent; Corobrik; Western Cape Provincial Department of Environmental Affairs and Development Planning; Alcan aluminium smelter (Coega); Namaqualand Restoration Initiative; AECI; Afrimat; Tiptrans.
- Soil resource evaluations and mapping for agricultural land use planning and management. Recent clients include: Zewenwacht Wine Estate, Lourensford Fruit Company; Thelema Mountain Vineyards; Delaire Wine estate; Newton-Johnson Wines; Spier Estate; Colors Fruit; Kaarsten Boerdery; Amanzi Country Estate (Port Elizabeth); Rudera Wines; Flagstone Wines; Cob Creek Estate (Jeffreys Bay); Solms Delta Wines; Dornier Wines.
- I have conducted several recent research projects focused on conservation farming, soil health and carbon sequestration.
- I have project managed the development of soil nutrition software for Farmsecure Agri Science.

- **Soil Science Consultant** — **Agricultural Consultors International (Tinie du Preez)** — **1998 - end 2001**

Responsible for providing all aspects of a soil science technical consulting service directly to clients in the wine, fruit and environmental industries all over South Africa, and in Chile, South America.

- **Contracting Soil Scientist** — **De Beers Namaqualand Mines** — **July 1997 - Jan 1998**

Completed a contract to make recommendations on soil rehabilitation and re-vegetation of mined areas.

Publications

- Lanz, J. 2012. Soil health: sustaining Stellenbosch's roots. In: M Swilling, B Sebitosi & R Loots (eds). *Sustainable Stellenbosch: opening dialogues*. Stellenbosch: SunMedia.
- Lanz, J. 2010. Soil health indicators: physical and chemical. South African Fruit Journal, April / May 2010 issue.
- Lanz, J. 2009. Soil health constraints. South African Fruit Journal, August / September 2009 issue.
- Lanz, J. 2009. Soil carbon research. *AgriProbe*, Department of Agriculture.
- Lanz, J. 2005. Special Report: Soils and wine quality. *Wineland Magazine.*

I am a reviewing scientist for the *South African Journal of Plant and Soil*.

SPECIALIST DECLARATION

I, Johann Lanz, as the appointed independent specialist, in terms of the 2014 EIA Regulations, hereby declare that I:

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

Signature of the specialist:

Name of specialist: Johann Lanz

Professional Registration (including number): SACNASP Registration Number: 400268/12

Date: 05 February 2016

EXECUTIVE SUMMARY

The proposed development is located on land zoned and used for agriculture. South Africa has very limited arable land and it is therefore critical to ensure that development does not lead to an inappropriate loss of land that may be valuable for cultivation. This assessment has found that the proposed site is on land which is of very low agricultural potential and is not suitable for cultivation.

The key findings of this study are:

- There are three factors that influence the significance of all potential agricultural impacts. The first is that the actual footprint of disturbance of the proposed power line is very small in relation to available, surrounding land. The second is that the impact of a power line on the kind of agricultural activity (grazing) along the proposed development is very minimal, as this can continue in the presence of a power line with negligible disturbance. The third is that the site has very low agricultural potential, limited by severe climatic moisture availability constraints and shallow, rocky soils.
- Because of these factors, there will be a very low significance overall impact of the proposed development on agricultural production and resources and also a very low significance cumulative impact.
- No agriculturally sensitive areas occur within the assessed corridor.
- Soils are shallow, red sandy soils on underlying rock and hard-pan carbonate, predominantly of the Coega and Mispah soil forms.
- The land capability is classified as Class 7 - non-arable, low potential grazing land.
- The site has a low grazing capacity of 31 - 40 hectares per large stock unit.
- Five potential negative impacts of the proposed development on agricultural resources and productivity were identified as:
    - Loss of agricultural land use caused by direct occupation of land by the proposed transmission line footprint.
    - Loss of topsoil in disturbed areas, causing a decline in soil fertility.
    - Soil erosion caused by alteration of the surface characteristics.
    - Degradation of veld vegetation beyond the footprint of the proposed transmission line.
    - Cumulative regional loss of agricultural land use as a result of several other developments in the area.
- All impacts were assessed as having very low significance (without the implementation of mitigation measures).
- The following mitigation measures were recommended:
    - Implement an effective system of stormwater run-off control;
    - Control dust during construction through appropriate dust suppression methods;
    - Strip and stockpile topsoil before disturbance and re-spread it on the surface as soon as possible after disturbance;
    - Manage any sub-surface spoils from excavations in such a manner that it will not impact on agricultural land; and
    - Minimise road footprint and control vehicle access on designated roads only.
- Because of the low agricultural potential of the site, the development should, from an agricultural impact perspective, be authorised. Authorisation is promoted by the fact that the site falls within a proposed renewable energy development zone, where such land use has been assessed as very suitable in terms of a number of factors,

including agricultural impact. It is preferable to incur a loss of agricultural land in such a region, without cultivation potential, than to lose agricultural land that has a higher potential, to renewable energy development elsewhere in the country.

- No agriculturally sensitive areas occur within the site and no part of it is therefore required to be set aside from the development. Because the site is uniformly low potential, from an agricultural point of view, there is no preferred location or layout within the assessed site. There are no conditions resulting from this assessment for inclusion in the environmental authorisation.

COMPLIANCE WITH THE APPENDIX 6 OF THE 2014 EIA REGULATIONS

Requirements of Appendix 6 – GN R982	**Addressed in the Specialist Report**
1. (1) A specialist report prepared in terms of these Regulations must contain- a) details of- i. the specialist who prepared the report; and ii. the expertise of that specialist to compile a specialist report including a curriculum vitae;	Preliminary Section of this report
b) a declaration that the specialist is independent in a form as may be specified by the competent authority;	Appendix I of the BA Report, Preliminary Section of this report and Section 1.6 of this report
c) an indication of the scope of, and the purpose for which, the report was prepared;	Sections 1.1 & 1.2
d) the date and season of the site investigation and the relevance of the season to the outcome of the assessment;	Section 1.3
e) a description of the methodology adopted in preparing the report or carrying out the specialised process;	Section 1.3
f) the specific identified sensitivity of the site related to the activity and its associated structures and infrastructure;	Section 3.8
g) an identification of any areas to be avoided, including buffers;	Section 3.8
h) a map superimposing the activity including the associated structures and infrastructure on the environmental sensitivities of the site including areas to be avoided, including buffers;	Figure 1
i) a description of any assumptions made and any uncertainties or gaps in knowledge;	Section 1.4
j) a description of the findings and potential implications of such findings on the impact of the proposed activity, including identified alternatives on the environment;	Section 6
k) any mitigation measures for inclusion in the EMPr;	Section 6
l) any conditions for inclusion in the environmental authorisation;	Not applicable
m) any monitoring requirements for inclusion in the EMPr or environmental authorisation;	Section 8
n) a reasoned opinion- i. as to whether the proposed activity or portions thereof should be authorised; and ii. if the opinion is that the proposed activity or portions thereof should be authorised, any avoidance, management and mitigation measures that should be included in the EMPr, and where applicable, the closure plan;	Section 9
o) a description of any consultation process that was undertaken during the course of preparing the specialist report;	Section 1.3
p) a summary and copies of any comments received during any consultation process and where applicable all responses thereto; and	Not applicable
q) any other information requested by the competent authority.	Not applicable

TABLE OF CONTENTS

TABLES

FIGURES

LIST OF ABBREVIATIONS

AGIS	Agricultural Geo-Referenced Information System
CSIR	Council for Scientific and Industrial Research
DAFF	Department of Agriculture, Forestry and Fisheries
EIA	Environmental Impact Assessment
PET	Potential evapotranspiration

SOILS AND AGRICULTURAL POTENTIAL ASSESSMENT

1 INTRODUCTION AND METHODOLOGY

This report presents the Soil and Agricultural Potential Assessment undertaken by Mr. Johann Lanz (an independent consultant), under appointment to the CSIR, as part of the Basic Assessment (BA) for the proposed transmission line for the proposed Kenhardt PV 1 Solar Photovoltaic (PV) Facility, near Kenhardt in the Northern Cape Province, which is referred to as the Kenhardt PV 1 – Transmission Line project).

1.1 OBJECTIVES OF THE SPECIALIST STUDY

The objectives of the study are to identify and assess all potential impacts of the proposed developments on agricultural resources including soils and agricultural production potential, and to provide recommended mitigation measures, monitoring requirements, and rehabilitation guidelines for all identified impacts.

The scope of work is captured and listed under the terms of reference below.

1.2 SCOPE OF WORK AND TERMS OF REFERENCE

The following terms of reference apply to this study:

The report will fulfil the terms of reference for an agricultural study as set out in the National Department of Agriculture's document, *Regulations for the evaluation and review of applications pertaining to renewable energy on agricultural land*, dated September 2011, with an appropriate level of detail for the agricultural suitability and soil variation on site (which may therefore be less than the standardised level of detail stipulated in the above regulations).

The above requirements together with requirements for a specialist report may be summarised as follows:

- Research and describe the existing environment in terms of its soils, geology and agricultural potential. Identify any significant soils and agricultural features or disturbances, as well as any sensitive features and receptors within the proposed project area.
- Undertake a desktop assessment to compile a baseline description, including an assessment of the existing soil and agricultural potential data for the site.
- Provide a sensitivity map indicating the presence of sensitive features and receptors (i.e. sensitive soil and agricultural features), “no-go” areas, setbacks/buffers, as well as any red flags or risks associated with soil and agricultural impacts.
- Define the environmental risks to the soils and agricultural land and potential, as well as the consequences thereto.
- Highlight any gaps in baseline data.
- Conduct a site visit and a field investigation of soils and agricultural conditions across the site and conduct a soil survey to distinguish areas that do not have and have potential for cultivation.

- Describe and map soil types (soil forms) and characteristics (soil depth, soil colour, limiting factors, and clay content of the top and sub soil layers).
- Describe the topography of the site and map soil survey points.
- Summarise available water sources for agriculture.
- Describe historical and current land use, agricultural infrastructure, as well as possible alternative land use options.
- Describe the erosion, vegetation and degradation status of the land.
- Determine and map, if there is variation, the agricultural potential across the site.
- Determine and map the agricultural sensitivity to development across the site.
- Identify relevant protocols, legal and permit requirements relating to soil and agricultural potential impacts likely to be generated as a result of the proposed project.
- Identify and assess all potential impacts (direct, indirect and cumulative) of the construction, operational and decommissioning phases of the proposed development on soils and agricultural potential, and note the economic consequences of the proposed development on soils and agricultural potential.
- Provide recommended mitigation measures, management actions, monitoring requirements, and rehabilitation guidelines for all identified impacts (for inclusion into the EMPr as well).

1.3 APPROACH AND METHODOLOGY

The pre-fieldwork assessment was based on the existing Agricultural Geo-Referenced Information System (AGIS) data as well as satellite imagery for the site. This was supplemented by a field investigation that aimed at ground-proofing the AGIS data and assessing specific field conditions and the variation of these across the site. It did not comprise a detailed soil mapping exercise, but was based on an overview assessment, which involved driving and walking across the site, assessing topography and surface conditions, investigating existing cuttings in numerous excavations along the railway, and in animal burrows. Because of the shallow soils and the existing burrows and excavations, it was not necessary to auger additional holes. The field investigation also included a visual assessment of erosion and erosion potential on site, taking into account the proposed development layout. The field assessment was completed on 18 November 2015 (summer). An assessment of soils (soil mapping) and long term agricultural potential is in no way affected by the season in which the assessment is made, and therefore the fact that the assessment was done in summer has no bearing on its results. The conducted soil investigation is considered adequate for the purposes of this study (i.e. for the purposes of determining the impact of the proposed development on agricultural resources and productivity). Detailed soil mapping has no relevance to an assessment of agricultural potential in this environment, as the limitations are overwhelmingly climatic. In other words, even where soils suitable for cultivation may occur, they cannot be utilised because of the aridity constraints. More detailed soil mapping would add no value to the assessment.

Soils have been classified according to the South African soil classification system.

Telephonic consultation was done with the current farmer of the land, Mr Sarel Strauss to get details of current farming practices on the farm.

The impacts have been assessed in line with the methodology indicated in Section D of the BA Report. The developments listed in Section D of the BA Report, which are located within a 20 km radius of the proposed Kenhardt PV 1 project, have been considered in the assessment of cumulative impacts.

1.4 ASSUMPTIONS AND LIMITATIONS

The following assumption was used in this specialist study:

- It was assumed that water is not available anywhere on the site for irrigation. Given the very severe moisture constraints of the environment and that no suitable water has ever been identified by farmers in the area, this is a fair assumption.
- The cumulative impact assessment assumes that a number of other renewable energy developments will take place in the surrounding area (See Section D of the BA Report).

The following limitations were identified in this study:

- Soils were not mapped in detail for the study. However detailed soil mapping has no relevance to an assessment of agricultural potential in this environment, as the limitations are overwhelmingly climatic. In other words, even where soils suitable for cultivation may occur, they cannot be utilised because of the aridity constraints. The study had more than sufficient information on the soils to make an assessment on the impacts of the development on agriculture, and so this is not seen as a limitation.
- The assessment rating of impacts is not an absolute measure. It is based on the subjective considerations and experience of the specialist, but is done with due regard and as accurately as possible within these constraints.

There are no other specific constraints and limitations for this study.

1.5 INFORMATION SOURCES

All data on land types, land capability, grazing capacity etc. was sourced from the online AGIS, produced by the Institute of Soil, Climate and Water (Agricultural Research Council, undated). Satellite imagery of the site available on Google Earth was also used for evaluation.

1.6 DECLARATION OF INDEPENDENCE OF SPECIALIST

Refer to the preliminary section of this specialist report for the Curriculum Vitae of Mr. Johann Lanz, which highlights his experience and expertise. The declaration of independence by the specialist is provided in Box 1.1 below (with a full declaration included in the preliminary sections of this report and Appendix I of the BA Report).

BOX 1.1: DECLARATION OF INDEPENDENCE

I, Johann Lanz, declare that I am an independent consultant and have no business, financial, personal or other interest in the proposed Kenhardt PV 1 – Transmission Line Project, application or appeal in respect of which I was appointed, other than fair remuneration for work performed in connection with the activity, application or appeal. There are no circumstances that compromise the objectivity of my performing such work.

JOHANN LANZ

2 DESCRIPTION OF PROJECT ASPECTS RELEVANT TO SOILS AND AGRICULTURAL IMPACTS

This project will entail construction of an approximately 4 km 132 kV transmission line extending from the proposed Kenhardt PV 1 facility to the Eskom Nieuwehoop Substation. The proposed transmission lines for the Kenhardt PV 1, Kenhardt PV 2 and Kenhardt PV 3 projects are assessed separately as part of a BA Process. The proposed transmission lines are expected to be overhead, with concrete and steel tower structures. All transmission lines for the Kenhardt PV 1, PV 2 and PV 3 transmission line projects will be constructed within an electrical infrastructure corridor (as shown in Figure 1), which has been assessed in this report.

The components of the project that can impact on agricultural resources and productivity, during all phases of the project, are:

1. Occupation of land by the footprint of the proposed infrastructure as part of the development. This is confined largely to the pylon bases as agricultural activities can continue unhindered below the power lines.
2. Constructional activities that denude the surface cover of vegetation or disturb the soil below surface.
3. Vehicle traffic on site.

It is important to note that a detailed project description is included in Section A of the BA Report.

3 DESCRIPTION OF THE SOILS AND AGRICULTURAL CAPABILITY OF THE AFFECTED ENVIRONMENT

A satellite image of the site including the development layout is given in Figure 1. Photographs of site conditions are given in Figures 2 to 5.

3.1 CLIMATE AND WATER AVAILABILITY

Rainfall for the site is given as a very low 183 mm per annum, with a standard deviation of 71 mm according to the South African Rain Atlas (Water Research Commission, undated). The average monthly distribution of rainfall is shown in Table 1. One of the most important climate parameters for agriculture in a South African context is moisture availability, which is the ratio of rainfall to evapotranspiration. Moisture availability is classified into six categories across the country (as shown in Table 2). The proposed development site falls within Class 6, which is described as a very severe limitation to agriculture.

Table 1. Average monthly rainfall for the site (29° 10' S; and 21° 21' E) in mm (Water Research Commission, undated)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
25	33	38	24	11	5	3	4	5	8	11	16	183

Table 2. The classification of moisture availability climate classes for summer rainfall areas across South Africa (Agricultural Research Council, Undated)

Climate Class	Moisture Availability (Rainfall/0.25 PET)	Description of Agricultural Limitation
C1	>34	None to slight
C2	27-34	Slight
C3	19-26	Moderate
C4	12-18	Moderate to severe
C5	6-12	Severe
C6	<6	Very severe

Water for stock is obtained from wind pumps on the farm. There is insufficient water available for any form of irrigation.

3.2 TERRAIN, TOPOGRAPHY AND DRAINAGE

The proposed development is located on level plains with some relief in the Northern Cape interior at an altitude of between 900 and 1000 meters. Slopes across the site are almost entirely less than 2%.

The underlying geology is migmatite, gneiss and granite of the Namaqualand Metamorphic Complex with abundant calcrete.

There are no perennial drainage courses within the proposed project footprint. There are temporary drainage courses, typical of arid environments, where surface run-off would accumulate and flow, but this would only occur very occasionally, immediately after high rainfall events.

3.3 SOILS

The land type classification is a nationwide survey that groups areas of similar soil, terrain and climatic conditions into different land types. The proposed development is located on one land type, Ag6. This land type comprises predominantly shallow, red sands to loamy sands on underlying rock, hard-pan carbonate, or hard-pan dorbank. The soils fall into the arid Silicic, Calcic, and Lithic soil groups according to the classification of Fey (2010). A summary detailing soil data for the land type is provided in Table A1 in Appendix 1 of this report. The field investigation confirmed that the soils on site are shallow, red sandy soils on underlying rock and hard-pan carbonate. Actual soil forms vary within short distances depending on rock ridges that run across the area and the extent of calcrete formation. There are numerous outcrops of rocky ridges at the soil surface across the entire area. All investigated sample points across the area were one of four soil forms: Coega, Mispah, Plooysberg or Hutton. However there is very little practical difference between these different soil forms. All have a clay content of approximately 7%, are shallow and are underlain by a hard impenetrable layer (either rock or hard-pan carbonate).

The land has low to moderate water erosion hazard, mainly due to the low slope, but is susceptible to wind erosion because of the sandy texture of the soil.

Figure 1. Satellite image of site showing proposed transmission line corridor to the Eskom Nieuwehoop Substation (currently under construction).

Figure 2. Photograph showing typical site conditions.

Figure 3. Photograph showing typical site conditions in parts where more rocks occur.

Figure 4. Photograph showing typically occurring, shallow hard-pan carbonate horizon (Coega soil form).

Figure 5. Photograph showing typically occurring, red sandy soil overlying shallow rock (Hutton soil form).

3.4 AGRICULTURAL CAPABILITY

Land capability is the combination of soil suitability and climate factors. The area has a land capability classification, on the eight category scale, of Class 7 - non-arable, low potential grazing land. The limitations to agriculture are aridity and lack of access to water in addition to the shallow soil depth and rockiness. Because of these constraints, agricultural land use is restricted to low intensity grazing only. The natural grazing capacity is low, at mostly 31 - 40 hectares per animal unit. The current farmer uses an average stocking rate of 10 hectares per sheep.

3.5 LAND USE AND DEVELOPMENT ON AND SURROUNDING THE SITE

The farm is located within a sheep farming agricultural region and land use for the farm and surrounding area is sheep farming only. There is no cultivation or any history of cultivation on the farm. The Sishen–Saldanha railway line with its associated infrastructure runs through the farm to the south of the proposed transmission line corridor. Apart from fences and one stock watering point, there is no agricultural infrastructure on the site. There are no buildings on the site.

There are two proposed access roads. The one makes use of the existing road running along the Sishen-Saldanha railway line, which is in good condition. The other makes use of a farm track running northwards to the site through the farm. This will require upgrading. A maintenance gravel road (lesser than 6 m wide) will also be constructed below the proposed transmission line (within the electrical infrastructure corridor).

3.6 STATUS OF THE LAND

The biome classification for the site is Bushmanland Arid Grassland. The natural vegetation is grazed, veld conditions are very sparse but there is no evidence of significant erosion or other land degradation on the site.

3.7 POSSIBLE LAND USE OPTIONS FOR THE SITE

Because of both the climate and soil limitations, the site is not suitable for any agricultural land use other than low intensity grazing.

The site is within one of South Africa's eight proposed renewable energy development zones, and has therefore been identified as one of the most suitable areas in the country for renewable energy development, in terms of a number of environmental impact, economic and infrastructural factors. These factors include an assessment of the significance of the loss of agricultural land. Renewable energy development is therefore a very suitable land use option for the site.

3.8 AGRICULTURAL SENSITIVITY

Agricultural potential is uniformly low across the farm and the choice of placement of the development on the farm therefore has no influence on the significance of agricultural impacts. No agriculturally sensitive areas occur within the area of the proposed transmission line corridor, and so no parts of it need to be avoided by the development. No buffers are required.

4 APPLICABLE LEGISLATION AND PERMIT REQUIREMENTS

A servitude for the proposed transmission line will need to be registered on the affected farm portions. Rehabilitation after disturbance to agricultural land is managed by the Conservation of Agricultural Resources Act (Act 43 of 1983) (CARA). The Department of Agriculture, Forestry and Fisheries reviews and approves applications in terms of these Acts according to their *Guidelines for the evaluation and review of applications pertaining to renewable energy on agricultural land*, dated September 2011.

5 IDENTIFICATION OF KEY ISSUES AND POTENTIAL IMPACTS

The following have been identified by the specialist as potential impacts on agricultural resources and productivity.

5.1 CONSTRUCTION AND DECOMMISSIONING PHASES ONLY

1. Degradation of veld vegetation beyond the direct footprint of the proposed transmission line corridor due to construction and decommissioning phase disturbance and potential trampling by vehicles.
2. Loss of topsoil due to poor topsoil management (burial, erosion, etc.) during construction and decommissioning related soil profile disturbance (levelling, excavations etc.) and resultant decrease in that soil's capability for supporting vegetation.

5.2 ALL PHASES – CONSTRUCTION, OPERATION AND DECOMMISSIONING

1. Loss of agricultural land use due to direct occupation by the infrastructural footprint of the proposed development for the duration of the project (all phases). This will take affected portions of land out of agricultural production.
2. Soil erosion by wind or water due to the alteration of the land surface characteristics. Alteration of surface characteristics may be caused by construction related land surface disturbance, vegetation removal, and the establishment of excavations and surfaces for the proposed pylon bases. Erosion will cause loss and deterioration of soil resources and may occur during all phases of the project.

5.3 CUMULATIVE IMPACTS

1. Cumulative impacts due to the regional loss of agricultural land resources as a result of other developments on agricultural land in the region.

The BA (and EIA) Reports were released to I&APs for a 30-day comment period in March 2016. To date, no comments and issues have been raised by I&APs specifically in relation to soil and agricultural potential. All comments raised and responses thereto are included in Appendix E.3 of the finalised BA Report.

The National DEA has certain requirements for the Soils and Agricultural Potential Assessment, as shown in Table 3 below. Table 3 also shows how the requirements from the National DEA have been met.

Table 3: National DEA Requirements for the Soils and Agricultural Potential Assessment

DEA Requirement	Feedback from Specialist
• Detailed soil assessment of the site in question, incorporating a radius of 50 m surrounding the site, on a scale of 1:10 000 or finer. The soil assessment should include the following: - Identification of the soil forms present on site; - The size of the area where a particular soil form is found; - GPS readings of soil survey points; - The depth of the soil at each survey point; - Soil colour; - Limiting factors; - Clay content; - Slope of the site; - A detailed map indicating the locality of the soil forms within the specified area; and - Size of the site.	Detailed soil mapping has no relevance to an assessment of agricultural potential in this environment, where cultivation is not possible, soil conditions are generally poor and the agricultural limitations are overwhelmingly climatic. In such an environment, even where soils suitable for cultivation may occur, they cannot be cultivated because of the aridity constraints. The level of detail in the DEA (and DAFF) requirement is appropriate for arable land only. It is not appropriate for this site. Conducting a soil assessment at the required level of detail would be very time consuming and be a complete waste of that time. It would add absolutely no value to the assessment. The level of soil assessment that was conducted for this report is considered more than adequate for a thorough assessment of all agricultural impacts. The assessment did include identification of soil forms, soil depth, colour, limiting factors and clay content, and the slope and size of the site.
• Exact locality of the site	Refer to the site map shown in Figure 1.
• Current activities on the site, including developments or buildings.	Refer to Section 3.5 of this report.
• Surrounding developments/land uses and activities in a radius of 500 m of the site.	Refer to Section 3.5 of this report.
• Access routes and the condition thereof.	Refer to Section 3.5 of this report.
• Current status of the land (including erosion, vegetation, and a degradation assessment).	Refer to Section 3.6 of this report.
• Possible land use options for the site.	Refer to Section 3.7 of this report.
• Water availability, source and quality (if available).	Refer to Section 3.1 of this report.
• Detailed descriptions of why agriculture should or should not be the land use of choice.	Refer to Sections 3.7 and 9 of this report.
• Impact of the change of land use on the surrounding area.	Refer to Section 6 of this report.
• A shape file containing the soil forms and relevant attribute data as depicted on the map.	A shapefile containing soil forms is not relevant - see first point above

6 ASSESSMENT OF IMPACTS AND IDENTIFICATION OF MANAGEMENT ACTIONS

The five potential impacts identified in Section 5 above are assessed in table format in Tables 4 and 5 below.

The proposed development is located on land zoned and used for agriculture. South Africa has very limited arable land and it is therefore critical to ensure that development does not lead to an inappropriate loss of land that may be valuable and important for agricultural production. The proposed site is however on land which has very low agricultural potential and is only suitable for low intensity grazing.

There are three factors that influence the significance of all potential agricultural impacts. The first is that the actual footprint of disturbance of the proposed power line is very small in relation to available, surrounding land. The second is that the impact of a power line on the kind of agricultural activity (grazing) along the proposed development is very minimal, as this can continue in the presence of a power line with negligible disturbance. The third is that the site has very low agricultural potential, limited by severe climatic moisture availability constraints and shallow, rocky soils.

Furthermore, the low slope gradients reduce the significance of potential erosion impacts. Irreplaceability of impacts is considered low because of the very low significance impact and because the resource that is being impacted on is non-arable, low potential grazing land which is not a scarce resource in the country. The confidence level of the assessment is considered high because there is certainty about the low agricultural potential of the land and the impacts are fairly easy to understand and predict.

Although there are a large number of other potential projects in the area that will also lead to some loss of agricultural land, the impact of this development is so small that its contribution to the cumulative impact is also very low.

Because agricultural potential and conditions are uniform across the proposed transmission line corridor, impact assessment is identical for all transmission line sites.

Mitigation measures are also included in Tables 4 and 5. Recommendations for the monitoring and review of all identified mitigation measures are described in Section 8 of this report, as well as the EMPr (Appendix G of the BA Report).

6.1 DEGRADATION OF VELD VEGETATION BEYOND THE DIRECT FOOTPRINT OF THE PROPOSED TRANSMISSION LINE DUE TO CONSTRUCTION AND DECOMMISSIONING DISTURBANCE AND POTENTIAL TRAMPLING BY VEHICLES

The potential impact of degradation of veld vegetation beyond the direct footprint of the proposed Transmission Line is rated as a negative, direct impact that is predicted to occur as a result of disturbance during activities undertaken during the construction and decommissioning phases. The impact is rated with a site specific spatial extent and medium-term duration (i.e. the impact and risk will be experienced between 1 and 10 years). The consequence and probability of the impact are respectively rated as slight and likely. The reversibility and irreplaceability of the impact are respectively rated as moderate and low. The significance of the impact without the implementation of mitigation measures is rated as very low.

The following mitigation measures have been recommended during the construction and decommissioning phases in order to reduce the significance of veld degradation:

- Minimize the footprint of disturbance during construction and decommissioning activities.
- Confine vehicle access to roads only. Control dust generation during construction and decommissioning activities by implementing standard construction site dust control measures (dampening with water) where required. Because of water scarcity, this should only be done where and when dust generation is a significant problem.

With effective implementation of these mitigation actions, the impact of the project on veld degradation is predicted to be of very low significance.

6.2 LOSS OF TOPSOIL DUE TO POOR TOPSOIL MANAGEMENT

The potential impact of loss of topsoil due to poor topsoil management (burial, erosion, etc.) during construction and decommissioning related soil profile disturbance (such as levelling, excavations, etc.) and the resultant decrease in the capability of the soil to support vegetation is rated as a negative, direct impact. The impact is rated with a site specific spatial extent and medium-term duration (i.e. the impact and risk will be experienced between 1 and 10 years). The consequence and probability of the impact are respectively rated as slight and likely. The reversibility and irreplaceability of the impact are respectively rated as moderate and low. The significance of the impact without the implementation of mitigation measures is rated as very low.

The following mitigation measures have been recommended during the construction and decommissioning phases in order to reduce the loss of topsoil:

- Strip and stockpile topsoil from all areas where soil will be disturbed. There are no particular requirements for stockpile management and it can therefore be done in the way that is most practical for the operation.
- After cessation of disturbance, re-spread topsoil over the surface.
- Dispose of any sub-surface spoil material, generated from excavations, where they will not impact on land that supports vegetation, or where they can be effectively covered with topsoil.

With effective implementation of these mitigation actions, the impact of the project on topsoil is predicted to be of very low significance.

6.3 LOSS OF AGRICULTURAL LAND USE

The potential impact of loss of agricultural land use due to the direct footprint of the proposed project for the construction, operational and decommissioning phases is predicted to be a negative, direct impact. The impact is rated with a site specific spatial extent and long-term duration (i.e. the impact and risk will be experienced for the duration of the proposed project). The consequence and probability of the impact are respectively rated as slight and very likely. The reversibility and irreplaceability of the impact are respectively rated as high and low. The significance of the impact without the implementation of mitigation measures is rated as very low. No mitigation measures are recommended.

6.4 SOIL EROSION DUE TO ALTERATION OF THE LAND SURFACE CHARACTERISTICS

The potential impact of soil erosion by wind or water due to alteration of the land surface characteristics is predicted to be a negative, direct impact. As noted above, alteration of surface characteristics may be caused by construction related land surface disturbance, vegetation removal, and the establishment of excavations and surfaces for the proposed pylon bases. The impact is rated with a site specific spatial extent and long-term duration (i.e. the impact and risk will be experienced for the duration of the proposed project). The consequence and probability of the impact are respectively rated as slight and likely. The reversibility and irreplaceability of the impact are both rated as low. The significance of the impact without the implementation of mitigation measures is rated as very low.

The following mitigation measures have been recommended during the construction, operational and decommissioning phases in order to reduce soil erosion:

- Implement an effective system of run-off control, where it is required, that collects and safely disseminates run-off water from all hardened surfaces and prevents potential down slope erosion.

With effective implementation of these mitigation actions, the impact of increased soil erosion is predicted to be of very low significance.

6.5 CUMULATIVE IMPACT: REGIONAL LOSS OF AGRICULTURAL LAND RESOURCES

As mentioned above, the implementation of various other developments (refer to Section D of the BA Report) in conjunction with the proposed Scatec Solar PV facilities and transmission lines are expected to result in a cumulative impact in terms of the loss of agricultural land resources on a regional scale. The impact is rated with a regional spatial extent and long-term duration (i.e. the impact and risk will be experienced for the duration of the proposed project). The consequence and probability of the impact are respectively rated as slight and very likely. The reversibility and irreplaceability of the impact are respectively rated as moderate and low. The significance of the impact without the implementation of mitigation measures is rated as very low. No mitigation measures are recommended.

7 IMPACT ASSESSMENT SUMMARY

The potential impacts of the proposed project on soils and agricultural potential is summarised in Tables 4 and 5.

Table 4. Impact assessment summary table.

Aspect/Impact pathway	Nature of impact	Status	Spatial Extent	Duration	Consequence	Probability	Reversibility	Irreplaceability	Mitigation/ Management Actions	Significance		Ranking of residual impact	Confidence level
										Without Mitigation	*With Mitigation*		
Construction and Decommissioning Phases (Direct Impacts).													
Vehicle traffic and dust generation	Veld degradation	Negative	Site	Medium term	Slight	Likely	Moderate (i.e. Partially)	Low	1. Minimize footprint of disturbance. 2. Confine vehicle access on roads only. 3. Control dust generation during construction and decommissioning activities by adopting standard construct site dust control methods (such as dampening surfaces with water), where required. Because of water scarcity, this should only be done where and when dust generation is a significant problem.	Very Low	Very Low	5	High
Constructional and decommissioning activities that disturb the soil profile.	Loss of topsoil	Negative	Site	Medium term	Slight	Likely	Moderate (i.e. Partially)	Low	1. Strip and stockpile topsoil from all areas where soil will be disturbed. 2. After cessation of disturbance, re-spread topsoil over the surface.	Very Low	Very Low	5	High

Aspect/Impact pathway	Nature of impact	Status	Spatial Extent	Duration	Consequence	Probability	Reversibility	Irreplaceability	Mitigation/ Management Actions	Significance		Ranking of residual impact	Confidence level
										Without Mitigation	*With Mitigation*		
									3. Dispose of any sub-surface spoils from excavations where they will not impact on land that supports vegetation, or where they can be effectively covered with topsoil.				
Construction, Operational and Decommissioning Phases (Direct Impacts).													
Occupation of the land by the project infrastructure	Loss of agricultural land use	Negative	Site	Long term	Slight	Very Likely	High	Low	None	Very Low	Not Applicable	5	High
Change in surface characteristics and surface cover.	Erosion	Negative	Site	Long term	Slight	Likely	Low	Low	Implement an effective system of run-off control, where it is required, that collects and safely disseminates run-off water from all hardened surfaces and prevents potential down slope erosion.	Very Low	Very Low	5	High

Table 5. Cumulative impact assessment summary table.

Aspect/Impact pathway	Nature of impact	Status	Spatial Extent	Duration	Consequence	Probability	Reversibility	Irreplaceability	Mitigation/ Management Actions	Significance		Ranking of residual impact	Confidence level
										Without Mitigation	*With Mitigation*		
Occupation of the land by the infrastructure of multiple projects	Regional loss of agricultural land	Negative	Regional	Long term	Slight	Very Likely	Moderate	Low	None	Very Low	Not Applicable	5	High

8 INPUT TO THE ENVIRONMENTAL MANAGEMENT PROGRAMME

The following main mitigation measures and monitoring requirements are proposed for inclusion in the EMPr:

- Minimize the footprint of disturbance during construction and decommissioning activities.
- Confine vehicle access to roads only.
- Control dust generation during construction and decommissioning activities by adopting standard construct site dust control methods (such as dampening surfaces with water), where required. Because of water scarcity, this should only be done where and when dust generation is a significant problem..
- Strip and stockpile topsoil from all areas where soil will be disturbed.
- After cessation of disturbance, re-spread topsoil over the surface.
- Dispose of any sub-surface spoil material, generated from excavations, where they will not impact on land that supports vegetation, or where they can be effectively covered with topsoil.
- Implement an effective system of run-off control, where it is required, that collects and safely disseminates run-off water from all hardened surfaces and prevents potential down slope erosion.

The following main monitoring requirements are proposed for inclusion in the EMPr:

- Undertake a periodic site inspection to verify the occurrence of off-road vehicle tracks surrounding the site.
- Establish an effective record keeping system for each area where soil is disturbed for constructional and decommissioning purposes. Recommendations for the recording system are included in the EMPr (Appendix G of the BA Report).
- Undertake a periodic site inspection to verify and inspect the effectiveness and integrity of the run-off control system and to specifically record the occurrence of any erosion on site or downstream. Corrective action must be implemented to the run-off control system in the event of any erosion occurring.

9 CONCLUSION AND RECOMMENDATIONS

The proposed development is on land zoned and used for agriculture. South Africa has very limited arable land and it is therefore critical to ensure that development does not lead to an inappropriate loss of land that may be valuable for cultivation. This assessment has found that the proposed site is on land which is of very low agricultural potential and is not suitable for cultivation.

Because of the low agricultural potential of the site, the development should, from an agricultural impact perspective, be authorised.

Authorisation is promoted by the fact that the site falls within a proposed renewable energy development zone, where such land use has been assessed as very suitable in terms of a number of factors, including agricultural impact. It is preferable to incur a loss of agricultural land in such a region, without cultivation potential, than to lose agricultural land that has a higher potential, to renewable energy development elsewhere in the country.

No agriculturally sensitive areas occur within the site and no part of it is therefore required to be set aside from the development. Because the site is uniformly low potential, from an agricultural point of view, there is no preferred location or layout within the assessed site. There are no conditions resulting from this assessment for inclusion in the environmental authorisation. The following management and mitigation measures should be included in the EMPr:

- Minimize the footprint of disturbance during construction and decommissioning activities.
- Confine vehicle access to roads only.
- Control dust generation during construction and decommissioning activities by implementing suitable, standard construction site dust control measures (i.e. dampening with water) where required. Because of water scarcity, this should only be done where and when dust generation is a significant problem.
- Strip and stockpile topsoil from all areas where soil will be disturbed.
- After cessation of disturbance, re-spread topsoil over the surface.
- Dispose of any sub-surface spoil material, generated from excavations, where they will not impact on land that supports vegetation, or where they can be effectively covered with topsoil.
- Implement an effective system of run-off control, where it is required, that collects and safely disseminates run-off water from all hardened surfaces and prevents potential down slope erosion.

10 REFERENCES

Agricultural Research Council. Undated. AGIS Agricultural Geo-Referenced Information System available at http://www.agis.agric.za/.

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APPENDIX 1: SOIL DATA

Table A1. Land type soil data for site.

Land type	Land capability class	Soil series (forms)	Depth (cm)	Clay % A horizon	Clay % B horizon	Depth limiting laye	% of land type
Ag6	7	Hutton	10-35	6-12	7-15	ca, so, db	43
		Mispah	5-15	5-12		R	14
		Hutton	45->120	6-12	7-15	ca, so, R	10
		Hutton	10-35	10-20	15-25	ca, so, db	9
		Rock outcrop	0			R	8

Land capability classes: 7 = non-arable, low potential grazing land.
Depth limiting layers: R = hard rock; so = partially weathered bedrock; ca = hardpan carbonate; db = dorbank hardpan.

BASIC ASSESSMENT REPORT

Appendix D.7:
Social Impact Assessment

SOCIAL IMPACT ASSESSMENT:

Basic Assessment for the proposed transmission lines connecting the Kenhardt Solar Photovoltaic Facilities PV 1, PV 2 and PV 3 on Onder Rugzeer Farm 168 to the Nieuwehoop Substation on Gemsbok Bult 120, north-east of Kenhardt, Northern Cape Province

Report prepared for:

CSIR – Environmental Management Services

P O Box 17001

Congella, Durban, 4013

South Africa

Report prepared by:

Rudolph du Toit

P.O. Box 320

11 Jan Cilliers Road, Stellenbosch, 7600

South Africa

June 2016

SPECIALIST EXPERTISE

Curriculum Vitae – Rudolph du Toit

Personal information

Name:	Rudolph du Toit
Firm:	Council for Scientific and Industrial Research (CSIR)
Position in Firm:	Senior Environmental Planner
Profession:	Environmental Planning, Assessment & Management
Date of Birth:	23 May 1978
Languages:	English and Afrikaans
Marital status:	Married
Email:	rdutoit@csir.co.za
Telephone number:	021 888 2538 / 076 902 6479

Tertiary Education

Undergraduate
Bachelor of Arts (BA) Environmental and Development Studies
Department of Geography and Environmental Studies
University of Stellenbosch (US), 2003-2005

Bachelor of Law (LLB) (in progress)
College of Law
University of South Africa (UNISA), 2015

Honours
Bachelor of Philosophy (B.Phil.) Sustainable Development Planning and Management
School for Public Leadership
University of Stellenbosch (US), 2006

Masters
Master of Philosophy (M.Phil.) Development Planning
School of Public Leadership
University of Stellenbosch (US), 2007-2009

Employment Experience

1. Organisation: Independent contractor for the CapeNature Working for Water Project
   Position: Team leader: Natural resource management (Alien clearing)
   Period: 1998 to 2001

2. Organisation: Magnetic South
   Position: Outdoor pursuit management
   Period: 2003 to 2007 (part-time during studies)

3. Organisation: Strategic Environmental Focus (SEF) (Pty) Ltd.
   Position: Sustainability coordinator: Environmental planning & reporting
   Period: 2008 to 2010

4. Organisation: Council for Scientific and Industrial Research (CSIR)
   Position: Environmental Planner
   Period: 2010 to present

5. Organisation: University of Stellenbosch
   Position: Guest lecturer: Development Planning and Environmental Analysis module (part-time)
   Period: 2013 to present

6. Organisation: University of Stellenbosch
   Position: External moderator: Development Planning (School for Public Leadership) (part-time)
   Period: 2015

Professional Affiliations

Registered member of the South African Institute for Impact Assessment (Registration Number 2779)

Research Publications

- Du Toit, R. (2009). ***Developing a Scorecard for Sustainable Transport: A Cape Town Application.*** Stellenbosch University Press

- Michelle Audouin, Mike Burns, Alex Weaver, David le Maitre, Patrick O'Farrell, Rudolph du Toit, Jeanne Nel. (2015). ***An Introduction to Sustainability Science and its Links to Sustainability Assessment.*** *In Morrison-Saunders, A. and Pope, J., Eds. Handbook of Sustainability Assessment.* Edward Elgar Publishing, 321 -349. ISBN 978-1-78347-136-2

Conference Presentations & Papers

- Du Toit, R. (2012). **Wind *Energy and Public Participation: A one-sided debate?*** Proceedings of the 17th Annual Conference of the International Association for Impact Assessment South Africa: "Urban Evolution", 27 - 29 August, 2012.
- Du Toit, R. & Van der Westhuizen, C. (2013). ***Strategic Environmental Assessment (SEA) as a means of building the Green Economy in South Africa: The development of a national wind and solar energy roll-out plan.*** Proceedings of the OECD DAC SEA Task Team Workshop on SEA & Green Economy, Lusaka (Zambia), 17- 18 January 2013.
- Contributing author to: Dalal-Clayton, B. (2013) ***The Role of Strategic Environmental Assessment in Promoting a Green Economy: Background document for the OECD DAC SEA task Team workshop on SEA & Green Economy, Lusaka, 17- 18 January 2013***. IIED, London
- Burns, M., Du Toit, R. & Schreiner, G. (2013). ***Graphical Causal Loop modelling of socio-ecological systems to identify & evaluate key impact "strings".*** Proceedings of the 18th Annual Conference of the International Association for Impact Assessment South Africa: 16 - 18 September, 2013.

Key courses

- Advanced Facilitation & Experiential Learning: Team Building Institute (Pty) Ltd (2001)
- Clean Development Mechanism (CDM) Project Development Training: Danish Energy Management (Pty) Ltd (2008)
- Project Management Principles & Practice: University of Pretoria (2011)
- Integrating Sustainability with Environmental Assessment in South Africa (Presented by A. Morrison –Saunders & J. Pope): North-West University (2012)
- Sharpening the Tool: New techniques and methods in Environmental Impact Assessment: Sustainable Environmental Solutions (Pty) Ltd (2015)
- Effective Skills for Challenging Meetings & Engagements: Conflict Dynamics (2015)

Projects and Environmental Assessment Reports

The following table presents an abridged list of projects that I have been involved in, indicating my role in each project:

Environmental Impact Assessment (EIA) Experience		
Project	**Role**	**Date**
1. Basic Assessment: Bottelary Road Upgrade: Van der Merwe Venter Twenty Group and Silmore Trust	Environmental Control Officer	July 2009
2. MTN Remote Hub: Umbutho Civil & Electrical	Environmental Control Officer	July 2009
3. Basic Assessment: Hermanus (Overberg Municipality) substation upgrade & underground cable	Junior Environmental Manager and co-author	August 2009
4. Basic Assessment for the InnoWind Swellendam wind energy project: Single test turbine construction	Project Manager and Lead Author	January 2010
5. Basic Assessment for the InnoWind Heidelberg wind energy project: Single test turbine construction	Project Manager and Lead Author	January 2010
6. Basic Assessment for the InnoWind Albertinia wind energy project: Single test turbine construction	Project Manager and Lead Author	January 2010
7. Basic Assessment for the InnoWind Mossel Bay wind energy project: Single test turbine construction	Project Manager and Lead Author	January 2010
8. EIA for InnoWind Swellendam wind energy project, Western Cape	Project Manager and Lead Author	July 2010

Environmental Impact Assessment (EIA) Experience		
Project	**Role**	**Date**
9. EIA for InnoWind Heidelberg wind energy project, Western Cape	Project Manager and Lead Author	July 2010
10. EIA for InnoWind Albertinia wind energy project, Western Cape	Project Manager and Lead Author	July 2010
11. EIA for InnoWind Mossel Bay wind energy project, Western Cape	Project Manager and Lead Author	July 2010
12. EIA for the Electrawinds (NL) Coega IDZ Wind Energy Project: Proposed construction of 75 MW installed capacity	Project Manager	January 2010
13. EIA for Glencore Exploration (UK): On-shore and off-shore exploration drilling operation; Matanda Block, Cameroon	Project Manager	November 2010
14. EIA for Noble Energy (Cameroon): Off-shore exploration drilling, Yoyo Concession and Tilapia Exploration Block, Cameroon	Management, integration and drafting of water quality section of the EIA report.	April 2011
15. EIA for the Vleesbaai Independent Power Producer (VIPP) Wind Energy Facility near Vleesbaai	Project Manager and Lead Author	August 2012 (on-going)
16. Windlab Developments South Africa (Pty) Ltd Ishwati Emoyeni 140 MW Wind Energy EIA near Murrysburg in the Western Cape	Project Manager	September 2014 (on-going)
17. EIA for the City of Cape Town 1500 MW Gas-to-power facility, Atlantis, Western Cape	Project Leader	July 2015 (on-going)

Strategic Environmental Assessment (SEA) Experience		
Project	**Role**	**Date**
18. Strategic Environmental Assessment (SEA) for the Port of Saldanha: Transnet National Ports Authority (TNPA)	Project Manager and Lead Author	July 2012
19. City of Cape Town Far South Strategic Environmental Assessment (SEA)	Project Manager and Lead Author	June 2014

Specialist Study Experience		
Project	**Role**	**Date**
20. Mulilo Renewable Project Developments (Pty) Ltd Gemsbok Solar PV1 75MW Solar Photovoltaic EIA in the Northern Cape	Conducting the Social Impact Assessment (SIA) as part of the suite of EIA specialist studies	September 2014

Specialist Study Experience		
Project	**Role**	**Date**
21. Mulilo Renewable Project Developments (Pty) Ltd Gemsbok Solar PV2 75MW Solar Photovoltaic EIA in the Northern Cape	Conducting the Social Impact Assessment (SIA) as part of the suite of EIA specialist studies	September 2014
22. Mulilo Renewable Project Developments (Pty) Ltd Boven Solar PV1 75MW Solar Photovoltaic EIA in the Northern Cape	Conducting the Social Impact Assessment (SIA) as part of the suite of EIA specialist studies	September 2014
23. Scatec Solar 330 (Pty) Ltd Kenhardt PV 1 75MW Solar Photovoltaic EIA in the Northern Cape	Conducting the Social Impact Assessment (SIA) as part of the suite of EIA specialist studies	August 2015
24. Scatec Solar 350 (Pty) Ltd Kenhardt PV 2 75MW Solar Photovoltaic EIA in the Northern Cape	Conducting the Social Impact Assessment (SIA) as part of the suite of EIA specialist studies	August 2015
25. Scatec Solar 370 (Pty) Ltd Kenhardt PV 3 75MW Solar Photovoltaic EIA in the Northern Cape	Conducting the Social Impact Assessment (SIA) as part of the suite of EIA specialist studies	August 2015
26. Scatec Solar 163 (Pty) Ltd Kenhardt PV 1 – Transmission Line Basic Assessment to service the proposed Kenhardt PV 1 75MW Solar Facility in the Northern Cape	Conducting the Social Impact Assessment (SIA) as part of the suite of BA specialist studies	August 2015
27. Scatec Solar 163 (Pty) Ltd Kenhardt PV 1 – Transmission Line Basic Assessment to service the proposed Kenhardt PV 1 75MW Solar Facility in the Northern Cape	Conducting the Social Impact Assessment (SIA) as part of the suite of BA specialist studies	August 2015
28. Scatec Solar 163 (Pty) Ltd Kenhardt PV 1 – Transmission Line Basic Assessment to service the proposed Kenhardt PV 1 75MW Solar Facility in the Northern Cape	Conducting the Social Impact Assessment (SIA) as part of the suite of BA specialist studies	August 2015

Environmental Management & Sustainability Planning Experience		
Project	**Role**	**Date**
29. Working for Water (CapeNature) alien clearing project: Uniondale Poort	Team Leader: natural resource management	January 1998
30. Working for Water (CapeNature) alien clearing project: Avontuur area	Team Leader: natural resource management	March 1999
31. Working for Water (CapeNature) alien clearing project: Prince Alfred Pass area	Team Leader: natural resource management	January 2000
32. Working for Water (CapeNature) alien clearing project: Langkloof farms	Team Leader: natural resource management	February 2001
33. Qualitative Environmental Impact Analysis related to Major Incedent:	Project Manager and Lead	October 2010

Environmental Management & Sustainability Planning Experience		
Project	**Role**	**Date**
PetroSA Mossel Bay GTL refinery	Author	
34. Maseve Platinum Sustainability Assessment, Rustenburg	Project Manager	August 2011
35. Notice of Impacts Associated with Exploration Drilling in BHP Billiton Gabon's Licensed Areas of Okondja, Akieni & Lastoursville (Gabon)	Project Manager	June 2011
36. PetroSA LNG Importation Pipeline Screening Study (Saldanha Bay to Mosselbay)	Responsible investigating and assessing planning impacts	March 2014
37. Department of Environmental Affairs (DEA) National Sustainable Development Strategy and Action Plan (NSSD) 1: Monitoring & Evaluation Report	Project manager and lead author	November 2013 (on-going)
38. Apollo Brick (Pty) Ltd energy efficiency and fuel switching CDM project	Investigation of possible conversation of the energy efficiency project to an accredited CDM project	January 2008
39. Mxit Lifestyle (Pty) Ltd carbon footprint audit	Carbon audit of Mxit Lifestyle (Pty) Ltd	January 2009
40. EIA for Addax Petroleum: Off-shore exploration/appraisal drilling; Ngosso Permit, Cameroon	Research team: collection of benthic macrofauna samples and bio-indicators for water quality analysis	August 2010
41. EIA for Glencore Exploration (UK): Off-shore exploration drilling, Bolongo Block, Cameroon	Research team: collection of benthic macrofauna samples and bio-indicators for water quality analysis	February 2011
42. Integrated State of the Environment Report For Namibia (Phase 1)	Project Leader	June 2015 (on-going)
43. Guest lecturer: Stellenbosch University's Sustainability Institute (School of Public Leadership)	Guest lecturer: Theory & Practice of Sustainability Assessment	July 2013 (on-going)

SPECIALIST DECLARATION

I, **Rudolph du Toit**, as the appointed independent specialist, in terms of the 2014 EIA Regulations, hereby declare that I:

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

Signature of the specialist:

Name of Specialist: **Rudolph du Toit**

Date: **28 January 2016**

EXECUTIVE SUMMARY

Project Context

Scatec Solar SA 163 (PTY) Ltd (hereinafter referred to as Scatec Solar) is proposing to develop three 75 Megawatt (MW) Solar Photovoltaic (PV) power generation facilities and associated electrical infrastructure (including transmission lines for each 75 MW facility) on the remaining extent of Onder Rugzeer Farm 168 and the connection points to the Eskom Nieuwehoop Substation on the remaining extent of Portion 3 of Gemsbok Bult Farm 120, approximately 80 km south of Upington and 30 km north-east of Kenhardt within the !Kheis Local Municipality, Northern Cape Province.

The three proposed 75 MW Solar PV facility projects, which require a full Scoping and Environmental Impact Assessment (EIA), are referred to as (together with the corresponding assigned DEA Reference Numbers):

- Kenhardt PV 1 – DEA Reference: 14/12/16/3/3/2/837;
- Kenhardt PV 2 – DEA Reference: 14/12/16/3/3/2/838; and
- Kenhardt PV 3 – DEA Reference: 14/12/16/3/3/2/836.

The proposed transmission lines which will connect each 75 MW Solar PV facility to the Eskom Nieuwehoop Substation require a separate Basic Assessment (BA) Process. These projects are referred to as:

- Kenhardt PV 1 – Transmission Line: DEA Reference: 14/12/16/3/3/1/1547;
- Kenhardt PV 2 – Transmission Line: DEA Reference: 14/12/16/3/3/1/1546; and
- Kenhardt PV 3 – Transmission Line: DEA Reference: 14/12/16/3/3/1/1545.

This Social Impact Assessment (SIA), compiled by Rudolph du Toit of the Council for Scientific and Industrial Research (CSIR) and externally reviewed by Ms. Liza van der Merwe (a private consultant), contributes to the abovementioned separate, requisite EIA and BA Processes. A single SIA has been compiled based on the following reasons:

Employment opportunities created during the construction phase of each project (i.e. each 75 MW PV project) are estimated to number approximately 1 260 - 2 100 man months (for skilled opportunities) and approximately 5 600 - 6 400 man months (for unskilled opportunities). Employment opportunities created during the construction phase of each transmission line project are estimated to range between 1 560 and 1 820 man months. Employment opportunities to be created during the operational phase of each project (i.e. each 75 MW PV project) are estimated to number approximately 4 800 man months (for skilled opportunities) and approximately 9 600 man months (for unskilled opportunities) over the 20 year plant lifespan. Scatec Solar further proposes an Economic Development Plan which will be developed to achieve the following:

- Create a local community trust which has an equity share in the project life to benefit historically disadvantaged communities;

- Initiate a training strategy to facilitate employment from the local community; and
- Where possible, give preference to local suppliers of components for the construction of the proposed Solar PV facilities and transmission lines.

The study area is located within the ZF Mgcawu District Municipality (formerly known as the Siyanda District Municipality). The actual project footprint (Remaining Extent of Onder Rugzeer Farm 168 and the remaining extent of Portion 3 of Gemsbok Bult Farm 120 (for the connection points to the Eskom Nieuwehoop Substation)) is located in the !Kheis Local Municipality. However, the closest urban centre, Kenhardt, is located in the Kai !Garib Local Municipality. Given the proximity of the proposed projects to the town of Kenhardt (i.e. approximately 20 to 30 km north-east of Kenhardt); the focus of this SIA will be on the Kai !Garib Local Municipality.

Affected Socio-Economic Environment

The total population of the Kai !Garib municipal area is 65 869; of which 6 679 reside in the Kenhardt area. A total of 16 703 households are located in the Kai !Garib Local Municipality, with 35% of households being female headed. The total female population dominates the total male population by 8.5% (Kai !Garib Draft Integrated Development Plan (IDP), 2014). The working age demographic (15 to 65 years) makes-up 70.5% of the population, whereas those below 15 years of age comprise 24.4% of the population. The +65 years age group makes-up 5.1% of the population. Accordingly, the dependency ratio (the economically active population versus the non-economically active population) is 41.9% (Stats SA, 2011).

The official unemployment rate of 10% has decreased by 6.1% since the 2011 Census measurement of 16.1%. The economic sector is dominated by agriculture which provides 51.8% of jobs, followed by the Community and Government Services sector with 15.9%.

Informants[1] in Kenhardt indicated that levels of unemployment in the town are particularly high (i.e. higher than reflected in the relevant census data). All informants indicated that the vast majority of the economically active population is dependent on some form of government subsidy[2] (reported to be approximately R 1300 per person per month). Subsequently, the local labour market appears to offer very limited absorption of the economically active population component (i.e. approximately 4675 employment opportunities, based on a 70.5% working age demographic for the Kai !Garib municipal area) of the 6679 inhabitants of the Kenhardt area.

Public infrastructure (public telephones, the public swimming pool and benches) was vandalised to an extent that will probably render future utilisation impossible without municipal upgrades. Acts of social disorder, such as loitering and vandalism, are regularly associated with poverty and elevated levels of distress within communities (Richardson &

[1] Sociological research ethics dictates that the identity of informants (i.e. those being interviewed) should be protected if *any* possibility of physical, mental, emotional or legal harm exists. Accordingly, the identities of informants are not disclosed in this study.

[2] 'Subsidy' is used here to represent a variety of government subsidies.

Shackleton, 2014). According to Fisher and Baron's (1982) Equity-Control Theory (ECT), acts of vandalism are often triggered by a perceived violation of norms related to fairness in terms of social and environmental arrangements. According to the ECT, acts of vandalism can be understood as an attempt to reduce inequality.

Informants further indicated that teenage pregnancies and drug abuse were major social issues in Kenhardt, and that the prevalence of these issues is increasing. This claim is validated by secondary data contained in the Kai !Garib Draft IDP (2014), which lists teenage pregnancy and drug abuse as major social challenges within the larger municipal area. Both these issues elevate the local dependency ratio, thereby placing already stressed livelihood strategies under even more strain.

It is suggested that teenage pregnancy is positively related to elevated levels of poverty, associated idleness and inappropriate forms of recreation (Were, 2007). Poverty and limited recreation opportunities appear to be clear contributing factors to the high teenage pregnancy rate. However, poor sex education, limited understanding of and access to modern contraception and lack of parental guidance are likely exacerbating factors.

Informants complained that informal shop owners and traders are generally foreign nationals and are not seen as members of the community. This outsider versus insider experience, coupled with a dependency of the local community on the services offered by outsiders, appears to generate feelings of distrust and vulnerability. This existing outsider versus insider phenomenon suggests that the local community could be sensitive to the influx of job seekers and other forms of in-migration into Kenhardt.

Informants further reported frustration regarding job creation expectations created by other developments in the area. Consequently, the Kenhardt community is likely to be particularly sensitive to similar expectation which could be created by the proposed developments.

Methods

Applied Anthropological Methods

Collection of primary data during the site visit was guided by a Participant Observation Methodology (Anderson & Taylor, 2002). Participant observation is an applied anthropological approach, whereby the researcher 'becomes' a resident in the community for a given period of time to observe the normal daily lives of community members and to conduct informal interviews with informants. The intention of interviews is to uncover the major livelihood strategies present in the study area, to understand the key socio-economic challenges, and gain insights into the 'constructed reality' of the Kenhardt community. Observation of community members' lives, routines and living environments help to gain insight into practices, patterns and processes which community members may not be consciously aware of.

Systems Theory

Conventional SIA reports generally describe the affected environment in terms of social and economic conditions, with only very cursory references to the biophysical environment. Due to the inherent complexity of human-nature interaction, and the profound impacts resulting from this interaction, a more holistic approach was adopted towards understanding and representing the affected environment. Accordingly, the receiving environment and subsequent impacts thereon were viewed and interpreted as a coupled socio-ecological system (SES). This approach is a radical departure from viewing the receiving environment as a loose collection of independent economic, social and environmental variables.

Vulnerability Context

Finally, an Asset Pentagon has been used to interpret the collected information. An Asset Pentagon is an assessment method developed within the discipline of Livelihoods Assessment, and aims to establish the vulnerability context of a given social grouping. People's access to productive assets (Human-, Social-, Natural-, Physical- and Financial capital) lies at the heart of their vulnerability context. Generally, the greater access people have to assets, the more livelihood strategies are available and the easier it is for them to switch from one strategy to the next. Conversely, limited access to assets results in reduced livelihood strategies and impaired ability to assume alternative strategies should the need arise.

Assessment of Impacts and Identification of Management Actions

Potential Impact 1: Influx of Jobseekers

Construction of the proposed projects (i.e. three Solar PV facilities and three transmission lines) is likely to attract job seekers to the town of Kenhardt. Such an influx generally causes a disturbance in the existing social order as prevailing leadership, kinship and social control mechanisms are challenged by new and alternative values, beliefs and practices. The impact is expected to be ***long to medium term*** in duration and ***local in extent***. Influx of job seekers into the study area is therefore rated as having a ***moderate significance (negative)*** rating before mitigation. Should the mitigation measures discussed below be implemented, this significance rating should reduce to ***low***.

Mitigation

The proponent must develop a Workforce Recruitment Policy. The proponent should also clearly define who is considered to be local (Kenhardt) residents; known as the Project Affected People (PAP). It is also suggested that the proponent assembles a database of local residents and their relevant skills and experience well in advance of the construction phase of the proposed projects. Finally, the proponent should develop a Stakeholder Engagement Plan which sets-out the communication strategy to be followed with regards to the proposed solar development and transmission lines.

Potential Impact 2: Increases in Social Deviance

In-migration into the study area, particularly Kenhardt, is likely to increase the incidence of teenage pregnancies, drug abuse, prostitution and other socially deviant behaviour. This impact is expected to be ***medium term*** in duration and ***local*** in extent. Increases in social deviance within the study area are therefore rated as having a ***moderate significance (negative)*** rating before mitigation which will drop to ***low significance*** with mitigation. Increases in social deviance are extremely difficult to control and often lie outside the exclusive control of the proponent as it is driven by complex socio-ecological conditions related to poverty and feelings of hopelessness.

Mitigation

The mitigation measures proposed for Potential Impact 1 must also be used to mitigate impacts resulting from increases in social deviance, as Potential Impact 1 is a precursor to Potential Impact 2. Furthermore, the proponent must be contractually bound to deliver on its Economic Development Plan for the area once the proposed project is successfully selected as a preferred bidder.

Potential Impact 3: Expectations regarding jobs

Informants in the Kenhardt area indicated a significant level of frustration with other proposed developments in the area due to expectations of possible employment. Unrealised expectations in a poor community could lead to feelings of desperation, disempowerment, anger and a general distrust in developers. In isolated cases, such frustration of expectations might lead to malicious damage of project property and intimidation of employees. The impact is expected to be ***short term*** in duration and ***local in extent***. Expectations regarding jobs are therefore rated as having a ***low significance (negative)*** rating before mitigation. Should the mitigation measures discussed below be implemented, this significance rating will be reduced to ***very low***.

Mitigation

Proper implementation of the Stakeholder Engagement Plan proposed for Potential Impact 1 should lead to realistic expectations of employment for most of the local community.

Potential Impact 4: Local Spending

Procurement of goods and services in the Kenhardt area during the construction and operational phase of the proposed project is likely to hold socio-economic benefits as a result of the multiplier effect (i.e. the increase in final income resulting from a new injection of spending). A secondary positive impact might result from entrepreneurial development in the project area especially in the service industry. The impact is expected to be ***medium to long term*** in duration and ***local in extent***. Local spending in the study area is therefore rated as having a ***low significance (positive)*** rating.

Enhancement

The proponent must procure goods and services, as far as practically possible, from within the project area (with a focus on Kenhardt). It is also suggested that regularly required goods and services (e.g. food and accommodation) be obtained from as large a selection of local service providers as possible to ensure distribution of project benefits.

Potential Impact 5: Local employment

The creation of short term employment for low skilled community members in the study area, though not ideal, does provide much needed temporary financial relief, while also contributing to a sense of empowerment and dignity. The limited number of long term employment offered by the proponent provides long term (small scale) socio-economic benefit to the affected community and may also contribute to the multiplier effect, as more income generally results in greater spending. The impact is expected to be ***long term*** in duration and ***local in extent***. Local employment is therefore rated as having a ***moderate significance (positive)*** rating.

Enhancement

As recommended for Potential Impact 1, the proponent must develop a Workforce Recruitment Policy. This policy must reserve employment, where practically possible, for local residents (particularly for vulnerable groups such as women and previously disadvantaged individuals). This requirement should be contractually binding on the proponent.

Potential Impact 6: Human Development via the proposed Economic Development Plan

Scatec Solar indicated that an Economic Development Plan is suggested for the study area, should the proposed project be successful. The positive impacts of this plan are self-evident and will relate to the creation of employment, local spending and human capacity development. The impact is expected to be ***long term*** in duration and ***local in extent***. Human development is therefore rated as having a ***moderate significance (positive)*** rating.

Enhancement

It is proposed that the proponent must engage with local Non-governmental Organisations (NGOs), Community Based Organisations (CBOs) and local government structures to identify and agree upon relevant skills and competencies required in the Kenhardt community. The proponent should also consider aligning economic development and skills development initiatives with the Kai !Garib Local Municipality's IDP objectives.

Potential Impact 7: Job losses

It is expected that the proposed projects could possibly be decommissioned after an operational lifespan of approximately 20 years. Decommissioning of the proposed developments will result in job losses. Secondary impacts might result from incorrect decommissioning of project infrastructure which might be used for inappropriate purposes. This in turn could result in health and safety impacts on the local community. This impact is expected to be ***long term*** in duration and ***local in extent***. Job losses resulting from decommissioning within the study area are therefore rated as having a ***moderate significance (negative)*** rating before mitigation and a ***low significance (negative)*** with mitigation. This impact is however considered to be acceptable in light of the local need for employment and development.

Mitigation

The proponent must comply with relevant South African labour legislation when retrenching employees. Scatec Solar should also consider appropriate succession training of locally employed staff earmarked for retrenchment during decommissioning. Such training could gradually equip workers to enter gainful employment in other locally viable sectors. Finally, all project infrastructures should be decommissioned appropriately and thoroughly to avoid misuse and disposed of or re-used according to relevant standards.

Overall significance rating

The overall significance rating of the *negative* socio-economic impacts associated with the proposed projects is ***low*** to ***moderate***; whereas the overall significance rating of the *positive* socio-economic impacts associated with the proposed development is ***moderate***. It is therefore concluded that the prospective socio-economic benefits of the proposed projects outweigh the socio-economic losses/impacts.

COMPLIANCE WITH THE APPENDIX 6 OF THE 2014 EIA REGULATIONS

Requirements of Appendix 6 – GN R982	**Addressed in the Specialist Report**
1. (1) A specialist report prepared in terms of these Regulations must contain- a) details of- i. the specialist who prepared the report; and ii. the expertise of that specialist to compile a specialist report including a curriculum vitae;	Specialist Expertise Section at the beginning of this report and Appendix A of the EIA Report
b) a declaration that the specialist is independent in a form as may be specified by the competent authority;	Specialist Declaration Section (Appendix B of the EIA Report, Appendix I of the BA Report and at the beginning of this report).
c) an indication of the scope of, and the purpose for which, the report was prepared;	Section 1.1
d) the date and season of the site investigation and the relevance of the season to the outcome of the assessment;	30 July 2014. The season of the site visit is immaterial as social impacts likely to result from the proposed project are not seasonal in nature.
e) a description of the methodology adopted in preparing the report or carrying out the specialised process;	Section 1.3
f) the specific identified sensitivity of the site related to the activity and its associated structures and infrastructure;	Section 3
g) an identification of any areas to be avoided, including buffers;	Not applicable as the project is not proposed in an urban area where social impacts are expected to manifest.
h) a map superimposing the activity including the associated structures and infrastructure on the environmental sensitivities of the site including areas to be avoided, including buffers;	Not applicable as the project is not proposed in an urban area where social impacts are expected to manifest.
i) a description of any assumptions made and any uncertainties or gaps in knowledge;	Section 1.5
j) a description of the findings and potential implications of such findings on the impact of the proposed activity, including identified alternatives on the environment;	Sections 4.3, 4.4, 4.5 and 4.6
k) any mitigation measures for inclusion in the EMPr;	Sections 5
l) any conditions for inclusion in the environmental authorisation;	No conditions identified or required.
m) any monitoring requirements for inclusion in the EMPr or environmental authorisation;	No monitoring conditions identified

Requirements of Appendix 6 – GN R982	**Addressed in the Specialist Report**
	or required.
n) a reasoned opinion- i. as to whether the proposed activity or portions thereof should be authorised; and ii. if the opinion is that the proposed activity or portions thereof should be authorised, any avoidance, management and mitigation measures that should be included in the EMPr, and where applicable, the closure plan;	Section 5
o) a description of any consultation process that was undertaken during the course of preparing the specialist report;	Section 3.1.2
p) a summary and copies of any comments received during any consultation process and where applicable all responses thereto; and	Section 4.1
q) any other information requested by the competent authority.	External Peer Review required by the DEA. This external review report is included as an appendix to this specialist report.

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ABBREVIATIONS AND ACRONYMS:

CLD	Causal Loop Diagram
DEA	Department of Environmental Affairs
ECT	Equity Control Theory
EIA	Environmental Impact Assessment
IDP	Integrated Development Plan
MW	Megawatt
PV	Photovoltaic
SIA	Social Impact Assessment
SES	Socio-ecological System

SOCIAL IMPACT ASSESSMENT

1 INTRODUCTION AND METHODOLOGY

This Social Impact Assessment (SIA) was commissioned in response to the Environmental Impact Assessment (EIA) and Basic Assessment (BA) application processes initiated by Scatec Solar SA 163 (PTY) Ltd (Scatec) for the three proposed 75 Megawatt (MW) Solar Photovoltaic (PV) Facilities and three transmission lines to connect each facility to the National Grid, near Kenhardt in the Northern Cape. The proposed EIA and BA projects are referred to as follows:

- EIA Projects - Kenhardt PV 1, Kenhardt PV 2, and Kenhardt PV 3; and
- BA Projects – Kenhardt PV 1 – Transmission Line, Kenhardt PV 2 – Transmission Line, and Kenhardt PV 3 – Transmission Line.

This SIA has been compiled by Rudolph du Toit of the Council for Scientific and Industrial Research (CSIR) and externally reviewed by Ms. Liza van der Merwe (a private consultant). As part of the acceptance of the Scoping Reports, the Department of Environmental Affairs requested for an external review of the SIA to be conducted. The review report is included as Appendix A of this report.

A single SIA has been compiled based on the following reasons:

- The proposed project sites (as included in the official survey area) are located in very close proximity to each other and therefore present very similar baseline social conditions;
- The nature of the proposed development (i.e. solar PV electricity generation and transmission line development) is exactly the same for all the proposed projects sites. As such, the anticipated impacts resulting from the proposed developments will be similar regardless of its location; and
- Anticipated significant social impacts are expected to manifest in the urban node or sizeable human settlement in closest proximity to the proposed development (i.e. the town of Kenhardt) and not on the actual project sites. This is due to the extremely low population density of the relevant farms, its remote location and the relative absence of infrastructure and economic opportunity capable of attracting and sustaining agents of social change. Accordingly, it makes no difference on which land parcel or ERF the relative impacts originate, as the consequences resulting from such impacts are expected to manifest in Kenhardt, and can therefore be addressed in a single report.

A SIA can be defined as the process of determining "*[t]he consequences to human populations of any public or private actions (these include policies, programmes, plans and/or projects) that alter the ways in which people live, work, play, relate to one another, organise to meet their needs and generally live and cope as members of society. These* *impacts are felt at various levels, including individual level, family or household level, community, organisation or society level. Some social impacts are felt by the body as a physical reality, while other social impacts are perceptual or emotional*" (Barbour, 2007).

Evidently, the realm of human experience is characterised by subjectivity; both in terms of affected community's experiences and the SIA practitioner's interpretation of such experiences. Such subjectivity is known as the "social construct of reality" (Anderson & Taylor, 2002). However, social well-being can largely be agreed upon regardless of ones worldview. Accordingly, the SIA process must be committed to the following objectives (Barbour, 2007):

- The principles of sustainable development and social sustainability;
- Vulnerable groups;
- Meeting basic needs and services;
- Livelihood strategies;
- Fairness and equity;
- Social justice;
- Openness and participation; and,
- Accountability.

In pursuit of these objectives, it is imperative that an SIA looks beyond the direct positive and negative impacts likely to result from proposed projects and looks at promoting the well-being of communities potentially affected by a project by addressing entrenched structural issues of empowerment, minority groups, gender issues and poverty reduction.

1.1 SCOPE AND OBJECTIVES

This SIA Report investigates the potential social disruptors and associated social impacts likely to result from the development of the proposed Kenhardt PV 1, Kenhardt PV 2, and Kenhardt PV 3 solar energy projects, as well as the proposed Kenhardt PV 1 – Transmission Line, Kenhardt PV 2 – Transmission Line, and Kenhardt PV 3 – Transmission Line projects near Kenhardt in the Northern Cape. In this regard, the study focuses on the town of Kenhardt and not the individual land parcels on which the proposed projects will developed, as most, if not all, of the anticipated social impacts will be experienced in the urban area nearest to the proposed developments (i.e. Kenhardt). Social disruptors and impacts under investigation are those which are most likely to significantly influence social and cultural concerns, values, consequences and benefits to communities.

The objective of this SIA is to assist with informed decision-making by the competent authority (DEA) as, as well as the development of appropriate management directives, as it relates to the consideration of social impact likely to result from the proposed development.

1.2 TERMS OF REFERENCE

The SIA will include:

- A review of existing information, and collecting and reviewing baseline social information etc.
- Conducting interviews with key affected parties, including local communities, local landowners, key government officials (local and regional) etc.
- An identification and assessment of key social issues and potential impacts (negative and positive) associated with the construction, operational and decommissioning phases of the proposed projects.
- An identification of potential mitigation and enhancement measures.
- A specialist report which includes an assessment of the potential social impacts associated with the proposed projects.
- An outline of mitigatory measures and additional management or monitoring guidelines.
- Provide input to the Environmental Management Programme (EMPr), including mitigation and monitoring requirements to ensure that negative social impacts are limited.

1.3 STUDY APPROACH AND METHODOLOGY

This SIA consulted secondary data sources (published documentation) to obtain basic socio-economic baseline demographics. This secondary data was then augmented with primary data generated by a site visit to the proposed project site as well as the town of Kenhardt and the surrounding areas.

1.3.1 Applied Anthropological Methods

Collection of primary data during the site visit was guided by a Participant Observation Methodology (Anderson & Taylor, 2002). Participant observation is an applied anthropological approach, whereby the researcher 'becomes' a resident in the community for a given period of time to observe the normal daily lives of community members and to conduct informal interviews with informants. The intention of interviews is to uncover the major livelihood strategies present in the study area, to understand the key socio-economic challenges, and gain insights into the 'constructed reality' of the Kenhardt community. Observation of community members' lives, routines and living environments help to gain insight into practices, patterns and processes which community members may not be consciously aware of.

1.3.2 Systems Theory

Conventional SIA reports generally describe the affected environment in terms of social and economic conditions, with only very cursory references to the biophysical environment. Due to the inherent complexity of human-nature interaction, and the profound impacts resulting from this interaction, a more holistic approach was adopted towards understanding and representing the affected environment. Accordingly, the receiving environment and subsequent impacts thereon were viewed and interpreted as a coupled socio-ecological system (SES). This approach is a radical departure from viewing the receiving environment as a loose collection of independent economic, social and environmental variables.

Systems theory provides insight into complex system relationships by interpreting a given system through the following set of principles:

- Complex systems **are open systems** (i.e. free interaction with other systems across systemic boundaries);
- Complex systems operate under conditions **not at equilibrium** (i.e. supply and demand of systemic services are not in balance, also known as redundancy in cases of over supply);
- Complex systems have an **asymmetrical structure** (i.e. structure is maintained, though component parts my change);
- Complex systems consist of **many** components;
- In a complex system, components on average **interact with many others** via numerous possible routes;
- Some sequences of interaction within complex systems will result in **feedback routes;**
- Parts of a complex system interact in non-linear ways to create properties and behaviours which is not inherent to the system's component parts; known as **emergence.**

Subsequently, typical socio-economic baseline data is then represented in a Causal Loop Diagram (CLD) to illustrate the systemic causal linkages between variables present in the SES in which the study area is located.

1.3.3 Vulnerability Context

Finally, an Asset Pentagon has been used to interpret the collected information. An Asset Pentagon is an assessment method developed within the discipline of Livelihoods Assessment, and aims to establish the vulnerability context of a given social grouping. People's access to productive assets (Human-, Social-, Natural-, Physical- and Financial capital) lies at the heart of their vulnerability context. Generally, the greater access people have to assets, the more livelihood strategies are available and the easier it is for them to switch from one strategy to the next. Conversely, limited access to assets results in reduced livelihood strategies and impaired ability to assume alternative strategies should the need arise.

As a result, the SIA research approach is descriptive in nature and uses indicative reasoning to reach its impact assessment findings. In terms of the impact assessment, the methodology adopted is outlined in Section D of the BA Report and Chapter 4 of the EIA Report.

1.4 INFORMATION SOURCES

The primary and secondary data sources used in the SIA include:

- Primary data generated through participant observation techniques;
- The South African Guideline for Involving Social Assessment Specialists in EIA (Barbour, 2007);
- The Kai !Garib Local Municipality Draft IDP of 2014;
- Orlight SA (Pty) Ltd's "Kenhardt Solar PV Power Plant"; BioTherm (Pty) Ltd's "Aries Solar PV Facility"; AES Solar Energy Limited's "Olvyn Kolk PV Power Plant" and the Eskom SOC's "Aries-Helios 765 kV transmission line upgrade");
- The 2011 Census report (Statistics South Africa (StatsSA), 2011); and
- Academic journal articles on the topics of vandalism, teenage pregnancy and poverty such as Ceccato and Haining (2005).

1.5 ASSUMPTIONS AND LIMITATIONS

Secondary data on the study area is very limited. The site visit was therefore intended to gather sufficient primary data to guide the SIA. However, information gathered during the site visit generally carries a medium level of confidence as the SIA is an applied research method, as opposed to a scientific research method. This means that much less time and resources are available for primary research and the subsequent verification of findings. As a result, the majority of significance ratings ascribed to both the potential positive and negative impacts of the proposed Kenhardt PV and Transmission Line projects were given a ***medium*** confidence rating.

The SIA[3] assumes that the majority of socio-economic impacts will be experienced in the town of Kenhardt; due to its proximity to the project site. It is however possible for socio-economic impacts to be experienced in other urban nodes close to the project site. The project boundary, in terms of socio-economics, is therefore arbitrarily constructed.

Various energy-related developments are present in the general study (i.e. within a 50 km radius) area and were considered in this study (e.g. Mulilo Renewable Project Developments (Pty) Ltd's "Phase 1 and Phase 2- Nieuwehoop Solar PV Power Plants"; Orlight SA (Pty) Ltd's "Kenhardt Solar PV Power Plant"; BioTherm (Pty) Ltd's "Aries Solar PV Facility"; AES Solar Energy Limited's "Olvyn Kolk PV Power Plant" and the Eskom SOC's "Aries-Helios 765 kV transmission line upgrade"). However, when considering cumulative impacts, the combined impacts of *all* developments in a given area should be considered; not only the impacts resulting from *similar* activities/projects. Clearly, considering the possible socio-economic impacts likely to result from all development in an arbitrarily defined study area is not practically possible in the limited timeframe of the EIA process. However, this SIA

[3] This study is a SIA as per the definition contained in the *Guideline for Involving Social Assessment Specialists in the EIA Process* (Barbour, 2007): "*Social impacts can be defined as 'The consequences to human populations of any public or private actions (these include policies, programmes, plans and/or projects) that alter the ways in which people live, work, play, relate to one another, organise to meet their needs and generally live and cope as members of society*'".

attempts to identify and understand the cumulative socio-economic impacts likely to result from the interaction of similar (i.e. solar energy and electrical infrastructure developments) development activities within the general study area. Section D of the BA Report and Chapter 4 of the EIA Report notes the developments within a 20 km radius that have been considered in order to assess cumulative impacts.

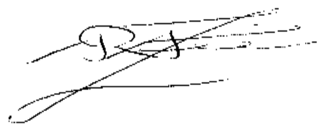
In terms of the employment estimates, the man months noted in this study, which are also known as “person months", is the total number of employees in each of the Contract Months, within the Construction Measurement Period and the Operating Measurement Period, as applicable. It should be noted that the said “person months” are, at present, best estimates only and could well change once the project is initiated.

1.6 DECLARATION OF INDEPENDENCE OF SPECIALIST

Refer to the beginning of Appendix D.7 and Appendix A of the EIA Report for the Curriculum Vitae of Rudolph du Toit, which highlights his experience and expertise. The declaration of independence by the specialist is provided in Box 1 below and included in Appendix I of the BA Report and Appendix B of the EIA Report.

BOX 1: DECLARATION OF INDEPENDENCE

I, Rudolph du Toit, declare that I am an independent consultant and have no business, financial, personal or other interest in the proposed Kenhardt PV Facilities and Transmission Lines Project, application or appeal in respect of which I was appointed, other than fair remuneration for work performed in connection with the activity, application or appeal. There are no circumstances that compromise the objectivity of my performing such work.



RUDOLPH DU TOIT

2 PROJECT CONTEXT (SOCIO-ECONOMICS)

2.1 PROJECT INFORMATION

As noted above, Scatec is proposing to develop three 75 MW Solar PV power generation facilities and associated electrical infrastructure (including transmission lines for each 75 MW facility) on the remaining extent of Onder Rugzeer Farm 168 and the connection points to the Eskom Nieuwehoop Substation on the remaining extent of Portion 3 of Gemsbok Bult Farm 120, approximately 80 km south of Upington and 30 km north-east of Kenhardt within the !Kheis Local Municipality, Northern Cape Province (Figure 2.1).

The three proposed 75 MW Solar PV facilities require a separate EIA Process and the three transmission line/electrical infrastructure projects (that will support the Kenhardt PV facilities) require a BA Process.

The following proposed transmission line and electrical infrastructure connectivity options have been considered in the BA Process:

- Each PV facility will be connected by a separate short 132 kV transmission line to the Eskom Nieuwehoop Substation that is currently being constructed on Farm Gemsbok Bult (remaining extent of Portion 3 of Farm 120); or
- Connect the Kenhardt PV 2 and Kenhardt PV 3 projects via separate 22/33 kV transmission lines to the proposed Kenhardt PV 1 on-site substation which will link via a 132 kV line to the Eskom Nieuwehoop Substation; or
- Construct one 132 kV transmission line from the Kenhardt PV 1 project to the Eskom Nieuwehoop Substation and connect the Kenhardt PV 2 and Kenhardt PV 3 facilities together via medium voltage transmission lines to either the on-site substation of Kenhardt PV 2 or PV 3, followed by the construction of one 132 kV transmission line from the on-site substation to the Eskom Nieuwehoop Substation.

The above connectivity options occur within an electrical infrastructure corridor (Figure 2.1).

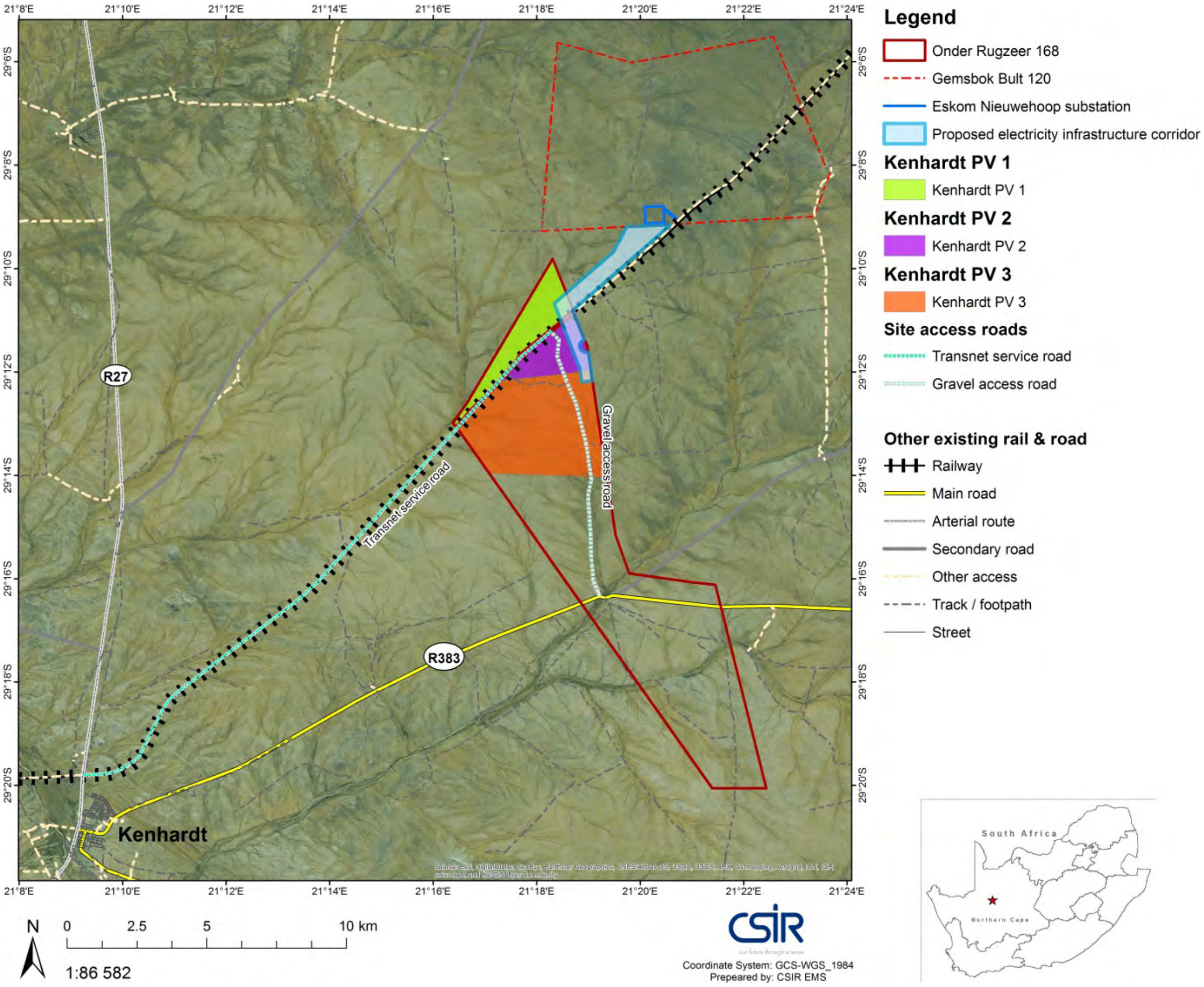


Figure 2.1 Preferred site locations of the three proposed Kenhardt PV solar developments (namely Kenhardt PV 1 (outlined in green); Kenhardt PV 2 (outlined in purple); and Kenhardt PV 3 (outlined in orange), and the transmission line projects (namely Kenhardt PV 1 – Transmission Line; Kenhardt PV 2 – Transmission Line; and Kenhardt PV 3 – Transmission Line) which will collectively occur within an electrical infrastructure corridor (outlined in blue).

The current land use of the proposed project areas, as well as the surrounding land parcels is zoned for agricultural development and use. The construction phase of each proposed solar PV facility would last approximately 14 months. The construction phase of each proposed transmission line (which is subject to the BA Process) is expected to last 12 to 14 months. However, it should be noted that the construction period is subject to the final requirements of Eskom and the REIPPPP Request for Proposal provisions at that point in time. Employment opportunities created during the construction phase for the PV projects equates to approximately 1 260 – 2 100 man months (for skilled opportunities) and approximately 5 600 - 6 400 man months (for unskilled opportunities) per project (i.e. three 75 MW PV projects in total). Employment opportunities created during the construction phase of each transmission line project are estimated to range between 1 560 and 1 820 man months. Table 2.1 lists the anticipated number of skilled and unskilled employment associated with the solar PV plant developments as well as the associated transmission lines projects. It should be noted that the employment opportunities provided in this report are estimates and is dependent on the final engineering design and the REIPPPP Request for Proposal provisions at that point in time.

Employment opportunities to be created during the operational phase equate to approximately 4 800 man months (for skilled opportunities) and approximately 9 600 man months (for unskilled opportunities) per project (i.e. three 75 MW PV projects in total) over the 20 year plant lifespan.

Scatec further proposes an Economic Development Plan which sets out to achieve the following:

- Create a local community trust which has an equity share in the project life to benefit historically disadvantaged communities;
- Initiate a training strategy to facilitate employment from the local community; and
- Give preference to local suppliers of components for the construction of the facility.

Table 2.1: Anticipated skilled and unskilled employment opportunities created during construction and operational phases of the project

EIA SOLAR PV PROJECTS:	
Construction Phase	**Man Months** **(Man months is also known as "Person Months": means the total number of Employees in each of the Contract Months, within the Construction Measurement Period and the Operating Measurement Period, as applicable, which are adjusted for the actual working time, compared to normal working time).**
Kenhardt PV 1 - between 90 and 150 skilled and 400 and 460 unskilled employment opportunities are expected be created during the construction phase.	Skilled: 90 * 14 months = 1260 man months Skilled: 150 * 14 months = 2100 man months Unskilled: 400 * 14 = 5600 man months Unskilled: 460 * 14 = 6440 man months
Kenhardt PV 2 - between 90 and 150 skilled and 400 and 460 unskilled employment opportunities are expected be created during the construction phase.	Skilled: 90 * 14 months = 1260 man months Skilled: 150 * 14 months = 2100 man months Unskilled: 400 * 14 = 5600 man months Unskilled: 460 * 14 = 6440 man months
Kenhardt PV 3 - between 90 and 150 skilled and 400 and 460 unskilled employment opportunities are expected be created during the construction phase.	Skilled: 90 * 14 months = 1260 man months Skilled: 150 * 14 months = 2100 man months Unskilled: 400 * 14 = 5600 man months Unskilled: 460 * 14 = 6440 man months
Operation Phase	
Kenhardt PV 1 - approximately 20 skilled and 40 unskilled employment opportunities will be created over the 20 year lifespan of the proposed facility	Skilled: 20 * 240 months = 4800 man months Unskilled: 40 * 240 months = 9600 man months
Kenhardt PV 2 - approximately 20 skilled and 40 unskilled employment opportunities will be created over the 20 year lifespan of the proposed facility.	Skilled: 20 * 240 months = 4800 man months Unskilled: 40 * 240 months = 9600 man months
Kenhardt PV 3 - approximately 20 skilled and 40 unskilled employment opportunities will be created over the 20 year lifespan of the proposed facility.	Skilled: 20 * 240 months = 4800 man months Unskilled: 40 * 240 months = 9600 man months
BA TRANSMISSION LINE PROJECTS:	
Construction Phase	
Transmission Line for PV 1 – about 130 employment opportunities, 30 % of which will accrue to previously disadvantaged individuals.	130 * 12 construction months = 1560 man months 130 * 14 construction months = 1820 man months
Transmission Line for PV 2 – about 130 employment opportunities, 30 % of which will accrue to previously disadvantaged individuals.	130 * 12 construction months = 1560 man months 130 * 14 construction months = 1820 man months
Transmission Line for PV 3 – about 130 employment opportunities, 30 % of which will accrue to previously disadvantaged individuals.	130 * 12 construction months = 1560 man months 130 * 14 construction months = 1820 man months
Operational Phase	
There will no additional new employment opportunities as the operation and maintenance of transmission lines is an Eskom competency.	n/a

It is important to note that a detailed project description is provided in Chapter 2 of the EIA Report and Section A of the BA Report.

2.2 LEGAL, POLICY AND PLANNING CONTEXT

The Draft Integrated Development Plan (IDP) (2014) for the Kai! Garib Local Municipality was considered in the drafting of this specialist study, due to its specific relevance to social and economic considerations related to proposed developments. Note that other key statutes were also considered in drafting this study (i.e. National Environmental Management Act (NEMA); National Heritage Act; and the Development Facilitation Act), but are discussed in greater detail in Section A of the BA Report and Chapter 4 of the EIA Report.

2.2.1 Constitution of the Republic of South Africa, 1996 (Act No. 108 of 1996)

Section 24 of the Constitutional Act states that everyone has the right to an environment that is not harmful to their health or well-being and to have the environment protected, for the benefit of present and future generations, through reasonable legislative and other measures, that –

i. Prevents pollution and ecological degradation;
ii. Promotes conservation; and
iii. Secures ecologically sustainable development and use of natural resources while promoting justifiable economic and social development.

In support of the above rights, the environmental management objectives of proposed projects are to protect ecologically sensitive areas and support sustainable development and the use of natural resources, whilst promoting justifiable socio-economic development in the towns nearest to the project sites.

2.2.2 National Environmental Management Act, 1998 (Act No. 107 of 1998)

The National Environmental Management Act, 1998 (Act No. 107 of 1998) (NEMA) requires cooperative environmental governance by establishing principles for decision making on matters affecting the environment, institutions that will promote cooperative governance and procedures for coordinating environmental functions exercised by organs of state. NEMA also aims to achieve sustainable development. In this regard NEMA requires the integration of social, economic and environmental factors into planning, implementation and decision-making to ensure that development serves present and future generations.

2.2.3 National Heritage Resources Act, 1999 (Act No. 25 of 1999)

The National Heritage Resources Act, 1999 (Act No. 25 of 1999) (NHRA) transfers responsibility for the identification of local heritage resources and the inclusion of heritage areas to all municipalities in South Africa. Developers/proponents need to integrate the NHRA into relevant planned projects and obtain approval (if necessary) from the relevant heritage authorities or municipalities before commence of the project.

2.2.4 Draft Integrated Development Plan, 2014 for the Kai !Garib Local Municipality

The objective of the IDP is to create an economically viable and maturely developed municipality, which enhances the standard of living of all the inhabitants and communities through good governance and excellent service. The IDP has identified key priority issues for the municipality.

2.2.5 Development Facilitation Act (Act 67 of 1995)

The Development Facilitation Act, 1995 (Act 67 of 1995) (DFA) sets out a number of key planning principles which have a bearing on assessing proposed developments in light of the national planning requirements. The planning principles most applicable to the study area include:

- Promoting the integration of the social, economic, institutional and physical aspects of land development;
- Promoting integrated land development in rural and urban areas in support of each other;
- Promoting the availability of residential and employment opportunities in close proximity to or integrated with each other;
- Optimising the use of existing resources including such resources relating to agriculture, land, minerals, bulk infrastructure, roads, transportation and social facilities;
- Contributing to the correction of the historically distorted spatial patterns of settlement in the Republic and to the optimum use of existing infrastructure in excess of current needs;
- Promoting the establishment of viable communities; and,
- Promoting sustained protection of the environment.

3 AFFECTED SOCIO-ECONOMIC ENVIRONMENT

The intention of this section is to provide background information of the socio-economic baseline conditions present in the study area. Information sources used to compile the socio-economic baseline consists of both primary (a site visit conducted on the 30 July 2014) and secondary research (relevant published literature and policy documents).

3.1.1 Socio-economic Baseline Data

3.1.1.1 Secondary Data

The study area is located within the ZF Mgcawu District Municipality (formally known as the Siyanda District Municipality). The actual project footprint (I.e. the remaining extent of Onder Rugzeer Farm 168 and the remaining extent of Portion 3 of Gemsbok Bult Farm 120 (for the connection points to the Eskom Nieuwehoop Substation)) is located in the !Kheis Local Municipality (part of the ZF Mgcawu District Municipality). However, the closest urban centre, Kenhardt, is located in the Kai !Garib Local Municipality. Given the proximity of the proposed projects to the town of Kenhardt; the focus of this SIA will be on the Kai !Garib Local Municipality (Figure 3.1), as this is where the vast majority of potential project impacts (both positive and negative) might manifest.

