ZITHOLELE CONSULTING ON BEHALF OF ESKOM HOLDINGS

D615 - SOLAR INTEGRATION PROJECT
ENVIRONMENTAL IMPACT ASSESSMENT
DRAFT BIOPHYSICAL REPORT

REFERENCE NUMBER: D615

Report No.: JW194/12/D615

14 February 2013

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EXECUTIVE SUMMARY

Zitholele Consulting On Behalf Of Eskom Holdings has appointed Jones and Wagener (Pty) Ltd (J&W), an independent company, to conduct an Environmental Impact Assessment (EIA) to evaluate the potential environmental and social impacts of the proposed project. The Environmental Assessment Practitioner (EAP) is Konrad Kruger.

This report aims to identify the surface water, terrestrial ecology and soils that could be impacted by the proposed Solar Integration Project. From the detailed assessments it became clear that the bulk of the sensitivities in the study area are located around the Orange River, where the sensitive habitats as well as the main farming activities occur. The Orange River is also the only perennial water body in the area and of utmost importance to the Province.

The routes to Ferrum provided a different environment with the occurrence of the red Kalahari sands and in some cases dunes. These red sands are susceptible to erosion and also “shifting”, and could be a tricky obstacle when constructing.

As a whole the study area is devoid of access routes and access to the alternatives that are far from existing provincial or national roads might be problematic.

The study identified preferred alternatives for each route, based on the potential impacts to sensitive features along the routes. In addition mitigation and management measures were proposed for each of the criteria assessed and with the successful implementation of these measures, it is the opinion of the consultant that the impacts from this proposed development are within the acceptable range.

CONTENTS **PAGE**

LIST OF TABLES

LIST OF FIGURES

APPENDICES

APPENDIX A – SPECIES LISTS

APPENDIX B – OTHER

TERMS AND ABBREVIATIONS

ARC .... Agricultural Research Council
ASPT .... Average Score per Taxon
BA .... Basic Assessment
BMWP .... Biological Monitoring Working Party
CBA .... Critical Biodiversity Area
CSP .... Concentrating Solar Power
DAFF .... Department of Agriculture, Forestry and Fisheries
DEA .... Department of Environmental Affairs
DEMC .... Default Ecological Management Classes
DoE .... Department of Energy
DWEA .... Department of Water and Environmental Affairs
DWA .... Department of Water Affairs
DWAF .... Department of Water Affairs and Forestry
EA .... Environmental Authorisation
EAP .... Environmental Assessment Practitioner
EIA .... Environmental Impact Assessment
EIR .... Environmental Impact Report
EMPr .... Environmental Management Program (NEMA)
FAII .... Fish Assemblage Integrity Index
GIS .... Geographic Information Systems
GN .... Government Notice
HIA .... Heritage Impact Assessment
I&APs .... Interested and Affected Parties
IEM .... Integrated Environmental Management
IHAS .... Invertebrate Habitat Assessment System
IHIA .... Intermediate Habitat Integrity Assessment
IPP .... Independent Power Producer
IUCN .... International Union for Conservation of Nature
IWULA .... Integrated Water Use Licence Application
km .... kilometres
kV .... kilovolt
m .... metres
m^3 .... cubic metres
mamsl .... metres above mean sea level
NEMA .... National Environmental Management Act
NEM:BA .... National Environmental Management Biodiversity Act
NEM:WA .... National Environmental Management Waste Act

NFA .... National Forestry Act
NFEPA .... National Freshwater Ecosystem Priority Area
NWA .... National Water Act
PES .... Present Ecological Status
R .... Regulation
RoD .... Record of Decision
RVI .... Riparian Vegetation Index
S&EIR .... Scoping and Environmental Impact Reporting Process
SAHRA .... South African Heritage Resources Agency
SANBI .... South African National Biodiversity Institute
SAS .... Scientific Aquatic Services
SASS5 .... South African Scoring Standards version 5
SIA .... Social Impact Assessment
SR .... Scoping Report
ToR .... Terms of Reference
TWQR .... Target Water Quality Range
WUL .... Water Use Licence
WULA .... Water Use Licence Application

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1. INTRODUCTION

1.1 Background Information

Eskom Holdings SOC Limited (Eskom) is the main South African utility that generates, transmits and distributes electricity and whilst Eskom's reliance on coal fired power stations has allowed for the generation of some of the cheapest electricity in the world at ~R10/W, it has resulted in South Africa being the largest producer of greenhouse gases in Africa, and one of the Top 20 greenhouse gas producing countries in the world.

South Africa and Eskom have started to focus on more reliable energy generation. Demonstration projects and research, undertaken by Eskom, have shown that both solar and wind energy show great potential in South Africa. As a result (and in view of reducing their carbon footprint) Eskom is looking to increase the renewable energy component of its supply mix to at least 1 600 MW by 2025.

The power supply crisis has also accelerated the need to diversify Eskom's energy mix and its move towards alternative energy sources such as nuclear power and natural gas, as well as various forms of renewable energy.

The Upington area has been identified as one of the highest solar radiation locations in the world, providing the best opportunities for using the sun to generate electricity. In an effort to utilise renewable energy resources to meet the growing demand for electricity, the South African Government proposes the establishment of a R 150 billion Solar Park at Klipkraal, ~15 km west of Upington in the Northern Cape. The Solar Park will use the sun's energy to eventually generate 1 500 MW of electricity.

Eskom is planning constructing a 100 MW Concentrating Solar Power (CSP) plant at the Solar Park. This employs an array of mirrors controlled by tracking systems to focus a large area of sunlight into a small beam. The resulting heat is used to generate electricity. CSP also has the backing of the World Bank, which views it as the only zero-emission technology that could potentially rival coal-fired power. Eskom received a positive Record of Decision (RoD), approving a 100 MW CSP facility for this project in August 2007.

The Department of Energy as well as several Independent Power Producers (IPPs) are busy with investigations to construct solar plants at the Solar Park which should source sufficient electricity to make up the 1 500 MW planned for the solar park.

The electricity generated at the Upington Solar Park (by IPP's and Eskom) will need to be integrated into the National Grid. The purpose of the Solar Park Integration Project is to address the major infrastructural investments that Eskom will need to make in order to tie the Upington Solar Park into the National Grid. The proposed Solar Park Integration Project entails the construction of a substation at the Upington Solar Park, 400kV transmission lines to the east and south of Upington to feed the electricity into Eskom's National Grid as well as the construction of a number of 132kV power lines inter-linking the IPP solar plants with the Eskom Grid and distributing the power generated to Upington.

1.2 Regional Setting

This project is located in the Northern Cape Province between the towns of Kathu, Upington, Kakamas and Kenhardt as shown in Figure 1-1.

1.3 Project Team Details

The following project personnel were involved in the compilation of this report.

Konrad Kruger, BSc Hons (Geog)

Mr. Konrad Kruger graduated from the University of Pretoria with a BSc in Environmental Science in 2002 and BSc Honours in Geography in 2003. He has been involved in a variety of environmental projects in the last eight years and has undertaken a variety of specialist studies, mapping and environmental consulting. The specialist studies included vegetation assessments, soil mapping and agricultural assessments, wetland delineations, visual assessments and terrestrial ecological assessments. In terms of similar work, he has undertaken the biophysical specialist studies for the following approved Environmental Impact Assessments (EIA's) for transmission lines:

- Camden (Ermelo) to Mbewu (Empangeni) 765 kV power lines;
- 400 kV power lines from Kusile Power Station to Lulamisa (Diepsloot);
- 400 kV power lines from Kendal Power Station to Zeus (Secunda); and
- 400 kV Duvha – Minerva power line deviation.

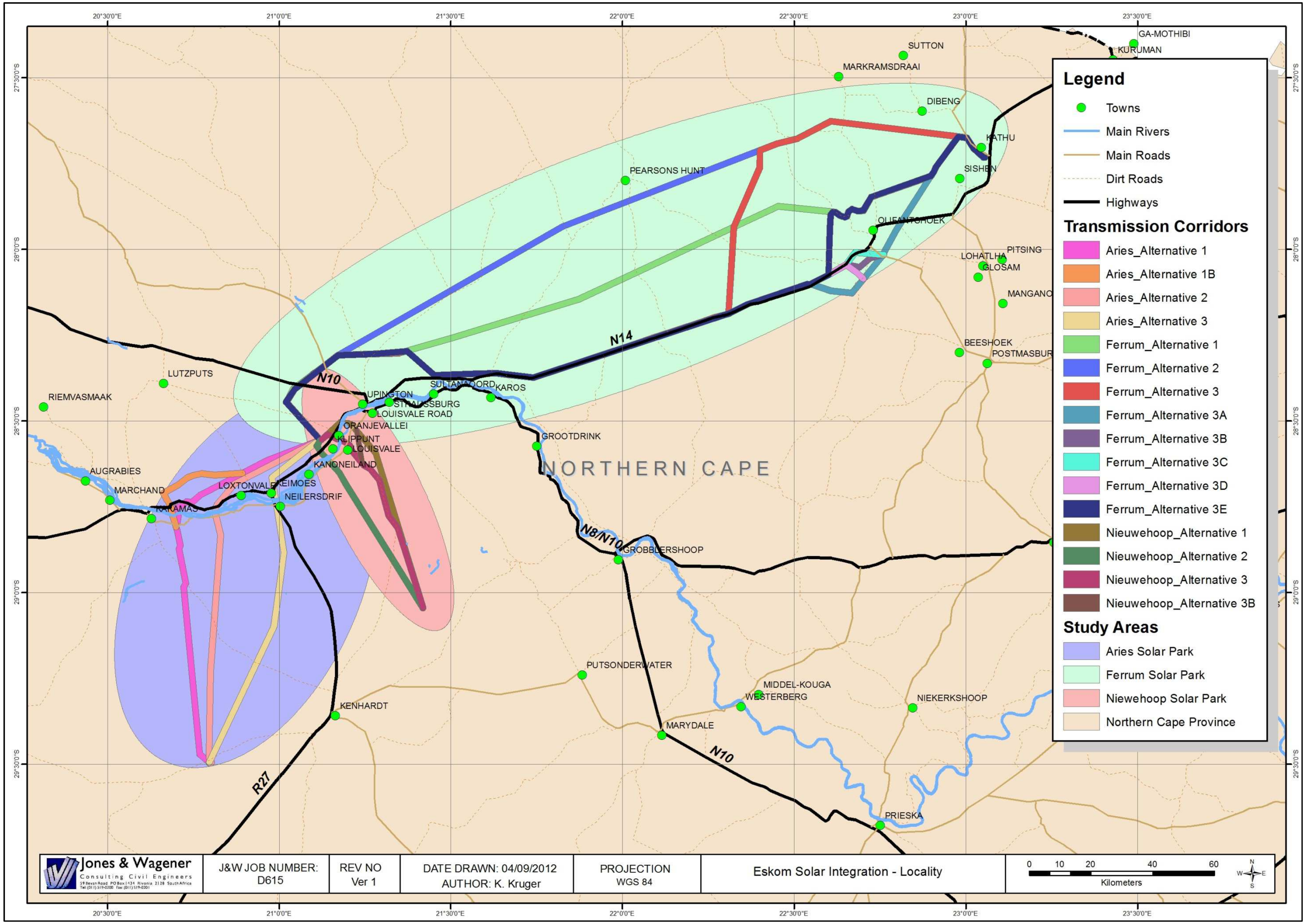

Figure 1-1: Regional locality of the proposed study area.

1.4 Objectives of this Report

This report aims to detail the specialist soil, agricultural potential, terrestrial ecology, surface water and wetland assessments that were undertaken for the Solar Integration Project. The information in this report will be included in the relevant EIA's for each of the Integration Project segments.

2. PROJECT DESCRIPTION

2.1 Project Location

As mentioned above, due to the size of the study area covered by this project, the description of the project is broken into three sections. The first section is the corridors from the Solar Substation to the Ferrum Substation; the second is the two corridors from the Solar Substation to the Aries and Nieuwehoop Substations. Lastly the third section of the corridor is made up of all the 132 kV lines that connect the Solar Substation with the surrounding solar projects in the park as well as with the Upington grid. Each of these is described in more detail below.

2.1.1 Solar Substation to Ferrum Substation

2.1.1.1. Ferrum_Alternative 1

Alternative 1 commences at the CSP outside of Upington, traverses north-eastward approximately 15 km before turning eastwards for ~10 km. From here the corridor turns north-east again for ~ 120 km before meandering through the Langeberge for some 30 km. Lastly the corridor circles around Sishen Mine and into Kathu parallel to existing power lines and into the existing Ferrum Substation (Figure 2-1).

2.1.1.2. Ferrum_Alternative 2

Alternative 2 commences at the CSP outside of Upington, traverses north-eastward approximately 160 km before navigating through the Langeberge for some 10 km. Lastly the corridor joins Alternative 1 and circles around Sishen Mine and into Kathu parallel to existing power lines and into the existing Ferrum Substation (Figure 2-1).

2.1.1.3. Ferrum_Alternative 3:

In addition to the alternatives mentioned above the stakeholders at the public meeting requested that an additional alternative be investigated during the EIA phase that is aligned with the N 14 highway after passing by the Upington Airport, rather than traversing through farming land (Figure 2-1). The corridor follows the highway up and till about 50 km before the town of Olifantshoek. Here the route splits into two options, the first is to traverse northwards until Alternative 2 is reached and then to follow the same alignment to the Ferrum substation. The second option is split into 5 potential route options as shown on the map. These options are:

- Ferrum_Alternative 3A – follow the N14 highway until 30 km before the town of Olifantshoek, turn eastwards up and till the existing Ferrum – Garona power line is reached. Here the route turns north-eastward and follows the existing line to the Ferrum substation.
- Ferrum_Alternative 3B/3D – follow the N14 highway until 15 km before the town of Olifantshoek, turn eastwards, cross over the ridge and continue up and till the

existing Ferrum – Garona power line is reached. Here the route turns north-eastward and follows the existing line to the Ferrum substation.

- Ferrum_Alternative 3C – follow the N14 highway until 10 km before the town of Olifantshoek, turn eastwards and continue up and till the existing Ferrum – Garona power line is reached. Here the route turns north-eastward and follows the existing line to the Ferrum substation.
- Ferrum_Alternative 3E – follow the N14 highway until 20 km before the town of Olifantshoek, turn northwards until the Alternative 1 alignment is reached, then turn towards Ferrum and follow the Alternative 1 alignment to Kathu.

2.1.2 Solar Substation to Aries and Nieuwehoop Substation

2.1.2.1. Aries_Alternative 1 and 1B

Alternative 1 commences at the CSP outside of Upington traverses south-westward along the Orange River and N14 Highway next to an existing 132 kV distribution line to just before Kakamas (about 60 km). There the line turns south, crosses over the Orange River and heads south for 75 km to the Aries Substation, crossing over the Hartbees River (Figure 2-2).

As a recent addendum to the Alternative, Alternative 1B was added in order to avoid potential future infrastructure in the area as proposed by the Square Kilometre Array (SKA) team.

2.1.2.2. Aries_Alternative 2

Alternative 2 commences at the CSP outside of Upington traverses south-westward along the Orange River and N14 Highway next to an existing 132 kV distribution line to 10 km before Kakamas (about 50 km). There the line turns south, crosses over the Orange River and heads south for 75 km to the Aries Substation, crossing over the Hartbees River (Figure 2-2).

2.1.2.3. Aries_Alternative 3

Alternative 3 commences at the CSP outside of Upington traverses south-westward along the Orange River and N14 Highway next to an existing 132 kV distribution line up to 10 km after Loxtonvale (about 40 km). There the line turns south, crosses over the Orange River and heads south for 75 km to the Aries Substation, crossing over the Hartbees River (Figure 2-2).

2.1.2.4. Nieuwehoop_Alternative 1

Alternative 1 commences at the CSP outside of Upington traverses north-eastward along the Orange River for 5 km. After Louisvale the line turn southeast, crosses over the Orange River and travels the approximately 60 km to the Nieuwehoop Substation, crossing over the Kareeboom River (Figure 2-2).

2.1.2.5. Nieuwehoop_Alternative 2

Alternative 2 commences at the CSP outside of Upington traverses south-westward for a very short distance (<2km) before turning southeast, crossing over the Orange River and travelling the approximately 60 km to the Nieuwehoop Substation, crossing over the Kareeboom River (Figure 2-2).

2.1.2.1. Nieuwehoop_Alternative 3 and 3B

In addition to the Nieuwehoop alternatives mentioned above the stakeholders at the public meeting requested that that an additional alternative be investigated during the EIA phase that is aligned along the local gravel road rather than traversing through farming land (Figure 2-2). This Alternative was called Alternative 3 and a small connection to the crossing at Alternative 1 and this short connection was called Alternative 3B

2.1.3 Solar Substation and 132 kV corridors

At the time of writing this report Eskom indicated that there are three potential locations for the proposed Solar Substation (refer to the Figure 2-3 below) and provided the anticipated 132 kV power lines corridors that will be utilised for each location. It should be noted that the Eskom CSP site has been approved in a previous EIA and it is assumed that all the line alignments inside this area were included. The Eskom CSP will provide power to the Department of Energy (DoE) plant as well as the two IPP's on the adjacent properties as shown in the figure. In addition a 132 kV power line will also provide power to the town of Upington via the Gordonia Substation. As show in Figure 2-3, no alternatives were given for these alignments and it is assumed that the 132 kV power line to Upington will follow the existing power line on site.

2.2 Components of the Project

The project under consideration includes the following main components once authorised:

- Power lines
  - 1 x 400kV to Ferrum;
  - 1 x 400 kV to Nieuwehoop;
  - 2 x 400 kV to Aries;
  - 2 x 132 kV to Gordonia; and
  - 11 x 132 kV to Eskom CSP, IPP's and DoE.
- Access corridors;
- Construction camps; and
- Construction, operation and maintenance of the above.