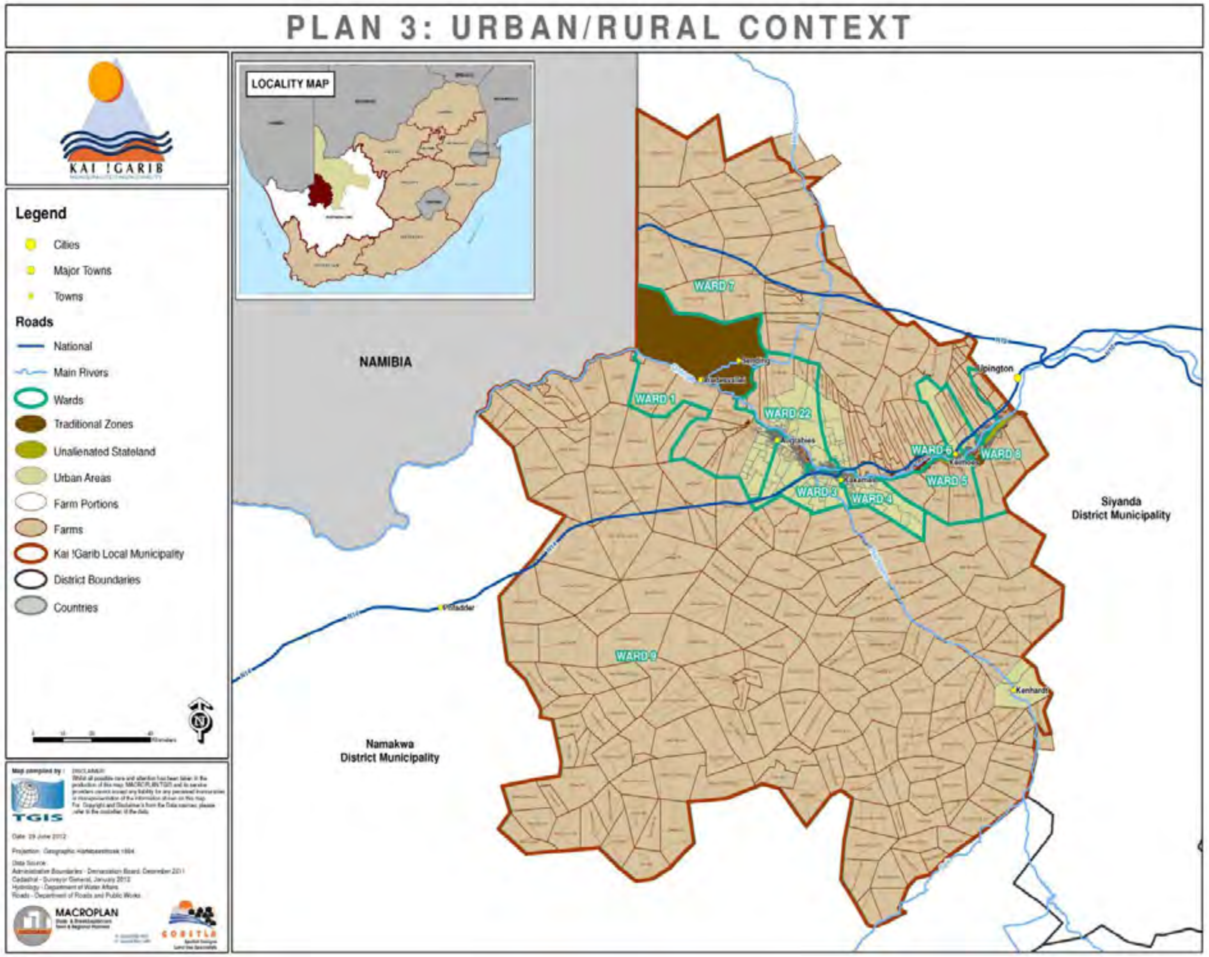


Figure 3.1 Kai !Garib Local Municipality

(Source: Kai !Garib Draft IDP, 2014)

According to the Kai !Garib Draft IDP (2014) and the Stats SA 2011 Census data, the total population of the Kai !Garib municipal area is 65 869; of which 6 679 resides in the Kenhardt area. A total of 16 703 households resides in the Kai !Garib Local Municipality, with 35% of households being female headed. The total female population dominates the total male population by 8.5% (Kai !Garib Draft IDP, 2014). Population of the working age demographic (15 to 65 years) makes-up 70.5% of the population, whereas those below 15 years of age comprises 24.4% of the population; the + 65 years age group makes-up 5.1% of the population. Accordingly, the dependency ratio (the economically active population vs the non-economically active population) is 41.9% (Stats SA, 2011).

The official unemployment rate of 10% has decreased by 6.1% since the 2011 Census measurement of 16.1%. The economic sector is dominated by agriculture which provides 51.8% of jobs, followed by the Community and Government Services sector with 15.9% (Figure 3.2).

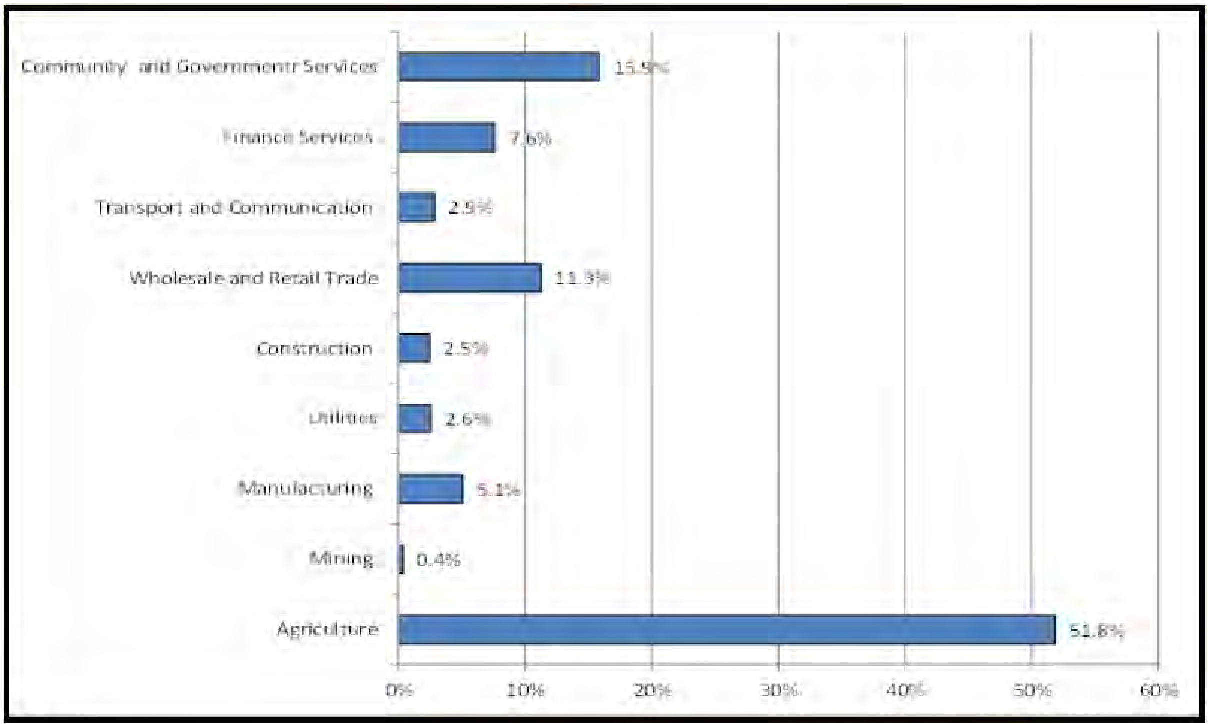


Figure 3.2 Most active economic sectors within the Kai !Garib Local Municipality

(Source Kai !Garib Draft IDP, 2014)

The major social challenges faced in the Kai !Garib Municipal area include (Kai !Garib Draft IDP, 2014):

- Increases in drug abuse;
- Increases in children under 10 years abusing alcohol;
- Increases in teenage pregnancies;
- Increased crime linked to alcohol and drug abuse;
- High youth unemployment rates; and
- Increased prevalence of HIV & AIDS.

3.1.1.2 Fieldwork

Clearly, the above mentioned figures and findings relate to the larger municipal area and subsequently provide limited detailed information regarding the actual study area (i.e. Kenhardt and surrounding areas). Furthermore, a dramatic difference in landscape character and environmental features occurs throughout the Kai !Garib municipal area that are due to the availability of irrigation water along the areas immediately adjacent to the Orange River. For example, due to the higher productivity of areas under irrigation, the total employment opportunities in the municipal area (especially in the agricultural and support services sector) tend to be limited to the banks of the Orange River. It is therefore safe to assume that Kenhardt, being located approximately 70 km away from the Orange River, has a different profile in terms of employment figures, as well as the various socio-economic impacts resulting from gainful employment. Consequently, it was deemed necessary to supplement the limited secondary data with a site visit to Kenhardt and the surrounding area to try and obtain useful data relating to socio-economic conditions.

Informants[4] in Kenhardt indicated that levels of unemployment in the town are particularly high. All informants interviewed indicated that the vast majority of the economically active population is dependent on some form of government subsidy (reported to be approximately R 1300 per person per month). These statements appear to be reliable given the very limited amount of businesses operating within Kenhardt. Businesses generally consist of liquor stores, restaurants and accommodation (Bed and Breakfast), with only one observed clothing store (PEP) and one general dealer (KLK). Employment figures for these businesses appear to range from a minimum of one to a maximum of four employees. Agriculture in the Kenhardt area is dominated by sheep farming which requires particularly low levels of labour (approximately 2-4 labours per farm) (R. Grobbelaar, personal communication, 31 July 2014), with limited seasonal increases in labour requirements during the shearing season. Larger employers in Kenhardt include the local high school, the Kai !Garib municipal offices, the Department of Social Development satellite office and the local police station.

Subsequently, the local labour market appears to offer very limited absorption of the economically active component (i.e. approximately 4675 employment opportunities, based on a 70.5% working age demographic for the Kai !Garib municipal area) of the 6679 inhabitants of the Kenhardt area.

Participant observation further supports the claim of high unemployment. Groups of young men (approximately 16 to 30 years of age) where observed loitering on various street corners during the normal working hours of both days of the site visit (a Wednesday and Thursday during the weekday). Furthermore, public infrastructure (public telephones, the public swimming pool and benches) where vandalised to such an extent that further use of these facilities is impossible. Acts of social disorder, such as loitering and vandalism, are

[4] Sociological research ethics dictates that the identity of informants (i.e. those being interviewed) should be protected if *any* possibility of physical, mental, emotional or legal harm exists. Accordingly, the identities of informants are not disclosed in this study.

regularly associated with poverty and elevated levels of distress within communities (Richardson & Shackleton, 2014). According to Fisher and Baron's (1982) Equity-Control Theory (ECT), acts of vandalism are often triggered by a perceived violation of norms related to fairness in terms of social and environmental arrangements. From this perspective, acts of vandalism can be understood as an attempt to reduce inequality.

Ceccato and Haining (2005) report that vandalism is particularly obvious in areas with low social integration and organisation; whereas Nowak *et. al.* (1990) reports higher levels of vandalism in areas with high unemployment rates and low private property ownership. A possible alternative interpretation of social disorder could be the "Broken Windows" theory put forward by Wilson and Keeling (1982). According to this theory, the presence of vandalism (or social disorder), however minor, creates a condition in which further vandalism is sanctioned; thereby increasing its frequency. However, acts of vandalism in Kenhardt were perpetrated in the formal, well maintained precinct of the town, as well as in the informal, poorly maintained precinct. This suggests that the "Broken Windows" theory does not apply to the observed social disorder in Kenhardt.

Informants further indicated that teenage pregnancies and drug abuse were major social issues in Kenhardt, and that the prevalence of these issues is increasing. This claim is validated by secondary data contained in the Kai !Garib Draft IDP (2014), which lists teenage pregnancy and drug abuse as major social challenges within the larger municipal area. Both these issues elevate the local dependency ratio, thereby placing already stressed livelihood strategies under even more strain.

Teenage pregnancy may be positively related to elevated levels of poverty, associated idleness and inappropriate forms or recreation (Were, 2007). Recreational opportunities in Kenhardt are extremely limited. A public rugby field and an oval racing track just outside of town are the only public recreational facilities offered. Informants identified an informal nightclub on the north-eastern outskirts of Kenhardt, which is associated (according to informants) with alcohol abuse and other forms of inappropriate recreation. Informants further confirmed that no internet cafes or public internet facilities are available in Kenhardt, which contributes to the overall lack of recreation/entertainment opportunities. Poverty and limited recreation opportunities may be contributing factors to the high teenage pregnancy rate. However, poor sex education, limited understanding of and access to modern contraception and lack of parental guidance are likely exacerbating factors.

With regards to teenage pregnancy; interviewed parents communicated disappointment and indignation, rather than concern about the practical implications of teenage pregnancy. This suggests a violation of existing cultural norms. It is therefore assumed that further escalation of teenage pregnancies (and/or teenage sexual activity) would continue to disrupt the Kenhardt community not only in terms of livelihoods, but also in terms of family relations. The relative lack of employment in and around Kenhardt is suggestive of a community heavily reliant on kinship and reciprocity for its economic survival. Accordingly, further deterioration of kinship ties as a result of cultural taboos might jeopardize the already precarious livelihood strategies of young mothers and their children.

A study of Kenhardt's urban form is revealing. The town displays typical apartheid planning structure, with a distinct poorer urban node (previously a coloured township) to the north and a wealthier urban node (previously white urban node) to the south. A clear buffer zone (*cordon sanitaire)* separates the two areas (Figure 3.3). The poorer urban node to the north is characterised by small ERF sizes, erratic street patterns, a significant informal housing component and no business nodes.

Conversely, the wealthier urban node to the south is characterised by larger ERF sizes, a clear grid patterned road infrastructure, a complete absence of informal structures and a business node in the shape of a ribbon development along the R 27. Furthermore, the secondary school, municipal offices, and local clinic are all located within the wealthier southern node. During fieldwork, it was also observed that informal traders are located throughout the poorer northern node, but are virtually absent from the wealthier southern node. Informants complained that informal shop owners and traders are generally foreign nationals and are not seen as 'members' of the community. This outsider versus insider experience, coupled with a dependency of the local community on the services offered by outsiders appears to generate feelings of distrust and vulnerability. A secondary issue might also be the potential "leakage" of investment from the local economy due to foreign nationals not reinvesting in Kenhardt, but rather evacuating their funds to friends and family abroad or residing elsewhere. This existing outsider versus insider phenomenon suggests that the local community could be sensitive to the influx of job seekers and other forms of in-migration into Kenhardt.

Interestingly, the poorer northern node is expanding, while the wealthier southern node remains unchanged. Figure 3.4 indicate the expansion of the northern urban node through satellite imagery from 2005 and 2013, respectively. The yellow polygons indicate new informal residential units and the orange polygons indicate densification of informal units. These images show a potentially significant residential growth in the poorer community of Kenhardt.

Figure 3.5 indicate the wealthier southern node in 2005 and 2013, respectively. No discernable growth in the formal residential housing stock can be observed. Fieldwork also revealed that some houses in the southern node are for sale. This suggests that the southern urban node may be shrinking.

The growth of informal housing in Kenhardt is difficult to explain as the town does not appear to offer any significant social or economic pull factors. Recent declines in local rainfall and subsequent knock-on effects on agriculture are unlikely to fully account for increased urbanisation, as sheep farming does not generate significant employment opportunities. It therefore seems reasonable to assume that the increase can, to a large degree, be attributed to natural growth. This would suggest that wealthier residents (residing in the south) have the ability to 'escape' from the area, should they wish to; whereas the poorer residents (residing in the north) are 'trapped' in the area, thereby causing a natural growth in population numbers. The general trend of declining birth rates among white South Africans might also be a contributing factor. This increase in population is bound to add additional strain on the livelihoods of the poor community.

The fastest growing industry in Kenhardt appears to be Bed and Breakfast (B&B) establishments. Observations during fieldwork indicated that B&Bs were the single largest industry (in terms of number of establishments, not turnover) in the town. This observation is supported by local informants who suggested that the growth in the industry is attributable to the recent increases in energy–related projects (solar energy and Eskom transmission lines) proposed in the area.

Informants further reported frustration regarding job creation expectations created by other developments in the area. Apparently, other energy-related developments in the Kenhardt area, for which EIA processes are currently underway, communicated to the community that employment opportunities will be offered to local residents. When residents established that these jobs would only materialise in 5 to 10 years' time; considerable frustration and anger was (and is) experienced. According to Barbour (2007), the expectation of an occurrence (in social terms) should be considered as an impact resulting from a planned development. Consequently, the Kenhardt community is likely to be particularly sensitive to similar expectation which could be created by the proposed development.

3.1.2 Vulnerability Context

According to the Department for International Development (DFID) (1999), a community's vulnerability context is a product of *trends*, *shocks* and *seasonality* within the context of the community being researched. Informants indicated that very little seasonal variation is experience in income levels and livelihood strategies; therefore seasonality is of negligible interest in the vulnerability context of the Kenhardt community. Shocks, interpreted as an impact of sudden occurrence which directly destroy assets or livelihood strategies, also appears to have a limited role in the Kenhardt community. Trends do however seem to have a significant impact on those living in the area. Of particular importance are the increasing trends in unemployment and social deviance (teenage pregnancies and drug abuse), as well as the decreasing trend in the relative contribution of agriculture to job creation in Kenhardt.

Figure 3.3 Urban form of Kenhardt, with the (i) red polygon indicating the historical coloured township, (ii) the yellow polygon indicating the historical white urban node; and (iii) the green arrow indicating the cordon sanitaire

Figure 3.4 Satellite image of the poorer (northern) urban node of Kenhardt in 2005 on the left, and a satellite image of the same node in 2013 on the right; with (i) the yellow polygons indicating urban expansion; and (ii) the orange polygon indicating densification.

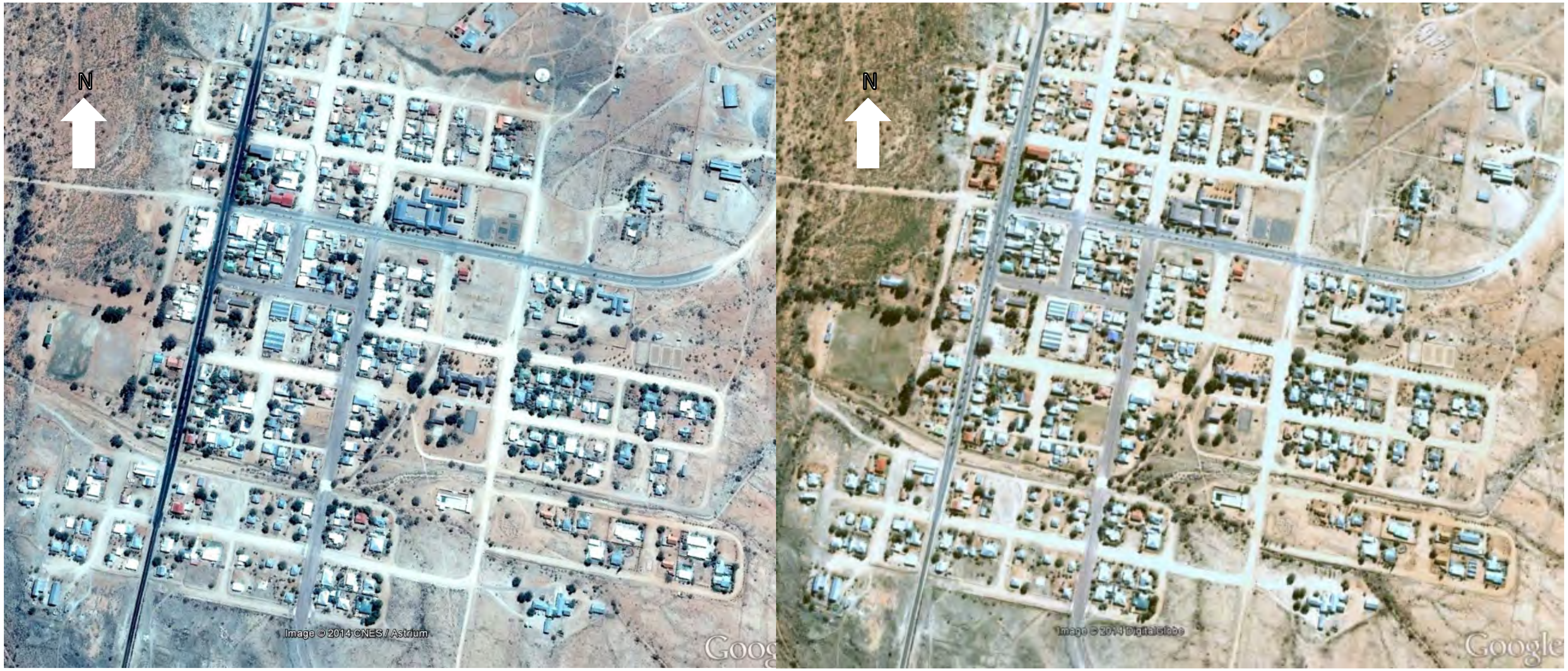


Figure 3.5 Satellite image of the wealthier (southern) urban node of Kenhardt in 2005 on the left, and satellite image of the same node of Kenhardt in 2013 on the right; indicating no discernible expansion or densification

People's access to productive assets (Human-, Social-, Natural-, Physical- and Financial capital) lie at the heart of their vulnerability context. Table 3.1 provides a brief explanation of the various forms of capital. Generally, the greater access people have to assets, the more livelihood strategies they have available and the easier it is for them to 'switch' from one strategy to the next. An effective way to assess access to assets is by using an Asset Pentagon (Figure 3.6).

The Asset Pentagon schematically represents variations in people's access to assets. The centre of the pentagon represents zero access to assets. Consequently, a resilient[5] community will have a pentagon characterised by a relative balance between all 5 forms of capital. Conversely, a pentagon wherein one or two capital classes dominate could be indicative of a vulnerable community.

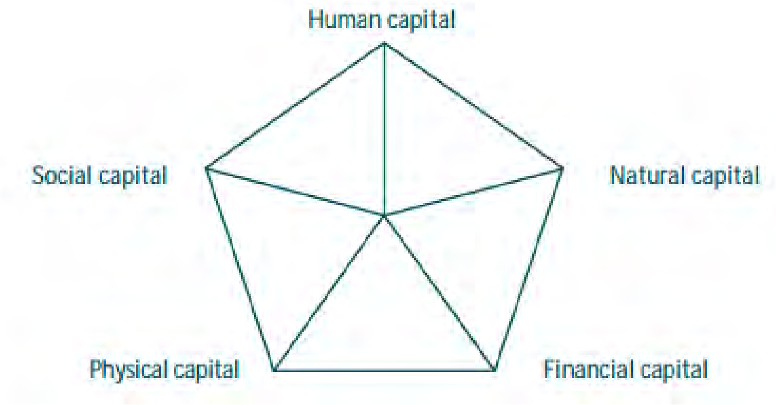


Figure 3.6 Example of an Asset Pentagon with 100% access to all 5 forms of capital

Table 3.1: Brief definition of the 5 capital forms

Capital class	Description
Human capital	Human capital signifies the ability to perform labour, skills-set, knowledge and health that empowers people to pursue different livelihood strategies and attain their livelihood objectives.
Social capital	These are the social resources available to people in the pursuit of their livelihood strategies. These include: networks and social connectedness, membership of formalised groups and/or relationships of trust reciprocity and exchange.
Natural capital	Natural capital refers to the natural resource stocks, flows and services which are beneficial for livelihoods. There are numerous natural resources that make up natural capital, from intangible services such as the atmosphere, to divisible assets used directly for production.
Physical capital	Physical capital is the basic infrastructure and producer goods, necessary for people to pursue their relevant livelihood strategies. Such capital includes; inexpensive transport, affordable energy, secure shelter, adequate and safe potable water supply, and access to information.
Financial capital	Financial capital simply refers to the financial resources people use to achieve their livelihood strategies. Generally financial capital consists of available stocks (savings, livestock, jewellery, etc.) or, regular inflows (pensions, remittances, government subsidies, etc.).
Source: DFID (1999)	

[5] The use of the term 'resilient' in this context should not be confused with 'resilience theory' (i.e. the ability of a system to accommodate change while still maintaining its core function structure and identity), but is here merely used to refer to adaptability and robustness.

The Kenhardt community appears to have acceptable access to both Human and Social capital. Informants reported that community members are generally in very good health and that most young adults have a secondary education. The high level of unemployment and the increasing number of teenage pregnancies present in Kenhardt requires robust social capital to prevent affected community members from falling into abject poverty. The relative success of the local community in preventing this, suggests that access to Social capital is satisfactory.

Access to Physical capital in Kenhardt seems average to low. The community has access to bulk services (water, electricity and waste collection), and a range of housing types ranging from formal to informal. Transport is not a significant factor within Kenhardt, due to its very small size; however, access to other urban areas (e.g. Keimoes, Kakemas and Upington) is limited to private transport. Informants also indicated that access to information and awareness of basic rights and public services are very low. Natural capital in Kenhardt is limited due to the harsh climatic conditions and general lack of irrigation water. As a result, community members appear to have limited access to productive natural assets. Finally, access to financial capital is very limited as the bulk of the vulnerable section of the Kenhardt community seems to be dependent on government subsidies and pensions.

Represented as an Asset Pentagon; the Kenhardt community's access to assets is indicated in Figure 3.7.

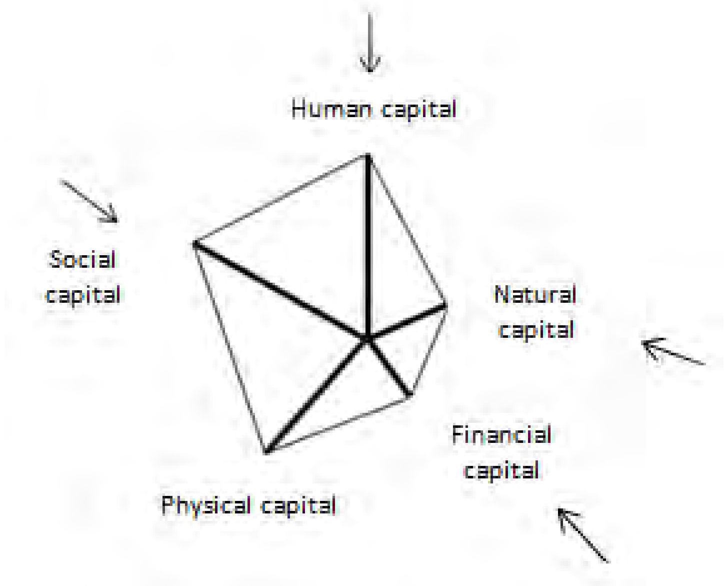


Figure 3.7 Kenhardt Asset Pentagon

The Kenhardt community appears to be vulnerable in terms of its livelihood strategies due to a relative imbalance in access to assets classes, with Human and Social capital dominating the pentagon. The arrows (Figure 3.7) indicate downward pressure (or trends) on the various asset classes. Climate change is expected to continue to deteriorate Natural capital; while high levels of unemployment coupled with a growth in population size is likely to weaken Human, Social and Financial capital. Future development in the Kenhardt area needs to take cognisance of the community's current vulnerability context. In this context, the proposed solar energy development could offer much need relief in terms of Human, Social and Financial capital through the creation of employment (even short-term employment) and local spending. Accordingly, the receiving social environment is not deemed to be sensitive (in a negative sense) to the proposed development, its structures and associated infrastructure.

3.1.3 Systems Analysis

A systemic analysis of the SES of Kenhardt is informed by the discipline of Systems thinking. According to Systems thinking, development (as proposed by Scatec) is introduced in complex systems of human-nature interaction. Such systems are open, functions in non-linear ways, are characterised by feedback loops and display emergence. Emergence is simply the creation of system characteristics which are not present in the individual variables constituting the system. Put differently, the sum of the individual parts does not necessarily equal the whole.

Systems thinking has been applied in this SIA for its ability to engage with complexity and uncertainty; something conventional reductionist and empirical research methods fails to do effectively. Of particular interest are the unintended consequences or causal relationships of the proposed development (indirect impacts), as well as the cumulative impacts likely to result from it. Such impacts are systemic consequences and are therefore complex in nature.

The CLD presented in Figure 3.8 is a simplified representation of the SES of which Kenhardt is part. The CLD contains system variables (i.e. goods, services and stocks of capital) displayed as boxes; linking relationships indicating the causal flow of goods, services and/or impacts which are displayed as arrows; and the polarity of causal flows (i.e. is the causal flow reinforcing or diminishing a subsequent variable), indicated by a "+" or "-" at the head of each arrow (reinforcing relationships are depicted in blue and diminishing relationships are depicted in red). Linking relationships represented by dashed arrows indicate weak causality, while solid arrows show strong causality (the thicker the arrow, the stronger the causal relationship). Together, these attributes of the CLD enables a more holistic understanding of causality and the relative impact of causal relationships.

Figure 3.8 consists of 27 causal relationships. However, of greatest importance to this study are relationships 9, 11 and 12. Relationship 9 indicates a strong causal relation between "Government subsidies" and "Livelihoods", wherein subsidies are heavily contributing to the livelihoods of the local community. Relationship 11 explains a strong causal link between "Energy sector developments" in the study area with "Livelihoods". Accordingly, new energy-related developments in the area are contributing significantly to livelihoods. Relationship 12 indicates that "Sheep farming" has a weak causal link with "Livelihoods", as it has a limited contribution to local livelihood strategies.

Both "Government subsidies" and "Energy sector developments" are variables which are sustained by exogenous capital flows (i.e. it is *not* generated and maintained by the

Kenhardt SES); however, both contribute significantly to local livelihood strategies. "Sheep farming" is endogenous to the SES (i.e. it *is* generated and maintained by the Kenhardt SES), but it is suggested that it only contributes weakly to local livelihoods. This suggests that the Kenhardt SES is vulnerable to exogenous shocks. Any proposed developments within the Kenhardt SES should therefore aim to reduce this vulnerability by growing the number of alternative endogenous livelihood strategies. The ability to choose from a variety of income streams (redundancy[6]) enables adaptive capacity within the system.

A second observation relates to relationships 21 and 22. Relationship 21 indicates a diminishing causal relationship between "Energy sector developments' and "Biodiversity". Similarly, relationship 22 explains a diminishing causal link between "Energy sector developments and "Tourism". These relationships demonstrate that energy related developments in the study area will ultimately reduce biodiversity and could also negatively impact on tourism. Clearly, this could impact negatively on livelihood strategies related to biodiversity and tourism. However, the significant vulnerability of the SES to exogenous shocks and the subsequent need to transform exogenous capital flows into endogenous adaptive capacity; suggests that *limited* loss of biodiversity, tourism and subsequent income is acceptable in order to achieve greater *systemic* resilience.

[6] Redundancy is used here in a systems perspective, and aims to indicate that the SES under consideration does not necessarily function at equilibrium levels (i.e. a balance between supply and demand of goods, services and functions). Accordingly, an oversupply of income generating options, though not resulting in equilibrium, does cause greater adaptive capacity by allowing people to change from one option to the next as needed.

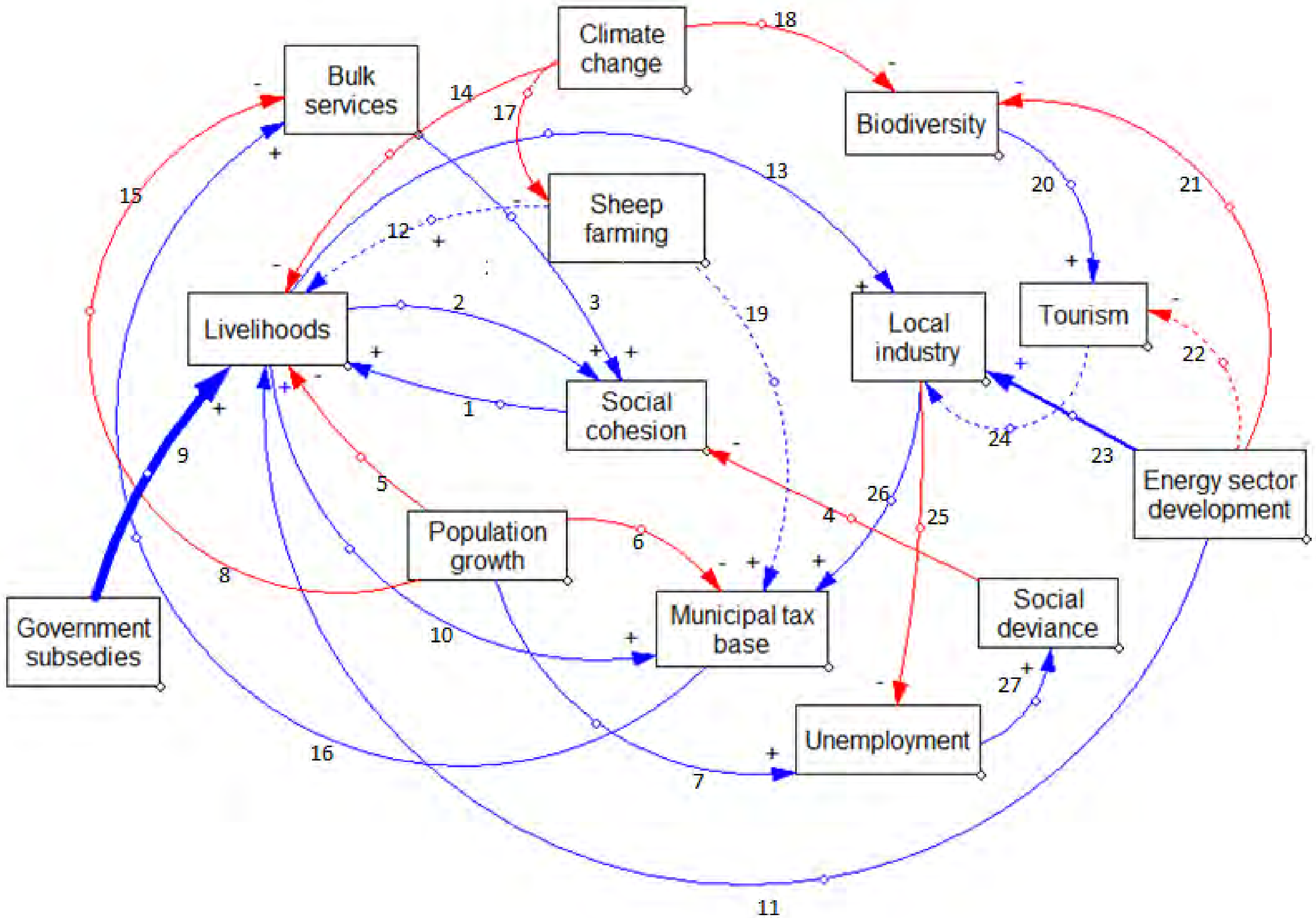


Figure 3.8 Causal Loop Diagram (CLD) of the Kenhardt Socio-ecological System (SES)

4 IDENTIFICATION OF KEY ISSUES AND ASSESSMENT OF IMPACTS AND IDENTIFICATION OF MANAGEMENT ACTIONS

This section of the report discusses the expected social impacts resulting from the proposed Solar PV and transmission line projects near Kenhardt. These impacts are discussed in terms of its construction-, operational- and/or decommissioning phase impacts. Impacts are determined based on the assessment methodology discussed in Section D of the BA Report and Chapter 4 of the EIA Report.

All proposed projects will result in the same anticipated impacts. This is due to the remote location of the actual project footprint and the subsequent absence of substantial concentrations of people (i.e. communities) wherein socio-economic impacts could manifest. As previously noted, Kenhardt is the closest settlement; accordingly, most of the significant socio-economic impacts are expected to be experienced here.

4.1 KEY ISSUES IDENTIFIED DURING THE PROJECT INITIATION AND SCOPING PHASE

By far the most significant driver of change likely to result from the proposed project is the influx of people into the study area, and the corresponding increase in spending and employment. Such an influx of “strangers” into the receiving environment is likely to cause a disturbance in the order of the existing social structure and might also lead to increases in social deviance. Increased spending and employment (even though such employment might be short-term) generates positive impacts through the multiplier effect and by providing much needed financial relief in the area. However, it also creates significant, and often unrealistic, expectations regarding potential employment. The specific influence of anticipated impacts on woman and children will be an important consideration in the SIA.

During the Project Initiation Phase in July 2015, the Background Information Document was made available to I&APs for a 30-day comment period. The Scoping Report was released for a 30-day comment period which extended from 25 September 2015 to 27 October 2015. The Addendum to the Scoping Report was also released for a 30-day comment period, extending from 6 October 2015 to 5 November 2015. The BA (and EIA) Report was also released for a 30-day comment period, extending from 3 March 2016 to 5 April 2016. To date, no specific comments have been raised by I&APs that relate to social impacts. However, the following comment relating to the change in land use was raised by the Northern Cape Department of Environment and Nature Conservation on 5 November 2015:

- The EIA should indicate how the Social-Agricultural-Conservation dynamic will change in terms of land use. Will the properties on which the developments occur still be actively farmed or will they become dormant or effectively be converted into conservation land with minimal land use management. Will problem animal control still occur as in standard practice in small livestock farming? How will fencing infrastructure change around the properties which has a bearing on problem animal control, but also on wildlife movement and landscape connectivity.

The above comment asks multiple questions, some of which fall beyond the scope of the SIA (e.g. issues related to conservation management, land-use management, fencing and problem animal control). However, the issue of whether the farms on which the developments are proposed will still be actively farmed once the developments are operational appears to have at least some bearing on social impacts likely to result from the project.

Given the limited footprint of the proposed developments in relation to the overall size of the relevant properties, and given the large surface area but low density nature of sheep farming; the likelihood of property owners abandoning their commercial farming operations as a result of the presence of the proposed solar PV plants on their properties appears unlikely. This is due to the fact that sheep farming will remain commercially viable and profitable on the remaining extents of the affected properties and it would therefore be economically irrational to abandon such a profitable income generating activity (in which the property owners have invested money over extended periods of time) simply because an additional income generating activity (i.e. solar PV plants) is present on their properties. Furthermore, to the best of the author's knowledge, other South African farms on which commercial-scale solar PV plants have been constructed are still being actively farmed. This would suggest that the abandonment of farming in favour of limited passive income from solar PV plants is a conceivable, but relatively unlikely impact to result from the proposed projects.

Comments raised during the Public Participation Process and responses thereto are included in Appendix E.3 of the finalised BA Report.

4.2 IDENTIFICATION OF POTENTIAL IMPACTS

Based on the status quo conditions of the study area and the nature of the proposed development, the following social impacts are identified:

- Influx of jobseekers;
- Increases in social deviance;
- Increases in incidence of HIV/AIDS infections;
- Expectations regarding jobs;
- Local spending;
- Local employment;
- Human development resulting from the proposed Economic Development Plan; and
- Job losses at the end of the project life-cycle.

The above mentioned impacts are discussed and assessed according to its relevant construction phase and operational phase (Section 4.3) and decommissioning phase (Section 4.4) impacts, as well as expected residual (Section 4.5) and cumulative impacts (Section 4.6) below.

4.3 CONSTRUCTION AND OPERATIONAL PHASE IMPACTS

Social impact discussed in this section is expected to occur in the construction phase and persist into the operational phase of the project.

4.3.1 Potential Impact 1: Influx of job seekers

Construction of the proposed projects is likely to attract job seekers to the town of Kenhardt. Such an influx generally causes a disturbance in the existing social order as prevailing leadership, kinship and social control mechanisms are challenged by new and alternative values, beliefs and practices. Disturbance of the existing social order commonly results in the deterioration of social capital and general disorientation of affected communities. Furthermore, in-migration is likely to place additional strain on formal housing and bulk services. This can lead to a growth in informal housing and a deterioration of hygiene conditions in informal areas. It should however be noted that influx of job seekers is considered as a social disruptor and not an impact in itself. Accordingly, disturbance in the existing social order might result from such an influx, or it might not. The influx of job seekers, in the interest of the precautionary principle, is treated as an impact for the purposes of this impact assessment process.

The potential impact is expected to be ***long to medium term*** in duration and ***local in extent***. Influx of job seekers into the study area is therefore rated as having a ***moderate significance (negative)*** rating before mitigation. Should the mitigation measures discussed below be implemented, this significance rating will drop to ***low***.

Mitigation

The proponent (Scatec) must develop a Workforce Recruitment Policy. This policy must clearly state the criteria used to allocate jobs. It is strongly recommended that the Workforce Recruitment Policy should reserve employment, where practically possible, for local residents (particularly for vulnerable groups such as women and previously disadvantaged individuals). This requirement should be contractually binding. Local in this regard is defined as firstly, the residents of Kenhardt (given its close proximity); followed by the residents of the other urban nodes in the immediate area (i.e. Grobelaarshoop, Marydale and Keimoes). Position should only be filled with outsiders should the requisite skills not be available in the study area.

The proponent must also clearly define who is considered to be local (Kenhardt) residents; known as the Project Affected People (PAP). This should ideally be conducted in collaboration with the local community and local government structures. The purpose of demarcating the PAP is to develop a criterion of characteristics considered to identify a given job seeker as a PAP. Once this criterion is known; all subsequent job seekers can be screened against it in order to determine whether they qualify for employment. The criterion for a PAP should be incorporated into the Workforce Recruitment Policy.

It is also suggested that the proponent assembles a database of local residents and their relevant skills and experience (in collaboration with local structures such as the NGO

Marcyrox: www.marcyrox.org) well in advance of the construction phase of the project. This will assist in the early identification of a suitable workforce. Should a similar database already be available in the study area; it can be used by the proponent to achieve the same purpose. However, such an existing database must be regarded as legitimate by the local community in order for it to be used as a substitute by the proponent.

Finally, the proponent must develop a Stakeholder Engagement Plan which sets-out the communication strategy to be followed with regards to the proposed projects. This should be done well in advance of the construction phase of the project. The intention of the plan should be to ensure that all project related information (including those related to employment) is communicated: (*i*) accurately; (*ii*) timeously; (*iii*) to the appropriate constituency; (*iv*) in an appropriate format; and is aimed towards fostering realistic expectations.

4.3.2 Potential Impact 2: Increases in social deviance

In-migration into the study area, particularly Kenhardt, could lead to an increase the incidence of teenage pregnancies, drug abuse, prostitution and other socially deviant behaviour. As discussed above, such increases are associated with the social disturbance caused by in-migration; however, it is also related to a growth in alternative livelihood strategies (e.g. prostitution) and conflict regarding limited employment opportunities. Increase in socially deviant behaviour could deteriorate both Social and Human capital through the violation of cultural norms and values (Social capital), as well as through the spread of Sexually Transmitted Diseases (STDs) (Human capital).

This impact is expected to be ***long term to medium term*** in duration and ***local*** in extent. Increases in social deviance within the study area are therefore rated as having a ***moderate significance (negative)*** rating before mitigation which drops ***to low significance*** after mitigation. Increases in social deviance are extremely difficult to control and often lies outside the exclusive control of the proponent as it is driven by complex socio-ecological conditions related to poverty and feelings of hopelessness.

Mitigation
Mitigation against increases in social deviance is largely indirect in nature. In other words, the overall success of the project and the ability and commitment of the proponent to involve the local community in the benefits of the project is of much greater importance than direct interventions. This is due to the need to change the prevailing conditions of unemployment, poverty and disempowerment, as opposed to command and control mechanisms aimed at simple regulation of activities.

The mitigation measures proposed for Potential Impact 1 must also be used to mitigate impacts resulting from increases in social deviance, as Potential Impact 1 is a precursor to Potential Impact 2. Furthermore, the proponent should be contractually bound to deliver on its Economic Development Plan for the area once the proposed projects are successfully awarded preferred bidder status.

Though not an official mitigation measure; it is proposed that the proponent seeks to actively engage with Marcyrox NPC to investigate possible synergies in community development within Kenhardt.

4.3.3 Potential Impact 3: Expectations regarding jobs

Informants in the Kenhardt area indicated a significant level of frustration with other potential developments in the area due to expectations related to possible employment. Unrealised expectations in a poor community could lead to feelings of desperation, disempowerment, anger and a general distrust in developers. In isolated cases, such frustration of expectations might lead to malicious damage of project property and intimidation of employees.

The impact is expected to be ***short term*** in duration and ***local in extent***. Influx of job seekers into the study are is therefore rated as having a ***low (negative)*** rating before mitigation. Should the mitigation measures discussed below be implemented, this significance rating will drop to ***very low***.

Mitigation
It should be recognised that expectations of employment are probably unavoidable in totality. However, proper implementation of the Stakeholder Engagement Plan proposed for Potential Impact 1 should lead to realistic expectation of employment for most of the local community. It is important to note that communication should not only elaborate on what kind of employment is on offer and to whom it is offered; but also the worst-case timeframe for such employment to commence. Forewarned community members are better equipped to adjust livelihood strategies to the variability of the project timeframe.

4.3.4 Potential Impact 4: Local Spending

Procurement of goods and services in the Kenhardt area during the construction and operational phases of the proposed projects is likely to hold socio-economic benefits as a result of the multiplier effect (i.e. the increase in final income resulting from a new injection of spending). Such benefits are already evident in Kenhardt as a result of other energy-related developments in the area. As indicated earlier, B&B establishments appear to dominate local industry in Kenhardt as a result of increased numbers of consultants and project staff frequenting the area. It is therefore reasonable to assume that the proposed project will result in similar positive impacts.

A secondary positive impact might result from entrepreneurial development in the project area, whereby niche and/or supporting goods and service industries are developed in response to the demand created for such services in the area. It is important to note the unintended consequence related to this positive impact. Clearly, the economic pull factors created by demand could lead to the in-migration of outsiders.

The impact is expected to be ***medium to long term*** in duration and ***local in extent***. Local spending in the study area is therefore rated as having a ***low significance (positive)*** rating.

Enhancement
The proponent must procure goods and services, as far as practically possible, from within the project area (with a focus on Kenhardt). Only if required goods and services are not available in the study area should the proponent seek to obtain it elsewhere. It is also suggested that regularly required goods and services (e.g. food and accommodation) be obtained from as large a selection of service providers as possible to ensure distribution of project benefits.

4.3.5 Potential Impact 5: Local Employment

The creation of short term employment for low skilled community members in the study area, though not ideal, does provide much needed temporary financial relief, while also contributing to a sense of empowerment and dignity. The limited number of long term employment offered by the proponent provides long term (small scale) socio-economic benefit to the affected community and may also contribute to the multiplier effect, as more income generally results in greater spending.

Local employment not only improves access to Financial capital, but also boosts Human and Social capital as skills sets and experience increases and reciprocal and kinship relationships are invigorated through the ability to give and support. Importantly, on an individual level, employment has the ability to empower people. Such empowerment could lead individuals (and communities) to perceive themselves not as suffering entities, but as active, doing entities that has the ability and potential to change their environment in a positive way (Davids, Theron & Maphunye, 2005).

The impact is expected to be ***long term*** in duration and ***local in extent***. Local employment is therefore rated as having a ***moderate significance (positive)*** rating.

Enhancement
As recommended for Potential Impact 1, the proponent must develop a Workforce Recruitment Policy. This policy should reserve employment, where practically possible, for local residents (particularly for vulnerable groups such as women and previously disadvantaged individuals). This requirement should be contractually binding on the proponent.

Though not an official mitigation measure; it is proposed that the proponent actively engages with the local government and other NGOs and CBOs to investigate how skills can be developed to enable short term workers to gain the necessary skills in pursuit of longer-term employment. Such employment does not necessarily have to be with Scatec.

4.3.6 Impact 6: Human development via the proposed Economic Development Plan

Scatec indicated that an Economic Development Plan will be developed, should the proposed project be successful (i.e. selected as a preferred bidder, not merely obtaining a positive Environmental Authorisation). The proposed Economic Development Plan aims to achieve the following broad objectives:

- Create a local community trust which has an equity share in the project life to benefit historically disadvantaged communities;
- Initiate a training strategy to facilitate employment from the local community; and
- Give preference to local suppliers of components for the construction of the facility.

It is recognised that this plan is still in its infancy and will be refined once the proposed project has reached maturity. However, it is clear that even the obtainment of the broad objectives alone will result in significant positive and negative impacts.

The positive impacts are self-evident and will relate to the creation of employment, local spending and human capacity development. However, the attainment of these positive impacts will create substantial social and economic pull factors which are likely to attract job seekers. Such job seekers will not only be attracted by the employment offered by Scatec, but also by the secondary growth and development which might result from the Economic Development Plan. Accordingly, negative socio-economic impacts resulting from in-migration are inherent to the positive impacts of the Economic Development Plan. Such negative impacts are however considered to be acceptable in light of the much needed development in the area. Furthermore, these negative impacts are largely unavoidable, especially through EIA-level (i.e. project-level) interventions; as it is caused by complex structural inequalities which needs to be addressed at a strategic policy level. Subsequently, no mitigation is proposed.

The impact is expected to be ***long term*** in duration and ***local in extent***. Human development is therefore rated as having a ***moderate significance (positive)*** rating.

<u>Enhancement</u>

A systems thinking approach (discussed in Section 2.2.3) reveals that the SES of which the Kenhardt area is a part of, can be considered to be vulnerable. This vulnerability is attributed to, amongst others, the system's disproportional dependence on exogenous flows of capital for its continued existence. It is therefore imperative to build resilience within the SES to enable greater adaptive capacity. Such adaptive capacity could be created by growing the skills base of the local community. However, such skills development should not be limited to vocational training relevant to the solar energy industry, but should also be extended to address life skills and other relevant skills/competencies as might be required.

The Economic Development Plan, once fully developed, must be implemented. It is also proposed that the proponent should engage with local NGOs, CBOs and local government structures to identify and agree upon relevant skills and competencies required in the Kenhardt community. Such skills and competencies should then be included in the proponent's Economic Development Plan. The proponent must also align economic development and skills development initiatives with the Kai !Garib Local Municipality's IDP objectives.

4.4 DECOMMISSIONING PHASE IMPACTS

Impacts identified in this section are expected to occur during the decommissioning phase of the proposed projects. Decommissioning of the proposed solar energy developments and transmission lines entails termination of most (if not all) local created employment opportunities.

4.4.1 Impact 7: Job Losses

It is expected that the proposed projects could be decommissioned after an operational lifespan of approximately 20 years. Decommissioning of the proposed development will result in job losses. Though unavoidable in projects of this nature, appropriate measures should be taken to plan for such retrenchments and to provide the affected community with alternatives where practical and appropriate. Secondary impacts might result from incorrect decommissioning of project infrastructure which might be used for inappropriate purposes. This in turn could result in health and safety impacts on the local community.

This impact is expected to be ***long term*** in duration and ***local*** in extent. Job losses resulting from decommissioning within the study area are therefore rated as having a ***moderate significance (negative)*** rating before mitigation and ***low (negative)*** with mitigation. This impact is however considered to be acceptable in light of the local need for employment and development.

Mitigation
The proponent must comply with relevant South African labour legislation when retrenching employees. Scatec should also consider appropriate succession training of locally employed staff earmarked for retrenchment during decommissioning. Such training could gradually equip workers to enter gainful employment in other locally viable sectors. Finally, all project infrastructures should be decommissioned appropriately and thoroughly to avoid misuse.

4.5 RESIDUAL IMPACTS

A number of potential negative socio-economic impacts resulting from the proposed projects are likely to persist regardless of proposed mitigation measures. Increases in social deviance are unlikely to be mitigated completely and a certain measure of social disruption and loss of social capital must be accepted as part of the proposed developments. Secondly, an influx of job seekers will occur in spite of the mitigation proposed. In-migration is a double edged sword; as not all in-migration necessary leads to social disruption. Lastly, job losses once the project reached the end of its operational lifespan are unavoidable.

4.6 CUMULATIVE IMPACTS

Socio-ecological cumulative impacts associated with the proposed projects, as with most cumulative impacts, are notoriously difficult to predict. Part of this challenge is due to the fact that a certain level of educated guesswork is required in order to construct a probable picture of the future as it relates to socio-economics in particular and the development in the area in general. Significant subjectivity in this regard should not be denied, nor should it be rejected. When faced with complex problems, like cumulative impacts, conventional reductionist and empirical processes tend to become less useful. It is therefore appropriate to employ subjective (but informed) reasoning as a pragmatic solution.

Development of more solar energy facilities and associated electrical infrastructure (such as transmission lines) in the study area is likely to negatively impact on biodiversity, farming and tourism. These impacts might further negatively affect local industries, and consequently diminish certain livelihood strategies. However, the relationship of biodiversity, tourism and farming to the majority of local livelihood strategies is weak (Section 3.3.3). As a result, cumulative impacts on biodiversity, tourism and farming in the study area appear to be acceptable.

Similarly, the incidence and severity of the in-migration of job seekers as well as increases in social deviance might increase as more solar energy facilities and associated electrical infrastructure (such as transmission lines) are developed in the study area. This is of importance as several other solar energy developments are being proposed in the Kenhardt area (e.g. the Mulilo Renewable Project Developments (PTY) Ltd Nieuwehoop Phase 1 and Phase 2 solar energy developments), as listed in Section D of the BA Report and Chapter 4 of the EIA Report. However, such increases are also associated with most other forms of economic and social development and should therefore be expected from any industrial scale developments in the study area.

Finally, the cumulative success of the proposed project and other projects offering significant socio-economic benefits are likely to present a major economic pull factor which might exacerbate in-migration into the study area as well as increases in social deviance. However, the cumulative socio-economic benefit offered by industrial scale development in the study area outweighs the negative impacts associated with economic growth. It should also be borne in mind that influx of job seekers does not necessarily equate in social deviance; i.e. influx of job seekers is a social disruptor which *could* result in social impacts. Given the relative balance between cumulative benefits and impacts, the significance rating ascribed to the cumulative impact of the proposed development is rated as is expected to be of ***long term to medium term*** in duration, ***local*** in extent and of ***moderate significance*** (negative) rating.

Table 4.1: Impact rating table

Aspect/ Impact pathway	Nature of potential impact/risk	Status	Spatial Extent	Duration	Consequence	Probability	Reversibility of impact	Irreplaceability of receiving environment/resource	Potential mitigation measures	Significance of impact/risk = consequence x probability		Ranking of impact/risk	Confidence level
										Without mitigation /management	With mitigation /management (residual risk/impact)		
CONSTRUCTION AND OPERATIONAL PHASE													
Impact 1: Influx of job seekers into the Kenhardt area	Disruption of existing social structures	Negative	Local	Medium to Long-term	Substantial	Likely	Low	Moderate	• Develop and implement a Workforce Recruitment Plan • Reserve employment, where practical, for local residents • Clearly define and agree upon the PAP • Develop a database of PAP and their relevant skills and experience • Develop and implement a Stakeholder Engagement Plan	Moderate	Low	4	Medium

Aspect/ Impact pathway	Nature of potential impact/risk	Status	Spatial Extent	Duration	Consequence	Probability	Reversibility of impact	Irreplaceability of receiving environment/resource	Potential mitigation measures	Significance of impact/risk = consequence x probability		Ranking of impact/risk	Confidence level
										Without mitigation /management	With mitigation /management (residual risk/impact)		
Impact 2: Outsiders moves into the Kenhardt area	Increases in social deviance	Negative	Local	Medium-term	Substantial	Likely	Low	Moderate	• Develop and implement a Workforce Recruitment Plan • Reserve employment, where practical, for local residents • Clearly define and agree upon the PAP • Develop a database of PAP and their relevant skills and experience • Develop and implement a Stakeholder Engagement Plan • Delivery on the Economic development Plan must be contractually binding on the proponent	Moderate	Low	4	Medium

Aspect/ Impact pathway	Nature of potential impact/risk	Status	Spatial Extent	Duration	Consequence	Probability	Reversibility of impact	Irreplaceability of receiving environment/resource	Potential mitigation measures	Significance of impact/risk = consequence x probability		Ranking of impact/risk	Confidence level
										Without mitigation /management	With mitigation /management (residual risk/impact)		
Impact 3: Expectations created regarding possible employment	Increased frustration in the local community	Negative	Local	Short-term	Moderate	Likely	High	Moderate to low	• Develop and implement the Stakeholder Engagement Plan	Low	Very low	5	Medium
Impact 4: Local spending	Socio-economic benefits as a result of the multiplier effect	Positive	Local	Medium to long-term	Moderate	Likely	n/a	n/a	• Procure goods and services, where practical, within the study area • Obtain regularly required goods and services from as large a selection of local service providers as possible	Low	Low	4	Medium
Impact 5: Local employment	Socio-economic benefits	Positive	Local	Long-term	Substantial	Very likely	n/a	n/a	• Develop and implement a Workforce Recruitment Policy	Moderate	Moderate	3	High

Aspect/ Impact pathway	Nature of potential impact/risk	Status	Spatial Extent	Duration	Consequence	Probability	Reversibility of impact	Irreplaceability of receiving environment/resource	Potential mitigation measures	Significance of impact/risk = consequence x probability		Ranking of impact/risk	Confidence level
										Without mitigation /management	With mitigation /management (residual risk/impact)		
Impact 6: Economic Development Plan	Contribute to local employment, local spending and human capacity development	Positive	Local	Long-term	Substantial	Very likely	n/a	n/a	• The proponent should engage with local NGOs, CBOs and local government structures to identify and agree upon relevant skills and competencies required in the Kenhardt community • Such skills and competencies should then be included in the Economic Development Plan • Where possible, align Economic development Plan with Local Municipality's IDP	Moderate	Moderate	3	High
DECOMMISSIONING PHASE													

Aspect/ Impact pathway	Nature of potential impact/risk	Status	Spatial Extent	Duration	Consequence	Probability	Reversibility of impact	Irreplaceability of receiving environment/resource	Potential mitigation measures	Significance of impact/risk = consequence x probability		Ranking of impact/risk	Confidence level
										Without mitigation /management	With mitigation /management (residual risk/impact)		
Impact 7: Decommissioning of the proposed development	Job losses	Negative	Local	Long-term	Substantial	Very likely	Moderate	Moderate	• The proponent should comply with relevant South African labour legislation when retrenching employees • Scatec should also implement appropriate succession training of locally employed staff earmarked for retrenchment during decommissioning • All project infrastructures should be decommissioned appropriately and thoroughly to avoid misuse	Moderate	Low	4	High

Aspect/ Impact pathway	Nature of potential impact/risk	Status	Spatial Extent	Duration	Consequence	Probability	Reversibility of impact	Irreplaceability of receiving environment/resource	Potential mitigation measures	Significance of impact/risk = consequence x probability		Ranking of impact/risk	Confidence level
										Without mitigation /management	With mitigation /management (residual risk/impact)		
CUMULATIVE IMPACTS													
Exacerbated in-migration	Disruption of social structures	Negative	Local	Medium to long-term	Substantial	Likely	Low	Moderate	n/a	Moderate	Moderate	3	Medium

5 INPUT TO THE ENVIRONMENTAL MANAGEMENT PROGRAMME

The key mitigation measures proposed by the specialist, and which needs to be included in the EMPr are listed below.

Construction and Operational Phase Mitigations:

- Develop and implement a Workforce Recruitment Plan;
- Reserve employment, where practical, for local residents;
- Clearly define and agree upon the PAP;
- Develop a database of PAP and their relevant skills and experience, or use an existing legitimate database of skills and expertise;
- Develop and implement a Stakeholder Engagement Plan;
- Delivery on the Economic Development Plan must be contractually binding on the proponent;
- Procure goods and services, where practical, within the study area;
- Obtain regularly required goods and services from as large a selection of local service providers as possible;
- The proponent should engage with local NGOs, CBOs and local government structures in the Kenhardt community to identify and agree upon relevant skills and competencies required;
- Such skills and competencies should then be included in the Economic Development Plan; and
- Where possible, align the Economic Development Plan with Local Municipality's IDP.

Decommissioning Phase Mitigations

- The proponent should comply with relevant South African labour legislation when retrenching employees;
- Scatec should also consider appropriate succession training of locally employed staff earmarked for retrenchment during decommissioning; and
- All project infrastructures should be decommissioned appropriately and thoroughly to avoid misuse.

Monitoring recommendations for the above mitigation measures are included in the complete EMPr (included as Part B of the EIA Report and Appendix G of the BA Report).

6 CONCLUSION AND RECOMMENDATIONS

Very little socio-economic data is available for the study area. Census data and information from the Kai !Garib Local Municipality Draft IDP (2014) was obtained; however, these only deal with the larger municipal area and offer no site specific data on socio-economic conditions within and around the town of Kenhardt. Secondary data was subsequently augmented by a site visit. The site visit suggests that Kenhardt is an area of low employment, substantial poverty and limited livelihood strategies. Access to Human and Social capital appears to be acceptable, while access to Physical capital seems average. However, access to Natural and Financial capital is limited. This constrained access to capital limits the ability of vulnerable members of the community to adapt livelihood strategies should it be required; which results in vulnerability.

The main income source among vulnerable communities appears to be government subsidies, with limited income generated from employment within industries operating in Kenhardt. Social deviance (i.e. teenage pregnancy and drug abuse) is a major challenge in the area. Such deviance could threaten Social capital on which much of the existing livelihood strategies depend. Unemployment seems to be the single greatest challenge and problem driver in Kenhardt. Not only does unemployment deprive community members from income, it also constrains empowerment and the subsequent ability to perceive one's subjective social reality as meaningful. This more often than not exacerbates social deviance.

Vulnerable community members might be negatively impact by the proposed project through the influx of opportunistic job seekers. Such an influx might threaten existing social structures and could lead to increased pressure on bulk services and housing. Social deviance might also be increased as a result of the proposed project; as deviant behaviour (e.g. prostitution and teenage pregnancy) are likely to increase as more outsiders migrate into Kenhardt in search of employment. Frustrated expectations of employment, created by the proposed development, could also contribute feelings of distrust in the developer and, in isolated instances, damage to project property and potential intimidation of staff. Furthermore, the likelihood of job losses once the proposed project reaches its decommissioning phase is high.

Positive socio-economic impacts likely to result from the project are increased local spending, the creation of local employment opportunities and the proposed development of an Economic Development Plan. These impacts will benefit the community through the creation of income generation opportunities and human development through skills development and training.

No conditions are proposed for inclusion in the environmental authorisation.

It should be noted that from a social perspective, the applicant can select any 250 ha area within the larger **surveyed** area to build the PV plants and associated transmission lines, provided that the recommended mitigation measures are implemented as applicable. As explained earlier, this is due (i) to the relative homogenous nature of the surveyed area, and (ii) the relative remoteness of the surveyed area in relation to any major urban node or human settlement where social impacts are likely to manifest.

6.1 OVERALL SIGNIFICANCE RATING AND SPECIALIST OPINION

The overall significance rating of the *negative* socio-economic impacts associated with the proposed project is ***low to moderate***; whereas the overall significance rating of the *positive* socio-economic impacts associated with the proposed development is ***moderate***.

It should be accepted that the development of the proposed projects is likely result in some form of negative social impact to the local community. However, such a negative impact needs to be weighed against the potential benefit likely to result from the same development. Given the overall medium significance negative impact of the project, as compared to the overall medium-high significance positive impact of the project; it can be concluded that the prospective socio-economic benefits of the proposed project outweighs the socio-economic losses/impacts. In addition, the local vulnerability context strongly suggests that acceptable, though declining, levels of Social and Human capital is present within the Kenhardt community, which should assist with the mitigation of potential negative socio-economic impacts resulting from the proposed project. Conversely, very limited Financial capital is available in the local community, which in turn adds to the erosion of existing Social and Human capital. Accordingly, there appears to be a clear need to invest in the development of Financial capital within the Kenhardt community in order to restore some level of balance between asset classes which in turn should facilitate more options to local community members in terms of viable livelihood strategies.

From a social impact perspective, in light of the above argument, the specialist conducting this SIA is of the opinion that the proposed projects should be authorised by the competent authority.

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APPENDIX A: EXTERNAL REVIEW REPORT

EXTERNAL PEER REVIEW

OF THE REPORT:

Social Impact Assessment for the Proposed 75 MW Solar Photovoltaic Facility and associated Transmission Lines on the remaining extent of Farm Onder Rugzeer 168, north-east of Kenhardt, Northern Cape Province.

PEER REVIEWER	**LIZA VAN DER MERWE**
EXPERTISE	• Resettlement Planning and Implementation • Social Impact Assessment • Land Acquisition • Social Monitoring
YEARS OF EXPERIENCE	• 28 Years
ORGANISATION	• Independent Consultant

PROJECT	Proposed 75 MW Solar Photovoltaic Facility and associated Transmission Lines
LOCATION	Remaining extent of Farm Onder Rugzeer 168, north-east of Kenhardt, Northern Cape Province
PROPONENT	Scatec Solar SA 163 (PTY) Ltd
EAP	CSIR
REPORT AUTHOR AND AFFILIATION	Rudolph du Toit (CSIR)
REPORT DATE	January 2016

3 February 2016

CONTENTS

1. BACKGROUND

I was appointed by the CSIR on 22 January 2016 to provide expert peer review of the above mentioned Social Impact Assessment (SIA) report. The peer review encompasses issues which include:

- Adequacy of the Social Impact Assessment (SIA);
- Validity of the report content; and
- Benchmarking against best practice.

2. DECLARATION

I **Liza van der Merwe**, declare that I am independent expert and that no conflict of interest exists in the performance of my review for the CSIR. In familiarising myself about the project, I have read the SIA report.

Liza van der Merwe
31 January 2016

3. SCOPE OF REVIEW

The scope of the review of the SIA report includes a focus on:

- Objective and non-judgemental presentation of information;
- Scientific validity and robustness of SIA methods;
- Technical credibility of report content;
- Impacts to be disaggregated from the impacts of other projects and the background social environment;
- Clear and systematic logic in identification of cause and effect relationships in terms of impact identification, quantification and assigning significance;
- Appropriateness and soundness of proposed mitigation and/or enhancement actions;
- Logical and systematic presentation of information;
- Identification of information gaps;
- Probability of alternative interpretations of impacts; and
- SIA Report is consistent with best practice.

4. REVIEW CRITERIA

The review is structured to assess the report in a systematic manner in terms of content, methodology, information gathering, data analysis, assessment and conclusions. The review is divided into the following sections:

1	**Project and SIA Context**: • Project description (project inputs and project activities) • Terms of reference • Issues of concern from Scoping Report	5	**Mitigation and Enhancement**: • Identification of mitigation options • Identification of enhancement opportunities • Identification of appropriate management actions
2	**Methodology**: • Data gathering • Method description	6	**Information Gaps, Uncertainty and Assumptions:** • Qualifying data sufficiency and reliability
3	**Social Baseline**: • community profile • Project affected people • Economic activities and livelihoods • Social systems • Use of natural resources	7	**References and Data Sources:** • Credible sources are listed
4	**Impact Assessment and Significance**: • Identification and understanding of social issues and linkages • social impact pathways • zones of influence • sensitive receptors • Linking social processes to social impacts • Differentiation of social impacts at the individual, household level and	8	**Report Structure:** • Organisation of information • Presentation of information

	community level • Job Creation • Population change • Social networks • Displacement and relocation • Economic opportunities (Lease Payments) • Tourism • Quality of Life • Social Cohesion • Health, noise and visual • Safety and security • Use and access to natural resources • Sense of place • Land acquisition		

5. PEER REVIEW SCORING SYSTEM

For each question posed under the Review Criteria, professional judgement is expressed in relation to the requirement for decision-making. Commentary is also provided to compare report content against best practice. The specific terminology used to express professional judgement is explained below:

- **Exceeds (E) requirements**: information exceeds requirements for decision-making. No changes to report section is required.
- **Meet (M) requirements**: the information meets requirements for decision-making. Minor edits/changes to report section is required.
- **Fail (F) to meet requirements**: the information does not meet the requirements for decision-making. Major edits/changes to report section is required.
- **Reject (R)**: Information cannot be used to decision-making. Major gaps in logic and content. Poor report writing and analysis. Section needs to be re-written.

6. PEER REVIEW SUMMARY FINDINGS

	Professional Judgement (E/M/F/R)	Comments
1. Project and SIA Context	**F**	The project description needs to be improved as suggested in this review. Examples of how the project description can be improved are given in Section 10 of this Review Report.
2. Methodology	**E**	The choice of systems theory and the application of social methods are commended. However, it is not carried through in the assessment, interpretation and design of mitigation measures.
3. Social Baseline	**M**	Social baseline is adequate, but can be improved as suggested in this review.
4. Impact Assessment and Significance	**M**	In general, impact assessment and significance ratings are adequate. However, there are areas for improvement and suggestions in this regard are provided in Section 11 of this Review Report.
5. Mitigation and Enhancement	**M**	Mitigation and enhancement measures proposed are adequate.
6. Information Gaps, Uncertainty And Assumptions	**E**	The SIA report clearly indicates the assumptions and inherent uncertainties.
7. References and Data Sources	**E**	The data sources and references are more than adequate.
8. Report Structure	**E**	The report structure is good.

7. PEER REVIEW CONCLUSIONS

The conclusion of the peer review is that the report is:

☐ **Good***:* The report exceeds the level and quality of information that is required for decision-making. No edits required to the report.

☑ **Adequate***:* The report meets the level and quality of information that is required for decision-making. Relatively minor information gaps in the report; requiring minimal changes.

☐ **Poor:** The report is of poor quality with flawed scientific logic. Major information gaps, requiring a complete report re-write. The report should be rejected.

8. PEER REVIEW RECOMMENDATIONS

In general the SIA report is adequate. Specific areas in the report have been identified in this peer review where the report can be improved.

9. DETAILED REVIEW QUESTIONS AND EVALUATION

		Professional Judgement (E/M/F/R)	Comments
1. PROJECT AND SIA CONTEXT			
i.	Does the report provide information on the project inputs, activities, sequencing of activities, nature of infrastructure and footprint of land required? Does the project description contain sufficient detail to understand the resultant social processes and likely impacts. Is there information on labour requirements (actual numbers, by sex and skills-base) and source(s) of such labour for both construction and operational phases?	**F**	The information provided in Section 2.1 (Project Information) does not give an indication of the spatial footprint (in hectares or m^2) of the infrastructure (e.g. PV facilities and transmission lines). There is also a lack of detailed information on the sequence of project activities. For social processes to be identified it needs to be linked to the detailed project activities during all phases of the project. It is suggested that a detailed "Project Activities Register/Table" be developed as a first step (a generic list of project activities is provided in Section 10 of this Review Report as an example). This should form the "y-axis" input to develop a detailed "social processes" list that forms the "x-axis" information in the matrix. The value of such a matrix gives the reader an immediate understanding of the social processes that can potentially be triggered by the individual project activities. Table 2.1 which outlines the employment opportunities and duration is useful, but not easily understood. It would be useful to differentiate between the specific skilled, semi-skilled and unskilled job categories. For example, it would be useful for local I&APs to know at this stage what the estimates are for semi-skilled labour such as for construction vehicle/heavy equipment operators (e.g. a rough estimate of the number of semi-skilled construction workers required to operate loaders, dump trucks, backhoes, excavators, bulldozers and graders). It is likely that for some local people are able to take advantage of the semi-skilled vehicle operator jobs on offer.
ii.	Does the report contain a terms of reference outlining the scope of the SIA?	**M**	Adequate terms of reference described.
iii.	Has the study area been delineated? Has the SIA defined the area of direct and indirect influence of the project? Has the social area of influence, likely impacted and beneficiary communities and stakeholders been identified?	**M**	SIA study area is defined as the urban node or human settlement at the town of Kenhardt. The project sites are on farm portions which have extremely low population densities.
iv.	Have location maps and existing land-use	**M**	It would be useful to include an additional map indicating the location of the PV facilities

		Professional Judgement (E/M/F/R)	Comments
	patterns been provided?		and the transmission lines in relation to Kenhardt.
2. METHODOLOGY			
i.	Is the theory and methods for the SIA explained? Is the selected SIA methodology appropriate for the project and location?	**E**	The author has a good grasp of social theory and methods and uses them appropriately. However, the author does not robustly use the theory and methods to inform data gathering, interpretation and analysis. The use of systems theory is commended; however, it is not carried through in the assessment, interpretation and design of mitigation measures.
ii.	Are the data gathering techniques described?	**M**	Data gathering techniques are adequately described.
3. SOCIAL BASELINE			
i.	Has the location of the local population in relation to the proposed project area been indicated?	**M**	SIA study area is defined as the urban node or human settlement at the town of Kenhardt.
ii.	Has demographic information been provided (population size, age composition, growth, literacy levels, education, etc)?	**F**	Sufficient demographic and health information has not been provided to contextualise the background social environment (at the municipal level) within which the proposed project will be located. Information presented in Section 3.3.1 needs to answer the “so what” question to make it relevant for the project. Currently the demographic information and primary qualitative data (gathered from field work) is presented without sufficient interpretation and does not assess the implications of the data for the project. For example, what are the implications to the project of having “35% of households being female headed”? Or, what are the implications to the project of having a high unemployment rate. It would be useful to include demographic graphs on key social indicators such as population diversity, sex and age distribution, employment, income, households, education and poverty levels. Information on the amount of people in the local community who access social grants would have been useful to know.
iii.	Has local community health status information been provided (HIV and AIDS prevalence, causes	**F**	No quantitative information has been presented on the health status of the local community. It needs to be stated whether this information is lacking. Qualitative

		Professional Judgement (E/M/F/R)	Comments
	of mortality, incidences of diseases such as TB, STIs; Life expectancy in project area)?		information from interviews reveals the prevalence of teenage pregnancies. Information on the health status of the local community has implications for the proposed project, as it provides an indicator of the ability of the local population to access opportunities from the project.
iv.	Have the Project affected people been identified?	**M**	The project affected people form the human settlement of the town of Kenhardt.
v.	Have the existing land uses and economic activities in the project area been described?	**M**	Adequate information is provided in Section 3.3.1
vi.	Has information on public safety and security been provided?	**F**	No information is provided on the existing levels of safety and security. In farming communities there is typically a feeling of over exposure to crime and stock theft. It would have been useful to even have a qualitative narrative on the perceived sense of safety and security.
vii.	Have the implications of the Local Integrated Development Plans and Spatial Development Plans for the project been analysed? What are the spatial policy and planning frameworks for the site and surround areas?	**F**	A cryptic overview is provided on relevant legislation and local plans and the implications for the project are not assessed. No indication is given whether a Spatial Development Framework exists for the Municipality and whether it covers the project site. A brief evaluation of the implications of the municipal planning frameworks would be useful. Even an indication that there are no implications would be useful to know, as well as a general recommendation that if the proposed project were to proceed, a significant development of this nature would need to be included in future municipal plans.
viii.	Does the report analyse the potential resilience and status of affected communities?	**E**	The report analyses vulnerability of the local community using an “Asset Pentagon”, as well as provide an insight into social dynamic by applying systems theory in the form of a “Socio-ecological System Causal Loop Diagram”. However, it would be useful if Figure 3.7 (Kenhardt Asset Pentagon) were to be analysed on much more detail, rather than the current high level generic evaluation. Section 3.3.2 (Vulnerability Context) can be much improved by a more in-depth analysis.
ix.	What are the existing land uses and land tenure patterns in the area?	**M**	Adequate information is provided (in Section 2.1) on land use and land tenure patterns for the project farm portions and surrounding area. Detailed information is provided for Kenhardt (in Section 3.3.1.2).
x.	What are the existing levels of municipal services (housing, water, electricity, schools, clinics, policing etc) and current state of infrastructure in	**F**	Information on the level of municipal services and the state of local infrastructure is not provided. An indication needs to be given whether there are any projects implications of the quality of municipal services and the state of infrastructure. Is the project (if it goes

		Professional Judgement (E/M/F/R)	Comments
	the area?		ahead) totally independent of municipal services and the state of local infrastructure?
4. IMPACT ASSESSMENT AND SIGNIFICANCE			
4.1 General			
i.	Does the SIA focus on the issues that most concern the community? Are the social issues that have been identified in the Scoping Report referred to in the SIA?	**M**	Issues raised in the Scoping Report are carried through to the SIA Report. However, I am not convinced that issues of concern from the landowner and farming community are reflected in the SIA report. An influx of job seekers, as well as a migrant construction workforce associated with the development, tends to increase the anxiety/concerns of farmers (real and perceived) with regards to issues of security, crime (stock theft) and negligence (e.g. the contractor leaving farm gates open).
ii.	Are the discrete social impacts clearly identified?	**F**	The impacts identified in Section 4.2 are not impacts in my opinion. What are mostly listed are social processes. The impacts are the actual experiences by sensitive receptors to social processes triggered by the development. Section 4.2 needs to be edited to clearly differentiate what social processes are triggered by the different project activities and then identify what the actual social impacts are that are felt by the individual sensitive receptor groups. For example, the influx of job seekers is not a social impact, it is a social process. How receptors (be it the municipality or certain sections of the local community) experience this social process is what matters and is where the impacts are experience and manifested. To explain what I mean, I've included a generic list of social processes and social impacts (at the individual and community level) as an example in Section 11 of this Review Report.
iii.	Are the social impact pathways identified?	**F**	Social impact pathways have not been identified. In addition, there is no clear link between project activities, social processes and the resultant social impacts.
iv.	Are the spatial zones of influence identified?	**M**	Kenhardt is considered to be the area of influence.
v.	Are the sensitive receptors (individuals, households and communities) clearly identified?	**F**	Particular sensitive receptors are not clearly identified. An analysis of the sensitive receptors and their levels of vulnerability need to be undertaken. For analysing "receptor sensitivity" you need to consider the type of receptor (namely, biological/ecological, human and physical receptor/feature) and their resilience to identified stressors. This is a particularly weak aspect of the SIA report.

	Professional Judgement (E/M/F/R)	Comments
		For each impact identified (in Section 4.2 and Table 4.1), there needs to be an identification of the particular "sensitive receptors". There is no way that a defined impact as a homogenous and equal impact across all community groups. The SIA makes the common mistake of not disaggregating impacts and differentiating how different groups experience impacts (e.g. women, unemployed men, farmers, etc.).
vi. Is there an indication whether residual impacts would be acceptable?	**F**	Discussion on residual impacts for each identified "impact" (in Section 4.2 and 4.3 and Table 4.1) is not adequately dealt with. There is hardly any indication of what the residual impacts are and whether they would be acceptable.
4.2 Community impacts		
i. <u>Population change</u>: Will the development lead to an increase in a certain section of the population? What would the impact of such a change be on the existing social environment?	**F**	The SIA report acknowledges the background local population increase. However, the report does not clearly distinguish what population segment will form the job seekers from outside.
ii. <u>In-migration of unemployed work seekers</u>: Will the development intentionally or unintentionally contribute to the in-migration of work seekers into the area? What would the impact of this change be on the existing social environment? Is rapid population growth predicted?	**M**	The report acknowledges the potential impact of the influx of job seekers on the population. However, the author assigns a "moderate negative significance" rating to the social process of "influx of job seekers. I disagree with this rating and believe that "with and without mitigation", the significance rating should be high. The reason is that no matter how good the Proponent is at communication and no matter the type of mitigation, it is inevitable that there will be an influx of job seekers and that it is highly likely that these job seekers will remain in the area after the construction period. No qualitative estimation is made of whether there is likely to be rapid in-migration. It is important to recognise that the dominant way in which governments and project proponents understand in-migration, is as a problem. In-migration of job seekers cannot be prevented. There is a powerful negative discourse around in-migration. In-migration is not a problem but rather a response to extreme poverty. In-migration needs to be acknowledged as an irreversible and integral part of rural livelihoods. A pragmatic approach to in-migration needs to be taken with the aim of facilitating the benefits and mitigating against the negative impacts faced by both the host community as well as the

		Professional Judgement (E/M/F/R)	Comments
			migrants. When in-migration is viewed through this lens, it then becomes clear that job seekers from elsewhere are also sensitive receptors that need to be acknowledged in the SIA report.
iii.	Disruption of social networks: Will the development impact on existing social networks? (e.g. due to the presence of outsiders in communities with a high degree of homogeneity and social cohesion)	**M**	Adequately dealt with in report.
iv.	Relocation or displacement of individuals or families: Will the development lead to relocation of residents? What will the implications be for their livelihood sustainability?	**M**	Not relevant.
v.	Disruption in daily living and movement patterns: Will the development change the lifestyle of residents? Will it impact on movement patterns? Will it divide communities physically	**M**	Adequately dealt with in report.
vi.	Job creation opportunities: Will the development lead to an increase or decrease in employment opportunities? Does the report clearly describe the gender, number and type of permanent and temporary employees required for each phase of the project, where the labour will be sourced from and the company's employment policies? Will skilled workers be imported? Will the local labour pool be qualified for professional, technical, and supervisory jobs? Has the report identified the secondary employment created indirectly by the facility (e.g. local stores, Bed & Breakfast, services)? Is loss of local labour from current jobs predicted (current workers may be tempted to	**M**	The report provides general information on job opportunities but does not disaggregate the jobs into the specific and typical type of jobs for unskilled, semi-skilled and skilled classes. No indication is given on whether the local labour would only be able to access the unskilled jobs. The SIA states that: "decommissioning of the proposed developments will result in job losses". The report needs to state what categories of permanent jobs would be lost. Section 10 in this Review Report outlines the activities/services that need to be performed during the Operation and Maintenance Phase. It is the jobs performing these services that will be lost.

		Professional Judgement (E/M/F/R)	Comments
	leave their jobs in pursuit of improved wages)?		
vii.	Infrastructure and services: Will the development create increased demand for basic services, e.g. water, electricity, sewerage, roads?	M	The SIA predicts that "in-migration is likely to place additional strain on formal housing and bulk services". I think it would be more plausible to suggest that in-migration is likely to be done by unemployed people desperate for jobs and who would likely stay in the informal settlement (which would not place a strain on formal housing and bulk services). In-migration in the short-term will cause a population increase and result in more job seekers for the limited available jobs.
viii.	Change in housing demands: Will the development create a housing need, e.g. due to the in-migration of construction workers?	M	The SIA report suggests that there will be additional strain on formal housing. No indication is given how the Proponent will deal with this matter. The Proponent may choose to specify to the Main Contractor, to price for the construction of temporary accommodation close to the construction site. In this instance, there will be no need for housing for the project. I recommend that the SIA Report includes a provision for the Proponent to commit to providing temporary accommodation.
ix.	Impact on other businesses: Will the development impact on tourism?	M	The SIA report considers tourism to only be affected at a cumulative level (when considered with the impact of all the regional renewable projects). No indication is given of whether this project would have any impact on tourism. It is likely that there will be no impact, except as a "curiosity feature" by South African tourists. A positive mitigation measure that can be considered, is for the Proponent to commit to installing interpretative signage on site and working with the local Municipality (to train tour guides) to include the PV facility as a tourism destination option.
x.	Local Content (economic): Will the development provide opportunities for local procurement and training? (e.g. rental housing, restaurants and stores, etc.)	F	The SIA report recommends that the proponent "must procure goods and services, as far as practically possible, from within the project area (with a focus on Kenhardt)". The report is lacking in detailing what the specific goods and services are that would be required. Section 10 below in this Review Report provides a list of the project activities and it can be inferred from this list what goods and services can realistically be provided from the local area.
xi.	Staff accommodation: Has accommodation (male and female) for construction and permanent staff been identified?	F	The SIA report recommends that: "accommodation be obtained from as large a selection of local service providers as possible to ensure distribution of project benefits". There is no indication in the report whether this is even possible. The SIA should at least have gathered data on whether there is sufficient rooms/housing available for construction staff.

	Professional Judgement (E/M/F/R)	Comments
4.3 Health impacts		
i. Spread of disease, addiction and antisocial behaviours: Has the the spread of HIV and its impacts on vulnerable groups such as women and children been identified? What are the health vulnerabilities of the host community? What are the predicted spread of the disease by construction workers, truck drivers and sex workers?	**F**	The SIA report does not provide any information on the existing health status of the local community and neither is there any indication and assessment the likely spread of disease from the migrant construction workforce. This is a deficiency in the report.
ii. Gender (women and girls): Will the project have a negative effect on women and girls?	**F**	The SIA report gives no indication on the discrete and separate impacts of the project on women and girls. The gendered nature of impacts is totally ignored. The report needs to acknowledge that typically, construction work is mostly provided to males in the demographic group between 18-50 years old. The report does however highlight the need for the "Workforce Recruitment Policy" to provide opportunities for women.
iii. Psychosocial disorder: What impact will the project have on psychosocial disorders of local residents?	**F**	No indication is given of potential psychosocial disorders such as: stress, substance abuse, social disruption, unrest, violence and decreased tolerance.
4.4 Quality of life and social well-being impacts		
i. Quality of Life: Have impacts on the landscape character, natural setting and visual amenity been identified?	**F**	No indication is given on the impacts to "quality of life".
ii. Crime and safety: Will the development impact on existing crime (petty crime and stock theft) and safety patterns?	**F**	No indication is given on the impacts to "crime and safety".
iii. Social well-being: Will the development impact on the peaceful coexistence of communities? Will the development lead to conflict between sectors of the social environment? Will tensions form in communities where the economic benefits are not	**F**	Social well-being issues are not addressed in the report. There is no indication of issues related to: social cohesion and support structures, self-determination, human rights and equity.

	Professional Judgement (E/M/F/R)	Comments
necessarily equally shared among the residents? Will the community identity be preserved?		
4.5 Cultural and heritage impacts		
i. Heritage: Will the development impact on archaeological, historical or cultural resources?	**M**	Heritage issues appear to not be applicable for this site. However, there is no mention in the report that heritage issues are not relevant.
ii. Culture: Will the development impact on the customs, values, religious and spiritual beliefs?	**F**	No mention is made of the existing cultural patterns and whether it is an issue.
4.6 Land and natural resource impacts		
i. Livelihoods: Will the development impact on the landowners and local people's (legal or illegal, formal or informal) access to natural resources that help to sustain their livelihoods?	**M**	The SIA report clearly indicates that the livelihoods of landowners will not be affected.
ii. Land acquisition: Will the development negatively impact the landowner/land users by having a large spatial footprint that limits existing land use (such as loss of grazing land)?	**F**	The SIA report does not mention land acquisition at all. It can be inferred that land acquisition (even through lease contracts) will not impact the landowner. However, an indication should be given that land acquisition is not an issue.
iii. Land rezoning: Will the existing land be required to be rezoned before the Project can commence?	**M**	It can be inferred from the report that rezoning will not be an issue.
4.7 Economic Impacts		
Have the social implications of economic impacts been assessed?: • Change in modes of production • Changes in property values	**M**	It can be inferred from the report that there are no negative economic impacts.
4.8 Impact Identification		
i. Have direct and indirect/ secondary effects of construction activities and, where relevant, operation and decommissioning of the project been clearly explained (including both positive	**F**	The SIA report can be improved by clearly indicating what the individual project activities are (see Section 10 in this Review Report) and the consequential primary and secondary impacts (see Section 11 in this Review Report).

		Professional Judgement (E/M/F/R)	Comments
	and negative effects)?		
ii.	Is there a clear understanding of impact causation processes, by first listing in detail the project activities per phase and the corresponding social effect? Have social processes clearly been differentiated from social impacts?	F	This is an area of deficiency in the SIA report and needs to be addressed. See Section 10 and 11 in this Review Report for suggestions on improvements to the report.
iii.	Have impacts been identified in a non-judgemental manner?	M	The SIA report by and large uses non-judgemental language in the identification of impacts. My preference is not to use the term “socially deviant behaviour”, but rather “social disorders” or “psychosocial disorder”.
iv.	Are there clear linkages (in impact identification) to health and ecosystem services issues?	F	There is no clear link with other specialist study areas and no link with health and ecosystem services issues.
v.	Have cumulative impacts been assessed?	M	Adequately addressed in Section 4.6.
4.9 Assessment of Impacts			
i.	Are impacts described in terms of the nature, magnitude and probability of the change occurring and the effect (location, number, value, sensitivity) on sensitive receptors?	M	Impacts are adequately described in a consistent manner. However, no mention is made of “sensitive receptors”.
ii.	Has the timescale over which the effects will occur been predicted such that it is clear whether impacts are short, medium or long term, temporary or permanent, reversible or irreversible?	M	Timescale are adequately described in a consistent manner.
iii.	Have qualitative predictions of impacts been adequately expressed?	M	Qualitative predictions of impacts have been adequately expressed.
iv.	Where quantitative predictions have been provided is the level of uncertainty attached to the results described?	M	No quantitative impact predictions have been made in the SIA report.
v.	Have the impacts of the social environment on the construction and operation of the project been	F	The impacts/implications of the dynamics of the existing social environment on the project is not adequately described.

		Professional Judgement (E/M/F/R)	Comments
	considered?		
4.10 Impact Significance			
i.	Does the information include a clear indication of which impacts may be significant and which may not and to whom?	**M**	Significance is adequately dealt with in the report. However, the report can be improved by answering the question: "to whom is this impact significant"?
ii.	Has the significance of effects been discussed taking account of appropriate national and international standards or norms, where these are available?	**M**	Significance is adequately dealt with in the report.
iii.	Where there are no generally accepted standards or criteria for the evaluation of significance, is a clear distinction made between fact, assumption and professional judgement?	**M**	There is a clear distinction in the report between assumption and professional judgement.
iv.	Have the magnitude, location and duration of the impacts been discussed in the context of value and sensitivity?	**F**	Issues of value and sensitivity are not addressed.
5. MITIGATION AND ENHANCEMENT			
i.	Is there evidence of the application of the Mitigation Hierarchy? (in terms of the sequential application of the mitigation options from avoid ⇨ minimise ⇨ restore ⇨ compensate)	**F**	There is no evidence of the application of the Mitigation Hierarchy.
ii.	Does the report clearly state the objectives and specific goals for the management of social impacts, socio-economic conditions and historical/cultural aspects?	**M**	There is a clear indication of performance objectives.
iii.	Does the report describe the appropriate technical and management options to address each social impact, socio-economic condition and historical/cultural aspects for each phase of the	**M**	Appropriate management actions and mitigation measures have been proposed.

		Professional Judgement (E/M/F/R)	Comments
	project?		
iv.	Where appropriate, do mitigation methods considered include modification of project design, construction and operation, the replacement of facilities/ resources, and the creation of new resources?	**M**	Suitable mitigation measures have been proposed.
v.	Is it clear to what extent the mitigation methods are likely to be effective?	**F**	There is no indication of the likely effectiveness of the proposed mitigation measures. A "Workforce Recruitment Policy" is recommended. Employment in its totality cannot be reserved for local residents, as the report recommends. Neither can this requirement be contractually binding. In any case, who would be the two contracting parties to make this mitigation measure contractually binding? Local residents may not have the requisite skills to take advantage of the job opportunities. In addition, they may be untrainable for a variety of reasons and therefore not suited for the available jobs. In any event, it is the responsibility of the Contractor to recruit people for jobs and not the Proponent. All the Proponent can do is to define the overall project objectives (for unskilled, semi-skilled and skilled jobs and training). The objectives can then form part of the contractual obligations for the Main Contractor. How the objectives should be achieved should be left up to the Main Contractor. It is recommended that the Proponent develops a local skills database. The SIA report should clearly identify the performance objective for this mitigation measure. It should be recognised that the responsibility for developing the skills database can lie with the Proponent, but how it is used to achieve the objective of optimising local employment is dependent on the nature of the Contract for project implementation (e.g. whether a EPC contract is used). The Proponent would need to hand over the skills database for the Main Contractor to use.
vi.	Have negative social effects of mitigation measures been investigated and described?	**F**	The negative social effects of mitigation measures proposed have not been described.

		Professional Judgement (E/M/F/R)	Comments
6. INFORMATION GAPS, UNCERTAINTY AND ASSUMPTIONS:			
i.	Has field work been undertaken and if not, has the implications been acknowledged?	M	Field work has been undertaken and the qualitative information from the interviews has added richness to the social baseline.
ii.	Has issues of data sufficiency and reliability been addressed?	F	The SIA report needs to make a statement in this regard.
iii.	Have information gaps been identified and its implications assessed?	F	The SIA report needs to clearly identify the information gaps.
iv.	Have the SIA assumptions been disclosed?	M	Assumptions have been fully disclosed. The author states that the "The project boundary, in terms of socio-economics, is therefore arbitrarily constructed". This is not the case. The project boundary for socio-economics has been logically deduced, based on available information and the locality of settlements in the area.
v.	Has any scientific uncertainty inherent been acknowledged and communicated?	M	The SIA report does allude to areas of uncertainty.
7. REFERENCES			
i.	Does the report contain a reference list?	M	All sources have been fully referenced.
ii.	Are the reference sources credible and reliable?	M	Reference sources are scientifically credible.
8. REPORT STRUCTURE			
8.1 Organisation			
i.	Does the report contain an Executive Summary which provides a concise presentation of the most significant issues contained in the body of the SIA?	M	Clear Executive Summary provided.
ii.	Is the information logically arranged in sections?	M	Report is logically structured.
iii.	Is the location of the information identified in an index or table of contents?	M	Table of Contents provided.
iv.	Are the credentials of the report authors and specialists presented, with a clear indication of	M	CV of report author included in report.

		Professional Judgement (E/M/F/R)	Comments
	their respective contributions?		
8.2 Presentation			
i.	Has information and analysis been offered to support all conclusions drawn?	**M**	Information and analysis is adequate, but interpretation can be improved as suggested in sections in this Review Report.
ii.	Has information and analysis been presented so as to be comprehensible to the non-specialist, using maps, tables and graphical material as appropriate?	**M**	Information is adequately presented in graphics, maps and tables where appropriate.
iii.	Is the information balanced and unbiased?	**M**	Information is presented in a balanced manner.
iv.	Is the layout, language and overall presentation of the information accessible to both the lay public and decision-makers?	**E**	The author writes well and the language is clear and unambiguous.

10. GENERIC EXAMPLE OF CONSTRUCTION ACTIVITIES FOR THE DEVELOPMENT OF A PV FACILITY

	PROJECT PHASE	SEQUENCE OF DETAILED ACTIVITIES
1	Mobilisation / Site Preparation	• Installing perimeter fencing around the site • Locating temporary construction offices and construction equipment to site • Earthworks for construction of road access and construction parking areas, including vegetation clearing • Minor grading and trimming of areas for permanent site office and switchyard • Minor grading and trimming in array areas • Drum rolling and compaction of array areas • Installation of onsite erosion and sediment controls
2	Construction	• Install steel support posts for array tables • Trenching and wiring of underground cabling (DC and AC) • Attachment of tilt brackets and rails using prefabricated steel members • Connection of PV modules to the brackets • Installation of inverter and transformer skid • Commencement of site rehabilitation works within the development area
3	Commissioning	• Commissioning and testing of solar plant, noting that each array block would be commissioned as it is completed.
4	Demobilisation	• Removal of temporary construction facilities and completion of works within the development area and of temporary access tracks within the site.
5	Operation and Maintenance	Compared to other power generating technologies, solar PV power plants have low maintenance and servicing requirements. Activities include: • Inverter servicing • ground-keeping • security • Low technology module cleaning using brush trolley or dust broom

11. GENERIC EXAMPLE OF THE DIFFERENTIATION BETWEEN SOCIAL PROCESSES AND SOCIAL IMPACTS

Selected list of social processes	***Selected list of social impacts at the individual and household level***	***Selected list of social impacts at the community level***
Demographic processes ▪ Increase in population size (in-migration) ▪ Presence of newcomers (perceived or real cultural differences) ▪ Presence of temporary construction workers ▪ Presence of tourists *Economic processes* ▪ Conversion of economic activities ▪ Conversion of land use ▪ Increase in economic activity ▪ Decrease in economic activity ▪ Job creation or job loss *Social processes* ▪ Prostitution ▪ Excessive alcohol, drug use and gambling ▪ Opposition ▪ Pollution (air, water and dust) ▪ Litter ▪ Traffic ▪ Vandalism	▪ Debt bondage ▪ Reduced level of health ▪ Reduced mental health, increased stress, anxiety, alienation, apathy, depression ▪ Uncertainty about impacts, development opportunities, about own life as a result of social change ▪ Reduced actual personal safety ▪ Reduction in perceived quality of life, subjective well being ▪ Worsening of economic situation, level of income, property values ▪ Change in status or type of employment or becoming unemployed ▪ Decrease in occupational opportunities ▪ Objection/opposition to project, NIMBY (not-in-my-back-yard) attitude ▪ Dissatisfaction due to failure of a project to achieve heightened expectations ▪ Annoyance because of dust, noise, strangers or more people ▪ Increased density and crowding ▪ Reduced aesthetic quality, outlook, visual impacts	▪ Reduced adequacy of infrastructure (water supply, sewerage, services and utilities) ▪ Reduced adequacy of community social infrastructure, health, welfare, education facilities ▪ Reduced adequacy of housing ▪ Increased workload on institutions ▪ Increase inequity (economic, social, cultural) ▪ Increased unemployment level ▪ Loss of other options (opportunity cost) ▪ Increased actual crime or violence ▪ Increased social tensions, conflict or divisions within community

BASIC ASSESSMENT REPORT

Appendix D.8:
Traffic Impact Statement

TRAFFIC IMPACT STATEMENT:

Basic Assessment for the proposed development of a 132 kV Transmission Line to connect to the proposed 75 MW Solar PV Facility (Kenhardt PV 1) on the Remaining Extent of Onder Rugzeer Farm 168, and the Remaining Extent of Portion 3 of Gemsbok Bult Farm 120, north-east of Kenhardt, Northern Cape.