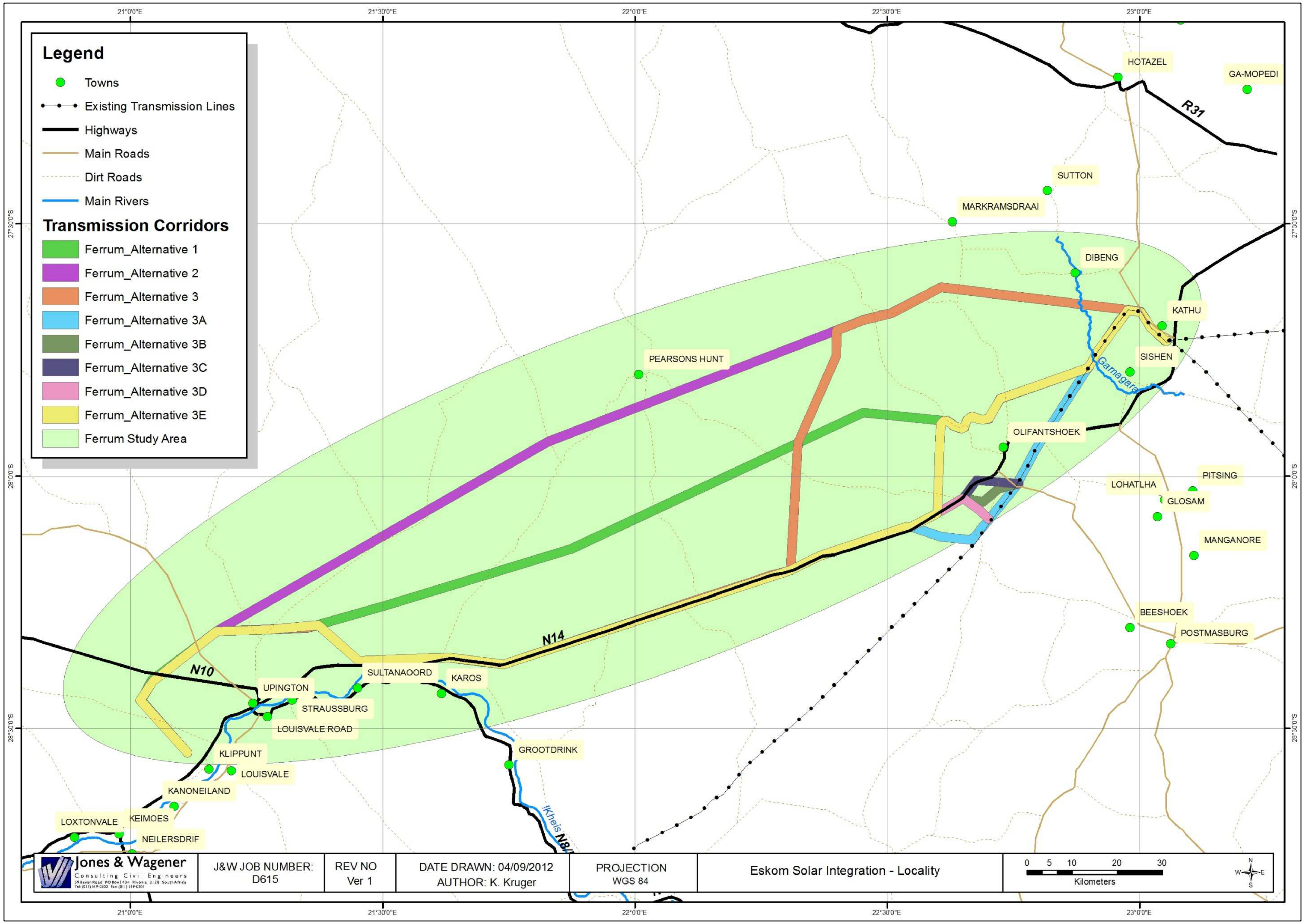

Figure 2-1: Regional locality of the Solar Substation to Ferrum Substation corridors.

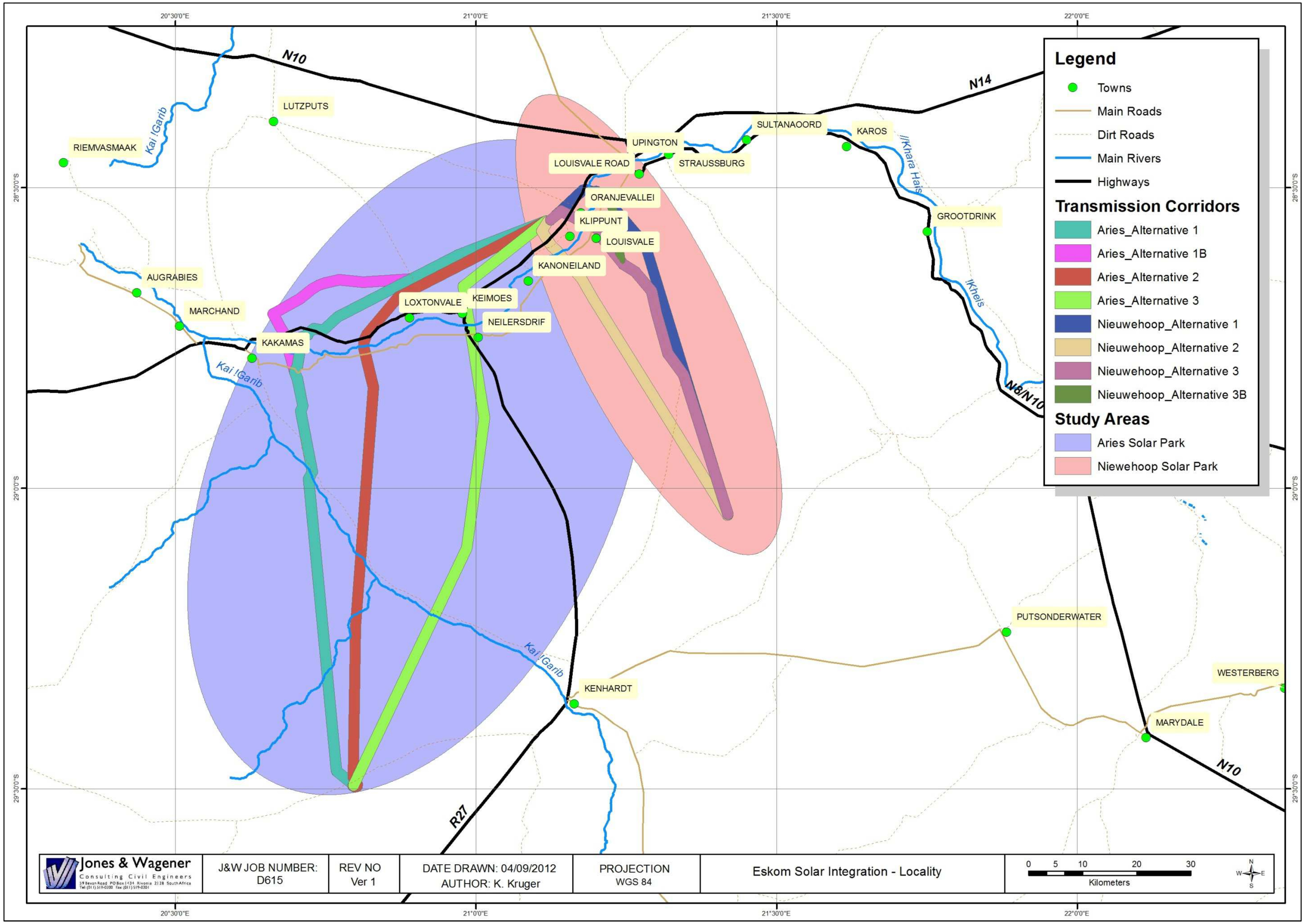

Figure 2-2: Regional locality of the Solar to Aries Substation and Solar to Nieuwehoop Substation corridors.

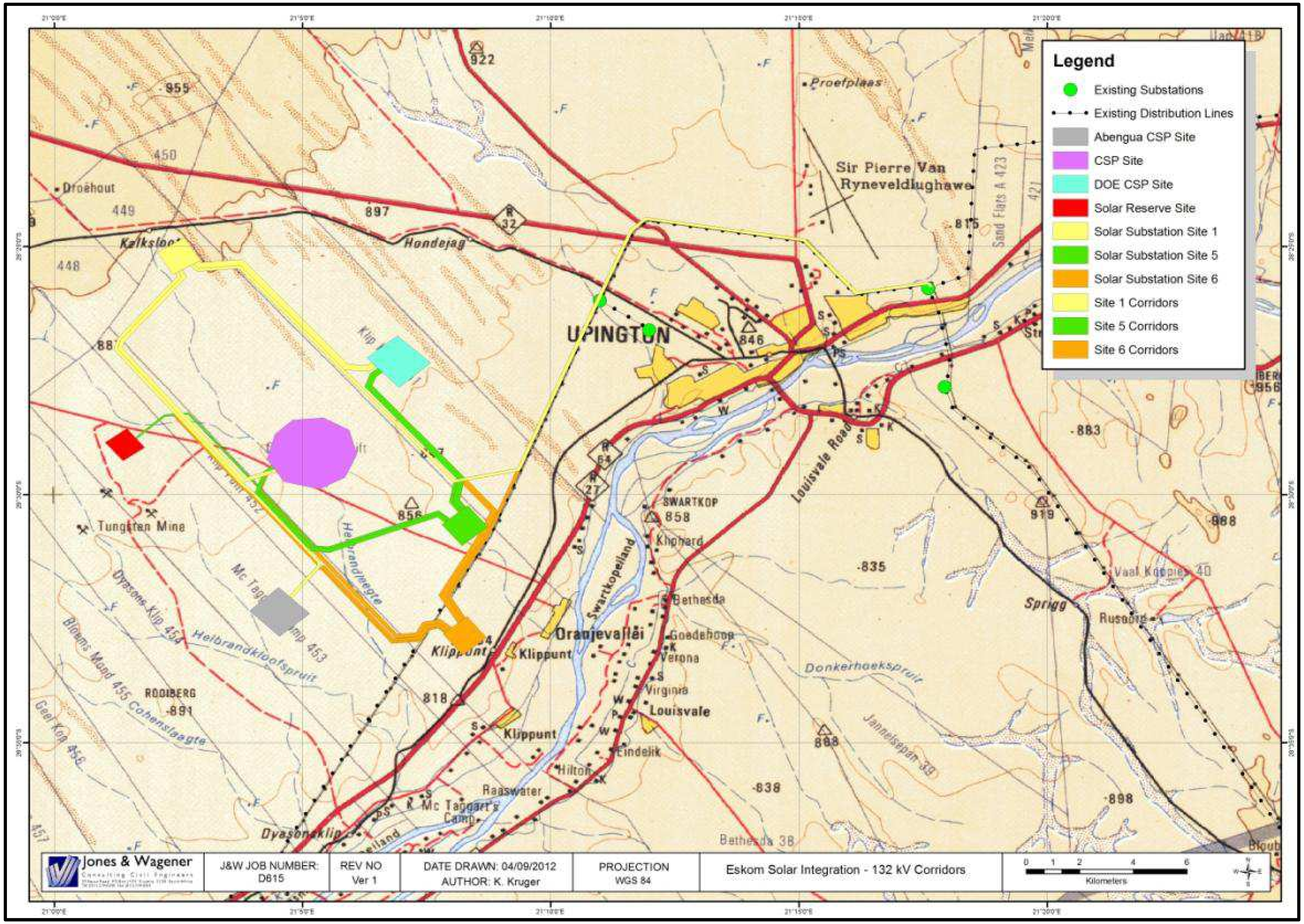

Figure 2-3: Location of the proposed Solar Substation (separate EIA) and 132kV power lines.

3. TERMS OF REFERENCE

The following terms of reference was approved by DEA as part of the Final Scoping Report for each of the studies undertaken.

3.1 ToR: Terrestrial Ecology

An ecological investigation will be conducted on all the alternatives and their associated infrastructure. The objectives of these studies will be to:

- Review existing ecological information available;
- Conduct a site visit to determine the general ecological state of the proposed route, determine the occurrence of any red data and/or vulnerable species
- Compile a detailed description of the baseline environment;
- Provide a ranking assessment of the suitability of the proposed routes;
- Undertake a comparative assessment of the various alternatives;
- Provide mitigation measures to prevent and/or mitigate any environmental impacts that may occur due to the proposed project; and
- Compile an ecological report, indicating findings, preferred route recommendations and maps indicating sensitive and/or no-go areas.

3.2 ToR: Wetland Delineation

The objectives of this study will be to:

- Review existing information available for the area;
- The riparian zone and wetlands will be delineated according to the Department of Water Affairs (DWA, previously known as the Department of Water Affairs and Forestry -DWAF) guideline, 2003: A practical guideline procedure for the identification and delineation of wetlands and riparian zones;
- During the site investigation the following indicators of potential wetlands will be identified:
    - Terrain unit indicator;
    - Soil form indicator;
    - Soil wetness indicator; and
    - Vegetation indicator.
- Assess the status of each of the wetlands identified and assess the potential impacts on the wetlands;
- Compilation of a wetland delineation report that is sufficient to address the requirements of a water license applications, the EIR and management practices including mitigation measures; and
- Recommend preferred route among the studied routes.

3.3 ToR: Aquatic Ecology (SAS report incorporated into this report)

A surface water aquatic ecological assessment in accordance with the River Health Programme (RHP) will focus primarily on the biological responses as an indicator of ecosystem health, with only a vague cause-and-effect relationship between the drivers and the biological responses. The minimum tools required for this assessment include:

- Drivers: Habitat and in situ Water Quality; and
- Responses: Fish, Aquatic Invertebrates and Riparian Vegetation.

The methodologies that will be adopted for the assessments are based on methodologies widely accepted by and utilized in the RHP of South Africa. The RHP is a national monitoring program used to monitor and assess South Africa's freshwater resources. An integrated ecological state assessment report will include:

- Habitat: Integrated Habitat Assessment System (IHAS) and the Index of Habitat Integrity (IHI);
- Water quality: pH, Dissolved oxygen concentration and saturation, temperature and conductivity (TDS)
- Fish: Fish Assessment Integrity Index (FAII);
- Aquatic invertebrates: South African Scoring System (SASS, version 5); and
- Riparian vegetation: Riparian Vegetation Index (RVI).

3.4 ToR: Soils and Land Capability/Agricultural Potential

The objectives of this study will be:

- Review existing information available from land type maps, previous reports and GIS information;
- An aerial photographic study to assess the accessibility, vegetation cover, drainage lines, slope aspects and percentage outcrop of each of the routes;
- A field visit to verify the aerial photographic study observations. Additionally, during the visit, the depth and properties of regolith will be judged from natural exposure (dongas) and hand augering where applicable. The following soil characteristics will be documented:
    - Soil horizons;
    - Soil colour;
    - Soil depth;
    - Soil texture (Field determination)
    - Wetness;
    - Occurrence of concretions or rocks; and
    - Underlying material (if possible).
- A map will be compiled of each of the alternative routes, indicating the features observed;
- Assess the potential impacts and their significance on the agricultural potential of each alternative;
- Propose mitigation measures to reduce or mitigate potential impacts;
- Compile a report detailing the findings of the assessment; and
- Recommend a preferred route among the studied routes.

4. RECEIVING ENVIRONMENT

4.1 Introduction

This section provides a general description of the environment in which the proposed project will be located. The purpose of this section is to provide a perspective of the local environment within which the proposed infrastructure will exist and operate, with a view to identify sensitive issues/areas, such as wetlands or other ecological aspects, which need to be considered when conducting the impact assessment and designing the various components of the project.

4.2 Climate

4.2.1 Data Collection and Methodology

Broad scale meteoric data was obtained from the CSIR as well as information contained in the existing Eskom CSP site EIA. It should be noted that this was not a detailed study, but merely a desktop assessment as input into the other detailed studies.

4.2.2 Regional Description

Rainfall

The study area is located in the north western portion of South Africa. This area receives very variable late summer rainfall between February and April. The study area receives between 70 – 200mm of precipitation annually (Figure 4-1).

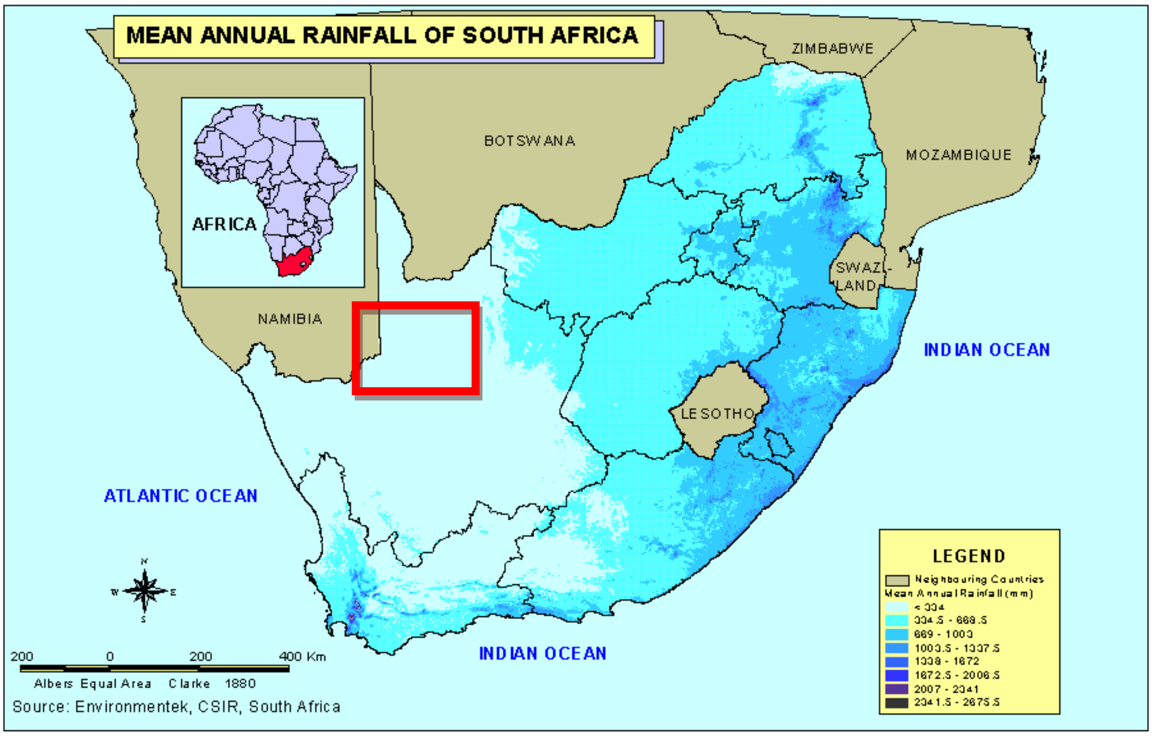

Figure 4-1: Mean Annual Rainfall.

Temperature

The study area is located in one of the warmer parts of the country with mean maximum and minimum temperature ranges from 40.6ºC to -3.7ºC with a mean annual temperature of 17.4ºC (Figure 3-2).