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June 2016

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FIGURES

TRAFFIC IMPACT STATEMENT

1 INTRODUCTION AND METHODOLOGY

As per the Plan of Study included in Scoping Report and subsequently approved by the DEA, it was indicated that a Traffic Impact Statement (TIS) will be produced by the CSIR to show the amount of traffic that can be expected during the construction and operational phases from the development of the proposed Kenhardt PV 1, Kenhardt PV 2, and Kenhardt PV 3 solar energy projects, as well as the proposed Kenhardt PV 1 – Transmission Line, Kenhardt PV 2 – Transmission Line, and Kenhardt PV 3 – Transmission Line projects near Kenhardt in the Northern Cape. In this regard, the study focuses on the regional setting in which these projects are proposed and the roads that will be utilised for these projects. The report has therefore been produced for all the projects due to the scale of the assessment and the fact that all the projects are going to use the same road infrastructure.

1.1 Terms of Reference

The key issues associated with the construction and operational phases of the project that will be assessed as part of the TIS are:

- Increase in traffic generation throughout the lifetime of the project;
- Decrease in air quality; and
- Increase in road maintenance required.

1.2 Assumptions and Limitations

The TIS has been based on the traffic information provided by Scatec. The traffic information was obtained from previous projects and estimates of similar projects currently proposed by Scatec.

2 APPROACH AND METHODOLOGY

2.1 Objectives

- Determine the current traffic conditions in sufficient detail so that there is a baseline against which impacts can be identified and measured;
- Identify potential impacts and cumulative impacts that may occur during the construction, operational and decommissioning phases of development;
- Provide recommendations with regards to potential monitoring programmes;
- Determine mitigation and/or management measures which could be implemented to as far as possible reduce the effect of negative impacts and enhance the effect of positive impacts; and
- Incorporate and address all issues and concerns raised by I&APs and the public (if applicable).

2.2 Methodology

The key steps followed in this assessment are:

- Review of available desktop information, including the South African National Roads Agency (SANRAL) National traffic count information, google earth images and similar projects; and
- Liaison with Transnet SOC Ltd regarding access roads to be used and requirements associated with it.

3 AFFECTED ENVIRONMENT

During all phases (construction, operation and decommissioning) of the project, traffic will be generated. The highest traffic volumes will be created during the construction phase. This includes activities associated with:

- Site preparation and transporting the construction materials, and associated infrastructure to the site; and
- Transportation of employees to and from the site on a daily basis.

The proposed project site can be accessed via an existing gravel road (an unnamed farm road) and the existing Transnet Service Road (private). Both access routes will be considered in the design of the facility and have been included in the proposed project. The R27 extends from Keimoes (in the north) to Vredendal in the south. The R27 is 6 m wide and falls within a 45 m road reserve. This National Road is designed for minimum daily traffic exceeding 1000 vehicle units. The Transnet Service Road can be accessed from the R27. The existing gravel road can be accessed from the R383 Regional Road also via the R27 National Road. The Transnet Service Road and unnamed farm road are both (in some sections) wider than 8 m, however in certain sections; the unnamed farm road is believed to be about 2-3 m wide.

Should the Transnet Service Road be considered the preferred access road, it is proposed that an internal gravel road be constructed from the road to the proposed site. This internal gravel road is not expected to exceed 6 m in width. The length of the internal gravel road will be confirmed as the location, design and layout of the facility progresses. Discussions have been initiated and held with Transnet and the Project Applicant during the Basic Assessment and, Scoping and EIA Process regarding the potential use of the Transnet Road and associated specific requirements. Transnet have informed the Project Applicant of their requirements that need to be met by the Project Applicant should the Transnet Service Road be used to gain access to the site. These requirements will be considered in the design of the facility where required, and the details of the agreement will be finalised outside of this Basic Assessment and EIA Process.

However, should the Transnet Service Road not be used for access, then the unnamed farm gravel road will be used. In order to make use of the unnamed farm road and to ensure easy access to and mobility of large trucks, the unnamed farm road, however, will need to be upgraded and widened by more than 6 m (where required).

A photo plate is included (Photos 1 - 4) to show the intersection of the Transnet Service Road with the R27 and the current condition of the roads.

Photo 1: R27 towards the south (taken towards Kenhardt). The board shows "Loop 14", located to the left, which is accessed via the Transnet Service Road. (Image source: Google, 2010)

Photo 2: The intersection of the R27 and Transnet Service Road, going towards Kenhardt. As can be seen on this image, the R27 was being upgraded in 2010 (Image source: Google, 2010)

Photo 3: The intersection of the R27 and Transnet Service Road, going towards Keimoes (Image source: Google, 2010)

Photo 4: The access point to the Transnet Service Road (Image taken: July 2014)

The closest roads to the site for which traffic counts are available show that the R383 (road between Kenhardt and Marydale) and the R361 (between Van Wyksvlei and Kenhardt) have Average Daily Traffic (ADT) counts of 35 and 41, respectively (SANRAL, 2007). The ADTs how that the current traffic volumes are well below the maximum traffic limits for the roads discussed above. Even though traffic will be generated during the construction and operation of the solar energy facility, given the low ADTs of the surrounding roads, it is not expected that the traffic generated by the solar energy facility will exceed the maximum daily traffic limits for the abovementioned roads.

4 TRANSPORT INFORMATION

The general current limitations on road freight transport are:

- Axle load limitation of 7,7t on front axle, 9,0t on single rear axles;
- Axle unit limitations are 18t for dual axle unit and 24t for 3 axle unit;
- Gross vehicle mass of 56t. This means a typical payload of about 30t;
- Maximum vehicle length of 22m for interlink, 18,5m for horse and trailer and 13,5 for a single unit;
- Width limit of 2,6m; and
- Height limit 4,3m.

Abnormal permits are required for vehicles exceeding these limits.

4.1 Solar Farm Freight

Materials and equipment transported to the site comprise of:

- Building materials (concrete aggregates, cement and gravel);
- Construction equipment such as piling rigs and cranes;
- Solar panels (panels and frames); and
- Transformer and cables.

The following is anticipated:

A. Building materials comprising of concrete materials for strip footings or piles will be transported using conventional trucks which would adhere to legal limits listed above.
B. Solar Panels and frames will probably be transported in containers using conventional heavy vehicles within the legal limits. The number of loads will be a function of the capacity of the solar farm and the extent of the frames (the anticipated number of loads are discussed below).
C. Transformers will be transported by abnormal vehicles.

4.2 Traffic generation

The traffic generation estimates detailed below have been determined based on a single solar energy facility and the associated electrical infrastructure (collector substation and transmission line).

- ***Construction Phase***

Approximately 800 x 40ft containers resulting in more or less 450 double axel trucks will come to site during the construction phase (i.e over a period of 9 to 24 months). In addition to this, more or less 20 light load trucks will come from and go to site on a daily basis during the construction phase. It is estimated that a total of 14 850 trips to the site, based on a 24 month construction phase.

In terms of water supply, the current proposal is to truck water to site via municipal water supply. It is estimated that 1 trip will be made by the water truck every 2 days. In total, this adds up to 365 trips by the water truck over a period of 24 months.

It is important to note that the construction period is likely to extend 12-14 months (as noted in Section A of the BA Report), however the worst case scenario has been considered in this TIS.

- ***Operational Phase***

More or less 4 light load trucks will come from and go to site on a daily basis and 1 small single axel truck to and from site on a weekly basis. The lifetime of the project is 20 years which means that the total amount of trips would be 30 240 over this period. For water supply, the current estimate is that 2 trips per month will be made by a water truck.

- ***Decommissioning Phase***

As per the construction phase, approximately 800 x 40ft containers resulting in more or less 450 double axel trucks will come to site during the decommissioning phase. The decommissioning phase usually takes 12 months (i.e over a period of 9 to 24 months). In addition to this, more or less 20 light load trucks to and from site will come and go to site on a daily basis.

5 IDENTIFICATION OF IMPACTS

The traffic impacts that will be generated by the proposed facility are detailed below. The impacts will largely occur during the construction phase of the project, since this is when the highest amount of traffic will be generated by the proposed facility (refer to Section 4.2).

The impacts identified and further assessed are:

1. Increase in traffic generation.
2. Accidents with pedestrians, animals and other drivers on the surrounding tarred/gravel roads.
3. Impact on air quality due to dust generation, noise and release of air pollutants from vehicles and construction equipment.
4. Decrease in quality of surface condition of the roads.
5. Cumulative impact of traffic generation of three projects and related projects.

6 ASSESSMENT OF IMPACTS AND IDENTIFICATION OF MANAGEMENT ACTIONS

This section assesses the significance of the impacts identified in Section 5. Appropriate mitigation and management measures to reduce the significance of the negative impacts and promote the positive impacts have been included in the draft EMPr.

6.1 Increase traffic generation

As discussed in Section 4 of this report, conventional trucks, conventional heavy vehicles and abnormal vehicles transporting loads will need to come to site to deliver the infrastructure required for the solar facility. The impact of this on the general traffic would be negligible as the additional peak hour traffic would be at most 2 trips.

Significance of impacts without mitigation

Although the construction phase would have the greatest impact on traffic generated by the proposed project, the increase in traffic will only result in an addition of 2 trips during peak hour traffic (worst case scenario). Based on the traffic counts discussed in Section 3 of this report, the ADT for this area is between 35 - 41 vehicles. The R27 is designed for 1000 units per day and therefore, the additional traffic generated during the construction phase will have a **low** negative impact.

The operational phase will have a lower traffic generation since only the personnel permanently employed on site would need to go to site every day. It is not expected that this would exceed 4 trips per day. This negative impact would therefore be **very low.**

Since is it unclear at this stage what the traffic numbers will be in the Kenhardt area in 20 years' time and the amount of trucks required for decommissioning, the impacts associated with this phase of the project were based on the construction phase details given that this is the worst case scenario in terms of traffic generation. Therefore, the significance of the impact would be **low** negative.

Proposed mitigation

Even though the traffic generated would not be significant, the following requirements should still be met by the developer during the construction and decommissioning phases:

- Should abnormal loads have to be transported by road to the site, a permit needs to be obtained from the Provincial Government Northern Cape (PGNC) Department of Public Works, Roads and Transport;
- Provide a Transport Traffic Plan to SANRAL;
- Ensure that roadworthy and safety standards are implemented at all time for all construction vehicles; and
- Plan trips so that it occurs during the day but avoid construction vehicles movement on the regional road during peak time (06:00-10:00 and 16:00-20:00).

Requirements to be met during the operational phase:

- Adhere to requirements made within Transport Traffic Plan;
- Limit access to site to personnel; and

- Ensure that where possible, staff members carpool to site.

6.2 Accidents with pedestrians, animals and other drivers on the surrounding tarred/gravel roads.

During all phases, vehicles will need to access the site via the R27 and the Transnet Service Road/alternative gravel access road. As shown in the photo plate in Section 3, the Transnet Service Road intersects with the R27 just outside of Kenhardt. There is the potential that should vehicles not indicate soon enough that they are turning off from the R27, an accident can occur. In addition, not adhering to the relevant speed limits may cause accidents with other drivers and collisions with animals.

Significance of impacts without mitigation

The significance of causing an accident with pedestrians, animals and other drivers would have a **high** negative impact significance since the probability of the impact occurring would be likely and could be fatal and therefore would cause irreplaceable loss.

Proposed mitigation

- Road kill monitoring programme (inclusive of wildlife collisions record keeping) should be established and fences installed, if needed to direct animals to safe road crossings;
- Adhere to speed limits applicable to all roads used; and
- Implement clear and visible signalisation indicating movement of vehicles and when turning off or onto the Transnet Service Road to ensure safe entry and exit.

Significance of impact with mitigation

By implementing the abovementioned mitigation measures the probability of the impact occurring would be lowered significantly which would reduce the significance of the impact to **moderate** negative impact during all the phases of the project.

6.3 Impact on air quality due to dust generation, noise and release of air pollutants from vehicles and construction equipment.

During all the phases of the projects, there will be a decrease in air quality due to the noise created by and pollutants released from vehicles coming to site during all phases of the projects, construction activities occurring on site and dust created from driving on the Transnet Service Road or gravel farm road. Since the site is located in a very rural setting, no sensitive receptors are present within close proximity of the proposed project. Therefore, the extent of the impact would remain local.

Significance of impacts without mitigation

As discussed above, the decrease in air quality would be local in extent. The worst case scenario for impacts on air quality is that no dust suppression is implemented on the Transnet Service Road, gravel access road, on site or that construction activities occur throughout very windy conditions. This negative impact would be **moderate** for all phases of the project, without mitigation.

Proposed mitigation

- Implement management strategies for dust generation e.g. apply dust suppressant on the Transnet Service Road, exposed areas and stockpiles;
- Postpone or reduce dust-generating activities during periods with strong wind;
- Limit noisy maintenance/operational activities to daytime only;
- Earthworks may need to be rescheduled or the frequency of application of dust control/suppressant increased;
- Ensure that all construction vehicles are roadworthy and respect the vehicle safety standards implemented by the Project Developer; and
- Avoid using old and noisy construction equipment and ensure equipment is well maintained.

Significance of impact with mitigation

With the implementation of the mitigation measures detailed above, the probability of noise emissions and dust realised would be lowered and the impact would be of a **low** significance.

6.4 Change in quality of surface condition of the roads

The Transnet Service Road or gravel farm road is going to be used as the main access road to the site. As discussed in Section 3. The Transnet Service Road and farm road are gravel roads and would require additional maintenance to ensure that the traffic generated would not decrease the surface condition of the road.

Significance of impacts without mitigation

The Transnet Service Road is currently being maintained by Transnet and it is unclear whether any maintenance is currently being undertaken on the gravel farm road. Since the Developer is going to use these roads during all phases of the project, it is expected that, should no mitigation measures be implemented, the road’s surface condition would decrease significantly. This would have a **low** negative impact on the road (due to the local spatial extent of the impact).

Proposed mitigation

- Construction activities will have a higher impact than the normal road activity and therefore the road should be inspected on a weekly basis for structural damage;
- Ensure that road network is maintained in a good state for the entire operational phase;
- Implement management strategies for dust generation e.g. apply dust suppressant on the Transnet Service Road, exposed areas and stockpiles; and
- A Road Maintenance Plan should be developed for the section of the Transnet Service Road that will addresses the following:
    - Grading requirements;
    - Dust suppressant requirements;
    - Drainage requirements;
    - Signage; and
    - Speed limits.

Significance of impact with mitigation

Provided that the above mitigation measures are implemented and agreed to by Transnet and the land owner whose farm road will be used, the impact would be a **low** positive impact since this section of the road would be well maintained.

6.5 Cumulative impact of traffic generation

The cumulative impact assessment assumes that all the projects outlined within the cumulative impact section occur at the same time. Even though there will most likely be overlap in the operational phases of these projects, it is unlikely that the construction phases for all these projects would occur at the same time. Since the construction phase will give rise to the most amount of trucks coming to site, this would be considered the worst case scenario in terms of traffic generation. The projects that are proposed within close proximity of each other are detailed within Table 1 below. The estimates detailed within the table below have been obtained from the Developers. Based on these current estimates, the total amount of additional trips that would occur on the R27 during the construction phase is 261.81, which is still well below the daily average limit of 1000 units. The impact on this road is therefore not anticipated to be significant but should the Transnet Service Road be used for all the projects, a maintenance plan, agreed upon all parties involved must be implemented to ensure that the road's quality and integrity is maintained.

Significance of cumulative impacts

It is assumed that the mitigation measures discussed in the Section 6 of this TIS and included in Table 2 below are implemented, that the traffic generation impacts would be suitable managed to ensure that the traffic impacts are suitably managed. Based on this, the cumulative negative impact is **low**.

Table 1. Cumulative daily traffic generation estimates for all PV projects proposed north-east of Kenhardt

PROJECT NAME		DAILY TRAFFIC GENERATION ESTIMATES		
		Construction Phase	Operational Phase	Decommission Phase
1	Proposed construction of Gemsbok PV1 75 MW Solar PV facility	20	10	20
2	Proposed construction of Gemsbok PV2 75 MW Solar PV facility	20	10	20
3	Proposed construction of Boven PV1 75 MW Solar PV facility	20	10	20
4	Proposed development of a 75 MW Solar PV Facility (Kenhardt PV 1) and proposed development of a 132 kV Transmission Line to connect to the proposed 75 MW Solar PV Facility (Kenhardt PV 1)	20.62	4.14	20.62
5	Proposed development of a 75 MW Solar PV Facility (Kenhardt PV 2) and proposed development of a Transmission Line to connect to the proposed 75 MW Solar PV Facility (Kenhardt PV 2)	20.62	4.14	20.62
6	Proposed development of a 75 MW Solar PV Facility (Kenhardt PV 3) and proposed development of a Transmission Line to connect to the proposed 75 MW Solar PV Facility (Kenhardt PV 3)	20.62	4.14	20.62
7	Proposed construction of the Mulilo Solar Development consisting of seven 75 MW PV or Concentrated PV Solar Energy Facilities and associated infrastructure	140	70	140
	TOTAL	**261.86**	**112.42**	**261.86**

Table 2. Traffic Impact Assessment Table

Aspect/Impact Pathway	Nature of impact	Status	Spatial Extent	Duration	Consequence	Probability	Reversibility	Irreplaceability	Mitigation Measures	Significance of Impact/Risk = Consequence x Probability		Ranking of Impact/ Risk	Confidence Level
										Without Mitigation	*With Mitigation*		
CONSTRUCTION AND DECOMMISSIONING PHASES													
Traffic generation	Increase in traffic	Negative	Regional	Short term	Moderate	Very likely	Yes	Replaceable	• Should abnormal loads have to be transported by road to the site, a permit needs to be obtained from the Provincial Government Northern Cape (PGNC) Department of Public Works, Roads and Transport • Provide a Transport Traffic Plan to SANRAL • Ensure that roadworthy and safety standards are implemented at all time for all construction vehicles • Plan trips so that it occurs during the day but avoid construction vehicles movement on the regional road during peak time (06:00-10:00 and 16:00-20:00).	**Low**	**Low**	4	**Medium**
	Accidents with pedestrians, animals and other drivers on the surrounding tarred/gravel roads	Negative	Local	Long term	Extreme	Likely	No	High irreplaceability	• Road kill monitoring programme (inclusive of wildlife collisions record keeping) should be established and fences (such as Animex fences) installed, if needed to direct animals to safe road crossings. • Adhere to all speed limits applicable to all roads used. • Implement clear and visible signalisation indicating movement of vehicles and when turning off or onto the Transnet Service Road to ensure safe entry and exit.	**High**	**Moderate**	3	**Medium**
	Impact on air quality due to dust generation, noise and release of air pollutants from vehicles and construction/ decommissioning equipment	Negative	Local	Medium term	Moderate	Unlikely	Yes	Replaceable	• Implement management strategies for dust generation e.g. apply dust suppressant on the Transnet Service Road, exposed areas and stockpiles. • Postpone or reduce dust-generating activities during periods with strong wind. • Earthworks may need to be rescheduled or the frequency of application of dust control/suppressant increased. • Ensure that all construction vehicles are roadworthy and respect the vehicle safety standards implemented by the Project Developer. • Avoid using old and noisy construction equipment and ensure equipment is well maintained.	**Moderate**	**Low**	4	**Medium**
	Change in quality of surface condition of the roads	Positive	Local	Long term	Slight	Likely	Yes	Replaceable	• Construction activities will have a higher impact than the normal road activity and therefore the road should be inspected on a weekly basis for structural damage; • Implement management strategies for dust generation e.g. apply dust suppressant on the Transnet Service Road, exposed areas and stockpiles; and • A Road Maintenance Plan should be developed for the section of the Transnet Service Road that will be used to addresses the following: o Grading requirements; o Dust suppressant requirements; o Drainage requirements; o Signage; and o Speed limits.	**Low**	**Low**	4	**Medium**

Aspect/Impact Pathway	Nature of impact	Status	Spatial Extent	Duration	Consequence	Probability	Reversibility	Irreplaceability	Mitigation Measures	Significance of Impact/Risk = Consequence x Probability		Ranking of Impact/ Risk	Confidence Level
										Without Mitigation	***With Mitigation***		
OPERATIONAL PHASE													
Traffic generation	Increase in traffic	Negative	Regional	Short term	Slight	Very likely	High	Replaceable	• Adhere to requirements made within Transport Traffic Plan; • Limit access to the site to personnel; and • Ensure that where possible, staff members carpool to site.	**Very low**	**Very low**	5	**Medium**
	Accidents with pedestrians, animals and other drivers on the surrounding tarred/gravel roads	Negative	Local	Long term	Extreme	Likely	No	High irreplaceability	• Road kill monitoring programme (inclusive of wildlife collisions record keeping) should be established and fences installed, if needed to direct animals to safe road crossings. • Adhere to all speed limits applicable to all roads used. • Implement clear and visible signalisation indicating movement of vehicles and when turning off or onto the Transnet Service Road to ensure safe entry and exit.	**High**	**Moderate**	3	**Medium**
	Impact on air quality due to dust generation, noise and release of air pollutants from vehicles and operational equipment	Negative	Local	Medium term	Moderate	Unlikely	Yes	Replaceable	• Implement management strategies for dust generation e.g. apply dust suppressant on the Transnet Service Road, exposed areas and stockpiles; • Limit noisy maintenance/operational activities to daytime only.	**Moderate**	**Low**	4	**Medium**
	Change in quality of surface condition of the roads	Positive	Local	Long term	Slight	Likely	Yes	Replaceable	• Implement requirements of the Road Maintenance Plan.	**Low**	**Low**	4	**Medium**
CUMULATIVE IMPACTS													
Traffic generation	Increase in traffic	Negative	Regional	Long term	Moderate	Very likely	High	Replaceable	n/a	**Low**	**Low**	4	**Medium**

7 TRAFFIC IMPACT STATEMENT

Based on the assessment of the potential impacts that can be associated with the traffic to be generated during the construction, operation and decommissioning phases of these projects, the overall impact from traffic generation is deemed to be **low** when implementing suitable mitigation measures, discussed in Sections 5 and 6 of this Statement. The highest traffic will be generated during the construction phase.

The measures included within the EMPr must be adhered to, with the main requirements outlined below:

- Should abnormal loads have to be transported by road to the site, a permit needs to be obtained from the Provincial Government Northern Cape (PGNC) Department of Public Works, Roads and Transport.
- Provide a Transport Traffic Plan to SANRAL.
- Ensure that roadworthy and safety standards are implemented at all time for all construction.
- Adhere to all speed limits applicable to all roads used.
- Implement clear and visible signalisation indicating movement of vehicles and when turning off or onto the Transnet Service Road to ensure safe entry and exit.
- Implement management strategies for dust generation e.g. apply dust suppressant on the Transnet Service Road, exposed areas and stockpiles.
- Construction activities will have a higher impact than the normal road activity and therefore the road should be inspected on a weekly basis for structural damage.
- A Road Maintenance Plan should be developed for the section of the Transnet Service Road.
- Ensure that road network is maintained in a good state for the entire operational phase.

BASIC ASSESSMENT REPORT

Appendix D.9:
Electromagnetic Interference Technical Report (Cumulative Topographical Analysis of Proposed PV Projects in AGA Area)

THE SCIENCE OF MEASUREMENT

Technical Report:

Cumulative Topographical Analysis of Proposed PV Projects in AGA Area

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Work done for: Scatec Solar SA 163 (Pty) Ltd.

A. J. Otto and P. S. van der Merwe

Document Number: SCA/16/01/29
Revision Number: REV1
Document Date: 10 February 2016

Document Approval

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Document History

Revision	Date of Issue	Comments
REV0	29 January 2016	Final Report Submission (SCA/16/01/29/REV0).
REV1	10 February 2016	Statement on compliance of Kenhardt PV developments.

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Executive Summary

MESA Solutions was asked by *Scatec Solar* to do a topographical analysis of the terrain profiles between various p hotovoltaic (PV) project locations in the Astronomy Geographic Advantage (AGA) area and the closest and core-site SKA telescopes. A total of three *Scatec Solar* sites (*Kenhardt PV1 to PV3*), as well as ten *Mulilo* sites (*Boven PV1 to PV4; Gemsbok PV1 to PV6*) in close proximity, are considered in this cumulative assessment.

EMI Characterisation of Representative Plant

Conducted Measurements

- TD conducted measurements on supply cables to the *Tracking Units* show large pulses when the plant is *ON*.
- Majority of the pulse energy extends up to at least 500 MHz.
- Equivalent FD measurements on the wireless antenna and pressure switch cables agree.
- Comparison with radiated results show higher frequencies radiate into the environment more efficiently.
- Better part of noise is likely to emanate from the inverter.
- *Tracking Unit* emissions are somewhat aggravated by the wireless communication.
- Switching noise associated with the tracking of the panels creates broadband interference.
- Biggest part of switching interference is generated by the pump contactor and relays.

Radiated Measurements

- Radiated results for the plant *ON* and in *STANDBY* mode show similar emissions levels.
- This confirms that interference producing systems are never completely *OFF*.
- Emissions associated with the *Inverter* units are dominant and occupy frequencies between 300 MHz and 2 GHz
- Peak levels identified range between 30 - 35 dBμV/m as measured at 10 m below 1 GHz and at 3 m above 1 GHz for both polarisations.
- For purposes of RFI mitigation, the fixed line communication would be the preferred implementation.
- The *String Cabinet* shows mostly broadband interference between 300 MHz and 800 MHz for both polarisations.
- Comparative measurements made with the doors to the *Inverters* and *Tracking Units* open show the limited levels of shielding provided by these enclosures.
- It is possible to improve the shielding by incorporating conductive gasketting.

Propagation Analysis

A preferred and alternative site location was included for the Mulilo developments in terms of the total path loss to the SKA receivers. This study attempts to define an E-field upper limit, as a function of frequency, at which the plants are allowed to radiate without exceeding emission limits (SARAS protection and receiver saturation limits) at the various SKA telescope locations. The conformance of the plant can be determined by comparing representative measured results, made at Scatec Solar's 75 MW Dreunberg plant, to the calculated levels provided.

From the results it is shown that:

- Radiated emissions at levels below that of CISPR 11/22 Class B are required (especially in the case of the closest telescope).
- Negligible terrain loss exists between majority of sites and closest SKA telescope.
- Predictions for the maximum allowed E-field level, as measured according to CISPR 11/22 Class B, are given in Figs. (a) to (c) below. A comparison with measured emission levels for each plant is shown.
- Based on plant emission and maximum allowed levels, the required (red) mitigation or surplus (green) attenuation for the closest, second closest and core-site telescopes are given in Tables 1 2 and 3 respectively.

The three proposed Kenhardt plants are shown in Table 1 to exceed the SARAS protection levels by up to 38 dB toward the closest SKA telescope. This includes the cumulative effect of a total of $N = 13$ PV plants developed. However, Boven PV1, PV3 and PV4 exceed this limit by approximately 50 dB in this scenario.

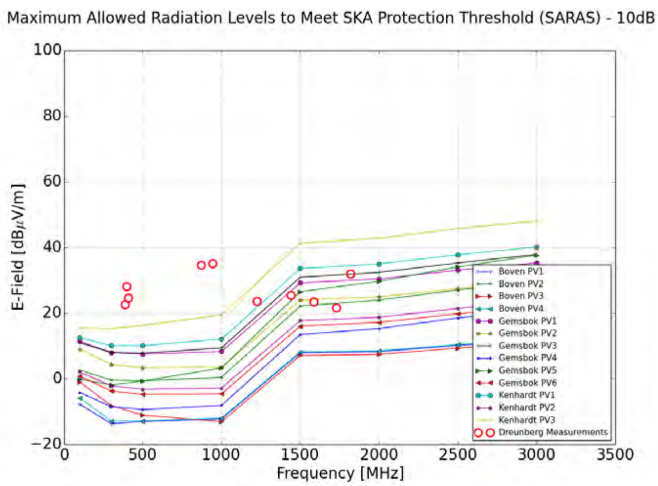
For the case where only the three Kenhardt plants are developed, the exceedance will reduce to 31.6 dB with a cumulative effect for $N = 3$ plants considered.

Mitigation Measures

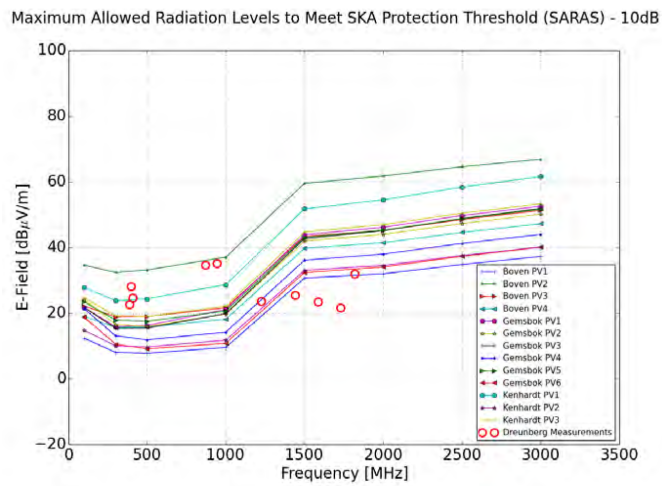
It is strongly recommended that the following **mitigation practises** be incorporated into the plants design:

- The inverter units, transformers, communication and control units for an array of panels all be housed in a single shielded environment.
- For shielding of such an environment ensure:
  - RFI gasketting be placed on all seams and doors.
  - RFI Honeycomb filtering be placed on all ventilation openings.
- Cables to be laid directly in soil or properly grounded cable trays (not plastic sleeves).
- The use of bare copper directly in soil for earthing is recommended.
- Assuming a tracking PV plant design, care will have to be taken to shield the noise associated with the relays, contactors and hydraulic pumps of the tracking units.
- All data communications to and from the plant to be via fibre optic.

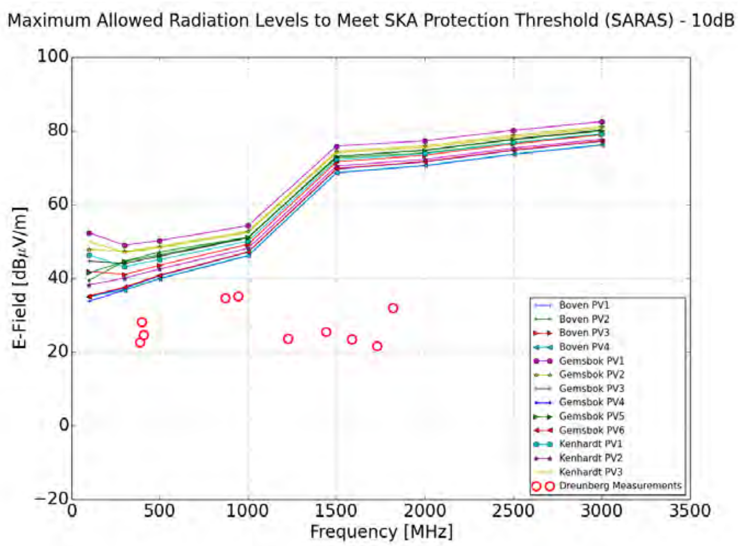
It is MESA's expectations that, if the mitigation measures that are specified are implemented correctly, attenuation of between 20 dB and 40 dB can be achieved. The required maximum mitigation 50 dB for some plant especially towards the closest telescope would require significant attention to detail. *It is important to note that the success of the mitigation measures cannot be guaranteed or confirmed until measurements on a representative mock-up installation with mitigation measures implemented are performed. Furthermore, the findings from this assessment are for the client's own edification, and will be taken into account by SKA-SA during their own propagation analysis. This study is therefore not meant to supersede any investigation done by SKA-SA or relevant RFI working groups. It remains the responsibility of the developer to meet compliance to the SKA requirements, and MESA Solutions cannot accept responsibility for any assessments made in this report which could cause non-compliance.*



(a)



(b)



(c)

Maximum allowed measured E-Field (CISPR 22 Class B) to ensure levels are 10 dB below SARAS protection levels toward: (a) Closest SKA telescope; (b) Second closest SKA telescope; and (c) SKA core-site telescopes compared to measured results at 75 MW Scatec Dreunberg PV plant.

Site Location	387.38 MHz	399.19 MHz	409.52 MHz	871.57 MHz	942.42 MHz	1223.81 MHz	1441.27 MHz	1584.12 MHz	1728.57 MHz	1819.05 MHz
Kenhardt PV1	12.55	18.03	14.58	23.06	23.28	1.96	-5.57	-10.4	-12.54	-2.51
Kenhardt PV2	25.23	30.77	27.38	37.53	37.99	17.28	10.17	5.52	3.5	13.6
Kenhardt PV3	6.94	12.37	8.87	15.98	16.03	-5.57	-13.22	-18.11	-20.3	-10.3
Boven PV1	36.02	41.47	37.99	47.05	47.43	26.85	19.92	15.43	13.61	23.82
Boven PV2	23.16	28.66	25.23	34.35	34.79	13.48	5.88	0.97	-1.29	8.67
Boven PV3	32.07	37.73	34.44	47.17	47.95	27.69	20.76	16.27	14.45	24.66
Boven PV4	35.48	40.95	37.5	46.79	47.17	26.59	19.66	15.17	13.35	23.56
Gemsbok PV1	14.85	20.36	16.94	26.52	26.91	5.98	-1.29	-6.01	-8.08	1.99
Gemsbok PV2	18.72	24.26	20.87	31.2	31.68	11.01	3.92	-0.72	-2.73	7.38
Gemsbok PV3	14.75	20.25	16.81	25.63	25.9	4.6	-2.93	-7.77	-9.92	0.09
Gemsbok PV4	31.52	37.06	33.66	43.06	43.38	22.1	14.54	9.64	7.38	17.34
Gemsbok PV5	24.01	29.42	25.92	32.36	32.29	9.96	1.69	-3.63	-6.27	3.43
Gemsbok PV6	26.8	32.34	28.94	39.25	39.73	19.02	11.88	7.2	5.14	15.21

Table 1: Required (red) and surplus (green) attenuation levels [dB] to meet SARAS protection limits at the closest SKA telescope.

Site Location	387.38 MHz	399.19 MHz	409.52 MHz	871.57 MHz	942.42 MHz	1223.81 MHz	1441.27 MHz	1584.12 MHz	1728.57 MHz	1819.05 MHz
Kenhardt PV1	-1.38	4.07	0.59	7.05	6.94	-15.35	-23.55	-28.78	-31.31	-21.52
Kenhardt PV2	12.74	18.24	14.81	23.39	23.6	2.36	-5.07	-9.89	-12.05	-2.03
Kenhardt PV3	3.57	9.07	5.63	13.31	13.36	-8.6	-16.59	-21.69	-24.06	-14.19
Boven PV1	14.73	20.23	16.8	25.52	25.77	4.64	-2.72	-7.48	-9.58	0.46
Boven PV2	3.73	9.21	5.76	13.68	13.81	-7.7	-15.32	-20.25	-22.51	-12.57
Boven PV3	3.73	9.21	5.76	13.68	13.81	-7.7	-15.32	-20.25	-22.51	-12.57
Boven PV4	6.95	12.43	8.98	17.08	17.24	-4.17	-11.73	-16.61	-18.82	-8.84
Gemsbok PV1	6.64	12.1	8.64	14.75	14.56	-7.66	-15.72	-20.84	-23.23	-13.37
Gemsbok PV2	6.39	11.91	8.49	15.91	15.87	-6.01	-13.88	-18.9	-21.21	-11.29
Gemsbok PV3	7.22	12.7	9.25	15.89	15.77	-6.42	-14.51	-19.67	-22.11	-12.27
Gemsbok PV4	10.1	15.65	12.27	21.01	21.18	-0.36	-8.05	-13.0	-15.27	-5.33
Gemsbok PV5	4.92	10.42	6.99	14.78	14.84	-7.04	-14.98	-20.04	-22.4	-12.51
Gemsbok PV6	12.72	18.28	14.91	24.24	24.5	3.19	-4.35	-9.23	-11.45	-1.48

Table 2: Required (red) and surplus (green) attenuation levels [dB] to meet SARAS protection limits at the second closest SKA telescope.

Site Location	387.38 MHz	399.19 MHz	409.52 MHz	871.57 MHz	942.42 MHz	1223.81 MHz	1441.27 MHz	1584.12 MHz	1728.57 MHz	1819.05 MHz
Kenhardt PV1	-21.33	-15.96	-19.51	-14.15	-14.35	-36.27	-44.03	-48.97	-51.19	-41.21
Kenhardt PV2	-18.46	-13.12	-16.7	-12.06	-12.35	-34.46	-42.33	-47.32	-49.57	-39.61
Kenhardt PV3	-24.93	-19.53	-23.04	-16.73	-16.81	-38.43	-46.01	-50.85	-52.99	-42.97
Boven PV1	-15.48	-10.18	-13.79	-9.87	-10.25	-32.51	-40.46	-45.49	-47.77	-37.84
Boven PV2	-19.45	-14.12	-17.69	-13.13	-13.44	-35.56	-43.45	-48.44	-50.7	-40.74
Boven PV3	-19.45	-14.12	-17.69	-13.13	-13.44	-35.56	-43.45	-48.44	-50.7	-40.74
Boven PV4	-15.58	-10.28	-13.89	-10.0	-10.38	-32.64	-40.59	-45.62	-47.89	-37.95
Gemsbok PV1	-26.86	-21.45	-24.96	-18.6	-18.67	-40.28	-47.85	-52.69	-54.83	-44.81
Gemsbok PV2	-25.18	-19.78	-23.3	-17.06	-17.15	-38.81	-46.41	-51.27	-53.42	-43.41
Gemsbok PV3	-22.2	-16.84	-20.39	-15.06	-15.27	-37.2	-44.97	-49.91	-52.13	-42.16
Gemsbok PV4	-16.1	-10.82	-14.44	-10.79	-11.19	-33.51	-41.49	-46.53	-48.82	-38.89
Gemsbok PV5	-22.7	-17.32	-20.87	-15.26	-15.43	-37.26	-44.97	-49.88	-52.07	-42.09
Gemsbok PV6	-16.36	-11.07	-14.68	-10.91	-11.31	-33.62	-41.61	-46.65	-48.94	-39.0

Table 3: Required (red) and surplus (green) attenuation levels [dB] to meet SARAS protection limits at the core-site SKA telescopes.

Contents

Nomenclature

AC	Alternating Current
AF	Antenna Factor
AGA	Astronomy Geographic Advantage
BW	Bandwidth
CISPR	Comitè International Spècial des Pertubations Radioèlectriques (French)
CISPR	International Committee on Radio Interference (English)
CM	Common Mode
CP	Current Probe
dB	Decibel
dBμA	Decibel Micro-Ampère
dBμV	Decibel Micro-Volt
dBμV/m	Decibel Micro-Volt per Metre
DC	Direct Current
DEM	Digital Elevation Model
DUT	Device Under Test
E-Field	Electric Field
EMI	Electromagnetic Interference
FD	Frequency Domain
FFT	Fast Fourier Transform
FSPL	Free Space Path Loss
GPS	Global Positioning System
ITM	Irregular Terrain Model
ITWOM	Irregular Terrain With Obstruction Model
KAT	Karoo Array Telescope
kV	Kilovolt
LOS	Line-of-Sight
mV	Millivolt
MW	Megawatt
NF	Noise Floor
PV	Photovoltaic
RBW	Resolution Bandwidth

RFI	Radio Frequency Interference
RFI-WG	Radio Frequency Interference Working Group
RTA	Real Time Analyser
SA	Spectrum Analyser
SARAS	South African Radio Astronomy Services
SKA	Square Kilometre Array
SKA-SA	Square Kilometre Array South Africa
SPLAT	Signal Propagation, Loss And Terrain - Analysis Tool
TD	Time Domain
TL	Terrain Loss
TPL	Total Path Loss
Z_T	Transfer Impedance

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1 Introduction

MESA Solutions was asked to investigate the cumulative effect and possible impact of a number of photovoltaic (PV) plants on the Square Kilometre Array (SKA) project. It is proposed that development of these plants take place in the Astronomy Geographic Advantage (AGA) area described in [1]. The proposed sites include three developments by *Scatec Solar*, as well as ten developments by *Mulilo Renewable Project Developments* in close proximity. From the terrain evaluation we are able to determine what influences, if any, natural topographical features will have on the total expected interference attenuation based on the location of the site. This determines the maximum allowable emission levels which the facility may generate in order to still comply with SKA threshold limits as specified in [2]. An initial study investigating the effect of three of the ten sites, namely *Boven PV1*, *Gemsbok PV1* and *Gemsbok PV2*, on the closest and core SKA telescopes were undertaken in [3].

The following additional sites considered in this cumulative study include:

Scatec Solar

- Kenhardt PV1
- Kenhardt PV2
- Kenhardt PV3

Mulilo Renewable Project Developments

- Boven PV2
- Boven PV3
- Boven PV4
- Gemsbok PV3
- Gemsbok PV4
- Gemsbok PV5
- Gemsbok PV6

For each of the additional Mulilo sites, a preferred and an alternative site location is considered in terms of the total path loss to the closest and core SKA telescopes. The purpose is to identify the recommended site location based on minimum potential impact.

The aim of this investigation is to define emission limits at relevant discrete frequencies to which *in situ* measurements, conducted once the project is built, have to adhere. Compliance to these limits, given the propagation analysis presented, will ensure that emissions will not exceed the SARAS protection or receiver saturation threshold levels. The report is not a prediction of what interference levels will be at each of the telescopes, but rather stipulates a requirement for the developer to ensure conformance. Assuming the same technology, the conformance of the plant can be determined by comparing representative measured results, from the 75 MW Scatec Dreunberg PV plant in Section 2, to the calculated levels provided in Section 6.

In the case where there are more than one PV plant (source of interference) emitting at a specific frequency, it is important that the cumulative effect be considered by taking into account:

$$P_{\text{Cumulative}} = 10\log_{10}(N) \quad (1)$$

where N=13 is the number of PV plants considered in this investigation. This could results in an accumulative effect of up to $P_{\text{Cumulative}}$=11.1 dB for power transmitted at a specific frequency.

It is important to note that the findings from this assessment are for the client's own edification, and will be taken into account by SKA-SA during their own propagation analysis. This study is therefore not meant to supersede any investigation done by SKA-SA or relevant RFI working groups. It remains the responsibility of the developer to meet compliance to the SKA requirements, and MESA Solutions cannot accept responsibility for any assessments made in this report which could cause non-compliance.

2 EMI Characterisation of 75 MW Dreunberg PV Plant

The cumulative study firstly requires the characterisation of electromagnetic interference (EMI) generated by a representative plant using similar technology as what will be implemented on the proposed sites. Secondly, by making use of the identified interference from the facility in propagation analysis, the potential impact of the sites on both the closest and core-site SKA telescopes are determined. Finally, recommendations for the mitigation of interference based on the anticipated impact and plant layout are given.

2.1 Background & Scope

The AGA act specifies that the declared astronomy advantage areas are to be protected, preserved and properly maintained in terms of radio frequency interference (RFI). Therefore, the potential impact from new developments in terms of emissions, specifically on the SKA SA project, have to be determined. MESA Solutions will assist *Scatec Solar* in trying to establish the impact of interference from all the proposed projects on both the closest and core-site SKA stations. It is, however, important to take into account the fact that all measured results in this report include background interference which is dependent on the representative plant's location.

MESA's philosophy for identifying RFI generated by an electric/electronic system is to do both radiated and conducted measurements. Conducted interference, in the form of common mode (CM) current on the cables connected to the system, could radiate if a resonant galvanic path exists. CM current measurements made throughout a system using a current probe (CP), are therefore a diagnostic tool which helps to determine the likely source of interference. Radiated measurements, usually made using active antennas, provide information about how much of the conducted interference is being radiated into the environment. Differences in spectral content between the two methods mean that some interference radiates directly from parts of the system. Levels of radiated interference are, furthermore, subject to multi-path interference and as a consequence have to be made at various separation distances.

Another level of investigation is to repeat some the radiated and conducted measurements in the time domain using a *MESA Product Solutions'* Real Time Analyser (RTA-3). This allows the capture of transient signals usually associated with switching events which a conventional sweeping spectrum analyser (SA) is unlikely to capture. While they might only last for a short duration, the consequence could be a frequency spectrum filled with interference (fast rise time pulse results in broadband frequency content). The combination of these measurement techniques is relied upon to provide information about the total amount of interference produced by a device under test (DUT). Current measurements were made from 70 MHz to 1 GHz due to the operational frequencies of interest (lower limit) and CP (upper limit). Radiated measurements were made from 70 MHz to 3.6 GHz which covers the band of conducted interference and provides some additional information.

2.2 Measurement Locations

A diagram of the plant layout is shown in Fig. 1. The plant is divided into an eastern and western section. Measurement positions were chosen in the eastern section close to inverters 22 and 23 (Position 1) as well as inverters 1 and 2 (Position 2). The two positions were evaluated because of differences in communication methods between the tracking units at each location. The associated global positioning system (GPS) coordinates for the two position are:

- **Position 1:** 30° 50.167' S, 26° 12.930' E
- **Position 2:** 30° 49.944' S, 26° 13.204' E

Figure 1: Diagram of plant layout showing measurement location at inverters 22 and 23.

The Dreunberg plant makes use of a horizontal single-axis tracking facility operated hydraulically. Each inverter/transformer station is supplied by six arrays of panels each operated by two tracking units. The measurement location was chosen to provide characteristic emissions of a typical *Inverter* station, as well as nearby *String* and *Tracking* cabinets.

The *String* cabinets (Fig. 2) combines all the direct current (DC) supplies for a particular part of the plant onto positive and negative 1000 V DC cables. The *String* cabinet also contain a smart solar energy monitoring system that monitors the voltage, current and power output from the various PV panels (or strings) that feed DC into the *String* cabinet. The *Tracking* cabinets located on the *Tracking* unit contain all the control electronics for the array movement. The hydraulic system makes use of a master and slave hydraulic rams situated either side of a particular array. Depending on the direction the panels are moved in, only one will operate at any given time. Communication between the *Tracking* units are done via a local wireless network for most units in the plant, except at a few units close to Position 2. For the wireless system (Position 1), each pair of *Tracking* units has a unique operating frequency to ensure exclusive communication. For the wired implementation (Position 2), a fixed *RS-485* communication cable runs underground connecting each pair of *Tracking* units.

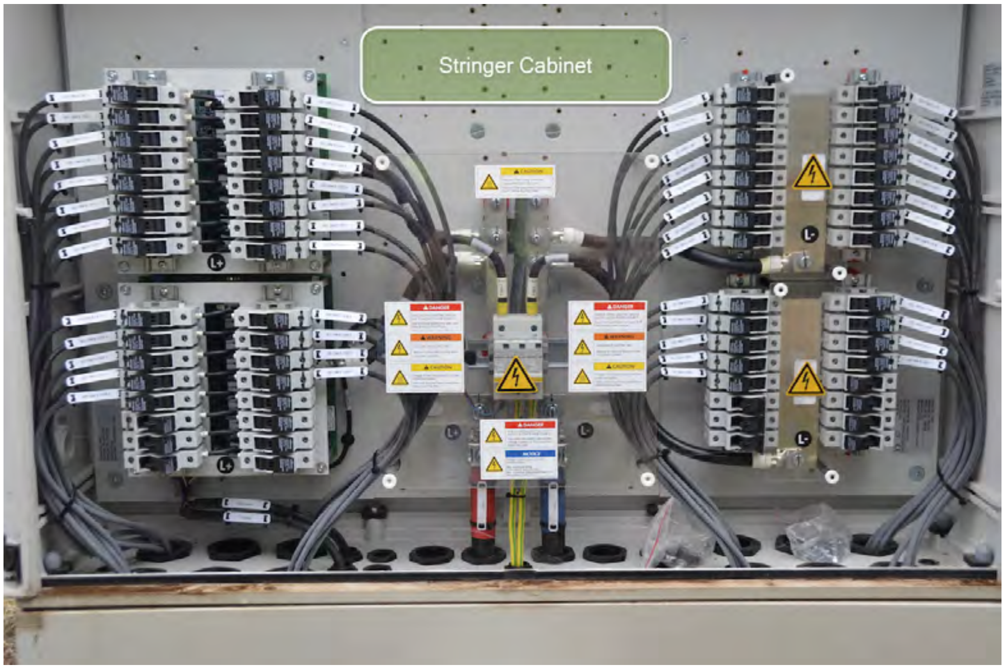


Figure 2: String Cabinet layout where supply from each panel is monitored.

2.3 Conducted Measurements

Conducted measurements were made using an *ETS-Lindgren EMCO* CM CP. Measurements in the time domain (TD) were made using a 800 MHz instantaneous bandwidth (BW) *MESA Product Solutions RTA-3* (Real Time Analyser) capable of measurements up to 2.6 GHz, while frequency domain (FD) measurements were made with a *Rohde & Schwarz ZVH-4* (70 MHz to 3.6 GHz) cable and antenna analyser (SA). In cases where strong low-frequency emissions compressed the receivers, a 100 MHz high pass filter was added.

The majority of measurements were made on cables close to the *Tracking Unit* and *String Cabinets* at Position 1 and 2. Measurements were also made on the cables connected to one of the weather stations located throughout the facility. A number of conducted interference measurement locations are shown in Figs. 3 to 5:

- Positive direct current (DC) panel cables
- Earth strap at the back of the PV panels
- DC cable bundle at the back of the PV panels
- Communication cable in String Cabinet
- Tracking Unit Position 1 wireless antenna cable
- Pressure switch cable (Tracking Unit)
- Tracking Unit communication cable Position 2
- Weather station cable

Measurements were made with the plant in full power generation mode, referred to as the *ON* state. After sunset the plant no longer produces power and enters an idle/standby mode. It is important to note, however, that most control and monitoring systems remain on during this period. This is referred to as the *STANDBY* state of operation and was also evaluated. With most systems remaining on, emissions levels will not necessarily change between *ON* and *STANDBY* modes of operation.

Figure 3: CP measurements on the panel earth strap.

Figure 4: CP measurements on cables connected to Tracking Cabinet.

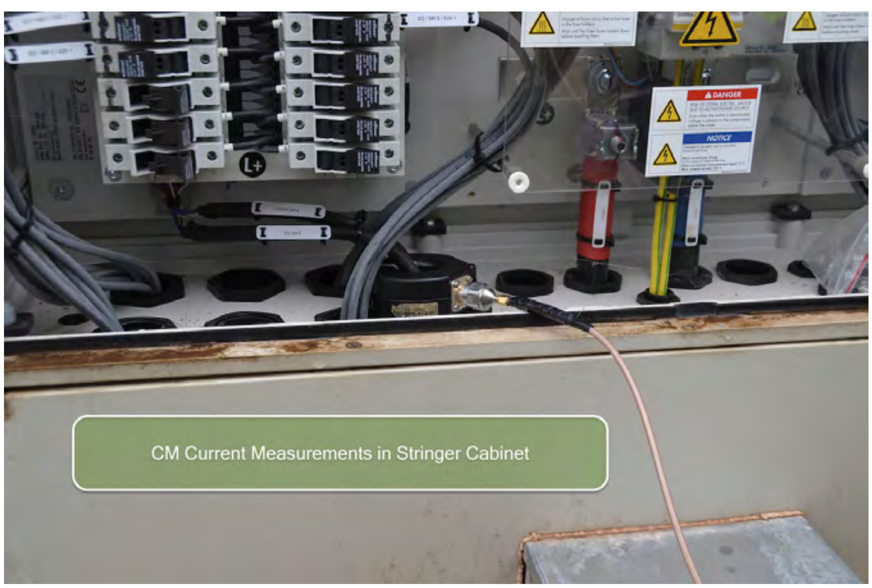


Figure 5: CP measurements on the communication cable inside the String Cabinet.

2.3.1 Frequency Domain Measurements

FD results obtained with the CM CP and SA are shown in Figs. 6 to 12. In these results the measured voltage levels [dBμV] are converted to current levels [dBμA] by removing the transfer impedance (Z_T [dBΩ]) of the probe. Each figure displays the frequency content measured from 70 MHz to 1 GHz. The dominating low-frequency content occasionally required the use of a low pass filter with a cut-in frequency of 100 MHz. The effect therefore on band of interest is negligible. In most cases the pre-amplifier was used with a 100 kHz resolution bandwidth (RBW) which is the closest option to CISPR equivalent RBW of 120 kHz for frequencies below 1 GHz.

Included in all results are the CISPR 11/22 Class B (more stringent standard for household applications) equivalent current limit. It is derived from antenna theory that any cable in free space carrying a CM current level of 5 μA (or 13.98 dBμA) above 230 MHz, will produce a worst-case E-field strength of 37 dBμV/m at a distance of 10 m from the DUT. This will only occur if the cable has resonant properties at a given frequency. The 37 dBμV/m limit is relaxed by 10 dB for CISPR 22 Class A (industrial applications). While the SKA, because of its sensitivity, enforces much more stringent limits than CISPR, it is purely included as a well-known reference.

Most of the results show a comparison between the *ON* and *STANDBY* modes of operation. Because the plant never fully switches off, evaluation of the *STANDBY* mode is relevant. In all cases where *STANDBY* measurements were made, the comparison with *ON* results confirms that there are no appreciable difference in terms of the interference generated. A prominent broadband interference signal seen on the DC cable bundle is visible at a lower level on the single panel DC cable. Also visible in the two DC results is a particularly strong narrowband emission at 872 MHz. It was also measured on the panel earth strap, the pressure switch and wireless antenna cables. Its narrowband feature and the fact that it was not measured on the cables connected to the *String* or fixed line *Tracking Cabinets* suggest it to be some local oscillator or clock frequency only visible at Position 1.

Other significant levels of conducted interference are seen on the pressure switch, wireless antenna and *Tracking Cabinet* communication cable. These levels are above the equivalent current limit between 100 MHz and 350 MHz and seem to be broadband in nature. The wireless antenna and pressure switch cables show narrowband higher frequency interference not measured anywhere else. The similarity in spectral content on these two cables can be attributed to their close proximity of the *Tracking Unit*, with the source likely to be the wireless communication system. Similar interference is not visible on the communication cable of the *Tracking Unit* at Position 2 where the wireless system is not used. A simple comparison of conducted and radiated interference will subsequently be presented to determine the contribution of CM current to the overall radiated emissions.

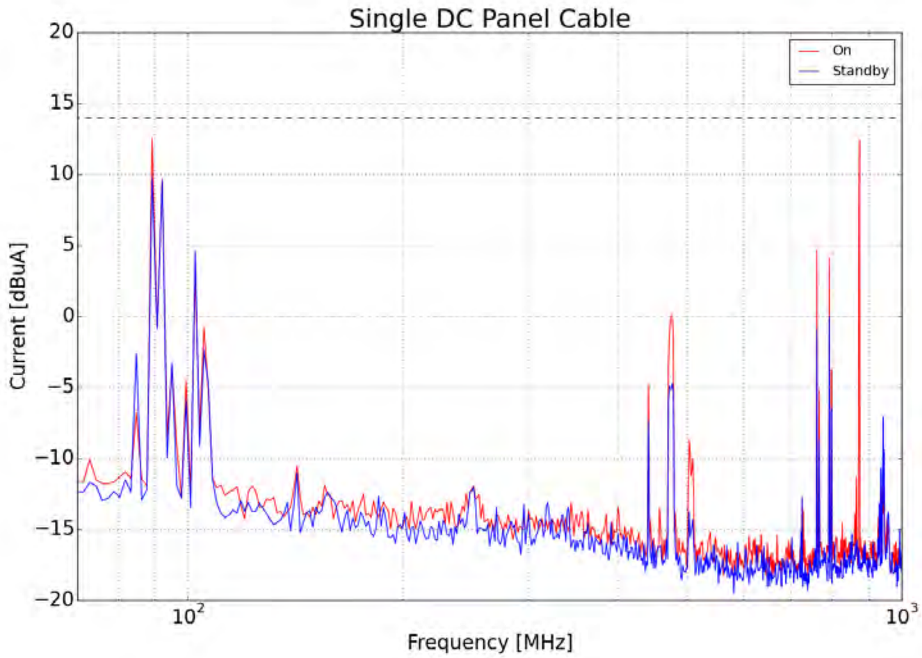


Figure 6: Frequency domain current probe measurements on the PV panel DC cables for the plant *ON* and in *STANBY* mode.

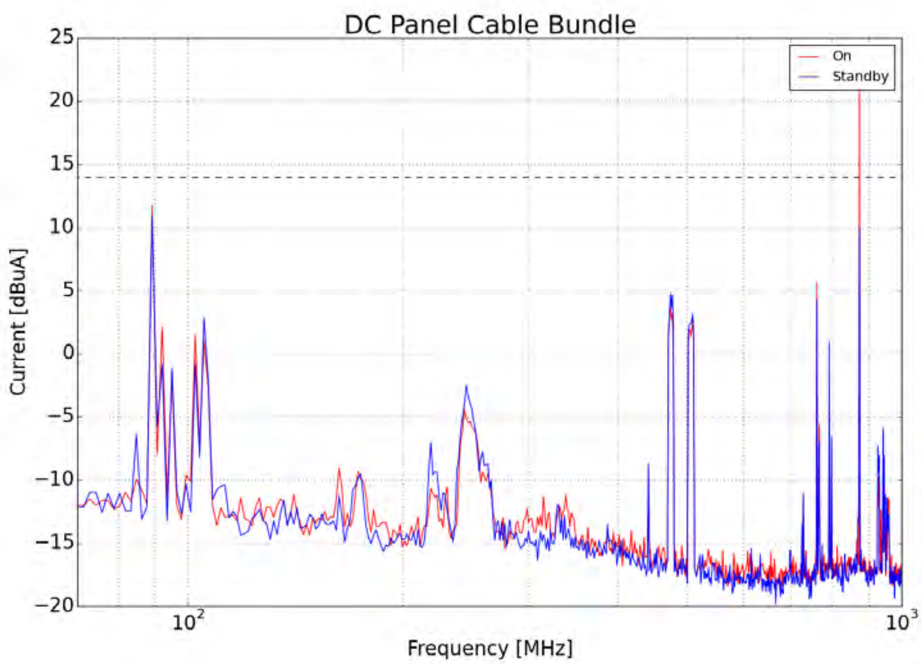


Figure 7: Frequency domain current probe measurements on DC cable bundle at the back of the PV pannels for the plant *ON* and in *STANDBY* mode.

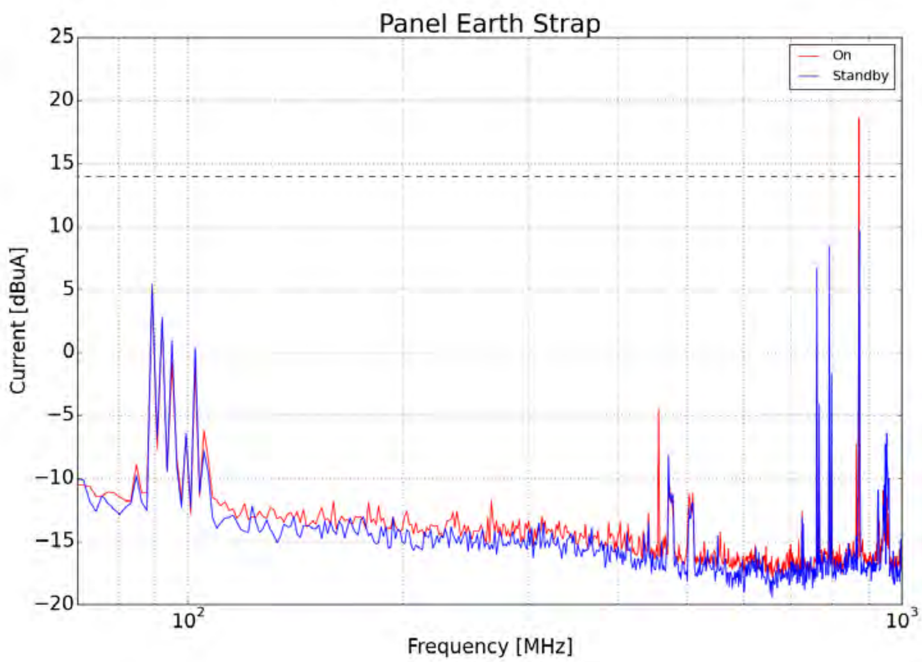


Figure 8: Frequency domain current probe measurements on PV earth strap for the plant *ON* and in *STANBY* mode.

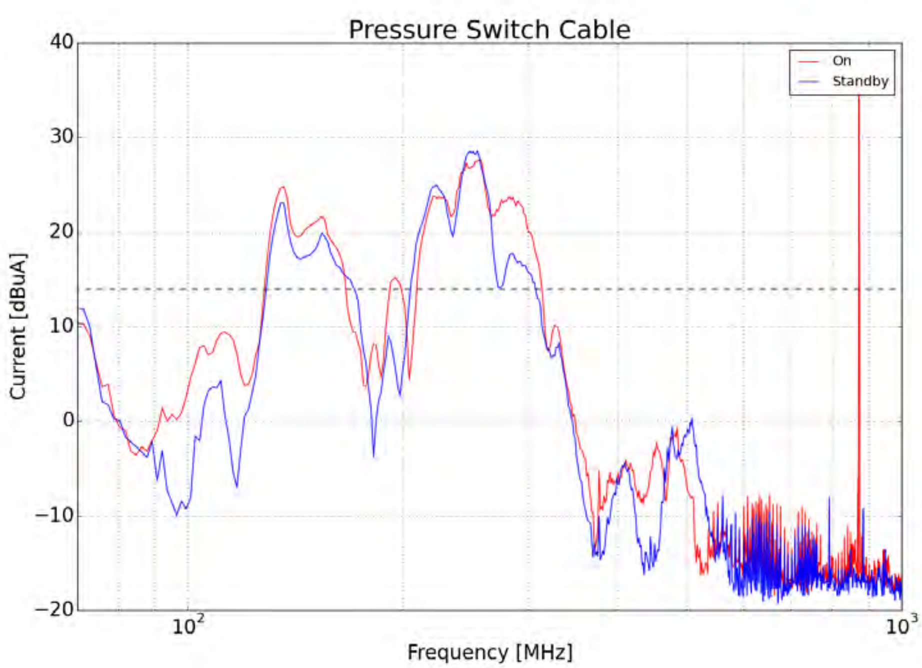


Figure 9: Frequency domain current probe measurements on the hydraulic pressure switch located at the Tracking Unit for the plant *ON* and in *STANDBY* mode.

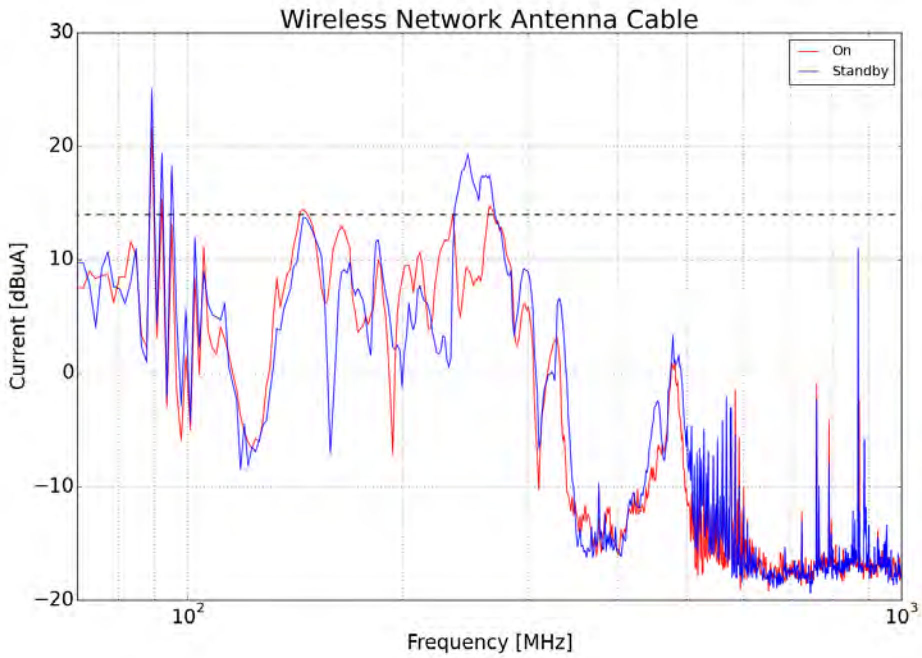


Figure 10: Frequency domain current probe measurements on wireless antenna cable located at the Tracking Unit at Position 1 for the plant *ON* and in *STANBY* mode.

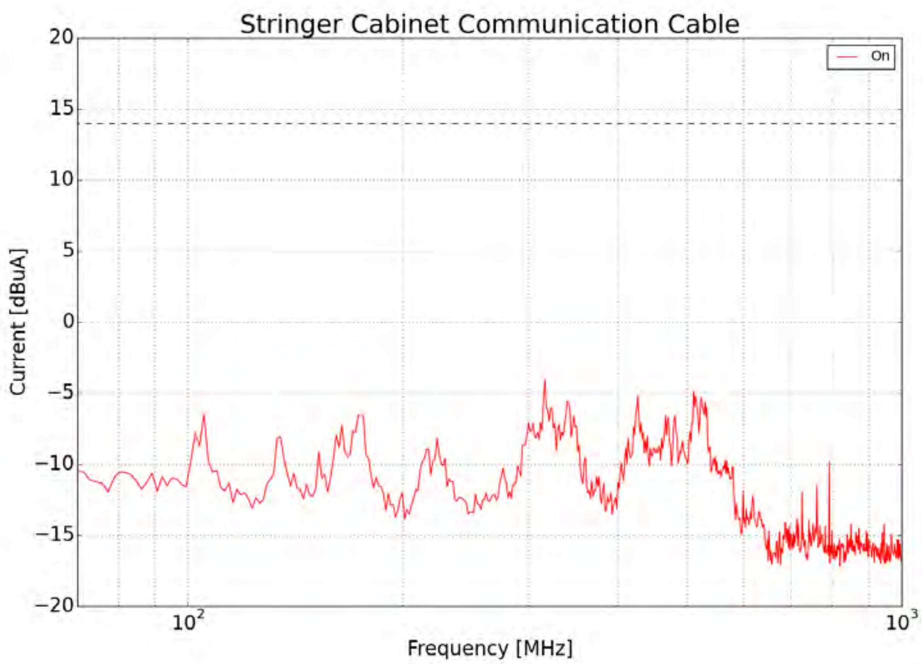


Figure 11: Frequency domain current probe measurements on String Cabinet communication cable for the plant *ON* and in *STANDBY* mode.

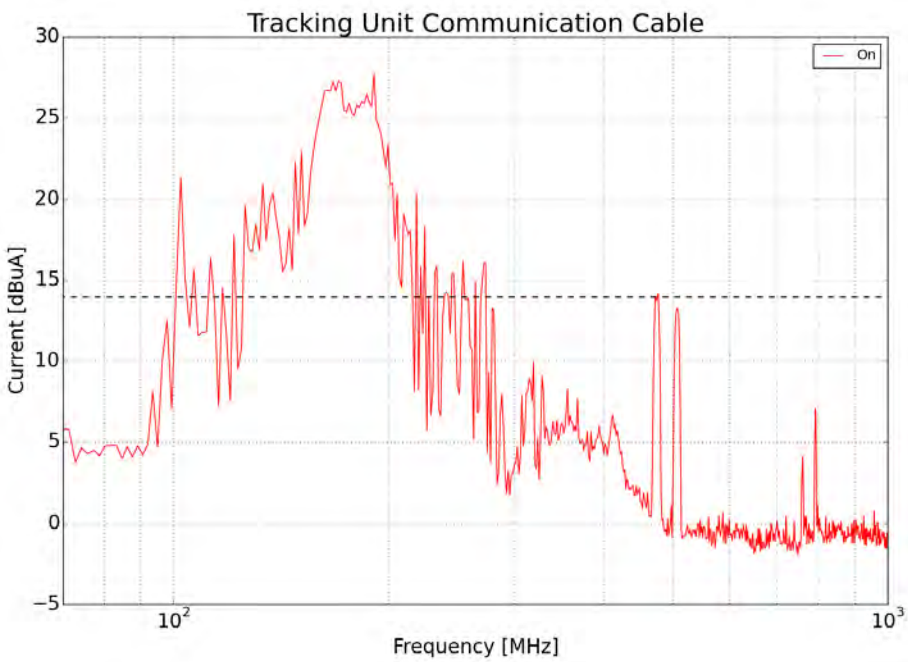


Figure 12: Frequency domain current probe measurements on Tracking Cabinet communication cable at Position 2 for the plant *ON* and in *STANBY* modes.

2.3.2 Time Domain Measurements

TD conducted measurements, focussing particularly on the *Tracking Unit* operation were made, as shown in Fig. 4. A typical TD transient pulse, as well as its corresponding Fast Fourier Transform (FFT) FD spectrum, captured on supply cables entering the cabinet of the unit at Position 1 with the RTA-3 and EMCO CM CP are shown in Fig. 13 and Fig. 14 respectively.

In both of the results shown above, the resultant spectrum gives the frequency content only associated with the particular pulse captured. The fast changing nature of the pulses cannot be captured using a conventional sweeping SA, so both TD and FD data have to both be considered. In the event of the supply cable that was measured, levels exceeding the CISPR equivalent current limit are seen from approximately 100 MHz across most of the frequency band. The pulse therefore suggests relatively strong transient events which will distribute to all cables closely spaced to this supply cable. A comparison with radiated results also measured in the TD in close proximity to the *Tracking Unit* are presented in Section 2.4.4.

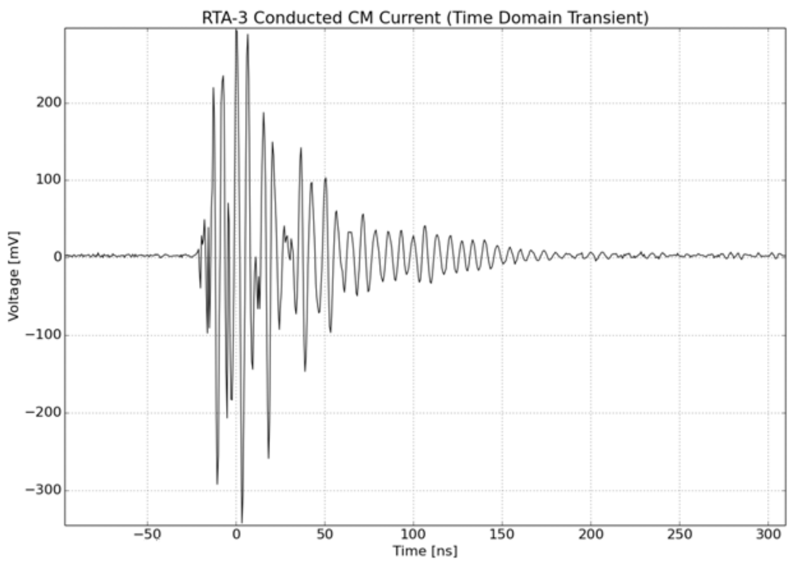


Figure 13: Typical CM current transient pulse captured with RTA-3 on supply cables to the Tracking Unit at Position 1.

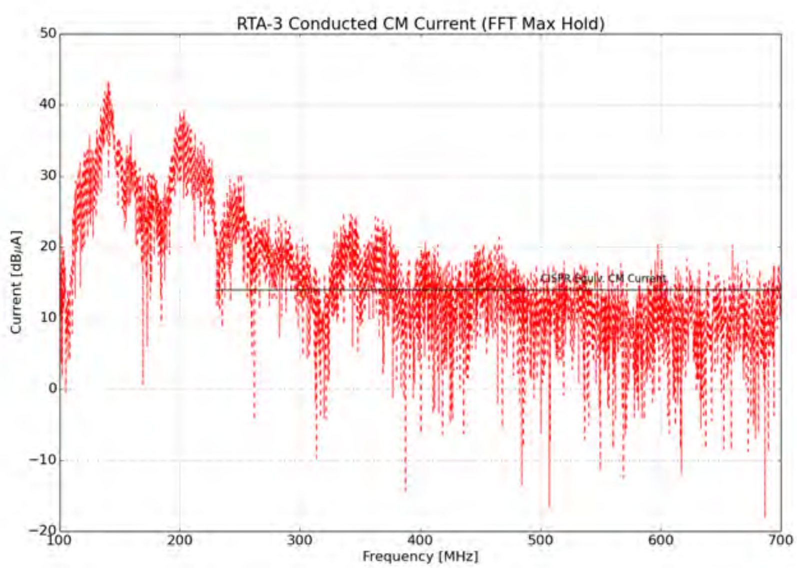


Figure 14: Equivalent Fast Fourier Transform spectrum for the conducted interference measured on supply cable to the Tracking Unit at Position 1.

2.4 Radiated Measurements

2.4.1 Frequency Domain Measurements

Inverters 22 and 23 Position 1

Radiated measurements were made in the TD and FD using the same conventional sweeping SA and RTA-3. A log periodic dipole array (LPDA) antenna in both active and passive modes were used as the receiver. Measurements were made between 70 MHz and 3.6 GHz, with measured voltage levels [dBμV] transformed into electric field (E-field) [dBμV/m] by incorporating the appropriate antenna factor (AF) values [dB/m].

Radiated measurements were made at Position 1 (Fig. 1) of Inverters 22 and 23 as well as the closest *Tracking* and *String Cabinets* at separation distances of 1, 3, 10 m as shown in Figs. 15 (a) and (b). Measurements were also made at Position 2 (Fig. 1) of the *Tracking Cabinet* at a location in the plant were fixed-line communication is used between the *Tracking Units*. A comparison of results for the two positions give an indication of the possible increased high frequency interference associated with the wireless communication network.

In addition to evaluating emissions as a function of distance, measurements were also made with the doors to the *Inverter* enclosures and *Tracking Cabinet* open. Both sets of results help to identify interference produced only by the plant. In all cases measurements were made during full power production (*ON*), and when no power was being generated (*STANDBY*) for both polarisations.

(a) (b)

Figure 15: Radiated measurements of (a) Inverter and Transformer units and (b) Tracking Cabinet.

Results as measured for *Inverters* 22 and 23 at Position 1 with the system *ON* and in *STANDBY* mode for both polarisations are given in Figs. 16 and 17. These results are with all doors to enclosures closed.

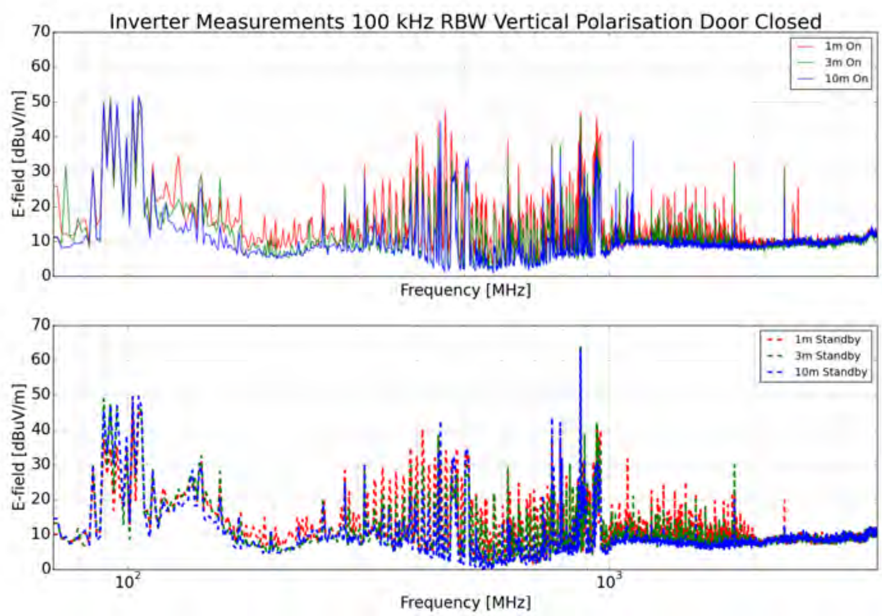


Figure 16: **Vertical** polarisation E-field measurements at a distance of 1, 3 and 10 m form the Inverters at Position 1 for both *ON* and *STANDBY* modes of operation with door **closed**.

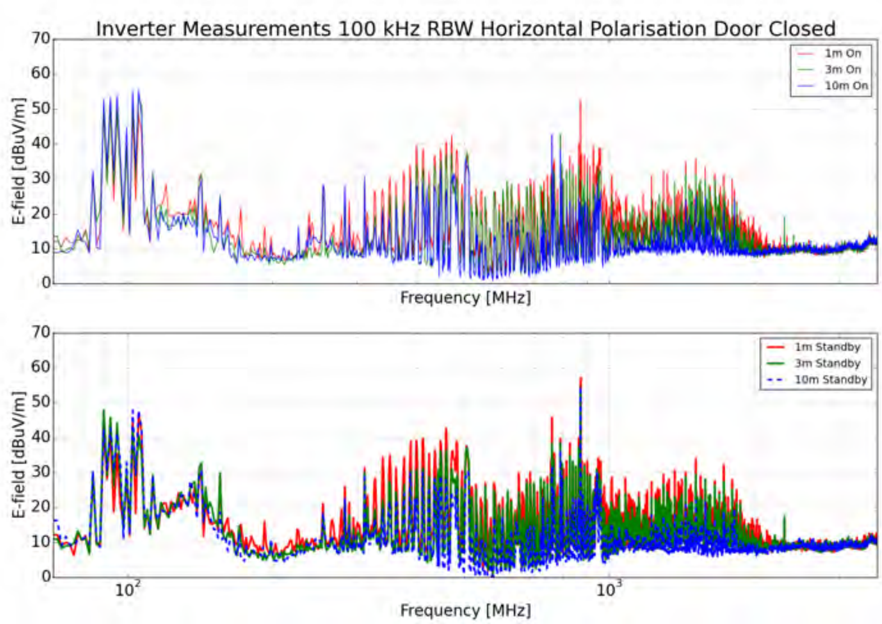


Figure 17: **Horizontal** polarisation E-field measurements at a distance of 1, 3 and 10 m form the Inverters at Position 1 for both *ON* and *STANDBY* modes of operation with doors **closed**.

Similar levels of interference are measured for both polarisations, as well as for the plant *ON* and in *STANDBY* mode. Variation with distance can be seen from 300 MHz up to 2 GHz, and peak emission levels reach 48 dBμV/m at 1 m for vertical polarisation and 42 dBμv/m at 1 m for horizontal polarisation. A particularly strong emission at 872 MHz can be seen in all results shown.

Results for a repeat measurement as a function of distance, but with the doors to the *Inverter* enclosures open, are shown in Fig. 18 for vertical polarisation and in Fig. 19 for horizontal polarisation. In both cases results are shown for the plant *ON* and in *STANDBY* mode.

The comparison shows emission in the vertical polarisation to increase, especially between 1 and 2 GHz. Peak levels for vertical polarisations have increased to above 50 dBμV/m compared to 48 dBμV/m for the door closed. In the case of horizontal polarisation signal levels have increased by at least 10 dB for measurements with the inverter and transformer doors open. The variation with distance and level increase with the doors open, albeit less than expected at some frequencies, confirms the radiating source to be the *Inverters*.

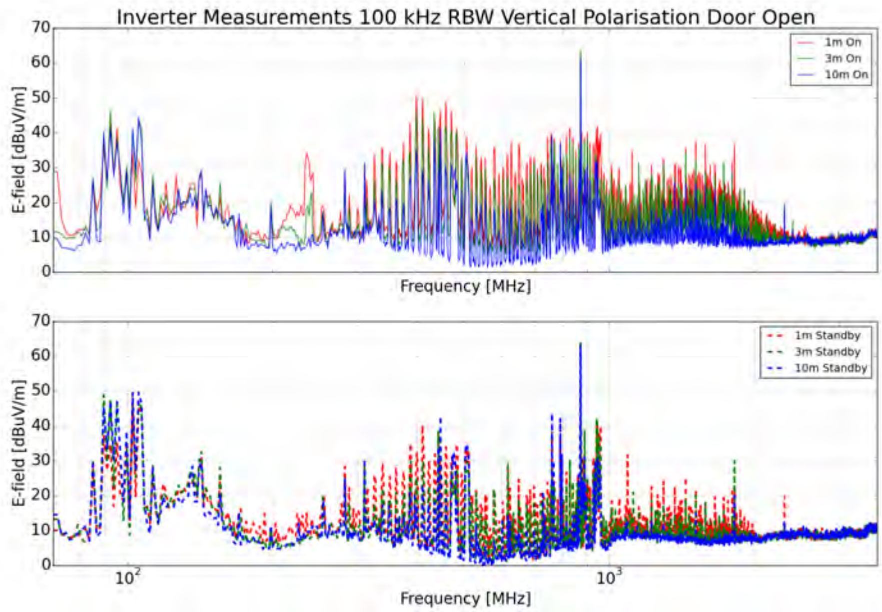


Figure 18: **Vertical** polarisation E-field measurements at a distance of 1, 3 and 10 m form the Inverter at Position 1 for both *ON* and *STANDBY* modes of operation with doors **open**.

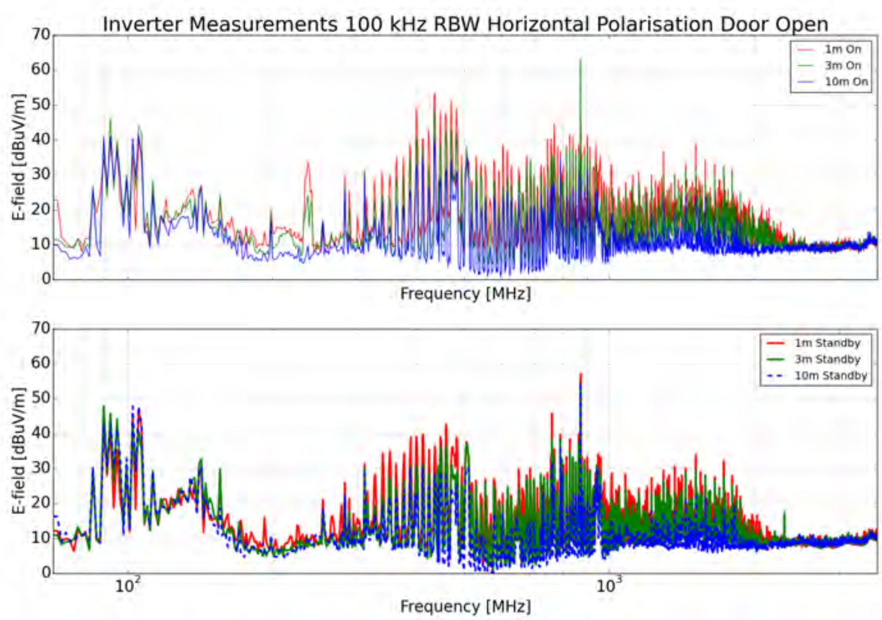


Figure 19: **Horizontal** polarisation E-field measurements at a distance of 1, 3 and 10 m form the Inverters at Position 1 for both *ON* and *STANDBY* modes of operation with doors **open**.

Tracking Unit Position 1
Results measured for one of the *Tracking Units* at Position 1 with the plant *ON* and in *STANDBY* mode are given in Figs. 22 and 21. These results are for the door of the *Tracking Cabinet*, visible in Fig. 15(b), closed.

Peak interference levels for both polarisations can be seen around 250 MHz as well as between 500 MHz and 1 GHz. A decrease in amplitudes when moving away from the cabinet is also visible, but for some frequencies this is less than predicted free space loss. This can be attributed to the reflective nature of the surroundings and uncertainty about where the measurement point is in the far-field of the radiating source is. However, these measurements indicate specifically that the source has been correctly identified.

String Cabinet Position 1
Emissions from one of the *String Cabinets* at Position 1 with the plant *ON* and in *STANDBY* mode for both polarisations are given in Figs. 24 and 25. With the *String Cabinet* being made of fibre glass, measurements with the door open were not required, so only comparisons for 1, 3, and 10 m are given.

The spectrum shows predominantly wideband interference between 300 MHz and 800 MHz for both polarisations and with the plant *ON* and in *STANDBY* modes. Variation in amplitude when moving from 1 m to 10 m are between 14 dB and 16 dB for vertical polarisation, and between 7 dB and 15 dB for horizontal polarisation. This is less that the predicted 20 dB free space reduction, which again confirms the influence of the complex reflective environment between the panels. The precise source of radiating interference are therefore influential.

Tracking Cabinet Position 2
Below are results showing the difference in radiated emissions from the *Tracking Unit*'s cabinet as measured at Position 1 and 2 (Fig. 1). It shows the difference in radiated interference when comparing the wireless and fixed line communication systems that are implemented. Results are only shown for the plant *ON*. The measurements being compared were all made using a 100 kHz RBW with the cabinet door closed.

The comparison for both polarisations at all three separation distances clearly show more frequency content for the wireless implementation, especially between 500 - 700 MHz. Prominent wideband interference between 200 - 300 MHz are also not present for the fixed line implementation, suggesting that for purposes of radio interference mitigation, this would be a better implementation.

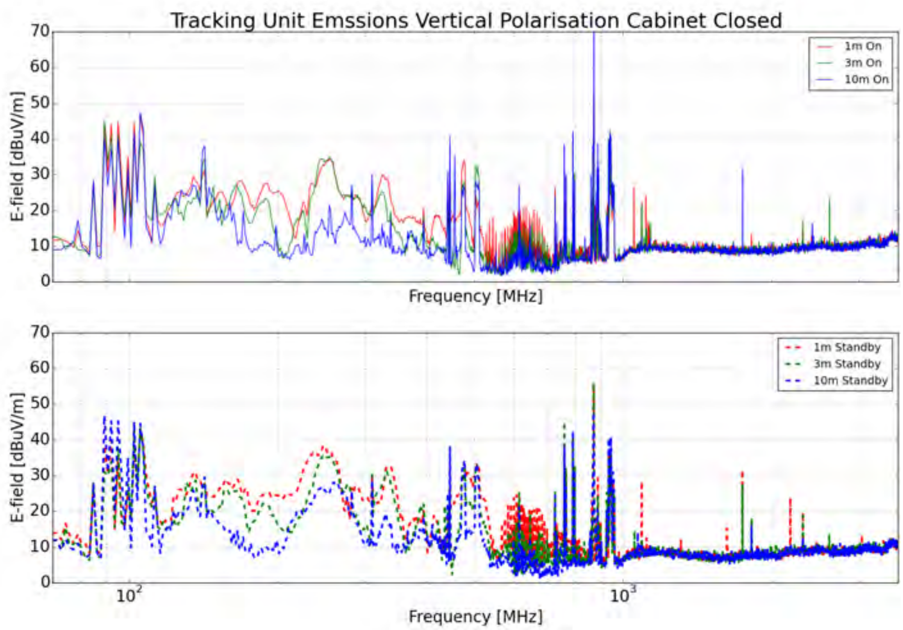


Figure 20: **Vertical** polarisation E-field measurements at a distance of 1, 3 and 10 m form the Tracking Unit at Position 1 for both *ON* and *STANDBY* modes of operation with cabinet **closed**.

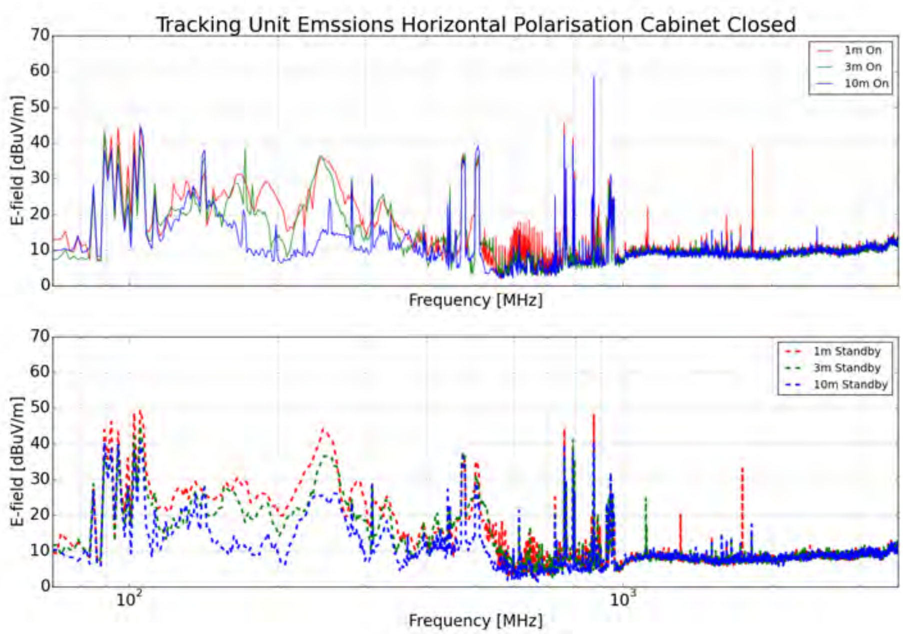


Figure 21: **Horizontal** polarisation E-field measurements at a distance of 1, 3 and 10 m form the Tracking Unit at Position 1 for both *ON* and *STANDBY* modes of operation with cabinet **closed**.

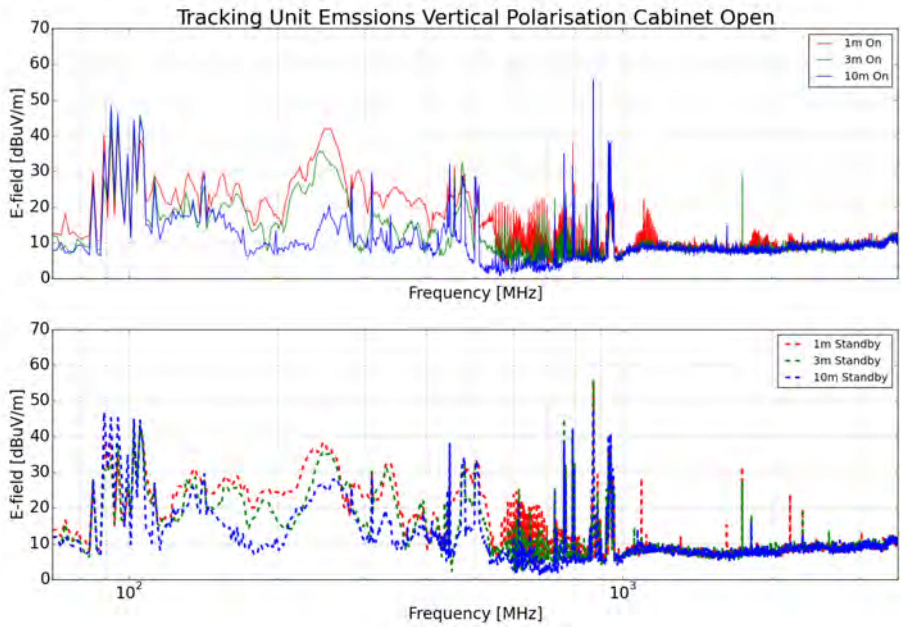


Figure 22: **Vertical** polarisation E-field measurements at a distance of 1, 3 and 10 m form the Tracking Unit at Position 1 for both *ON* and *STANDBY* modes of operation with cabinet **open**.

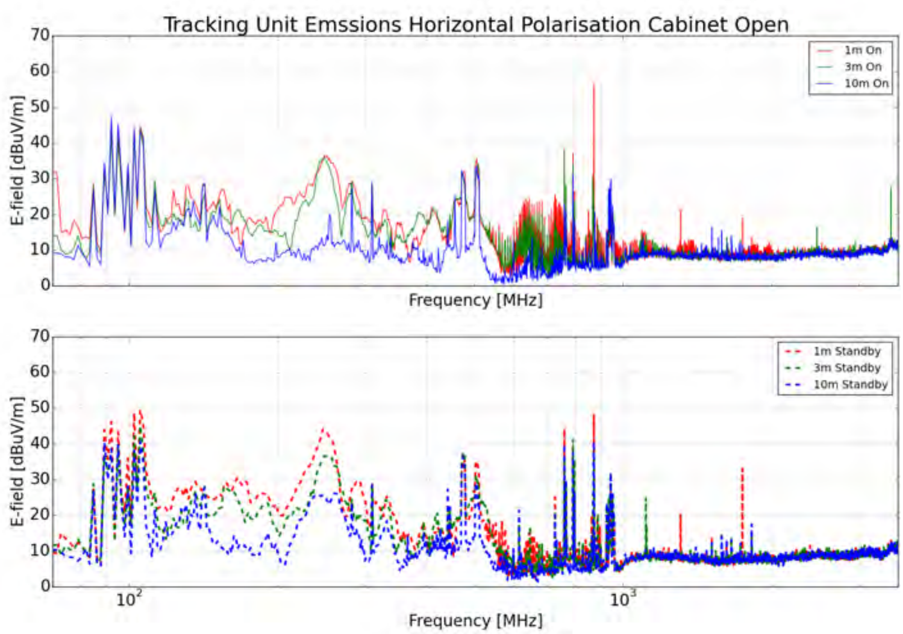


Figure 23: **Horizontal** polarisation E-field measurements at a distance of 1, 3 and 10 m form the Tracking Unit at Position 1 for both *ON* and *STANDBY* modes of operation with cabinet **open**.

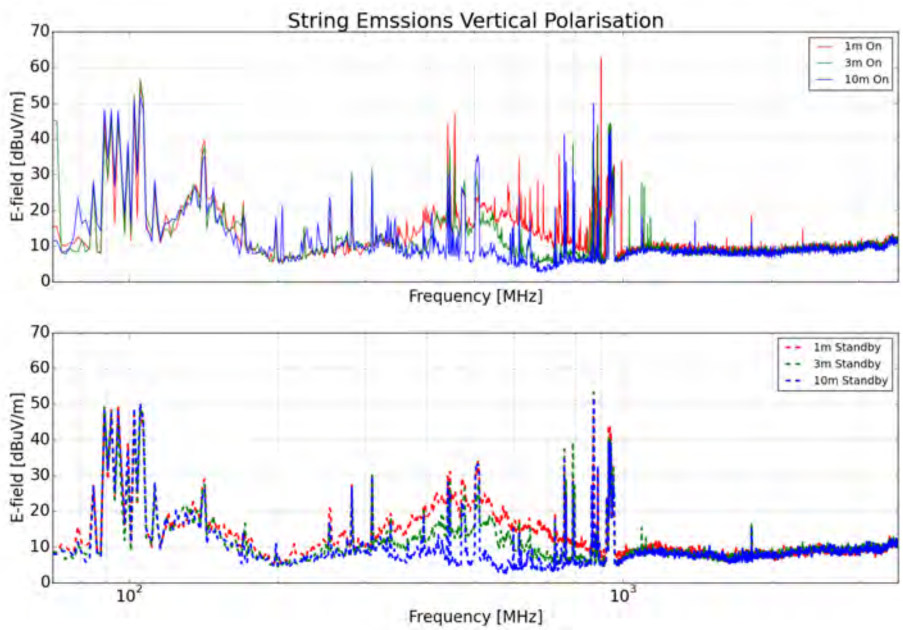


Figure 24: **Vertical** polarisation E-field measurements at a distance of 1, 3 and 10 m form the String Cabinet at Position 1 for both *ON* and *STANDBY* modes of operation.

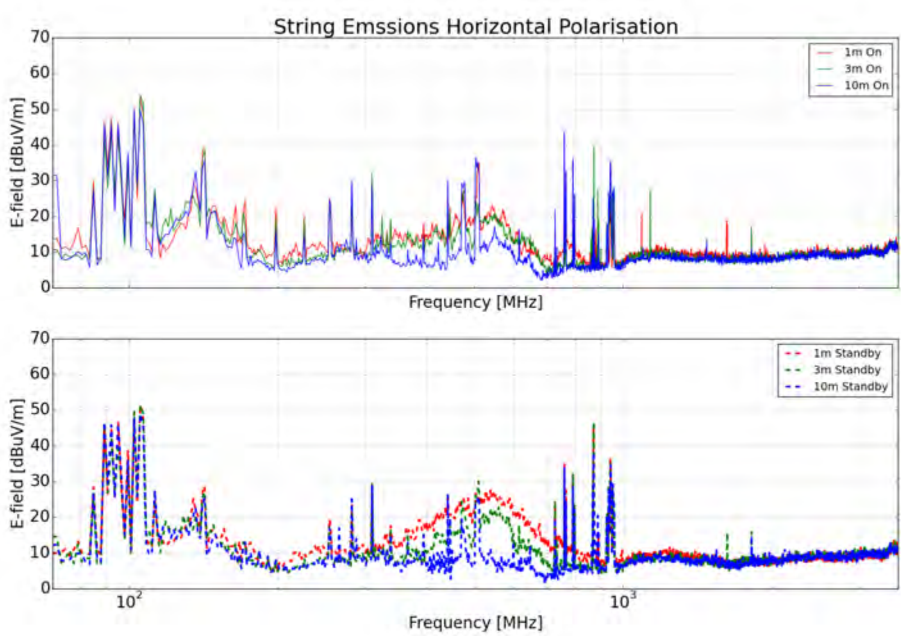
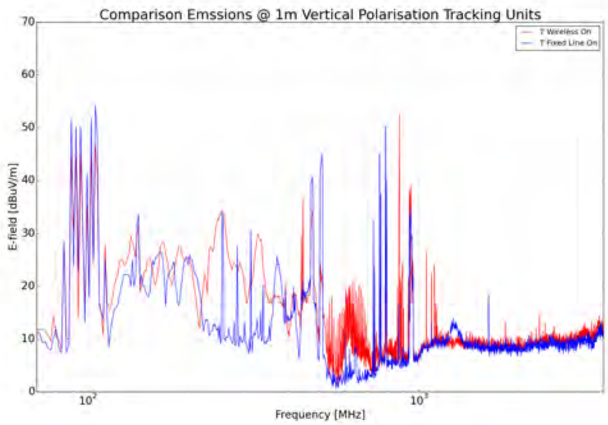
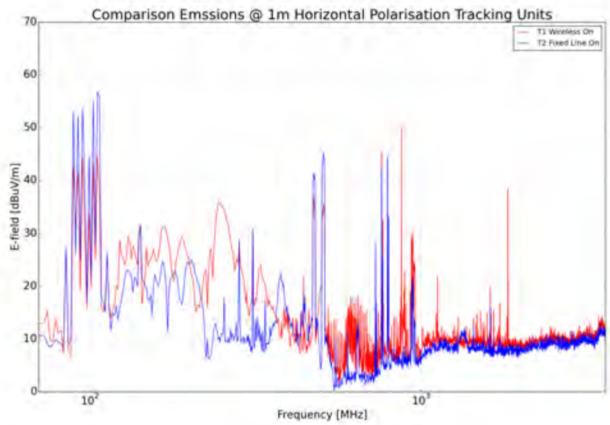


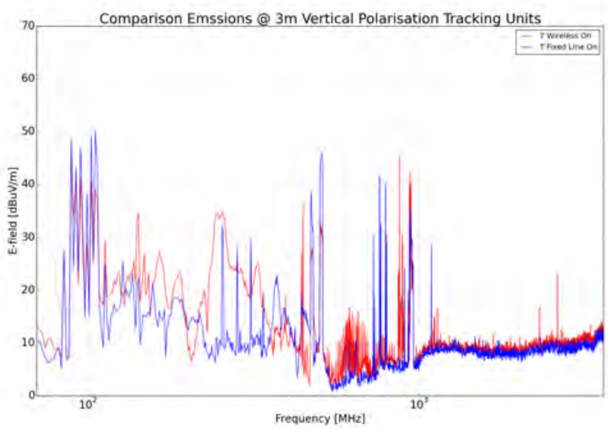
Figure 25: **Horizontal** polarisation E-field measurements at a distance of 1, 3 and 10 m form the String cabinet at Position 1 for both *ON* and *STANDBY* modes of operation.



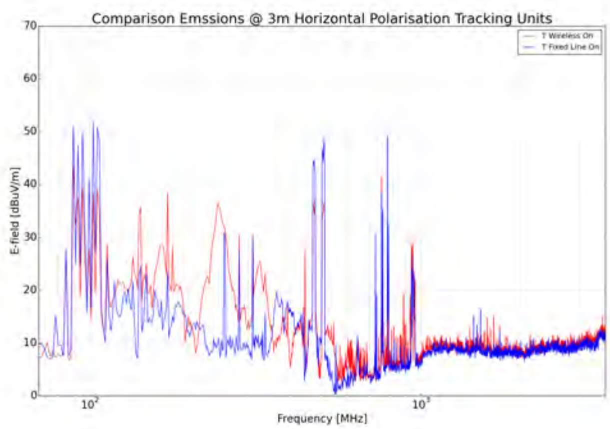
(a)



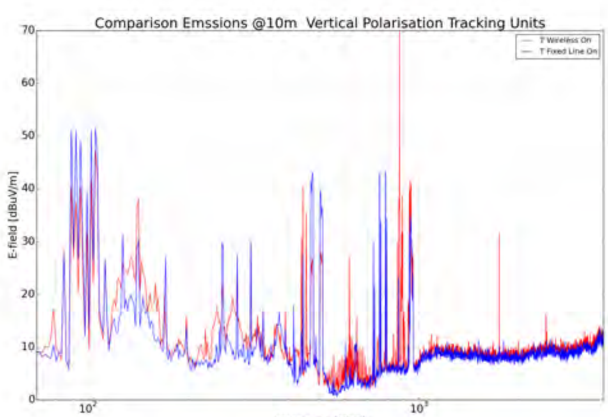
(b)



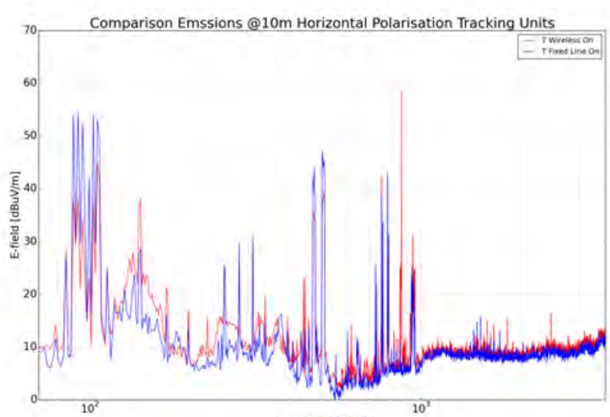
(c)



(d)



(e)



(f)

Figure 26: Comparison of radiated emissions measured for the Tracking Units at Position 1 and Position 2. Figures (a), (c) and (e) are for vertical polarisation at 1 m, 3 m, and 10 m and (b), (d) and (f) are for horizontal polarisation.

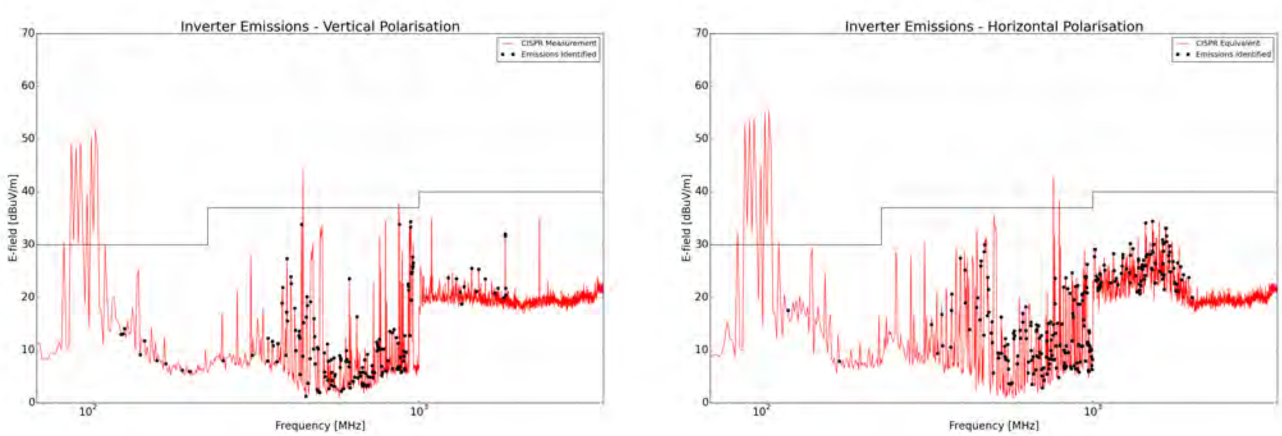
2.4.2 Interference Frequency Identification

Required for the subsequent propagation analysis are the maximum emission levels and associated frequencies identified to be generated by the plant. This is obtained by comparing emissions measured for the *Inverters*, *Tracking Units* and *String Cabinets* at 1, 3, and 10 m as discussed in Section 2.4. This is according to specifications in CISPR 11/22 Class B standard which is used as a well-known reference. It requires measurements at 3 m for frequencies above 1 GHz to use a 1 MHz RBW, and at 10 m below 1 GHz to use a 120 kHz RBW. The comparison to CISPR 11/22 Class B standard will subsequently be related to protection and saturation levels as specified by SKA-SA in [2].

To identify emissions generated by the plant, differences in measured levels at 1 m and 10 m are compared to the expected 20 dB free space path loss. However, from variations observed in the results in Section 2.4 due to the complex reflective environment, the 20 dB reduction was relaxed to 10 dB. The subsequent identified frequencies were then used in a second comparison of emissions measured at 3 m and 10 m, for which levels are expected to reduce by 10.46 dB. Again, considering the typical reduction seen in the radiated results, this criteria was relaxed to a 3 dB variation. All comparisons were were done using measurements made with a 100 kHz RBW, but the resulting frequency list in each case was used to identify the correct emission levels at 10 m for frequencies below 1 GHz (100 kHz RBW) and at 3 m for frequencies above 1 GHz (1 MHz RBW).

The results in Figs. 27 to 30 show both the total measured spectrum according to CISPR 11/22 Class B requirements as well as the plant-generated emissions using the search criteria just described for the *Inverters*, *Tracking Units* at both positions and *String Cabinet*. Included for reference purposes is the CISPR 11/22 Class B limit.

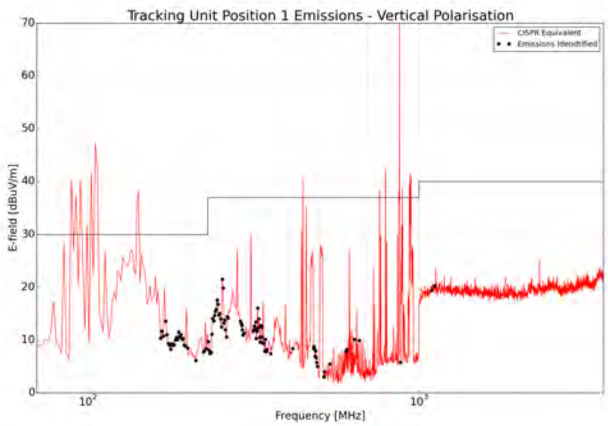
Inverters 22 and 23 Position 1



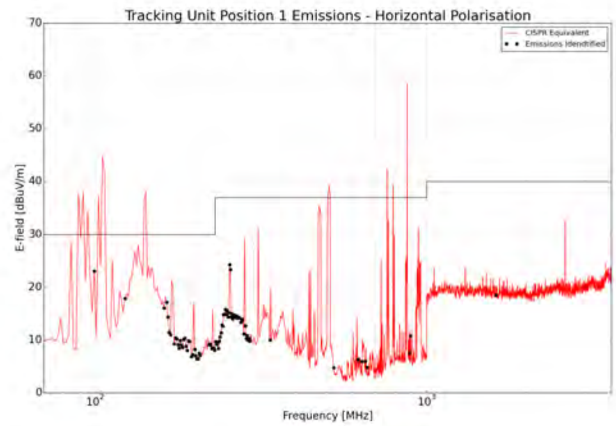
(a) (b)

Figure 27: Inverter radiated emissions as measured according to CISPR 11/22 Class B specifications identified for (a) vertical and (b) horizontal polarisations.

Tracking Unit Position 1



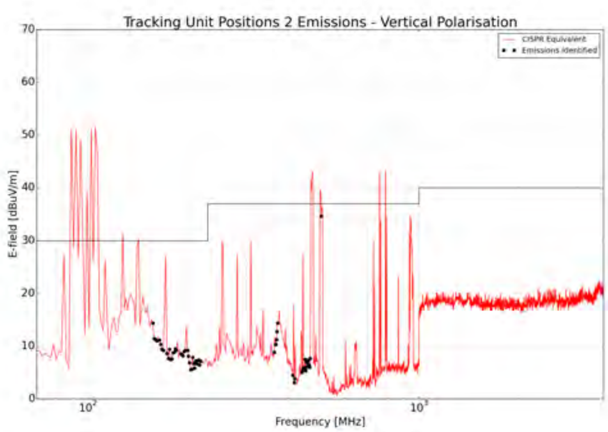
(a)



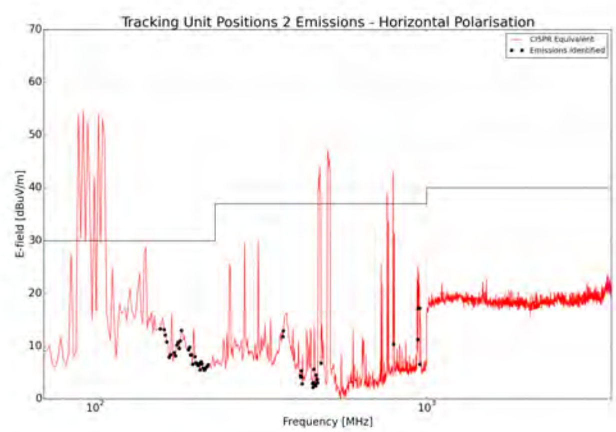
(b)

Figure 28: Tracking Unit at Position 1 radiated emissions as measured according to CISPR 11/22 Class B specifications identified for (a) vertical and (b) horizontal polarisations.

Tracking Unit Position 2



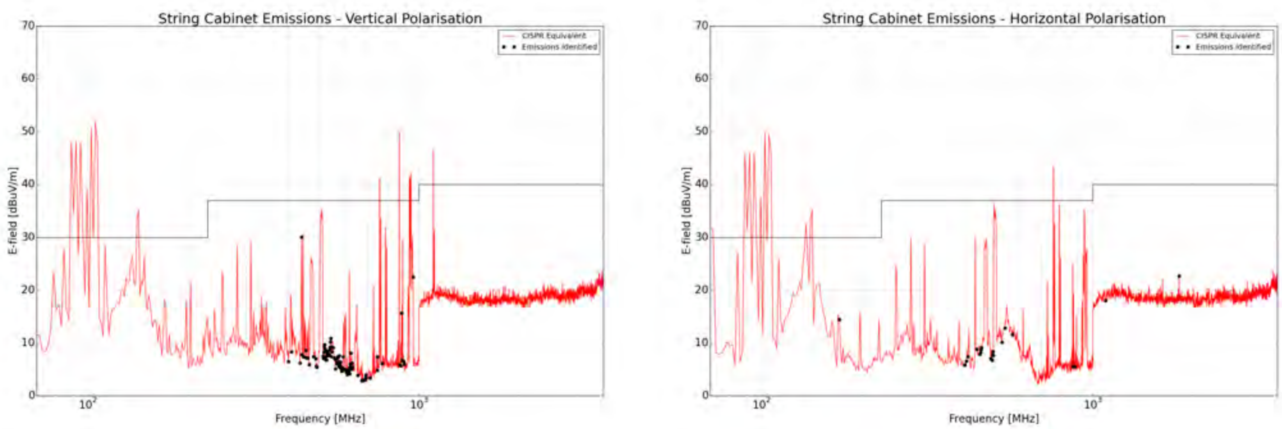
(a)



(b)

Figure 29: Tracking Unit at Position 2 radiated emissions as measured according to CISPR 11/22 Class B specifications identified for (a) vertical and (b) horizontal polarisation.

String Cabinet



(a) (b)

Figure 30: String Cabinet at Position 1 radiated emissions as measured according to CISPR 11/22 Class B specifications identified for (a) vertical and (b) horizontal polarisations.

2.4.3 CM Current and Radiated Emission Comparison

When comparing radiated with conducted FD results we make use of the identified peaks for the Position 1 *Tracking Unit* emissions presented in Fig. 28, but only focus on frequencies between 230 MHz and 1 GHz. The radiated results will be compared to conducted interference measured on the pressure switch cable shown in Fig. 9. Similarities can be seen in the narrowband conducted interference between 500 MHz and 700 MHz. The broadband conducted interference measured on the cable between 100 MHz and 300 MHz can be seen to exceed the equivalent CM current limit and should therefore produce radiated interference also exceeding the limit if a resonant cable length exist. With the majority of cables running below ground, however, this seem to attenuate resonant effects at the longer wavelengths and therefore do not radiate efficiently. Table 4 gives a comparison of the five frequencies identified in Fig. 28 between 500 MHz and 700 MHz.

The results in brackets are the difference between the measured level and theoretical 13.98 dBμA for conducted CM current interference, and 37 dBμV/m for E-field levels		
Frequency [MHz]	**CM Current [dBμA]**	**E-field V-pol [dBμV/m]**
536	-11.74 (-25.72)	5.4 (-31.6)
599	-9.5 (-23.47)	7.7 (-29.3)
603	-7.92 (-21.89)	8.1 (-28.9)
636	-8.31 (-22.28)	10.16 (-26.84)
660	9.98 (-27.02)	-8.81 (-22.78)

Table 4: Comparison of conducted and radiated emission levels based on theoretically predicted levels for the Tracking Unit at Position 1.

A second comparison between conducted and radiated interference is shown Table 5 for the communication cable of the *Tracking Unit* at Position 2. For this comparison the identified radiated emissions, shown in Fig. 29 between 230 MHz and 1 GHz, were again used. In some cases the identified frequencies give measured levels close to or on the noise floor of the instrument. These were therefore not considered as they might not be accurate in amplitude.

The results in brackets are the difference between the measured level and theoretical 13.98 dBμA for conducted CM current interference, and 37 dBμV/m for E-field levels		
Frequency [MHz]	**CM Current [dBμA]**	**E-field V-pol [dBμV/m]**
373	5.05 (-8.93)	14.33 (-22.67)
451	1.59 (-12.39)	7.49 (-29.51)
459	2.02 (-11.96)	7.3 (-29.7)
506	13.20 (-0.78)	35.1 (-1.9)

Table 5: Comparison of conducted and radiated emission levels based on theoretically predicted levels for the Tracking Unit at Position 2.

It is clear that for measurements at both positions, significant levels of low frequency broadband interference visible between 100 MHz and 300 MHz do not radiate very efficiently. They exceed the equivalent current limit as indicated, but do not produce radiated interference that exceed the indicated CISPR 11/22 Class B limit by the same amount. For the *Tracking Unit* at Position 1 the results in Table 4 show better agreement between conducted and equivalent radiated levels (taking into account the reflective environment for frequencies between 500 MHz and 700 MHz). The difference in measured levels compared to the limits for both conducted and radiated interference are within an acceptable margin. This confirms that this interference originates at the *Tracking Unit* and associated systems.

The measurements of the *Tracking Unit* at Position 2, which incorporates the fixed line communication, again show significant levels of low-frequency conducted interference with reduced levels between 500 MHz and 700 MHz. In this case, however, none of the spectral content in the CM results seem to radiate efficiently when considering the levels in Table 5. Only at 506 MHz is there acceptable correlation with no frequencies identified beyond this point. The results therefore confirm that while high levels of conducted CM current are present at both positions, they are not efficiently converted to radiated interference. High frequency conducted noise is less for the fixed line communication and therefore are not being radiated.

2.4.4 Time Domain Measurements

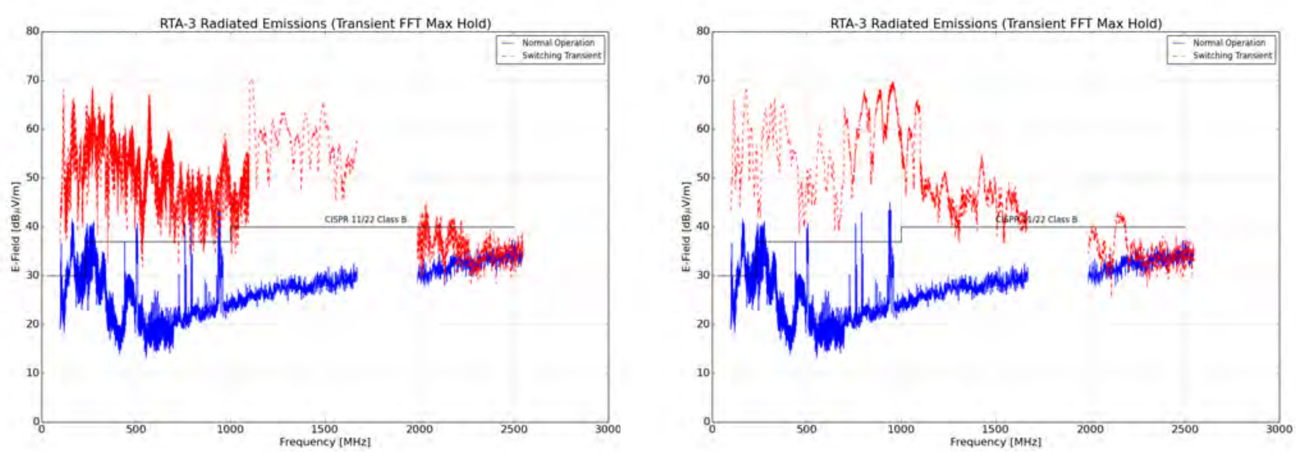
Tracking Units Position 1 and Position 2

A big concern is the switching noise generated every time the plant starts tracking. The system makes use of hydraulic rams which is operated by a small hydraulic pump located inside the hydraulic fluid reservoir located on top of each ram. The reservoir, a fully metallic enclosure, provides some level of attenuation of radiated interference generated by the pump. A cable still supplies the pump with power through a hole on top of the reservoir, but this can be mitigated.

A bigger contributor to transient interference is the switching contactor that operates the pump. An arcing effect can clearly be seen each time the pump switches on and off, and this produces wideband interference. Measurements were made at Position 1 and 2 as shown in Fig. 31. Typical spectrums when the plant is tracking compared to when it is stationary are shown in Fig. 32 (a) and (b) for vertical and horizontal polarisation respectively.

Peak level for measurements conducted at Position 1 are between 60 and 70 dBμV/m as measured at 1 m. This will however be influenced by likely near-field coupling. Transforming these levels to 10 m using the free space propagation loss, and accounting for a difference in RBW between the sweeping analyser and RTA-3 of approximately 7 dB, produce levels between 33 and 43 dBμV/m @ 10 m. A comparison with identified interference for the *Tracking Unit* at Position 1, given in Fig. 28, show higher levels in the TD. It should be considered that a sweeping analyser is inefficient at capturing transient events. The significance of these results should be the broadband nature of the interference.

Figure 31: Radiated time domain measurements of Tracking unit.



(a) (b)

Figure 32: Time domain radiated interference associated with the switching of the hydraulic pump to move the panels. The results can be seen for the system operating and stationary for (a) vertical polarisation and (b) horizontal polarisation as measured at Position 1.

A second measurement was done for the *Tracking Unit* at Position 2 making use of a fixed line communication. The radiated measurements were, however, made at a separation distances of 10 and 30 m to determine how efficiently the interference propagate with distance. This was again done with the system tracking and stationary, and the results are shown in Fig. 33. The absence of a trace for the system tracking below is because no reliable triggering of of interference from the plant could be established.

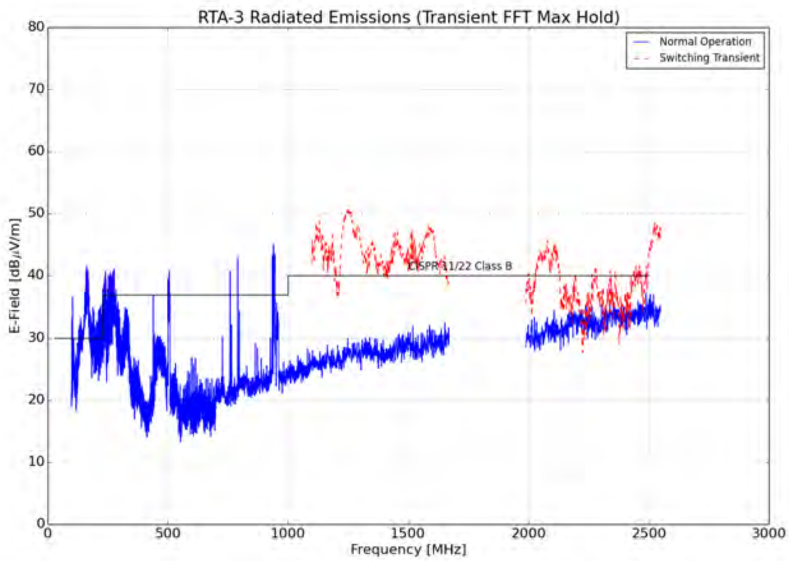


Figure 33: Time domain radiated interference associated with the switching of the hydraulic pump to move the panels. The results can be seen for the system operating and stationary for vertical polarisation as measured at Position 2.

2.5 Electric Fence Measurements

A radiate time domain pulse produced by a loose wire on the electric fence surrounding the PV plant (Fig. 36) are shown in Fig. 34. The equivalent FFT spectrum is given in Fig. 35.

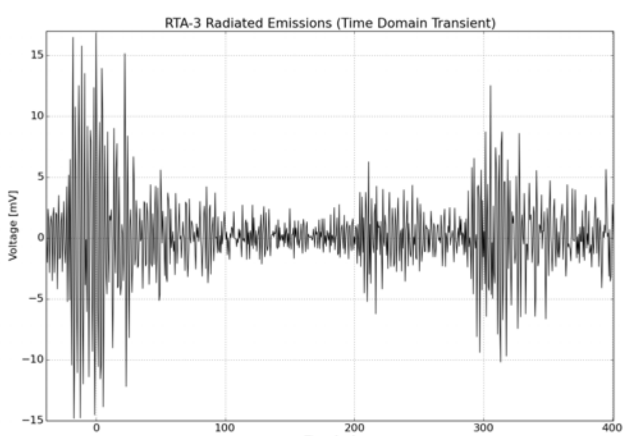


Figure 34: Radiated time domain pulse measured for a loose wire of the electric fence.

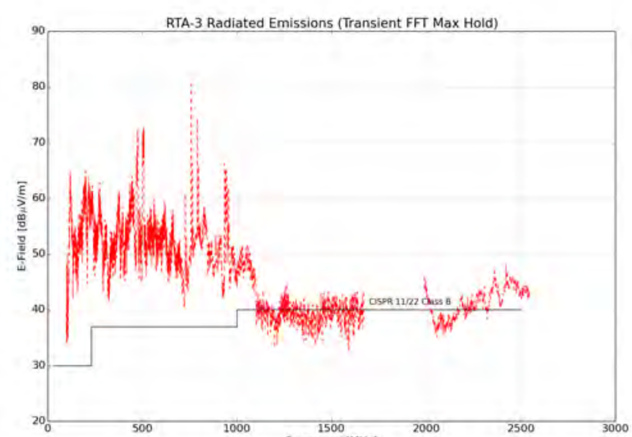


Figure 35: Equivalent Fast Fourier Transform spectrum for the radiated interference associated with a sparking electric fence.

Figure 36: Electric fence surrounding the perimeter of the Dreunberg PV plant.

Significant interference above the CISPR 11/22 Class B limit can be seen. While this is not directly associated with the operation of the plant, it will likely also be built on the proposed sites and could produce problematic levels of broadband interference.

2.6 Administration Building Emissions

An additional measurement of possible RFI culprits located at the Administration building (Fig. 37) were measured and the result is shown in Fig. 38. The results from this investigation are not meant to be comprehensive as it is unclear whether an Administration building will ultimately be built on the proposed site locations. This does, however, show some of the interference typically associated with such a building.

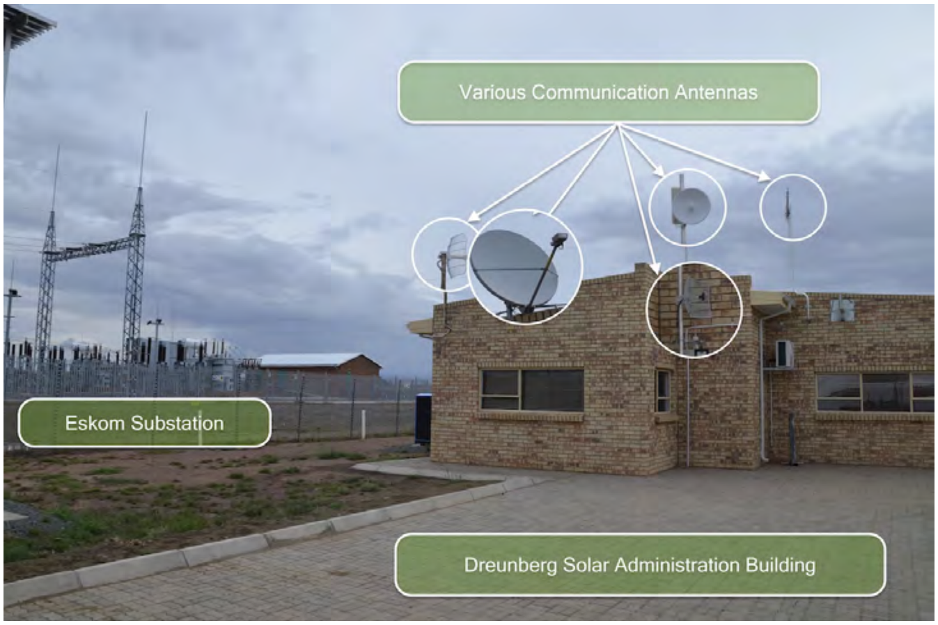


Figure 37: Administration building with potential RFI culprits

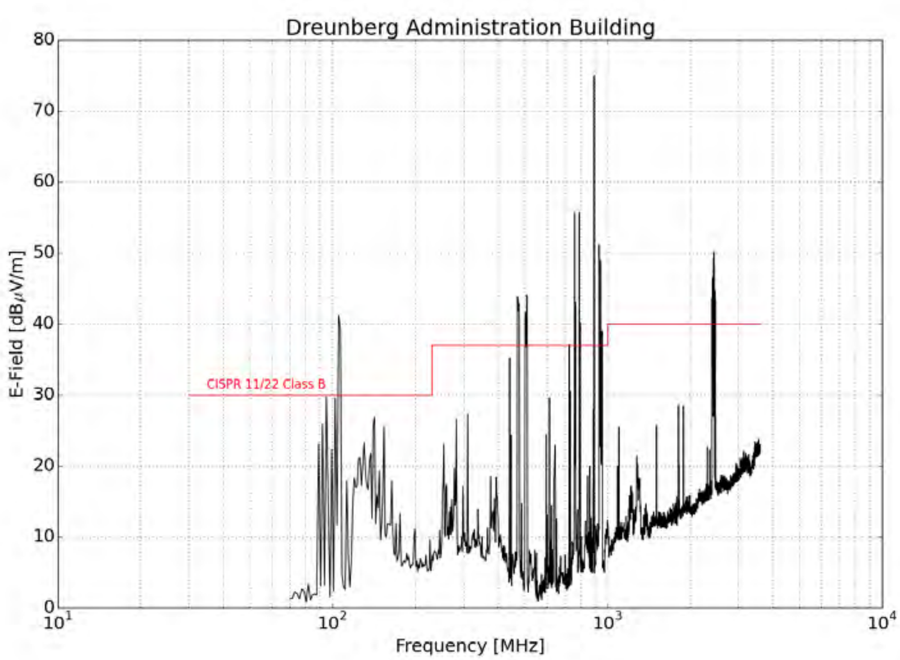


Figure 38: Radiated frequency domain emissions of the Administration building as measured at 10 m.

2.7 Discussion

2.7.1 Conducted Measurements

TD conducted measurements on supply cables to the *Tracking Unit* at Position 1 show large pulses when the plant is *ON*. When considering the FD content of these captured TD pulses (by applying the FFT), the majority of the energy extends up to at least 500 MHz. Equivalent FD measurements, particularly on the wireless antenna and pressure switch cables, agree with this, and additionally show trace peaks at frequencies around 150 MHz and 250 MHz. The higher frequencies seem to radiate into the environment more efficiently as confirmed by comparison with radiated results.

Conducted measurements, again made on the *Tracking Unit* at Position 2, still show significant levels of low frequency interference, but less higher frequency noise. This would indicate that the majority of the noise is likely to be in the vicinity of the inverter. The *Tracking Unit* emissions are somewhat aggravated by the wireless communication method. This is again confirmed with the radiated measurements.

Switching noise associated with the tracking of the panels, which were measured as conductive interference on cables connected to the *Tracking Unit* creates broadband interference. This happens both when the tracking pump switches *ON* and produces multiple pulses when it switches *OFF*. While some of the interference could be generated by the hydraulic pump, the majority is believed to be generated by the pump contactor.

2.7.2 Radiated Measurements

Radiated results for the plant *ON* and in *STANDBY* mode generally show similar emissions levels, confirming that interference producing systems are never completely *OFF*. Emissions associated with the *Inverter* units are dominant and occupy frequencies between 300 MHz and 2 GHz. Peak levels identified range between 30 - 35 dBμV/m as measured at 10 m below 1 GHz and at 3 m above 1 GHz for both polarisations.

Results for the *Tracking Unit* measured at Position 1 (wireless communication) show dominating frequencies around 250 MHz, with some additional components identified between 500 MHz and 1 GHz. Peak levels are again similar for both polarisations and are lower than *Inverter* emissions at 20 - 25 dBμV/m as measured at 10 m below 1 GHz and at 3 m above 1 GHz. In the case of emissions measured for the *Tracking Unit* at Position 2 (fixed line communication), broadband interference are present between 200 MHz and 300 MHz, and narrowband interference visible between 500 MHz and 700 MHz. Levels are lower by at least 10 dB, but this is only because of the limit in measurement sensitivity at 10 m. The results in Figs. 29 (a) and (b) show levels for many of the identified interference which are close to the measurement noise floor. Their exact levels can therefore be lower if sensitivity is improved. It shows that for purposes of RFI mitigation, the fixed line communication would be the preferred implementation.

The *String Cabinet* shows mostly broadband interference between 300 MHz and 800 MHz for both polarisations. Identified levels are again close to the measurement noise floor, with an exception at 440 MHz. The levels there are 30 dBμV/m.

Comparative measurements made with the doors to the *Inverters* and *Tracking Units* open not only helps to identify interference generated by the plant, but also show the limited levels of shielding provided by these enclosures. It is therefore possible to improve the shielding by incorporating conductive gasketting around the edges of the door and properly defining cable interfaces. This will help to reduce the level of radiated interference emitted by the devices. Radiated TD measurements of the *Tracking Units* at Position 1 and 2 show broadband interference across the 3.6 GHz frequency range. Levels of between 33 and 43 dBμV/m can be expected at 10 m. The main contributor is believed to be the switching relays and contactor inside the *Tracking Cabinet*. This, however, can be improved by proper shielding of the cabinet interfaces and apertures.

3 Site Location Data

The proximity of the proposed PV plant locations to the closest and core-site SKA telescopes are shown in Figs. 39 to 49, while separation distances, azimuth angles, transmitter and receiver heights for preferred and alternative site locations are given in Tables 6 to 24.

3.1 Scatec PV1, PV2 and PV3

Scatec PV1 Pref	Closest Telescope 1	Closest Telescope 2	SKA Core Site
Distance	20.92 km	56.60 km	169.79 km
Azimuth	86.21 ^{o}	163.45 ^{o}	173.55 ^{o}
PV Tx Height	3 m	3 m	3 m
SKA Rx Height	15 m	15 m	15 m

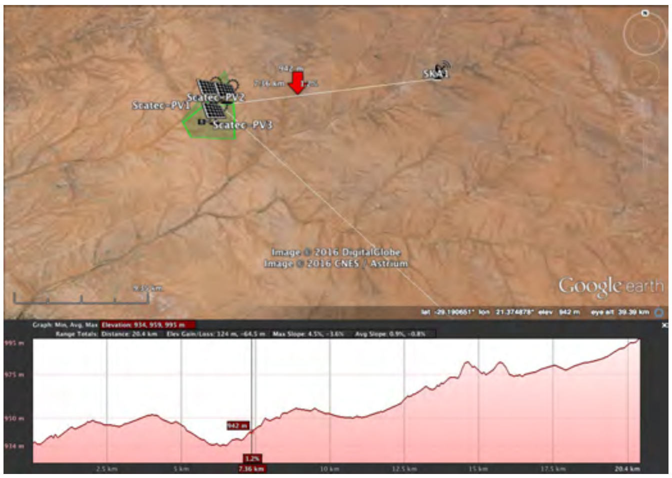
Table 6: Specifications of location Scatec PV1 solar farm relative to the SKA core and closest telescopes.

Scatec PV2 Pref	Closest Telescope 1	Closest Telescope 2	SKA Core Site
Distance	19.43 km	55.30 km	169.33 km
Azimuth	83.77 ^{o}	163.86 ^{o}	174.24 ^{o}
PV Tx Height	3 m	3 m	3 m
SKA Rx Height	15 m	15 m	15 m

Table 7: Specifications of location Scatec PV2 solar farm relative to the SKA core and closest telescopes.

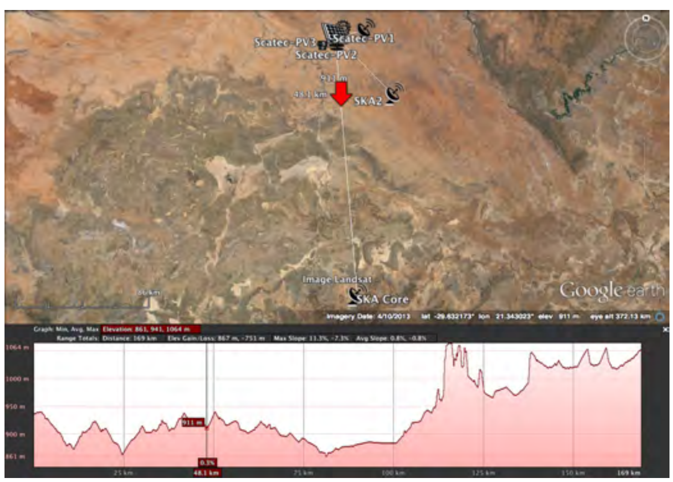
Scatec PV3 Pref	Closest Telescope 1	Closest Telescope 2	SKA Core Site
Distance	20.57 km	54.09 km	167.02 km
Azimuth	75.12 ^{o}	162.75 ^{o}	173.91 ^{o}
PV Tx Height	3 m	3 m	3 m
SKA Rx Height	15 m	15 m	15 m

Table 8: Specifications of location Scatec PV3 solar farm relative to the SKA core and closest telescopes.



(a)

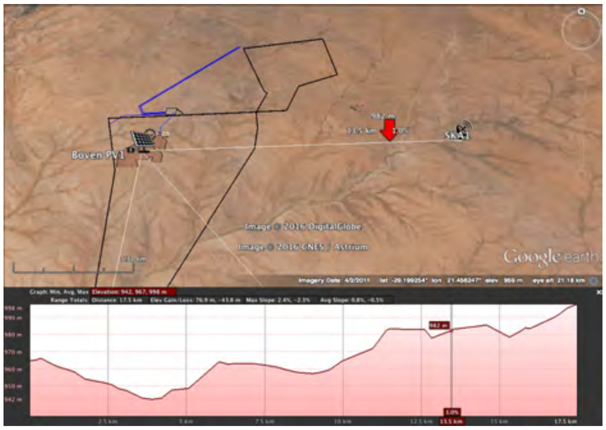
(b)



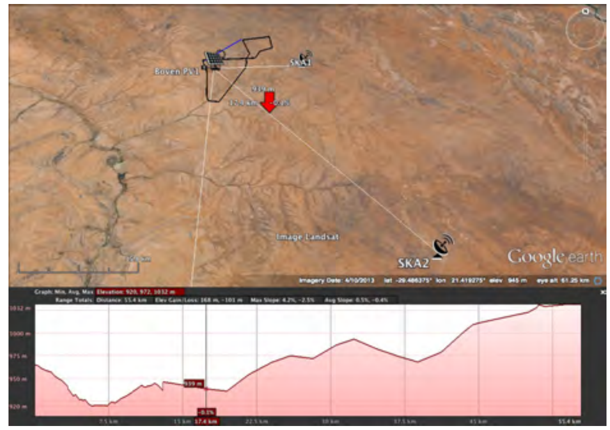
(c)

Figure 39: Google Earth terrain profile for Scatec PV1 to PV3 to (a) closest and (b) second closest and (c) core SKA telescopes.

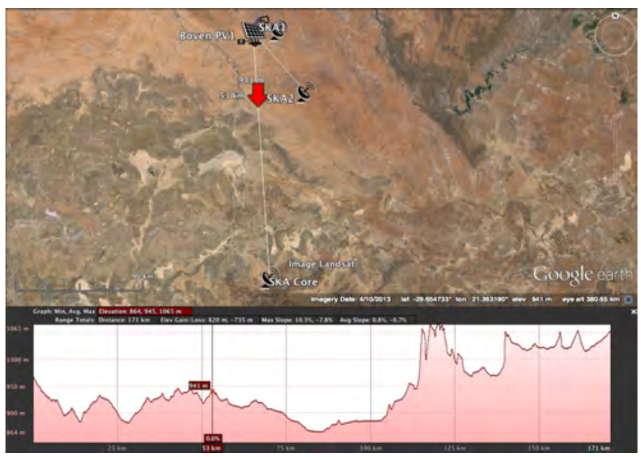
3.2 Boven PV1



(a)



(b)



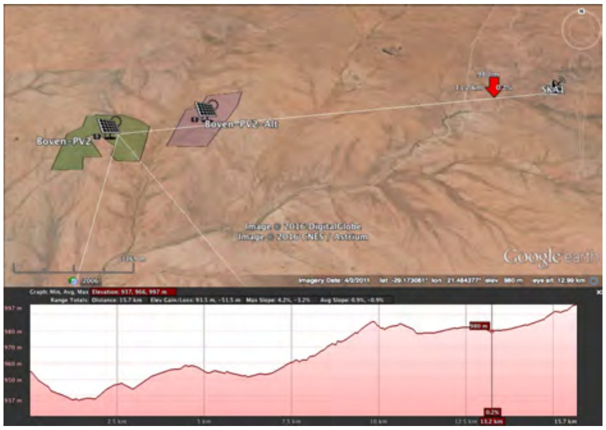
(c)

Figure 40: Google Earth terrain profile for Boven PV1 to (a) closest and (b) second closest and (c) core SKA telescopes.

Boven PV1	Closest Telescope 1	Closest Telescope 2	SKA Core Site
Distance	17.37 km	55.45 km	171.10 km
Azimuth	90.92 ^{o}	165.13 ^{o}	175.10 ^{o}
PV Tx Height	3 m	3 m	3 m
SKA Rx Height	15 m	15 m	15 m

Table 9: Specifications of location Boven PV1 solar farm relative to the SKA core and closest telescopes.

3.3 Boven PV2



(a)

(b)

(c)

Figure 41: Google Earth terrain profile for Boven PV2 to (a) closest and (b) second closest and (c) core SKA telescopes.

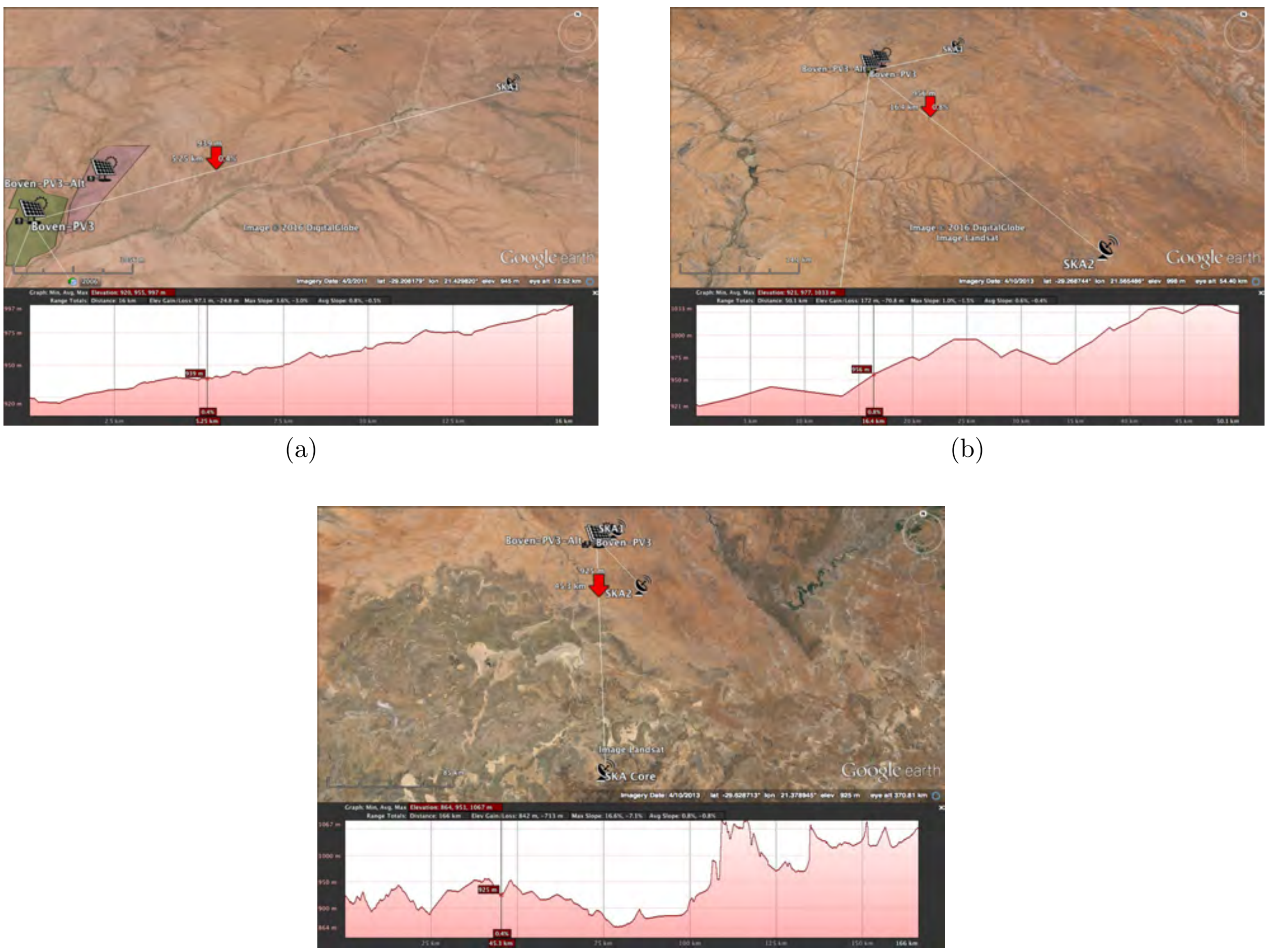
Boven PV2 Pref	Closest Telescope 1	Closest Telescope 2	SKA Core Site
Distance	15.00 km	52.46 km	169.08 km
Azimuth	80.68 ^{o}	140.60 ^{o}	177.13 ^{o}
PV Tx Height	3 m	3 m	3 m
SKA Rx Height	15 m	15 m	15 m

Table 10: Specifications of **preferred** location Boven PV2 solar farm relative to the SKA core and closest telescopes.

Boven PV2 Alt	Closest Telescope 1	Closest Telescope 2	SKA Core Site
Distance	12.52 km	52.07 km	170.30 km
Azimuth	84.93 ^{o}	143.50 ^{o}	177.93 ^{o}
PV Tx Height	3 m	3 m	3 m
SKA Rx Height	15 m	15 m	15 m

Table 11: Specifications of **alternative** location Boven PV2 solar farm relative to the SKA core and closest telescopes.

3.4 Boven PV3



(a) (b) (c)

Figure 42: Google Earth terrain profile for Boven PV3 to (a) closest and (b) second closest and (c) core SKA telescopes.

Boven PV3 Pref	Closest Telescope 1	Closest Telescope 2	SKA Core Site
Distance	15.69 km	50.06 km	166.01 km
Azimuth	69.50 ^{o}	138.46 ^{o}	177.11 ^{o}
PV Tx Height	3 m	3 m	3 m
SKA Rx Height	15 m	15 m	15 m

Table 12: Specifications of **preferred** location Boven PV3 solar farm relative to the SKA core and closest telescopes.

Boven PV3 Alt	Closest Telescope 1	Closest Telescope 2	SKA Core Site
Distance	13.79 km	50.41 km	167.63 km
Azimuth	73.94 ^{o}	140.96 ^{o}	177.63 ^{o}
PV Tx Height	3 m	3 m	3 m
SKA Rx Height	15 m	15 m	15 m

Table 13: Specifications of **alternative** location Boven PV3 solar farm relative to the SKA core and closest telescopes.

3.5 Boven PV4

Boven PV4 Pref	Closest Telescope 1	Closest Telescope 2	SKA Core Site
Distance	17.94 km	51.16 km	165.60 km
Azimuth	70.38 ^{o}	136.24 ^{o}	176.36 ^{o}
PV Tx Height	3 m	3 m	3 m
SKA Rx Height	15 m	15 m	15 m

Table 14: Specifications of **preferred** location Boven PV4 solar farm relative to the SKA core and closest telescopes.

Boven PV4 Alt	Closest Telescope 1	Closest Telescope 2	SKA Core Site
Distance	18.72 km	49.62 km	163.48 km
Azimuth	64.21 ^{o}	134.58 ^{o}	176.32 ^{o}
PV Tx Height	3 m	3 m	3 m
SKA Rx Height	15 m	15 m	15 m

Table 15: Specifications of **alternative** location Boven PV4 solar farm relative to the SKA core and closest telescopes.

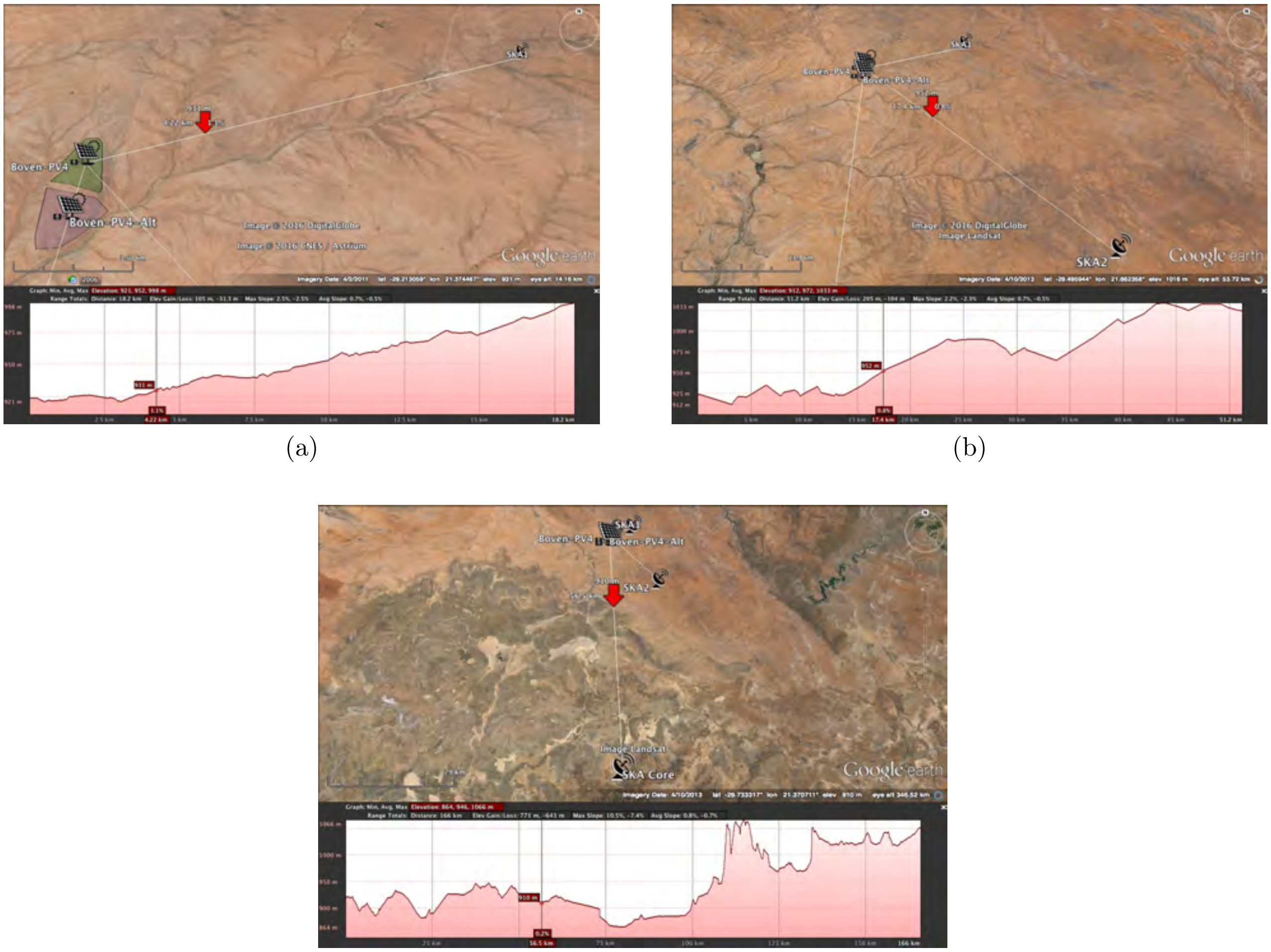
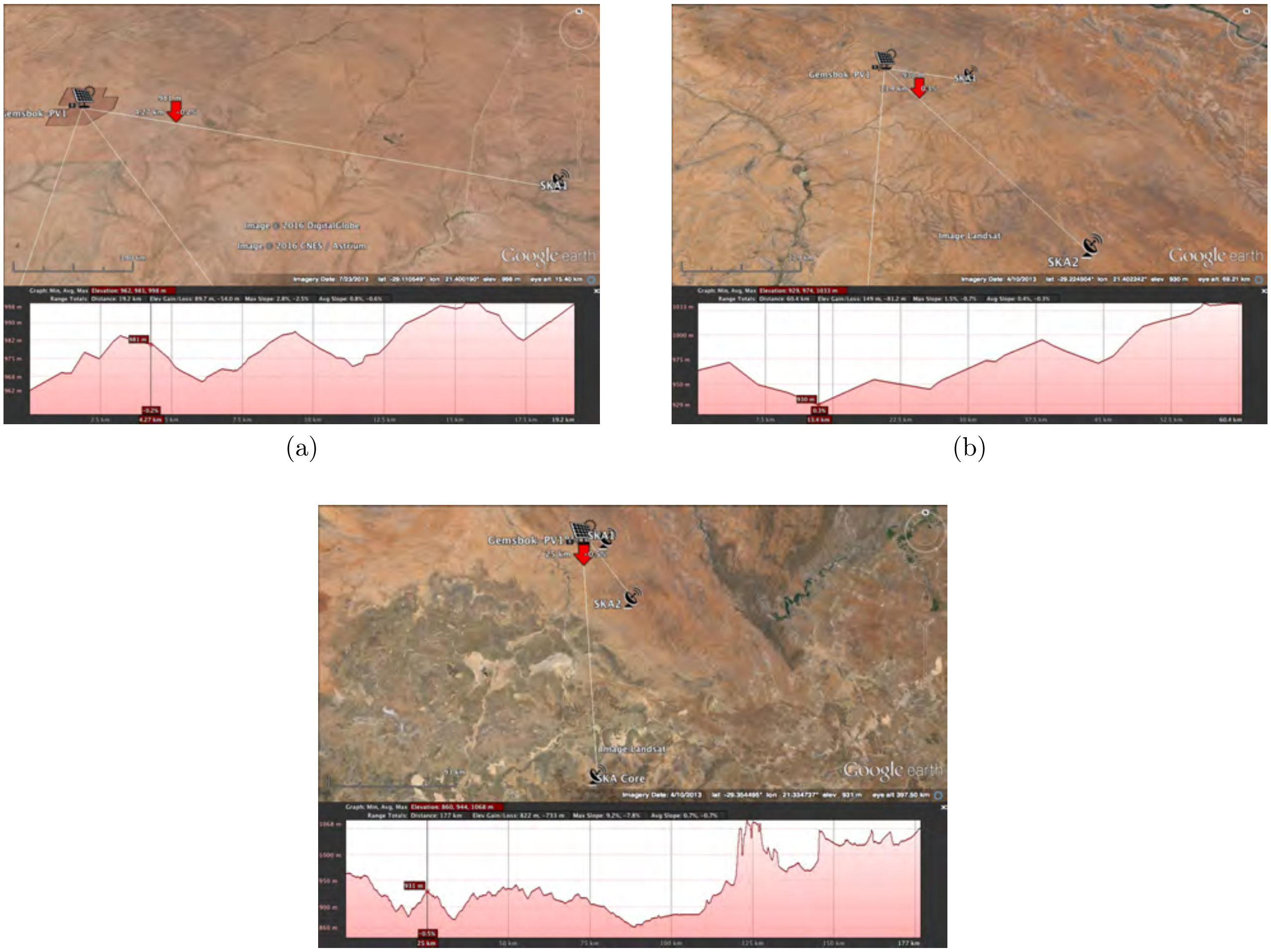


Figure 43: Google Earth terrain profile for Boven PV4 to (a) closest and (b) second closest and (c) core SKA telescopes.

3.6 Gemsbok PV1

Gemsbok PV1	Closest Telescope 1	Closest Telescope 2	SKA Core Site
Distance	19.12 km	60.45 km	176.67 km
Azimuth	113.77 ^{o}	166.26 ^{o}	174.59 ^{o}
PV Tx Height	3 m	3 m	3 m
SKA Rx Height	15 m	15 m	15 m

Table 16: Specifications of location Gemsbok PV1 solar farm relative to the SKA core and closest telescopes.



(a) (b)

(c)

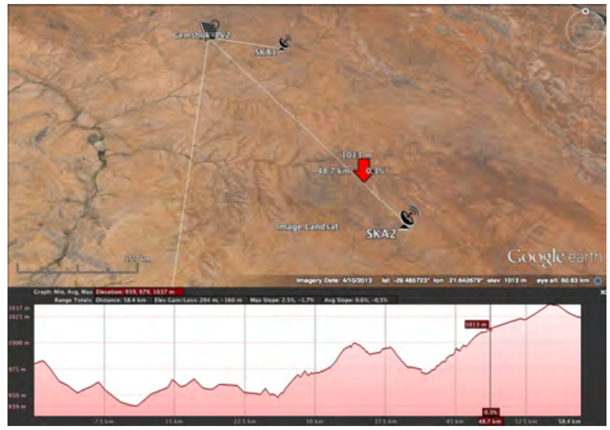
Figure 44: Google Earth terrain profile for Gemsbok PV1 to (a) closest and (b) second closest and (c) core SKA telescopes.

3.7 Gemsbok PV2

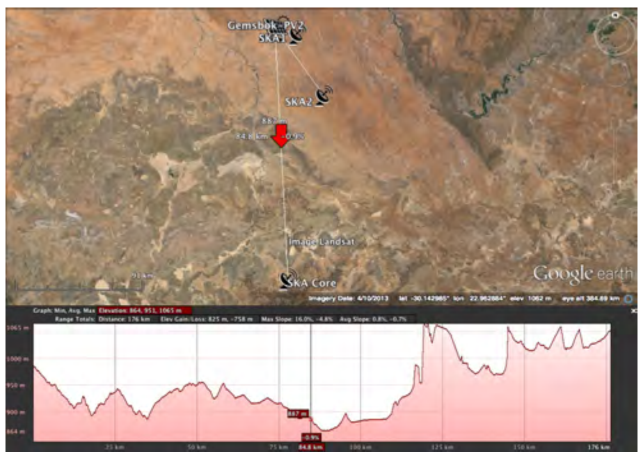
Gemsbok PV2	Closest Telescope 1	Closest Telescope 2	SKA Core Site
Distance	16.14 km	58.41 km	176.19 km
Azimuth	115.27 ^{o}	167.15 ^{o}	175.95 ^{o}
PV Tx Height	3 m	3 m	3 m
SKA Rx Height	15 m	15 m	15 m

Table 17: Specifications of location Gemsbok PV2 solar farm relative to the SKA core and closest telescopes.

(a)



(b)



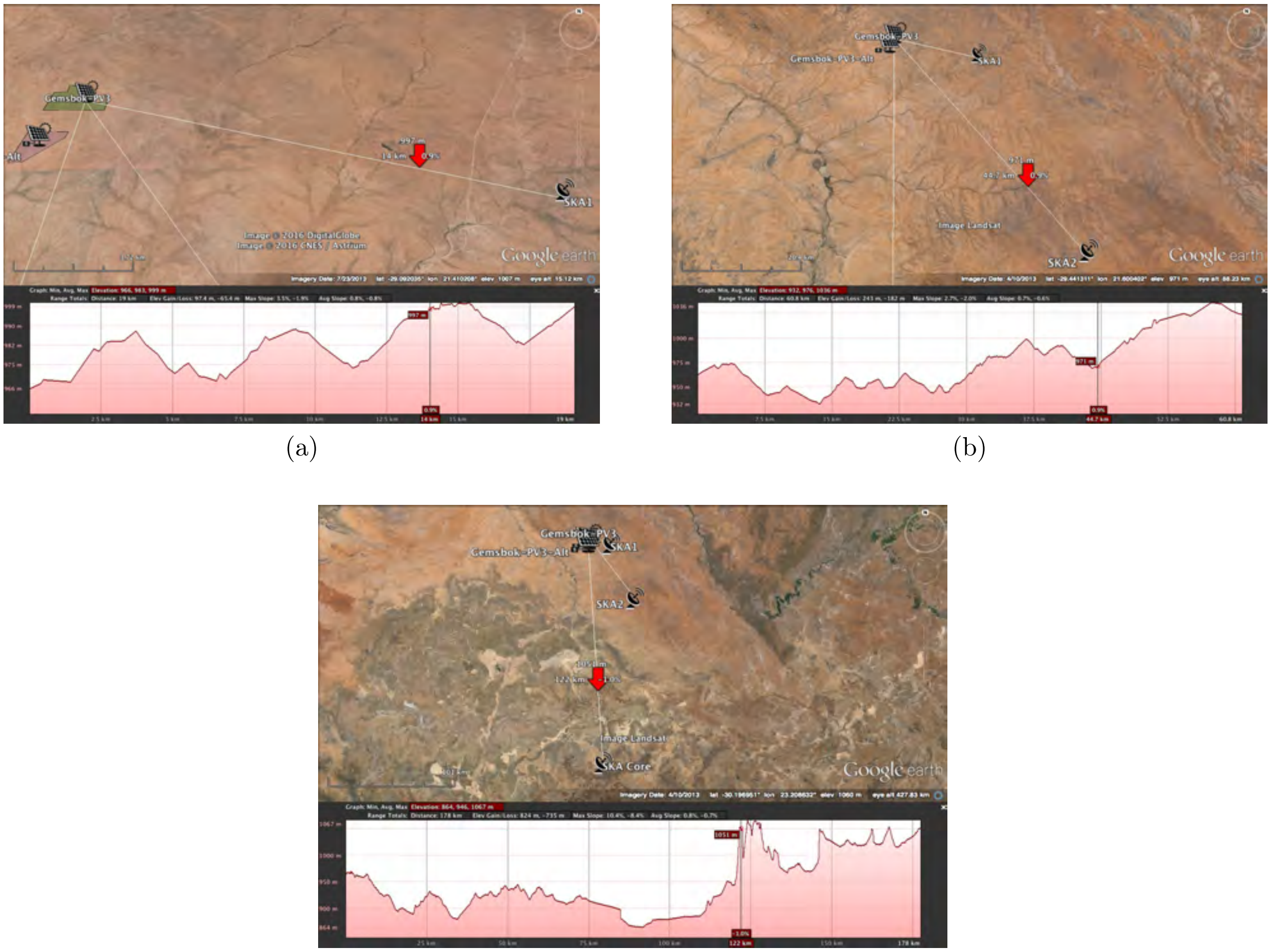
(c)

Figure 45: Google Earth terrain profile for Gemsbok PV2 to (a) closest and (b) second closest and (c) core SKA telescopes.

3.8 Gemsbok PV3

Gemsbok PV3 Pref	Closest Telescope 1	Closest Telescope 2	SKA Core Site
Distance	19.46 km	61.16 km	177.36 km
Azimuth	106.87 ^{o}	142.65 ^{o}	176.05 ^{o}
PV Tx Height	3 m	3 m	3 m
SKA Rx Height	15 m	15 m	15 m

Table 18: Specifications of **preferred** location Gemsbok PV3 solar farm relative to the SKA core and closest telescopes.



(a) (b) (c)

Figure 46: Google Earth terrain profile for Gemsbok PV3 to (a) closest and (b) second closest and (c) core SKA telescopes.

Gemsbok PV3 Alt	Closest Telescope 1	Closest Telescope 2	SKA Core Site
Distance	19.53 km	59.47 km	174.71 km
Azimuth	98.67 ^{o}	140.55 ^{o}	175.77 ^{o}
PV Tx Height	3 m	3 m	3 m
SKA Rx Height	15 m	15 m	15 m

Table 19: Specifications of **alternative** location Gemsbok PV3 solar farm relative to the SKA core and closest telescopes.

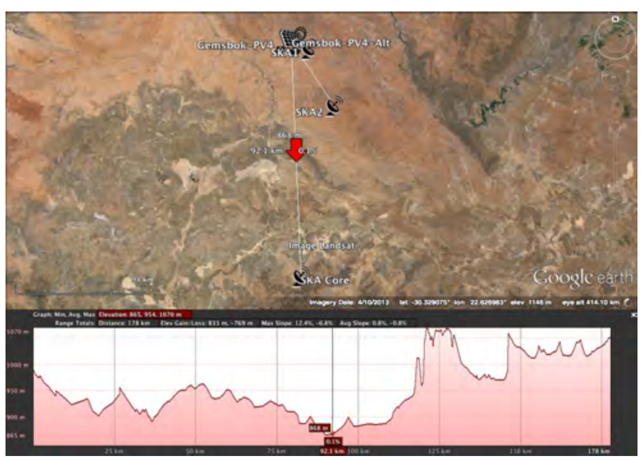
3.9 Gemsbok PV4

Gemsbok PV4 Pref	Closest Telescope 1	Closest Telescope 2	SKA Core Site
Distance	15.24 km	58.87 km	177.62 km
Azimuth	113.85 ^{o}	146.57 ^{o}	177.54 ^{o}
PV Tx Height	3 m	3 m	3 m
SKA Rx Height	15 m	15 m	15 m

Table 20: Specifications of **preferred** location Gemsbok PV4 solar farm relative to the SKA core and closest telescopes.

(a)

(b)



(c)

Figure 47: Google Earth terrain profile for Gemsbok PV4 to (a) closest and (b) second closest and (c) core SKA telescopes.

Gemsbok PV4 Alt	Closest Telescope 1	Closest Telescope 2	SKA Core Site
Distance	15.31 km	59.95 km	179.43 km
Azimuth	121.55 ^{o}	148.25 ^{o}	177.85 ^{o}
PV Tx Height	3 m	3 m	3 m
SKA Rx Height	15 m	15 m	15 m

Table 21: Specifications of **alternative** location Gemsbok PV4 solar farm relative to the SKA core and closest telescopes.

3.10 Gemsbok PV5

(a)

(b)

(c)

Figure 48: Google Earth terrain profile for Gemsbok PV5 to (a) closest and (b) second closest and (c) core SKA telescopes.

Gemsbok PV5 Pref	Closest Telescope 1	Closest Telescope 2	SKA Core Site
Distance	10.59 km	56.39 km	178.01 km
Azimuth	129.26 ^{o}	151.72 ^{o}	179.37 ^{o}
PV Tx Height	3 m	3 m	3 m
SKA Rx Height	15 m	15 m	15 m

Table 22: Specifications of **preferred** location Gemsbok PV5 solar farm relative to the SKA core and closest telescopes.

Gemsbok PV5 Alt	Closest Telescope 1	Closest Telescope 2	SKA Core Site
Distance	11.83 km	56.56 km	177.00 km
Azimuth	118.57 ^{o}	149.27 ^{o}	178.67 ^{o}
PV Tx Height	3 m	3 m	3 m
SKA Rx Height	15 m	15 m	15 m

Table 23: Specifications of **alternative** location Gemsbok PV5 solar farm relative to the SKA core and closest telescopes.

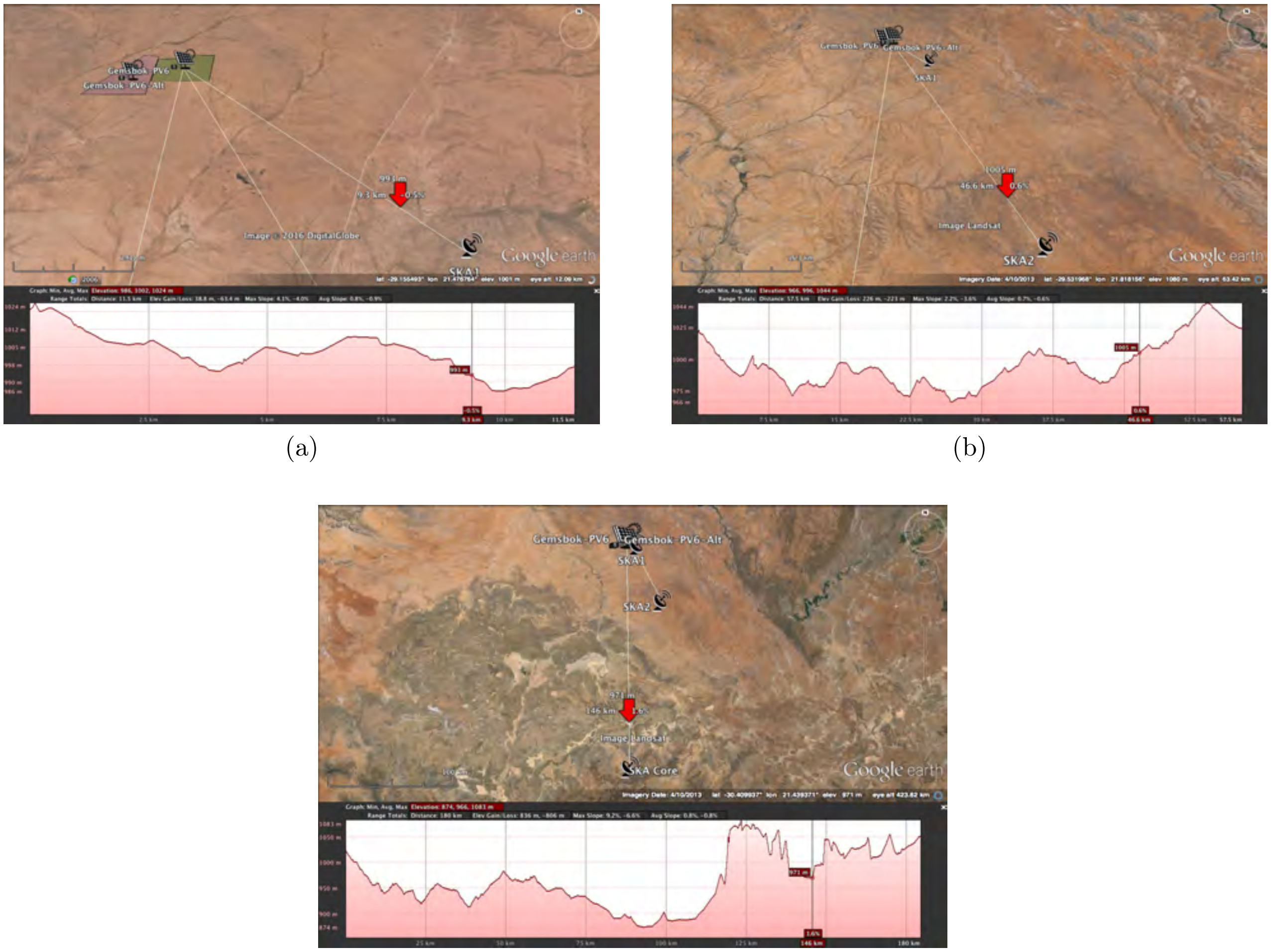
3.11 Gemsbok PV6

Gemsbok PV6 Pref	Closest Telescope 1	Closest Telescope 2	SKA Core Site
Distance	11.48 km	57.56 km	179.32 km
Azimuth	134.26 ^{o}	152.32 ^{o}	179.37 ^{o}
PV Tx Height	3 m	3 m	3 m
SKA Rx Height	15 m	15 m	15 m

Table 24: Specifications of **preferred** location Gemsbok PV6 solar farm relative to the SKA core and closest telescopes.

Gemsbok PV6 Alt	Closest Telescope 1	Closest Telescope 2	SKA Core Site
Distance	12.50 km	57.86 km	178.64 km
Azimuth	125.74 ^{o}	150.31 ^{o}	178.76 ^{o}
PV Tx Height	3 m	3 m	3 m
SKA Rx Height	15 m	15 m	15 m

Table 25: Specifications of **alternative** location Gemsbok PV6 solar farm relative to the SKA core and closest telescopes.



(a) (b) (c)

Figure 49: Google Earth terrain profile for Gemsbok PV6 to (a) closest and (b) second closest and (c) core SKA telescopes.

4 Signal Propagation Loss and Terrain Analysis

The default propagation analysis software used by MESA Solutions is called SPLAT!, which is a **S**ignal **P**ropagation, **L**oss **A**nd **T**errain analysis tool based on the *Longley-Rice Irregular Terrain Model (ITM)*, as well as the *Irregular Terrain With Obstructions Model (ITWOM 3.0)*. The software takes into account actual terrain elevation data, to ultimately predict the total path loss (TPL) between a transmitter and a receiver. As part of the analysis, certain assumptions are made regarding the source characteristics. For this investigation the various parameters defining the SPLAT! propagation model are listed in Table 26. The digital elevation model (DEM) makes use of 3-arc-second (90 m) elevation resolution data.

For this investigation, the frequency range of interest is defined from 100 MHz to 3 GHz. While the upper frequency limit of the standard in [2] is specified to at least 10 GHz, the span is limited to what is practically measurable and representative of the majority of expected interference. In the analysis the allowable SKA radiation limits defined by SARAS in citeAGA2007, including an additional 10 dB safety margin, are used as the reference level. This defines the maximum allowable levels of radiated interference than can be tolerated at the telescope.

This maximum level, which is given as a power spectral density (PSD) in dBm/Hz, is compensated for by the TPL as predicted by SPLAT!, to provide an equivalent PSD associated with the closest and core-site telescopes. This PSD for each case is then converted to an equivalent electric field (E-field) as measured at either 10 m (frequency $<$ 1 GHz) or 3 m (frequency $>$ 1 GHz) away from the plant. The 3 and 10 m separation distances is in accordance with measurement specifications defined in the latest international special committee on radio interference's (CISPR) 11/22 Class B standard. This standard is used for reference purposes as it is internationally know and used for industry qualification. This calculation is done for a number of representative frequencies within the band of interest and defines an E-field upper limit which the plant is allowed to radiate without exceeding emission limits at the various telescope locations. Ultimately, conformance of the plant can then be determined by comparing representative measured results to the calculated levels provided.

SPLAT! Analysis Parameters	
Frequency [MHz]	100 - 3000
Earth Dielectric Constant (Relative Permittivity [F/m])	4.000
Earth Conductivity [S/m]	0.001
Atmospheric Bending Constant	301
Radio Climate	4 (Desert)
Polarisation (Vertical=1; Horizontal=0)	1
Fraction of Time	0.05
Fraction of Situations	0.05

Table 26: SPLAT! parameters for predicted 100 MHz to 3 GHz emissions from proposed PV projects to SKA core and closest telescope.

5 Total Path Loss

Shown in Tables 27 to 45 are the values for the free space path loss (FSPL), terrain loss (TL), and total path loss (TPL) at each of the frequencies chosen for the investigation. The 0 dB TL at 100 MHz is a purely mathematical limitation of the software indicating a negligible contribution at that frequency over this particular terrain. The attenuation maps for 100, 1000, 2000 and 3000 MHz calculated at each of the site location are given in Figs. 50 to 69.

5.1 Scatec PV 1 Site Location

	Closest Telescope 1			Closest Telescope 2			SKA Core Site		
Frequency	**FSPL**	**TL**	**TPL**	**FSPL**	**TL**	**TPL**	**FSPL**	**TL**	**TPL**
100MHz	98.85dB	25.85dB	**124.7dB**	107.5dB	32.55dB	**140.05dB**	117.04dB	41.49dB	**158.53dB**
300MHz	108.4dB	22.11dB	**130.51dB**	117.04dB	27.16dB	**144.2dB**	126.58dB	36.97dB	**163.55dB**
500MHz	112.83dB	21.54dB	**134.37dB**	121.48dB	27.13dB	**148.61dB**	131.02dB	38.31dB	**169.33dB**
1000MHz	118.85dB	22.67dB	**141.52dB**	127.5dB	30.64dB	**158.14dB**	137.04dB	42.46dB	**179.5dB**
1500MHz	122.37dB	24.04dB	**146.41dB**	131.02dB	33.55dB	**164.57dB**	140.56dB	44.38dB	**184.94dB**
2000MHz	124.87dB	25.12dB	**149.99dB**	133.52dB	35.96dB	**169.48dB**	143.06dB	45.72dB	**188.78dB**
2500MHz	126.81dB	25.97dB	**152.78dB**	135.46dB	37.92dB	**173.38dB**	145.0dB	46.77dB	**191.77dB**
3000MHz	128.4dB	26.75dB	**155.15dB**	137.04dB	39.58dB	**176.62dB**	146.58dB	47.63dB	**194.21dB**

Table 27: SPLAT! Free Space Path Loss (FSPL), Terrain Loss (TL) and Total Path Loss (TPL) for vertical polarisation **preferred** site Scatec PV1 emissions.

5.2 Scatec PV 2 Site Location

	Closest Telescope 1			Closest Telescope 2			SKA Core Site		
Frequency	**FSPL**	**TL**	**TPL**	**FSPL**	**TL**	**TPL**	**FSPL**	**TL**	**TPL**
100MHz	98.21dB	16.04dB	**114.25dB**	107.3dB	19.65dB	**126.95dB**	117.02dB	33.37dB	**150.39dB**
300MHz	107.75dB	10.55dB	**118.3dB**	116.84dB	13.63dB	**130.47dB**	126.56dB	33.87dB	**160.43dB**
500MHz	112.19dB	8.9dB	**121.09dB**	121.28dB	12.7dB	**133.98dB**	131.0dB	35.77dB	**166.77dB**
1000MHz	118.21dB	8.42dB	**126.63dB**	127.3dB	13.91dB	**141.21dB**	137.02dB	40.56dB	**177.58dB**
1500MHz	121.73dB	8.83dB	**130.56dB**	130.82dB	15.07dB	**145.89dB**	140.54dB	42.73dB	**183.27dB**
2000MHz	124.23dB	9.49dB	**133.72dB**	133.32dB	16.21dB	**149.53dB**	143.04dB	44.18dB	**187.22dB**
2500MHz	126.17dB	10.26dB	**136.43dB**	135.25dB	17.3dB	**152.55dB**	144.98dB	45.28dB	**190.26dB**
3000MHz	127.75dB	10.93dB	**138.68dB**	136.84dB	18.3dB	**155.14dB**	146.56dB	46.16dB	**192.72dB**

Table 28: SPLAT! Free Space Path Loss (FSPL), Terrain Loss (TL) and Total Path Loss (TPL) for vertical polarisation **preferred** site Scatec PV2 emissions.

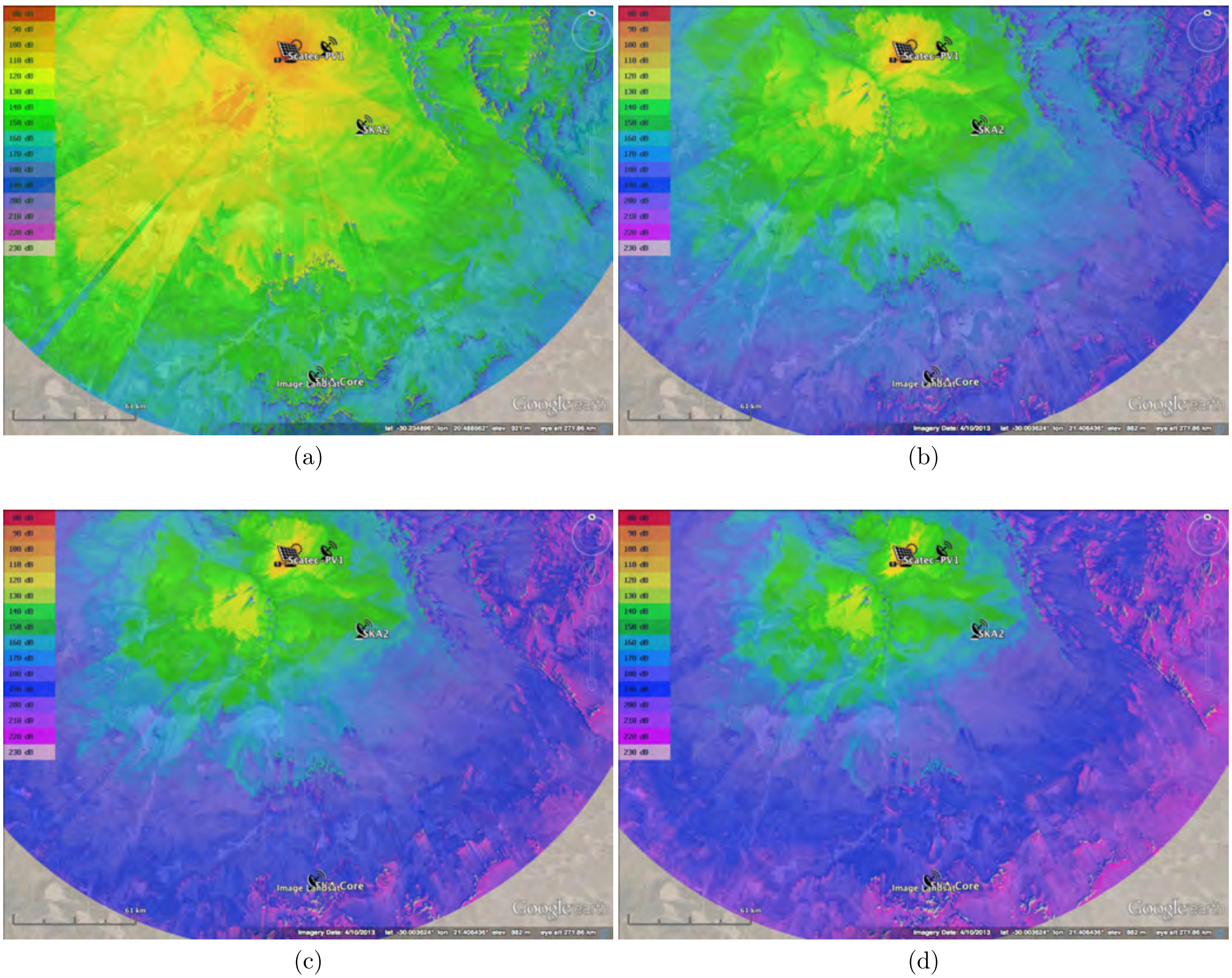
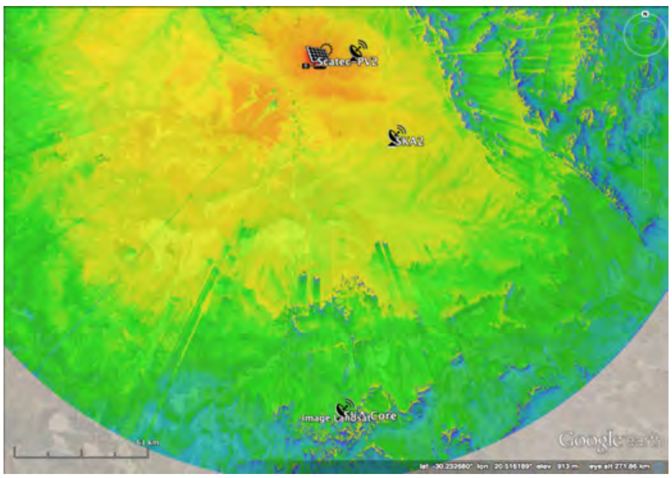
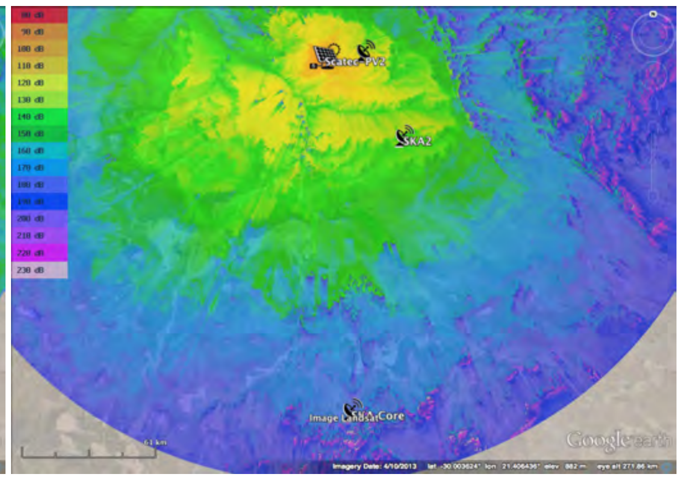


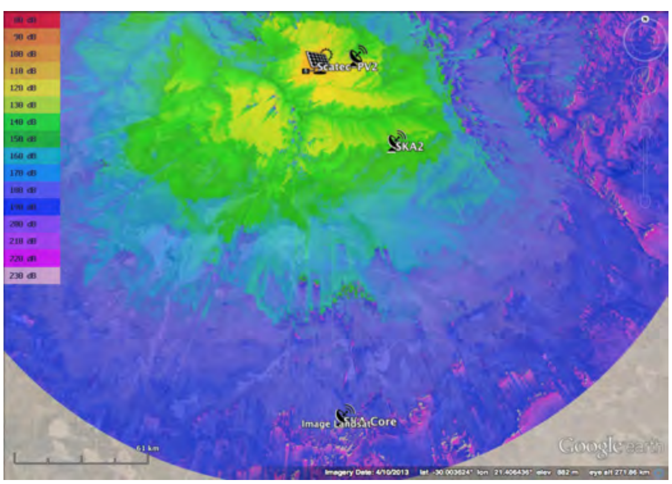
Figure 50: TPL attenuation maps for site location of Scatec PV1 to the closest and core SKA telescopes for (a) 100 MHz (b) 1000 MHz (c) 2000 MHz and (d) 3000 MHz.



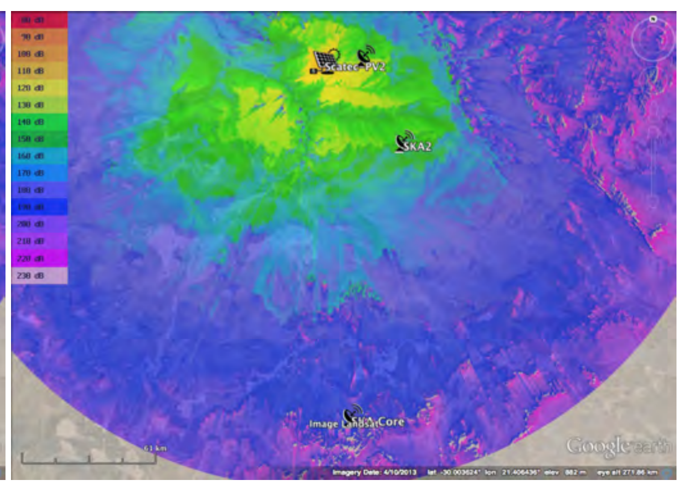
(a)



(b)



(c)



(d)

Figure 51: TPL attenuation maps for site location of Scatec PV2 to the closest and core SKA telescopes for (a) 100 MHz (b) 1000 MHz (c) 2000 MHz and (d) 3000 MHz.

5.3 Scatec PV 3 Site Location

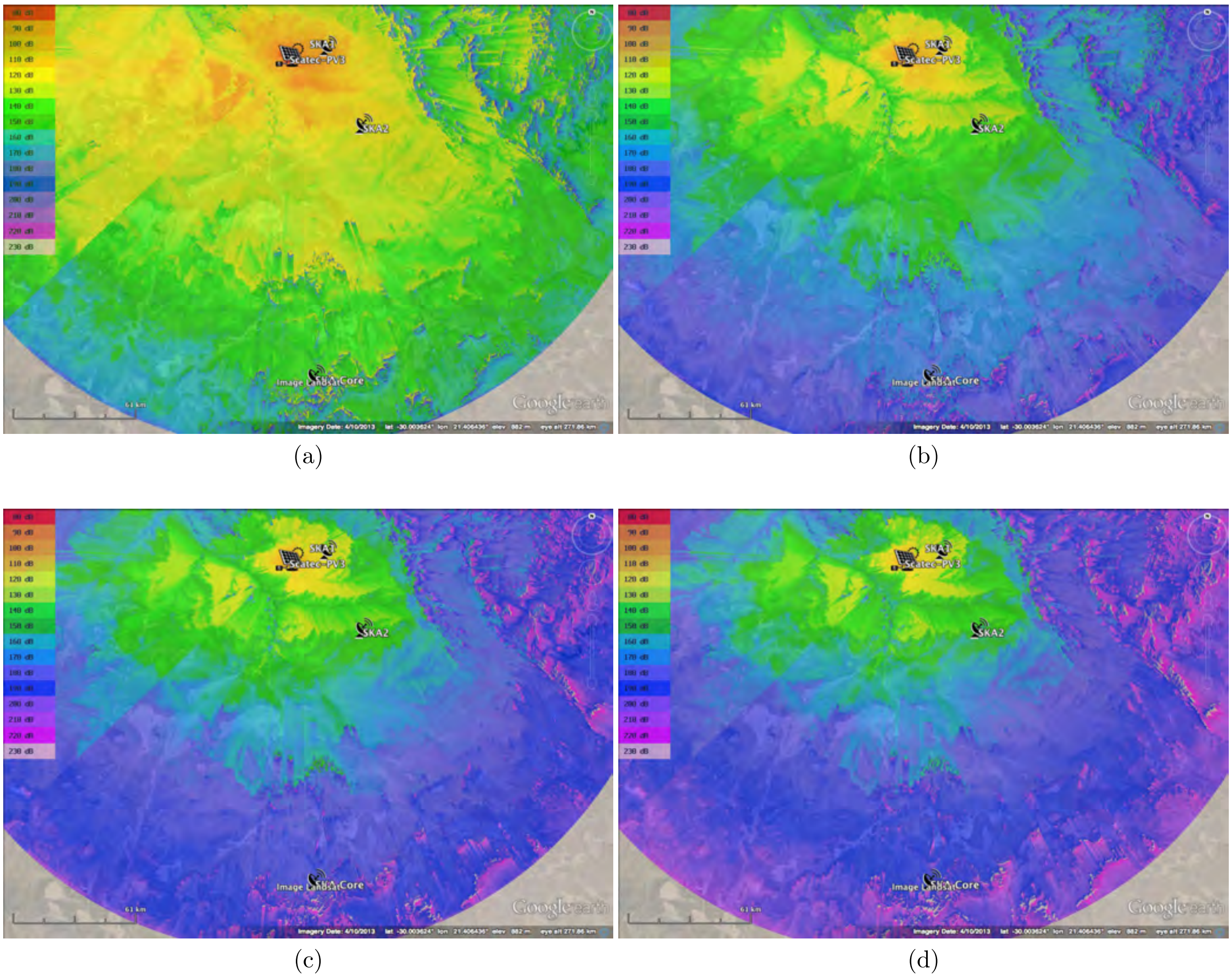


Figure 52: TPL attenuation maps for site location of Scatec PV3 to the closest and core SKA telescopes for (a) 100 MHz (b) 1000 MHz (c) 2000 MHz and (d) 3000 MHz.

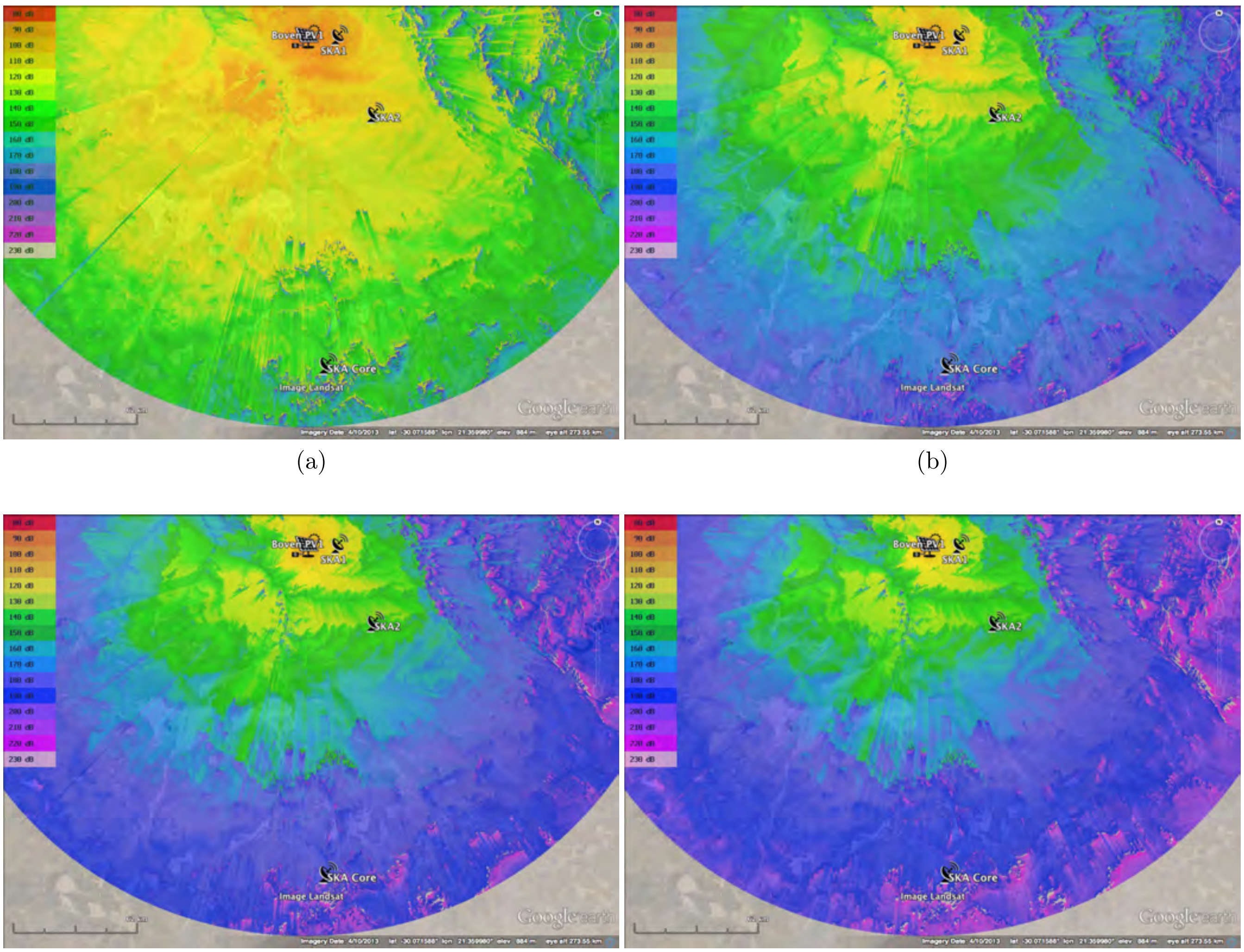
	Closest Telescope 1			Closest Telescope 2			SKA Core Site		
Frequency	**FSPL**	**TL**	**TPL**	**FSPL**	**TL**	**TPL**	**FSPL**	**TL**	**TPL**
100MHz	98.71dB	28.91dB	**127.62dB**	107.1dB	29.76dB	**136.86dB**	116.9dB	45.22dB	**162.12dB**
300MHz	108.25dB	27.45dB	**135.7dB**	116.65dB	22.96dB	**139.61dB**	126.44dB	41.0dB	**167.44dB**
500MHz	112.69dB	27.82dB	**140.51dB**	121.08dB	22.11dB	**143.19dB**	130.88dB	41.68dB	**172.56dB**
1000MHz	118.71dB	30.21dB	**148.92dB**	127.1dB	24.49dB	**151.59dB**	136.9dB	44.96dB	**181.86dB**
1500MHz	122.23dB	31.86dB	**154.09dB**	130.63dB	26.93dB	**157.56dB**	140.42dB	46.44dB	**186.86dB**
2000MHz	124.73dB	33.11dB	**157.84dB**	133.12dB	28.84dB	**161.96dB**	142.92dB	47.53dB	**190.45dB**
2500MHz	126.67dB	34.08dB	**160.75dB**	135.06dB	30.38dB	**165.44dB**	144.86dB	48.43dB	**193.29dB**
3000MHz	128.25dB	34.86dB	**163.11dB**	136.65dB	31.62dB	**168.27dB**	146.44dB	49.2dB	**195.64dB**

Table 29: SPLAT! Free Space Path Loss (FSPL), Terrain Loss (TL) and Total Path Loss (TPL) for vertical polarisation **preferred** site Scatec PV3 emissions.