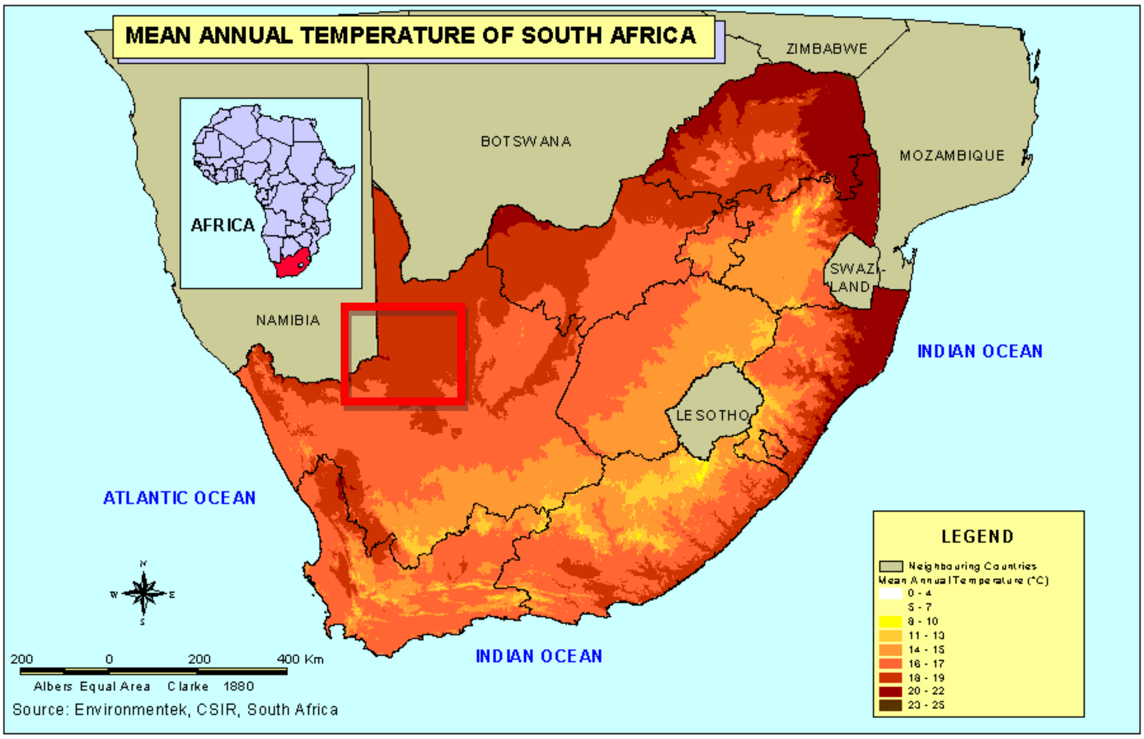

Figure 4-2: Mean Annual Temperatures.

4.2.3 Sensitivities

Wind

For the entire study area there is very low wind flow and no main wind direction. Whirl winds (dust devils) are common on hot summer days.

Lightning Strikes

The study area is located in an area with very low frequency of lightning strikes.

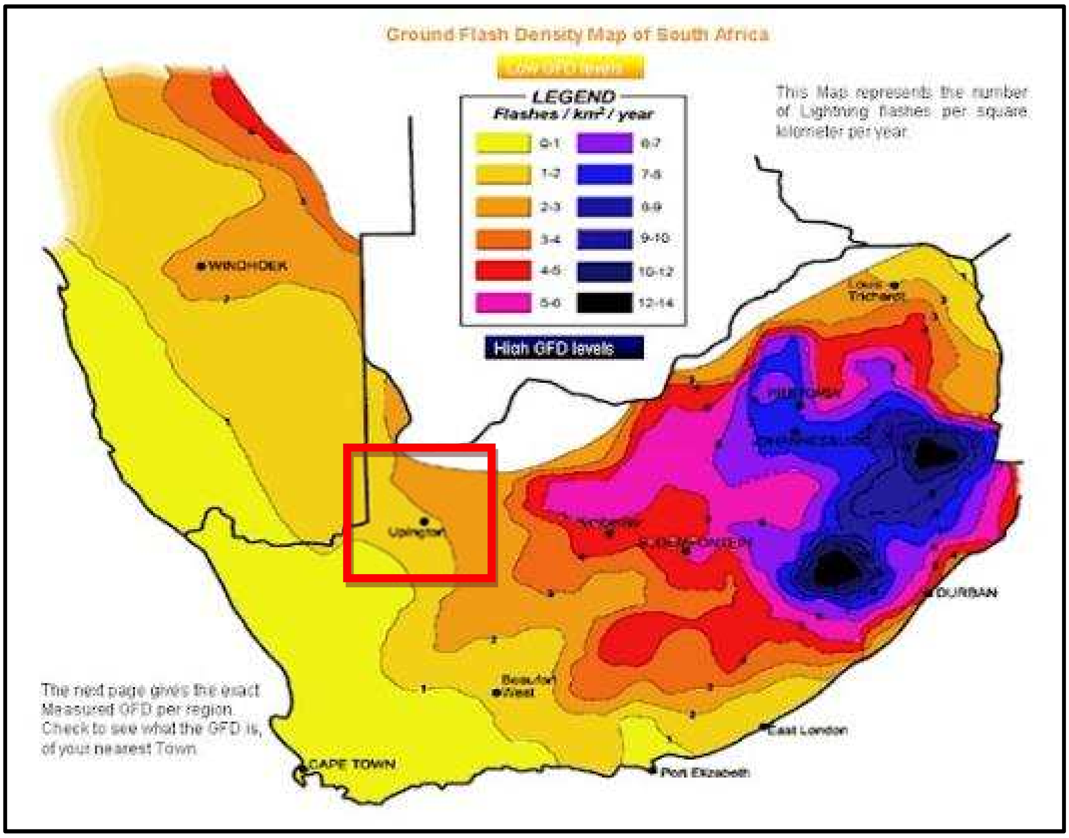

Figure 4-3: Lightning Ground Flash Density.

4.3 Topography and Drainage

4.3.1 Data Collection and Methodology

The topography data was obtained from the Surveyor General's 1:50 000 toposheet data for the region. Contours were combined from the topographical mapsheets to form a combined contours layer. Using the Arcview Geographic Information Systems (GIS) software the landforms of the region were compiled and are shown in the Figure below.

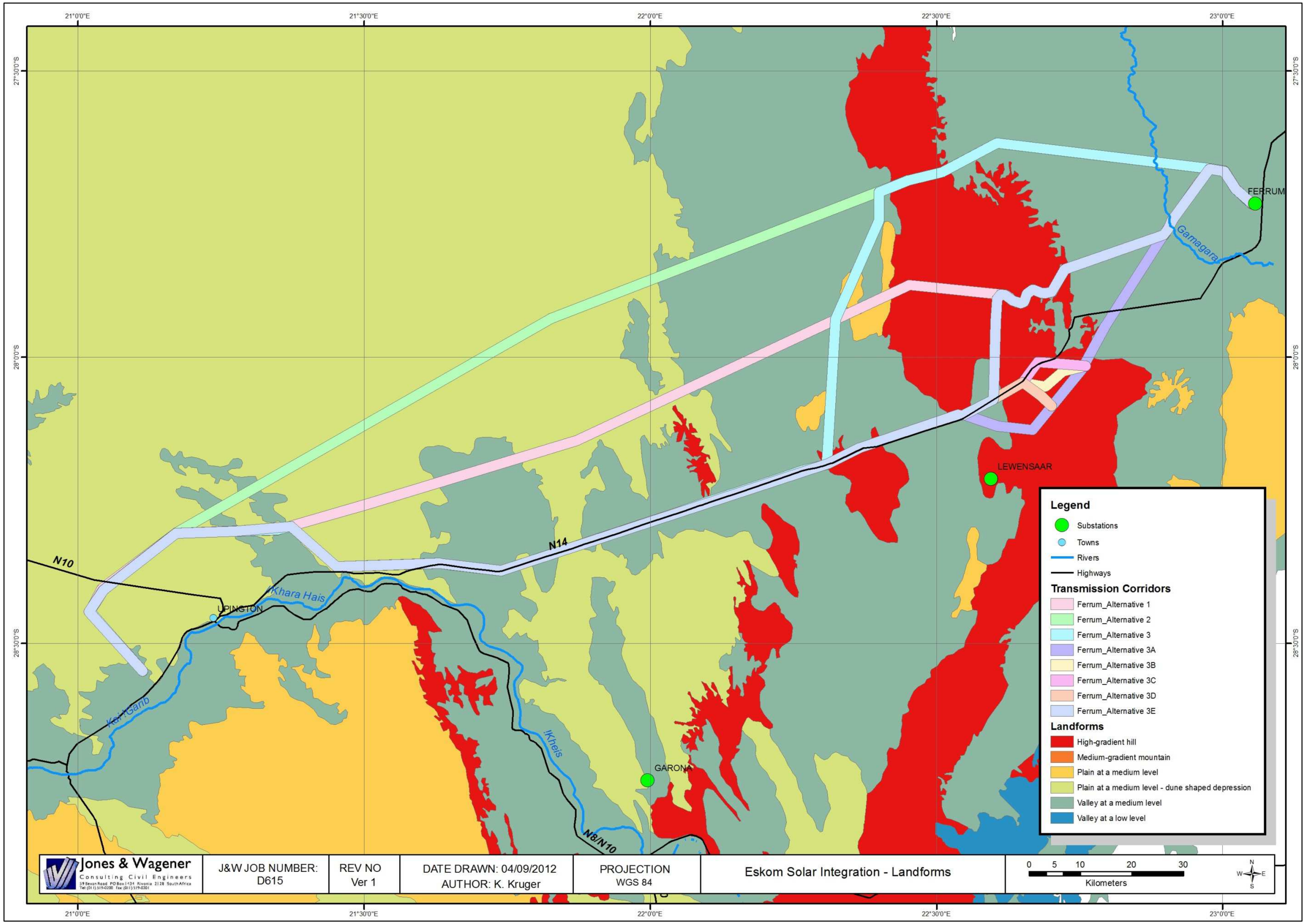

Figure 4-4: Landforms of the study area (Ferrum).

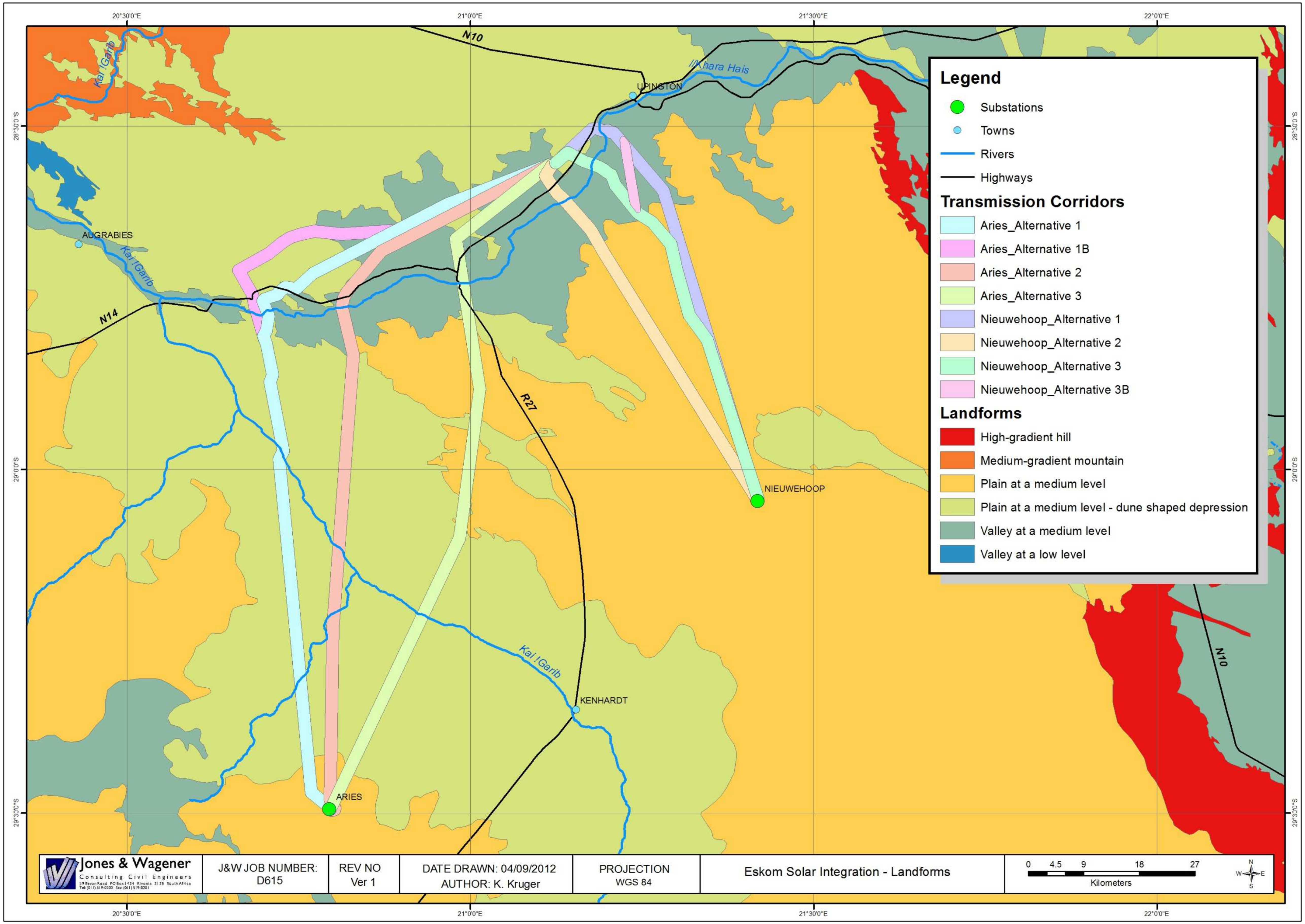

Figure 4-5: Landforms of the study area (Aries and Nieuwehoop).

4.3.2 Regional Description

The altitude in the study area ranges from 600 mamsl (metres above mean sea level) to 1800 mamsl. The highest parts of the study area are in the eastern portions (Olifantshoek) and in the southern portions (Kenhardt) and the lowest portions are in the southern portions of the study area (Orange River).

The study area comprises of one major valley in the Orange River Basin and the Kalahari that generally drains eastward. The area northeast of the Orange River is dominated by the Kalahari dunes and intermittent pans. On the eastern end of the study area the alternatives travel through the Langberge, a long linear mountain range that runs north-south through the study area. The area south of the Orange River is dominated by a flat plain with very few topographic features.

4.3.3 Sensitivities

In terms of topographical features no sensitivities exist although the dunefields in the Kalahari do afford some unique challenges discussed in more detail under the Soils Section below.

4.4 Soils

4.4.1 Data Collection and Methodology

The geological analysis was undertaken through desktop evaluation using a GIS and relevant data sources. The geological data was taken from the Environmental Potential Atlas Data generated by the Department of Environmental Affairs (DEA). Soil data was obtained from the Department of Agriculture, Forestry and Fisheries (DAFF).

The on-site soils assessment was conducted from August - October 2012. Soils were augered at 500 - 1000m intervals along the proposed power line corridors using a 150 mm bucket auger, up to refusal or 1.2 m. Soils were identified according to Soil Classification; a taxonomic system for South Africa (Memoirs on the Natural Resources of South Africa, no. 15, 1991). The following soil characteristics were documented:

- Soil horizons;
- Soil colour;
- Soil depth;
- Soil texture (Field determination);
- Wetness;
- Occurrence of concretions or rocks; and
- Underlying material (if possible).

4.4.2 Regional Description

The majority (>30%) of the study area is covered by recent (Quaternary) alluvium and calcrete. Superficial deposits of the Kalahari Group are also present in the east. The extensive Palaeozoic diamictites of the Dwyka Group also outcrop in the area as do gneisses and metasediments of Mokolian age.

The soils derived from these geologies are mostly red-yellow apedal soils, freely drained with a high base status and < 300mm deep. Along the Orange River recent alluvial deposit from the River form the main soil forms.

4.4.3 Site Description

Following the site survey a number of soil forms were identified. The soil forms were grouped into management units and are described in detail in the sections below and Figure 4-13 illustrates the location of the soil types. The land capability (agricultural potential) of the abovementioned soil form is described in more detail in Section 4.5.

The management units are broken up into:

- Alluvial soils (Undifferentiated deep deposits);
- Rocky Areas;
- Sandy soils:
    - Red soils; and
    - Red and Yellow soils.

Each of these management units are described in more detail below.

4.4.3.1. Alluvial soils

These soils are mainly found along the Orange River floodplains and form the basis for most of the cultivation in the Northern Cape. The main soil form is the Dundee soil form which is shown below and typified by an Orthic A-horizon over a Stratified Alluvium. The stratification (layers) in the soil horizon is created by the deposition of material during flood events. The criteria for such a soil are as follows:

- is unconsolidated and contains stratifications caused by alluvial or colluvial deposition;
- directly underlies a diagnostic orthic or melanic A horizon, or occurs at the surface; and
- does not qualify as diagnostic regic sand.

Unlike soil horizons that have developed by pedogenetic processes, stratified alluvium owes its distinguishing features to a depositional process and is thus not a sequence of so-called genetic horizons. Pedogenetic changes have been minimal and it is, probably, a C horizon or parent material. The rare occurrences of stratified colluvium are also accommodated by this concept.

Given time, homogenizing processes of soil formation will destroy the evidence of deposition: stratifications will disappear and be replaced by true genetic soil horizons, their kind depending upon the character of the particular material, the particular site and the particular external environment. However, alluvium is commonly utilized very intensively for crop production. For this practical reason, it has been regarded as desirable to recognise stratified alluvium as a diagnostic subsoil material. The classification reflects this importance of young alluvium by making provision, through a diagnostic horizon, for its easy inclusion. Other diagnostic subsoil horizons cater for the pedogenetic changes which affect alluvium with time.

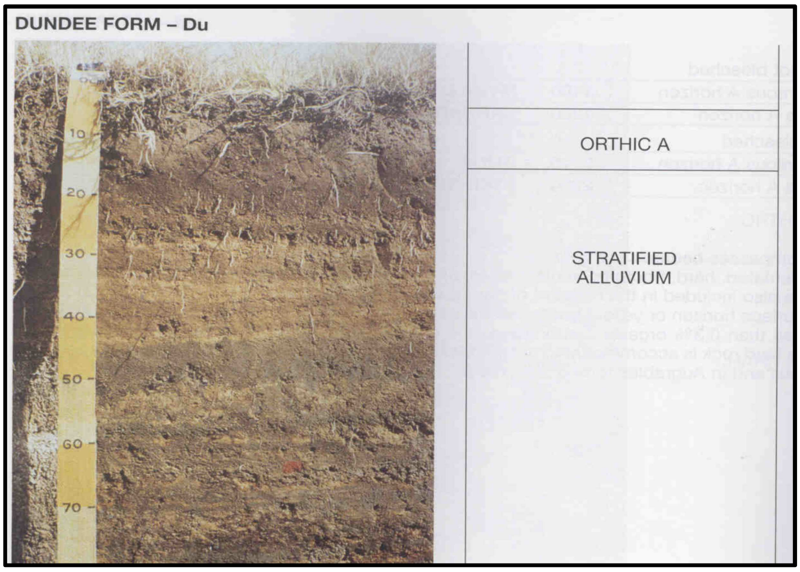

Figure 4-6: Dundee soil form.

4.4.3.2. Rocky Areas

As shown on the Soils map for the study area there are two rocky soil types. The first is rocky areas with miscellaneous soils and the second is hard rock areas. In both cases the rock originates from shallow geology found throughout the study area. In the east of the study area the hard rock areas originate from the Langeberge and some isolated outcrops en corridor to Upington. The first unit of miscellaneous soils with rocky areas are found closer to the Orange River and is associated with the Inselbergs that can be found throughout the area. The soil forms that are found in these areas are illustrated below. These include the Mispah and Glenrosa soil forms and both are characterised by their shallow nature overlying a hard layer.

Figure 4-7: Rocky areas on site, just south of the Orange River.

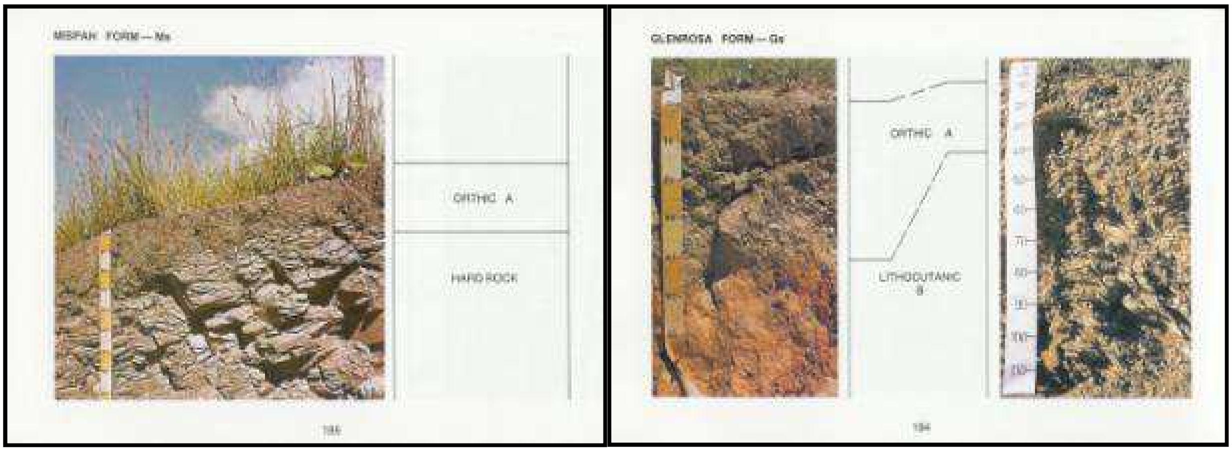

Figure 4-8: Mispah (left) and Glenrosa (right) soil forms.

The lithocutanic B horizon found in the Glenrosa soil form has to comply to the following requirements:

- underlies a diagnostic topsoil horizon, either directly or via a stone-line, or an E horizon;
- merges into underlying weathering rock;
- has, at least in part, a general organization in respect of colour, structure or consistence which has distinct affinities with the underlying parent rock;
- has cutanic character expressed usually as tongues or prominent colour variegations caused by residual soil formation and illuviation resulting in the localization of one or more of clay, iron and manganese oxides, and organic matter in a non-homogenized matrix of geological material (saprolite) in a variable but generally youthful stage of weathering;
- lacks a laterally continuous horizon which would qualify as either a diagnostic pedocutanic 8 or prismacutanic B;
- does not qualify as a diagnostic podzol B, a neocarbonate B, a soft or hardpan carbonate horizon, or diagnostic dorbank; and
- if the horizon shows signs of wetness, then more than 25% by volume has saprolite character.

The concept is one of minimal development of an illuvial B horizon in weathering rock. With the exception of its presence beneath an E horizon in Cartref form, the lithocutanic B occurs beneath a diagnostic topsoil horizon. In situ weathering of rock under topsoil has produced a heterogeneous and, typically, highly variegated zone consisting of soil material (relatively well homogenized without traces of weathering rock) interspersed with saprolite or weathering rock in various stages of breakdown. The latter is recognised by its general organization with respect to structure, colour or consistence which still has distinct affinities with the parent rock. Furthermore, this zone grades into relatively unaffected and, eventually, fresh rock, sometimes at fairly shallow depth.

4.4.3.3. Sandy soils

This management unit describes the majority of the soils within the study area. Being an arid environment, very little pedogenesis has taken place and clay material is not common. Throughout the study area there are red dunes of the Kalahari dominating the central region, surrounded by deep red soil plains without dunes. To the south and far east of the study area shallow red soils are present, mostly overlying calcrete and in the extreme south and eastern region you find mixed yellow and red soils with low clay percentages. Each of the soil forms found in these areas are illustrated and described below.

Deep red soils with and without dunes

The soil that dominates in these areas is the Namib soil form. This soil form is typified by a regic sand B-horizon that in the case of the study area is very red in colour. The illustration below shows a yellow version, however the photo on the right shows the colour of the soils within the study area. A regic sand has to meet the following criteria:

- is a recent deposit, usually aeolian, which, except for a possible darkening of the topsoil by organic matter, shows little or no further evidence of pedogenesis;
- is coarse textured and has little or no macroscopically visible structure; it may be massive or single grained; aeolian stratification (cross-bedding) may be present;
- may have any colour although "grey" as defined for the E horizon is common; aeolian stratification (cross-bedding), when present, prevents a material from qualifying as a diagnostic red or yellow-brown apedal B horizon or as an E-horizon;
- has mineralogical composition little, if any different from that of the parent material;
- has consistence that is loose, friable or soft;
- directly underlies an orthic A horizon or, if this is absent, occurs at the surface; and
- does not qualify as a neocutanic B, a neocarbonate B, an E horizon or as stratified alluvium.

The term regic (Gr.rhegos = blanket) is used here to convey the idea of cover sands in which, by virtue of their youth or environment, little or no profile development has taken place. The purpose of defining this class of materials as diagnostic is to provide a place in the classification for young sands of aeolian origin (red, yellow-brown or grey). Such materials often represent an important geographic entity in desert and littoral regions. Properties reflect minimal pedogenesis; essential is the fact that the mineralogical composition of the sand (e.g. quartz, feldspars, Ferro-magnesian minerals, shell fragments) is little if any different to that of the parent deposit and that there has been little if any clay formation.

Aeolian stratification (cross-bedding), if present, is diagnostic of regic sand; these should not, however, be confused with the more or less parallel, horizontally oriented lamellae which are common in certain E horizons. Because pedogenesis has been minimal in regic sand, changes within a sand body which are attributable to pedogenesis would tend to indicate the presence in the sand body of materials which do not qualify as regic sand. Regic sands are commonly but not necessarily deep.

When there is doubt as to whether a material qualifies as regic sand on the one hand or as a red or yellow-brown apedal B horizon on the other, regic sand is preferred when the sand body takes the form of a dune and, in the virgin state, vegetation is all but absent. The texture of regic sands is usually no finer than pure sand.

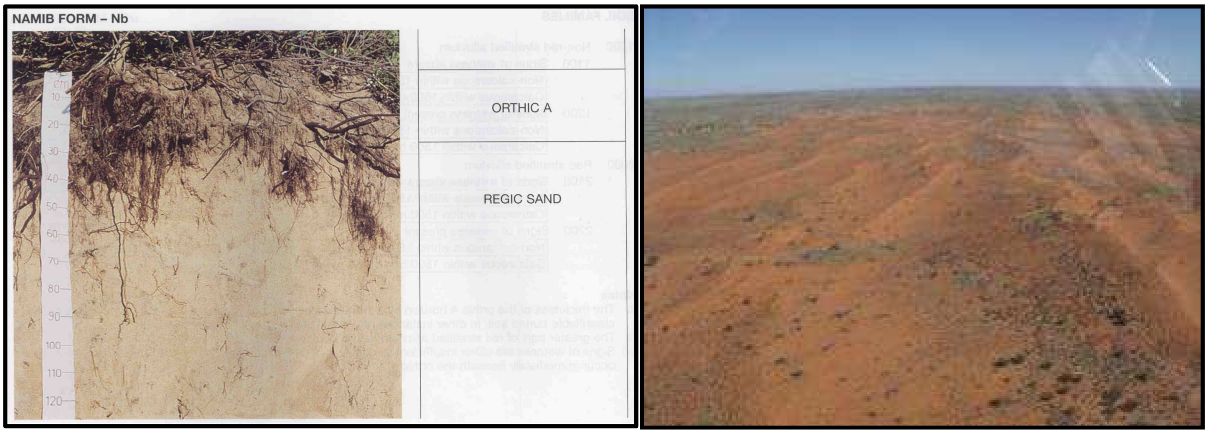

Figure 4-9: Namib soil form (left) red soils on site (right).

In cases where the regic sand horizon has undergone more pedogenesis this soil can be classified as a Hutton soil form, and in cases where the soil becomes shallow the Plooysburg soil form is found (as shown below).

Shallow red soils

The shallow red soils found throughout the study area most commonly overlie a calcrete layer, which in terms of the classification system is described as a soft Carbonate or a Hardpan Carbonate horizon. The dominant soils in this region are known as the Plooysburg and Kimberley soil forms as shown below. A Hardpan Carbonate layer is identified by the following criteria:

- is continuous throughout the pedon;
- is cemented by calcium and/or calcium-magnesium carbonates such as to be a barrier to roots and slowly permeable to water;
- is massive, vesicular or platy and extremely hard when dry and hard or very firm when moist;
- unless exposed by erosion, occurs beneath a melanic or orthic A, or yellow-brown apedal 8, red apedal B, neocutanic 8 or neocarbonate B horizon;
- does not qualify as diagnostic dorbank; and
- a laminar capping is common but not always present.

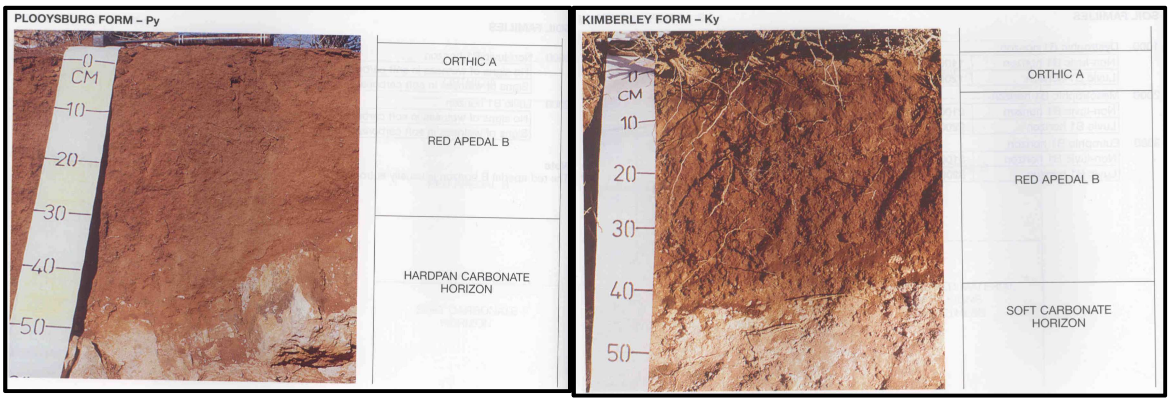

Figure 4-10: Plooysburg (left) and Kimberley (right) soil forms.

Mixed red and yellow soils with very little clay

As the red sands of the Kalahari recede the soils begin to become more diverse. These areas have a variety of soils including shallow calcrete, gravel plains and red or brown soils. Below are photos of the soils found in these areas.

Figure 4-11: Mixed shallow soils on site.

The soil forms identified in this area include Coega, Brandvlei, Mispah, and Glenrosa. The latter two soils are described above, while the other two are shown below. Both the Coega and Brandvlei soils have carbonate horizons, in the Coega the concrete has hardened into an impenetrable layer.

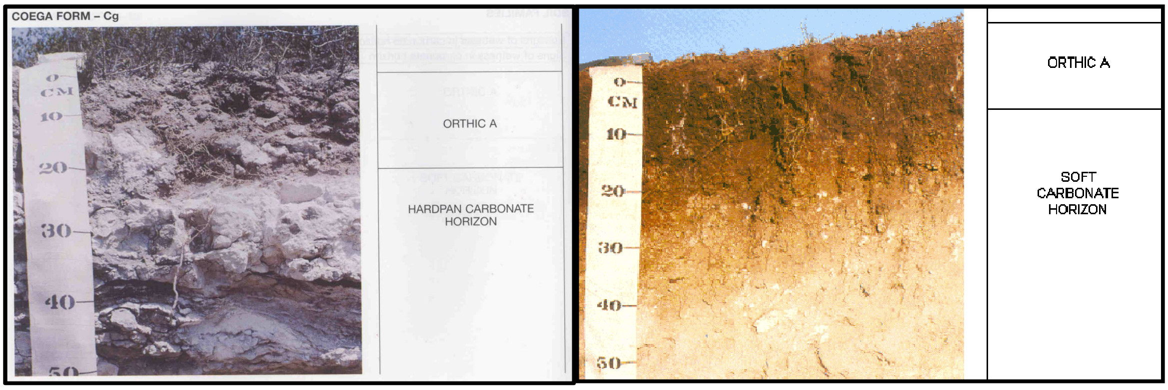

Figure 4-12: Coega soil form (left) and Brandvlei soil form (right).

4.4.4 Sensitivities

The potential sensitivities related to soils were screened using data from the Agricultural Research Council's (ARC) website AGIS. The data from the ARC indicates that the area is prone to two potential sensitivities relating to soil – erosion and shifting sands. These are usually interrelated and in the dunefields of the Kalahari they are especially high as indicated in Figure 4-15 below. As shown in the map Ferrum_Alternatives 1 and 2 traverse large areas of potentially shifting sands.

The potential for shifting sands is caused by the high amounts of Sodium in the soil along with the sandy nature of the soil. These factors create an environment where soils easily disperse when water is introduced or erode when the vegetative cover is removed. These areas require special attention when constructing roads, erection and siting the pylon footings. These aspects are covered in the Environmental Management Program (EMPr) and impact assessment.

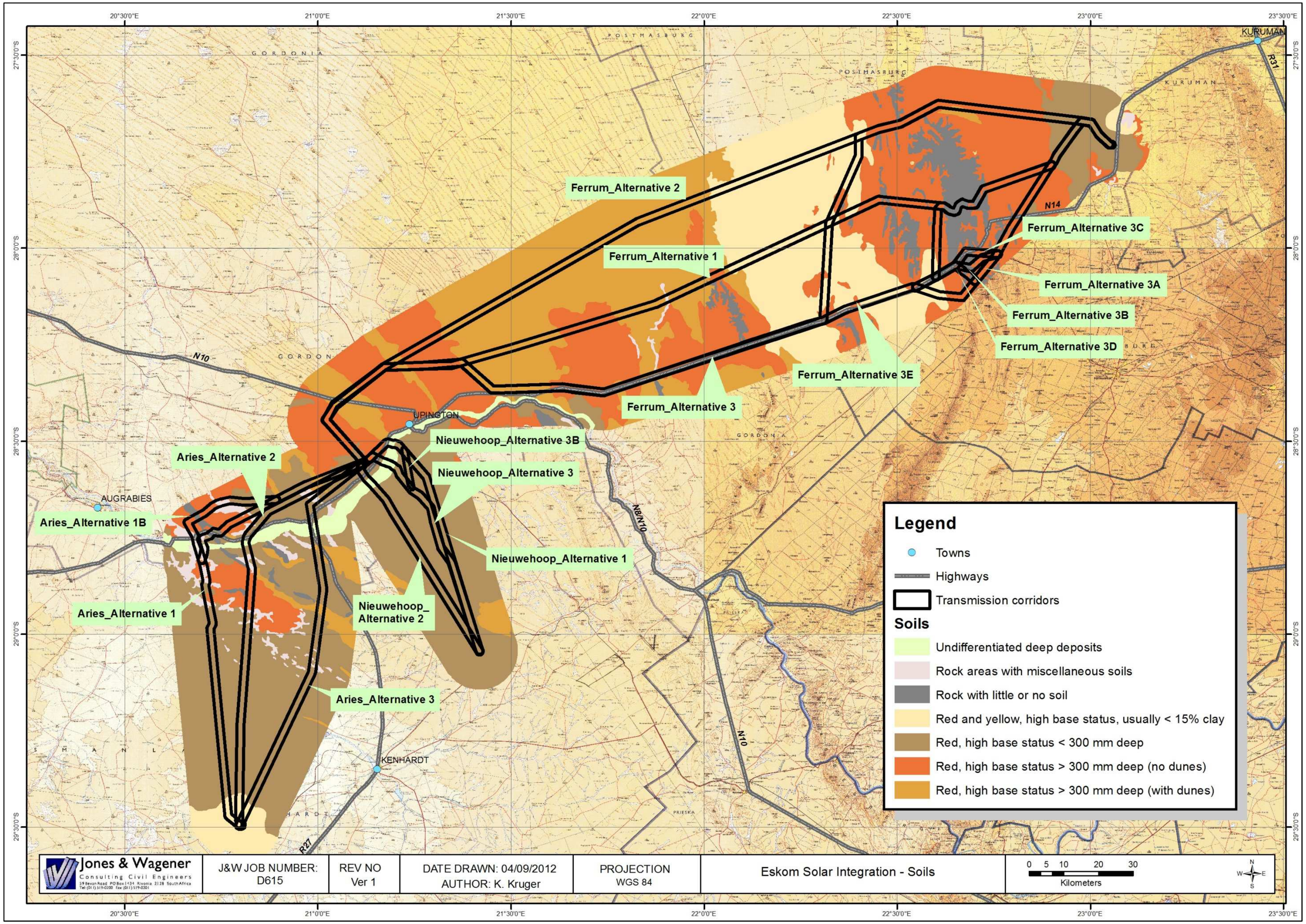

Figure 4-13: Soil map for the study area.