5.4 Boven PV1 Site Location

	Closest Telescope 1			Closest Telescope 2			SKA Core Site		
Frequency	**FSPL**	**TL**	**TPL**	**FSPL**	**TL**	**TPL**	**FSPL**	**TL**	**TPL**
100MHz	97.24dB	7.21dB	**104.45dB**	107.32dB	17.22dB	**124.54dB**	117.11dB	28.82dB	**145.93dB**
300MHz	106.78dB	0.0dB	**106.78dB**	116.86dB	11.61dB	**128.47dB**	126.65dB	30.53dB	**157.18dB**
500MHz	111.22dB	0.0dB	**111.22dB**	121.3dB	10.71dB	**132.01dB**	131.09dB	33.05dB	**164.14dB**
1000MHz	117.24dB	0.0dB	**117.24dB**	127.32dB	11.7dB	**139.02dB**	137.11dB	38.43dB	**175.54dB**
1500MHz	120.76dB	0.0dB	**120.76dB**	130.84dB	12.67dB	**143.51dB**	140.63dB	40.79dB	**181.42dB**
2000MHz	123.26dB	0.0dB	**123.26dB**	133.34dB	13.63dB	**146.97dB**	143.13dB	42.36dB	**185.49dB**
2500MHz	125.19dB	0.0dB	**125.19dB**	135.28dB	14.53dB	**149.81dB**	145.07dB	43.52dB	**188.59dB**
3000MHz	126.78dB	0.0dB	**126.78dB**	136.86dB	15.39dB	**152.25dB**	146.65dB	44.46dB	**191.11dB**

Table 30: SPLAT! Free Space Path Loss (FSPL), Terrain Loss (TL) and Total Path Loss (TPL) for vertical polarisation site Boven PV1 emissions.



(a) (b) (c) (d)

Figure 53: TPL attenuation maps for site location of Boven PV1 to the closest and core SKA telescopes for (a) 100 MHz (b) 1000 MHz (c) 2000 MHz and (d) 3000 MHz.

5.5 Boven PV2 Site Location

5.5.1 Boven PV2 Preferred Site Location

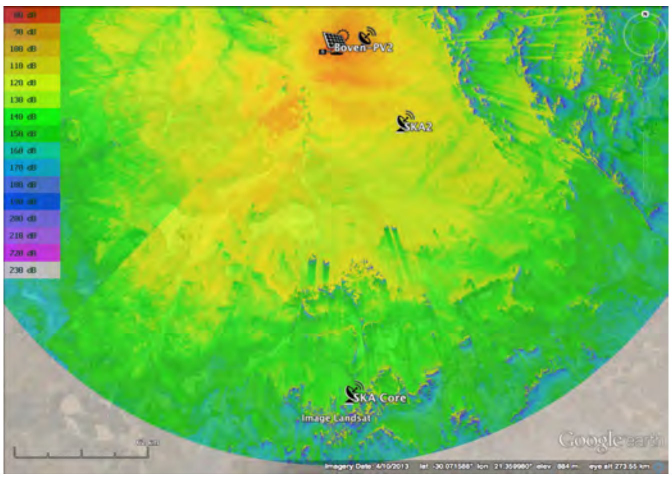
	Closest Telescope 1			Closest Telescope 2			SKA Core Site		
Frequency	**FSPL**	**TL**	**TPL**	**FSPL**	**TL**	**TPL**	**FSPL**	**TL**	**TPL**
100MHz	96.35dB	9.89dB	**106.24dB**	106.96dB	19.16dB	**126.12dB**	117.03dB	28.24dB	**145.27dB**
300MHz	105.89dB	1.91dB	**107.8dB**	116.5dB	13.49dB	**129.99dB**	126.57dB	30.09dB	**156.66dB**
500MHz	110.33dB	0.0dB	**110.33dB**	120.94dB	12.54dB	**133.48dB**	131.01dB	32.71dB	**163.72dB**
1000MHz	116.35dB	0.0dB	**116.35dB**	126.96dB	13.45dB	**140.41dB**	137.03dB	38.18dB	**175.21dB**
1500MHz	119.87dB	0.0dB	**119.87dB**	130.48dB	14.41dB	**144.89dB**	140.55dB	40.57dB	**181.12dB**
2000MHz	122.37dB	0.0dB	**122.37dB**	132.98dB	15.38dB	**148.36dB**	143.05dB	42.15dB	**185.2dB**
2500MHz	124.31dB	0.0dB	**124.31dB**	134.92dB	16.31dB	**151.23dB**	144.99dB	43.32dB	**188.31dB**
3000MHz	125.89dB	0.0dB	**125.89dB**	136.5dB	17.18dB	**153.68dB**	146.57dB	44.26dB	**190.83dB**

Table 31: SPLAT! Free Space Path Loss (FSPL), Terrain Loss (TL) and Total Path Loss (TPL) for vertical polarisation **preferred** site Boven PV2 emissions.

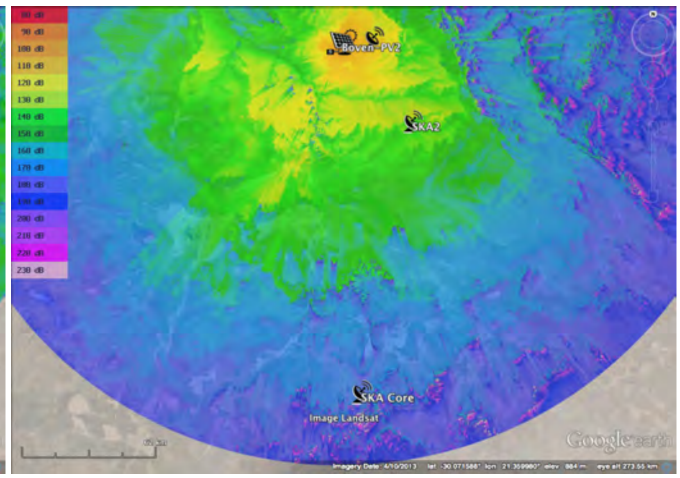
5.5.2 Boven PV2 Alternative Site Location

	Closest Telescope 1			Closest Telescope 2			SKA Core Site		
Frequency	**FSPL**	**TL**	**TPL**	**FSPL**	**TL**	**TPL**	**FSPL**	**TL**	**TPL**
100MHz	94.37dB	20.47dB	**114.84dB**	106.75dB	40.07dB	**146.82dB**	117.06dB	34.54dB	**151.6dB**
300MHz	103.91dB	16.13dB	**120.04dB**	116.29dB	36.53dB	**152.82dB**	126.61dB	38.39dB	**165.0dB**
500MHz	108.35dB	15.23dB	**123.58dB**	120.73dB	36.68dB	**157.41dB**	131.04dB	40.36dB	**171.4dB**
1000MHz	114.37dB	15.55dB	**129.92dB**	126.75dB	39.76dB	**166.51dB**	137.06dB	43.52dB	**180.58dB**
1500MHz	117.89dB	17.09dB	**134.98dB**	130.27dB	42.09dB	**172.36dB**	140.59dB	44.88dB	**185.47dB**
2000MHz	120.39dB	18.56dB	**138.95dB**	132.77dB	43.98dB	**176.75dB**	143.08dB	45.91dB	**188.99dB**
2500MHz	122.33dB	19.72dB	**142.05dB**	134.71dB	44.87dB	**179.58dB**	145.02dB	46.76dB	**191.78dB**
3000MHz	123.91dB	20.82dB	**144.73dB**	136.29dB	45.56dB	**181.85dB**	146.61dB	47.49dB	**194.1dB**

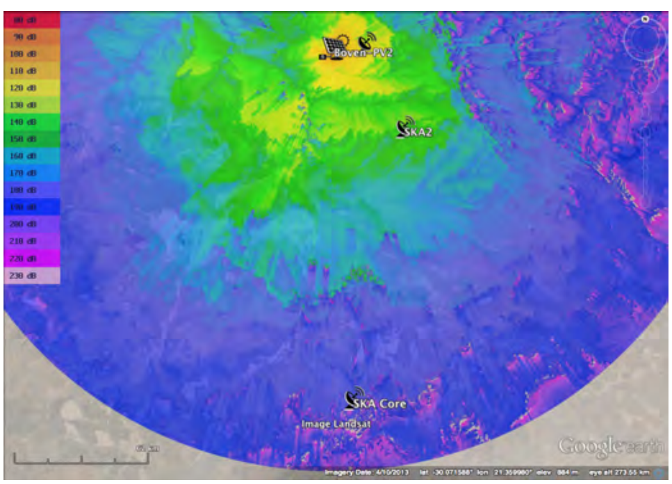
Table 32: SPLAT! Free Space Path Loss (FSPL), Terrain Loss (TL) and Total Path Loss (TPL) for vertical polarisation **alternative** site Boven PV2 emissions.



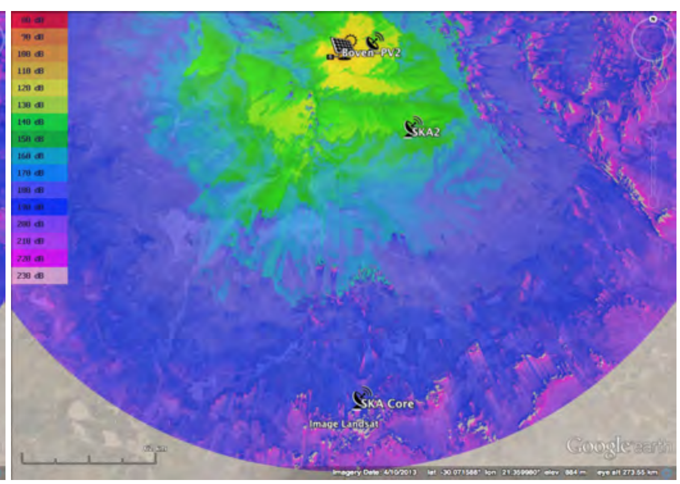
(a)



(b)

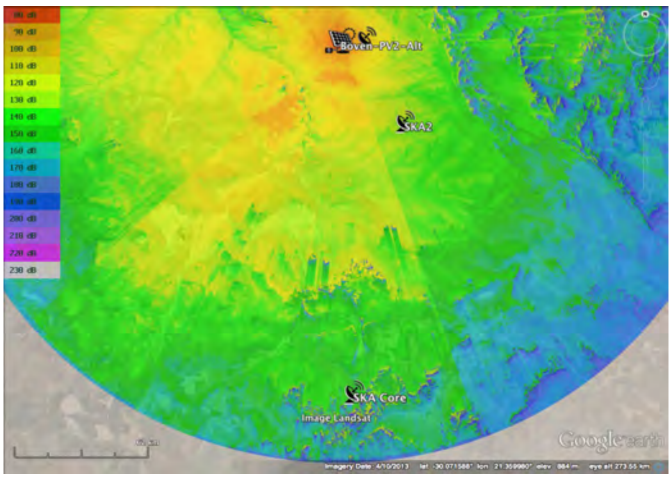


(c)

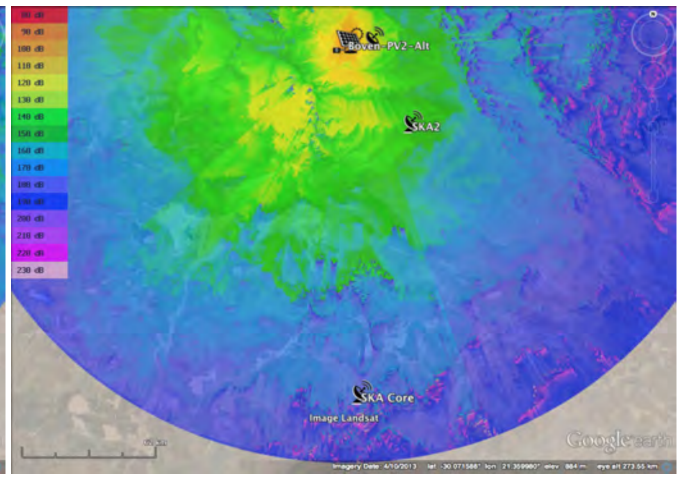


(d)

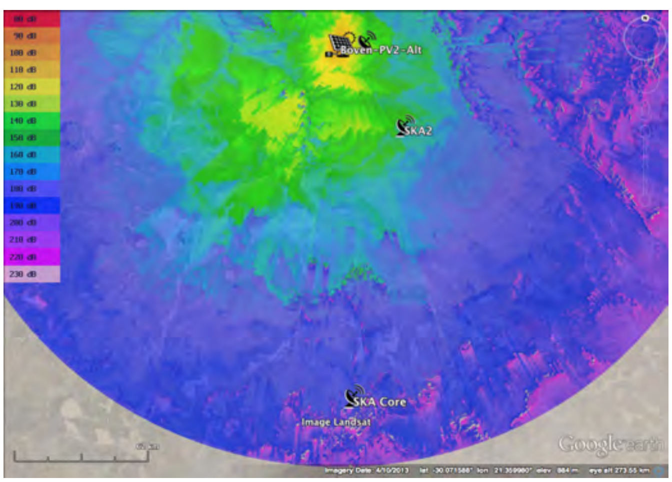
Figure 54: TPL attenuation maps for **preferred** site location of Boven PV2 to the closest and core SKA telescopes for (a) 100 MHz (b) 1000 MHz (c) 2000 MHz and (d) 3000 MHz.



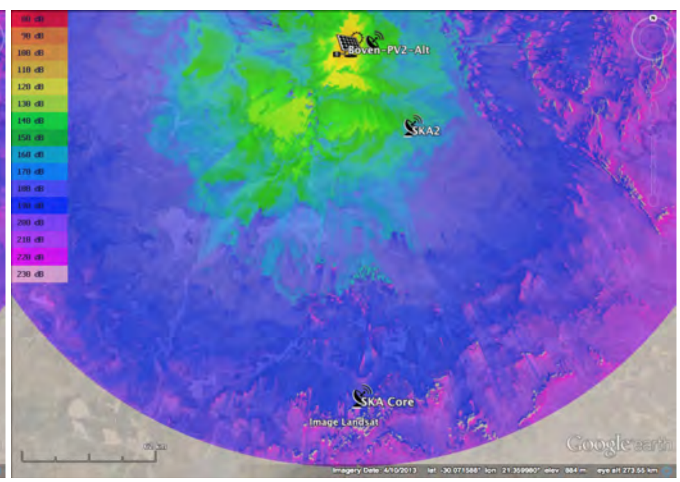
(a)



(b)



(c)



(d)

Figure 55: TPL attenuation maps for **alternative** site location of Boven PV2 to the closest and core SKA telescopes for (a) 100 MHz (b) 1000 MHz (c) 2000 MHz and (d) 3000 MHz.

5.6 Boven PV3 Site Location

5.6.1 Boven PV3 Preferred Site Location

	Closest Telescope 1			Closest Telescope 2			SKA Core Site		
Frequency	**FSPL**	**TL**	**TPL**	**FSPL**	**TL**	**TPL**	**FSPL**	**TL**	**TPL**
100MHz	96.4dB	14.84dB	**111.24dB**	106.43dB	27.93dB	**134.36dB**	116.85dB	37.22dB	**154.07dB**
300MHz	105.94dB	6.35dB	**112.29dB**	115.98dB	23.3dB	**139.28dB**	126.39dB	35.02dB	**161.41dB**
500MHz	110.38dB	2.78dB	**113.16dB**	120.41dB	22.83dB	**143.24dB**	130.83dB	36.95dB	**167.78dB**
1000MHz	116.4dB	0.0dB	**116.4dB**	126.43dB	24.64dB	**151.07dB**	136.85dB	41.82dB	**178.67dB**
1500MHz	119.92dB	0.0dB	**119.92dB**	129.96dB	26.23dB	**156.19dB**	140.37dB	44.02dB	**184.39dB**
2000MHz	122.42dB	0.0dB	**122.42dB**	132.46dB	27.74dB	**160.2dB**	142.87dB	45.49dB	**188.36dB**
2500MHz	124.36dB	0.0dB	**124.36dB**	134.39dB	29.1dB	**163.49dB**	144.81dB	46.61dB	**191.42dB**
3000MHz	125.94dB	0.0dB	**125.94dB**	135.98dB	30.29dB	**166.27dB**	146.39dB	47.51dB	**193.9dB**

Table 33: SPLAT! Free Space Path Loss (FSPL), Terrain Loss (TL) and Total Path Loss (TPL) for vertical polarisation **preferred** site Boven PV3 emissions.

5.6.2 Boven PV3 Alternative Site Location

	Closest Telescope 1			Closest Telescope 2			SKA Core Site		
Frequency	**FSPL**	**TL**	**TPL**	**FSPL**	**TL**	**TPL**	**FSPL**	**TL**	**TPL**
100MHz	95.25dB	19.28dB	**114.53dB**	106.47dB	29.2dB	**135.67dB**	116.93dB	35.52dB	**152.45dB**
300MHz	104.79dB	13.64dB	**118.43dB**	116.01dB	22.11dB	**138.12dB**	126.47dB	34.12dB	**160.59dB**
500MHz	109.23dB	11.02dB	**120.25dB**	120.45dB	20.61dB	**141.06dB**	130.9dB	36.33dB	**167.23dB**
1000MHz	115.25dB	8.35dB	**123.6dB**	126.47dB	21.35dB	**147.82dB**	136.93dB	41.43dB	**178.36dB**
1500MHz	118.77dB	7.28dB	**126.05dB**	129.99dB	22.42dB	**152.41dB**	140.45dB	43.71dB	**184.16dB**
2000MHz	121.27dB	6.94dB	**128.21dB**	132.49dB	23.61dB	**156.1dB**	142.95dB	45.19dB	**188.14dB**
2500MHz	123.21dB	7.07dB	**130.28dB**	134.42dB	24.82dB	**159.24dB**	144.88dB	46.32dB	**191.2dB**
3000MHz	124.79dB	7.19dB	**131.98dB**	136.01dB	26.06dB	**162.07dB**	146.47dB	47.21dB	**193.68dB**

Table 34: SPLAT! Free Space Path Loss (FSPL), Terrain Loss (TL) and Total Path Loss (TPL) for vertical polarisation **alternative** site Boven PV3 emissions.

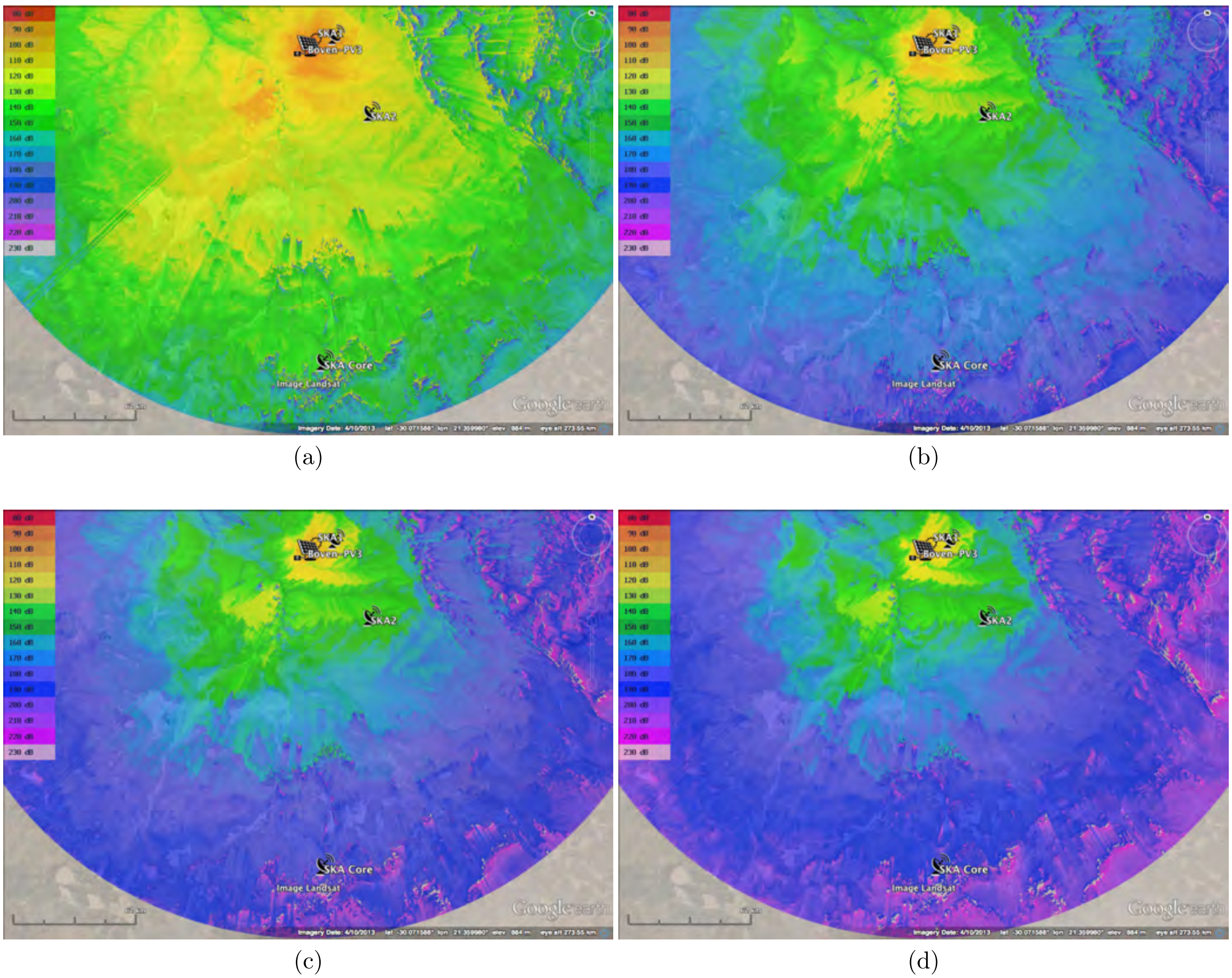


Figure 56: TPL attenuation maps for **preferred** site location of Boven PV3 to the closest and core SKA telescopes for (a) 100 MHz (b) 1000 MHz (c) 2000 MHz and (d) 3000 MHz.

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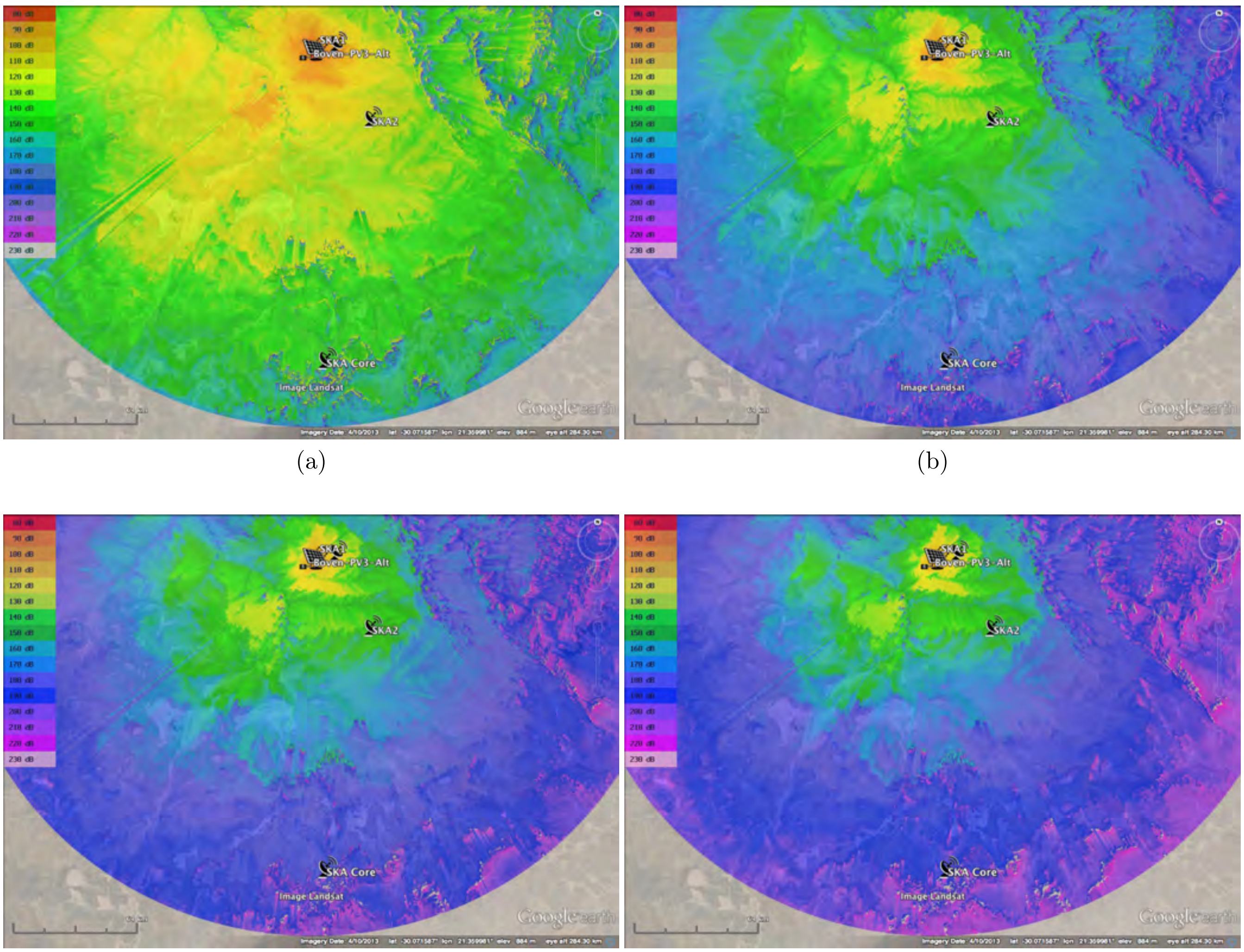


(a) (b)

(c) (d)

Figure 57: TPL attenuation maps for **alternative** site location of Boven PV3 to the closest and core SKA telescopes for (a) 100 MHz (b) 1000 MHz (c) 2000 MHz and (d) 3000 MHz.

5.7 Boven PV4 Site Location

5.7.1 Boven PV4 Preferred Site Location

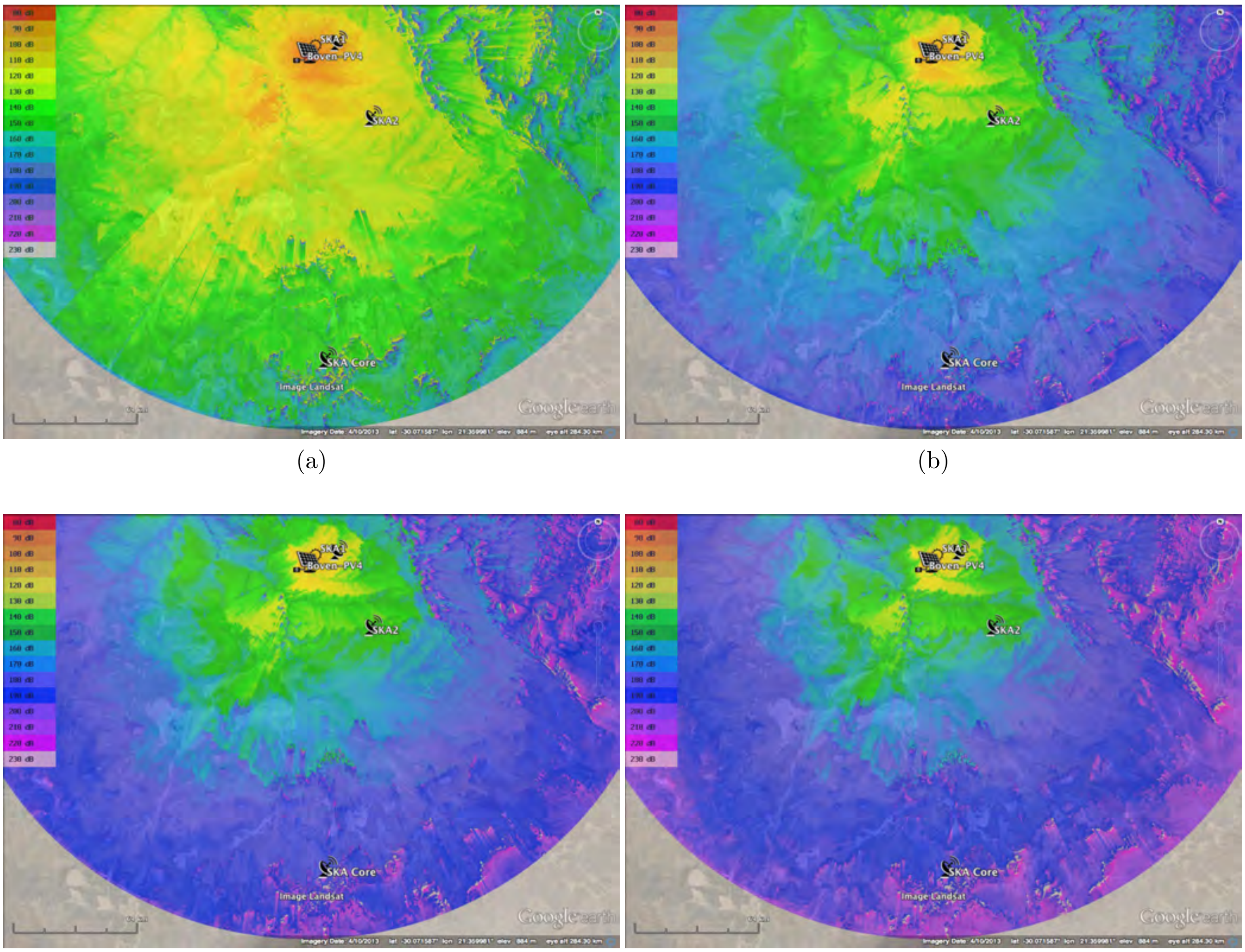
	Closest Telescope 1			Closest Telescope 2			SKA Core Site		
Frequency	**FSPL**	**TL**	**TPL**	**FSPL**	**TL**	**TPL**	**FSPL**	**TL**	**TPL**
100MHz	97.5dB	8.88dB	**106.38dB**	106.62dB	24.55dB	**131.17dB**	116.83dB	30.34dB	**147.17dB**
300MHz	107.04dB	0.51dB	**107.55dB**	116.16dB	19.93dB	**136.09dB**	126.37dB	30.91dB	**157.28dB**
500MHz	111.48dB	0.0dB	**111.48dB**	120.6dB	19.39dB	**139.99dB**	130.81dB	33.43dB	**164.24dB**
1000MHz	117.5dB	0.0dB	**117.5dB**	126.62dB	21.0dB	**147.62dB**	136.83dB	38.85dB	**175.68dB**
1500MHz	121.02dB	0.0dB	**121.02dB**	130.14dB	22.44dB	**152.58dB**	140.35dB	41.2dB	**181.55dB**
2000MHz	123.52dB	0.0dB	**123.52dB**	132.64dB	23.77dB	**156.41dB**	142.85dB	42.75dB	**185.6dB**
2500MHz	125.45dB	0.0dB	**125.45dB**	134.58dB	24.99dB	**159.57dB**	144.79dB	43.92dB	**188.71dB**
3000MHz	127.04dB	0.0dB	**127.04dB**	136.16dB	26.09dB	**162.25dB**	146.37dB	44.86dB	**191.23dB**

Table 35: SPLAT! Free Space Path Loss (FSPL), Terrain Loss (TL) and Total Path Loss (TPL) for vertical polarisation **preferred** site Boven PV4 emissions.

5.7.2 Boven PV4 Alternative Site Location

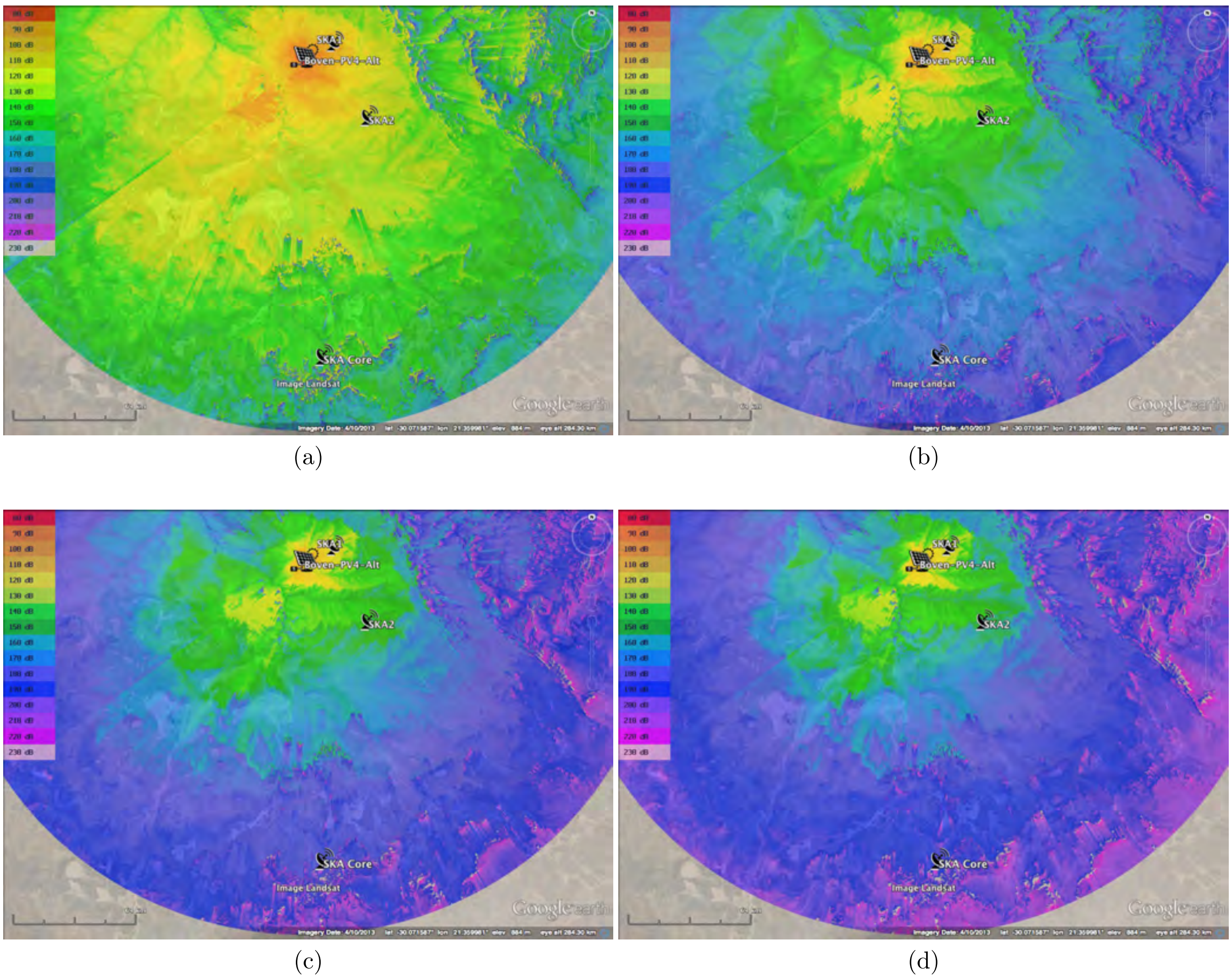
	Closest Telescope 1			Closest Telescope 2			SKA Core Site		
Frequency	**FSPL**	**TL**	**TPL**	**FSPL**	**TL**	**TPL**	**FSPL**	**TL**	**TPL**
100MHz	97.85dB	14.26dB	**112.11dB**	106.31dB	28.21dB	**134.52dB**	116.71dB	33.63dB	**150.34dB**
300MHz	107.39dB	6.09dB	**113.48dB**	115.85dB	23.98dB	**139.83dB**	126.25dB	32.17dB	**158.42dB**
500MHz	111.83dB	2.74dB	**114.57dB**	120.29dB	23.59dB	**143.88dB**	130.69dB	34.53dB	**165.22dB**
1000MHz	117.85dB	0.0dB	**117.85dB**	126.31dB	25.52dB	**151.83dB**	136.71dB	39.82dB	**176.53dB**
1500MHz	121.37dB	0.0dB	**121.37dB**	129.83dB	27.17dB	**157.0dB**	140.23dB	42.14dB	**182.37dB**
2000MHz	123.87dB	0.0dB	**123.87dB**	132.33dB	28.64dB	**160.97dB**	142.73dB	43.67dB	**186.4dB**
2500MHz	125.81dB	0.0dB	**125.81dB**	134.27dB	29.94dB	**164.21dB**	144.66dB	44.83dB	**189.49dB**
3000MHz	127.39dB	0.0dB	**127.39dB**	135.85dB	31.1dB	**166.95dB**	146.25dB	45.75dB	**192.0dB**

Table 36: SPLAT! Free Space Path Loss (FSPL), Terrain Loss (TL) and Total Path Loss (TPL) for vertical polarisation **alternative** site Boven PV4 emissions.



(a) (b) (c) (d)

Figure 58: TPL attenuation maps for **preferred** site location of Boven PV4 to the closest and core SKA telescopes for (a) 100 MHz (b) 1000 MHz (c) 2000 MHz and (d) 3000 MHz.



(a) (b) (c) (d)

Figure 59: TPL attenuation maps for **alternative** site location of Boven PV4 to the closest and core SKA telescopes for (a) 100 MHz (b) 1000 MHz (c) 2000 MHz and (d) 3000 MHz.

5.8 Gemsbok PV1 Site Location

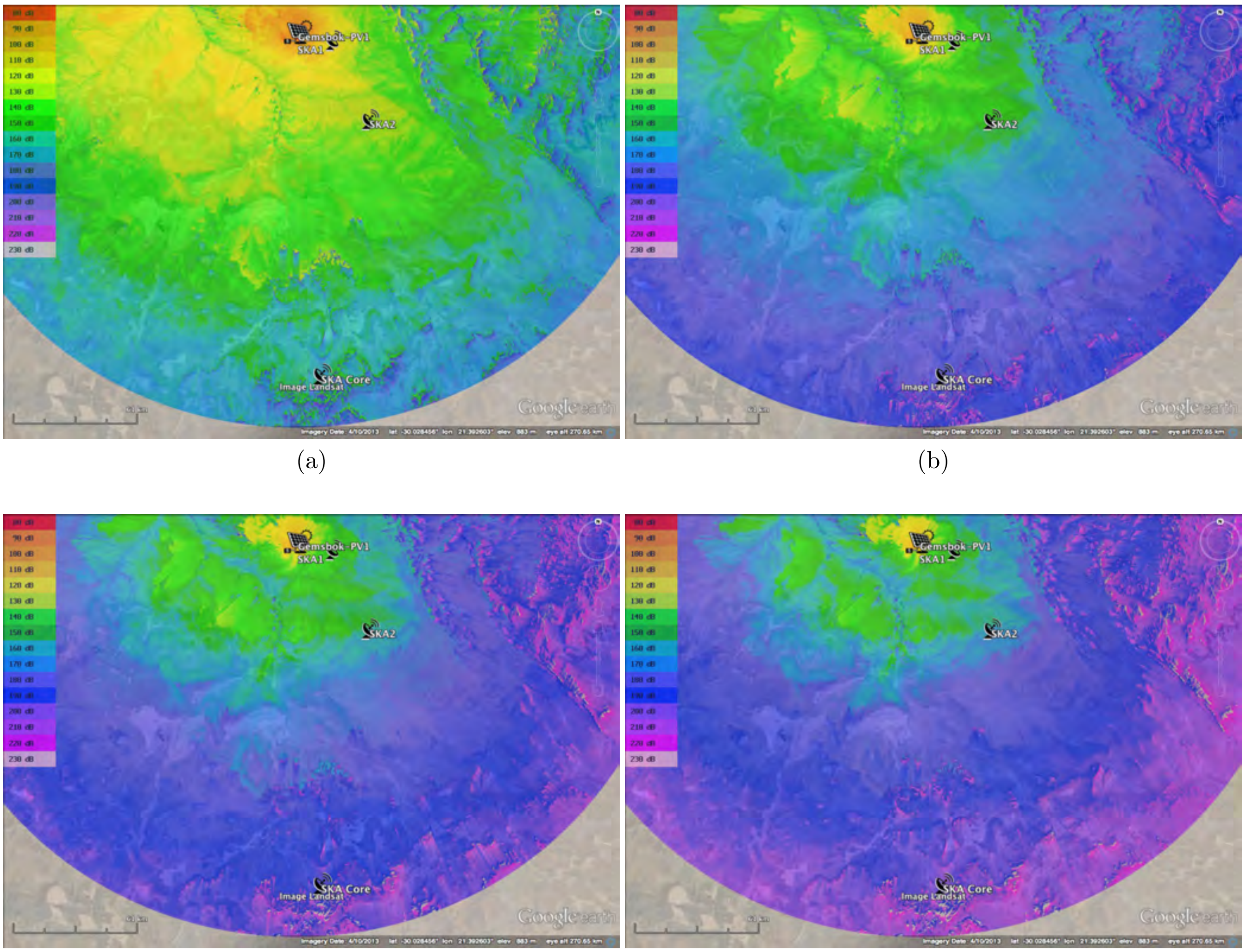
	Closest Telescope 1			Closest Telescope 2			SKA Core Site		
Frequency	**FSPL**	**TL**	**TPL**	**FSPL**	**TL**	**TPL**	**FSPL**	**TL**	**TPL**
100MHz	98.07dB	25.55dB	**123.62dB**	108.07dB	25.82dB	**133.89dB**	117.38dB	47.18dB	**164.56dB**
300MHz	107.62dB	20.83dB	**128.45dB**	117.61dB	18.67dB	**136.28dB**	126.93dB	42.44dB	**169.37dB**
500MHz	112.05dB	19.71dB	**131.76dB**	122.05dB	18.41dB	**140.46dB**	131.36dB	43.12dB	**174.48dB**
1000MHz	118.07dB	19.69dB	**137.76dB**	128.07dB	22.52dB	**150.59dB**	137.38dB	46.33dB	**183.71dB**
1500MHz	121.6dB	20.46dB	**142.06dB**	131.59dB	25.11dB	**156.7dB**	140.91dB	47.79dB	**188.7dB**
2000MHz	124.09dB	21.31dB	**145.4dB**	134.09dB	27.08dB	**161.17dB**	143.41dB	48.88dB	**192.29dB**
2500MHz	126.03dB	22.05dB	**148.08dB**	136.03dB	28.68dB	**164.71dB**	145.34dB	49.78dB	**195.12dB**
3000MHz	127.62dB	22.7dB	**150.32dB**	137.61dB	29.94dB	**167.55dB**	146.93dB	50.54dB	**197.47dB**

Table 37: SPLAT! Free Space Path Loss (FSPL), Terrain Loss (TL) and Total Path Loss (TPL) for vertical polarisation **preferred** site Gemsbok PV1 emissions.

5.9 Gemsbok PV2 Site Location

	Closest Telescope 1			Closest Telescope 2			SKA Core Site		
Frequency	**FSPL**	**TL**	**TPL**	**FSPL**	**TL**	**TPL**	**FSPL**	**TL**	**TPL**
100MHz	96.6dB	24.61dB	**121.21dB**	107.77dB	28.62dB	**136.39dB**	117.36dB	42.67dB	**160.03dB**
300MHz	106.14dB	18.66dB	**124.8dB**	117.31dB	19.64dB	**136.95dB**	126.9dB	40.76dB	**167.66dB**
500MHz	110.58dB	17.02dB	**127.6dB**	121.75dB	18.42dB	**140.17dB**	131.34dB	41.51dB	**172.85dB**
1000MHz	116.6dB	16.31dB	**132.91dB**	127.77dB	21.37dB	**149.14dB**	137.36dB	44.85dB	**182.21dB**
1500MHz	120.12dB	16.69dB	**136.81dB**	131.29dB	23.52dB	**154.81dB**	140.88dB	46.39dB	**187.27dB**
2000MHz	122.62dB	17.31dB	**139.93dB**	133.79dB	25.19dB	**158.98dB**	143.38dB	47.52dB	**190.9dB**
2500MHz	124.56dB	17.93dB	**142.49dB**	135.73dB	26.59dB	**162.32dB**	145.32dB	48.44dB	**193.76dB**
3000MHz	126.14dB	18.52dB	**144.66dB**	137.31dB	27.83dB	**165.14dB**	146.9dB	49.22dB	**196.12dB**

Table 38: SPLAT! Free Space Path Loss (FSPL), Terrain Loss (TL) and Total Path Loss (TPL) for vertical polarisation **preferred** site Gemsbok PV2 emissions.



(a) (b) (c) (d)

Figure 60: TPL attenuation maps for site location of Gemsbok PV1 to the closest and core SKA telescopes for (a) 100 MHz (b) 1000 MHz (c) 2000 MHz and (d) 3000 MHz.

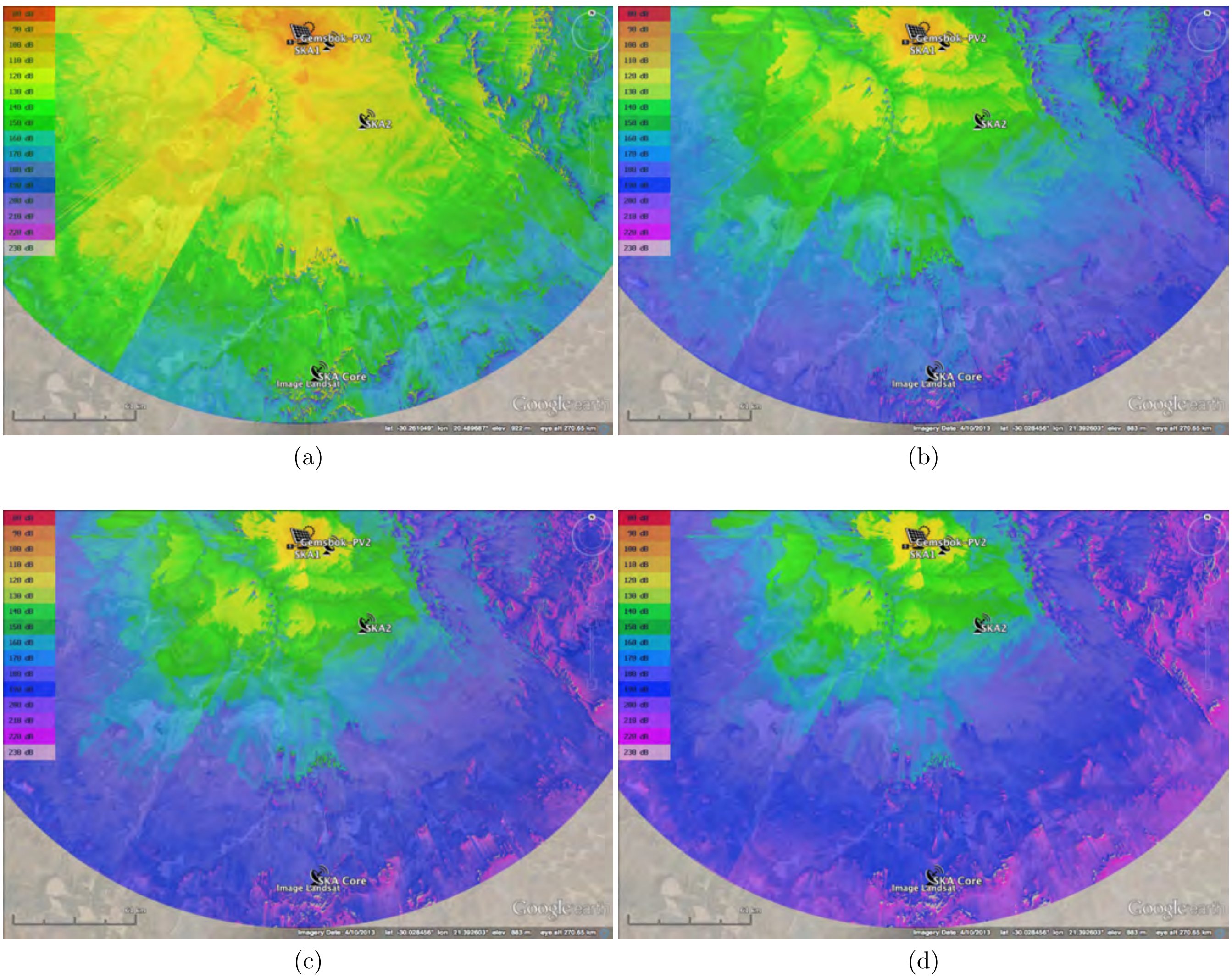


Figure 61: TPL attenuation maps for site location of Gemsbok PV2 to the closest and core SKA telescopes for (a) 100 MHz (b) 1000 MHz (c) 2000 MHz and (d) 3000 MHz.

5.10 Gemsbok PV3 Site Location

5.10.1 Gemsbok PV3 Preferred Site Location

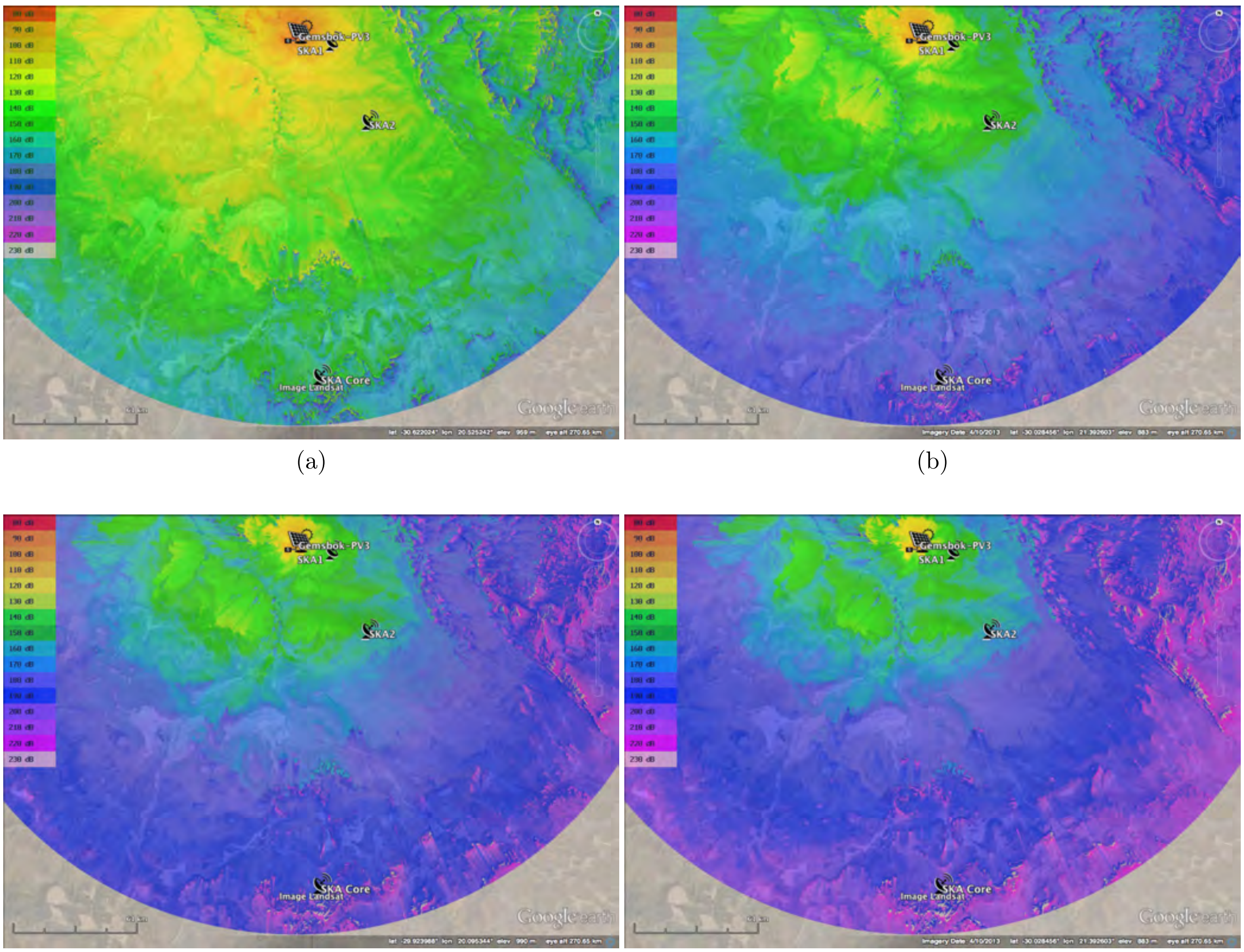
	Closest Telescope 1			Closest Telescope 2			SKA Core Site		
Frequency	**FSPL**	**TL**	**TPL**	**FSPL**	**TL**	**TPL**	**FSPL**	**TL**	**TPL**
100MHz	97.99dB	25.22dB	**123.21dB**	108.12dB	25.82dB	**133.94dB**	117.42dB	39.45dB	**156.87dB**
300MHz	107.53dB	20.88dB	**128.41dB**	117.66dB	18.16dB	**135.82dB**	126.96dB	37.44dB	**164.4dB**
500MHz	111.97dB	20.06dB	**132.03dB**	122.1dB	17.61dB	**139.71dB**	131.4dB	38.83dB	**170.23dB**
1000MHz	117.99dB	20.88dB	**138.87dB**	128.12dB	21.2dB	**149.32dB**	137.42dB	43.0dB	**180.42dB**
1500MHz	121.51dB	22.26dB	**143.77dB**	131.64dB	23.86dB	**155.5dB**	140.94dB	44.94dB	**185.88dB**
2000MHz	124.01dB	23.39dB	**147.4dB**	134.14dB	25.99dB	**160.13dB**	143.44dB	46.29dB	**189.73dB**
2500MHz	125.95dB	24.34dB	**150.29dB**	136.08dB	27.72dB	**163.8dB**	145.38dB	47.34dB	**192.72dB**
3000MHz	127.53dB	25.35dB	**152.88dB**	137.66dB	29.22dB	**166.88dB**	146.96dB	48.2dB	**195.16dB**

Table 39: SPLAT! Free Space Path Loss (FSPL), Terrain Loss (TL) and Total Path Loss (TPL) for vertical polarisation **preferred** site Gemsbok PV3 emissions.

5.10.2 Gemsbok PV3 Alternative Site Location

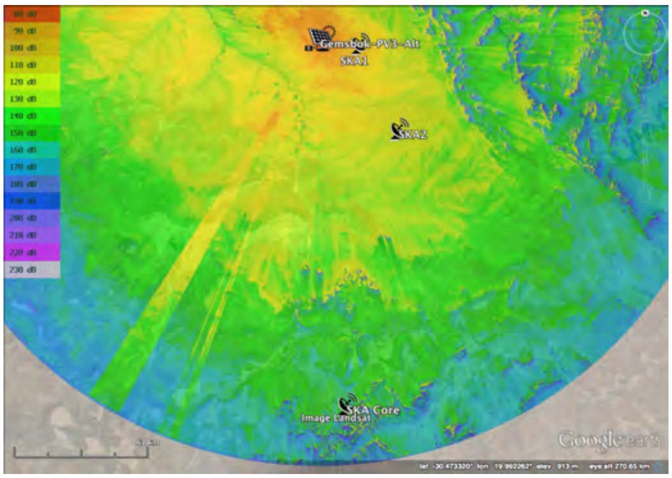
	Closest Telescope 1			Closest Telescope 2			SKA Core Site		
Frequency	**FSPL**	**TL**	**TPL**	**FSPL**	**TL**	**TPL**	**FSPL**	**TL**	**TPL**
100MHz	98.2dB	18.49dB	**116.69dB**	107.92dB	23.74dB	**131.66dB**	117.29dB	44.43dB	**161.72dB**
300MHz	107.75dB	12.49dB	**120.24dB**	117.46dB	15.51dB	**132.97dB**	126.84dB	42.4dB	**169.24dB**
500MHz	112.18dB	10.59dB	**122.77dB**	121.9dB	14.23dB	**136.13dB**	131.27dB	43.11dB	**174.38dB**
1000MHz	118.2dB	9.57dB	**127.77dB**	127.92dB	16.2dB	**144.12dB**	137.29dB	46.37dB	**183.66dB**
1500MHz	121.73dB	9.76dB	**131.49dB**	131.44dB	18.4dB	**149.84dB**	140.81dB	47.85dB	**188.66dB**
2000MHz	124.22dB	10.06dB	**134.28dB**	133.94dB	20.27dB	**154.21dB**	143.31dB	48.95dB	**192.26dB**
2500MHz	126.16dB	10.56dB	**136.72dB**	135.87dB	21.9dB	**157.77dB**	145.25dB	49.85dB	**195.1dB**
3000MHz	127.75dB	11.06dB	**138.81dB**	137.46dB	23.32dB	**160.78dB**	146.84dB	50.62dB	**197.46dB**

Table 40: SPLAT! Free Space Path Loss (FSPL), Terrain Loss (TL) and Total Path Loss (TPL) for vertical polarisation **alternative** site Gemsbok PV3 emissions.

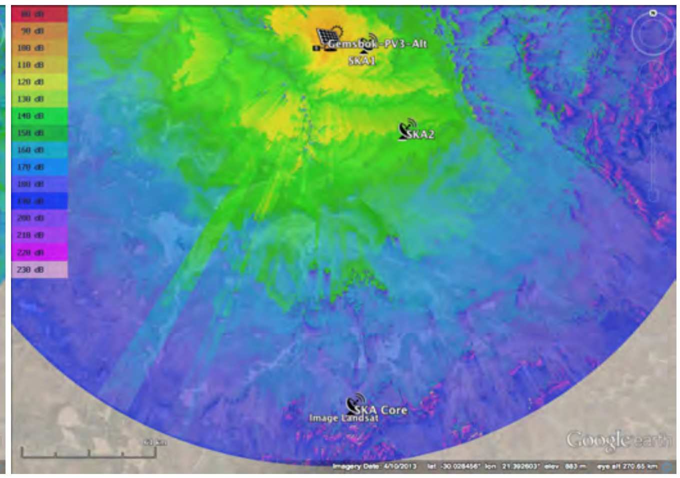


(a) (b) (c) (d)

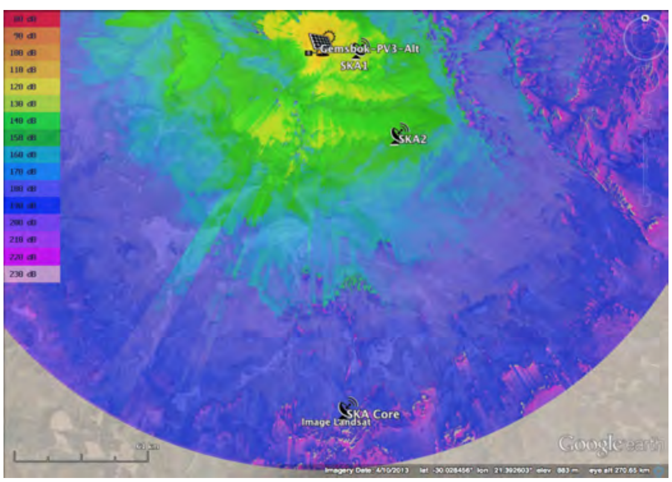
Figure 62: TPL attenuation maps for **preferred** site location of Gemsbok PV3 to the closest and core SKA telescopes for (a) 100 MHz (b) 1000 MHz (c) 2000 MHz and (d) 3000 MHz.



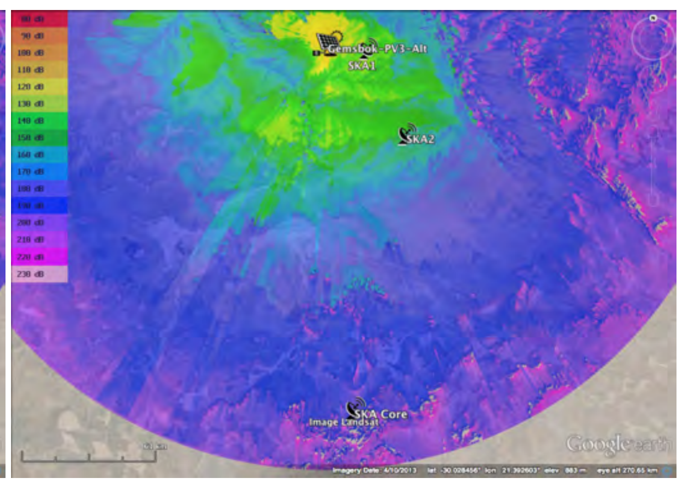
(a)



(b)



(c)



(d)

Figure 63: TPL attenuation maps for **alternative** site location of Gemsbok PV3 to the closest and core SKA telescopes for (a) 100 MHz (b) 1000 MHz (c) 2000 MHz and (d) 3000 MHz.

5.11 Gemsbok PV4 Site Location

5.11.1 Gemsbok PV4 Preferred Site Location

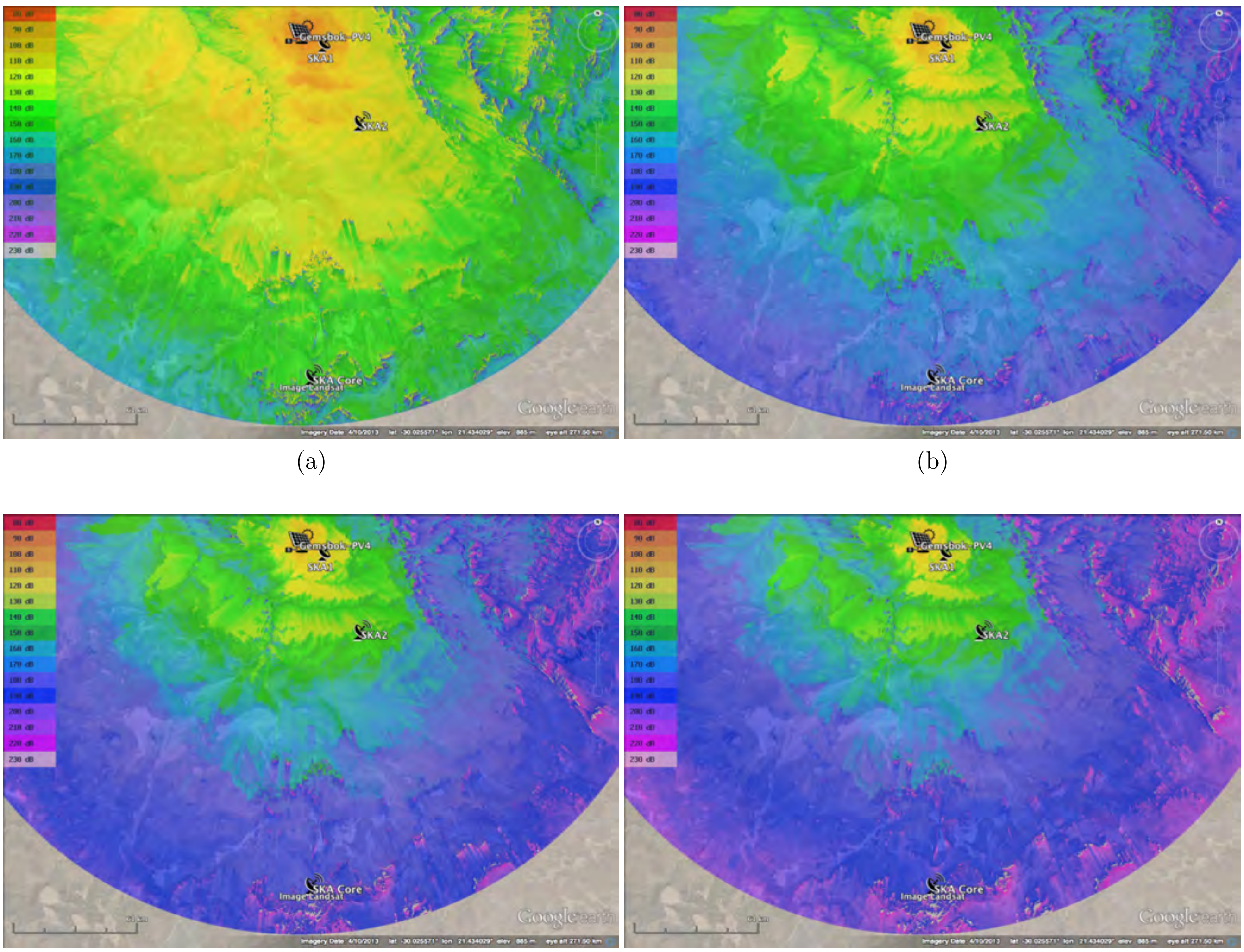
	Closest Telescope 1			Closest Telescope 2			SKA Core Site		
Frequency	**FSPL**	**TL**	**TPL**	**FSPL**	**TL**	**TPL**	**FSPL**	**TL**	**TPL**
100MHz	95.97dB	12.08dB	**108.05dB**	107.81dB	25.75dB	**133.56dB**	117.43dB	29.85dB	**147.28dB**
300MHz	105.51dB	6.43dB	**111.94dB**	117.35dB	16.16dB	**133.51dB**	126.97dB	30.72dB	**157.69dB**
500MHz	109.95dB	4.92dB	**114.87dB**	121.79dB	14.32dB	**136.11dB**	131.41dB	33.51dB	**164.92dB**
1000MHz	115.97dB	5.38dB	**121.35dB**	127.81dB	15.86dB	**143.67dB**	137.43dB	39.08dB	**176.51dB**
1500MHz	119.49dB	6.82dB	**126.31dB**	131.33dB	17.61dB	**148.94dB**	140.95dB	41.51dB	**182.46dB**
2000MHz	121.99dB	8.29dB	**130.28dB**	133.83dB	19.13dB	**152.96dB**	143.45dB	43.1dB	**186.55dB**
2500MHz	123.93dB	9.6dB	**133.53dB**	135.77dB	20.44dB	**156.21dB**	145.39dB	44.28dB	**189.67dB**
3000MHz	125.51dB	10.59dB	**136.1dB**	137.35dB	21.62dB	**158.97dB**	146.97dB	45.23dB	**192.2dB**

Table 41: SPLAT! Free Space Path Loss (FSPL), Terrain Loss (TL) and Total Path Loss (TPL) for vertical polarisation **preferred** site Gemsbok PV4 emissions.

5.11.2 Gemsbok PV4 Alternative Site Location

	Closest Telescope 1			Closest Telescope 2			SKA Core Site		
Frequency	**FSPL**	**TL**	**TPL**	**FSPL**	**TL**	**TPL**	**FSPL**	**TL**	**TPL**
100MHz	95.99dB	13.57dB	**109.56dB**	107.95dB	23.3dB	**131.25dB**	117.51dB	29.92dB	**147.43dB**
300MHz	105.54dB	8.15dB	**113.69dB**	117.49dB	13.5dB	**130.99dB**	127.05dB	30.93dB	**157.98dB**
500MHz	109.97dB	6.76dB	**116.73dB**	121.93dB	11.53dB	**133.46dB**	131.49dB	33.66dB	**165.15dB**
1000MHz	115.99dB	6.87dB	**122.86dB**	127.95dB	12.79dB	**140.74dB**	137.51dB	39.17dB	**176.68dB**
1500MHz	119.51dB	8.7dB	**128.21dB**	131.47dB	14.43dB	**145.9dB**	141.03dB	41.6dB	**182.63dB**
2000MHz	122.01dB	9.91dB	**131.92dB**	133.97dB	15.87dB	**149.84dB**	143.53dB	43.17dB	**186.7dB**
2500MHz	123.95dB	10.9dB	**134.85dB**	135.91dB	17.15dB	**153.06dB**	145.47dB	44.34dB	**189.81dB**
3000MHz	125.54dB	11.74dB	**137.28dB**	137.49dB	18.3dB	**155.79dB**	147.05dB	45.28dB	**192.33dB**

Table 42: SPLAT! Free Space Path Loss (FSPL), Terrain Loss (TL) and Total Path Loss (TPL) for vertical polarisation **alternative** site Gemsbok PV4 emissions.



(a) (b)

(c) (d)

Figure 64: TPL attenuation maps for **preferred** site location of Gemsbok PV4 to the closest and core SKA telescopes for (a) 100 MHz (b) 1000 MHz (c) 2000 MHz and (d) 3000 MHz.

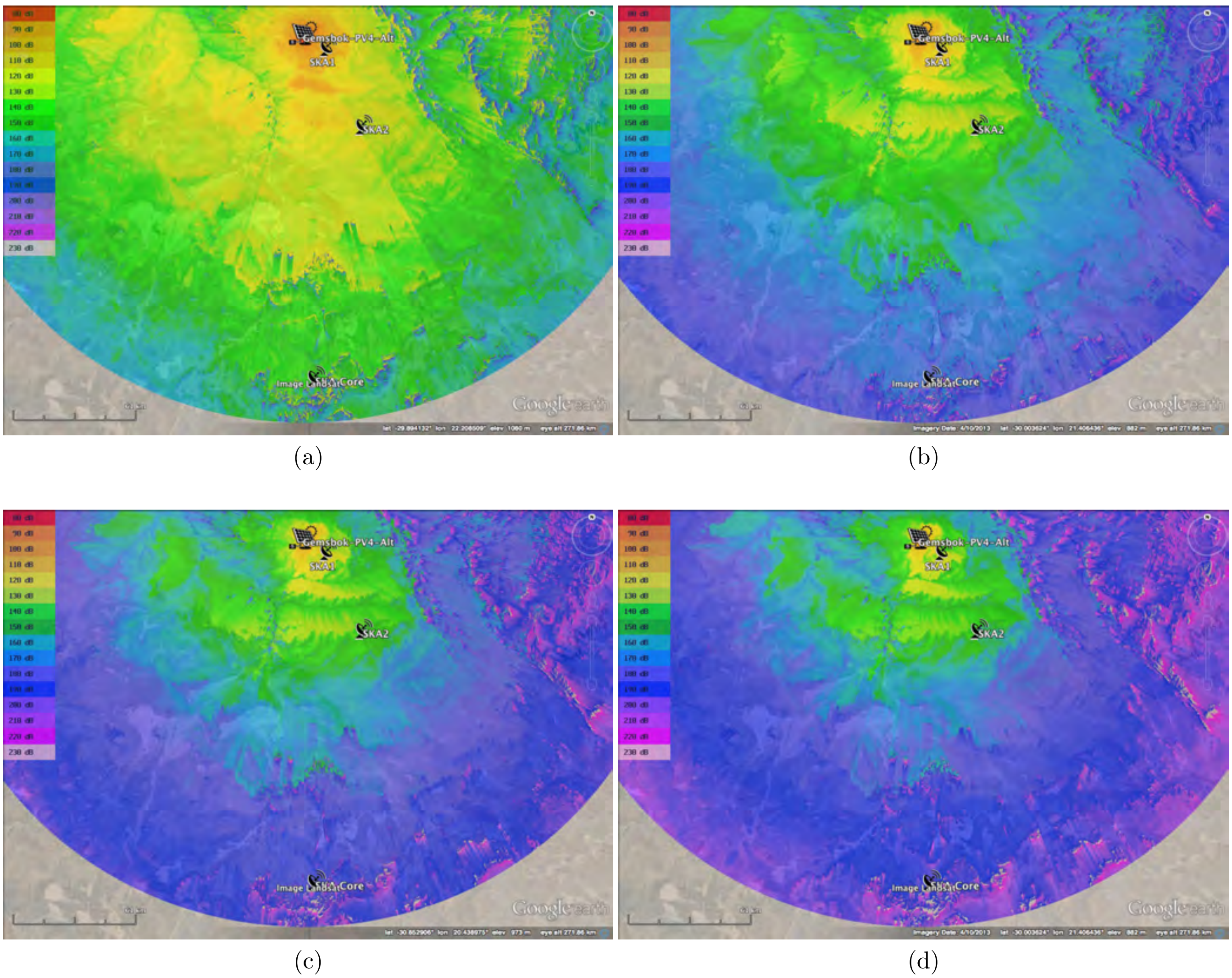


Figure 65: TPL attenuation maps for **alternative** site location of Gemsbok PV4 to the closest and core SKA telescopes for (a) 100 MHz (b) 1000 MHz (c) 2000 MHz and (d) 3000 MHz.

5.12 Gemsbok PV5 Site Location

5.12.1 Gemsbok PV5 Preferred Site Location

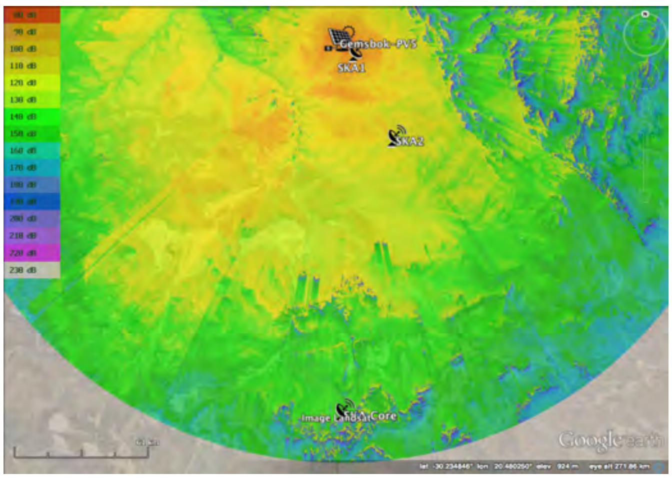
	Closest Telescope 1			Closest Telescope 2			SKA Core Site		
Frequency	**FSPL**	**TL**	**TPL**	**FSPL**	**TL**	**TPL**	**FSPL**	**TL**	**TPL**
100MHz	92.9dB	7.24dB	**100.14dB**	107.45dB	20.82dB	**128.27dB**	117.45dB	28.14dB	**145.59dB**
300MHz	102.44dB	0.0dB	**102.44dB**	116.99dB	13.65dB	**130.64dB**	126.99dB	30.17dB	**157.16dB**
500MHz	106.88dB	0.0dB	**106.88dB**	121.43dB	12.2dB	**133.63dB**	131.43dB	33.06dB	**164.49dB**
1000MHz	112.9dB	0.0dB	**112.9dB**	127.45dB	13.15dB	**140.6dB**	137.45dB	38.71dB	**176.16dB**
1500MHz	116.42dB	0.0dB	**116.42dB**	130.97dB	14.19dB	**145.16dB**	140.97dB	41.19dB	**182.16dB**
2000MHz	118.92dB	0.0dB	**118.92dB**	133.47dB	15.32dB	**148.79dB**	143.47dB	42.78dB	**186.25dB**
2500MHz	120.86dB	0.0dB	**120.86dB**	135.41dB	16.45dB	**151.86dB**	145.41dB	43.96dB	**189.37dB**
3000MHz	122.44dB	0.0dB	**122.44dB**	136.99dB	17.68dB	**154.67dB**	146.99dB	44.91dB	**191.9dB**

Table 43: SPLAT! Free Space Path Loss (FSPL), Terrain Loss (TL) and Total Path Loss (TPL) for vertical polarisation **preferred** site Gemsbok PV5 emissions.

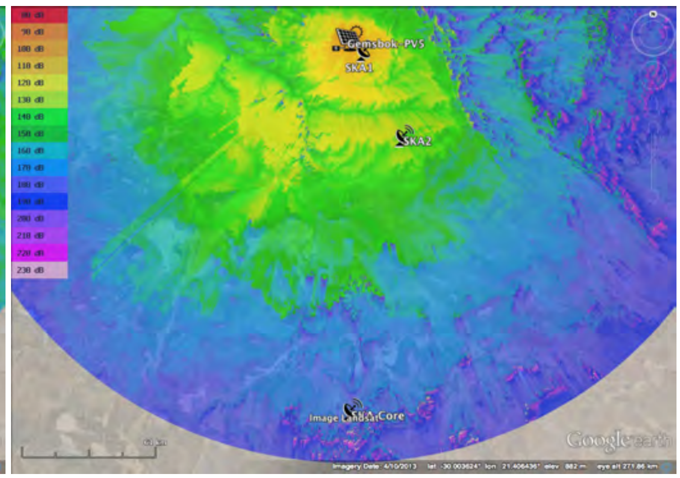
5.12.2 Gemsbok PV5 Alternative Site Location

	Closest Telescope 1			Closest Telescope 2			SKA Core Site		
Frequency	**FSPL**	**TL**	**TPL**	**FSPL**	**TL**	**TPL**	**FSPL**	**TL**	**TPL**
100MHz	93.79dB	18.23dB	**112.02dB**	107.45dB	28.16dB	**135.61dB**	117.39dB	36.27dB	**153.66dB**
300MHz	103.33dB	15.23dB	**118.56dB**	116.99dB	21.32dB	**138.31dB**	126.94dB	38.02dB	**164.96dB**
500MHz	107.77dB	15.77dB	**123.54dB**	121.43dB	20.35dB	**141.78dB**	131.37dB	39.27dB	**170.64dB**
1000MHz	113.79dB	18.96dB	**132.75dB**	127.45dB	22.65dB	**150.1dB**	137.39dB	43.16dB	**180.55dB**
1500MHz	117.31dB	22.04dB	**139.35dB**	130.97dB	24.96dB	**155.93dB**	140.91dB	44.95dB	**185.86dB**
2000MHz	119.81dB	24.86dB	**144.67dB**	133.47dB	26.79dB	**160.26dB**	143.41dB	46.22dB	**189.63dB**
2500MHz	121.75dB	27.33dB	**149.08dB**	135.41dB	28.31dB	**163.72dB**	145.35dB	47.22dB	**192.57dB**
3000MHz	123.33dB	29.32dB	**152.65dB**	136.99dB	29.63dB	**166.62dB**	146.94dB	48.04dB	**194.98dB**

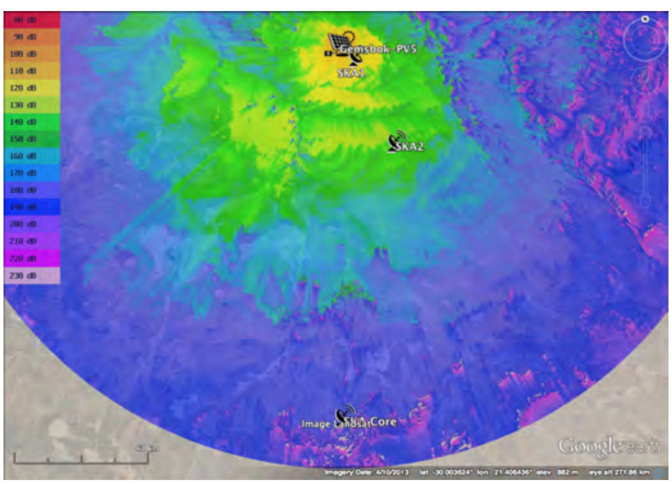
Table 44: SPLAT! Free Space Path Loss (FSPL), Terrain Loss (TL) and Total Path Loss (TPL) for vertical polarisation **alternative** site Gemsbok PV5 emissions.



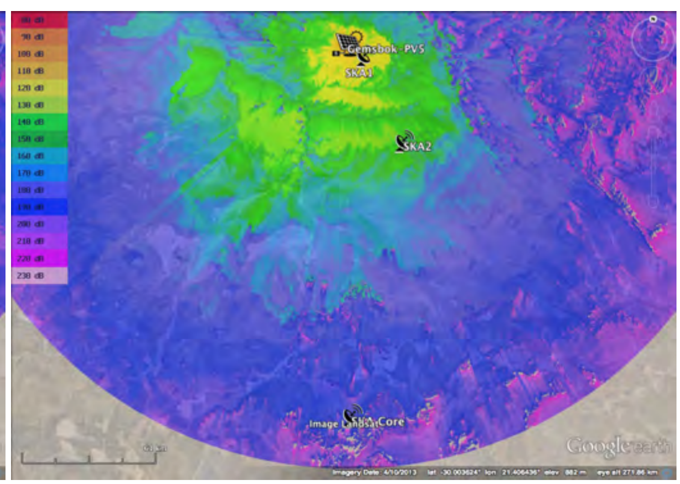
(a)



(b)

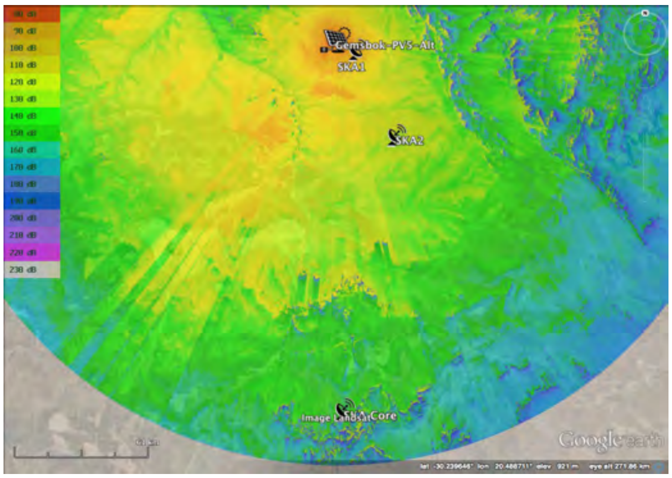


(c)

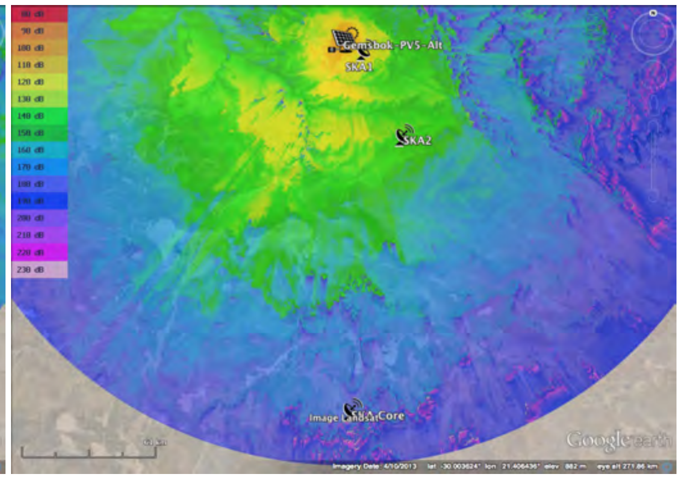


(d)

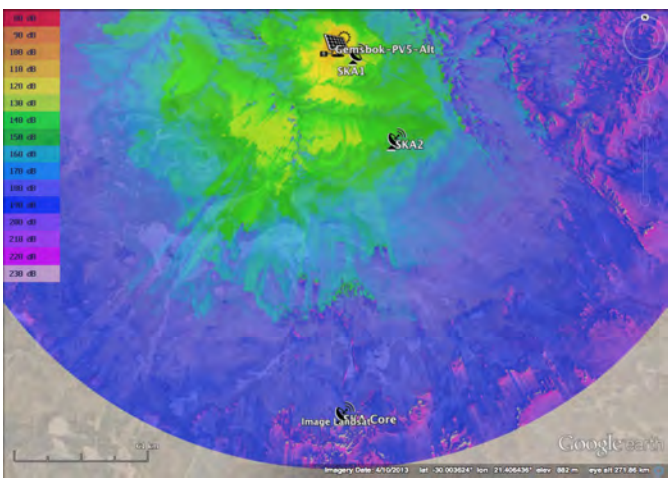
Figure 66: TPL attenuation maps for **preferred** site location of Gemsbok PV5 to the closest and core SKA telescopes for (a) 100 MHz (b) 1000 MHz (c) 2000 MHz and (d) 3000 MHz.



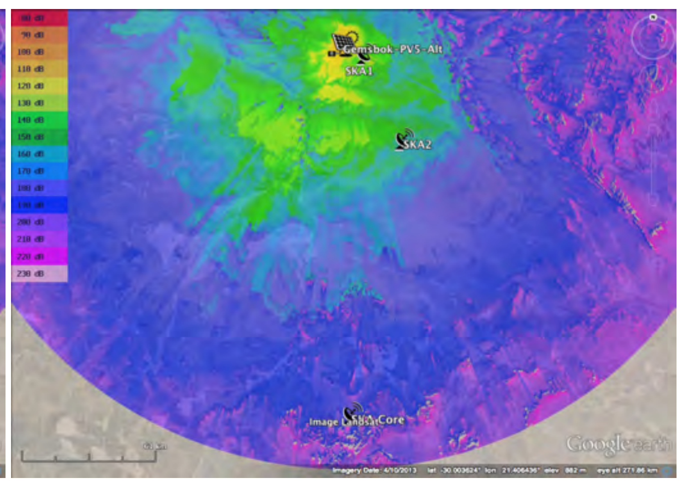
(a)



(b)



(c)



(d)

Figure 67: TPL attenuation maps for **alternative** site location of Gemsbok PV5 to the closest and core SKA telescopes for (a) 100 MHz (b) 1000 MHz (c) 2000 MHz and (d) 3000 MHz.

5.13 Gemsbok PV6 Site Location

5.13.1 Gemsbok PV6 Preferred Site Location

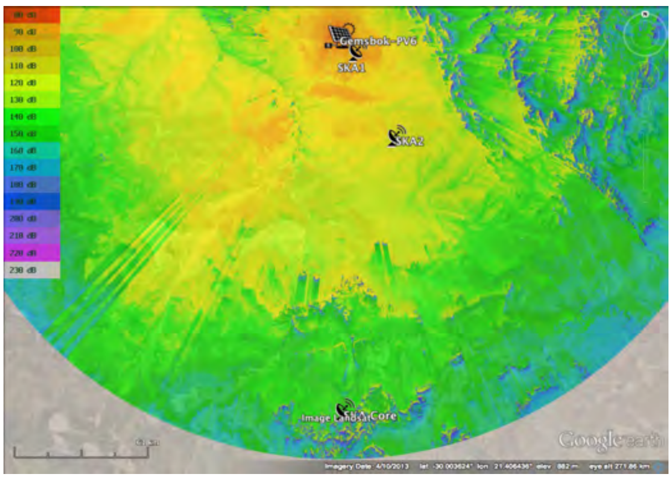
	Closest Telescope 1			Closest Telescope 2			SKA Core Site		
Frequency	**FSPL**	**TL**	**TPL**	**FSPL**	**TL**	**TPL**	**FSPL**	**TL**	**TPL**
100MHz	93.64dB	19.39dB	**113.03dB**	107.64dB	23.34dB	**130.98dB**	117.52dB	29.84dB	**147.36dB**
300MHz	103.18dB	13.52dB	**116.7dB**	117.18dB	13.78dB	**130.96dB**	127.06dB	30.93dB	**157.99dB**
500MHz	107.62dB	11.93dB	**119.55dB**	121.62dB	11.78dB	**133.4dB**	131.5dB	33.61dB	**165.11dB**
1000MHz	113.64dB	11.22dB	**124.86dB**	127.64dB	12.63dB	**140.27dB**	137.52dB	39.09dB	**176.61dB**
1500MHz	117.16dB	11.7dB	**128.86dB**	131.16dB	14.04dB	**145.2dB**	141.04dB	41.54dB	**182.58dB**
2000MHz	119.66dB	12.51dB	**132.17dB**	133.66dB	15.39dB	**149.05dB**	143.54dB	43.12dB	**186.66dB**
2500MHz	121.6dB	13.19dB	**134.79dB**	135.6dB	16.69dB	**152.29dB**	145.48dB	44.3dB	**189.78dB**
3000MHz	123.18dB	13.98dB	**137.16dB**	137.18dB	17.89dB	**155.07dB**	147.06dB	45.24dB	**192.3dB**

Table 45: SPLAT! Free Space Path Loss (FSPL), Terrain Loss (TL) and Total Path Loss (TPL) for vertical polarisation **preferred** site Gemsbok PV6 emissions.

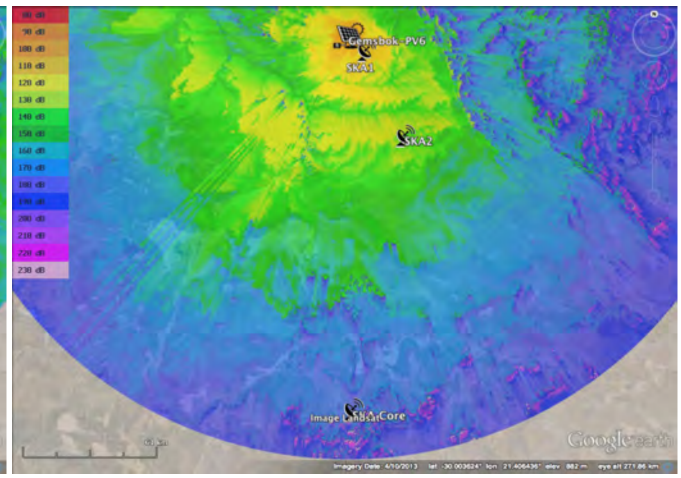
5.13.2 Gemsbok PV6 Alternative Site Location

	Closest Telescope 1			Closest Telescope 2			SKA Core Site		
Frequency	**FSPL**	**TL**	**TPL**	**FSPL**	**TL**	**TPL**	**FSPL**	**TL**	**TPL**
100MHz	94.3dB	15.79dB	**110.09dB**	107.68dB	27.14dB	**134.82dB**	117.49dB	32.67dB	**150.16dB**
300MHz	103.84dB	11.16dB	**115.0dB**	117.23dB	17.25dB	**134.48dB**	127.03dB	32.01dB	**159.04dB**
500MHz	108.28dB	10.33dB	**118.61dB**	121.66dB	15.36dB	**137.02dB**	131.47dB	34.33dB	**165.8dB**
1000MHz	114.3dB	10.76dB	**125.06dB**	127.68dB	17.13dB	**144.81dB**	137.49dB	39.51dB	**177.0dB**
1500MHz	117.82dB	12.25dB	**130.07dB**	131.21dB	18.9dB	**150.11dB**	141.01dB	41.82dB	**182.83dB**
2000MHz	120.32dB	13.61dB	**133.93dB**	133.7dB	20.34dB	**154.04dB**	143.51dB	43.39dB	**186.9dB**
2500MHz	122.26dB	14.71dB	**136.97dB**	135.64dB	21.62dB	**157.26dB**	145.45dB	44.56dB	**190.01dB**
3000MHz	123.84dB	15.65dB	**139.49dB**	137.23dB	22.76dB	**159.99dB**	147.03dB	45.5dB	**192.53dB**

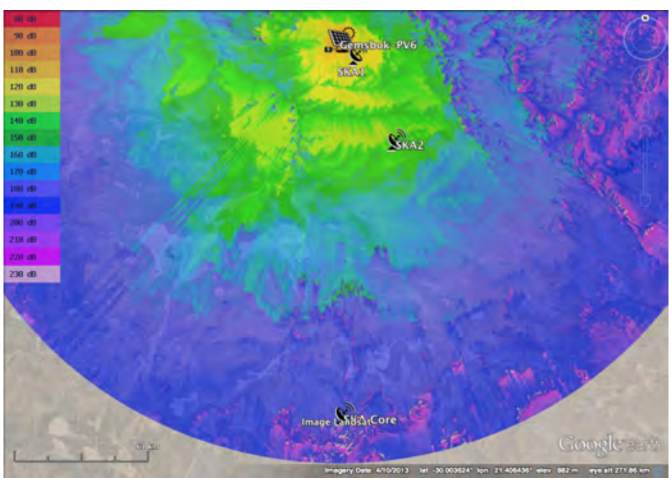
Table 46: SPLAT! Free Space Path Loss (FSPL), Terrain Loss (TL) and Total Path Loss (TPL) for vertical polarisation **alternative** site Gemsbok PV6 emissions.



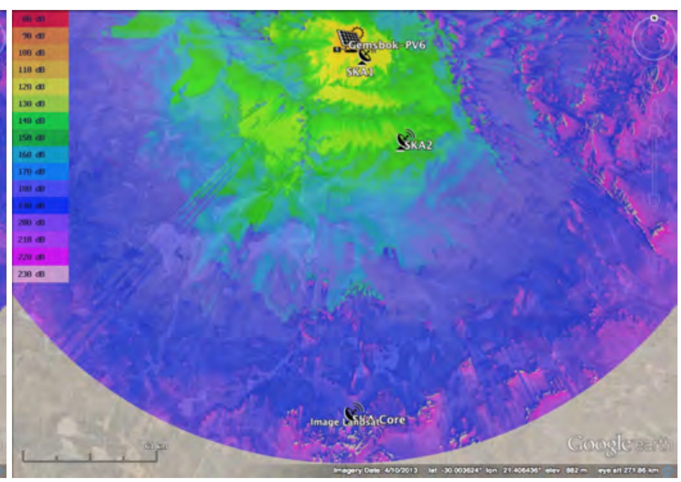
(a)



(b)



(c)



(d)

Figure 68: TPL attenuation maps for **preferred** site location of Gemsbok PV6 to the closest and core SKA telescopes for (a) 100 MHz (b) 1000 MHz (c) 2000 MHz and (d) 3000 MHz.