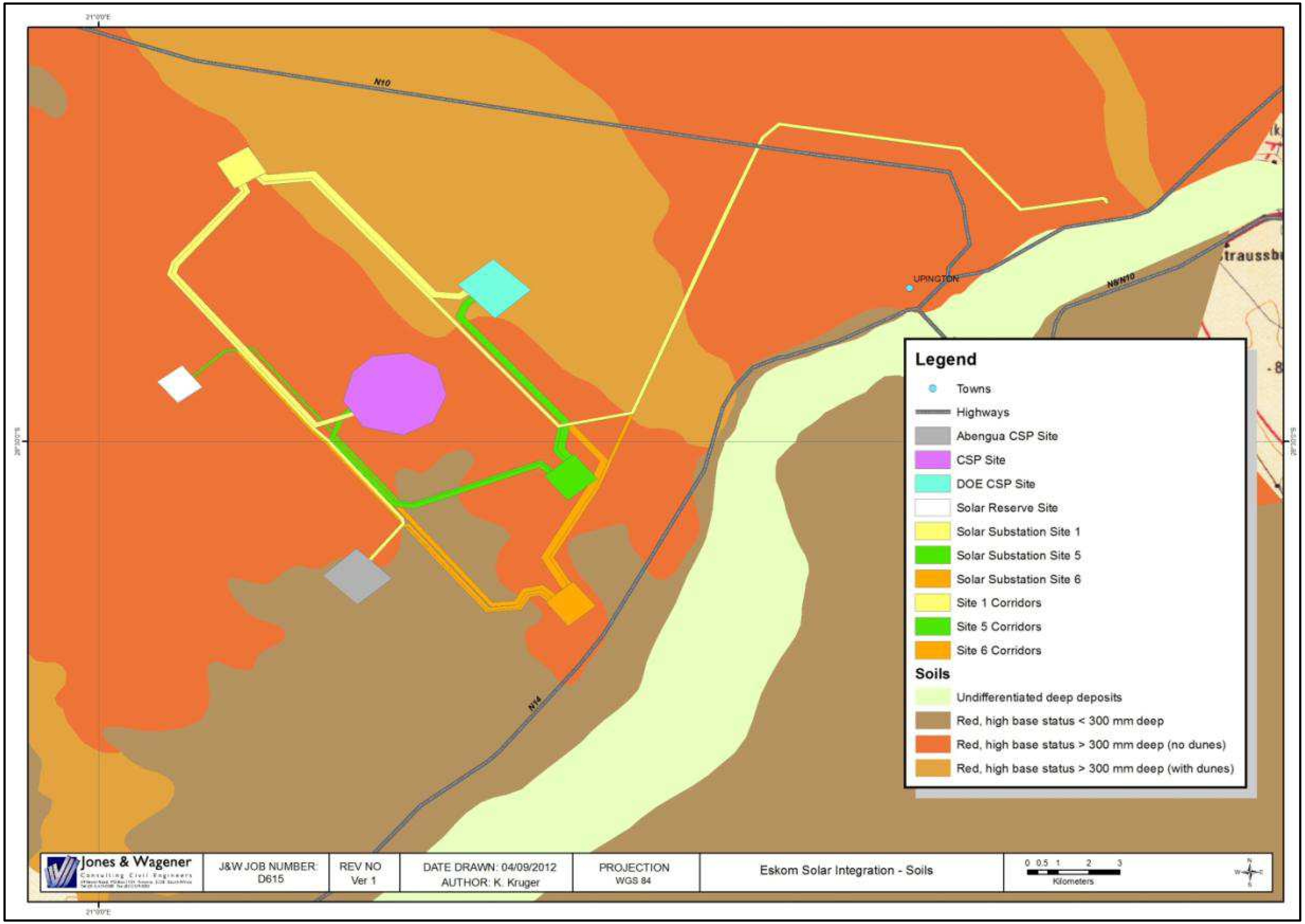

Figure 4-14: Distribution power line soils

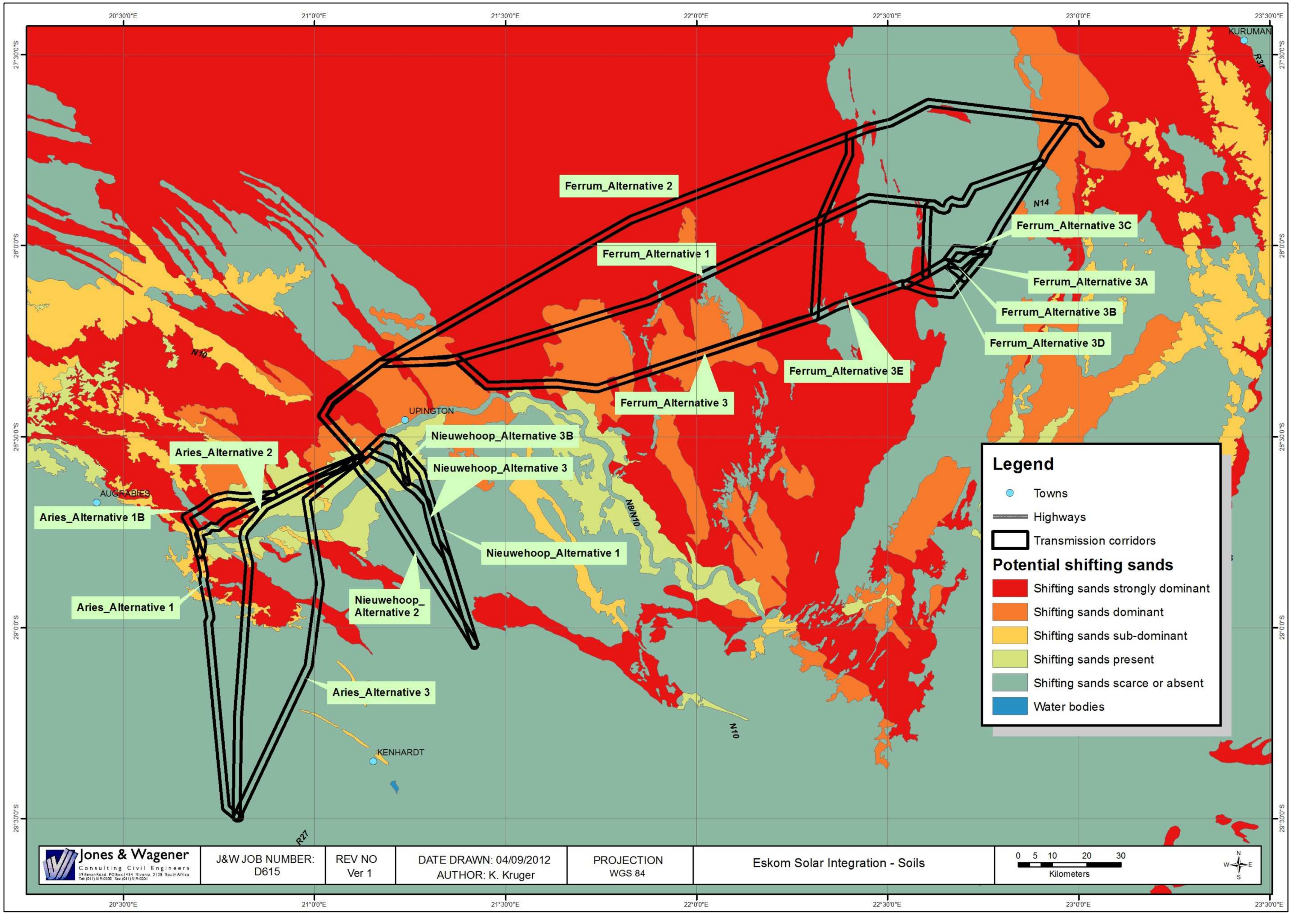

Figure 4-15: Soil sensitivity map

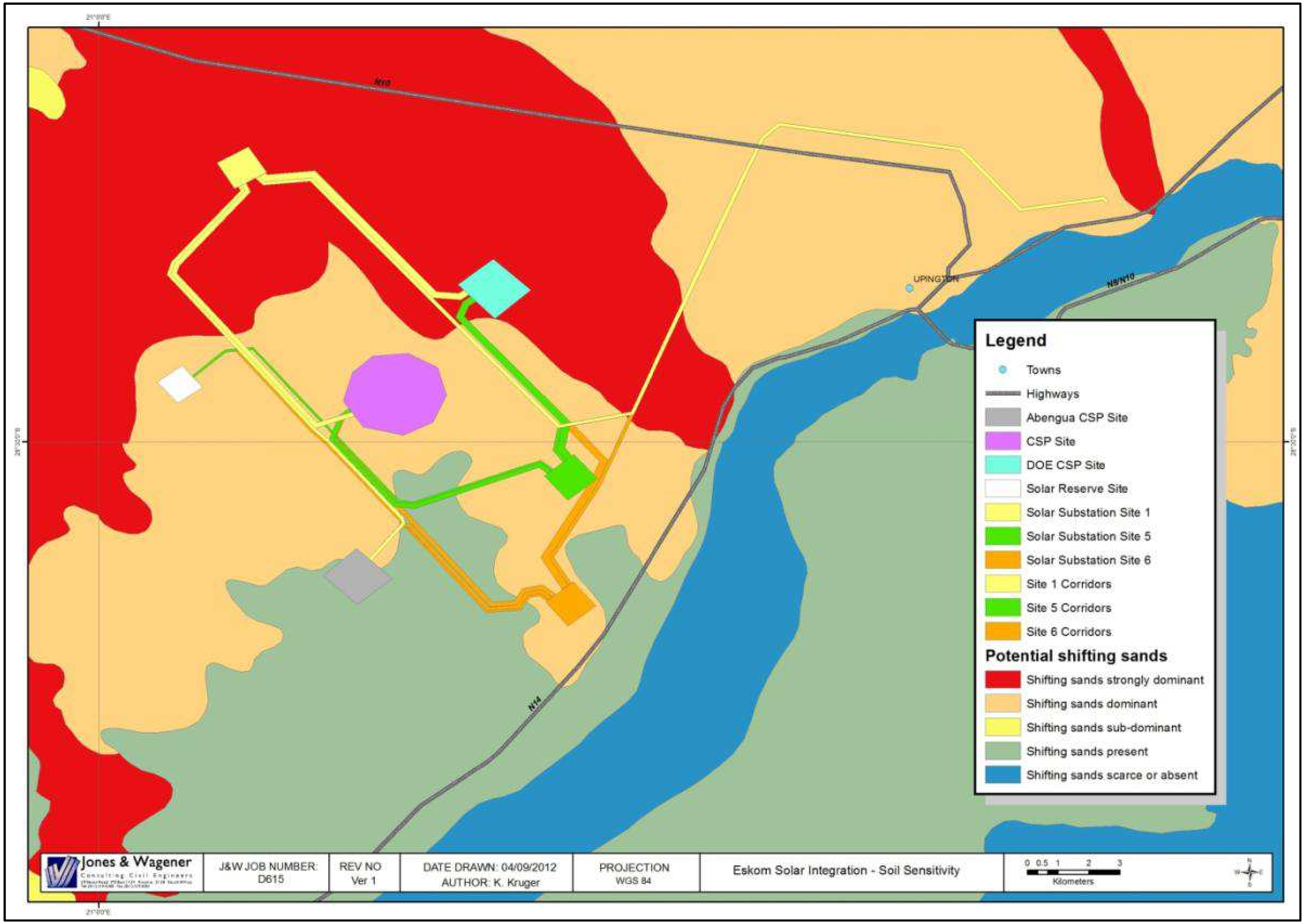

Figure 4-16: Distribution Soil Sensitivity

4.5 Agricultural Potential (Land Capability)

4.5.1 Data Collection and Methodology

Using the soil data collected during the site investigations and applying that to the land capability assessment methodology as outlined by the National Department of Agriculture[1], the agricultural potential/land capability of the site was determined.

4.5.2 Regional Description

Regionally the Northern Cape is not known for cultivation or high agricultural potential soils. The majority of the province is utilised for grazing of livestock due to the aridity and shallow soils that occur in the area.

4.5.3 Site Description

According to the land capability methodology, the potential for a soil to be utilised for agriculture is based on a wide number of factors. These are listed in the table below along with a short description of each factor.

Table 4-1: Agricultural Potential criteria

Criteria	Description
Rock Complex	If a soil type has prevalent rocks in the upper sections of the soil it is a limiting factor to the soil's agricultural potential
Flooding Risk	The risk of flooding is determined by the closeness of the soil to water sources.
Erosion Risk	The erosion risk of a soil is determined by combining the wind and water erosion potentials.
Slope	The slope of the site could potentially limit the agricultural use thereof.
Texture	The texture of the soil can limit its use by being too sandy or too clayey.
Depth	The effective depth of a soil is critical for the rooting zone of agricultural crops.
Drainage	The capability of a soil to drain water is important as most grain crops do not tolerate submergence in water.
Mechanical Limitations	Mechanical limitations are any factors that could prevent the soil from being tilled or ploughed.
pH	The pH of the soil is important when considering soil nutrients and hence fertility.
Soil Capability	The soil type's capability to sustain agriculture.
Climate Class	The climate class highlights the prevalent climatic conditions that could influence the agricultural use of a site.
Land Capability / Agricultural Potential	The land capability or agricultural potential rating for a site combines the soil capability and the climate class to arrive at the

[1] Agricultural Research Council – Institute for Soil, Climate and Water (2002), *Development and Application of a Land Capability Classification System for South Africa*, Final Report to Directorate Agricultural Land Resource Management, National Department of Agriculture.

Criteria	Description
	sites potential to support agriculture.

The soils identified in Section 3.4 above were classified according to the methodology described above. The criteria mentioned above were evaluated in the table below.

Table 4-2: Land Capability of the soils within the study site.

Soil	Agricultural	Sandy	Shallow	Hard Rock
% on Site	1.7 %	48.3%	44.3%	5.7%
Rock Complex	None	None	Yes	Yes
Flooding Risk	High	None	None	None
Erosion Risk	Moderate	High	High	Very Low
Slope %	<4	<4	<4	>4
Texture	Loam	Sand	Sand	Rock/Sandy
Effective Depth	> 90 cm	> 30 cm	< 30 cm	< 10 cm
Drainage	Imperfect	Excellent	Poorly drained	Poorly drained
Mech Limitations	None	None	Rocks	Rocks
pH	> 5.5	> 5.5	> 5.5	> 5.5
Soil Capability	Class III	Class V	Class VI	Class VIII
Climate Class	Severe	Severe	Severe	Severe
Land Capability	Class III – Moderately Arable Land	Class VII – Grazing Land	Class VII – Grazing Land	Class VIII – Wildlife

No limitation	Low	Moderate	High	Very Limiting

The site is made up of three land capability classes, namely Class III, VII and VIII as shown in the Figure below. The Class III soils are suitable for cultivation but they have some restrictions – in this case flooding and climate. The Class VII soils have continuing limitations that cannot be corrected; in this case rock complexes, climate, stoniness, and a shallow rooting zone constitute these limitations. Class VIII soils are basically hard rock and have no agricultural use.

4.5.4 Sensitivities

Of the uses above, the agricultural soils located adjacent to the Orange River supports the agricultural cultivation core for the province. Impacts to these areas should be limited as the soils as well as the water sources are very limited.

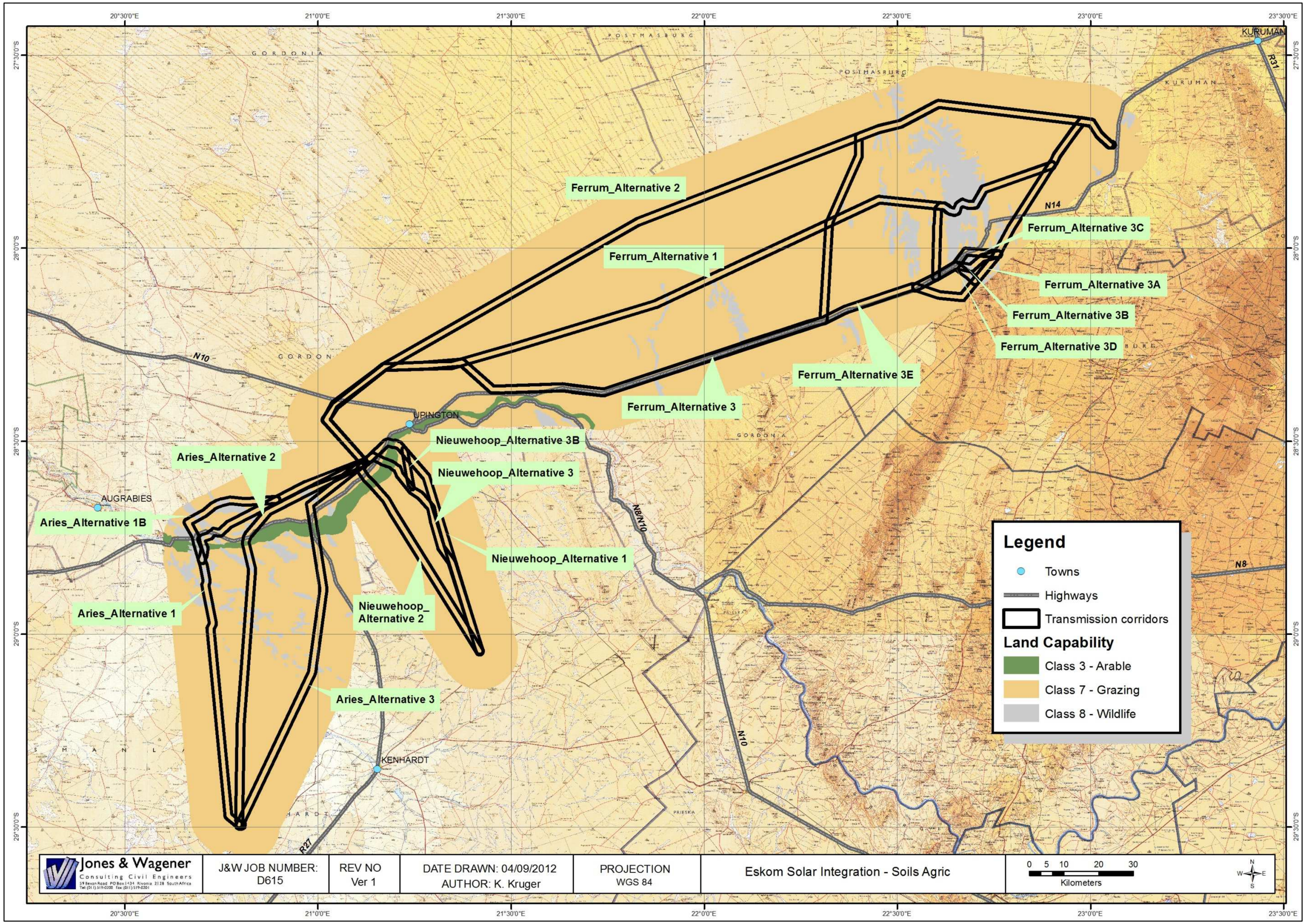

Figure 4-17: Agricultural potential for the study area

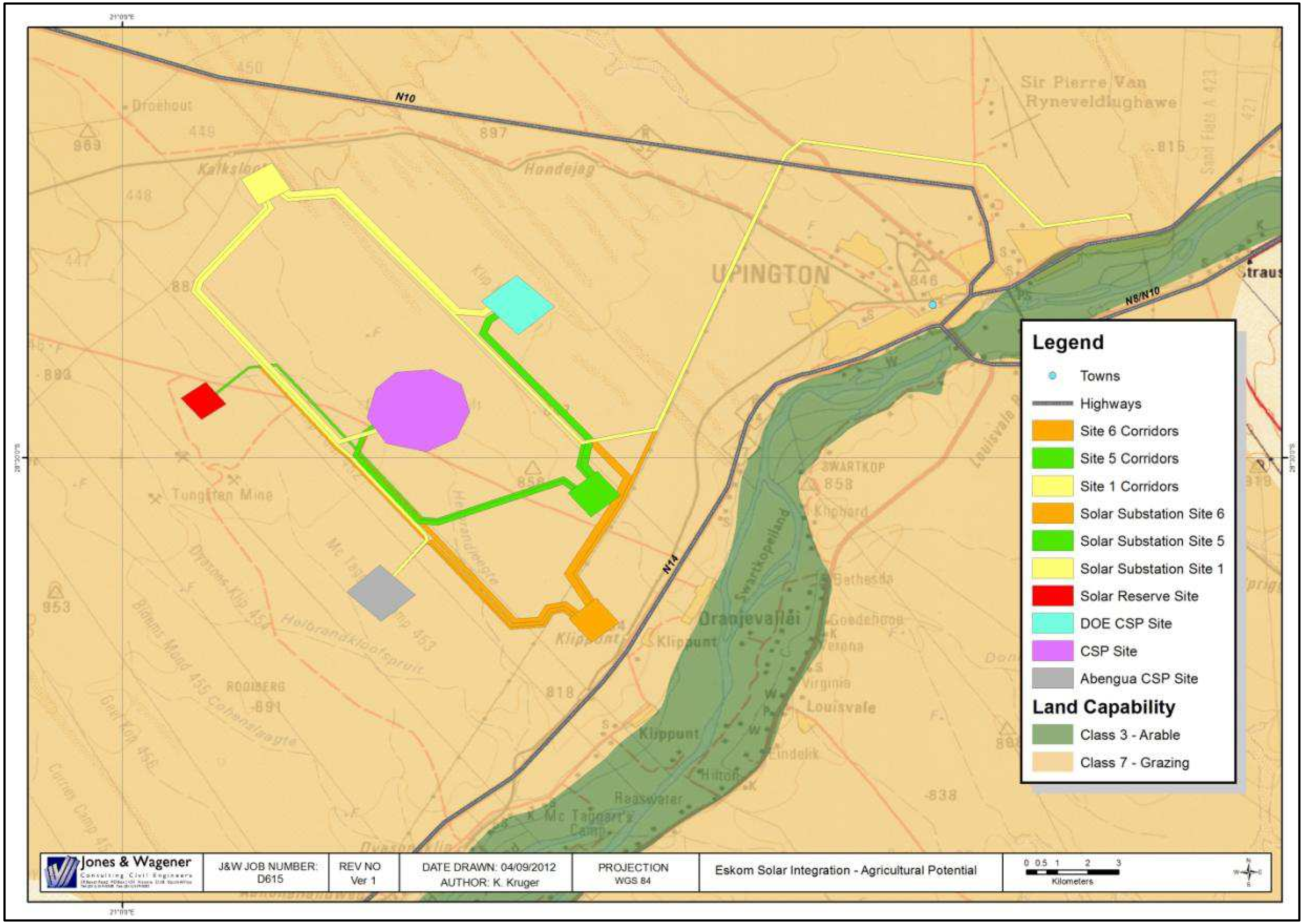

Figure 4-18: Agricultural Potential for the Distribution Lines.

4.6 Terrestrial Biodiversity

4.6.1 Data Collection and Methodology

A literature review of the faunal and floral species that could occur in the area was conducted. The flora and fauna descriptions and data below are taken from *The Vegetation of South Africa, Lesotho and Swaziland* (Mucina and Rutherford 2006). Biodiversity data was obtained from the BGIS website for the Northern Cape provincial department and was used to conduct a desktop study of the area. This data consists of terrestrial components; ratings provide an indication as to the importance of the area with respect to biodiversity. Species information was obtained from the SIBIS website.

The detailed study involved fieldwork, a literature review and a desktop study utilising GIS. Site investigations were conducted from October 2011 to September 2012, from spring to summer. The area within the servitude was sampled using transects placed at 500 m – 1 000m intervals. At random points along these transect an area of 20 m x 20 m was surveyed. All species within the 20 m x 20 m quadrant were identified, photographed and their occurrence noted. Sensitive features such as ridges or wetlands were sampled by walking randomly through the area concerned and identifying all species within the area.

In addition to the references mentioned above, the following field guides were used:

- Guide to Grasses of Southern Africa (Frits van Oudtshoorn, 1999);
- Field Guide to Trees of Southern Africa (Braam van Wyk and Piet van Wyk, 1997);
- Field Guide to the Wild Flowers of the Highveld (Braam van Wyk and Sasa Malan, 1998);
- Problem Plants of South Africa (Clive Bromilow, 2001); and
- Medicinal Plants of South Africa (Ben-Erik van Wyk, Bosch van Oudtshoorn and Nigel Gericke, 2002)

Species lists were obtained from the SIBIS (*South African National Biodiversity Institute - Accessed through the SIBIS portal, sibis.sanbi.org, 2012-08-25)*. In addition the following faunal guides were used on site and while compiling this report:

- Die Natuurlewe van Suider-Afrika, 'n veldgids tot diere en plante van die streek (Vincent Carruthers, 1997);
- Birds of Southern Africa (Ian Sinclair, 1994);
- Smithers' Mammals of Southern Africa, a field guide (Ed. Peter Apps, 2000).

4.6.2 Regional Description

Nama-Karoo Biome

The Nama-Karoo Biome overlaps the main part of the study area and is a large landlocked biome in the central plateau of the western part of the country. The name is derived from the Khoi San word meaning "dry" and only the desert biome has higher variability in rainfall and the Kalahari greater extremes in temperature.

The flora in this biome is not particularly rich, and also has very low species endemism. *Asteraceae* (Asters), *Fabaceae* (Thorn Trees) and *Poaceae* (Grasses) are the dominant families found in the biome. The biome is a complex of extensive plains dominated by dwarf shrubs (< 1m tall) intermixed with grasses, succulents, geophytes and annual forbs. Small trees are limited to drainage lines or rocky outcrops. According to Mucina and Rutherford, the following vegetation types are found within the study area and this biome:

- Bushmanland Arid Grassland;
- Bushmanland Basin Shrubland;
- Kalahari Karroid Shrubland; and
- Lower Gariep Broken Veld.

Savanna Biome

Most Savanna has an herbaceous layer usually dominated by grass species and a discontinuous to sometimes very open tree layer. This is the most widespread biome in Africa. The savannah biome is found along the sandy dunefields to the north and east of Upington. Here the deeper soils allow for larger trees to establish themselves, especially Acacias with the intermittent shrubland in the areas between the dunes. Further to the east the topography and rainfall allows even bigger trees to establish themselves, especially around Kathu. Vegetation types found in this biome, within the study area are:

- Gordonia Duneveld;
- Gordonia Plains Shrubland;
- Kathu Bushveld;
- Olifantshoek Plains Thornveld; and
- Koranna-Langeberge Mountain Bushveld.

Inland Azonal Vegetation

Also found in the study area is azonal vegetation, which is almost always associated with water bodies or wetlands. Within the study area the Orange River is the only perennial water source and the vegetation along its banks form a unique vegetation type i.e. the Lower Gariep Alluvial Vegetation.

In addition the salt pans in the area are also recognised as a separate vegetation type known as the Southern Kalahari Salt Pans. These areas are generally devoid of vegetation but some specialist plants do survive here. All the vegetation types mentioned above are illustrated in the maps below.

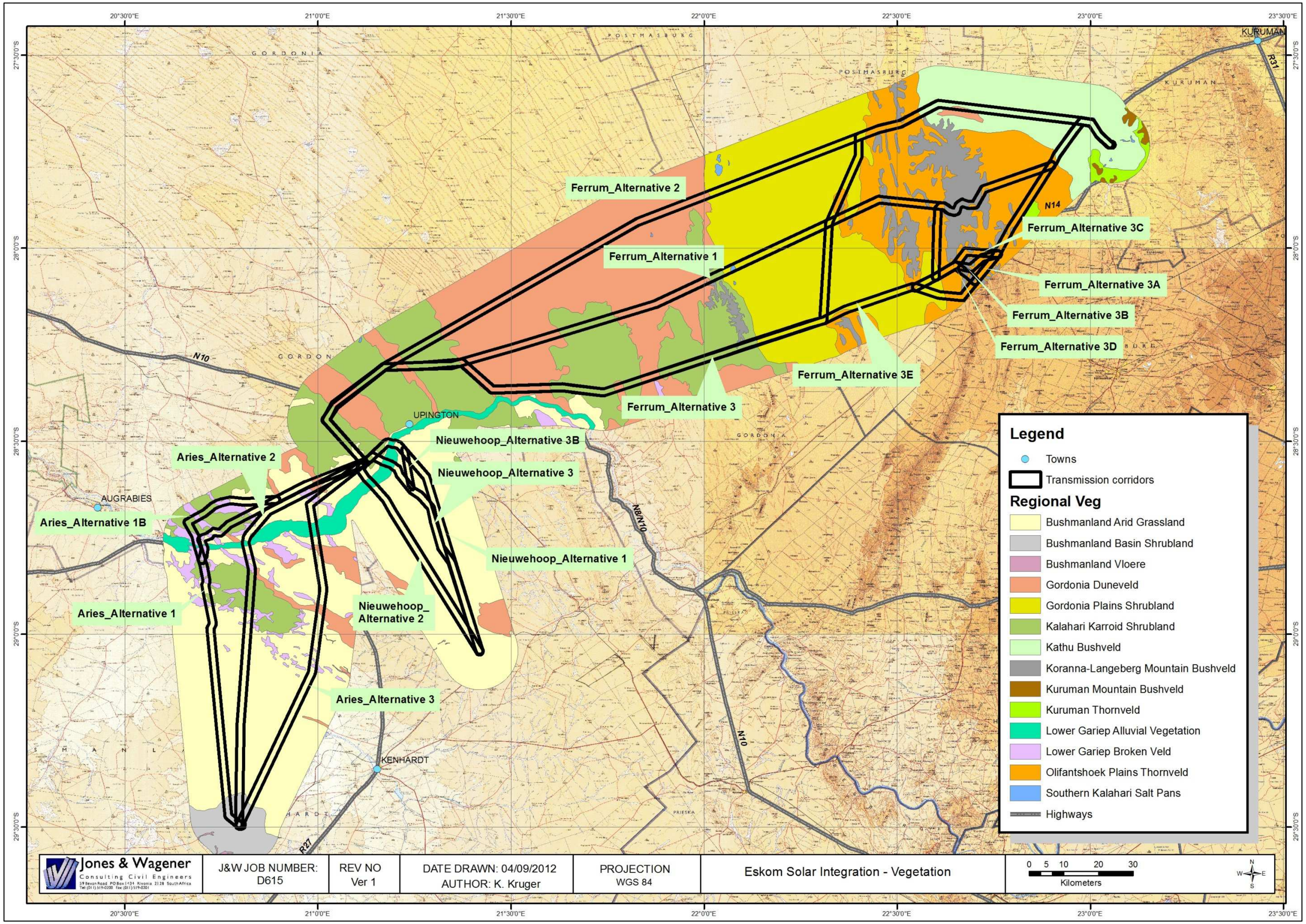

Figure 4-19: Vegetation of the study area.

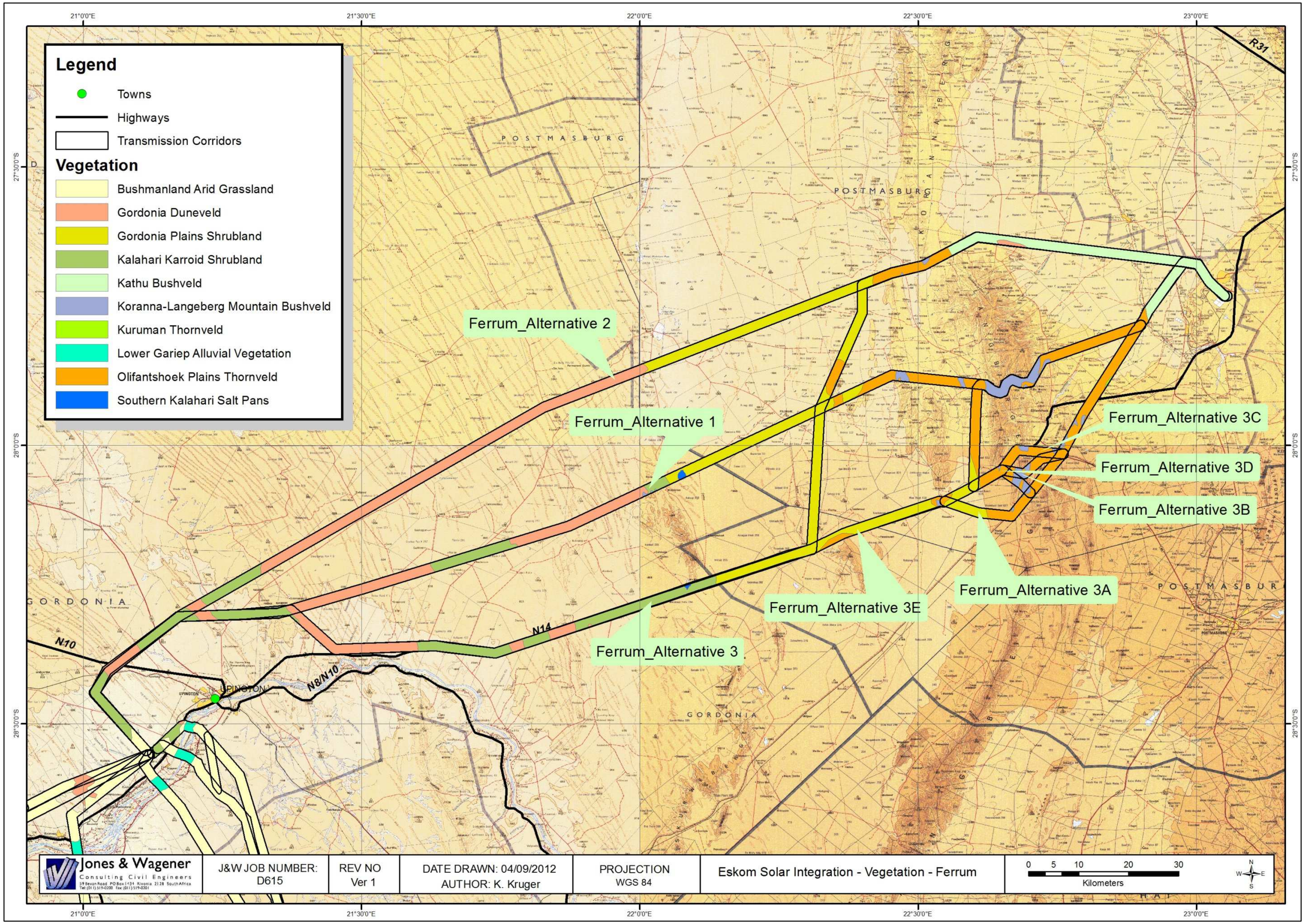

Figure 4-20: Vegetation of the Ferrum Corridors.

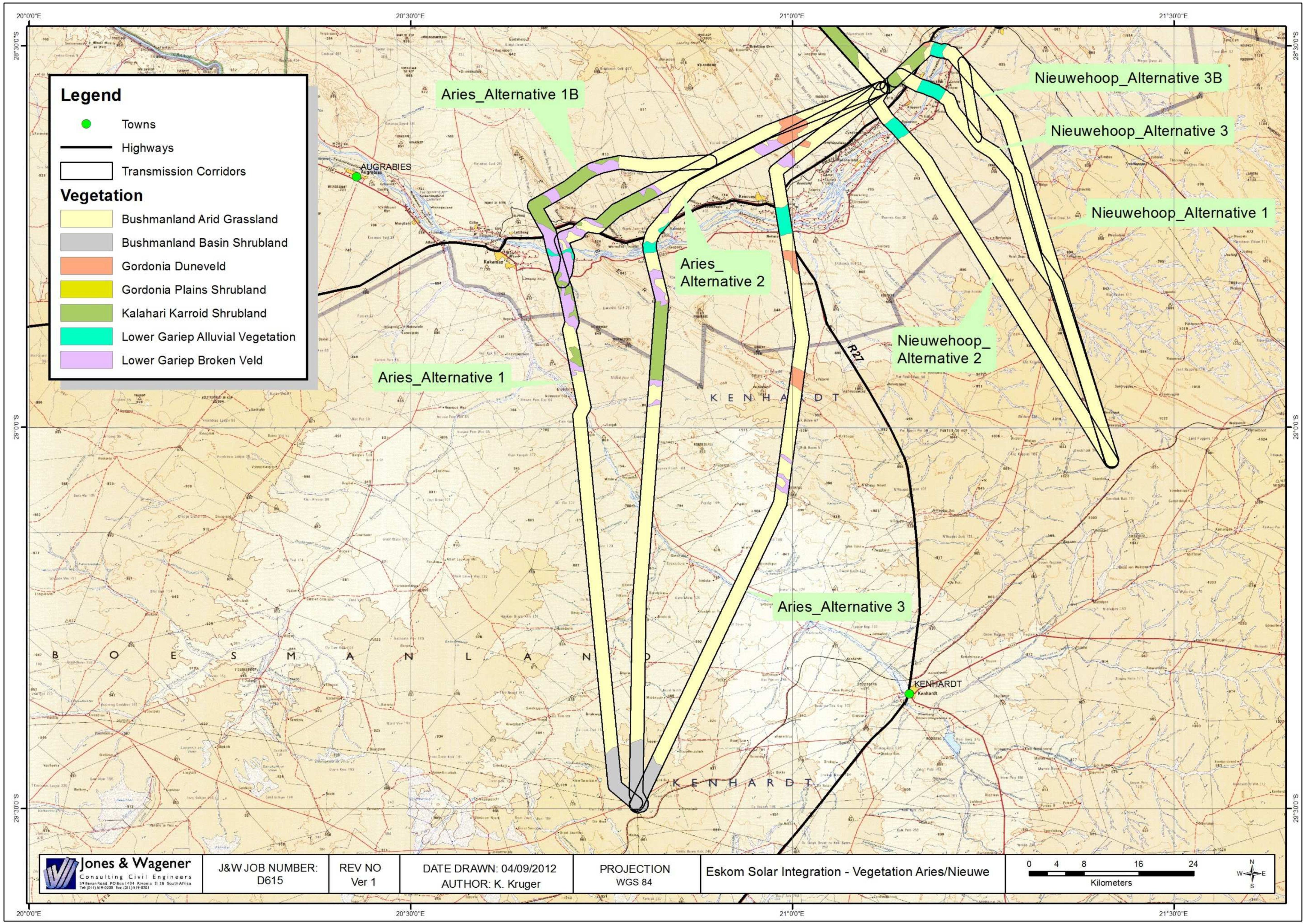

Figure 4-21: Vegetation of the southern section of the study area.