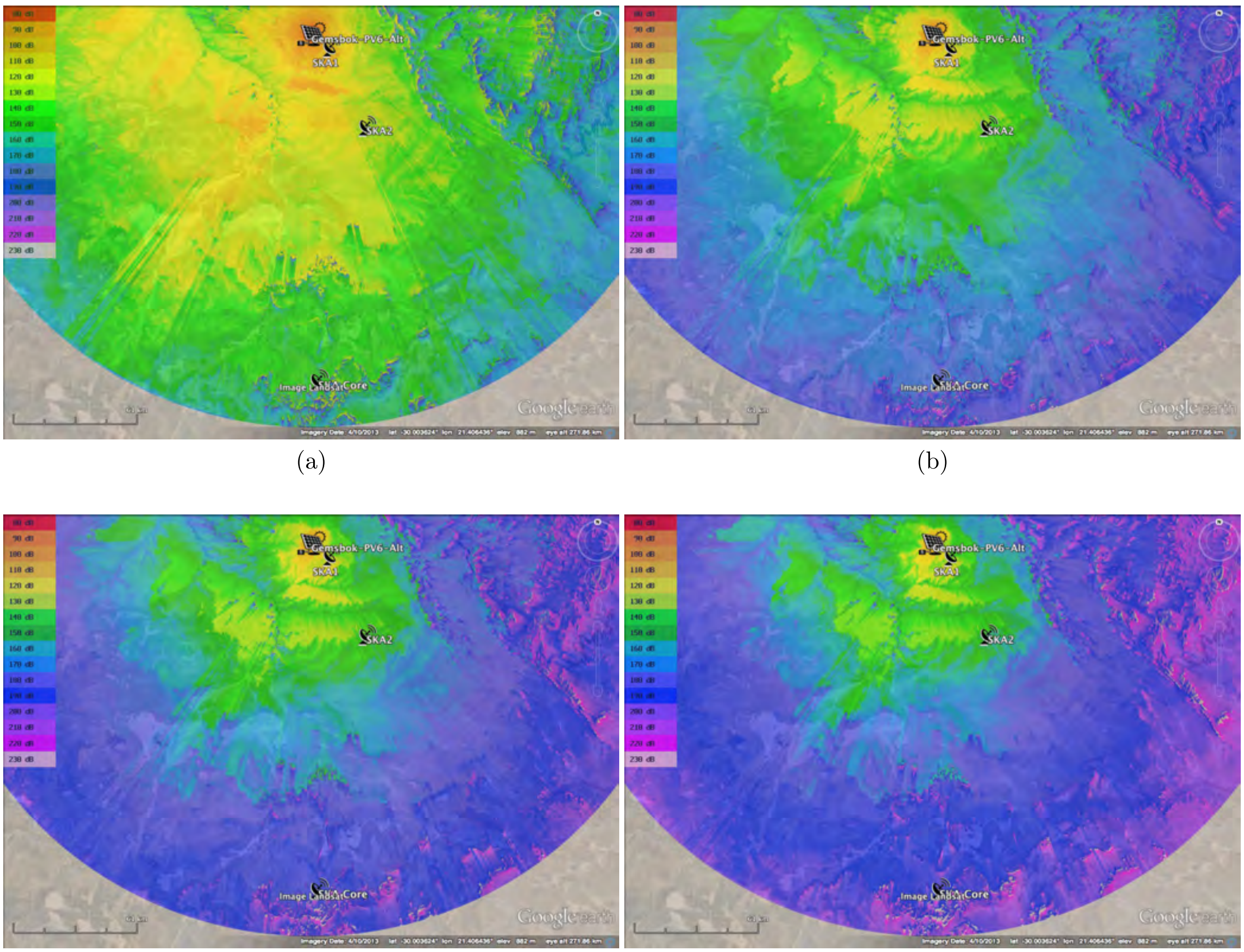


Figure 69: TPL attenuation maps for **alternative** site location of Gemsbok PV6 to the closest and core SKA telescopes for (a) 100 MHz (b) 1000 MHz (c) 2000 MHz and (d) 3000 MHz.

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6 SKA Threshold Limits

SKA threshold limits are defined as *Protection Limits* (dBm/Hz as defined by SARAS) and *Receiver Saturation Limits* (-100 dBm). Using the attenuation maps and topographical profiles calculated in Section 5 , we next compare the acceptable levels as measured at 10 m from each plant (according to CISPR 11/22 class B) that will produce radiated emission levels 10 dB below the SKA threshold as defined by SARAS. The 10 dB theoretical value is a safety margin to ensure that each of the plants complies with the SKA threshold, and attempts to take into account any multi-path effects (6 dB variation) and any measurement uncertainties. The required level 10 dB below the threshold takes into account the TPL calculated by SPLAT! and are indicated as *Required Radiation Levels After Propagation Loss*. The required PSD of the radiated emission levels experienced at each telescope are given by Eq. 2 below. The required levels are represented by the *black squares* in Figs. 70 (b) to 72 (b) for projects to the closest and core SKA telescope sites respectively.

$$PSD_{\text{Required}}\,[dBm/Hz] = PSD_{\text{SARAS Continuum}}\,[dBm/Hz] - 10\,dB \tag{2}$$

Considering the TPL, the required PSD at the source of the interference, indicated as *Required Radiation Levels Before Propagation Loss at PV Plant* in Figs. 70 (b) to 72 (b), is given by:

$$PSD_{\text{Source}}\,[dBm/Hz] = PSD_{\text{Required}}\,[dBm/Hz] + TPL\,[dB] \tag{3}$$

The effective isotropic radiated power (EIRP) level at the source, that will result in an E-field E_0 as measured according to the CSIPR 11/22 Class B standard with a RBW and separation distance of 120 kHz and 10 m for f $<$ 1 GHz, and 1 MHz and 3 m for f $>$ 1 GHz respectively, is given by:

$$EIRP\,[dBm] = PSD_{\text{Source}}\,[dBm/Hz] + 10\log_{10}(RBW)\,[Hz] \tag{4}$$

The electric field (E_0) levels associated with the EIRP defined in Eq. 4, again as measured according to the CISPR 11/22 Class B standard, are shown in Figs. 70 (c) to 72 (c) and given by:

$$E_0\,[dB\mu V/m] = EIRP - 20\log_{10} D + 104.8 \tag{5}$$

The maximum EIRP levels of the source, to ensure the *Receiver Saturation Limit* of -100 dBm is met, are shown in Figs. 70 (a) to 72 (a) and given by:

$$EIRP_{\max}\,[dBm] = -100\,dBm + TPL\,[dB] \tag{6}$$

6.1 Cumulative Impact Assessment

In the case where there are more than one source of interference for a specific frequency, the cumulative effect should be considered by taking into account:

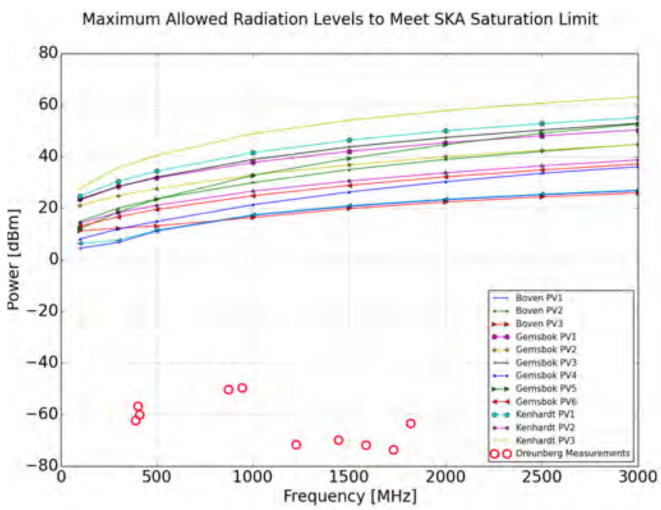
$$P_{\text{Cumulative}} = 10\log_{10}(N) \tag{7}$$

where $N = 13$ is the number of PV plants. This implies an increase in interference levels of up to 11.1 dB and is therefore subtracted from the maximum allowable radiated limits in Figs 70 to 72.

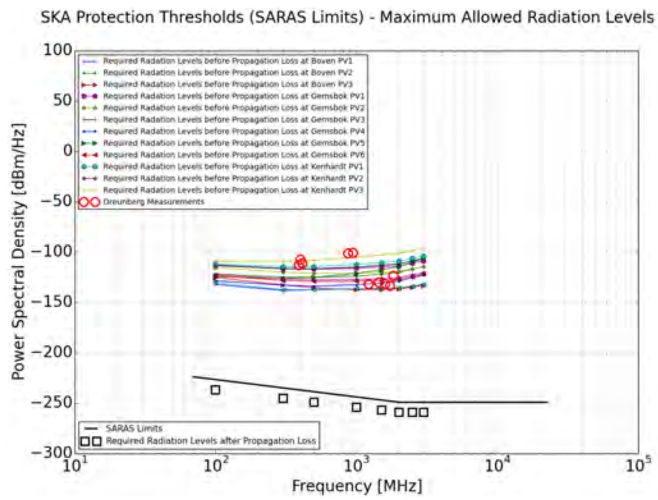
6.2 Maximum Allowed Radiation Levels

Below are given the maximum allowed radiation levels to meet both SKA *Saturation* and *Protection Threshold* (SARAS) limits for the two closest and core site telescopes for each of the proposed sites.

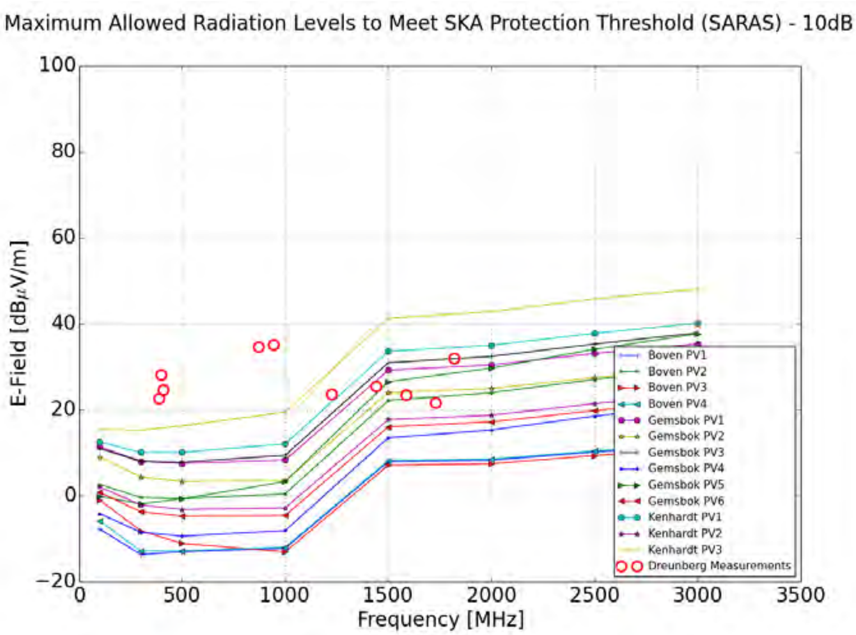
6.2.1 Closest SKA Telescope



(a)



(b)



(c)

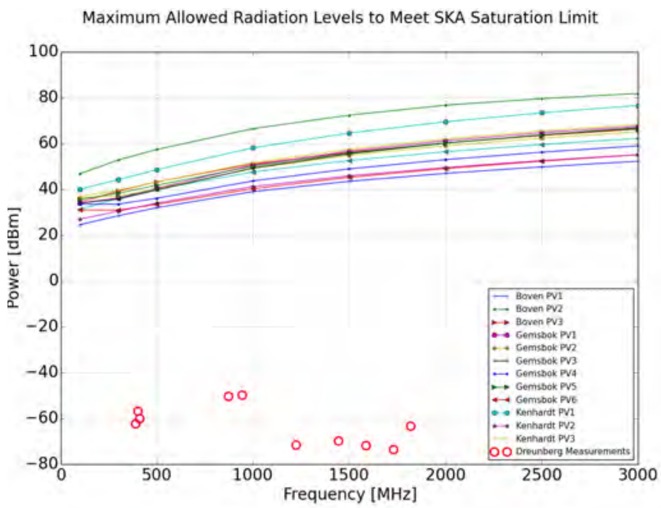
Figure 70: Closest SKA telescope receiver: (a) Maximum allowed EIRP to ensure levels are below the SKA saturation limit of -100 dBm at the telescope receiver; (b) Maximum allowed PSD to ensure levels are 10 dB below SARAS protection levels; (c) Maximum allowed measured E-Field (CISPR 22 Class B) to ensure levels are 10 dB below SARAS protection levels.

Given in Table 47 is a comparison between measured plant RFI and maximum allowed emission levels as shown in Fig. 70. It shows the approximate required mitigation (red), or surplus attenuation (green) for each recommended plant in relation to the closest SKA telescope. Required mitigation or surplus attenuation varies based on plant location and frequency. However, mitigation measures will have to be applied based on the highest required level. The required 50 dB of shielding at Boven PV1 @ 942 MHz, for example, would require significant attention to detail to achieve.

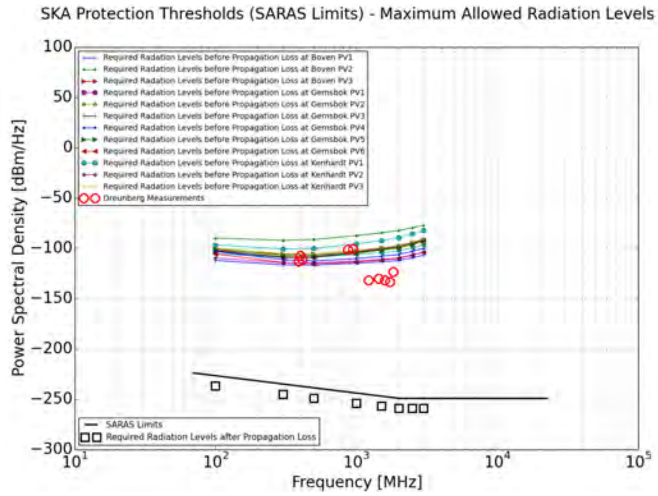
Site Location	387.38 MHz	399.19 MHz	409.52 MHz	871.57 MHz	942.42 MHz	1223.81 MHz	1441.27 MHz	1584.12 MHz	1728.57 MHz	1819.05 MHz
Kenhardt PV1	12.55	18.03	14.58	23.06	23.28	1.96	-5.57	-10.4	-12.54	-2.51
Kenhardt PV2	25.23	30.77	27.38	37.53	37.99	17.28	10.17	5.52	3.5	13.6
Kenhardt PV3	6.94	12.37	8.87	15.98	16.03	-5.57	-13.22	-18.11	-20.3	-10.3
Boven PV1	36.02	41.47	37.99	47.05	47.43	26.85	19.92	15.43	13.61	23.82
Boven PV2	23.16	28.66	25.23	34.35	34.79	13.48	5.88	0.97	-1.29	8.67
Boven PV3	32.07	37.73	34.44	47.17	47.95	27.69	20.76	16.27	14.45	24.66
Boven PV4	35.48	40.95	37.5	46.79	47.17	26.59	19.66	15.17	13.35	23.56
Gemsbok PV1	14.85	20.36	16.94	26.52	26.91	5.98	-1.29	-6.01	-8.08	1.99
Gemsbok PV2	18.72	24.26	20.87	31.2	31.68	11.01	3.92	-0.72	-2.73	7.38
Gemsbok PV3	14.75	20.25	16.81	25.63	25.9	4.6	-2.93	-7.77	-9.92	0.09
Gemsbok PV4	31.52	37.06	33.66	43.06	43.38	22.1	14.54	9.64	7.38	17.34
Gemsbok PV5	24.01	29.42	25.92	32.36	32.29	9.96	1.69	-3.63	-6.27	3.43
Gemsbok PV6	26.8	32.34	28.94	39.25	39.73	19.02	11.88	7.2	5.14	15.21

Table 47: Required (red) and surplus (green) attenuation levels [dB] to meet SARAS protection limits at the closest SKA telescope.

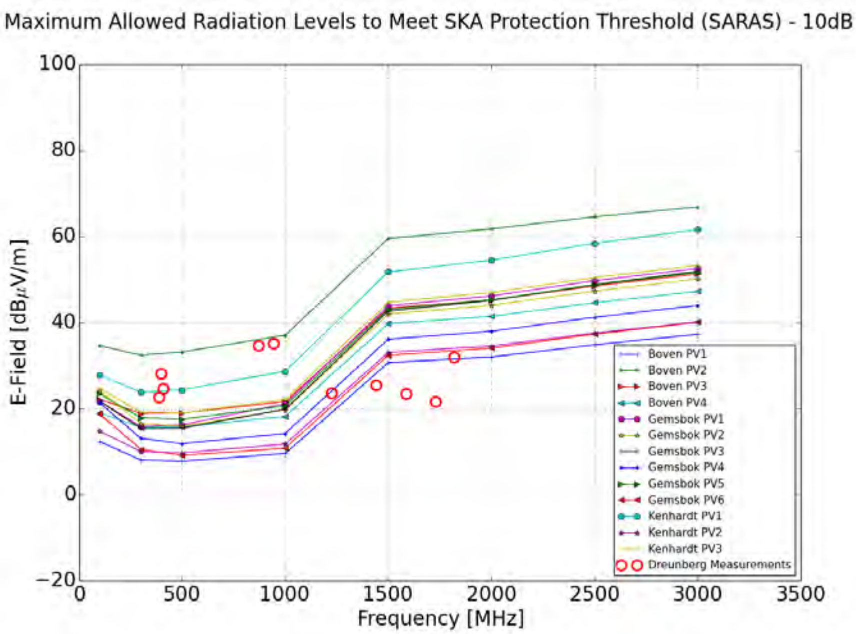
6.2.2 2nd Closest SKA Telescope



(a)



(b)



(c)

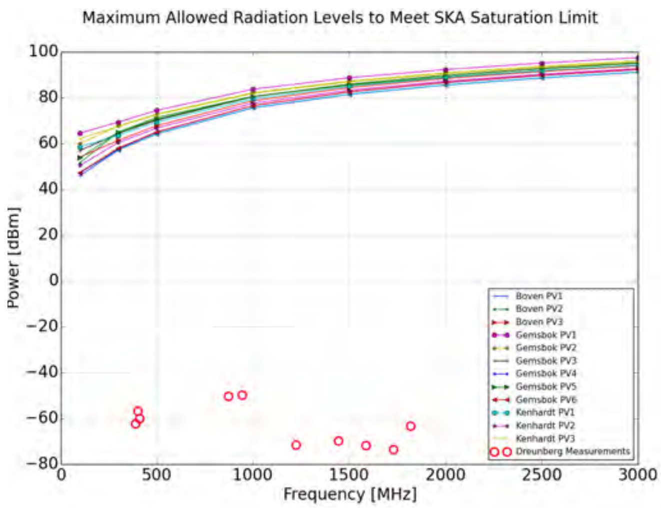
Figure 71: 2nd closest SKA telescope receiver: (a) Maximum allowed EIRP to ensure levels are below the SKA saturation limit of -100 dBm at the telescope receiver; (b) Maximum allowed PSD to ensure levels are 10 dB below SARAS protection levels; (c) Maximum allowed measured E-Field (CISPR 22 Class B) to ensure levels are 10 dB below SARAS protection levels.

Given in Table 48 is a comparison between measured plant RFI and maximum allowed emission levels as shown in Fig. 71. It shows the approximate required mitigation (red), or surplus attenuation (green) for each recommended plant in relation to the second closest SKA telescope. Required mitigation or surplus attenuation varies based on plant location and frequency. However, mitigation measures will have to be applied based on the highest required level. The required 50 dB of shielding at Boven PV1 @ 942 MHz, for example, would require significant attention to detail to achieve.

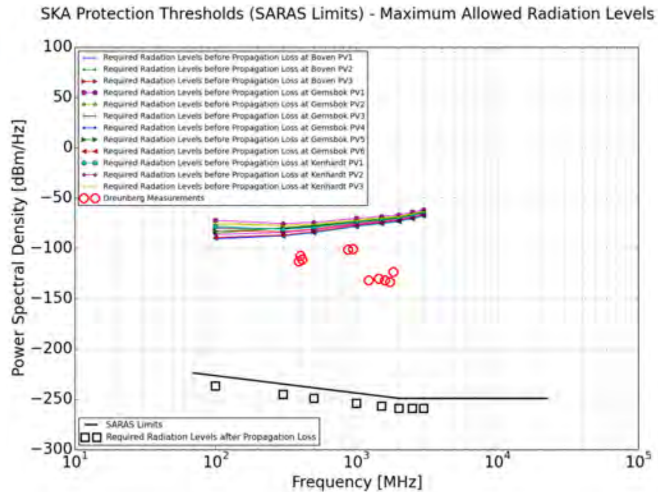
Site Location	387.38 MHz	399.19 MHz	409.52 MHz	871.57 MHz	942.42 MHz	1223.81 MHz	1441.27 MHz	1584.12 MHz	1728.57 MHz	1819.05 MHz
Kenhardt PV1	-1.38	4.07	0.59	7.05	6.94	-15.35	-23.55	-28.78	-31.31	-21.52
Kenhardt PV2	12.74	18.24	14.81	23.39	23.6	2.36	-5.07	-9.89	-12.05	-2.03
Kenhardt PV3	3.57	9.07	5.63	13.31	13.36	-8.6	-16.59	-21.69	-24.06	-14.19
Boven PV1	14.73	20.23	16.8	25.52	25.77	4.64	-2.72	-7.48	-9.58	0.46
Boven PV2	3.73	9.21	5.76	13.68	13.81	-7.7	-15.32	-20.25	-22.51	-12.57
Boven PV3	3.73	9.21	5.76	13.68	13.81	-7.7	-15.32	-20.25	-22.51	-12.57
Boven PV4	6.95	12.43	8.98	17.08	17.24	-4.17	-11.73	-16.61	-18.82	-8.84
Gemsbok PV1	6.64	12.1	8.64	14.75	14.56	-7.66	-15.72	-20.84	-23.23	-13.37
Gemsbok PV2	6.39	11.91	8.49	15.91	15.87	-6.01	-13.88	-18.9	-21.21	-11.29
Gemsbok PV3	7.22	12.7	9.25	15.89	15.77	-6.42	-14.51	-19.67	-22.11	-12.27
Gemsbok PV4	10.1	15.65	12.27	21.01	21.18	-0.36	-8.05	-13.0	-15.27	-5.33
Gemsbok PV5	4.92	10.42	6.99	14.78	14.84	-7.04	-14.98	-20.04	-22.4	-12.51
Gemsbok PV6	12.72	18.28	14.91	24.24	24.5	3.19	-4.35	-9.23	-11.45	-1.48

Table 48: Required (red) and surplus (green) attenuation levels [dB] to meet SARAS protection limits at the second closest SKA telescope.

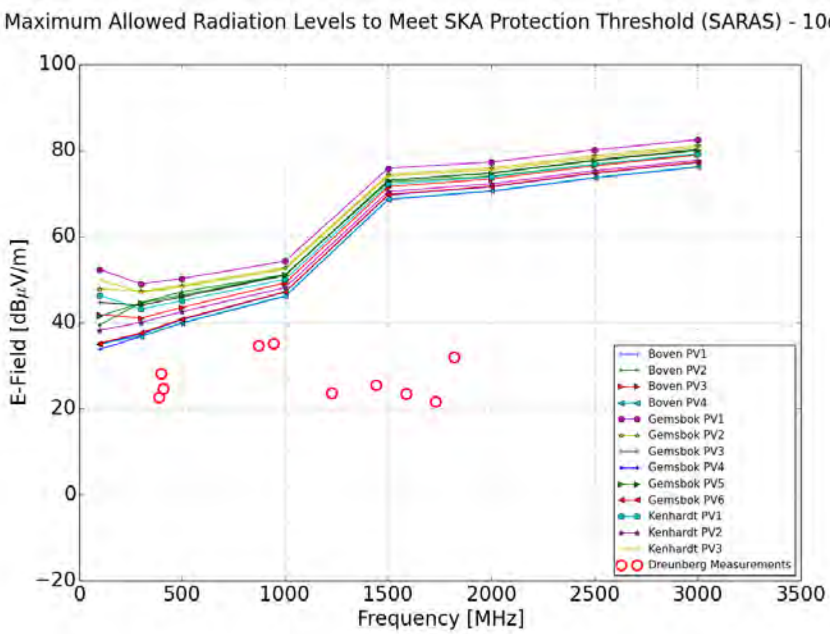
6.2.3 Core SKA Telescopes



(a)



(b)



(c)

Figure 72: Core SKA telescope receivers: (a) Maximum allowed EIRP to ensure levels are below the SKA saturation limit of -100 dBm at the telescope receiver; (b) Maximum allowed PSD to ensure levels are 10 dB below SARAS protection levels; (c) Maximum allowed measured E-Field (CISPR 22 Class B) to ensure levels are 10 dB below SARAS protection levels.

Given in Table 49 is a comparison between measured plant RFI and maximum allowed emission levels as shown in Fig. 72. It shows the approximate required mitigation (red), or surplus attenuation (green) for each recommended plant in relation to the closest SKA telescope. Required mitigation or surplus attenuation varies based on plant location and frequency. However, mitigation measures will have to be applied based on the highest required level. Towards the core site sufficient path attenuation exist to ensure emissions are below required limits.

Site Location	**387.38 MHz**	**399.19 MHz**	**409.52 MHz**	**871.57 MHz**	**942.42 MHz**	**1223.81 MHz**	**1441.27 MHz**	**1584.12 MHz**	**1728.57 MHz**	**1819.05 MHz**
Kenhardt PV1	-21.33	-15.96	-19.51	-14.15	-14.35	-36.27	-44.03	-48.97	-51.19	-41.21
Kenhardt PV2	-18.46	-13.12	-16.7	-12.06	-12.35	-34.46	-42.33	-47.32	-49.57	-39.61
Kenhardt PV3	-24.93	-19.53	-23.04	-16.73	-16.81	-38.43	-46.01	-50.85	-52.99	-42.97
Boven PV1	-15.48	-10.18	-13.79	-9.87	-10.25	-32.51	-40.46	-45.49	-47.77	-37.84
Boven PV2	-19.45	-14.12	-17.69	-13.13	-13.44	-35.56	-43.45	-48.44	-50.7	-40.74
Boven PV3	-19.45	-14.12	-17.69	-13.13	-13.44	-35.56	-43.45	-48.44	-50.7	-40.74
Boven PV4	-15.58	-10.28	-13.89	-10.0	-10.38	-32.64	-40.59	-45.62	-47.89	-37.95
Gemsbok PV1	-26.86	-21.45	-24.96	-18.6	-18.67	-40.28	-47.85	-52.69	-54.83	-44.81
Gemsbok PV2	-25.18	-19.78	-23.3	-17.06	-17.15	-38.81	-46.41	-51.27	-53.42	-43.41
Gemsbok PV3	-22.2	-16.84	-20.39	-15.06	-15.27	-37.2	-44.97	-49.91	-52.13	-42.16
Gemsbok PV4	-16.1	-10.82	-14.44	-10.79	-11.19	-33.51	-41.49	-46.53	-48.82	-38.89
Gemsbok PV5	-22.7	-17.32	-20.87	-15.26	-15.43	-37.26	-44.97	-49.88	-52.07	-42.09
Gemsbok PV6	-16.36	-11.07	-14.68	-10.91	-11.31	-33.62	-41.61	-46.65	-48.94	-39.0

Table 49: Required (red) and surplus (green) attenuation levels [dB] to meet SARAS protection limits at the core-site SKA telescopes.

7 Plant Design Overview

RFI associated with the regular switching of relays and contactors to operate the single axis tracking systems has subsequently been found by MESA Solutions to be contributors of significant levels of broadband interference. Assuming a tracking PV plant design, significant care and effort will be required to shield the broadband interference generated during operation of the tracking units.

7.1 Expected Sources of Interference

The biggest RFI producing culprits for a plant layout incorporating a similar tracking philosophy were identified to be the inverter units and solar power tracker and monitoring controllers. Coupled to this is the way cabling is distributed throughout the plant. The combination of all three factors will influence the level of interference each plant is likely to produce.

- **Inverters**
  - The inverters are considered to be the main source of interference due to their switching operation through which the direct current (DC) from the panels is converted to alternating current (AC) supplied to the transformers. This interference can be in the form of CM current present on the cables connected to the units, or through direct radiation.
- **Solar Power Tracker and Monitoring Controller**
  - RFI associated with the regular switching of relays and contactors to operate the single axis tracking systems has recently been found to be prominent sources of interference. These relays will switch the motors or hydraulic pumps on and off on a regular basis during the day, resulting in broadband interference with substantial frequency content. Furthermore, RFI generated by the tracking controller is typically due to the default system operation implementing a wireless mesh network for communication purposes between units. A number of other electrical components, which are also likely sources of interference, form part of the controller.
- **Cable Routing and Earthing**
  - The way noise-producing equipment in the plant are interconnected has a significant influence on the level of RFI emitted. Cabling is the means by which interference in the form of common mode current (CM) is distributed. When sections of cabling become resonant, the interference is radiated into the environment. Depending on a number of factors such as height of transmission, frequency, emission level at source and topography, the interference will have a certain severity at the nearest SKA telescope as well as the core-site.

7.2 Mitigating Measures

It is strongly recommended that the following **mitigation practises** be incorporated into the plants design. The inverter units, transformers, communication and control units for an array of panels all be housed in a single shielded environment. For shielding of such an environment ensure RFI gasketting be placed on all the seams and doors. Furthermore, RFI Honeycomb filtering should be placed on all ventilation openings. It is important to ensure that the cables to be laid directly in soil or properly grounded cable trays (not plastic sleeves). The use of bare copper directly in soil for earthing is recommended to shunt CM interference currents to ground. In the case of a tracking PV plant design, care will have to be taken to shield the noise associated with the relays, contactors and hydraulic pumps/motors of the tracking units. It is recommended that data communications to and from the plants to be via fibre optic.

7.3 Expected RFI Reductions due to Mitigation Measures

By simply following good practices such as implementing an adequate earthing philosophy, and paying attention to the cabling interconnections and layout below ground, a reduction of at least 20 dB in the typical plant emissions across the frequency range of interest can be achieved. With added attention to detail, particularly regarding the shielding of enclosures, defining cable interfaces by correctly terminating cable screens or armouring, and the use of galvanic earthed cable trays for short cable runs above ground, a total reduction of 40 dB is likely. A further 20 dB reduction would require detailed analysis of the required enclosure shielding and gasketting, more stringent filtering at all cable interfaces, and implementing additional cable screening that could include using fully enclosed metallic cable conduits. It is therefore MESA's expectations that if the mitigation measures specified are implemented correctly, an improvement of between 20 and 40 dB in emissions levels are likely. The required maximum mitigation of 50 dB towards the closest telescopes for some plant locations would therefore require significant care. **It is important to note that this is purely predicted values and cannot be guaranteed or confirmed until measurements on operating plants (or representative installations) with recommended mitigation measures have been performed.**

8 Conclusions

MESA Solutions was asked by *Scatec Solar* to do a cumulative topographical analysis of the terrain profile between three proposed *Scatec Solar* PV projects, as well as ten proposed *Mulilo* PV projects, towards the closest and core-site SKA Telescopes. The purpose of the investigation is to define a level that can be verified through measurements which will result in an equivalent emission level that is 10 dB below the SKA threshold limit. This measurement level is influenced by the TPL between both telescope locations. However, the TPL is a function of topography and frequency as well as characteristics such as the transmitter and receiver heights. The measurement level is related to the well-known CISPR 11/22 Class B standard that is defined at a measurement distance of 10 m for frequencies below 1 GHz and at 3 m for frequencies above 1 GHz.

From the results in Section 6 it is clear that radiated emissions at levels below that of CISPR 11/22 Class B are required (especially in the case of the closest telescope). This is mainly due to the absence of any TL over this short distance. This requirement relaxes slightly toward the second closest telescope, while allowable measured levels increase to slightly above the CISPR limit due to the additional TL toward the core. The possibility exists that, due to the large number of sites that are proposed in that area, the overall lower levels would have to be achieved to limit interference to the closest telescopes as much as possible. A comparison between measured plant RFI and required mitigation or surplus attenuation have been provided for the closest and core site telescopes

It is strongly recommended that the following **mitigation practises** be incorporated into the plants design:

- The inverter units, transformers, communication and control units for an array of panels all be housed in a single shielded environment.
- For shielding of such an environment ensure:
  - RFI gasketting be placed on all seams and doors.
  - RFI Honeycomb filtering be placed on all ventilation openings.
- Cables to be laid directly in soil or properly grounded cable trays (not plastic sleeves).
- The use of bare copper directly in soil for earthing is recommended.
- Assuming a tracking PV plant design, care will have to be taken to shield the noise associated with the relays, contactors and hydraulic pumps/motors of the tracking units.

The three proposed Kenhardt plants are shown in Table 47 to exceed the SARAS protection levels by up to 38 dB toward the closest SKA telescope. This includes the cumulative effect of a total of $N = 13$ PV plants developed.

However, Boven PV1, PV3 and PV4 exceed this limit by approximately 50 dB in this scenario. For the case where only the three Kenhardt plants are developed, the exceedance will reduce to 31.6 dB with a cumulative effect for $N = 3$ plants considered.

It is MESA's expectations that, if the mitigation measures that are specified are implemented correctly, an improvement of between 20 and 40 dB in emissions levels are likely. However the maximum required attenuation for some of the plants towards the closest telescope would require significant attention to detail to achieve shielding levels of 50 dB. If required attenuation for the closest telescope is achieved, the second closest and core site will comply. *It is important to note that this is purely predicted values and cannot be guaranteed or confirmed until measurements on a representative mock-up installation with mitigation measures implemented are performed. It remain the developers responsibility to ensure that compliance to SKA requirements is met and MESA Solutions cannot accept responsibility for any assessments made in this report which could cause non-compliance.*

MESA Solutions
Drs A. J. Otto and P. S. van der Merwe
January 2016

References

[1] *Astronomy Geographic Advantage Act, 2007*, No. 21 of 2007, Government Gazette, Vol. 516, No. 31157, Cape Town, Republic of South Africa, 17 June 2008.

[2] P. Dewdney and G. Han Tan, *SKA EMI/EMC Standards and Procedures*, Technical Report SKA-TEL-SKO-0000202, Revision 1, Square Kilometre Array (SKA) Organisation, Jodrell Bank Observatory, UK, 10 January 2015.

[3] A. J. Otto and P. S. van der Merwe, *Topographical Analysis of Proposed Nieuwehoop PV Projects*, Technical Report, MUL/NH/15/07/28, MESA Solutions (Pty) Ltd., Stellenbosch, Western Cape, South Africa, 7600, 31 July 2015.

[4] A. J. Otto and P. S. van der Merwe, *Basic Site Assesment of Proposed Prieska Photovoltaic Plant*, Technical Report, SUN/14/08/22, Revision 0, MESA Solutions Pty (Ltd), Stellenbosch, South Africa, 22 August 2014.

Appendix

A Fresnel Zones and Line of Sight

The Fresnel zones and elevation profiles, including the earth curvature, are shown in Figs. 73 to 132. In all case the profiles are given towards the two closest and core-site SKA telescopes. A more detailed terrain profile shows features not visible in a normal Google Earth profile. This profile is then compensated for the earth curvature, clearly visible for the longer distance toward the core site. Important to note is the scale used in these figures. The elevation change is in meters but the separation distance varies in kilometres. The earth curvature representation is therefore somewhat enhanced.

A.1 Boven PV1 to Closest SKA

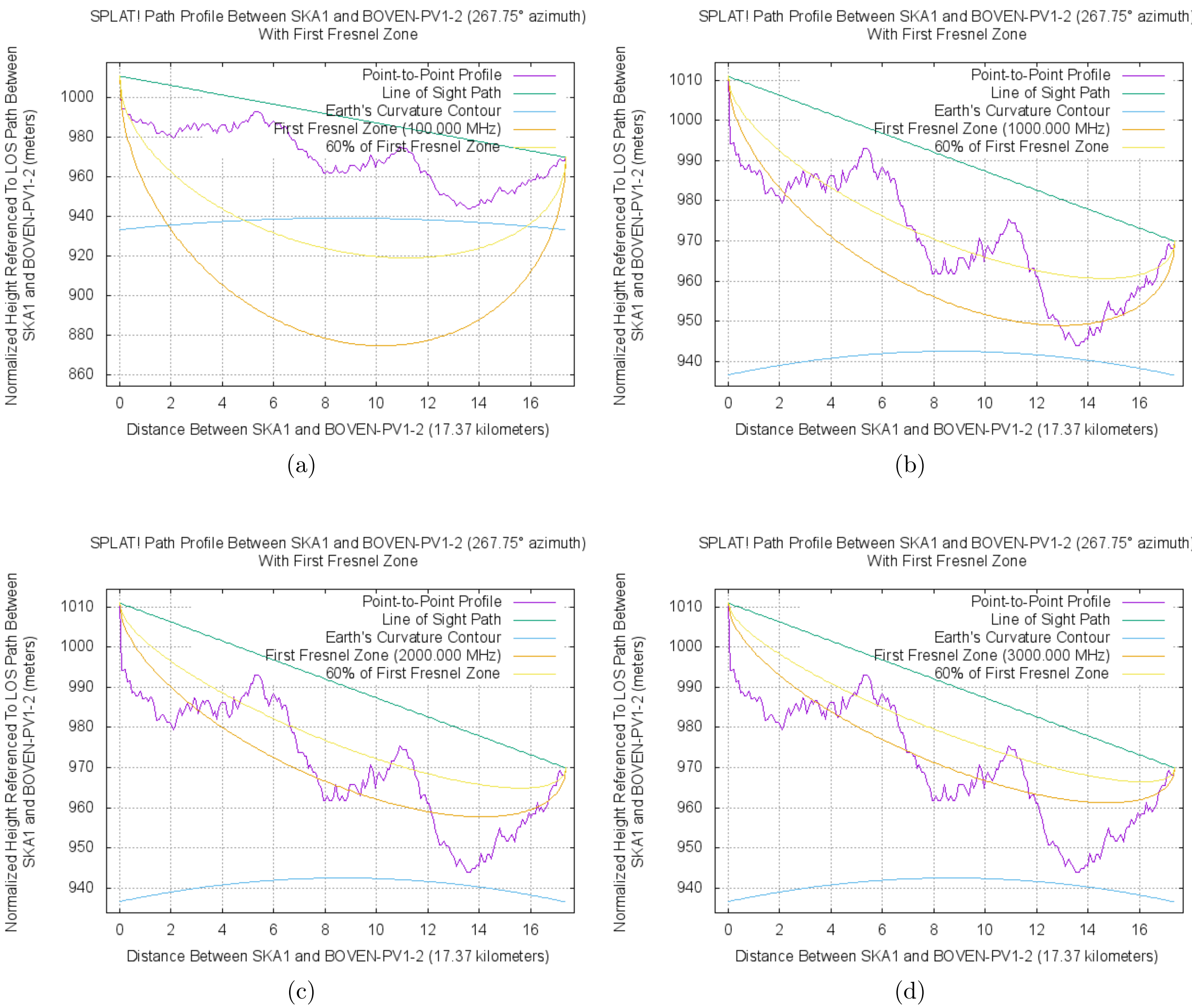
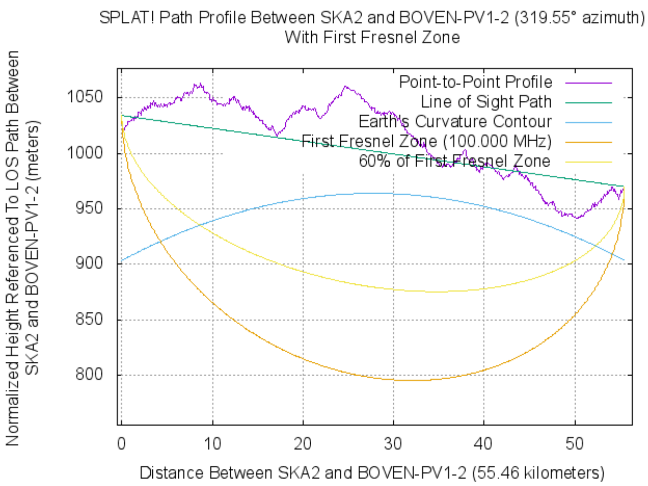
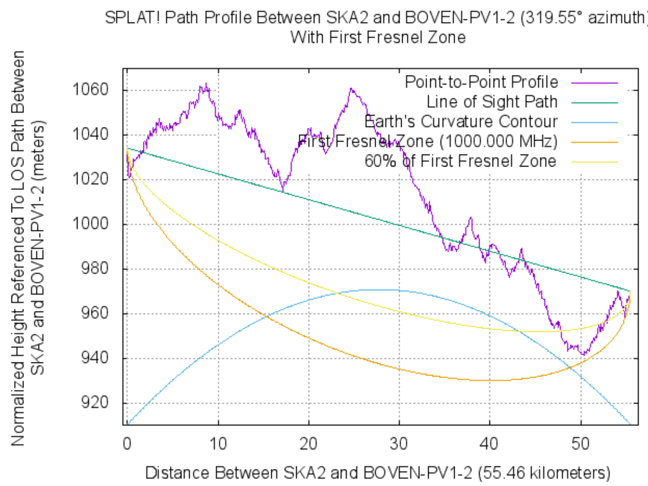


Figure 73: Fresnel zone, LOS and 60% of first Fresnel zone for site location of Boven PV1 to the closest SKA telescope for (a) 100 MHz (b) 1000 MHz (c) 2000 MHz and (d) 3000 MHz.

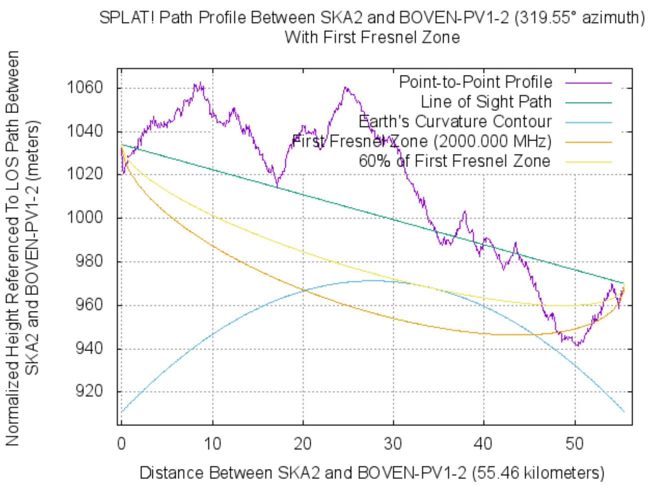
A.2 Boven PV1 to 2nd Closest SKA



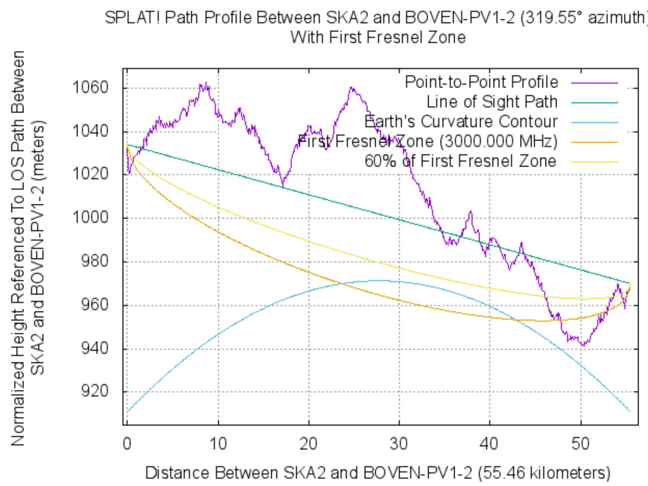
(a)



(b)



(c)



(d)

Figure 74: Fresnel zone, LOS and 60% of first Fresnel zone for site location of Boven PV1 to the second closest SKA telescope for (a) 100 MHz (b) 1000 MHz (c) 2000 MHz and (d) 3000 MHz.

A.3 Boven PV1 to Core SKA

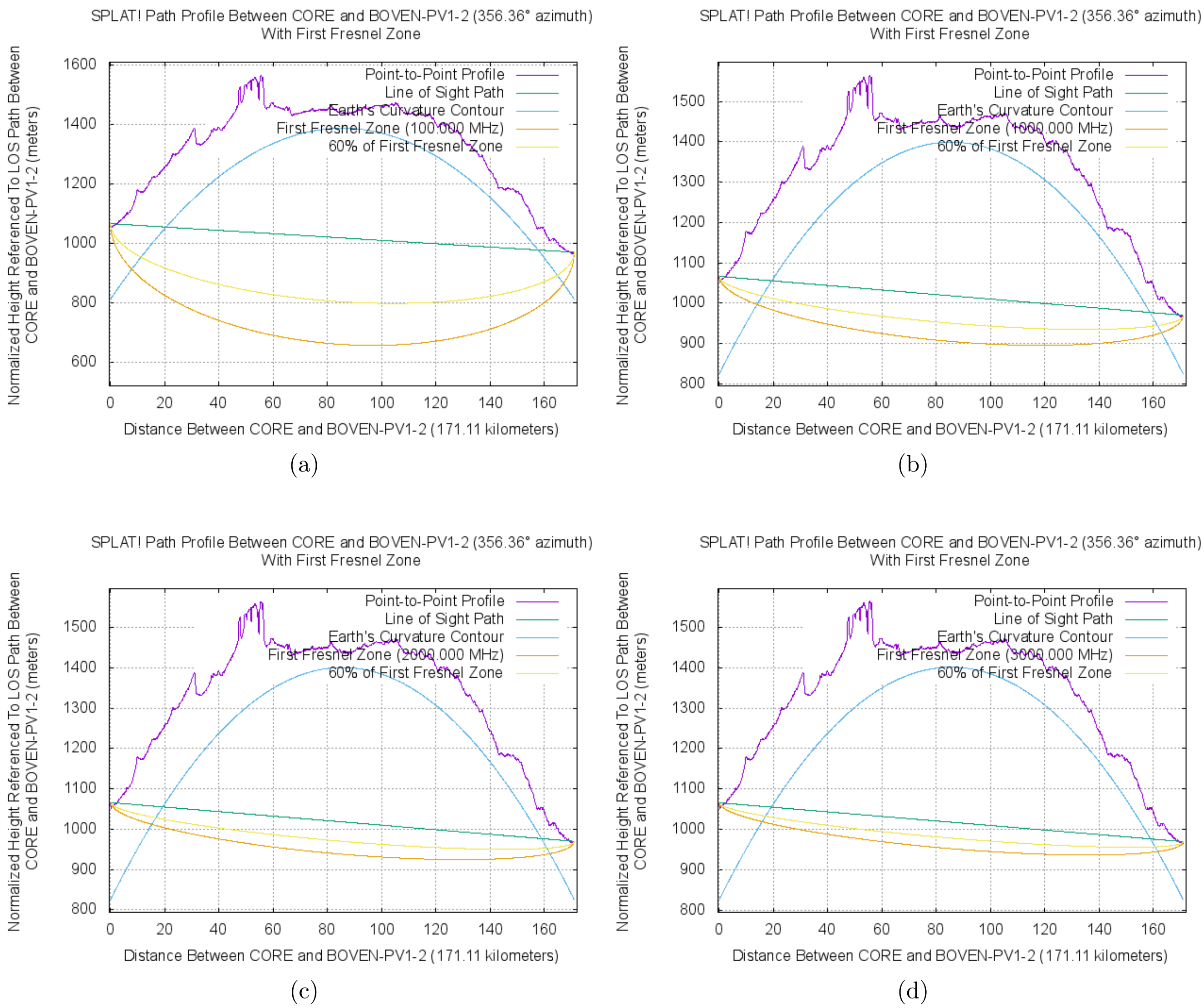


Figure 75: Fresnel zone, LOS and 60% of first Fresnel zone for site location of Boven PV1 to the core SKA telescopes for (a) 100 MHz (b) 1000 MHz (c) 2000 MHz and (d) 3000 MHz.

A.4 Boven PV2 to Closest SKA

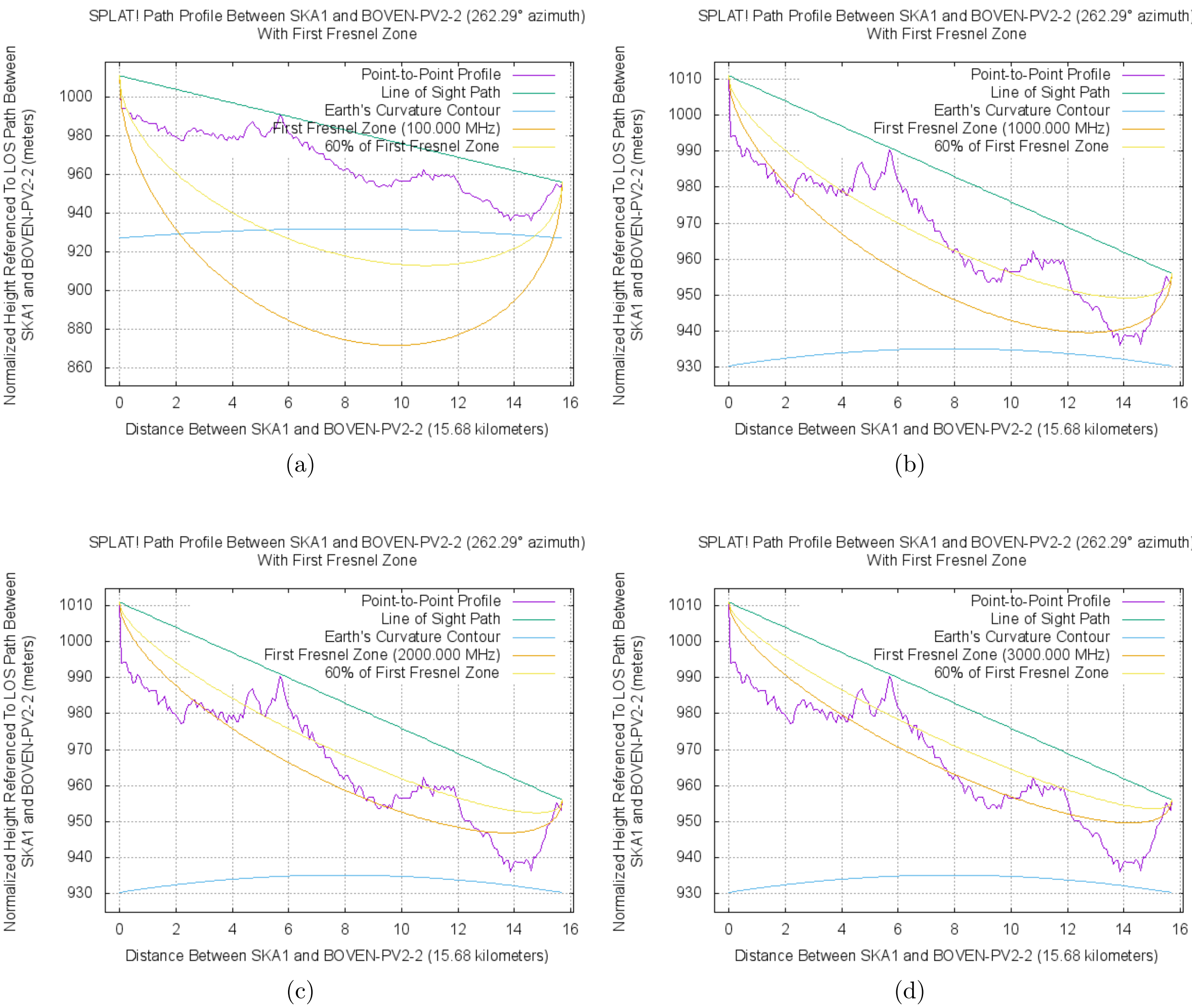
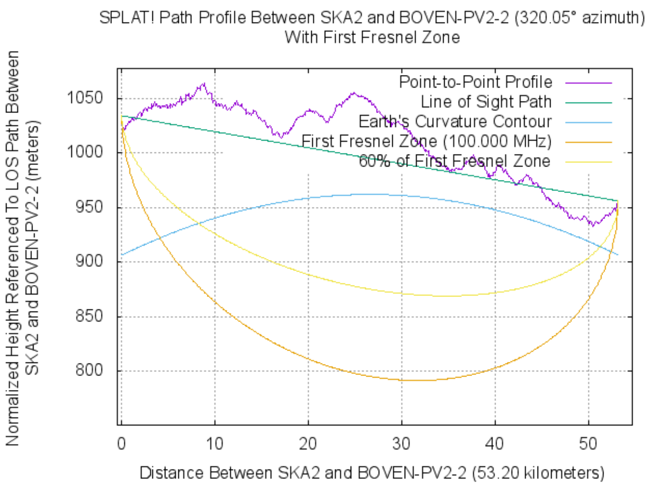
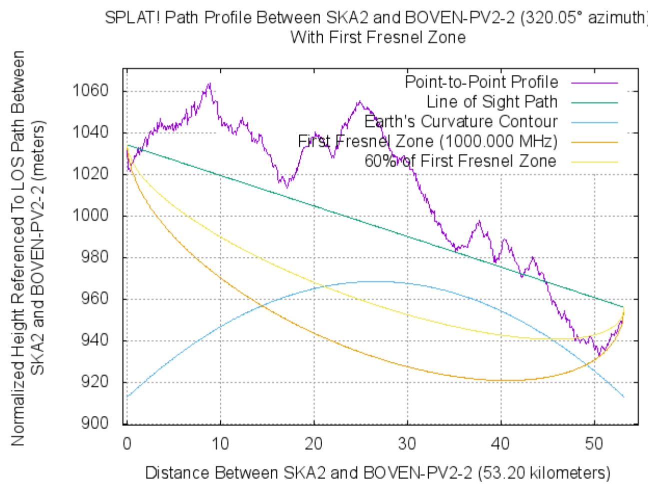


Figure 76: Fresnel zone, LOS and 60% of first Fresnel zone for site location of Boven PV2 to the closest SKA telescope for (a) 100 MHz (b) 1000 MHz (c) 2000 MHz and (d) 3000 MHz.

A.5 Boven PV2 to 2nd Closest SKA



(a)



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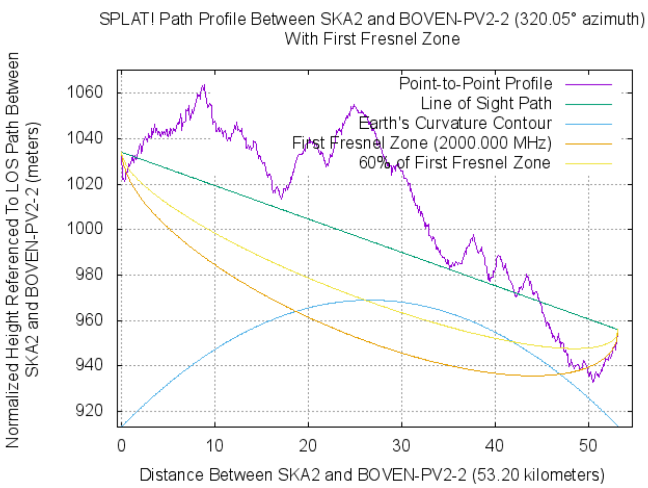
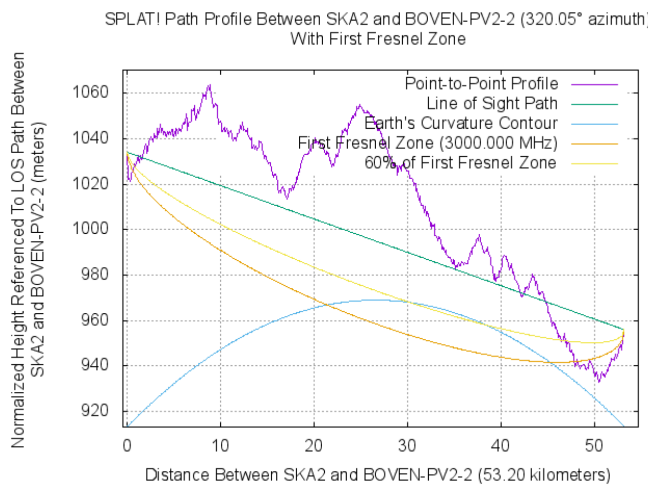


(c)



(d)

Figure 77: Fresnel zone, LOS and 60% of first Fresnel zone for site location of Boven PV2 to the second closest SKA telescope for (a) 100 MHz (b) 1000 MHz (c) 2000 MHz and (d) 3000 MHz.

A.6 Boven PV2 to Core SKA

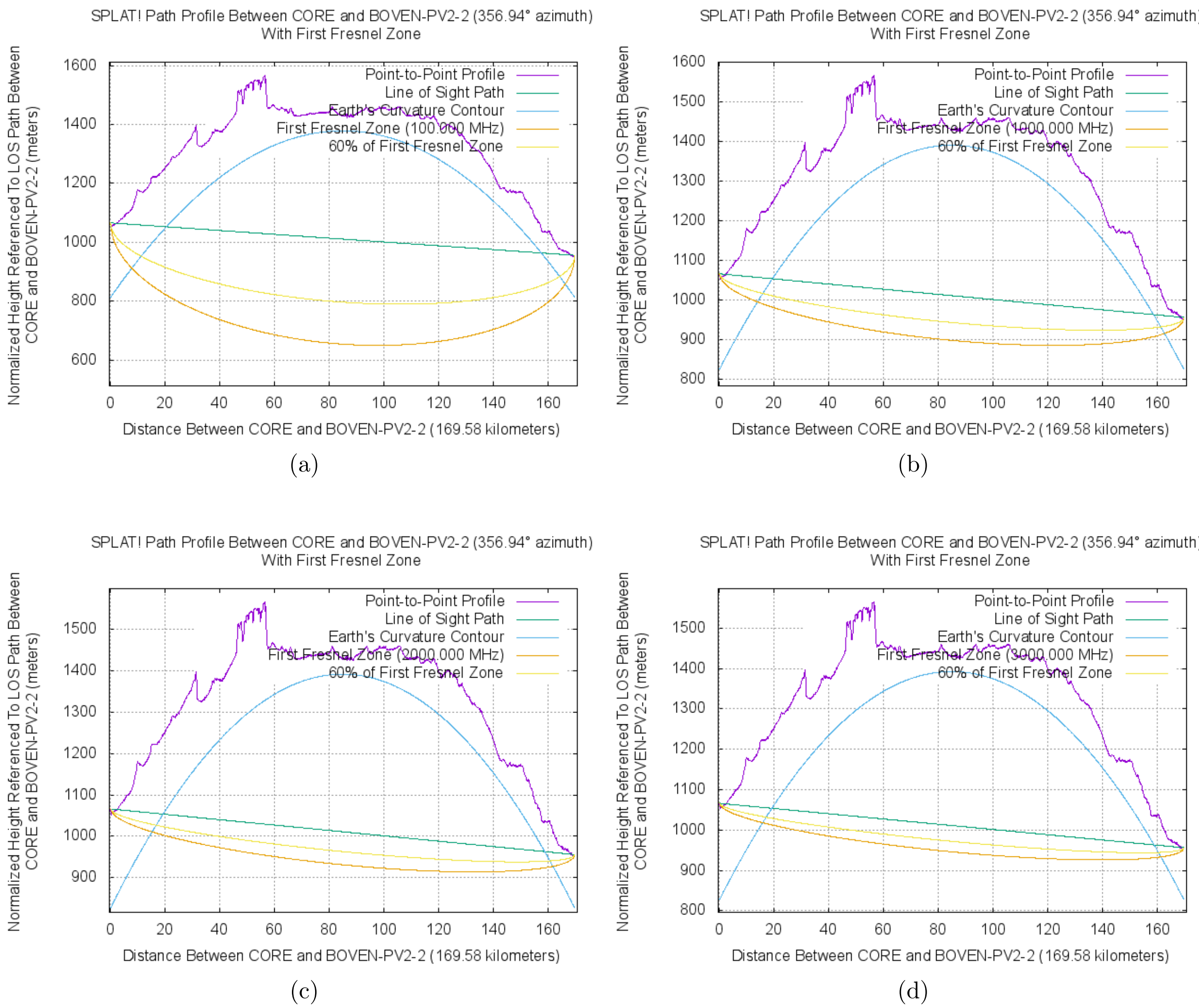
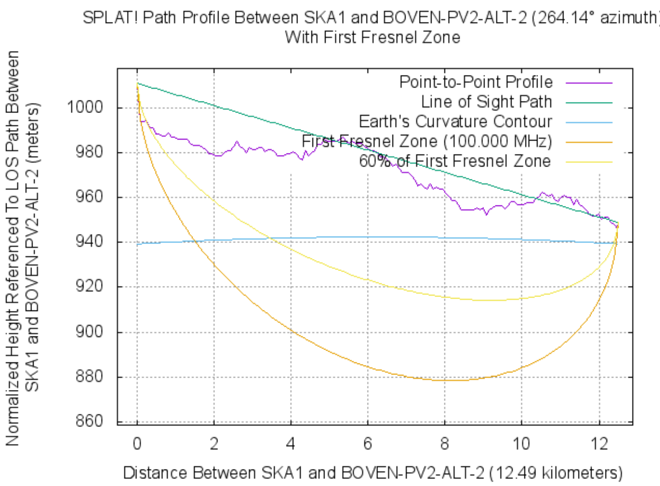
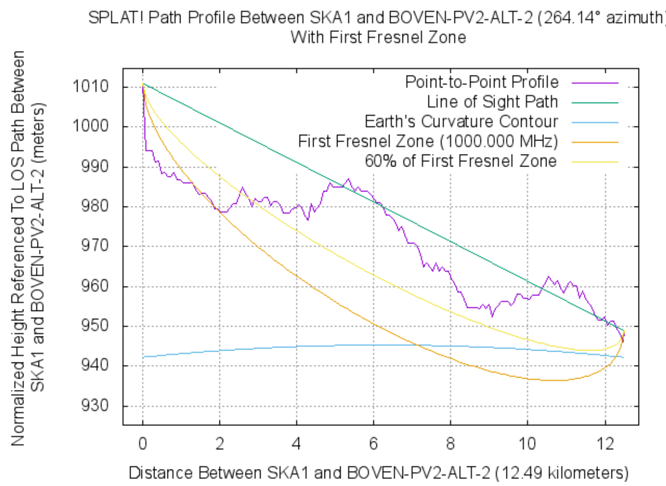


Figure 78: Fresnel zone, LOS and 60% of first Fresnel zone for site location of Boven PV2 to the core SKA telescopes for (a) 100 MHz (b) 1000 MHz (c) 2000 MHz and (d) 3000 MHz.

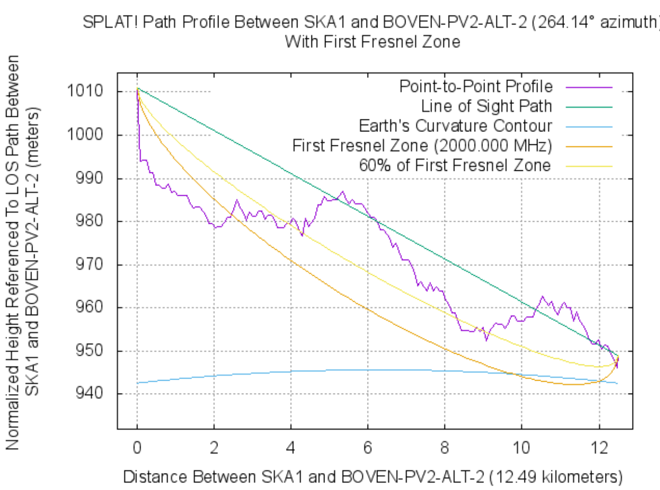
A.7 Boven PV2 Alternative to Closest SKA



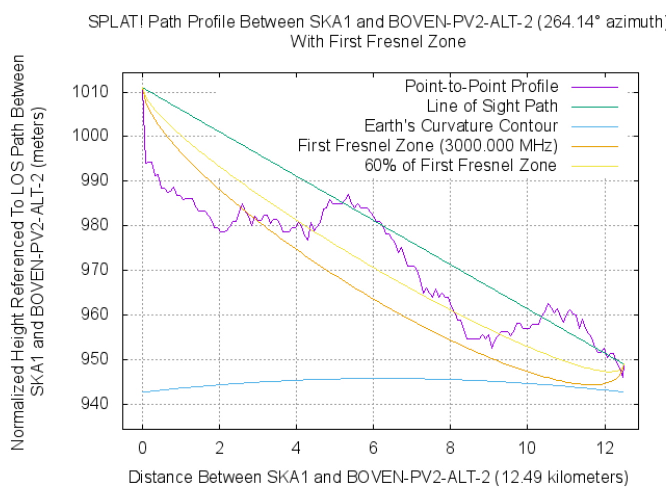
(a)



(b)



(c)



(d)

Figure 79: Fresnel zone, LOS and 60% of first Fresnel zone for site location of Boven PV2 Alternative to the closest SKA telescope for (a) 100 MHz (b) 1000 MHz (c) 2000 MHz and (d) 3000 MHz.

A.8 Boven PV2 Alternative to 2nd Closest SKA

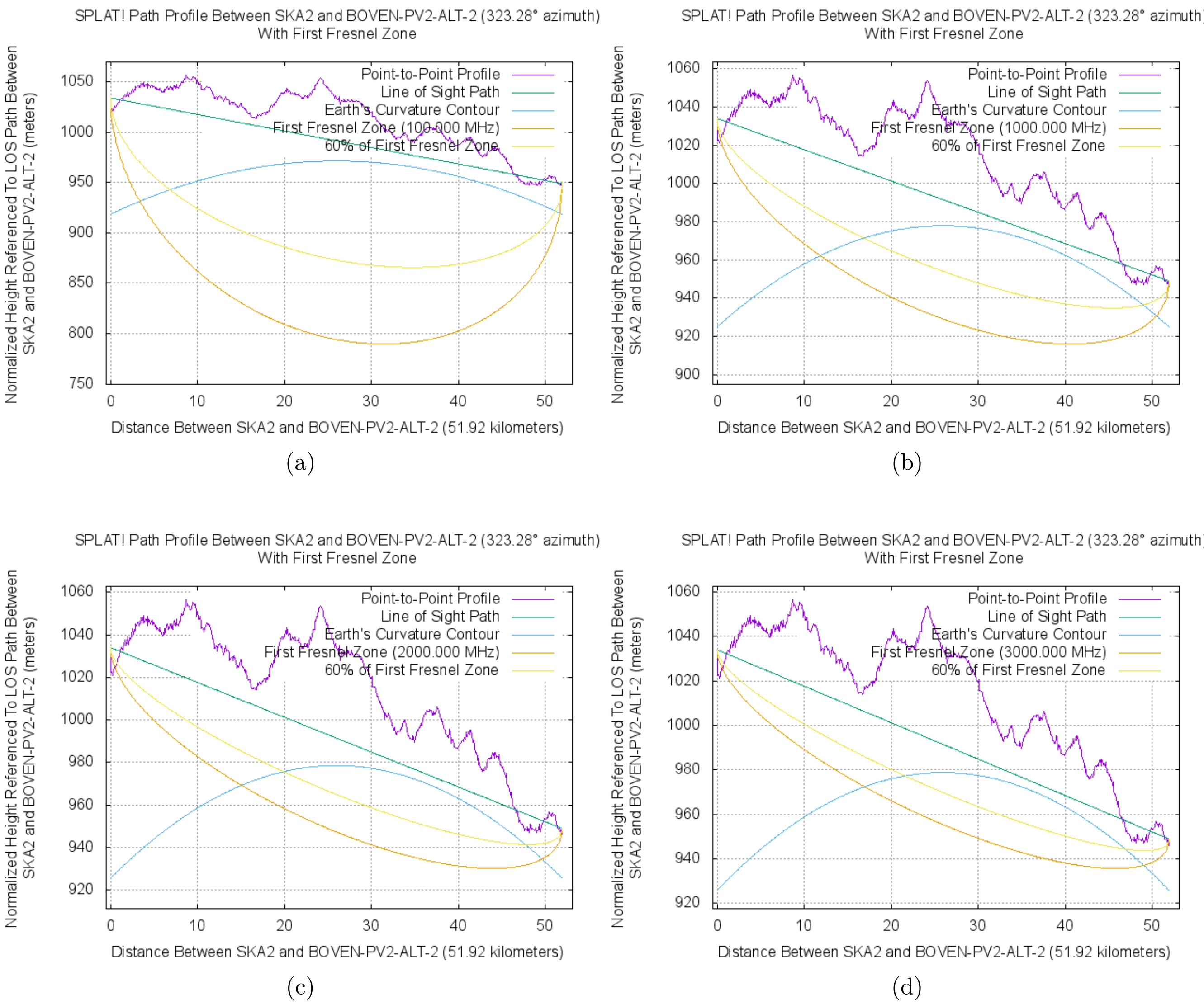


Figure 80: Fresnel zone, LOS and 60% of first Fresnel zone for site location of Boven PV2 Alternative to the second closest SKA telescope for (a) 100 MHz (b) 1000 MHz (c) 2000 MHz and (d) 3000 MHz.

A.9 Boven PV2 Alternative to Core SKA

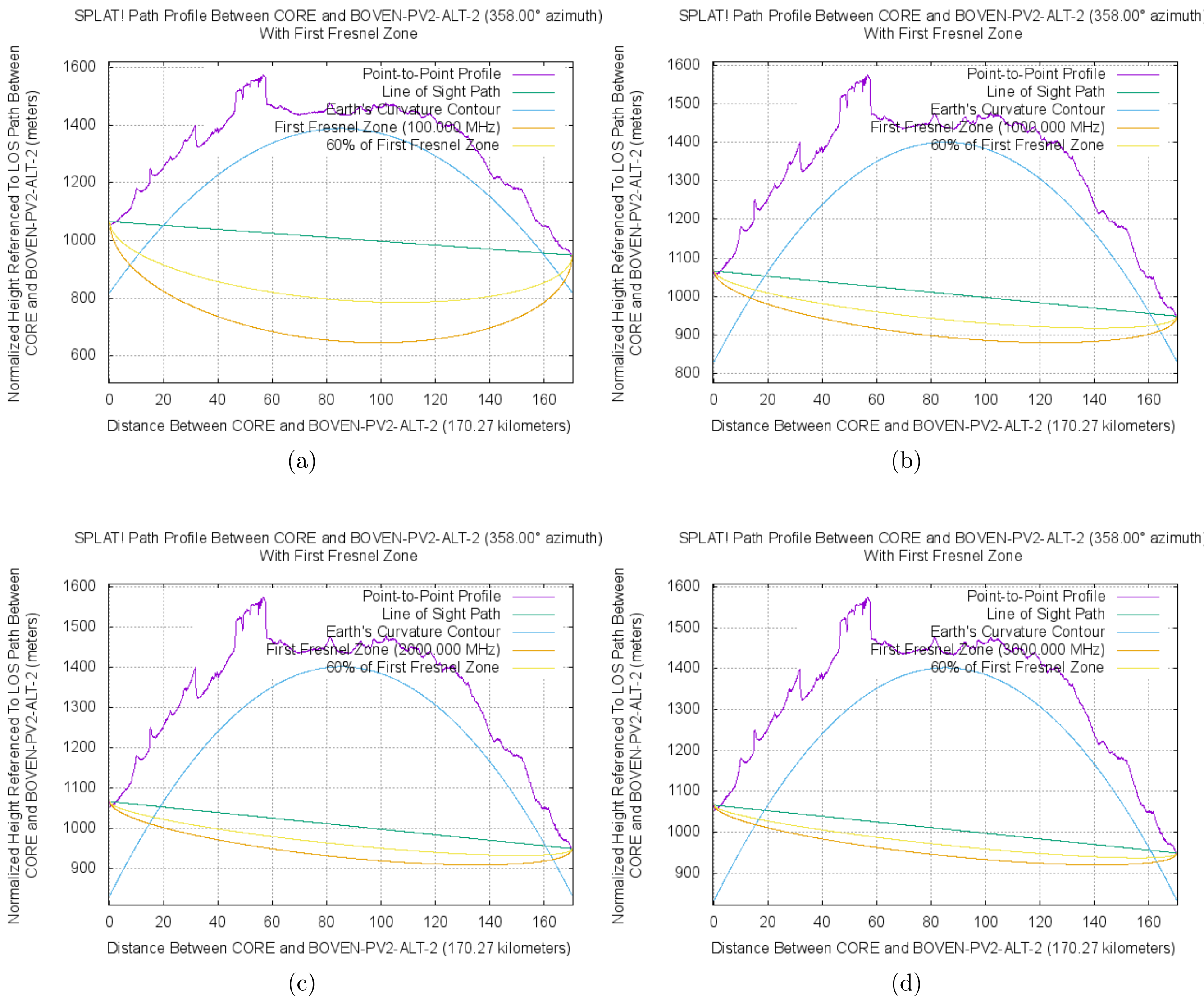


Figure 81: Fresnel zone, LOS and 60% of first Fresnel zone for site location of Boven PV2 Alternative to the core SKA telescopes for (a) 100 MHz (b) 1000 MHz (c) 2000 MHz and (d) 3000 MHz.

A.10 Boven PV3 to Closest SKA

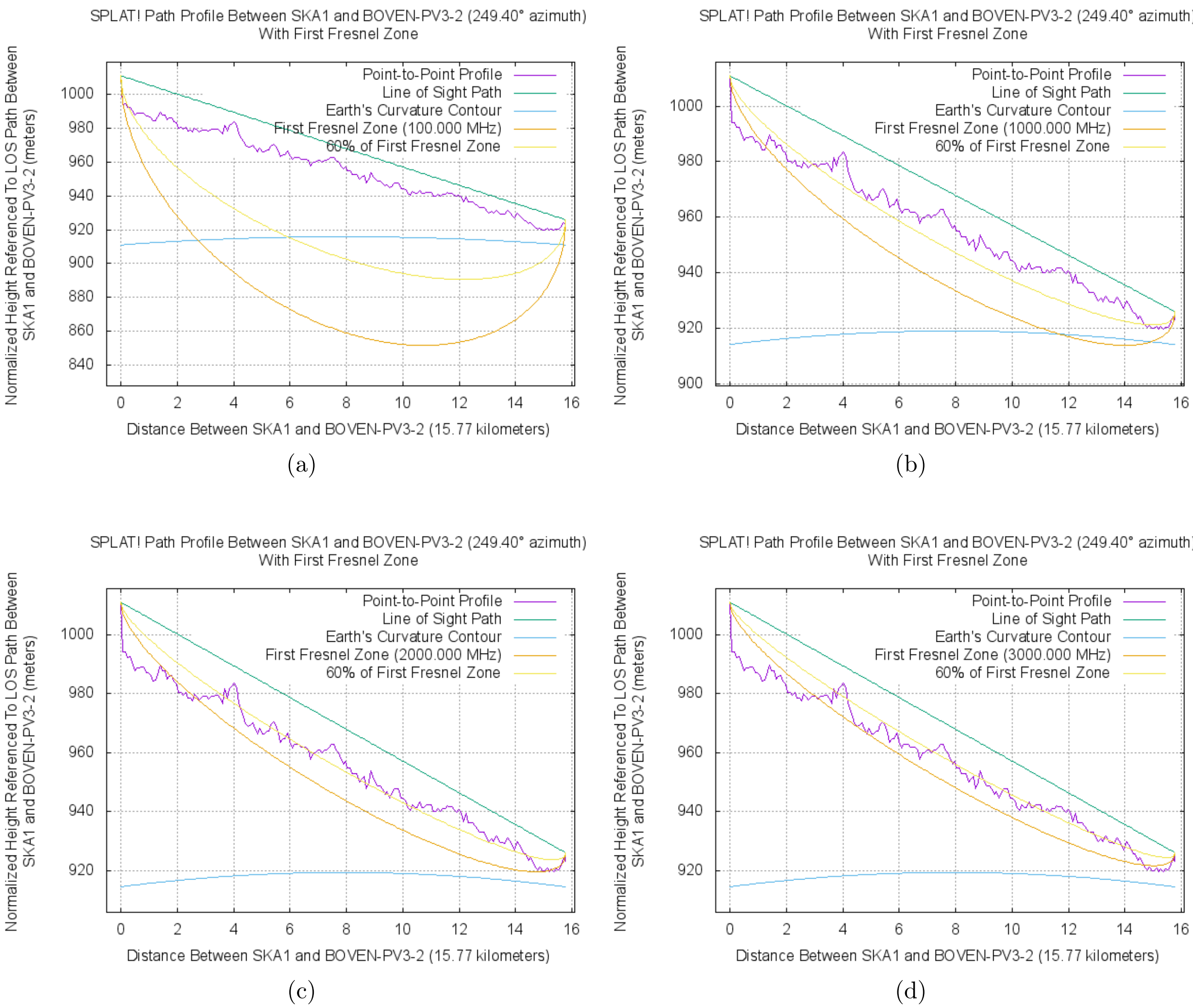
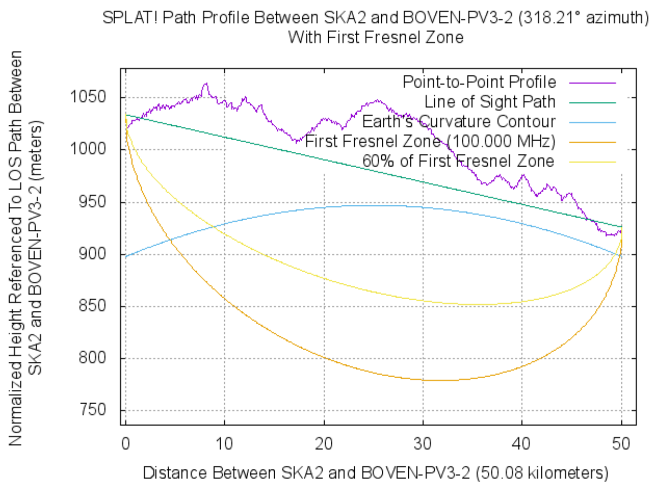


Figure 82: Fresnel zone, LOS and 60% of first Fresnel zone for site location of Boven PV3 to the closest SKA telescope for (a) 100 MHz (b) 1000 MHz (c) 2000 MHz and (d) 3000 MHz.

A.11 Boven PV3 to 2nd Closest SKA



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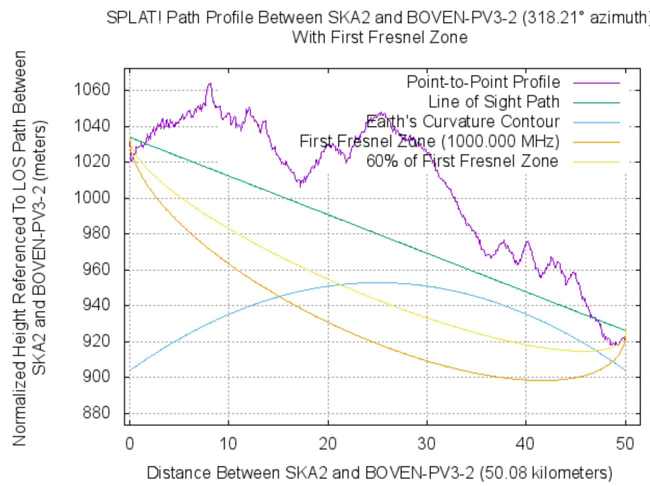
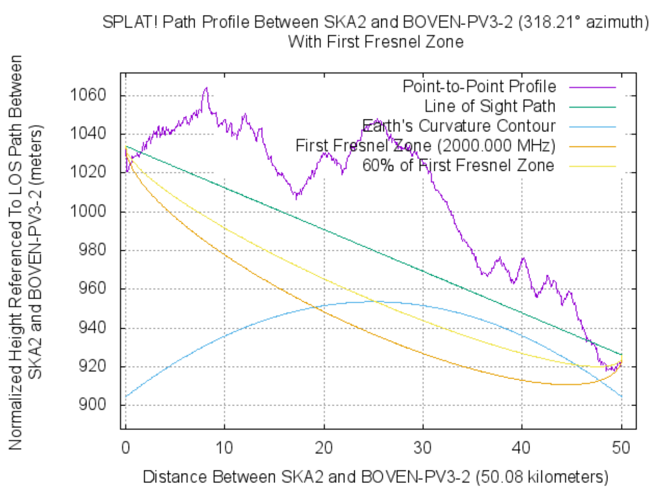
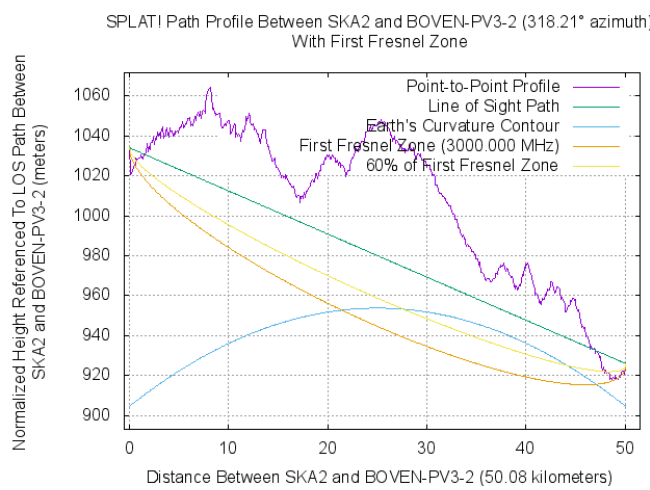


(b)



(c)



(d)

Figure 83: Fresnel zone, LOS and 60% of first Fresnel zone for site location of Boven PV3 to the second closest SKA telescope for (a) 100 MHz (b) 1000 MHz (c) 2000 MHz and (d) 3000 MHz.

A.12 Boven PV3 to Core SKA

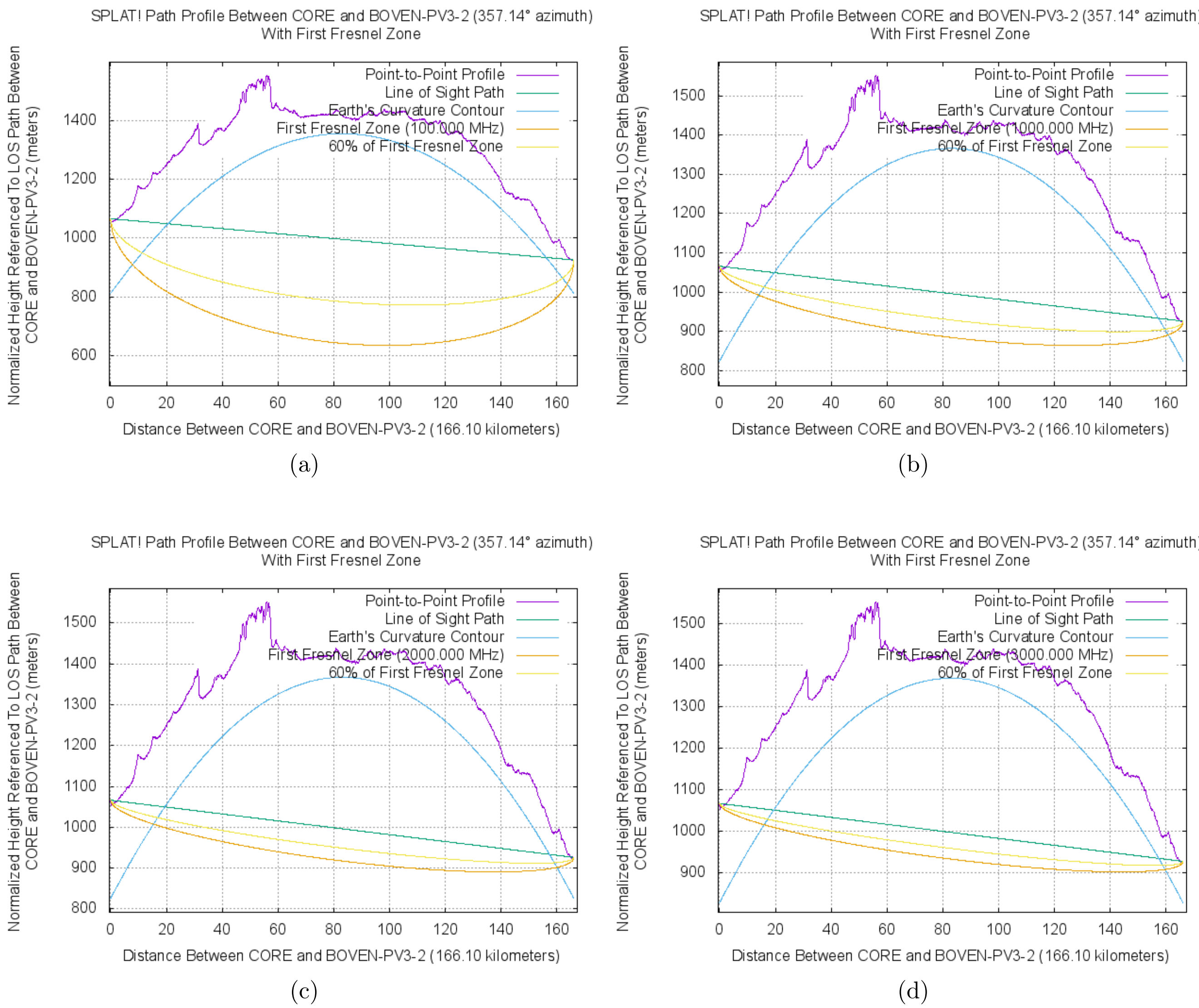
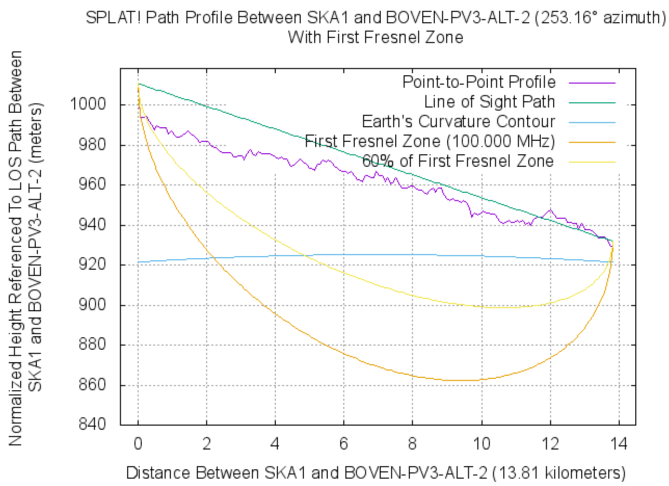
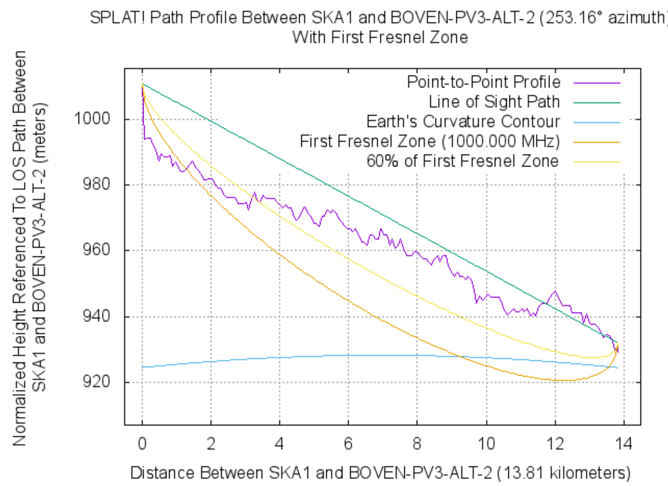


Figure 84: Fresnel zone, LOS and 60% of first Fresnel zone for site location of Boven PV3 to the core SKA telescopes for (a) 100 MHz (b) 1000 MHz (c) 2000 MHz and (d) 3000 MHz.

A.13 Boven PV3 Alternative to Closest SKA



(a)



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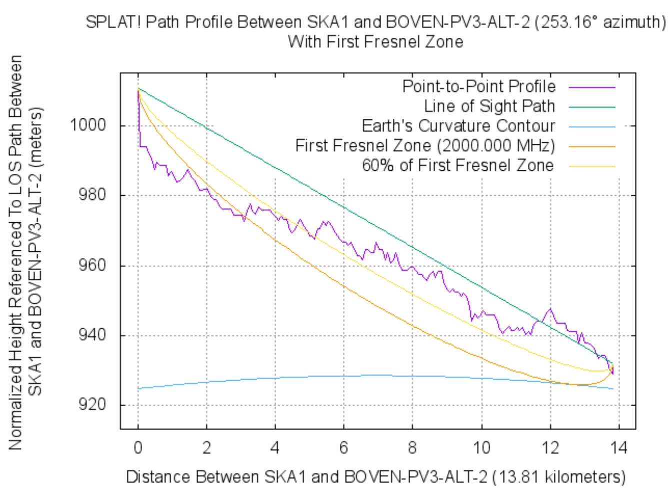

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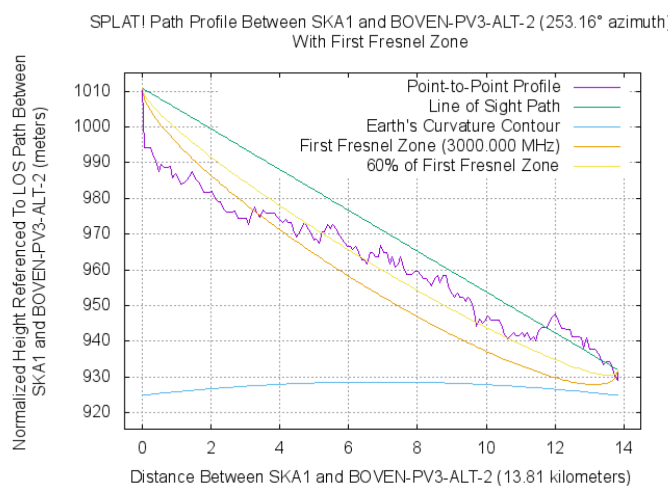
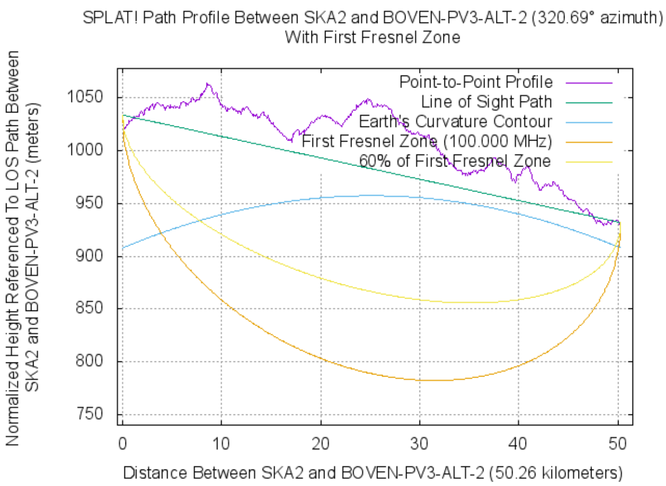


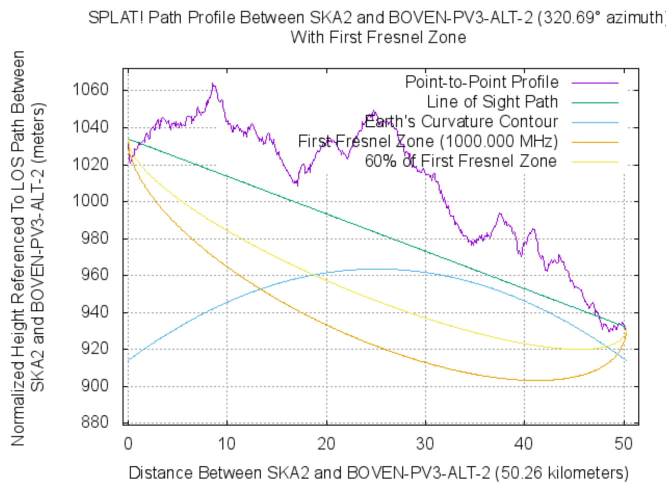
(d)

Figure 85: Fresnel zone, LOS and 60% of first Fresnel zone for site location of Boven PV3 Alternative to the closest SKA telescope for (a) 100 MHz (b) 1000 MHz (c) 2000 MHz and (d) 3000 MHz.

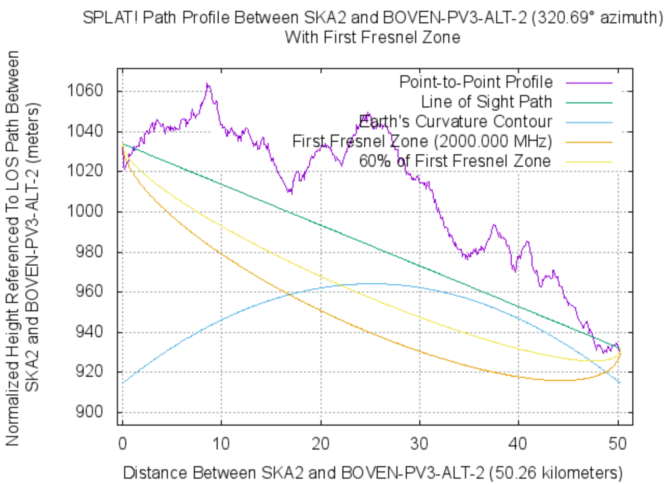
A.14 Boven PV3 Alternative to 2nd Closest SKA



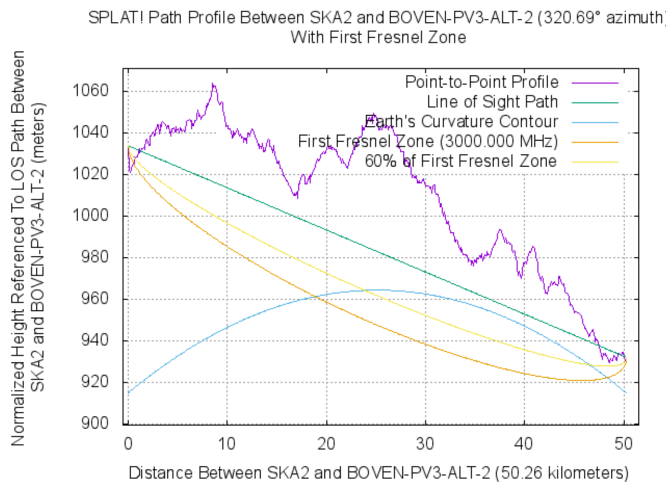
(a)



(b)



(c)



(d)

Figure 86: Fresnel zone, LOS and 60% of first Fresnel zone for site location of Boven PV3 Alternative to the second closest SKA telescope for (a) 100 MHz (b) 1000 MHz (c) 2000 MHz and (d) 3000 MHz.

A.15 Boven PV3 Alternative to Core SKA

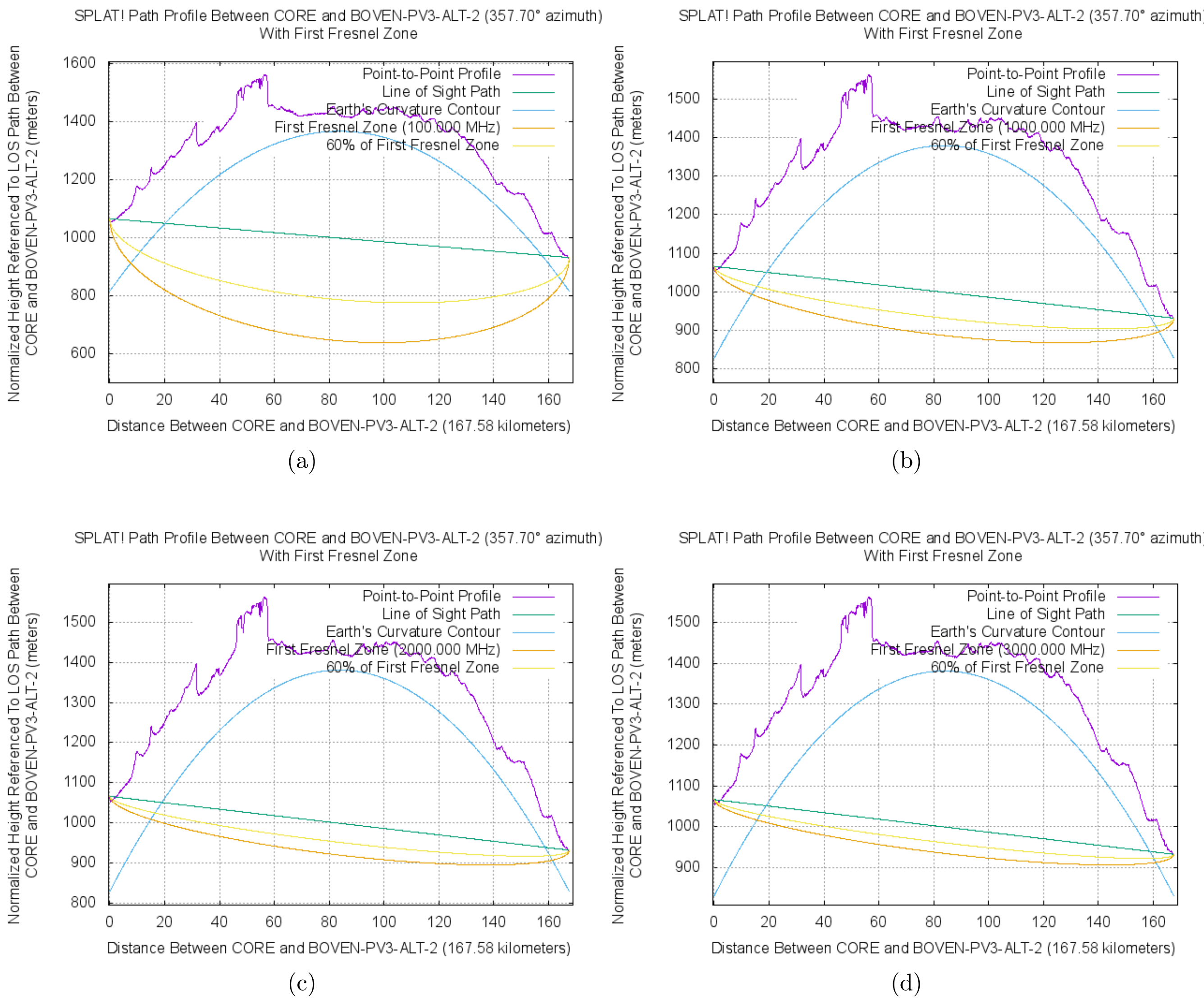


Figure 87: Fresnel zone, LOS and 60% of first Fresnel zone for site location of Boven PV3 Alternative to the core SKA telescopes for (a) 100 MHz (b) 1000 MHz (c) 2000 MHz and (d) 3000 MHz.