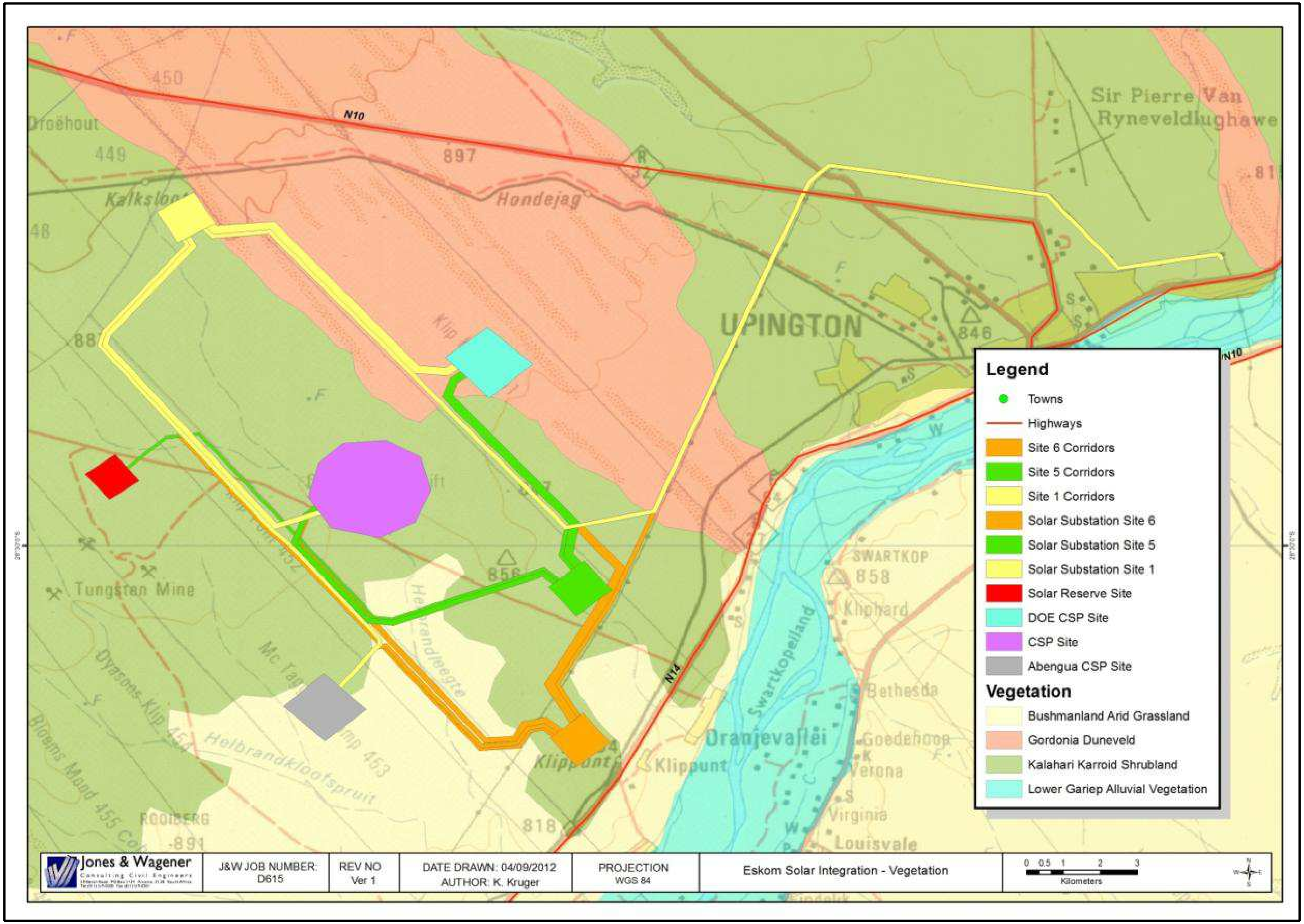

Figure 4-22: Vegetation for the Distribution Lines

4.6.3 Site description - Flora

In this section each of the vegetation/habitat types identified is described in more detail. This description starts at the easternmost section of the study area, at Kathu. It should be noted that as per the terms of reference for the study, this was an assessment aimed at determining the general ecological state of each of the corridors. Once a preferred corridor is identified and authorised, a detailed botanical assessment of the exact power line servitude will be undertaken. This assessment will identify all endangered, protected and specially protected species under the National Environmental Management, Biodiversity Act, the Forestry Act and the Northern Cape Nature Conservation Act.

4.6.3.1. Ferrum to Solar Park Corridors

Kathu Bushveld

This vegetation unit is found all around the Kathu area as the name suggests. The vegetation unit is typified by a medium-tall tree layer with *Acacia erioloba* in places, but the unit is mostly open with *Boscia albitrunca* as the other prominent tree. The shrub layer is the most important and dominant shrubs include *Acacia mellifera, Diospyros lycioides and Lycium hirsutum* with a variable grass layer. Dominant grasses include *Aristida meridionalis, Brachiaria nigropedata, Centropodia glauca, Eragrostis lehmanniana, Schmidtia pappophoroides and Stipagrostis ciliate*. Below are photographs taken from the helicopter flight over the study area. This unit is not threatened as only 1% of the vegetation unit has been transformed through mining.

It should be noted that a portion of the vegetation to the north-east of the Kathu town has been declared a protected area by DAFF, the Kathu forest as per GN 727 of July 2009. This area is known for a high density of large *Acacia erioloba* and is shown in Figure 4-34 in the protected areas section. It should be noted that the proposed power line corridors are more than 2 km from the declared forest and its buffer zones.

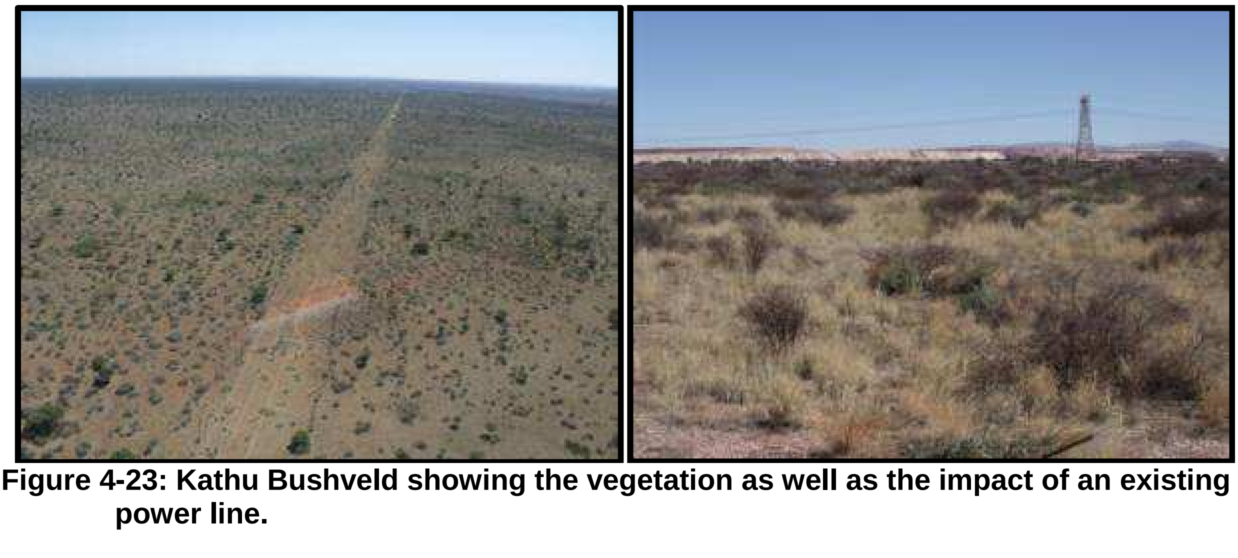

Figure 4-23: Kathu Bushveld showing the vegetation as well as the impact of an existing power line.

Olifantshoek Plains Thornveld

The plains surrounding the town of Olifantshoek are dominated by thornveld and this vegetation type extends to all the plains downslope of the Korannaberg, Langeberg as well as the Asbestos Mountains. Here a wide variety of thorny trees and shrubs form an open mosaic with sparse grasses. The dominant trees are *Acacia luderitzii, Boschia* *albitrunca and Rhus tenuinervis*. The odd large *Acacia erioloba* can occur and the dominant grasses are *Schmidtia pappophoroides and Stipagrostis uniplumis.* This vegetation unit is not threatened as only 1% has been disturbed.


Figure 4-24: Olifantshoek Plains Thornveld from the air (left) and ground level (right).

Koranna-Langeberg Mountain Bushveld

This vegetation unit is found all along the Koranna and Langeberg Mountains. These rugged slopes support open shrubland with moderate grass cover. Dominant shrubs and small trees include *Acacia meliffera and Croton gratissimus.* The grasses are dominated by *Aristida diffusa and Eragrostis curvula* with *Sarcostemma viminale* a common succulent climber. Virtually no transformation has taken place so this vegetation unit is not threatened. The photographs below give an illustration of the typical vegetation found in this unit.


Figure 4-25: Koranna-Langeberg Mountain Bushveld.

Gordonia Plains Shrubland

The Gordonia Plains Shrubland is found in a long band between the Kalahari dunes in the west and the Koranna and Langeberge in the east on the flat plains and are virtually devoid of dunes in between the two landscape features. These plains comprise of mainly open grassland with occasional shrubs *Rhigozum trichotomum, Grewia flava* and some scattered *Acacia haematoxylon and A. erioloba.* Dominant grasses include *Aristida meridionalis, Centropodia glauca, Eragrostis lehmanniana and Schmidtia kalahariensis*. Very little of this area has been disturbed and the vegetation type is not threatened. Please refer to some photographs of the typical vegetation within this unit below.

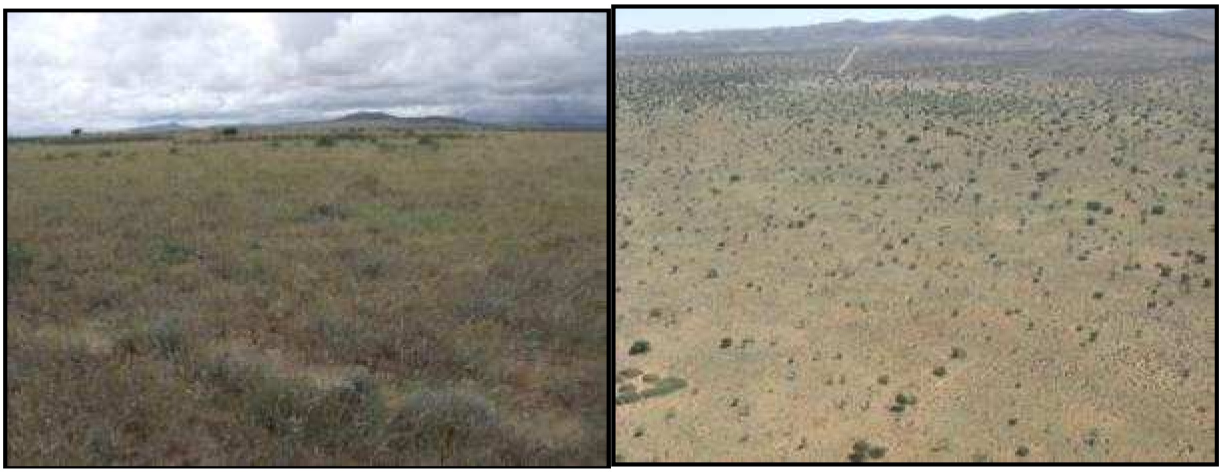

Figure 4-26: Gordonia Plains Shrubland.

Southern Kalahari Salt Pans

The North West and Northern Cape Provinces house a number of intermittent endorheic, closed depressions (pans). These pans are vegetated by low grasslands although the centre of the pans is usually devoid of vegetation. The grasses are often dominated by *Sporobolus spp.* with a mixture of dwarf shrubs with an outer belt of *Lycium and/or Rhigozum*. Other species also include the succulent shrub *Zygophyllum tenue* and the grass *Enneapogon desvauxii*. This vegetation unit is subject to natural degradation – regeneration cycles controlled by the grazing of animals on the vegetation. In addition this vegetation unit is not threatened.

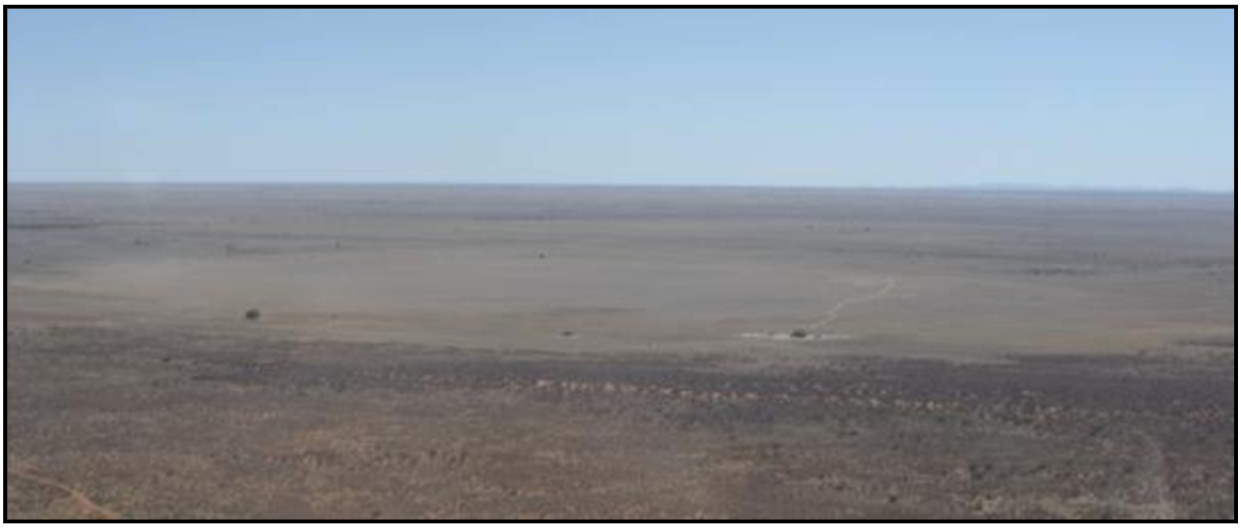

Figure 4-27: The salt pan found along the Ferrum-Solar 1 Corridor

Gordonia Duneveld

This vegetation unit covers a large expanse in the northern parts of the Northern Cape Province and is typified by the red Kalahari dunes. Several small pockets of dunes can be found scattered south of the Orange River. The dunes are parallel and about 3 – 8m above the plains. The vegetation comprises of open shrubland with *Stipagrostis amabilis* grasses dominating the dune crests, *Acacia haematoxylon* and *Acacia* *mellifera* trees on the slopes and *Rhigozum trichotomum* in the interdune "streets". Other common species include *Grewia flava* shrubs*, Schmidtia kalahariensis* grasses *and Hermbstaedtia fleckii* herbs*. The a*rea is sensitive to overgrazing as removal of vegetative cover can result in mobilisation of dune sands. This vegetation unit is well conserved and is not threatened.

Figure 4-28: Gordonia Duneveld showing the typical red dunes

Kalahari Karroid Shrubland

The Kalahari Karroid Shrubland forms alternating bands with the Gordonia Duneveld and usually occurs in the areas where the dunes do not occur. This vegetation type forms the transition between the Savanna biome and the Nama-Karroo biome as the tree elements reduce and shrubs and grasses start to dominate. Small trees and shrubs include *Acacia mellifera, Parkinsonia africana, and Rhigozum trichotomum.* Low shrubs dominate the area and include *Hermannia spinosa, Limeum aethiopicum and Phaeoptilum spinosum* while the common herbs include *Dicoma capensis, Chamaesyce inaequilatera.* Common grasses are *Aristida adscensionis, Enneapogon desvauxii, E. scaber and Stipagrostis obtusa.* This vegetation unit is not threatened although this area was the corridor of choice for early roads, which lead to the introduction of alien plants. The result is that some 25% of the unit has been colonised by scattered *Prosopis* species.

Figure 4-29: Kalahari Karroid Shrubland.

4.6.3.2. Aries and Nieuwehoop to Solar Corridors

This following section covers the vegetation found from Upington, to Kakamas and south to Kenhardt that is traversed by the corridors from Aries to Solar Park as well as the corridors from Nieuwehoop to the Solar Park.

Bushmanland Arid Grassland

This large vegetation unit comprises the grasslands between the shrublands to the north and east, the desert landscapes to the northwest and Namaqualand hills in the west. These extensive plains are dominated by white grasses mostly of the *Stipagrostis* genus giving the vegetation a semi-desert steppe character. In some low lying places the *Sasola* shrubs change the vegetation structure and in years of high rainfall a rich display of annual herbs and their flowers can be expected. Dominant grasses include *Aristida adscensiones, A. Congesta, Enneapogon desvauxii, Eragrostis nindensis, Schmidtia kalahariensis, Stipagrostis ciliate, S. obtusa and Cenchrus ciliaris.* Shrubs include *Lycium cinereum, Rhigozum trichotomum, Aptosimum spinescens, Hermannia spinosa and Pentzia spinescens.* Very little of this vegetation unit has been disturbed and hence the unit is not threatened.

Figure 4-30: Bushmanland Arid Grassland.

Lower Gariep Broken Veld

This vegetation unit is found along the broken koppies and inselbergs around Keimoes and just before Kakamas as well as a few outcrops to the south. This rugged terrain is sparsely populated with vegetation that is dominated by shrubs with annuals present in spring in the form of perennial grasses and herbs. Dominant trees include *Aloe dichotoma and Acacia mellifera* with the dominant shrubs *Rhigozum trichotomum, Blepharis mitrata.* The dominant grasses include *Aristida adscensionis, Enneapogon desvauxii, E. scaber, Eragrostis nindensis, Stipagrostis obtusa, S. uniplumis.* The main dominant herb is *Forsskaolea candida*. This vegetation unit is also not threatened as there is less than 1% transformed. Below are photographs of the vegetation unit.