A.16 Boven PV4 to Closest SKA

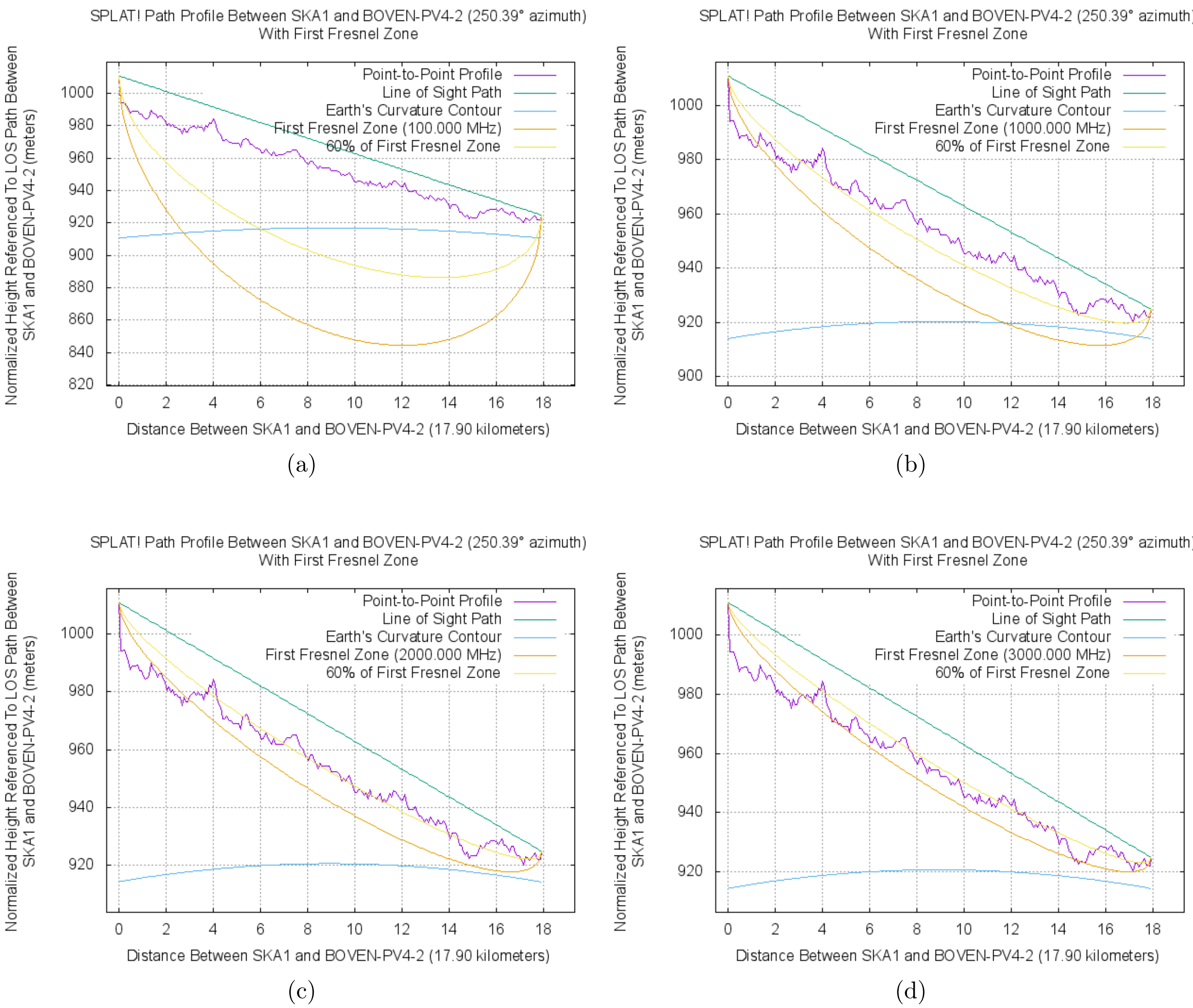


Figure 88: Fresnel zone, LOS and 60% of first Fresnel zone for site location of Boven PV4 to the closest SKA telescope for (a) 100 MHz (b) 1000 MHz (c) 2000 MHz and (d) 3000 MHz.

A.17 Boven PV4 to 2nd Closest SKA

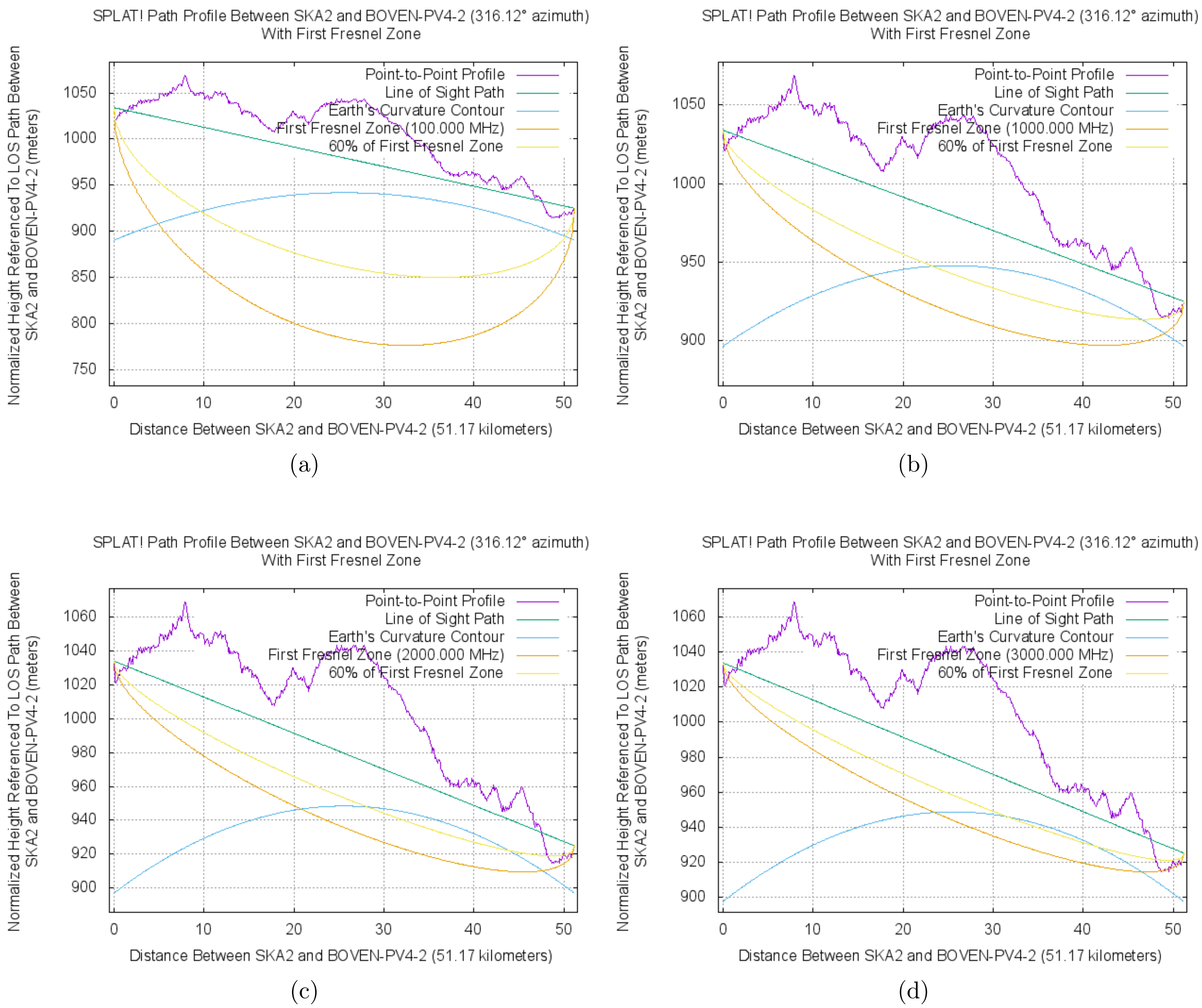
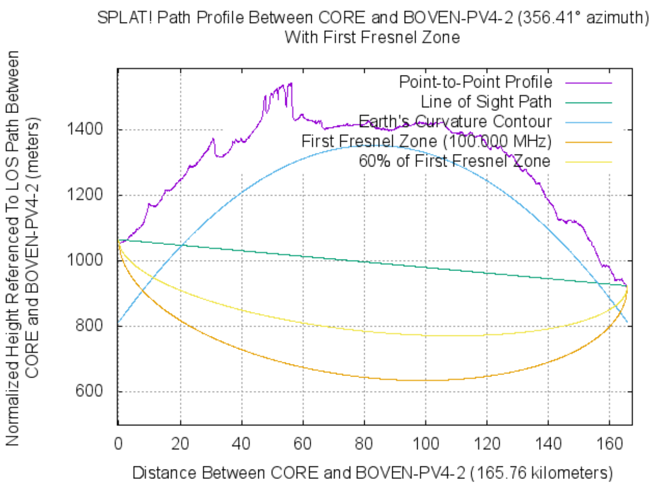


Figure 89: Fresnel zone, LOS and 60% of first Fresnel zone for site location of Boven PV4 to the second closest SKA telescope for (a) 100 MHz (b) 1000 MHz (c) 2000 MHz and (d) 3000 MHz.

A.18 Boven PV4 to Core SKA



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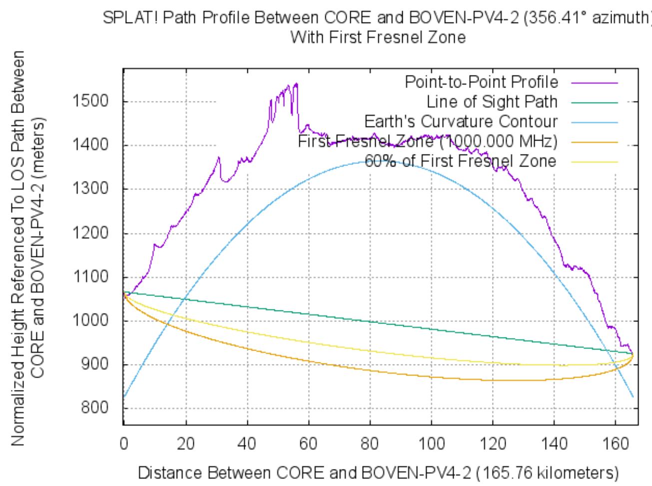

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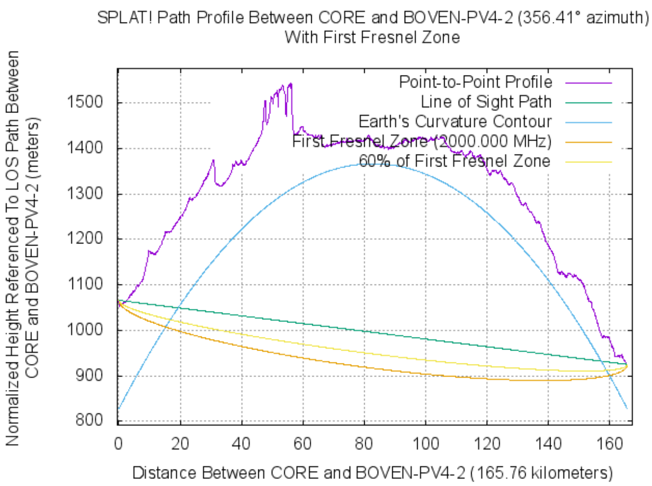

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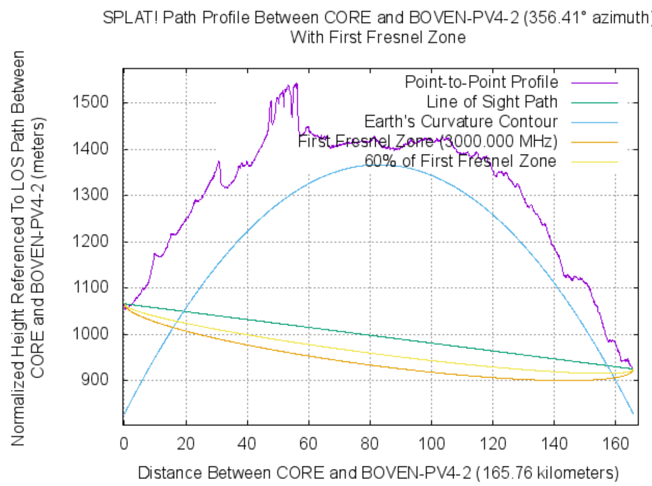
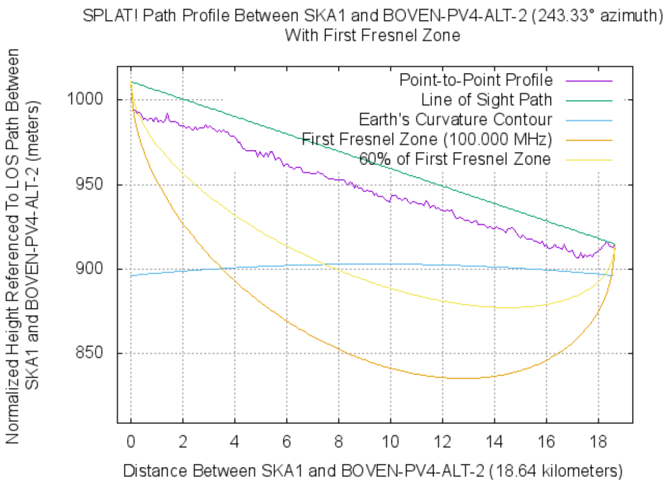


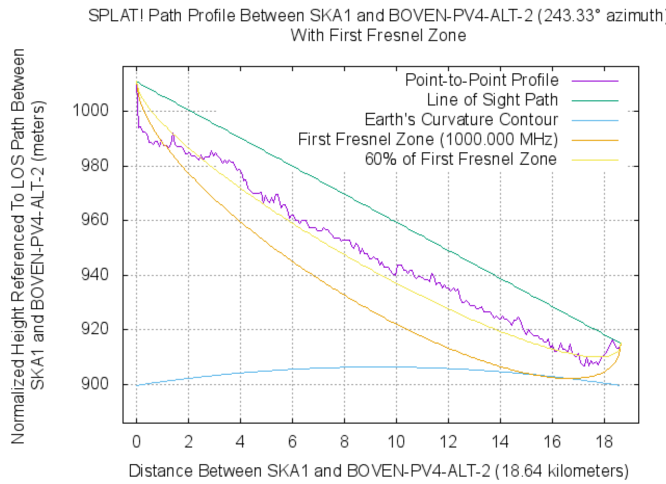
(d)

Figure 90: Fresnel zone, LOS and 60% of first Fresnel zone for site location of Boven PV4 to the core SKA telescopes for (a) 100 MHz (b) 1000 MHz (c) 2000 MHz and (d) 3000 MHz.

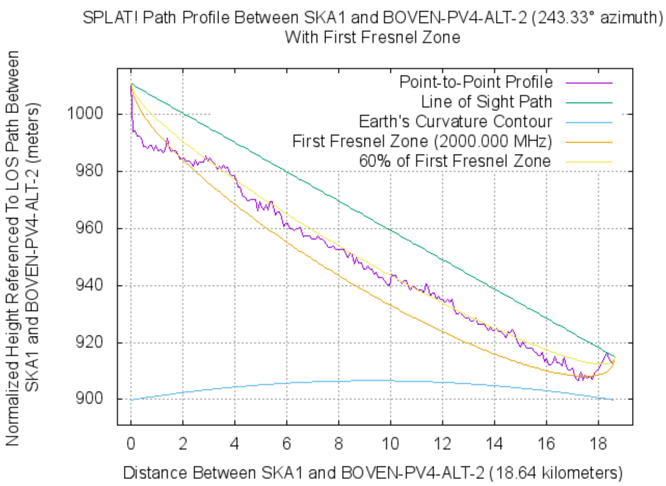
A.19 Boven PV4 Alternative to Closest SKA



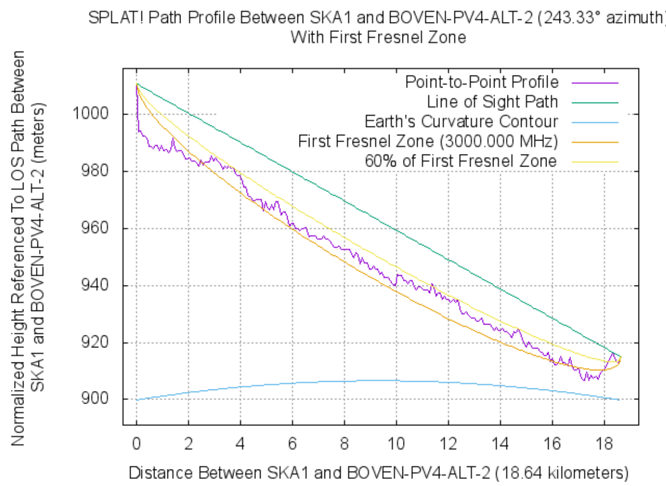
(a)



(b)



(c)



(d)

Figure 91: Fresnel zone, LOS and 60% of first Fresnel zone for site location of Boven PV4 Alternative to the closest SKA telescope for (a) 100 MHz (b) 1000 MHz (c) 2000 MHz and (d) 3000 MHz.

A.20 Boven PV4 Alternative to 2nd Closest SKA

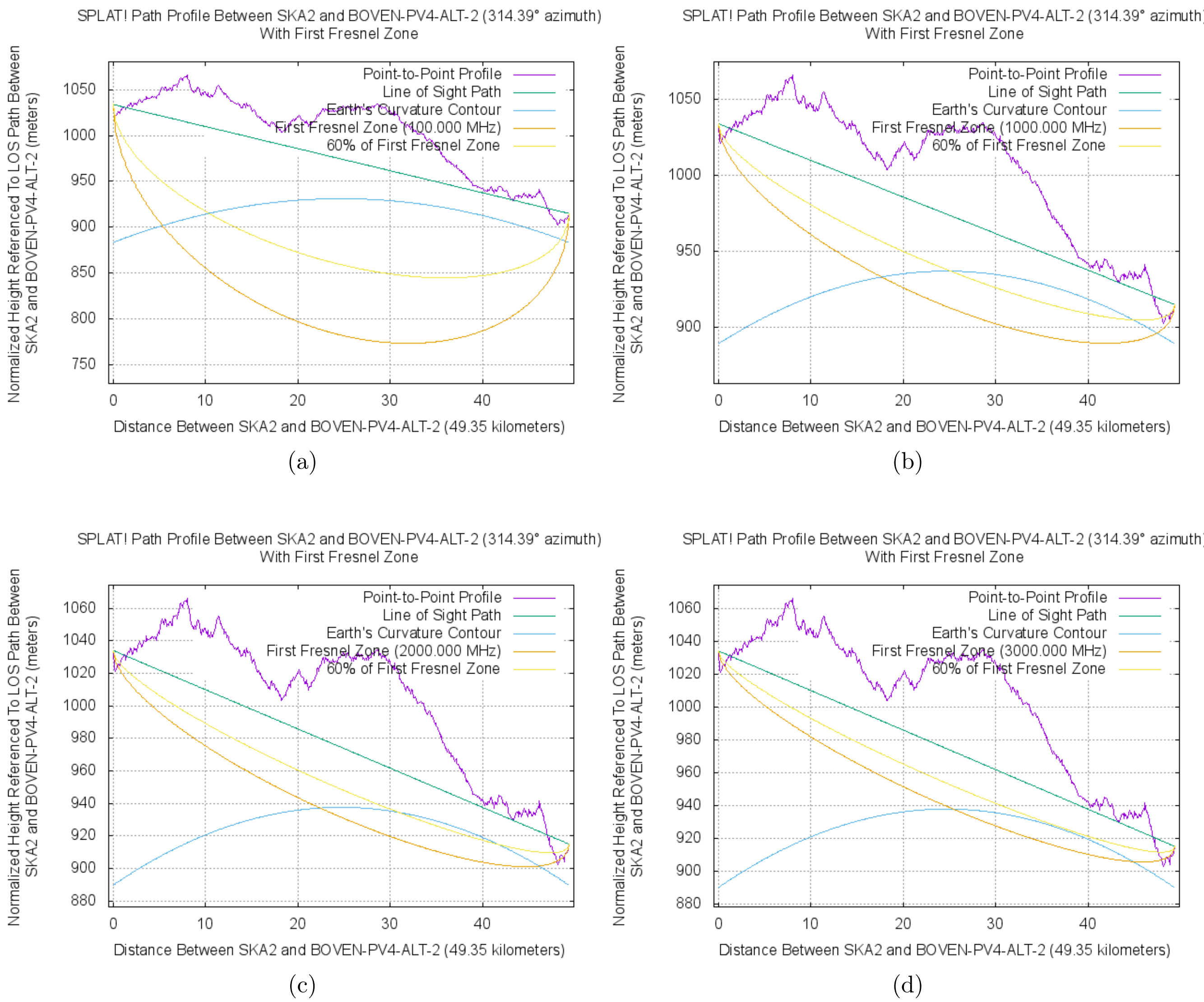
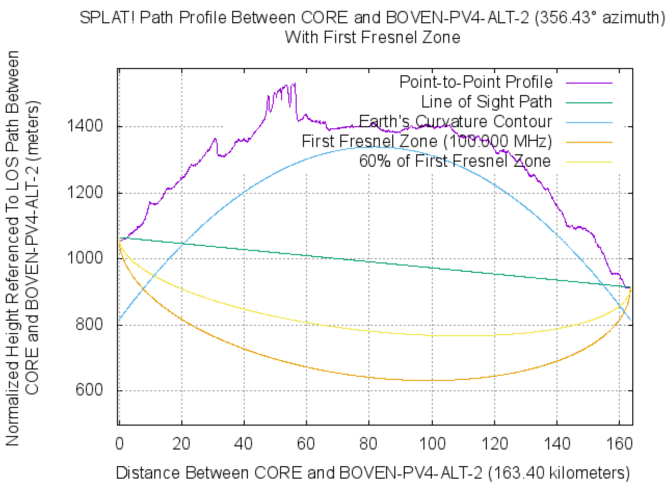
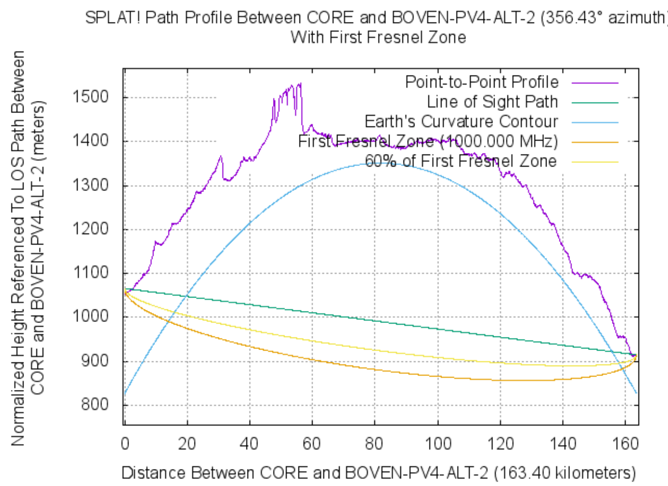


Figure 92: Fresnel zone, LOS and 60% of first Fresnel zone for site location of Boven PV4 Alternative to the second closest SKA telescope for (a) 100 MHz (b) 1000 MHz (c) 2000 MHz and (d) 3000 MHz.

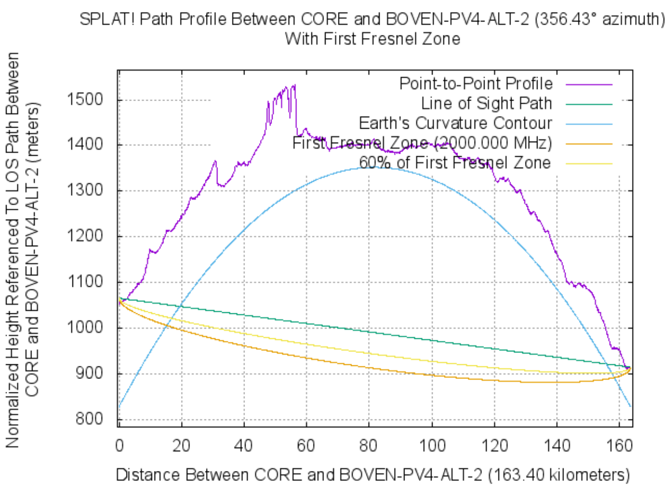
A.21 Boven PV4 Alternative to Core SKA



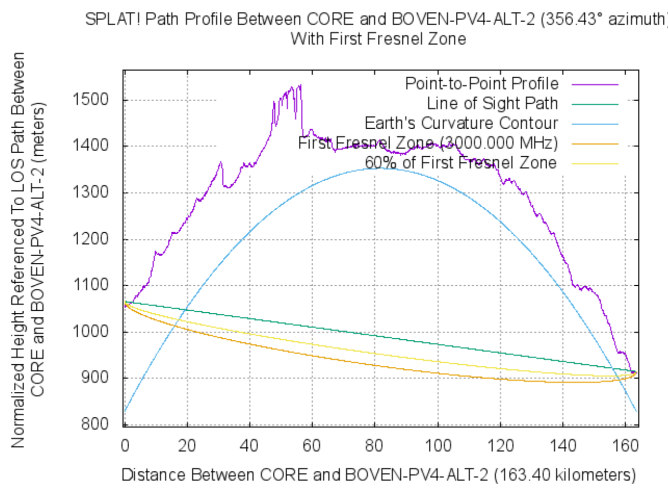
(a)



(b)



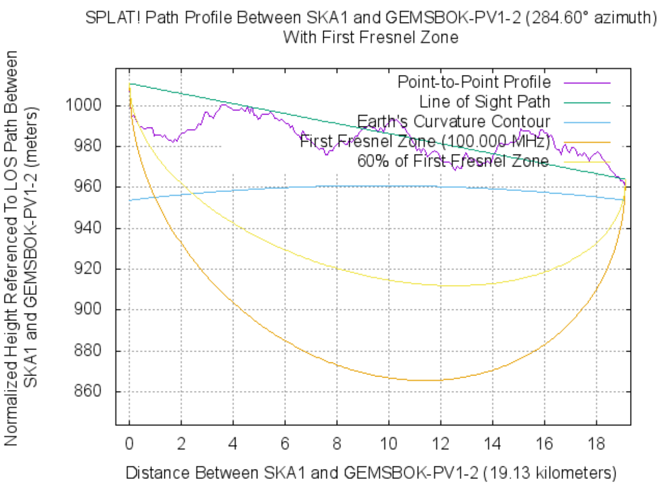
(c)



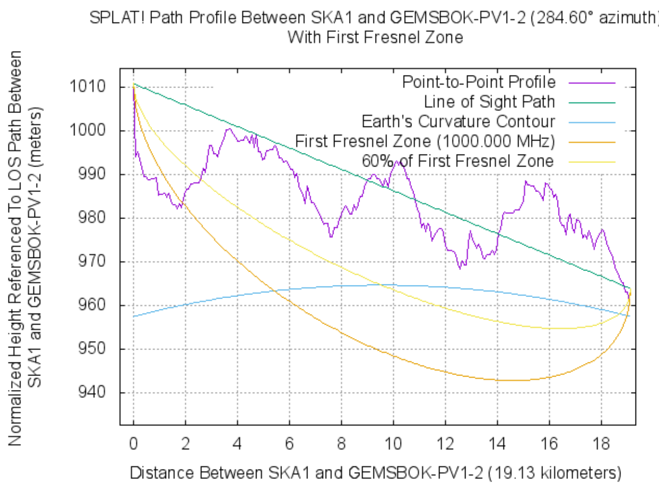
(d)

Figure 93: Fresnel zone, LOS and 60% of first Fresnel zone for site location of Boven PV4 Alternative to the core SKA telescopes for (a) 100 MHz (b) 1000 MHz (c) 2000 MHz and (d) 3000 MHz.

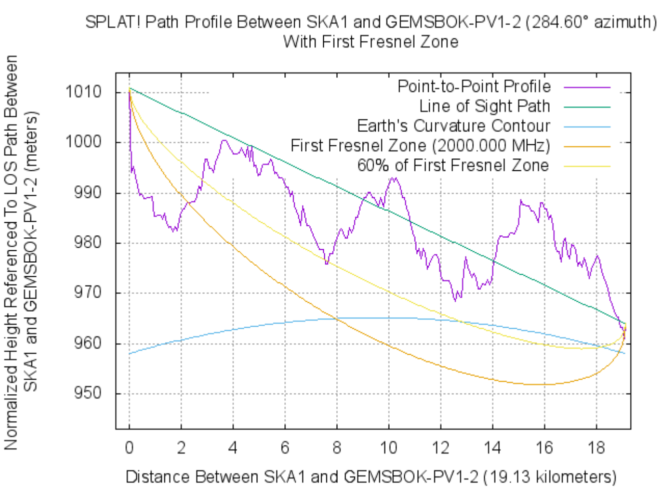
A.22 Gemsbok PV1 to Closest SKA



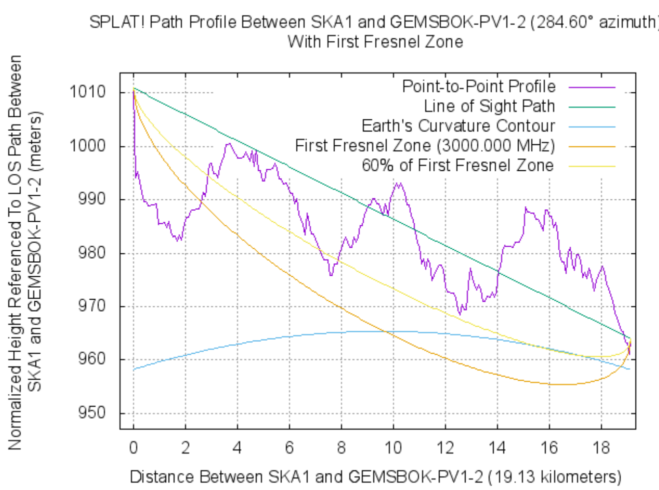
(a)



(b)



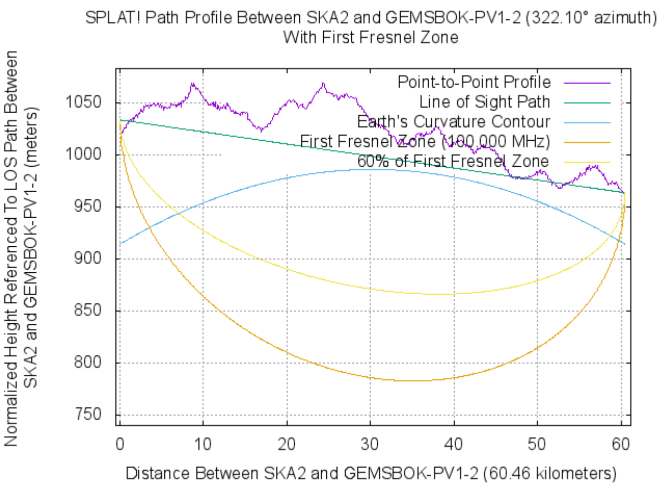
(c)



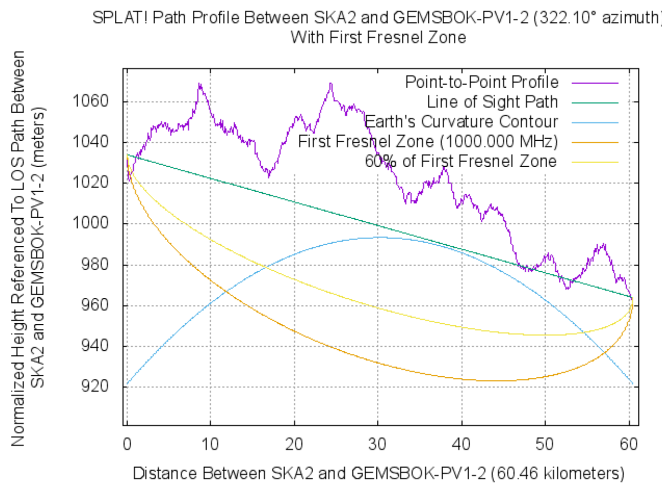
(d)

Figure 94: Fresnel zone, LOS and 60% of first Fresnel zone for site location of Gemsbok PV1 to the closest SKA telescope for (a) 100 MHz (b) 1000 MHz (c) 2000 MHz and (d) 3000 MHz.

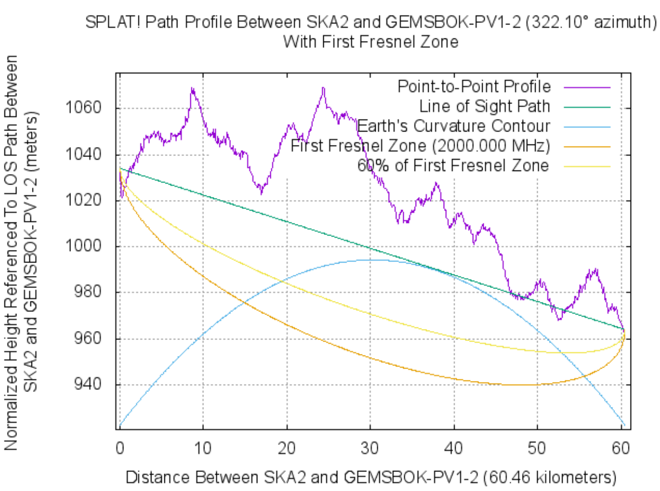
A.23 Gemsbok PV1 to 2nd Closest SKA



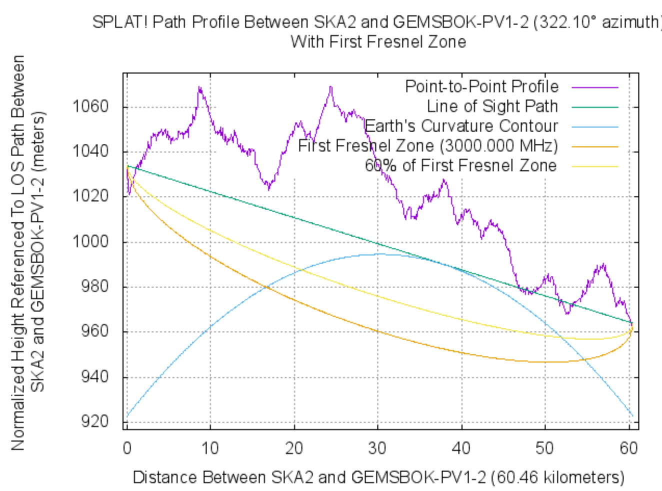
(a)



(b)



(c)



(d)

Figure 95: Fresnel zone, LOS and 60% of first Fresnel zone for site location of Gemsbok PV1 to the second closest SKA telescope for (a) 100 MHz (b) 1000 MHz (c) 2000 MHz and (d) 3000 MHz.

A.24 Gemsbok PV1 to Core SKA

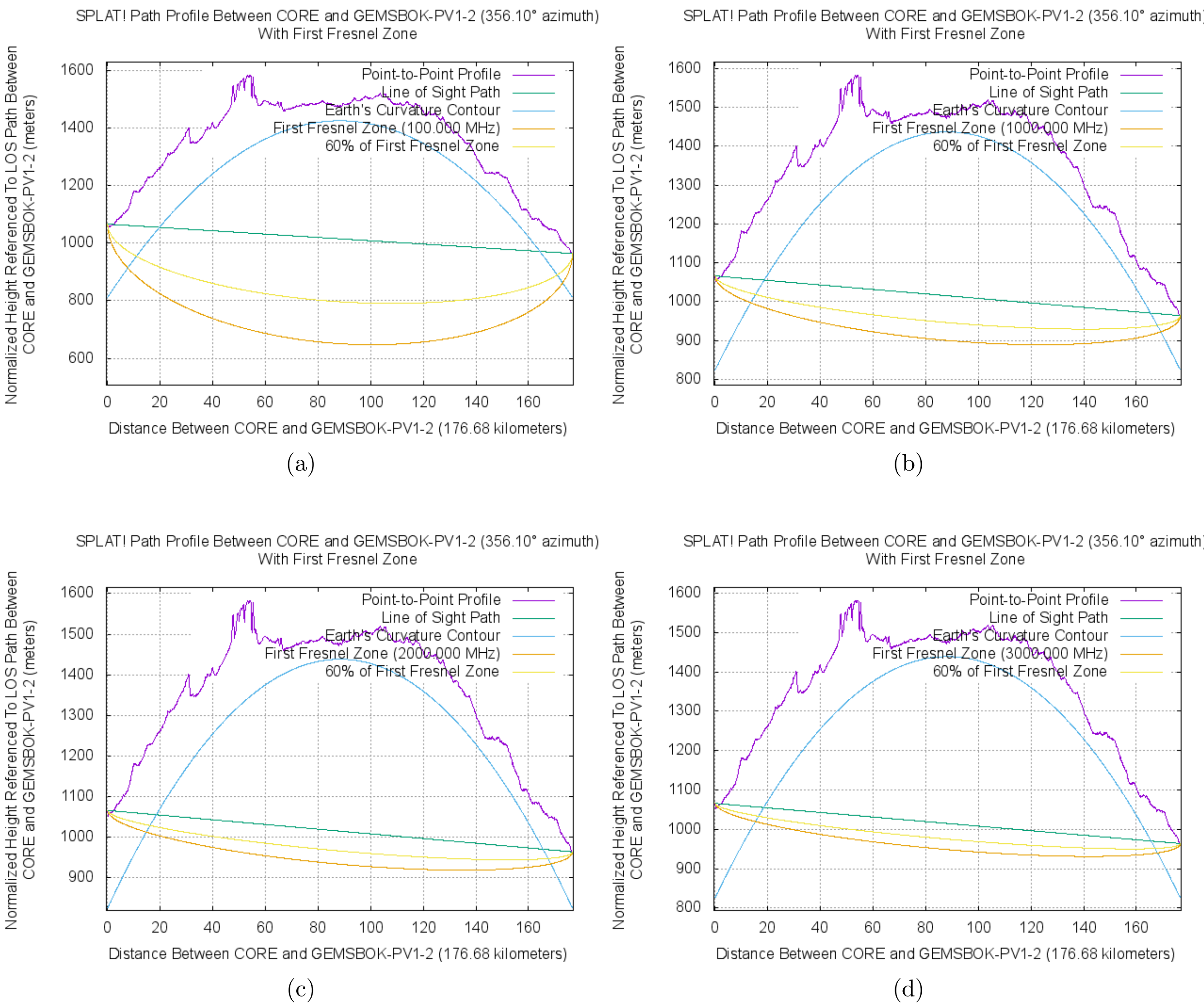
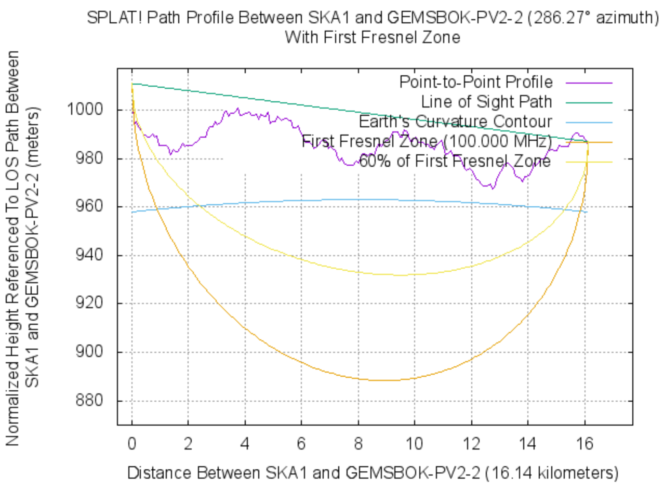
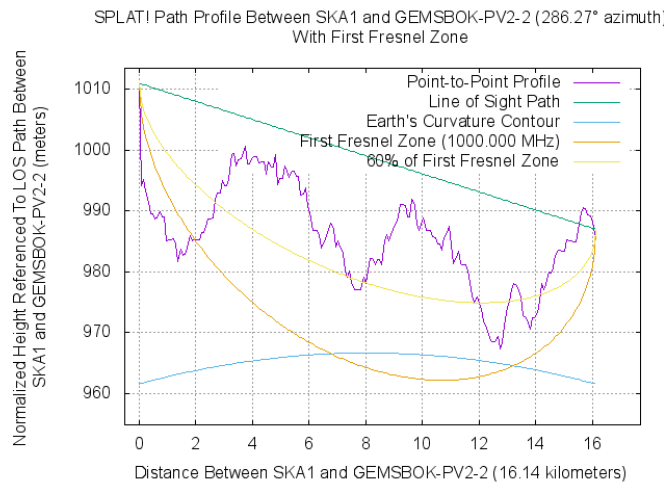


Figure 96: Fresnel zone, LOS and 60% of first Fresnel zone for site location of Gemsbok PV1 to the core SKA telescopes for (a) 100 MHz (b) 1000 MHz (c) 2000 MHz and (d) 3000 MHz.

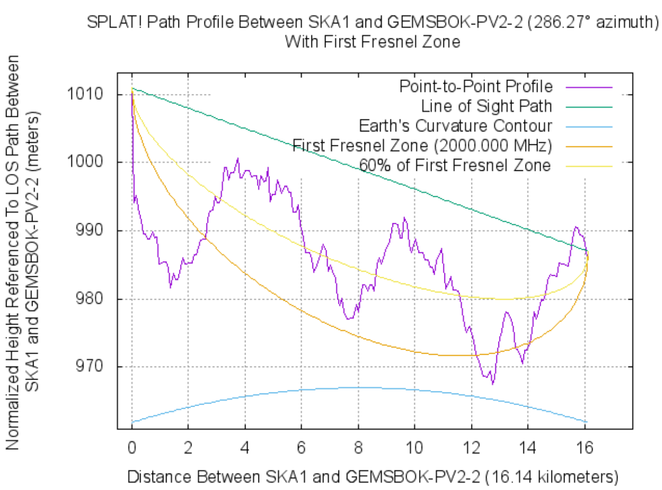
A.25 Gemsbok PV2 to Closest SKA



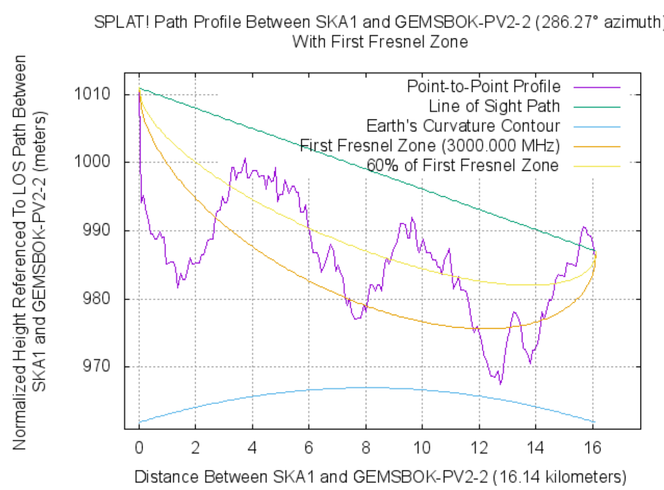
(a)



(b)



(c)



(d)

Figure 97: Fresnel zone, LOS and 60% of first Fresnel zone for site location of Gemsbok PV2 to the closest SKA telescope for (a) 100 MHz (b) 1000 MHz (c) 2000 MHz and (d) 3000 MHz.

A.26 Gemsbok PV2 to 2nd Closest SKA

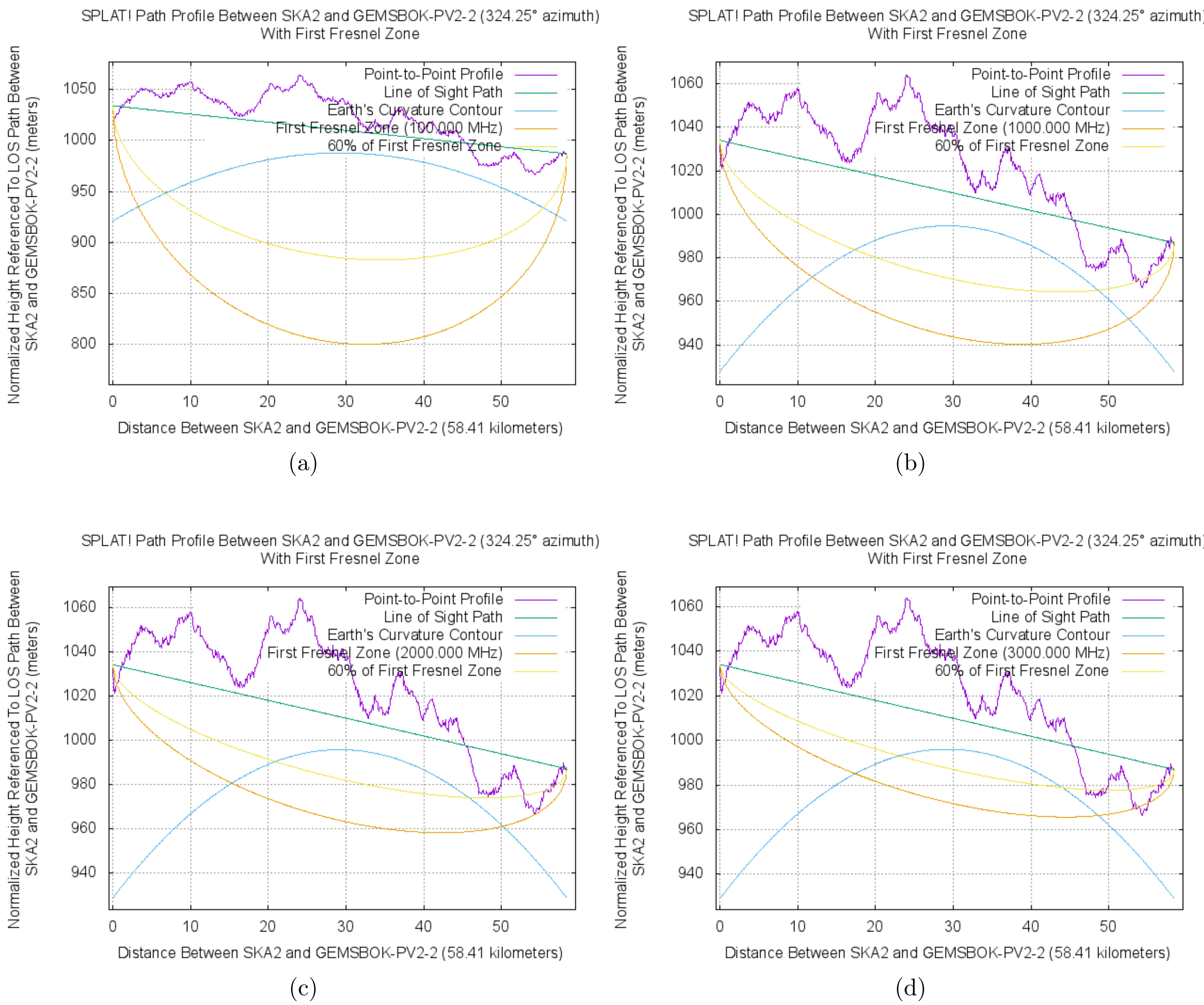


Figure 98: Fresnel zone, LOS and 60% of first Fresnel zone for site location of Gemsbok PV2 to the second closest SKA telescope for (a) 100 MHz (b) 1000 MHz (c) 2000 MHz and (d) 3000 MHz.

A.27 Gemsbok PV2 to Core SKA

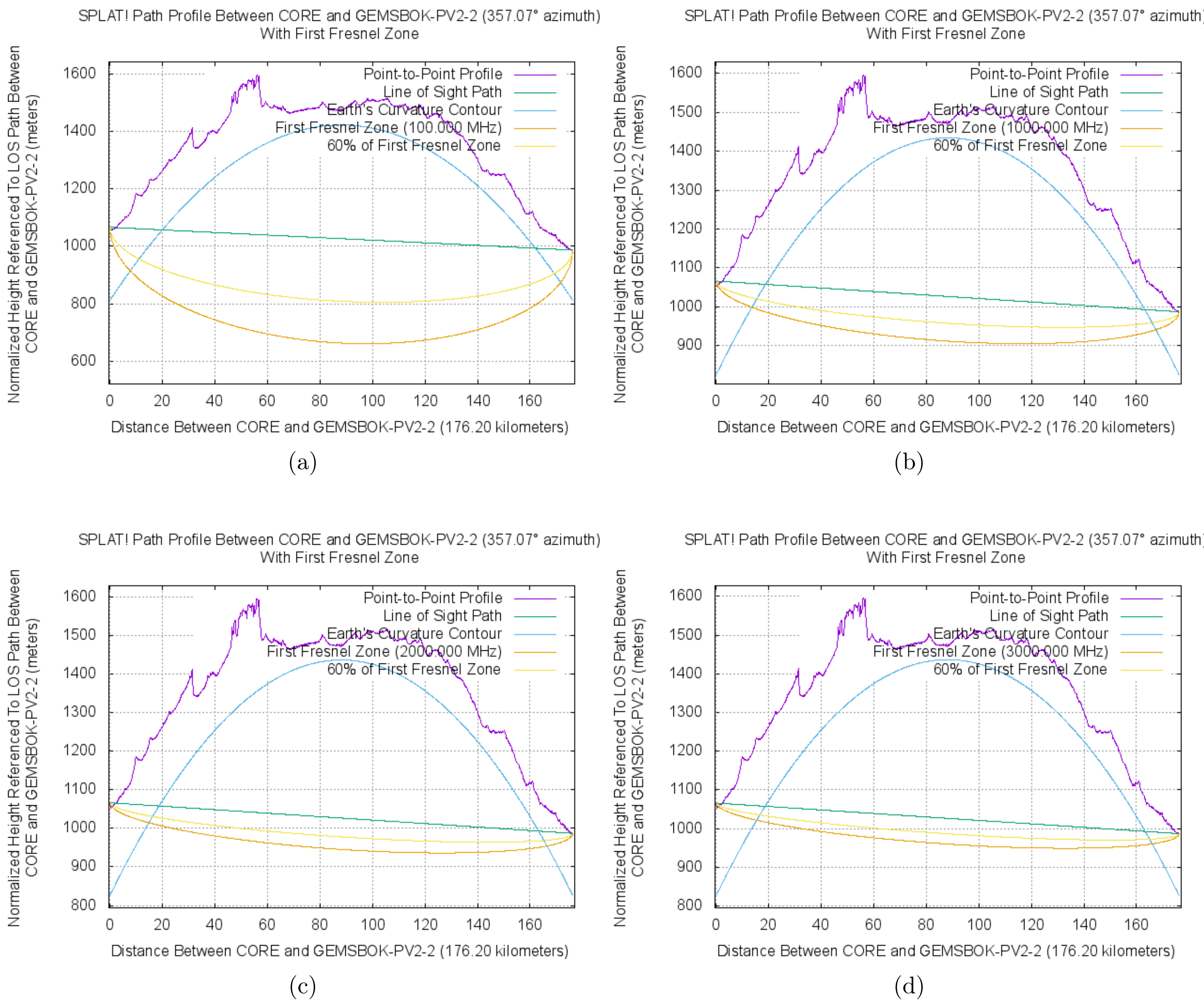
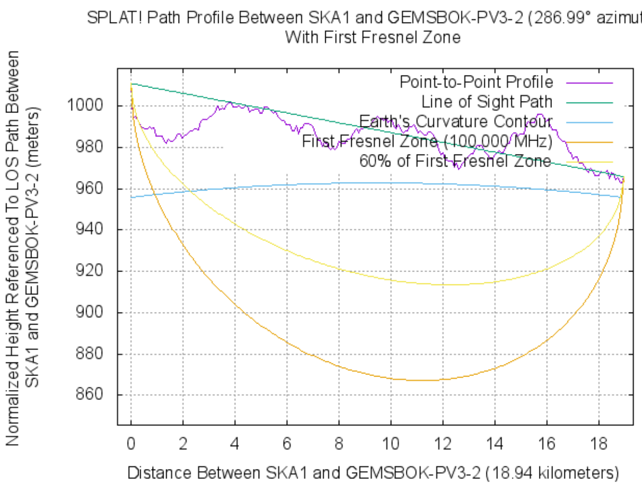
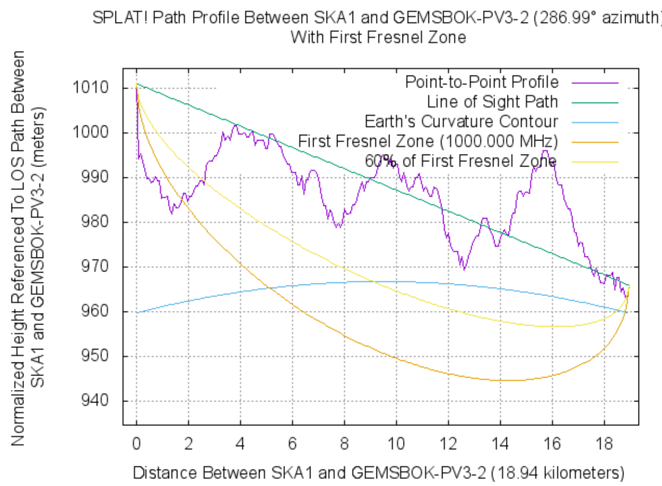


Figure 99: Fresnel zone, LOS and 60% of first Fresnel zone for site location of Gemsbok PV2 to the core SKA telescopes for (a) 100 MHz (b) 1000 MHz (c) 2000 MHz and (d) 3000 MHz.

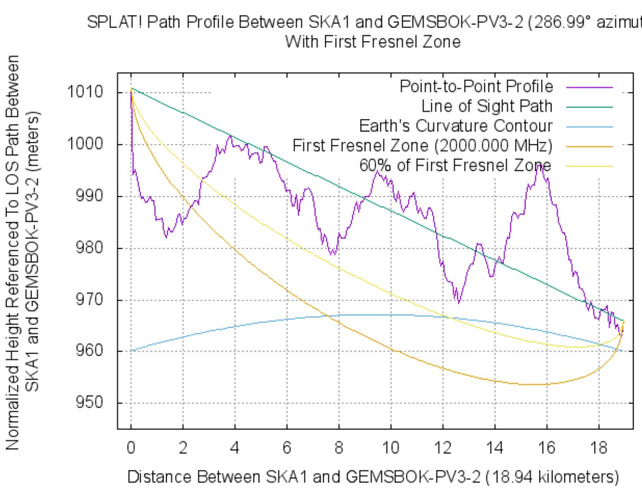
A.28 Gemsbok PV3 to Closest SKA



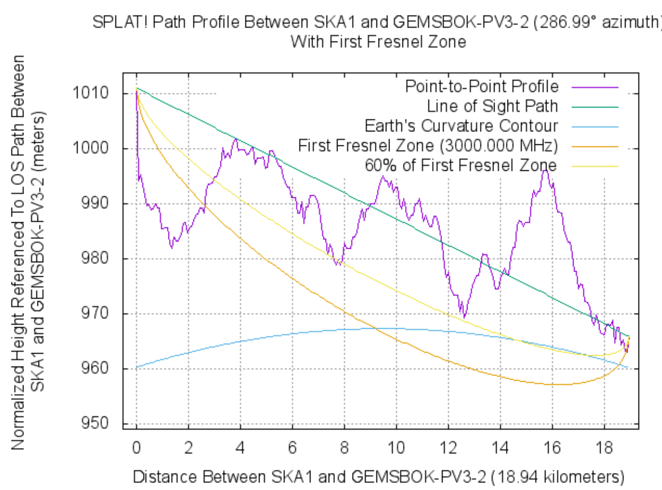
(a)



(b)



(c)



(d)

Figure 100: Fresnel zone, LOS and 60% of first Fresnel zone for site location of Gemsbok PV3 to the closest SKA telescope for (a) 100 MHz (b) 1000 MHz (c) 2000 MHz and (d) 3000 MHz.

A.29 Gemsbok PV3 to 2nd Closest SKA

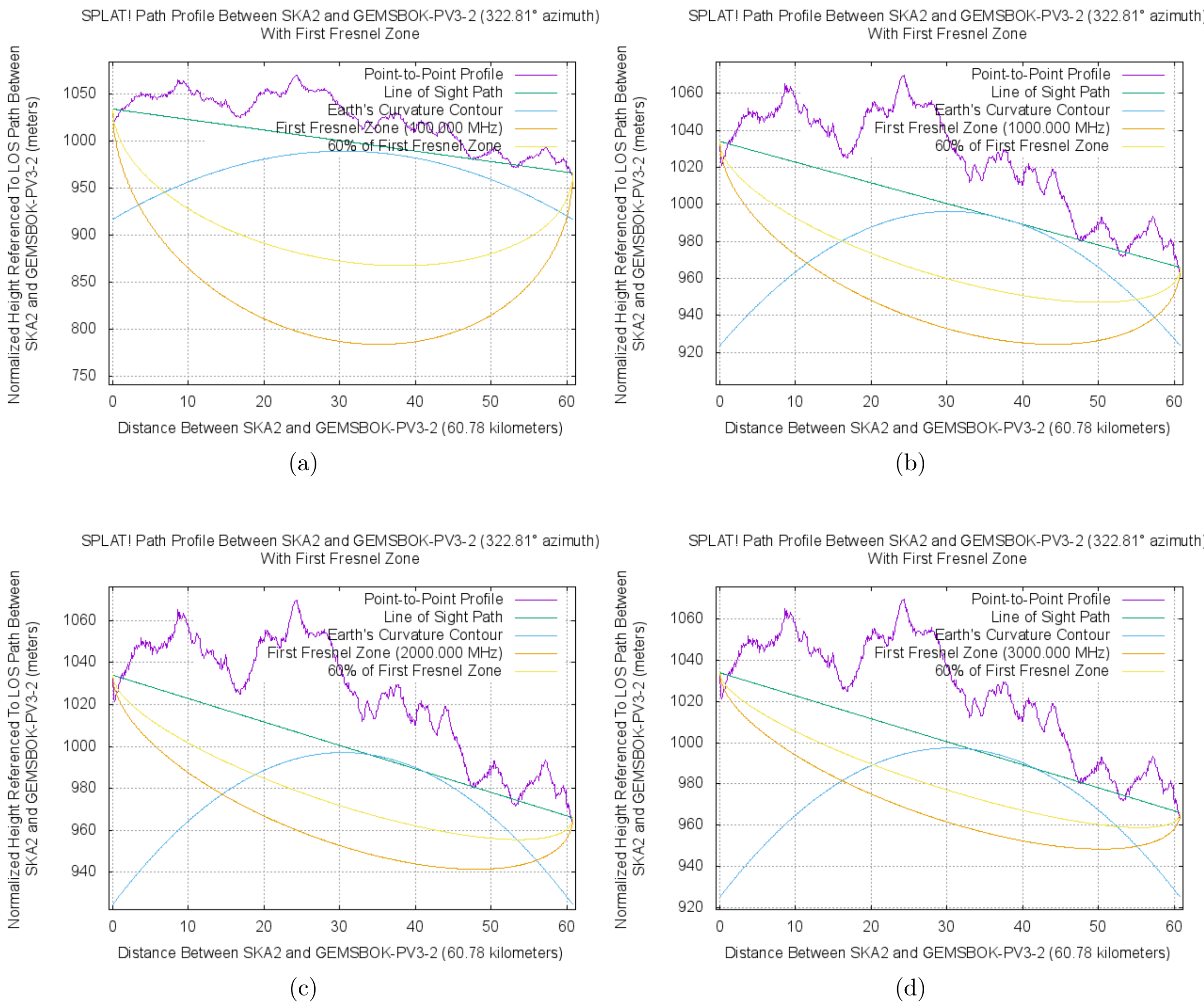
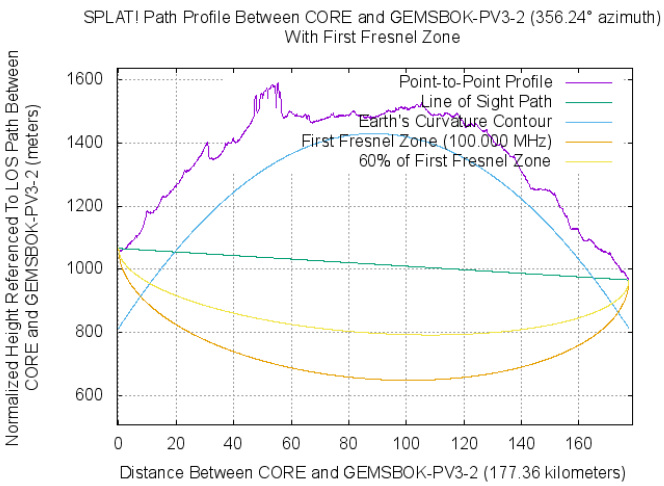
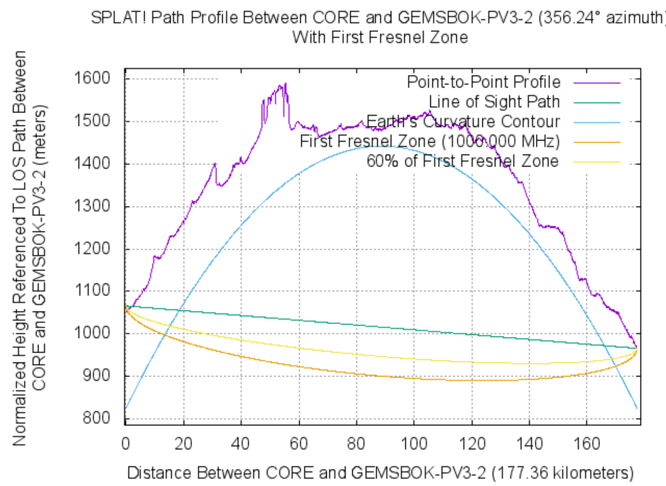


Figure 101: Fresnel zone, LOS and 60% of first Fresnel zone for site location of Gemsbok PV3 to the second closest SKA telescope for (a) 100 MHz (b) 1000 MHz (c) 2000 MHz and (d) 3000 MHz.

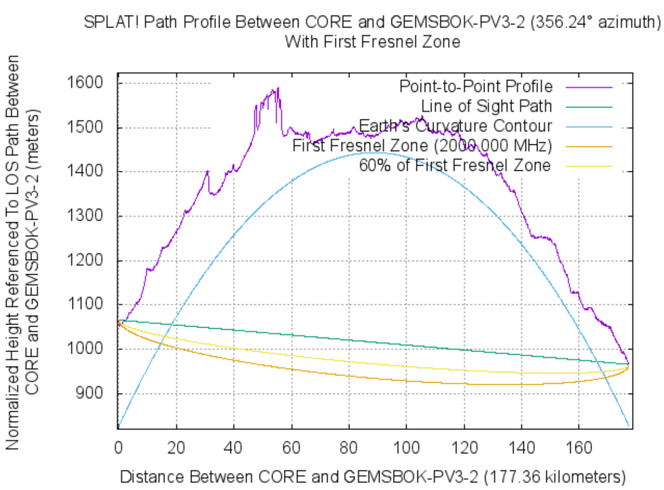
A.30 Gemsbok PV3 to Core SKA



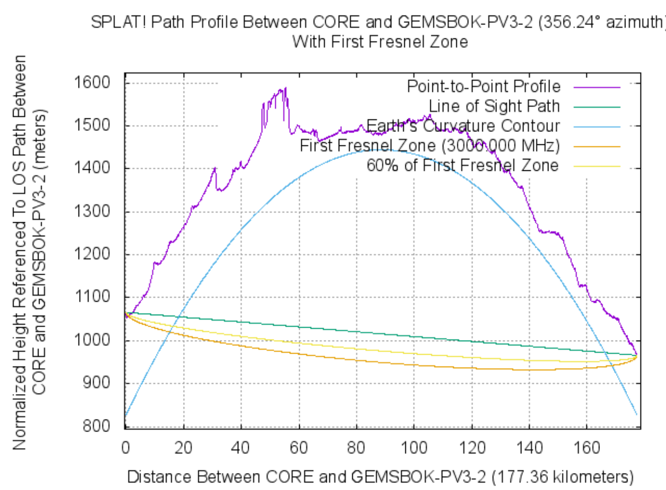
(a)



(b)



(c)



(d)

Figure 102: Fresnel zone, LOS and 60% of first Fresnel zone for site location of Gemsbok PV3 to the core SKA telescopes for (a) 100 MHz (b) 1000 MHz (c) 2000 MHz and (d) 3000 MHz.

A.31 Gemsbok PV3 Alternative to Closest SKA

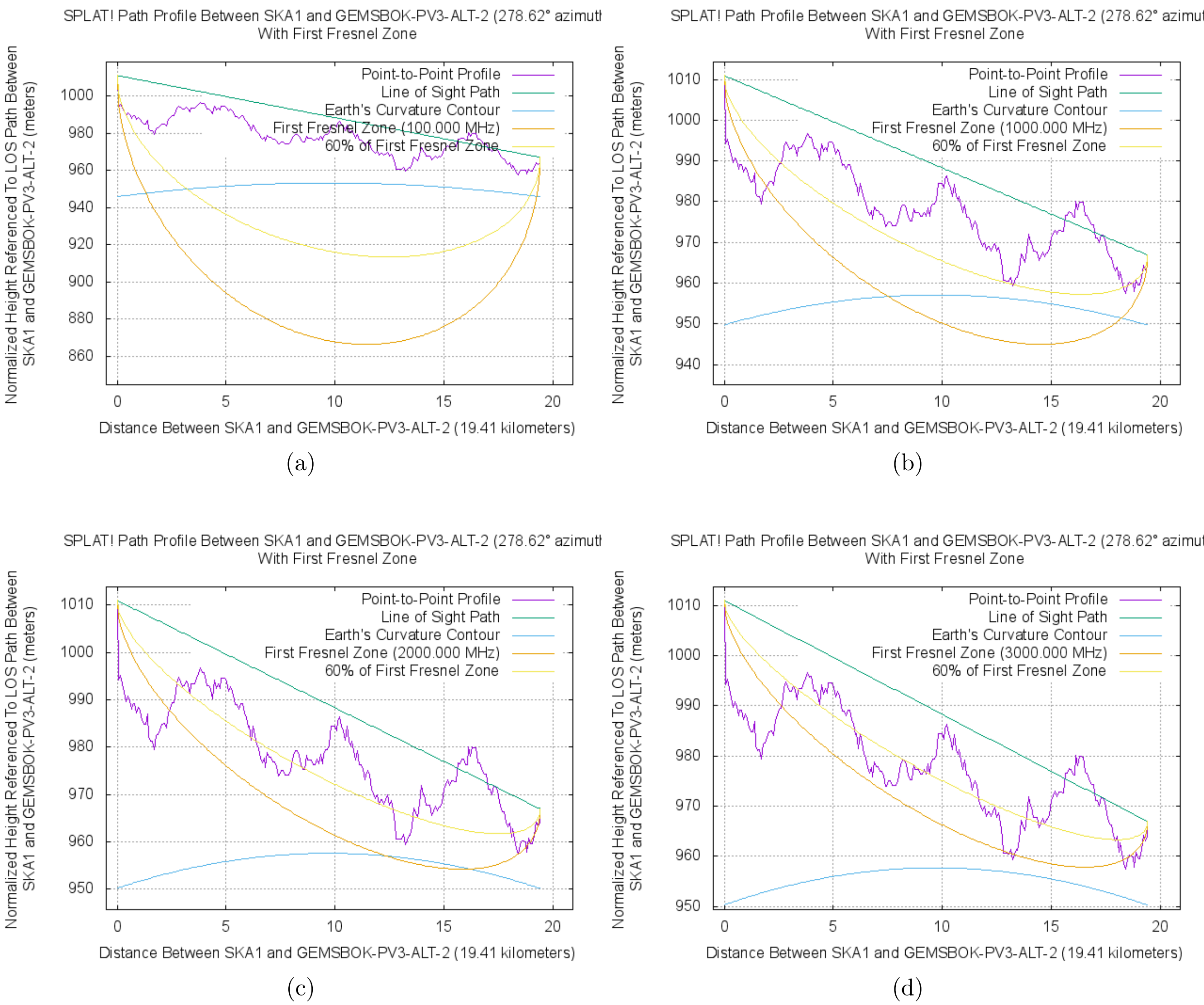
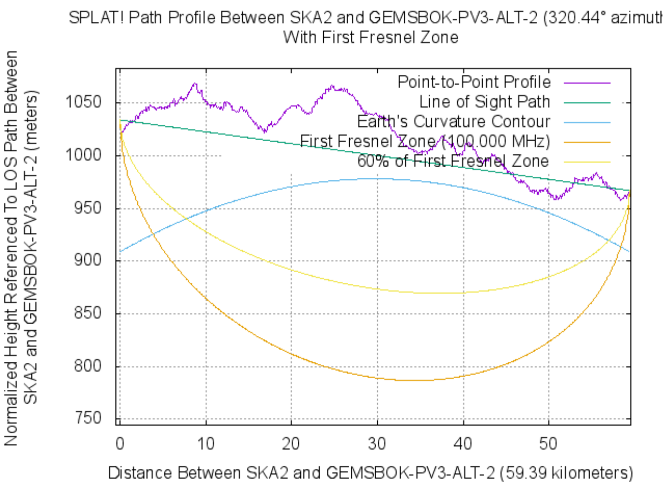
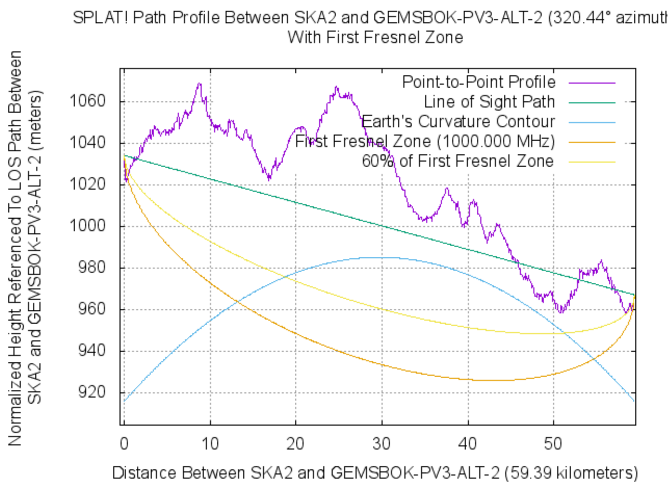


Figure 103: Fresnel zone, LOS and 60% of first Fresnel zone for site location of Gemsbok PV3 Alternative to the closest SKA telescope for (a) 100 MHz (b) 1000 MHz (c) 2000 MHz and (d) 3000 MHz.

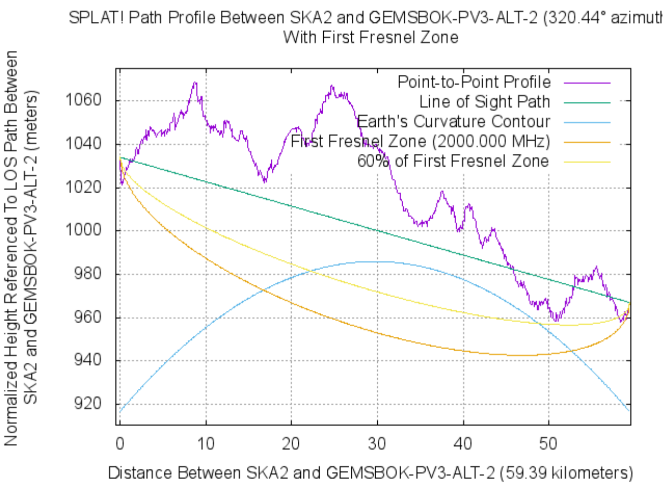
A.32 Gemsbok PV3 Alternative to 2nd Closest SKA



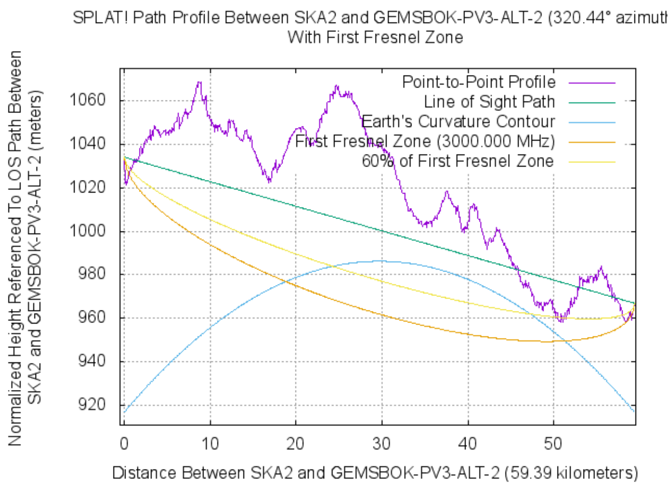
(a)



(b)



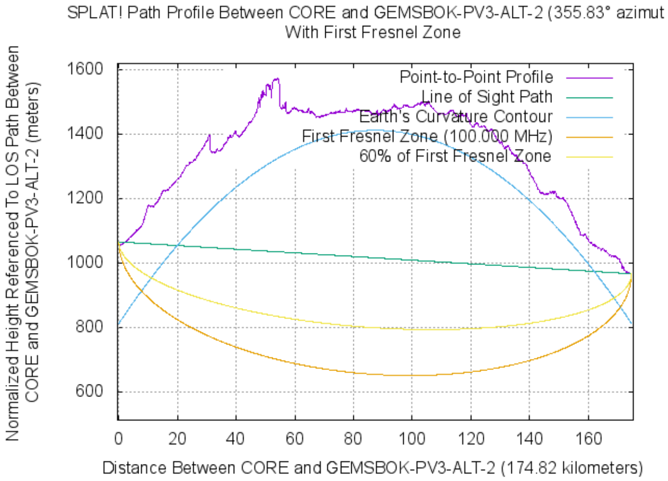
(c)



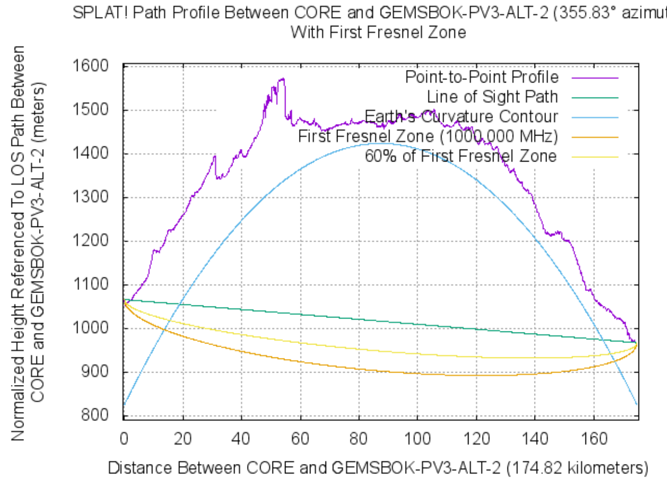
(d)

Figure 104: Fresnel zone, LOS and 60% of first Fresnel zone for site location of Gemsbok PV3 Alternative to the second closest SKA telescope for (a) 100 MHz (b) 1000 MHz (c) 2000 MHz and (d) 3000 MHz.

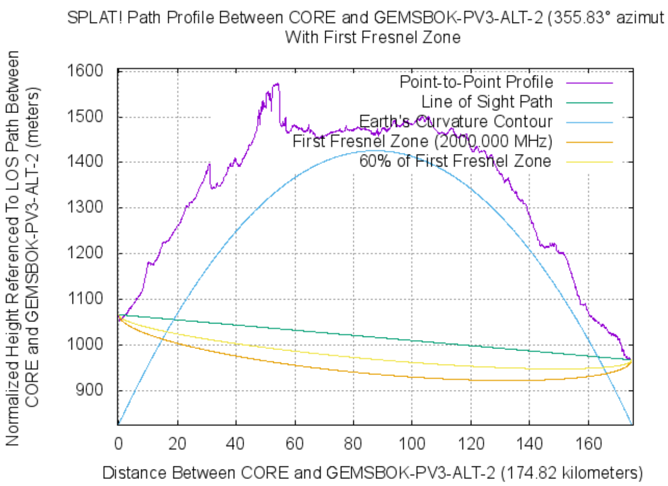
A.33 Gemsbok PV3 Alternative to Core SKA



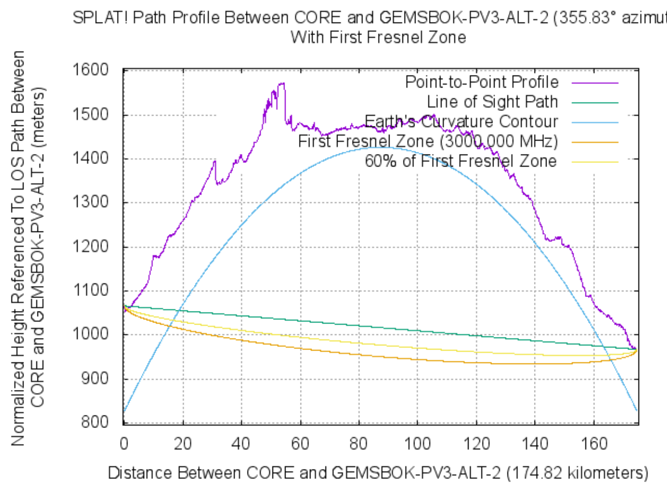
(a)



(b)



(c)



(d)

Figure 105: Fresnel zone, LOS and 60% of first Fresnel zone for site location of Gemsbok PV3 Alternative to the core SKA telescopes for (a) 100 MHz (b) 1000 MHz (c) 2000 MHz and (d) 3000 MHz.

A.34 Gemsbok PV4 to Closest SKA

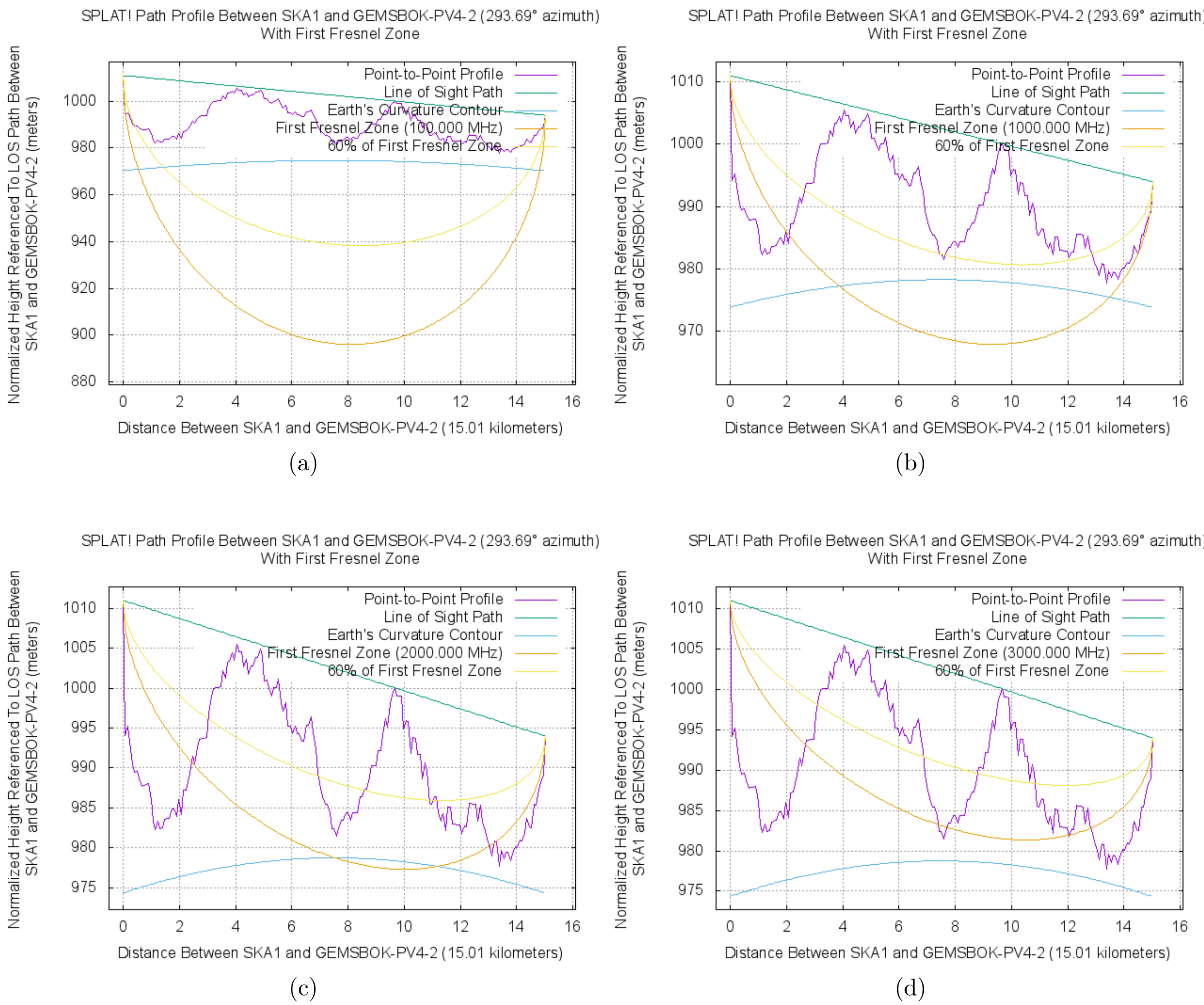
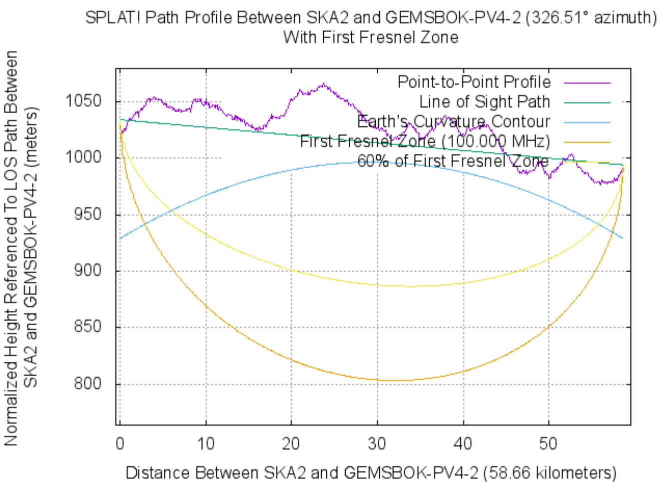
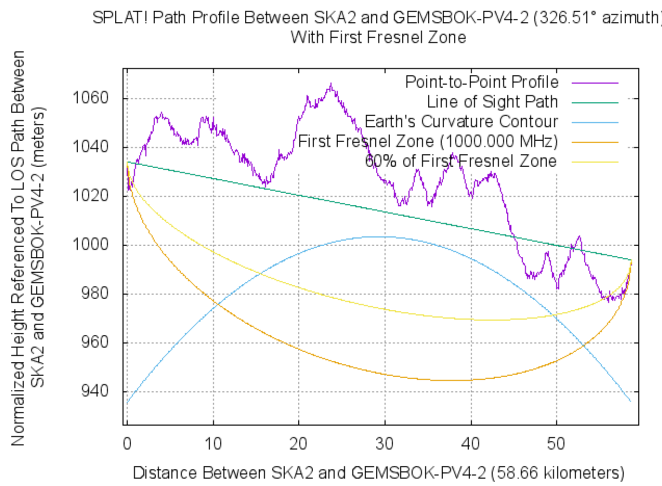


Figure 106: Fresnel zone, LOS and 60% of first Fresnel zone for site location of Gemsbok PV4 to the closest SKA telescope for (a) 100 MHz (b) 1000 MHz (c) 2000 MHz and (d) 3000 MHz.

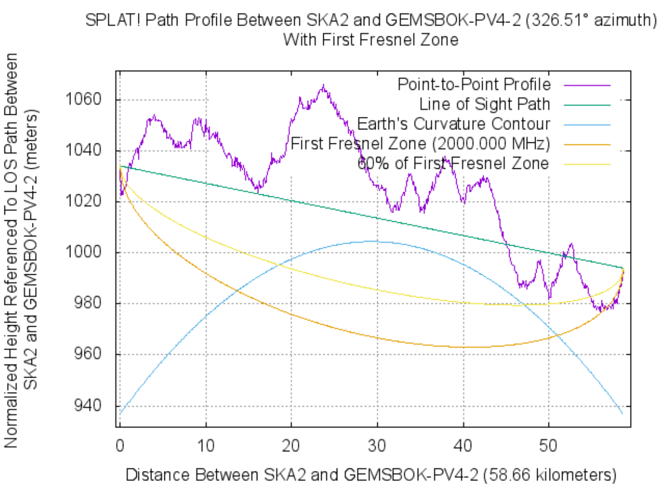
A.35 Gemsbok PV4 to 2nd Closest SKA



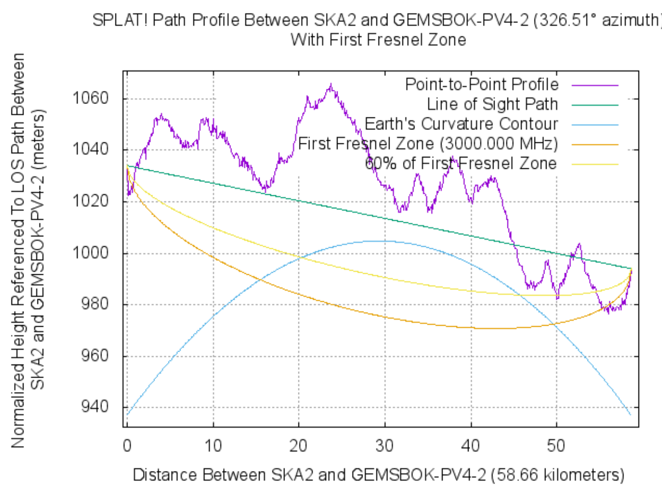
(a)



(b)



(c)



(d)

Figure 107: Fresnel zone, LOS and 60% of first Fresnel zone for site location of Gemsbok PV4 to the second closest SKA telescope for (a) 100 MHz (b) 1000 MHz (c) 2000 MHz and (d) 3000 MHz.

A.36 Gemsbok PV4 to Core SKA

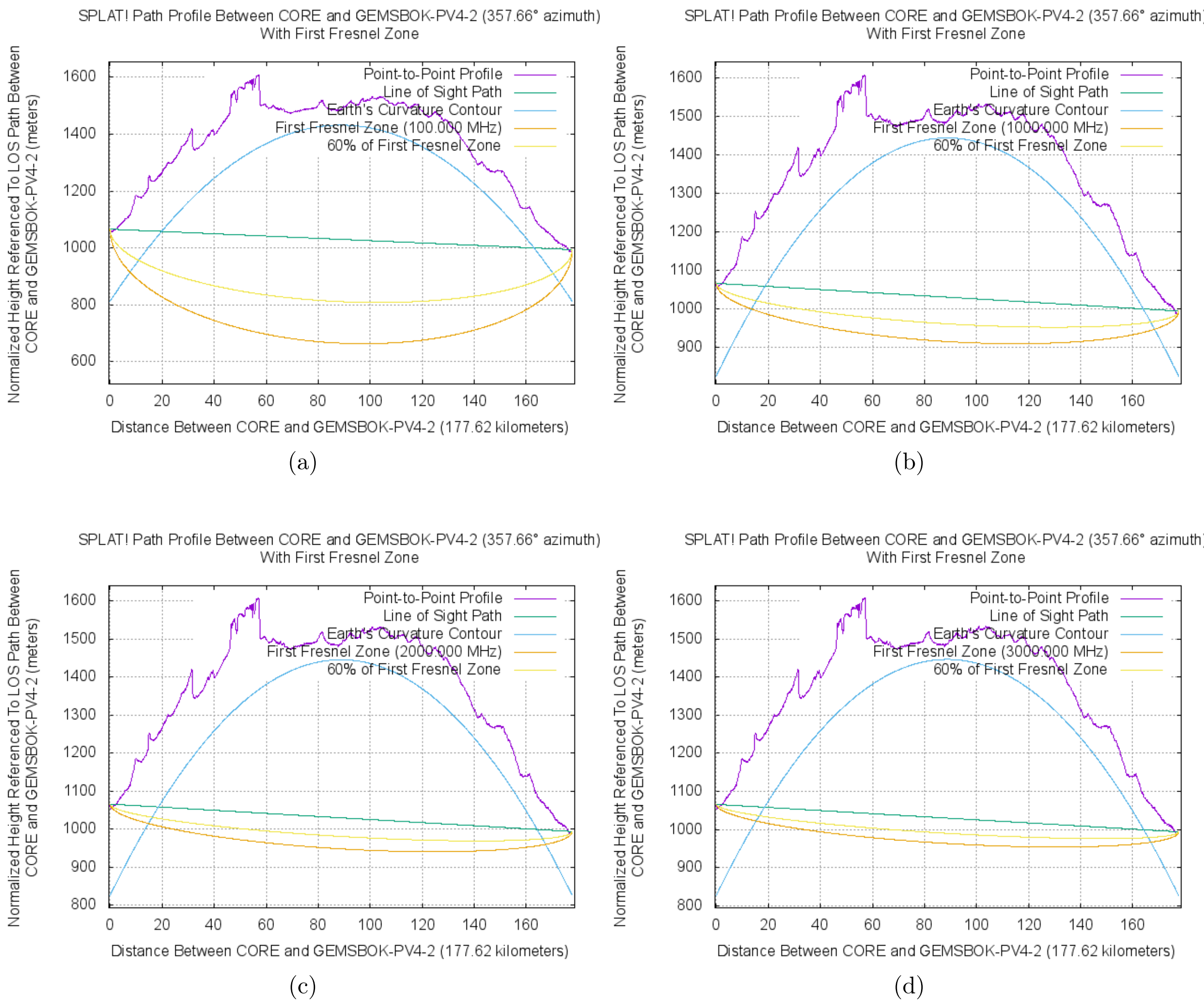


Figure 108: Fresnel zone, LOS and 60% of first Fresnel zone for site location of Gemsbok PV4 to the core SKA telescopes for (a) 100 MHz (b) 1000 MHz (c) 2000 MHz and (d) 3000 MHz.

A.37 Gemsbok PV4 Alternative to Closest SKA

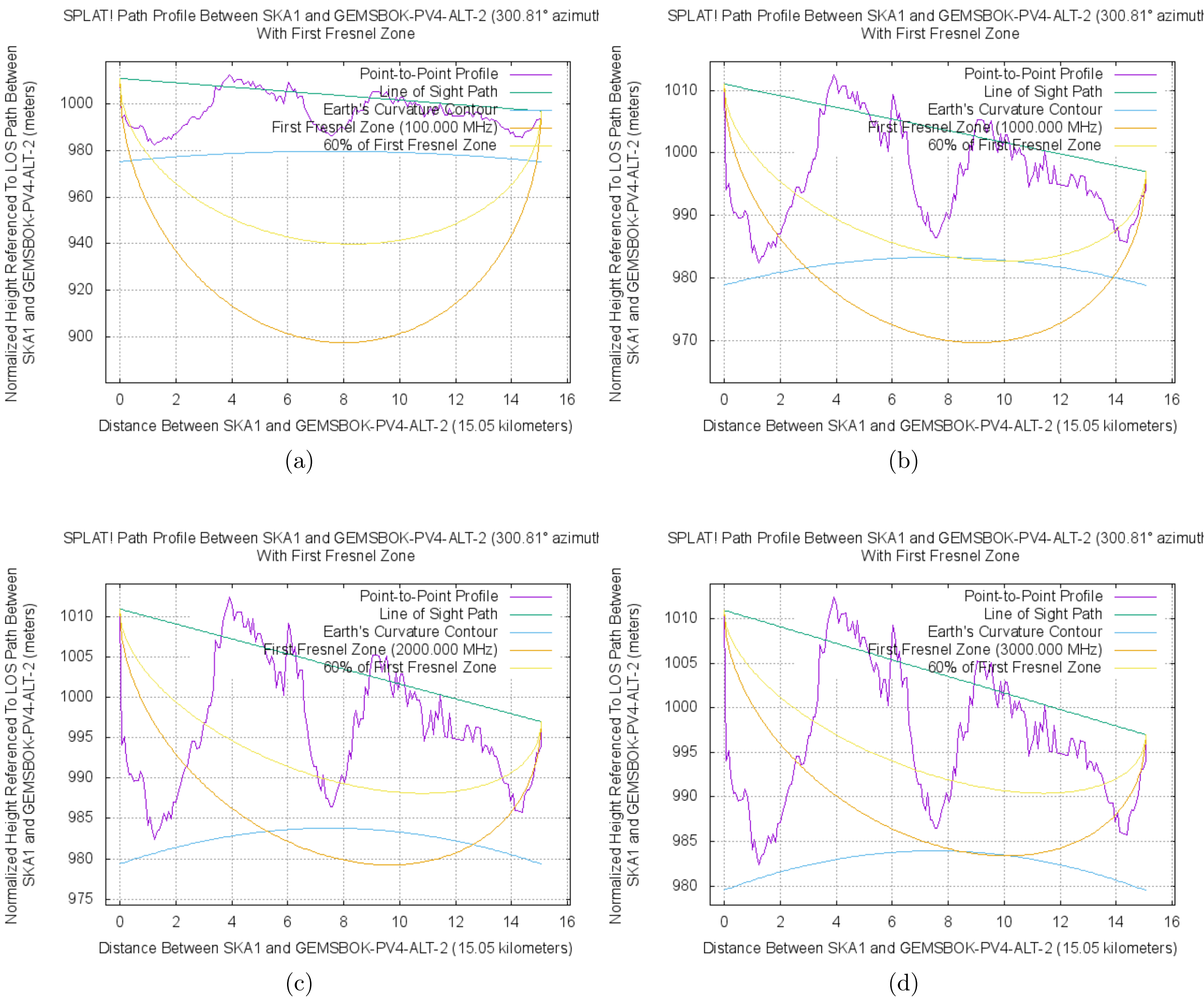


Figure 109: Fresnel zone, LOS and 60% of first Fresnel zone for site location of Gemsbok PV4 Alternative to the closest SKA telescope for (a) 100 MHz (b) 1000 MHz (c) 2000 MHz and (d) 3000 MHz.

A.38 Gemsbok PV4 Alternative to 2nd Closest SKA

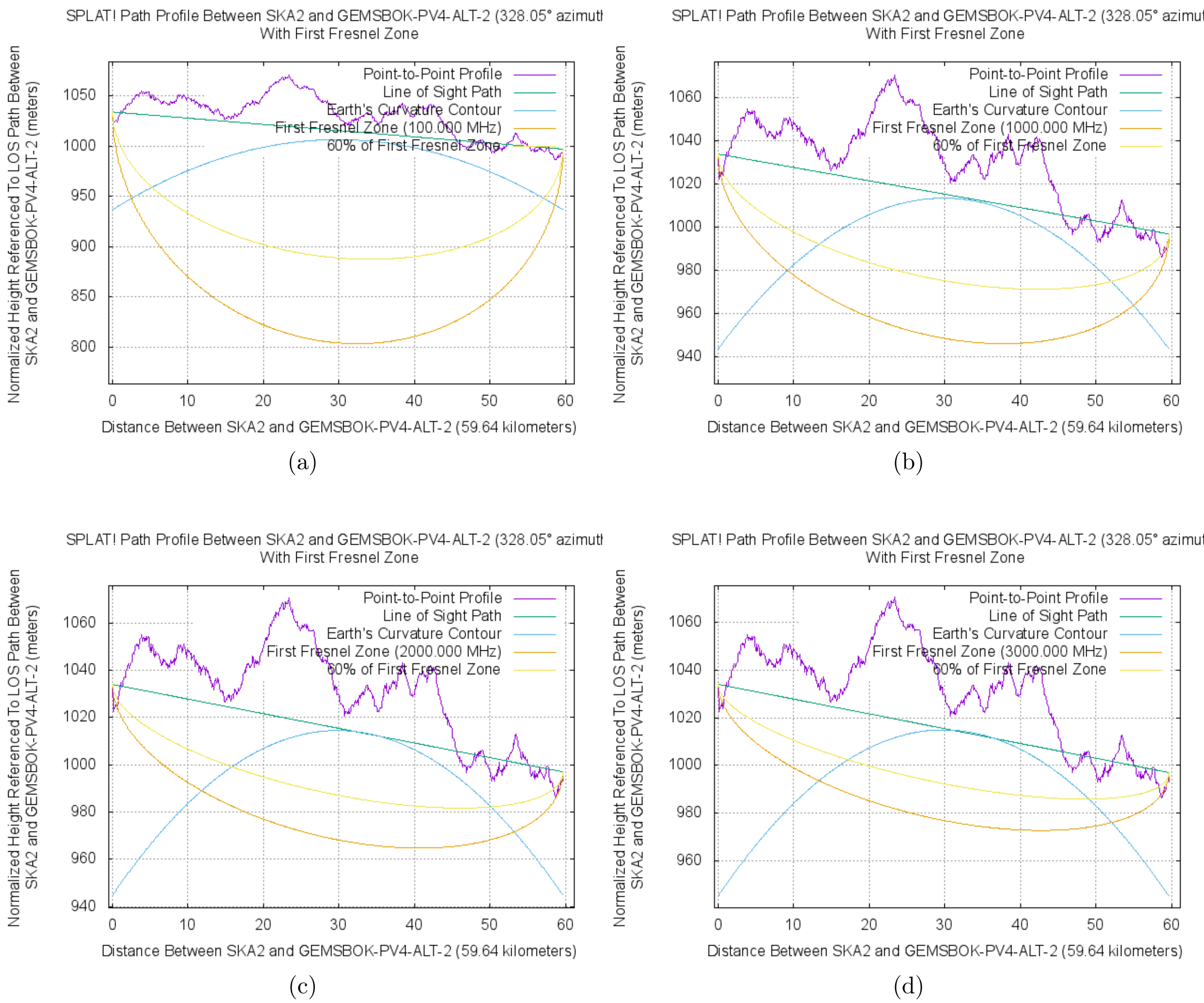


Figure 110: Fresnel zone, LOS and 60% of first Fresnel zone for site location of Gemsbok PV4 Alternative to the second closest SKA telescope for (a) 100 MHz (b) 1000 MHz (c) 2000 MHz and (d) 3000 MHz.

A.39 Gemsbok PV4 Alternative to Core SKA

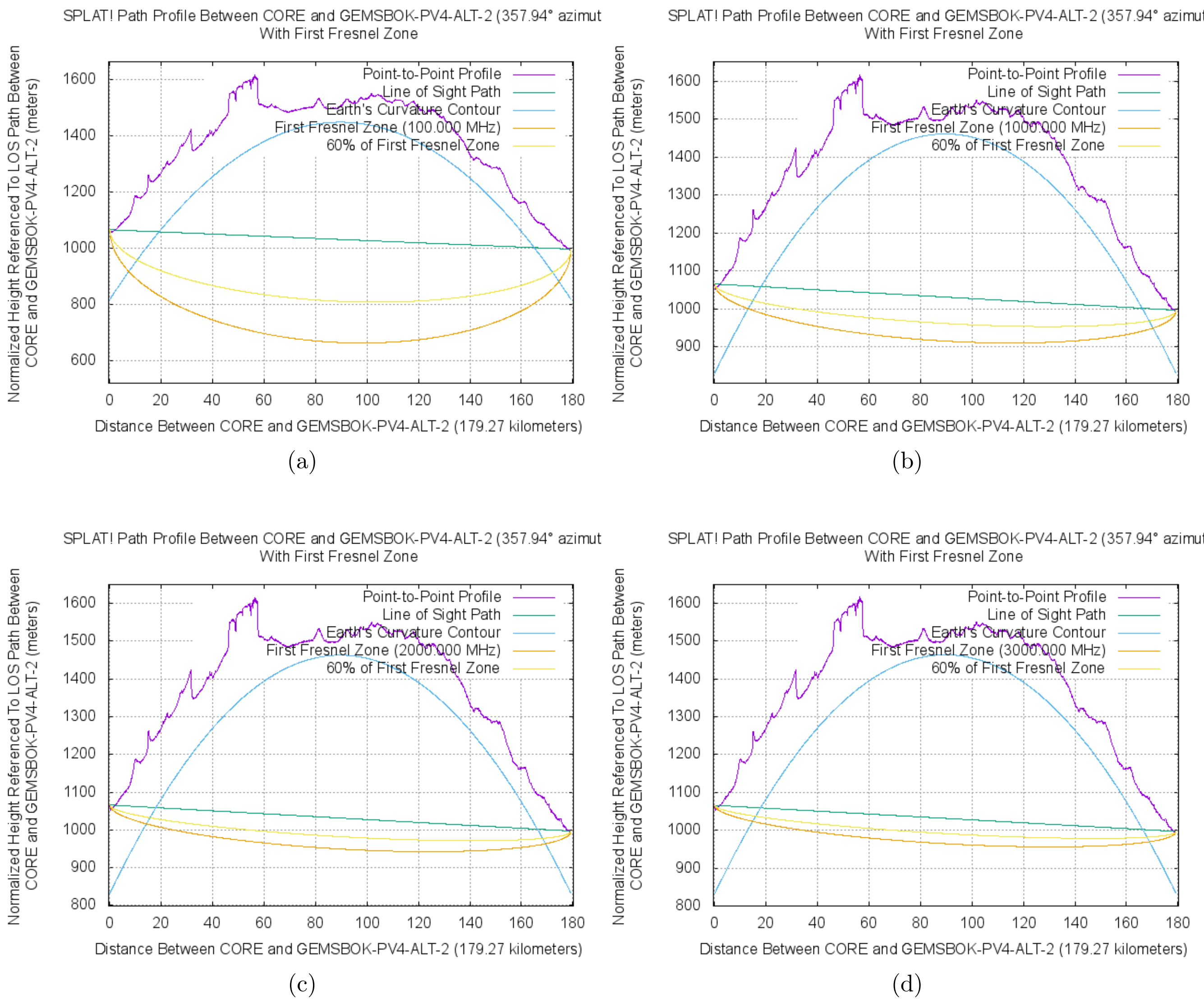
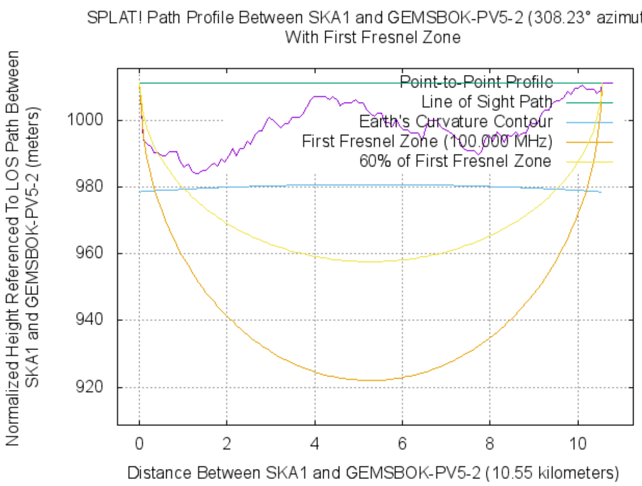
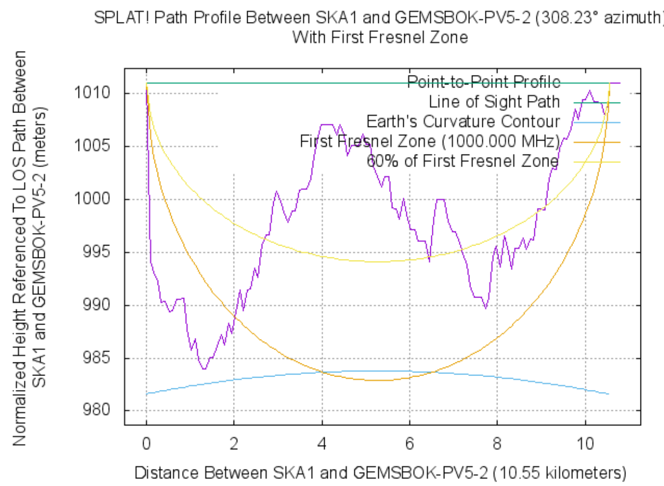


Figure 111: Fresnel zone, LOS and 60% of first Fresnel zone for site location of Gemsbok PV4 Alternative to the core SKA telescopes for (a) 100 MHz (b) 1000 MHz (c) 2000 MHz and (d) 3000 MHz.

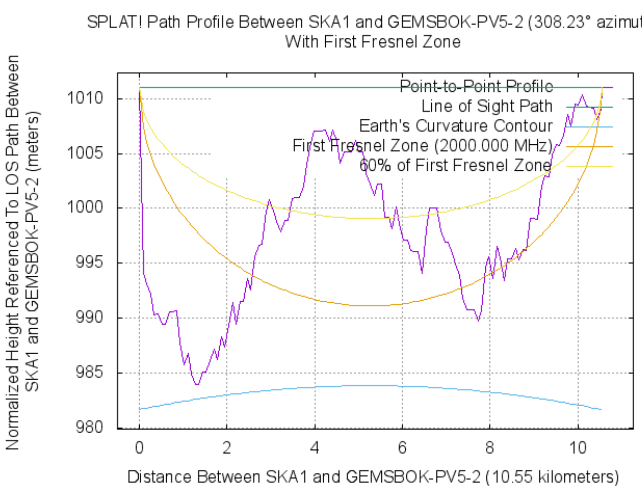
A.40 Gemsbok PV5 to Closest SKA



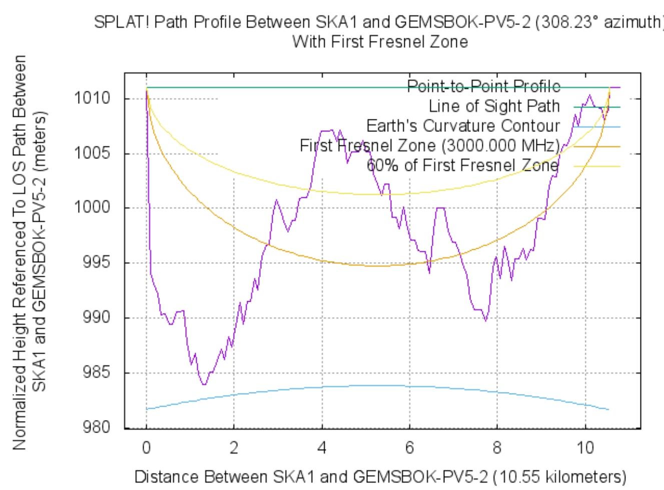
(a)



(b)



(c)



(d)

Figure 112: Fresnel zone, LOS and 60% of first Fresnel zone for site location of Gemsbok PV5 to the closest SKA telescope for (a) 100 MHz (b) 1000 MHz (c) 2000 MHz and (d) 3000 MHz.

A.41 Gemsbok PV5 to 2nd Closest SKA

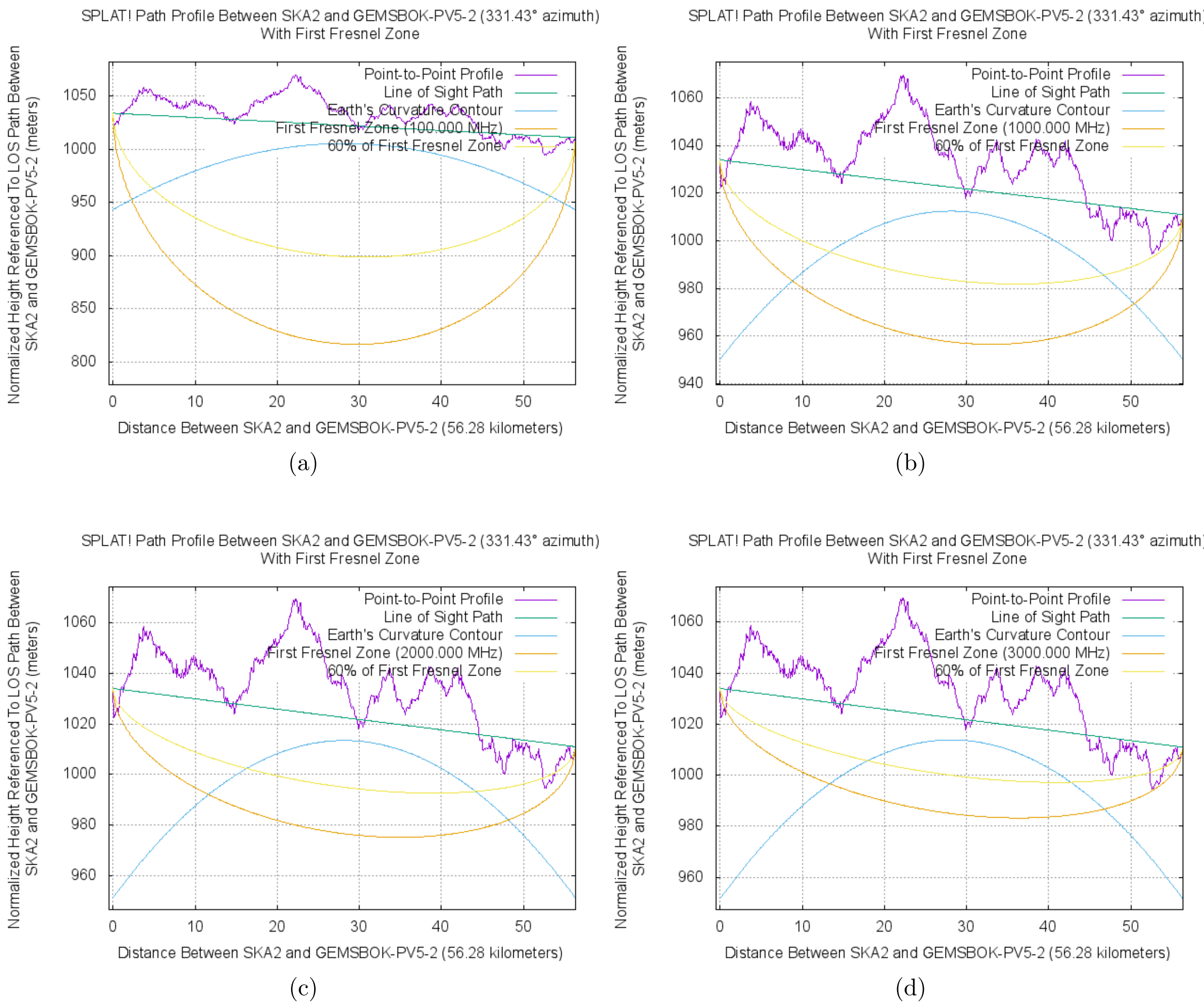


Figure 113: Fresnel zone, LOS and 60% of first Fresnel zone for site location of Gemsbok PV5 to the second closest SKA telescope for (a) 100 MHz (b) 1000 MHz (c) 2000 MHz and (d) 3000 MHz.

A.42 Gemsbok PV5 to Core SKA

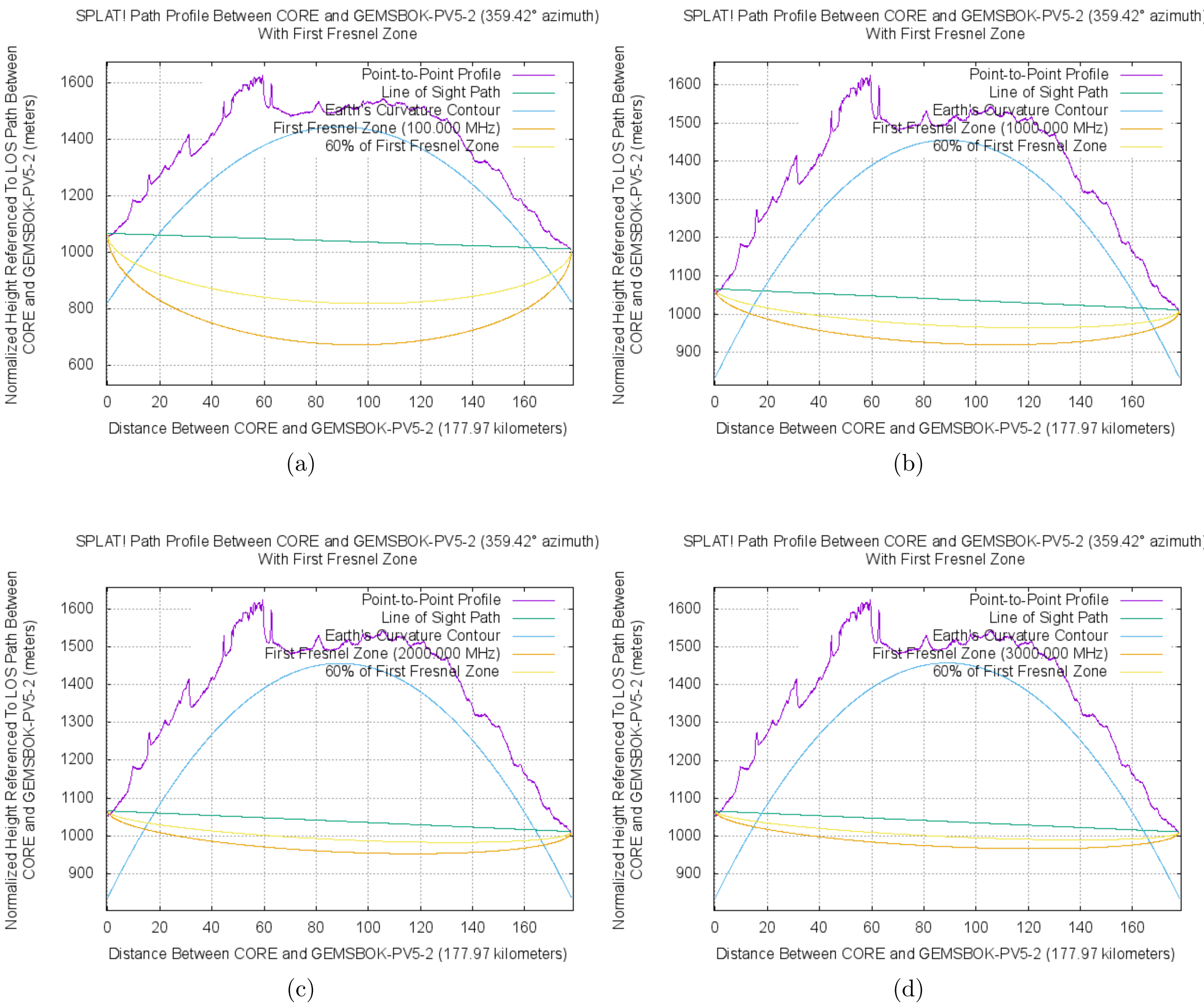
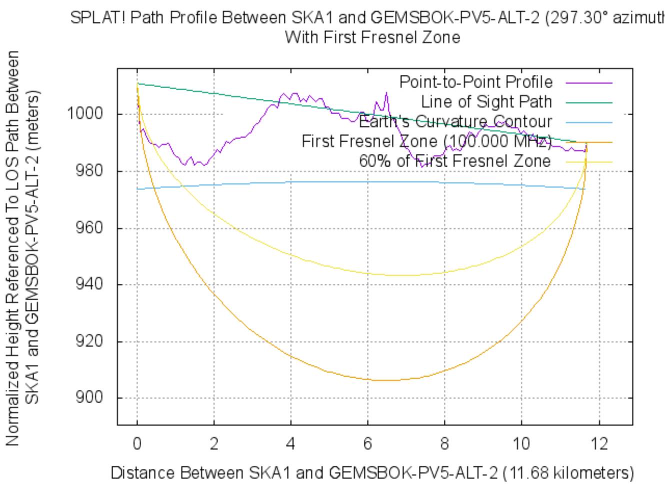
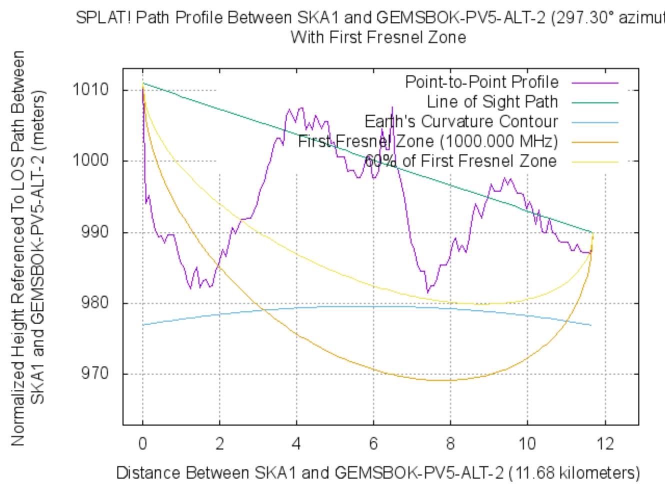


Figure 114: Fresnel zone, LOS and 60% of first Fresnel zone for site location of Gemsbok PV5 to the core SKA telescopes for (a) 100 MHz (b) 1000 MHz (c) 2000 MHz and (d) 3000 MHz.

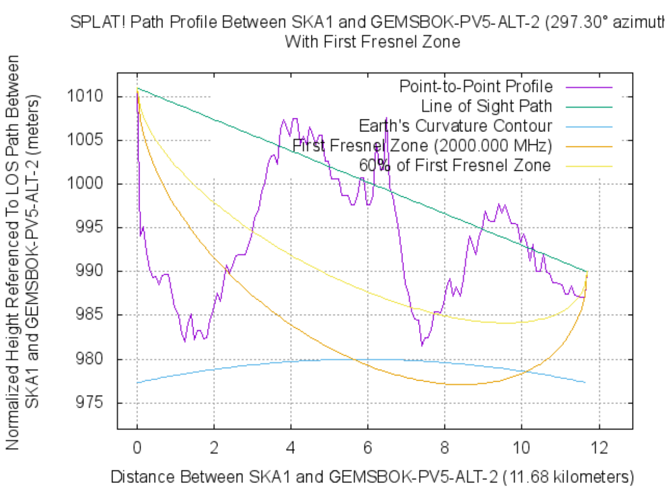
A.43 Gemsbok PV5 Alternative to Closest SKA



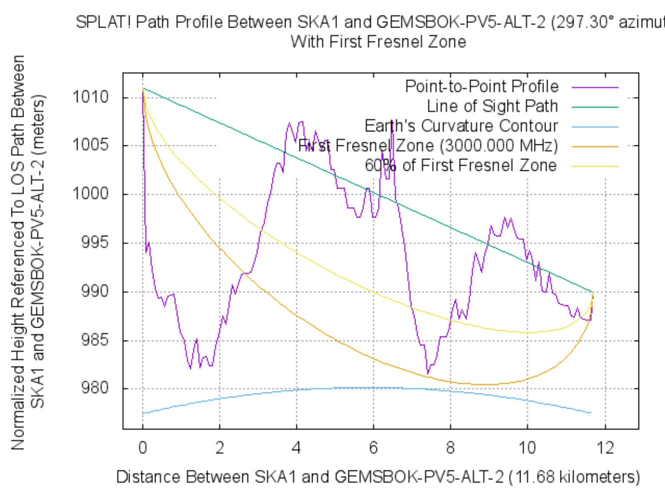
(a)



(b)



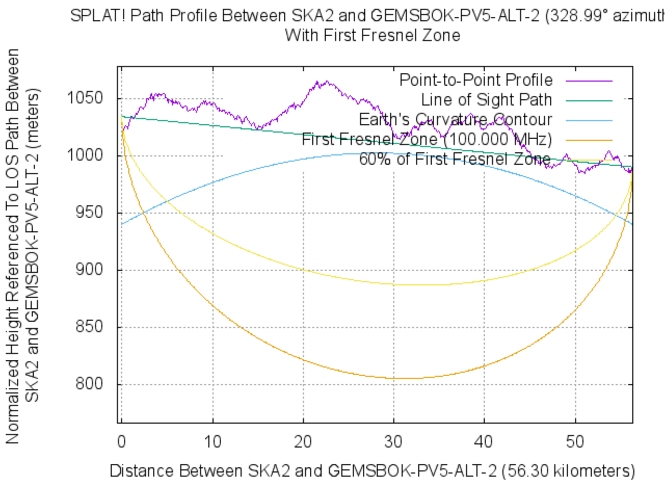
(c)



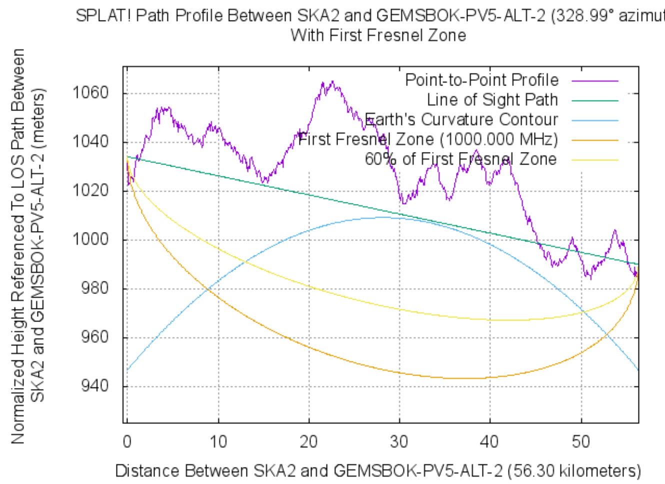
(d)

Figure 115: Fresnel zone, LOS and 60% of first Fresnel zone for site location of Gemsbok PV5 Alternative to the closest SKA telescope for (a) 100 MHz (b) 1000 MHz (c) 2000 MHz and (d) 3000 MHz.

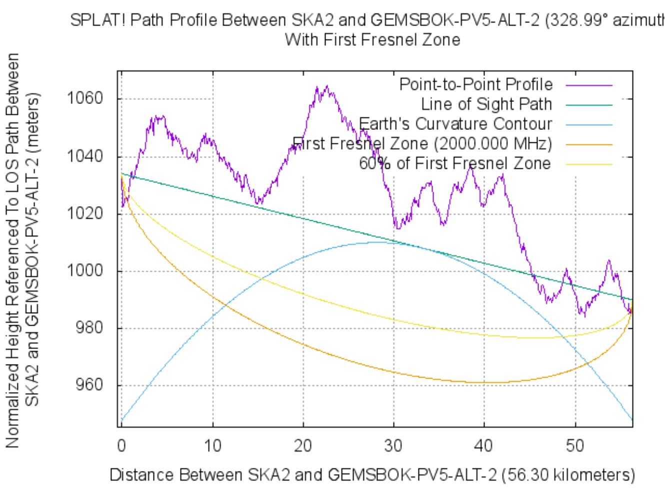
A.44 Gemsbok PV5 Alternative to 2nd Closest SKA



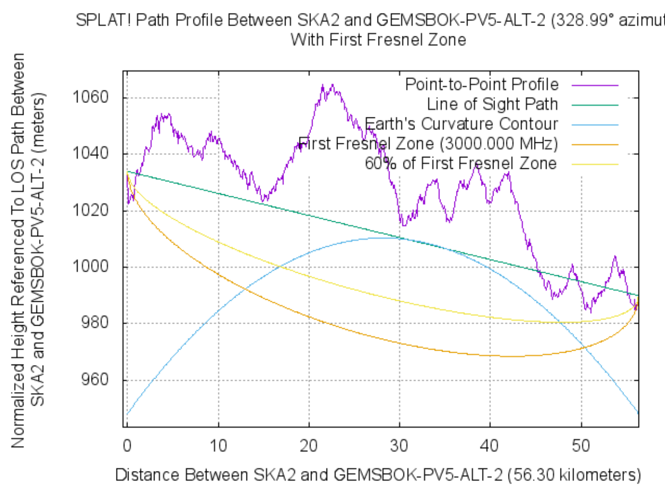
(a)



(b)



(c)



(d)

Figure 116: Fresnel zone, LOS and 60% of first Fresnel zone for site location of Gemsbok PV5 Alternative to the second closest SKA telescope for (a) 100 MHz (b) 1000 MHz (c) 2000 MHz and (d) 3000 MHz.

A.45 Gemsbok PV5 Alternative to Core SKA

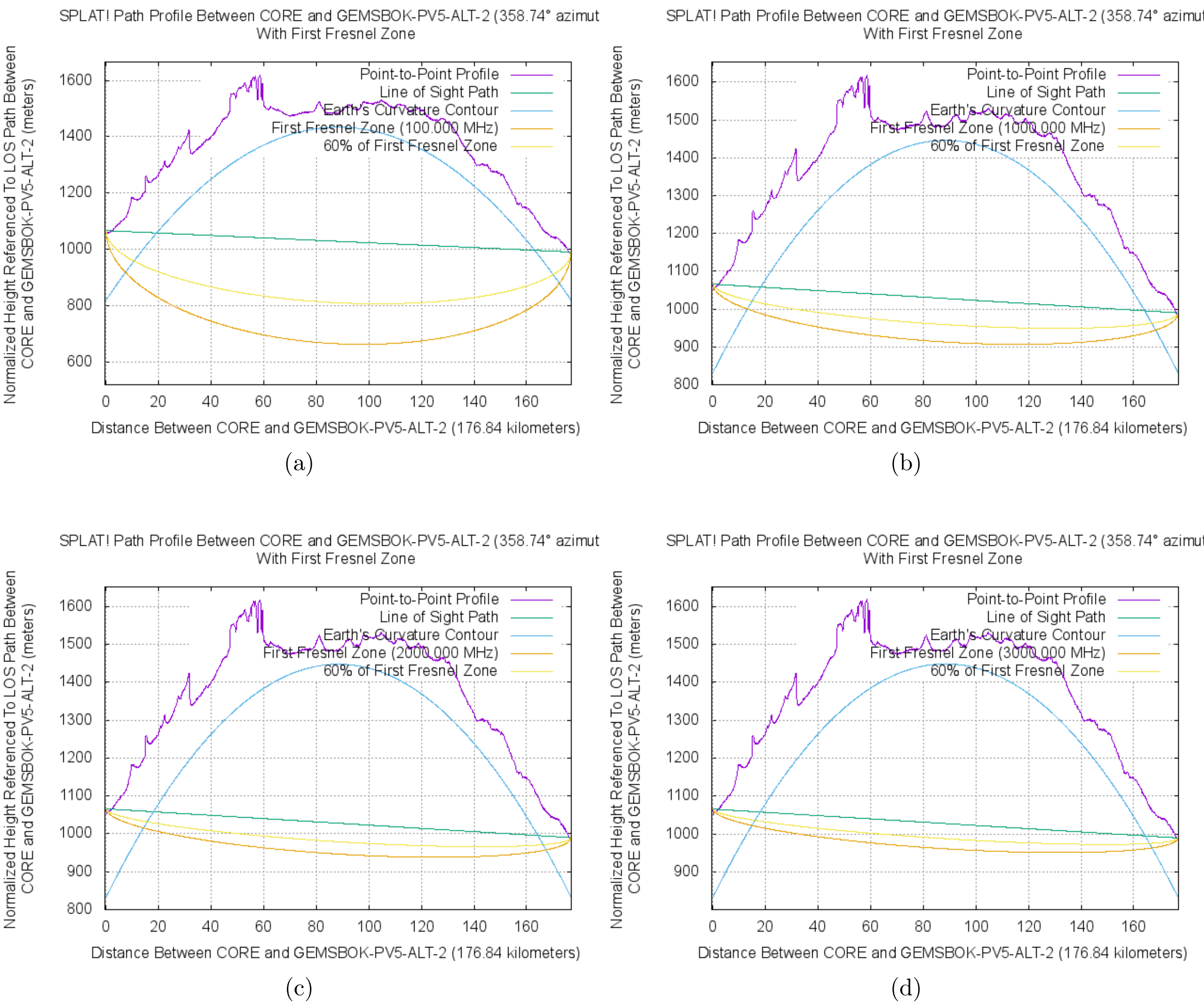


Figure 117: Fresnel zone, LOS and 60% of first Fresnel zone for site location of Gemsbok PV5 Alternative to the core SKA telescopes for (a) 100 MHz (b) 1000 MHz (c) 2000 MHz and (d) 3000 MHz.

A.46 Gemsbok PV6 to Closest SKA

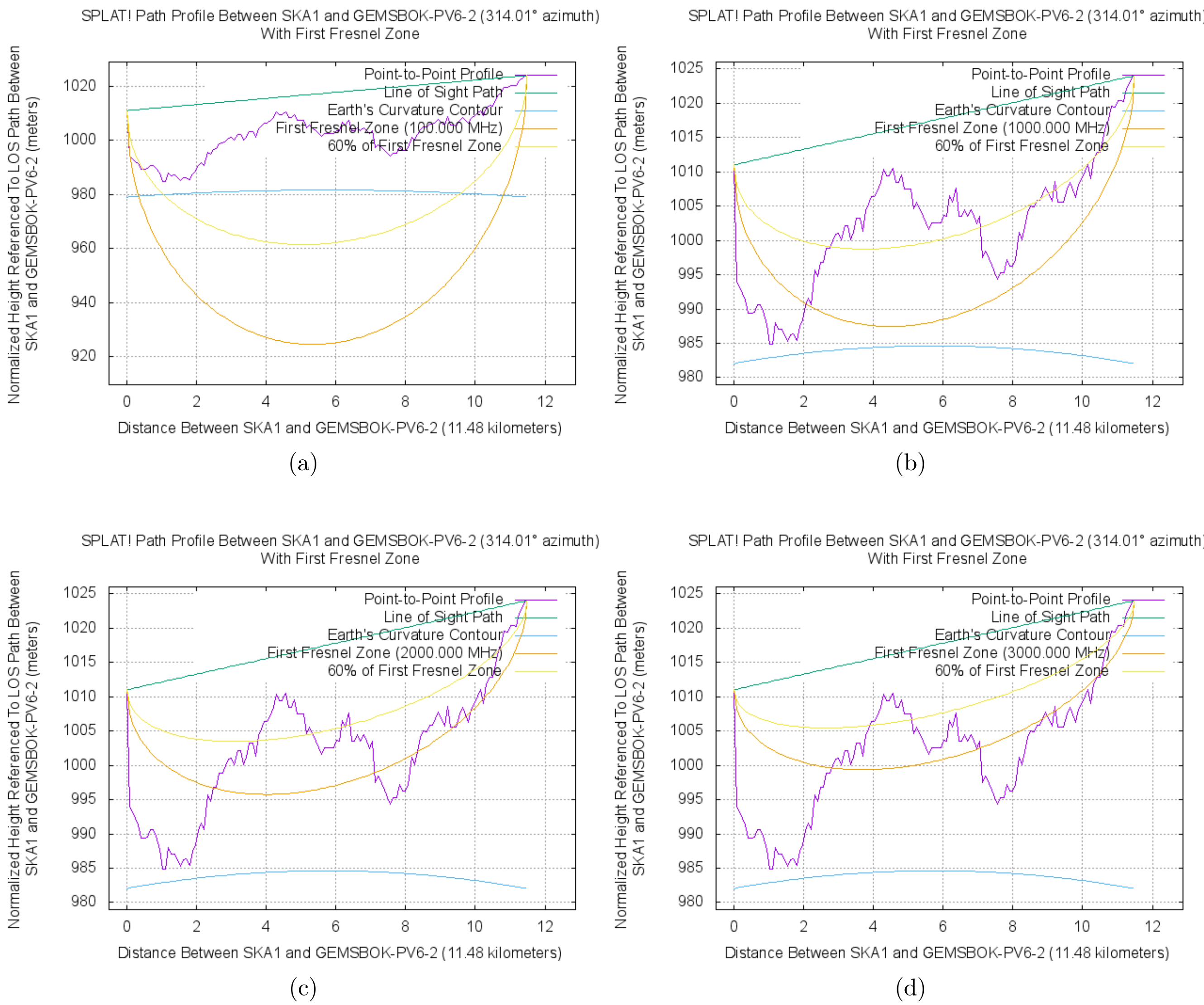
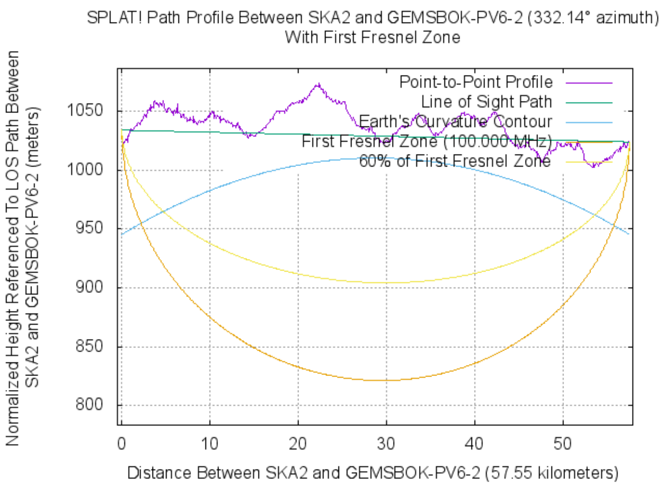
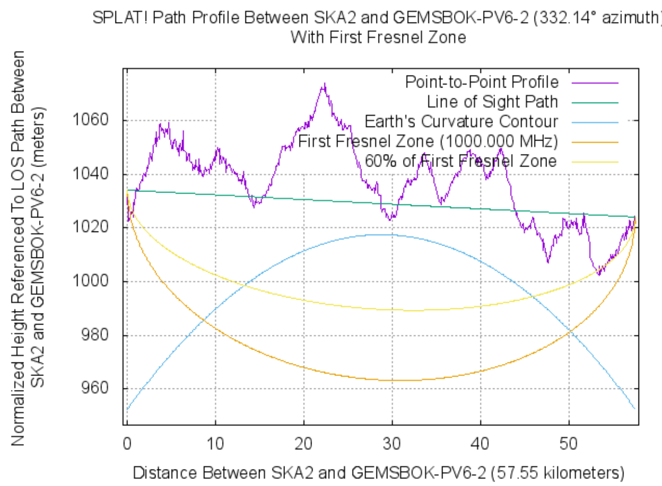


Figure 118: Fresnel zone, LOS and 60% of first Fresnel zone for site location of Gemsbok PV6 to the closest SKA telescope for (a) 100 MHz (b) 1000 MHz (c) 2000 MHz and (d) 3000 MHz.

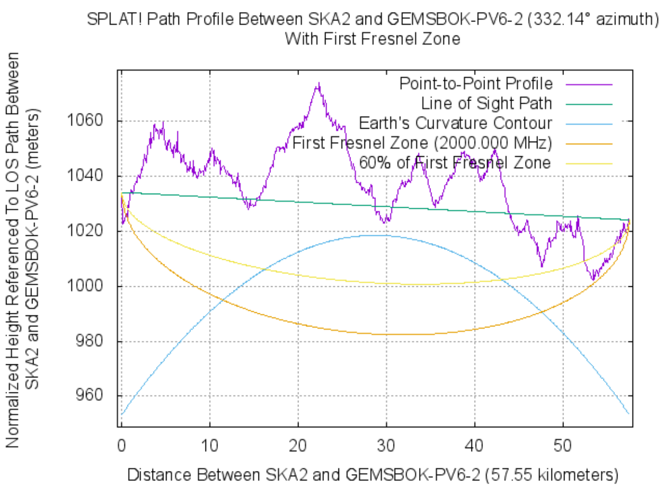
A.47 Gemsbok PV6 to 2nd Closest SKA



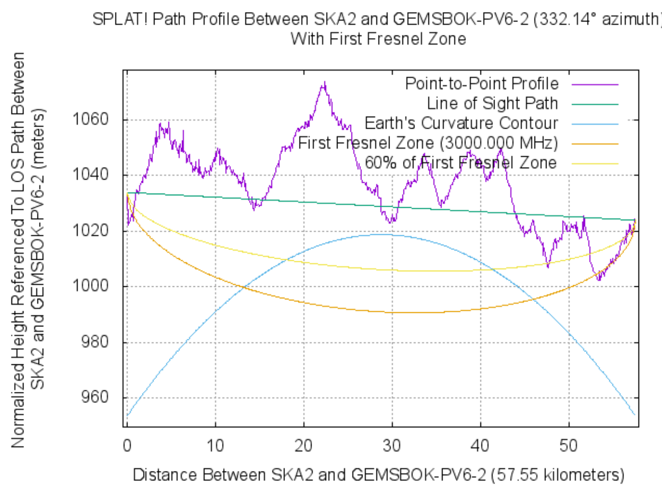
(a)



(b)



(c)



(d)

Figure 119: Fresnel zone, LOS and 60% of first Fresnel zone for site location of Gemsbok PV6 to the second closest SKA telescope for (a) 100 MHz (b) 1000 MHz (c) 2000 MHz and (d) 3000 MHz.

A.48 Gemsbok PV6 to Core SKA

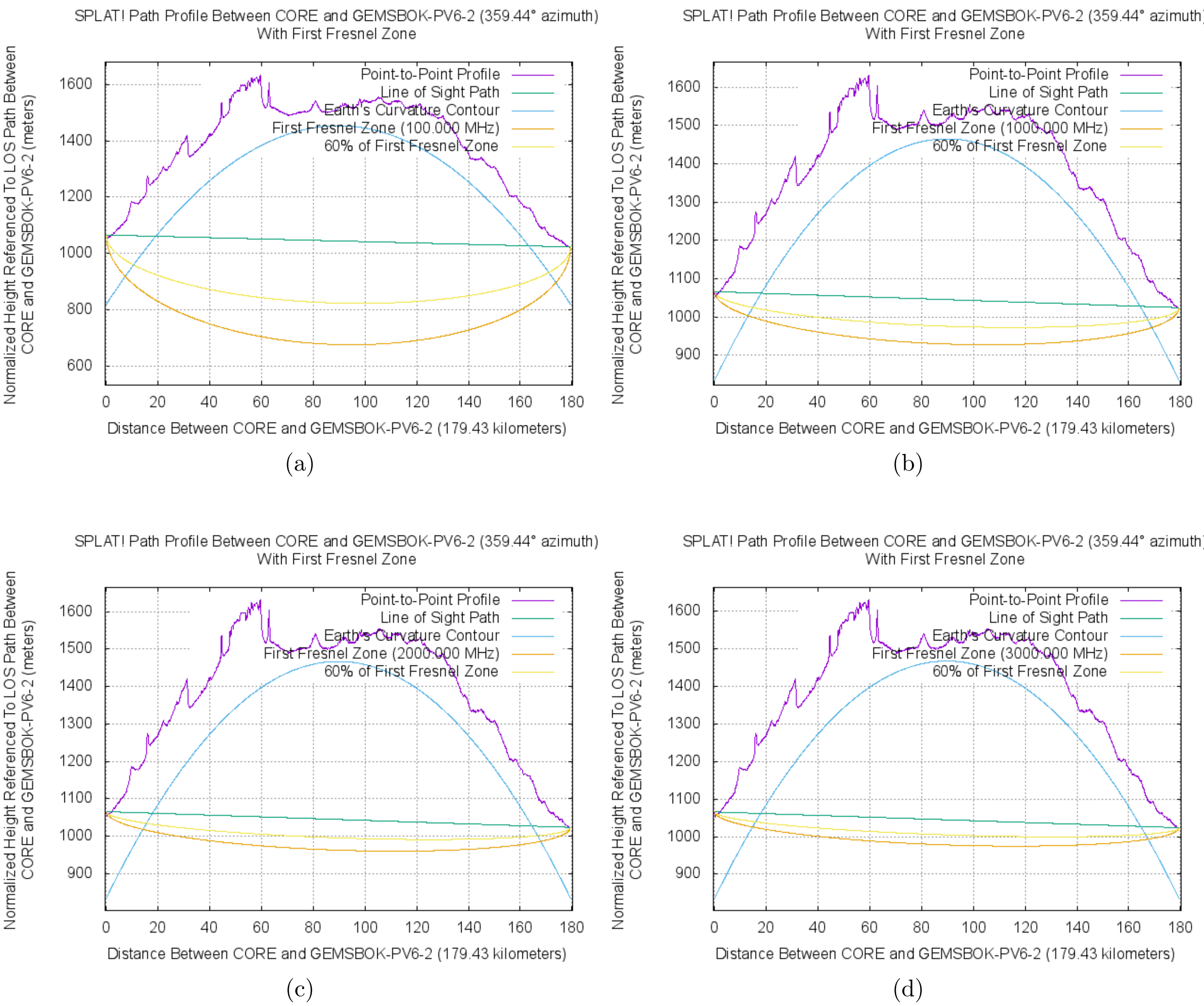


Figure 120: Fresnel zone, LOS and 60% of first Fresnel zone for site location of Gemsbok PV6 to the core SKA telescopes for (a) 100 MHz (b) 1000 MHz (c) 2000 MHz and (d) 3000 MHz.

A.49 Gemsbok PV6 Alternative to Closest SKA

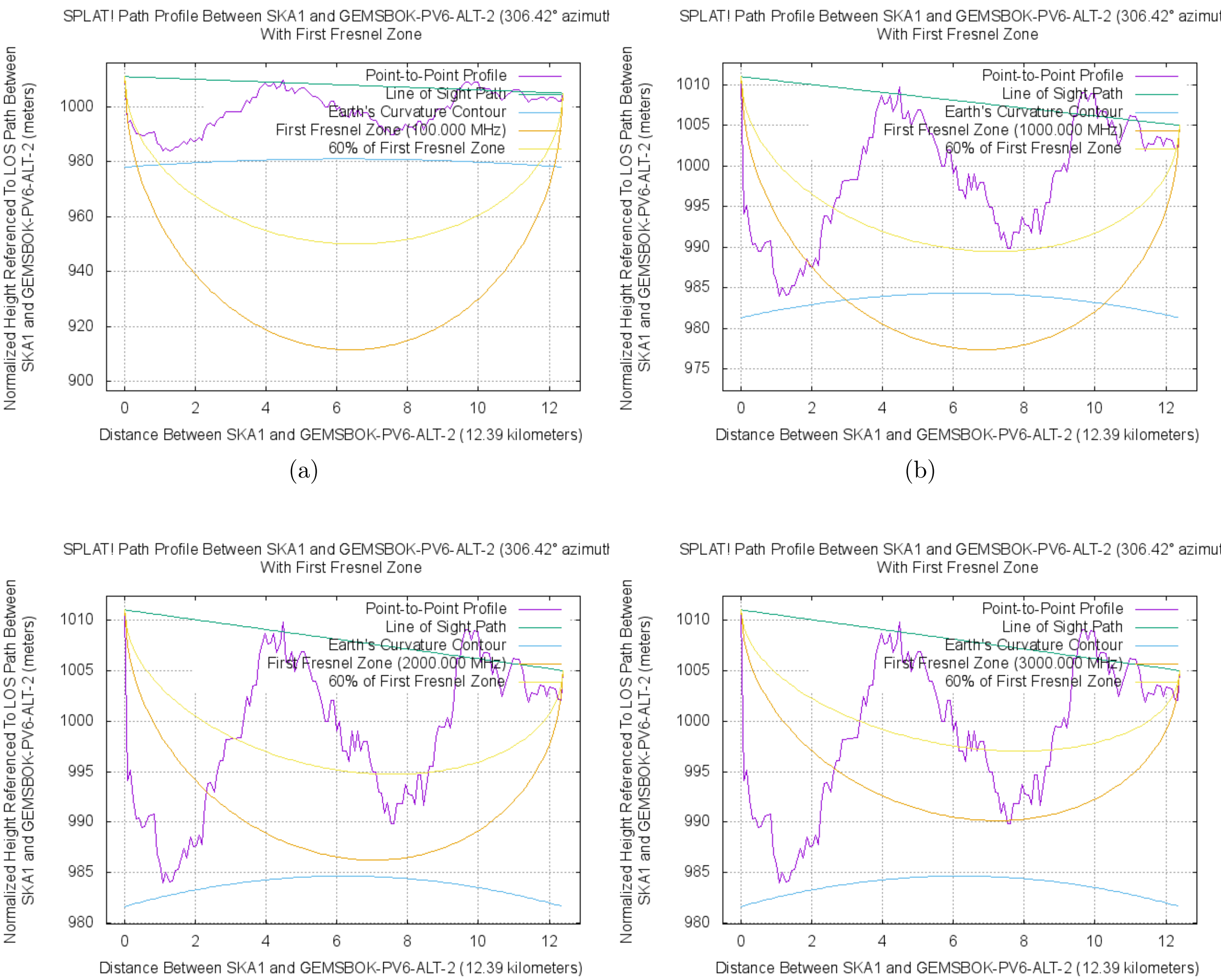


Figure 121: Fresnel zone, LOS and 60% of first Fresnel zone for site location of Gemsbok PV6 Alternative to the closest SKA telescope for (a) 100 MHz (b) 1000 MHz (c) 2000 MHz and (d) 3000 MHz.

A.50 Gemsbok PV6 Alternative to 2nd Closest SKA

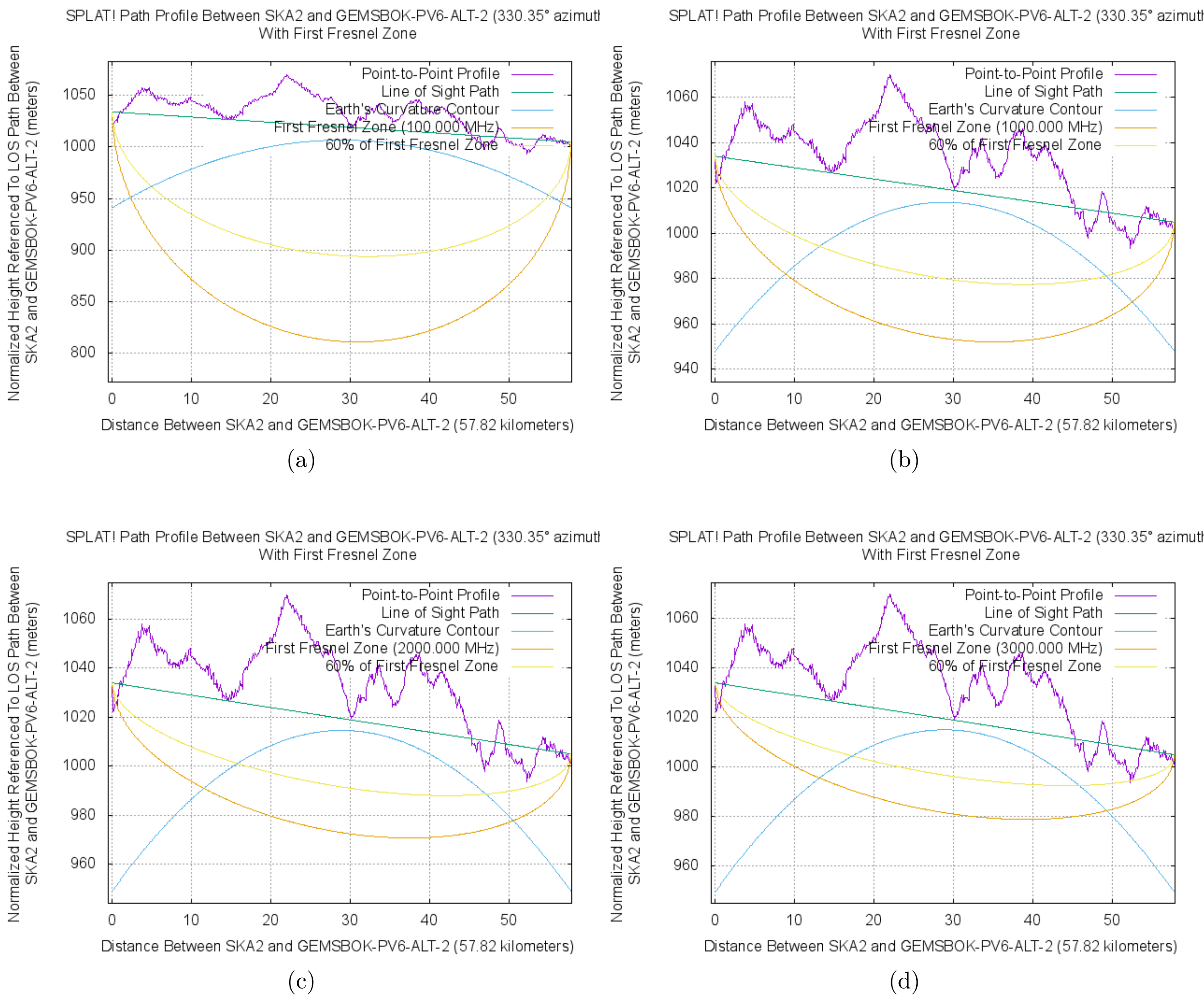


Figure 122: Fresnel zone, LOS and 60% of first Fresnel zone for site location of Gemsbok PV6 Alternative to the second closest SKA telescope for (a) 100 MHz (b) 1000 MHz (c) 2000 MHz and (d) 3000 MHz.

A.51 Gemsbok PV6 Alternative to Core SKA

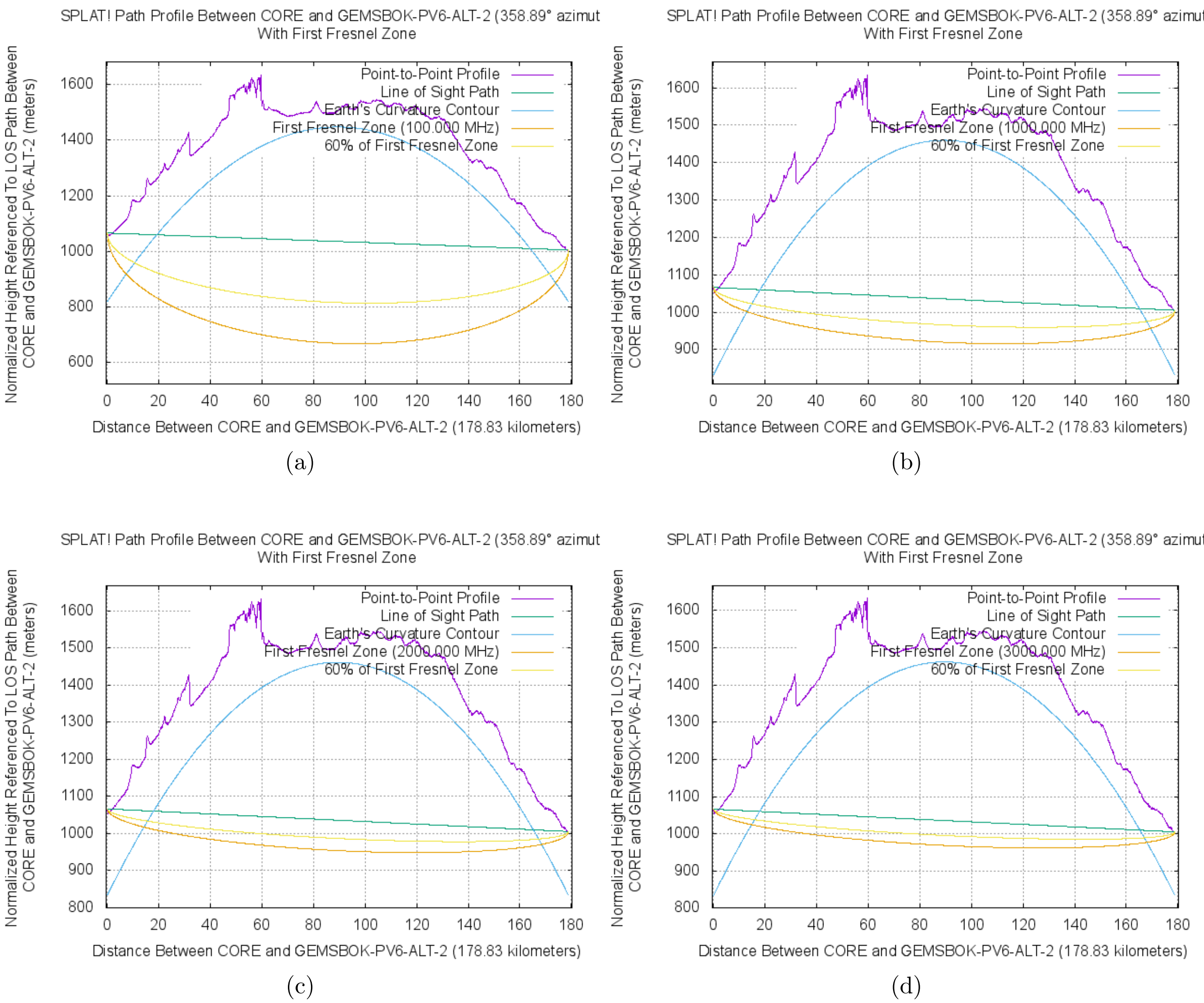
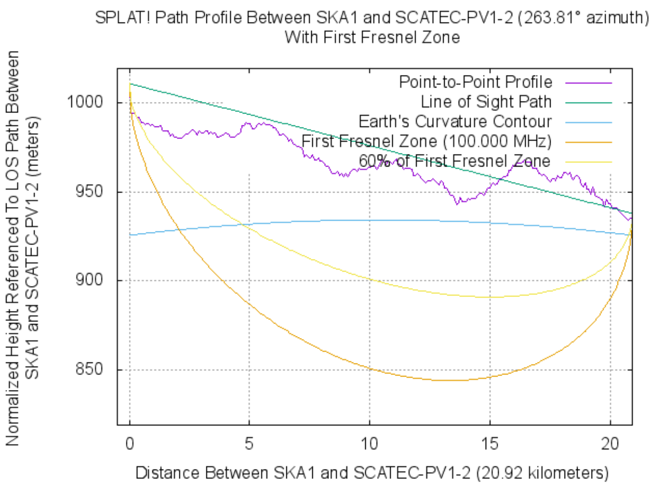
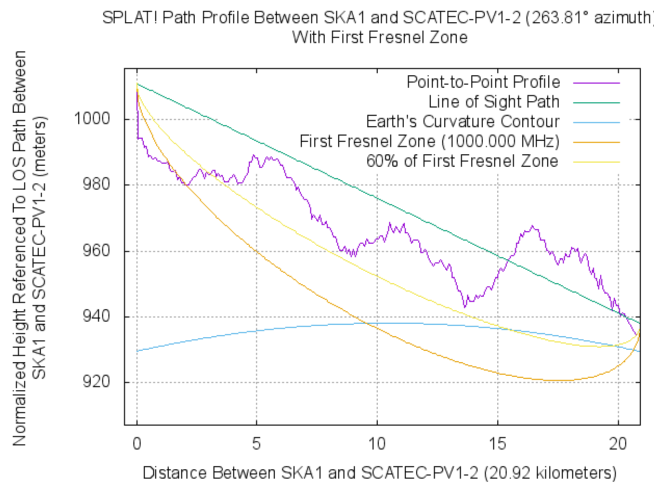


Figure 123: Fresnel zone, LOS and 60% of first Fresnel zone for site location of Gemsbok PV6 Alternative to the core SKA telescopes for (a) 100 MHz (b) 1000 MHz (c) 2000 MHz and (d) 3000 MHz.

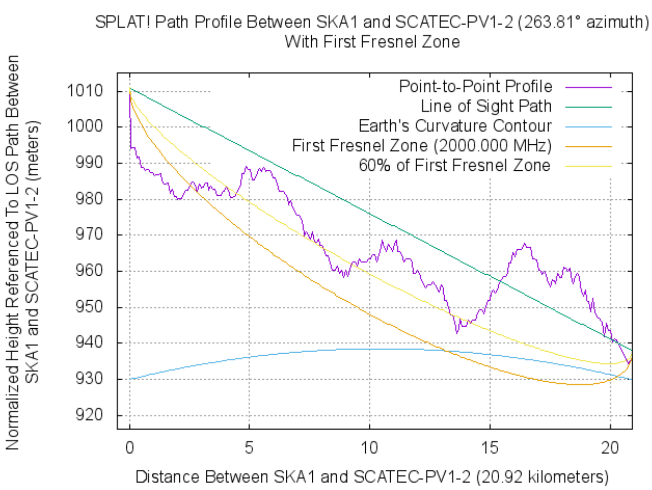
A.52 Scatec PV1 to Closest SKA



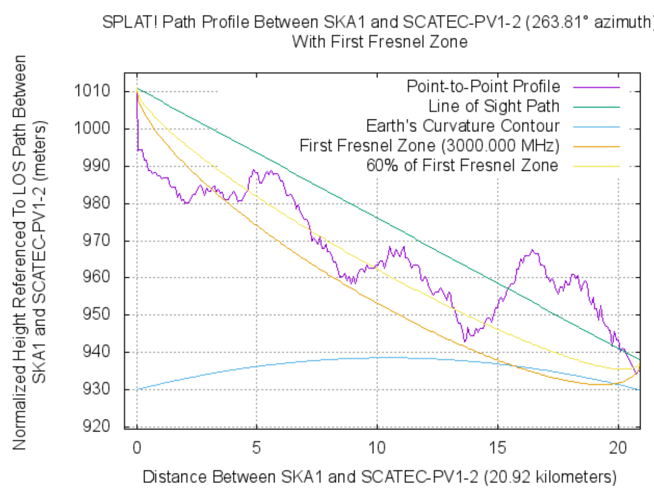
(a)



(b)



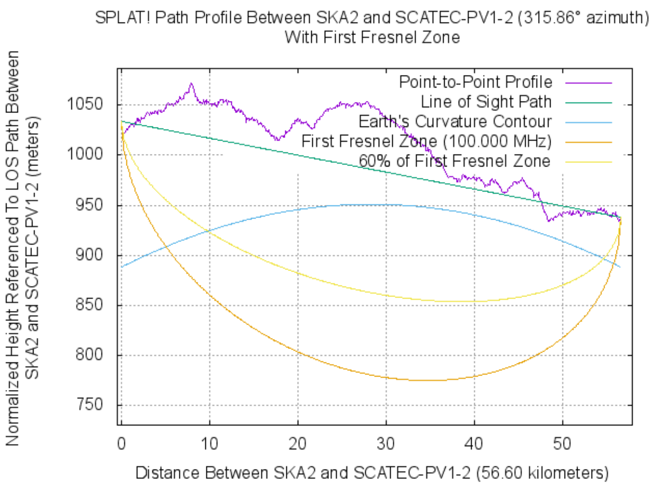
(c)



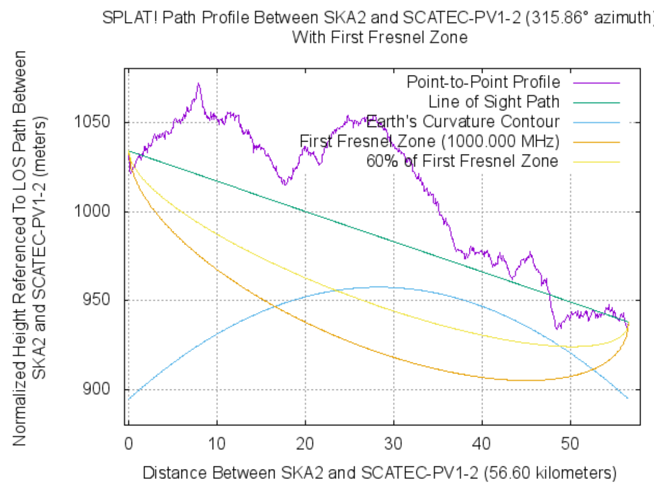
(d)

Figure 124: Fresnel zone, LOS and 60% of first Fresnel zone for site location of Scatec PV1 to the closest SKA telescope for (a) 100 MHz (b) 1000 MHz (c) 2000 MHz and (d) 3000 MHz.

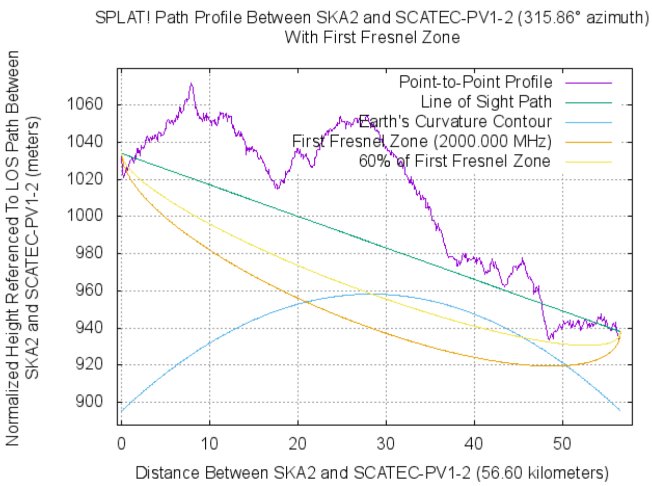
A.53 Scatec PV1 to 2nd Closest SKA



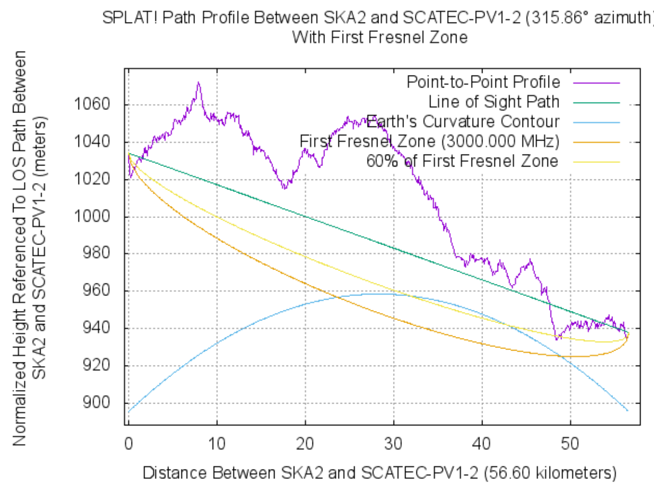
(a)



(b)



(c)



(d)

Figure 125: Fresnel zone, LOS and 60% of first Fresnel zone for site location of Scatec PV1 to the second closest SKA telescope for (a) 100 MHz (b) 1000 MHz (c) 2000 MHz and (d) 3000 MHz.

A.54 Scatec PV1 to Core SKA

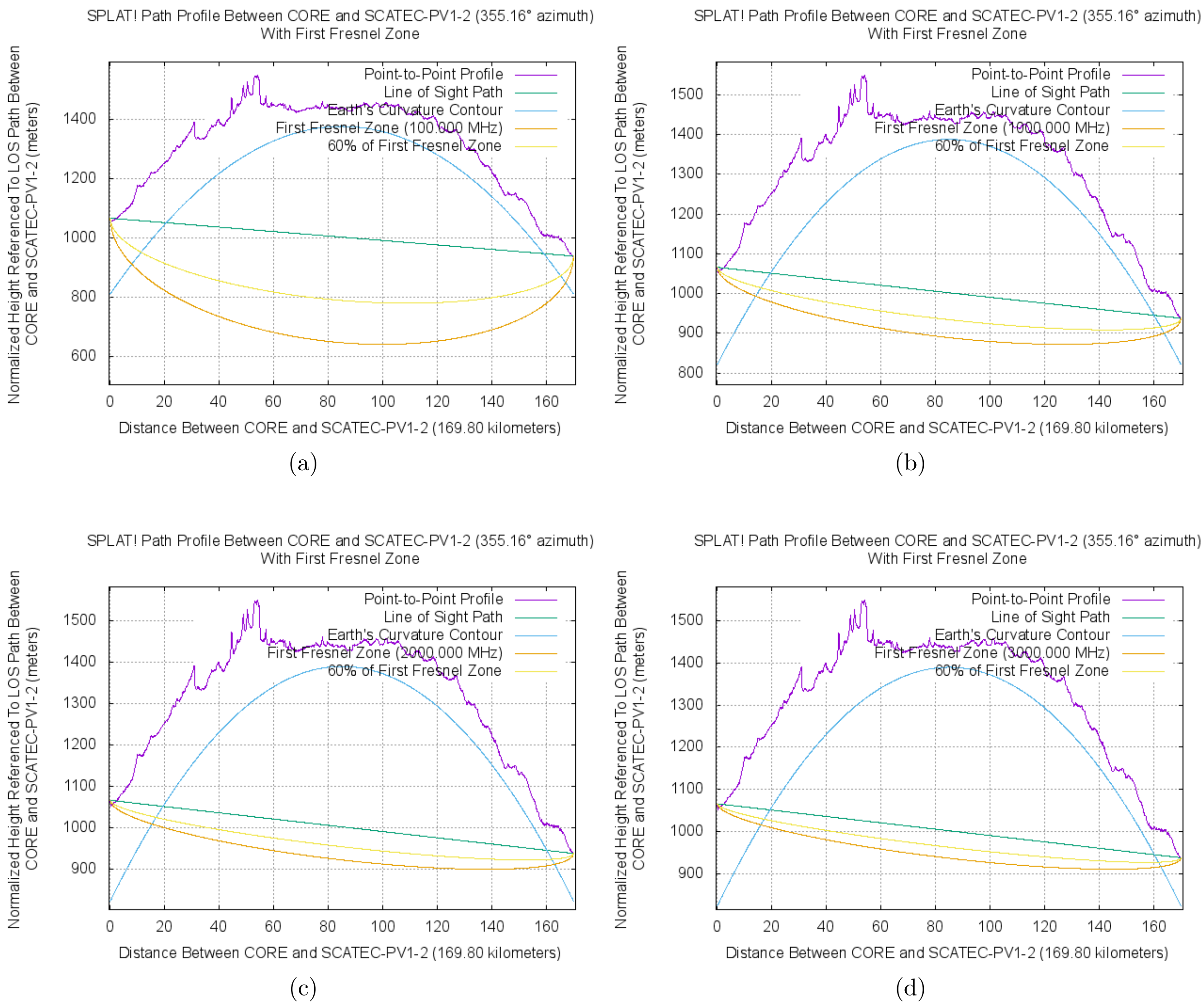


Figure 126: Fresnel zone, LOS and 60% of first Fresnel zone for site location of Scatec PV1 to the core SKA telescopes for (a) 100 MHz (b) 1000 MHz (c) 2000 MHz and (d) 3000 MHz.

A.55 Scatec PV2 to Closest SKA

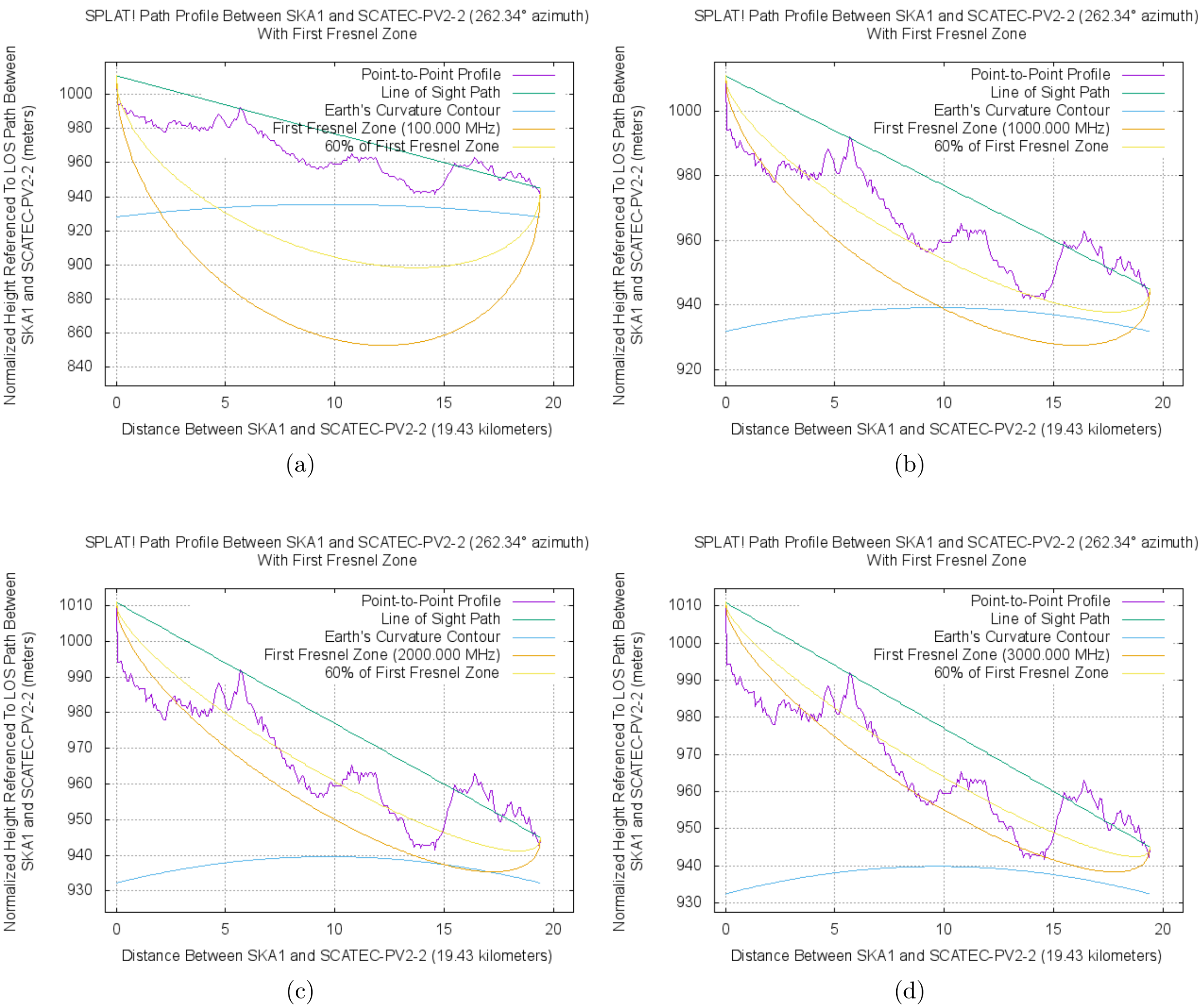


Figure 127: Fresnel zone, LOS and 60% of first Fresnel zone for site location of Scatec PV2 to the closest SKA telescope for (a) 100 MHz (b) 1000 MHz (c) 2000 MHz and (d) 3000 MHz.

A.56 Scatec PV2 to 2nd Closest SKA

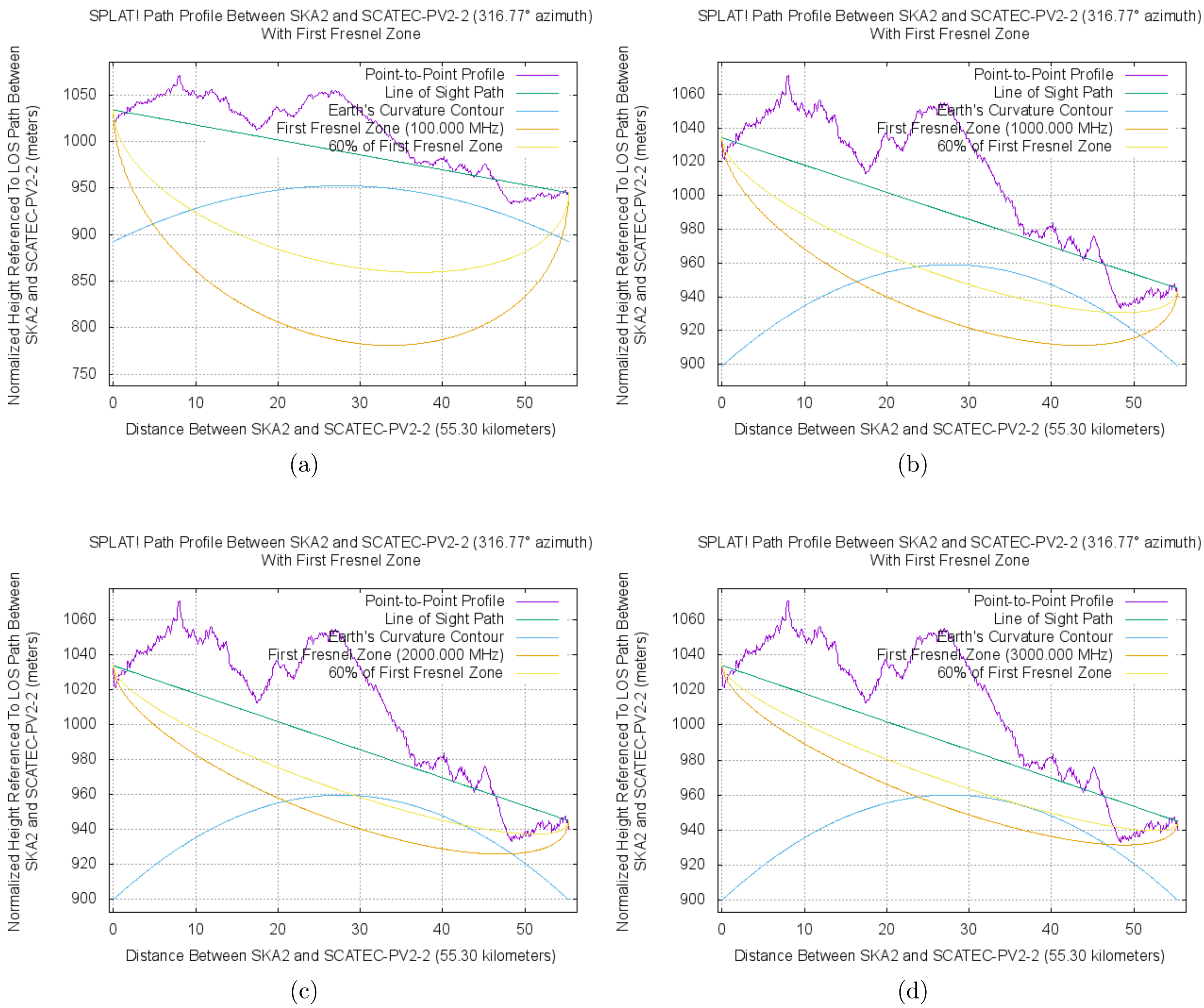


Figure 128: Fresnel zone, LOS and 60% of first Fresnel zone for site location of Scatec PV2 to the second closest SKA telescope for (a) 100 MHz (b) 1000 MHz (c) 2000 MHz and (d) 3000 MHz.

A.57 Scatec PV2 to Core SKA

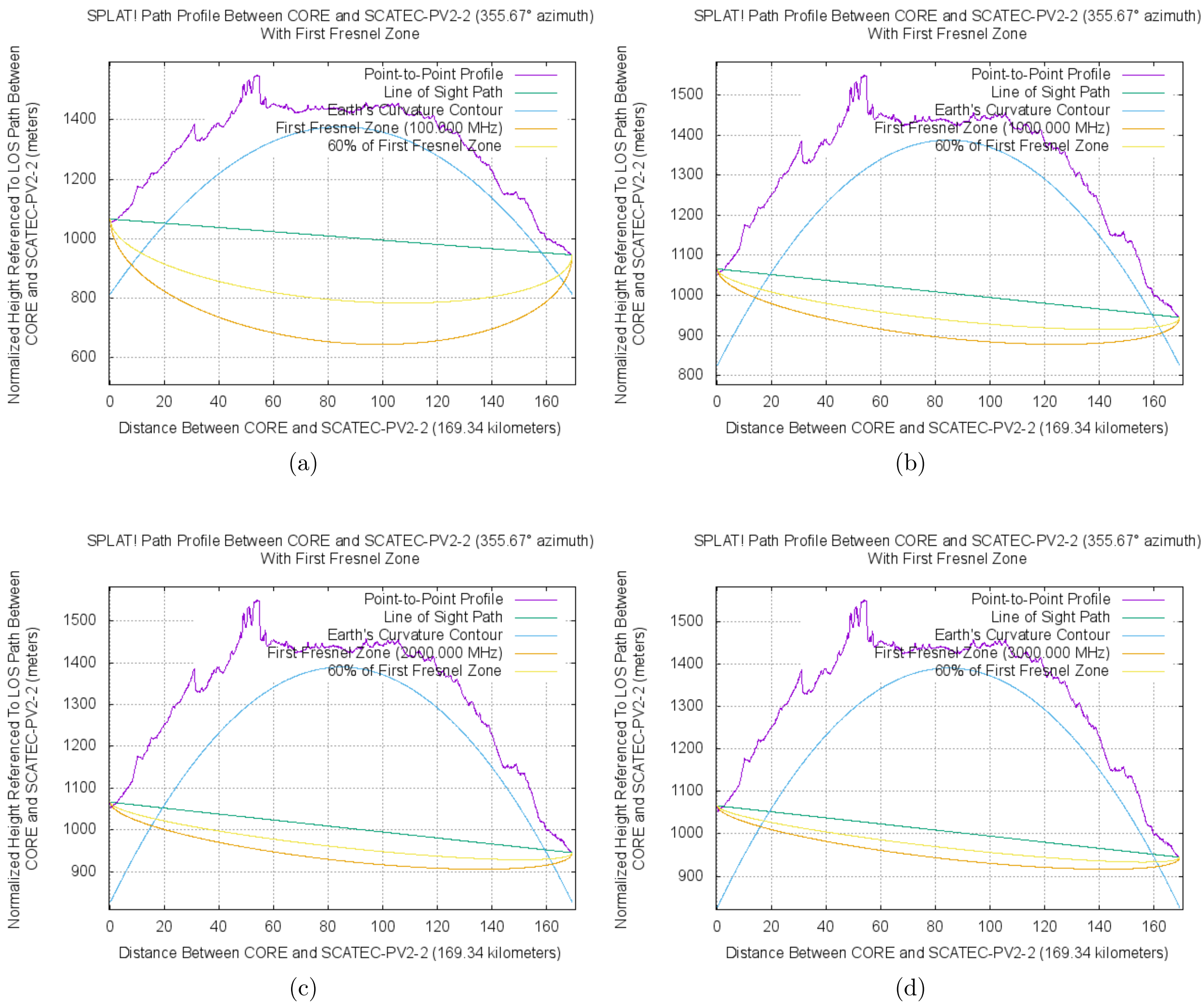


Figure 129: Fresnel zone, LOS and 60% of first Fresnel zone for site location of Scatec PV2 to the core SKA telescopes for (a) 100 MHz (b) 1000 MHz (c) 2000 MHz and (d) 3000 MHz.

A.58 Scatec PV3 to Closest SKA

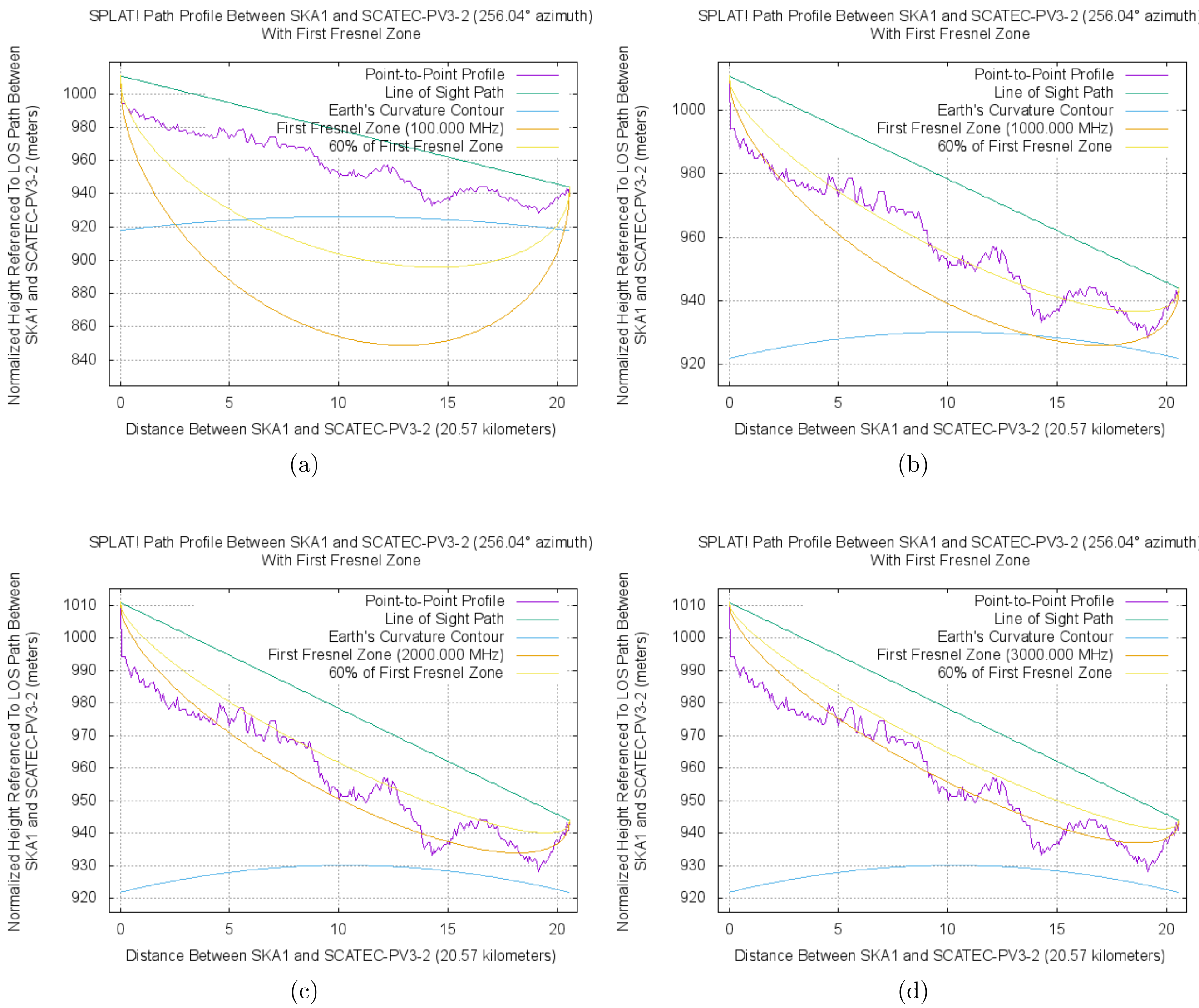


Figure 130: Fresnel zone, LOS and 60% of first Fresnel zone for site location of Scatec PV3 to the closest SKA telescope for (a) 100 MHz (b) 1000 MHz (c) 2000 MHz and (d) 3000 MHz.

A.59 Scatec PV3 to 2nd Closest SKA

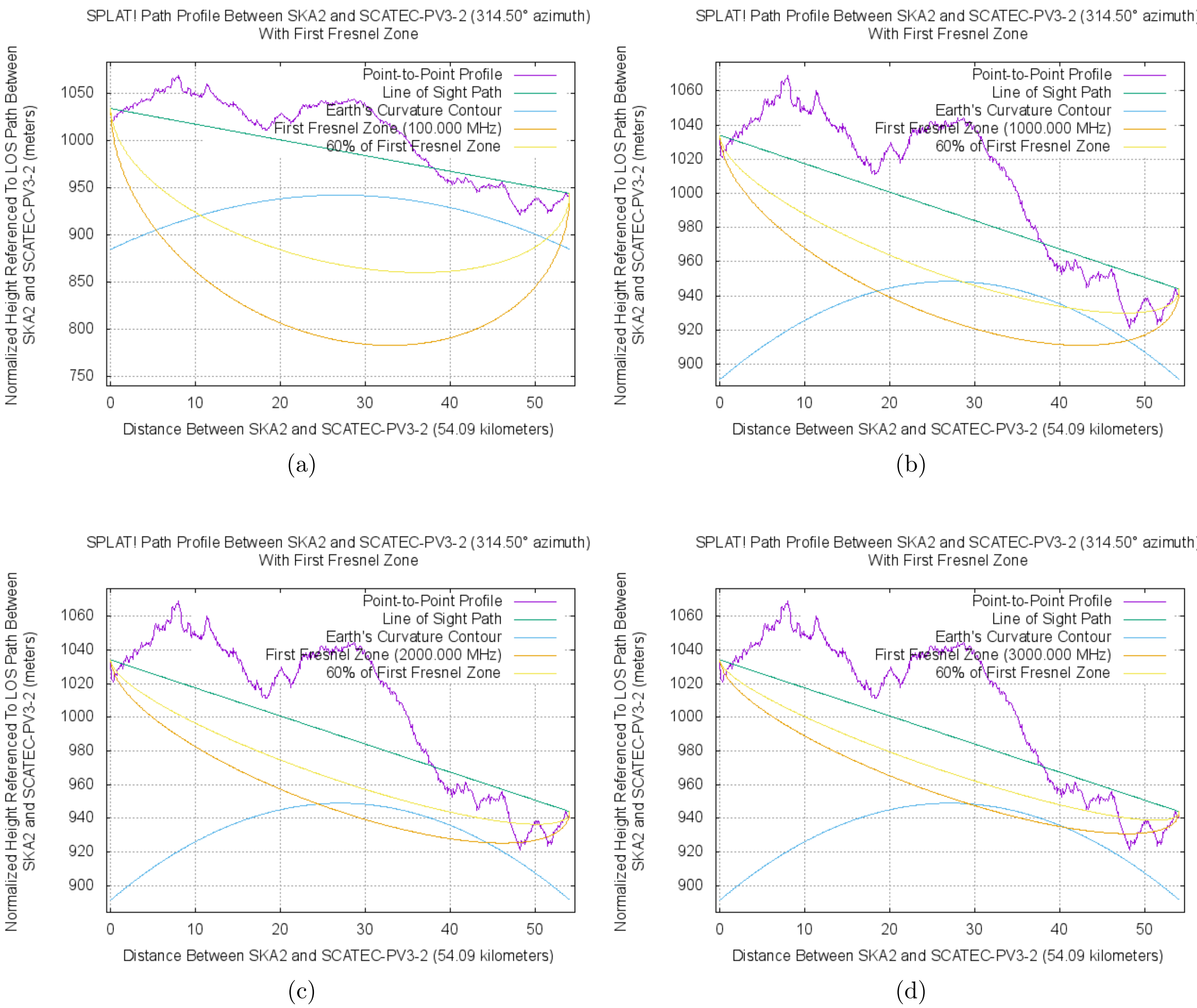


Figure 131: Fresnel zone, LOS and 60% of first Fresnel zone for site location of Scatec PV3 to the second closest SKA telescope for (a) 100 MHz (b) 1000 MHz (c) 2000 MHz and (d) 3000 MHz.

A.60 Scatec PV3 to Core SKA

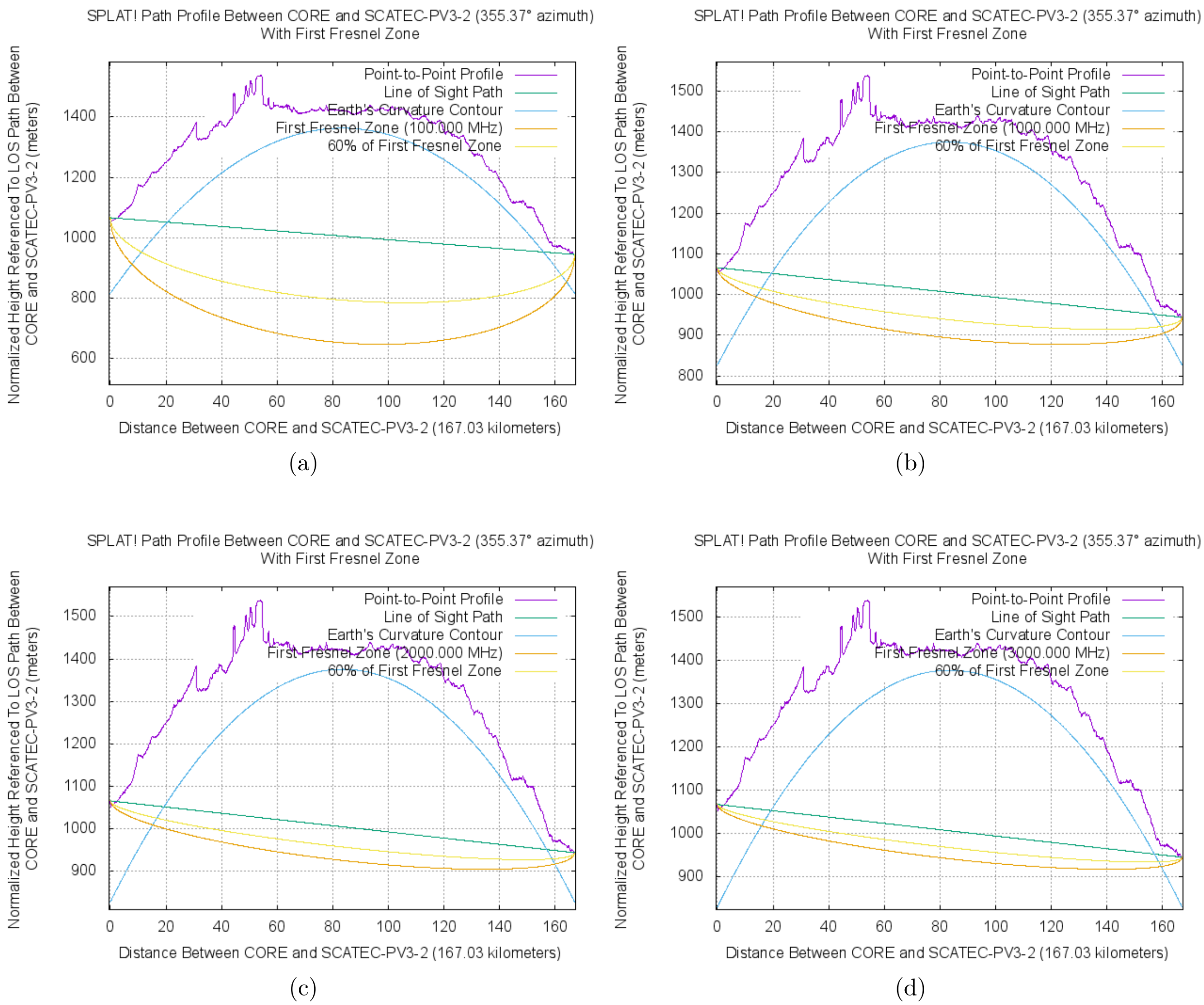


Figure 132: Fresnel zone, LOS and 60% of first Fresnel zone for site location of Scatec PV3 to the core SKA telescopes for (a) 100 MHz (b) 1000 MHz (c) 2000 MHz and (d) 3000 MHz.