Figure 4-31: Lower Gariep Broken Veld showing protected "kokerboom" on the left.

Lower Gariep Alluvial Vegetation

The Lower Gariep Alluvial Vegetation is found all along the alluvial floodplains and islands of the Orange River from Groblershoop to the Atlantic Ocean. These alluvial terraces support a variety of riparian thickets dominated by *Ziziphus mucronata, Euclea pseudebenus* (protected) *and Tamarix usneoides* along with reed beds with *Phragmites australis.* These are mixed with flooded grasslands and herblands on the terraces and banks of the river. Additional species in the riparian vegetation includes the trees and shrubs *Acacia karroo, Salix mucronata, Schotia afra and Gymnosporia linearis.* The grasslands and herblands include species such as *Tetragonia schenkii, Litogyne gariepina, Cynodon dactylon and Setaria verticillata.* This vegetation type has been extensively modified (>50% transformed) through agriculture (grapes and vegetables) as well as alluvial diamond mining. In addition this vegetation type is prone to invasion by *Nicotiana glauca and Argemone ochroleuca*. This vegetation type is therefore listed as ***endangered***.

Figure 4-32: Lower Gariep Alluvial Vegetation, showing the encroachment from agriculture (left).

Bushmanland Basin Shrubland

The Bushmanland Basin Shrubland is found at the very southern extremities of the study area around the Aries Substation. This is the northernmost part of a large basin centred around Brandvlei and Vanwyksvlei. These slightly irregular plains are dominated by a mixture of dwarf shrubs and “white” grasses and in years of high rainfall a number of annuals are also abundant. The dominant shrubs are *Lycium cinerum, Rhigozum trichotomum, Aptosimum spinescens, Hermannia spinosa, Pentzia spinescens, Zygopyllum micophyllum and Salsola tuberculata.* The dominant herbs and grasses are *Ganazia lichtensteinii, Leysera tenella, Aristida adscensionis, Enneapogon desvauxii, Stipagrostis obtuse and S. ciliate.* This vegetation unit is relatively undisturbed and not threatened.

Figure 4-33: Bushmanland Basin Shrubland surrounding Aries Substation.

4.6.3.3. Distribution Corridors

The distribution power lines cross over three main vegetation types including Bushmanland Arid Grassland, Kalahari Karroid Shrubland and Gordonia Duneveld as shown in Figure 4-22. These vegetation types have been described above.

4.6.4 Site Description - Fauna

The habitats described above form the home for a variety of species and detailed lists of these are provided in Appendix A. In general the grasslands and shrub plains described above house species that can withstand the arid climate. Due to the large expanses of relatively undisturbed habitat available, animals that occur in this area are not threatened by the proposed development, as there as large expanses of habitat to move to. Common species include the following:

- Mammals;
  - Bat-eared foxes;
  - Steenbok;
  - Scrub hare;
  - Springbok;
  - Aardvark;
  - Meerkat; and
  - Mongoose (variety).
- Reptiles
  - Puff adder; and
  - Leopard tortoise.

Avifauna has been specifically left out as that was a separate specialist study. In total an estimated 23 mammal, 17 reptile and 39 Arthropods as listed in the Appendix A.

4.6.5 Sensitivities

4.6.5.1. Endangered Ecosystems

Using data from South African National Biodiversity Institute (SANBI) on the protected and threatened ecosystems found in the study area Figure 4-34 was generated. The provincial data highlights Critical Biodiversity Areas (CBA) as shown in yellow on the map. It also highlights biodiversity corridors as shown in green on the map. Lastly the remaining pockets of the threatened ecosystems (Lower Gariep Alluvial vegetation) inside the CBA are shown in red.

From the map it can be seen that the Lower Gariep Alluvial vegetation adjacent to the Orange River is classified as a threatened ecosystem. Impacting this area requires approval as per the National Environmental Management Act (NEMA, 107 of 1998) Listing 3 Regulations and the National Environmental Management Biodiversity Act (NEM:BA, 10 of 2004). When evaluating the most preferred crossing of the Orange River and its environs, the threatened status of this vegetation unit should be considered as a critical factor in the evaluation. Refer to Section 5.2 for a quantification of the actual potential impact each of the alternative corridors can have on this sensitive vegetation type.

Furthermore it should be noted that the area indicated in purple on the map is known as the Griqualand West Centre of Endemism (Van Wyk & Smith, 2001). This centre is has some 1800 species present in the area of which more than 40 is endemic or near endemic species and of these endemics some 32,5% are succulents.

4.6.5.2. Endangered Species

Further to the endangered ecosystem there is the consideration of protected and endangered species. In terms of the NEM:BA and the IUCN website the study area could contain the following endangered species:

- ***Aloe pillansii*** (Bastard Quiver Tree)
    - Status: Critically Endangered
- ***Aloe ramosissima*** (Maiden's Quiver Tree)
    - Status: Vulnerable
- ***Mystromys albicaudatus*** (White-tailed Mouse)
    - Status: Endangered
- ***Pachypodium namaquanum*** (Elephant's Trunk)
    - Status: Lower risk/near threatened
- ***Manis temminckii*** (Pangolin)
    - Status: Vulnerable
- ***Panthera pardus*** (Leopard)
    - Status: Vulnerable

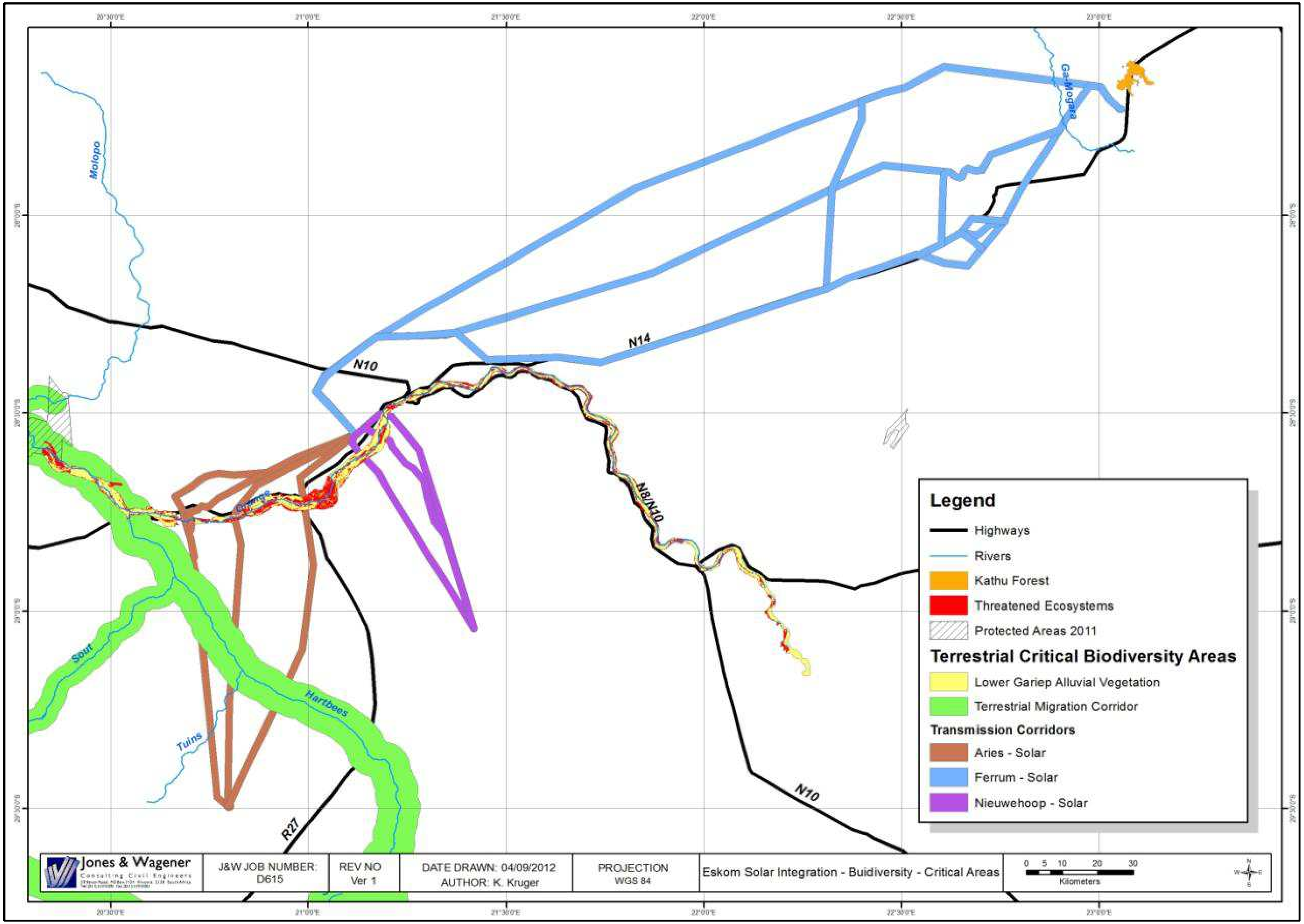

Figure 4-34: Endangered habitat as well as Critical Biodiversity Areas (CBA)

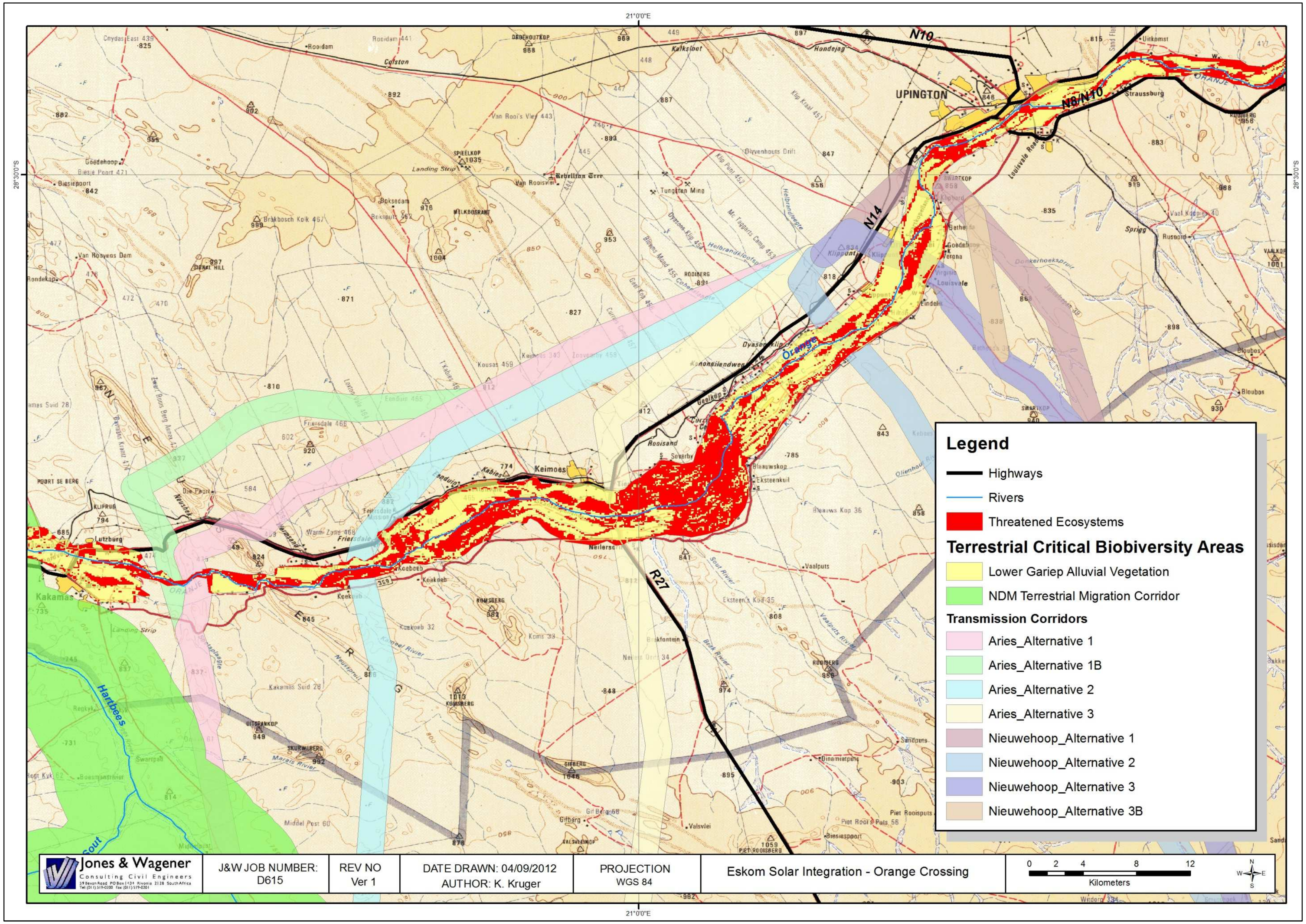

Figure 4-35: Zoomed in view of endangered habitat crossing.

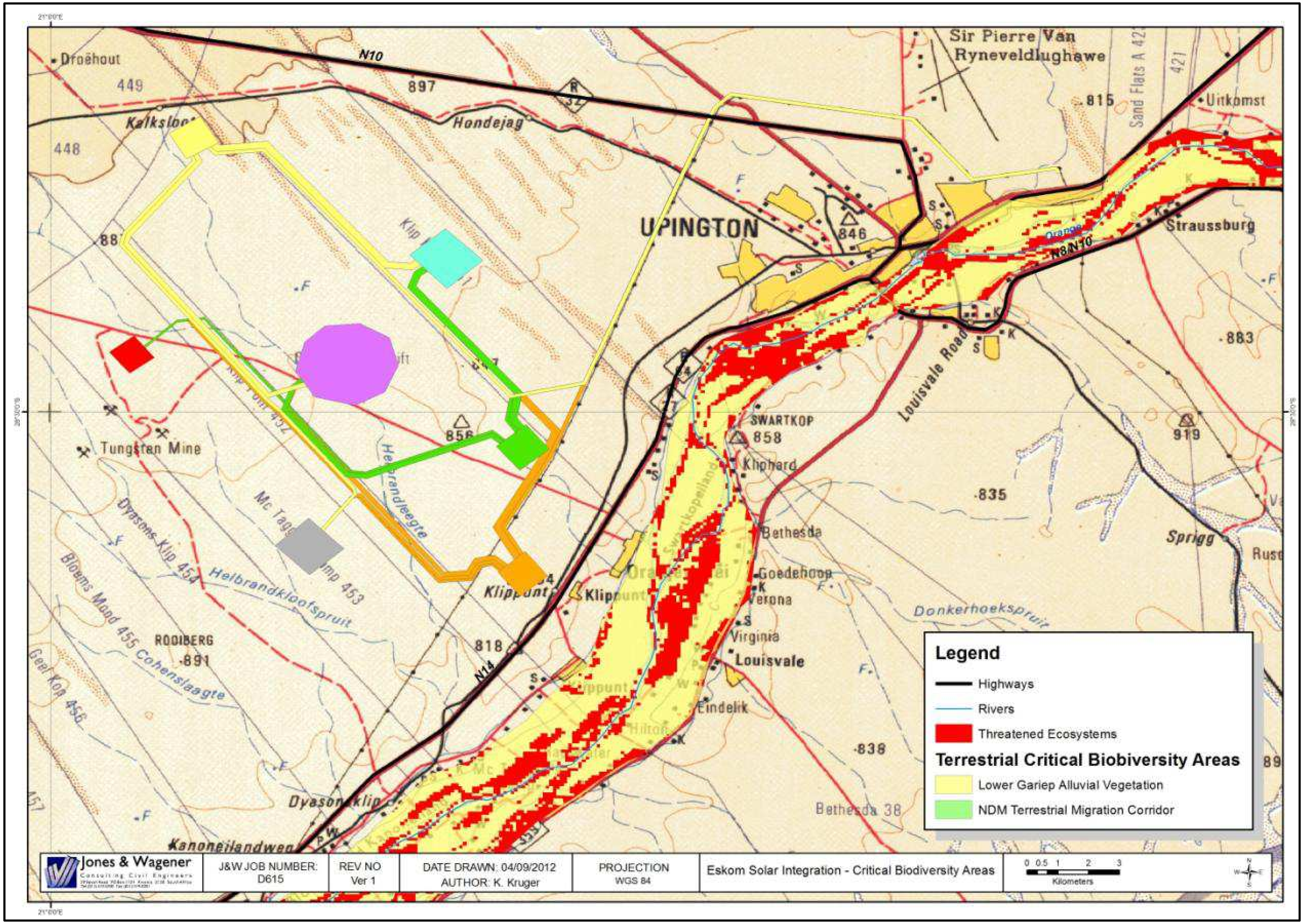

Figure 4-36: CBA's in relation to the distribution lines.

4.6.5.3. Protected Species

In addition to the NEM:BA regulations, the DAFF also have a list of protected trees that require a licence in order to remove, crop or disturb specific species prior to the commencement of an activity. These trees are listed in terms of Section 15(1) of the National Forests Act (NFA), 1998, as amended. It should be noted that an EIA authorisation does not exempt the applicant from the NFA requirements.

Furthermore the recently proclaimed Northern Cape Nature Conservation Act (Act no. 9 of 2009) also lists two Schedules of protected species, Schedule 1 – specially protected species and Schedule 2 – protected species. These schedules are included in Appendix A. If any of these trees are to be removed a permit is required from the Nature Conservation Department prior to any removal of trees.

As mentioned above, this report details the general ecological status of the corridors, while aiming to identify potential sensitivities and protected species. Once the preferred corridor is selected and the detailed power line route design has been completed, a detailed botanical assessment of the route will be undertaken aimed at identifying all plants that require a permit from DAFF, Northern Cape Nature Conservation or DEA. It should be noted that an EIA authorisation does not automatically mean approval of permits to remove protected or endangered plants from the other authorities.

The EMPr has a section that details how these requirements should be met. The species that could occur in the study area are highlighted below (descriptions adapted from the SANBI's plant information website www.plantzafrica.com and supplemented with description from van Wyk and van Wyk, 1997):

***Acacia erioloba* aka Camel Thorn, Kameeldoring / Mogohlo (NS) / Mogôtlhô (T)**

This large Acacia is found throughout the drier parts of southern Africa. It frequently occurs in areas of deeper sandy soils and groundwater, often found along dry river beds. The area around Kathu is especially rich in these trees and they occur sporadically throughout the study area. These trees can become quite large and range from a 2m spiny shrub to a 16m robust tree as shown below. Due to the potential height of these trees it is anticipated that they might require removal or pruning prior to construction of the power lines – applicant to ensure that the licence is obtained from DAFF prior to the start of construction. As mentioned the Kathu Forest is a declared protected forest by DAFF, however the proposed power lines do not enter the protected area or its buffer zones.

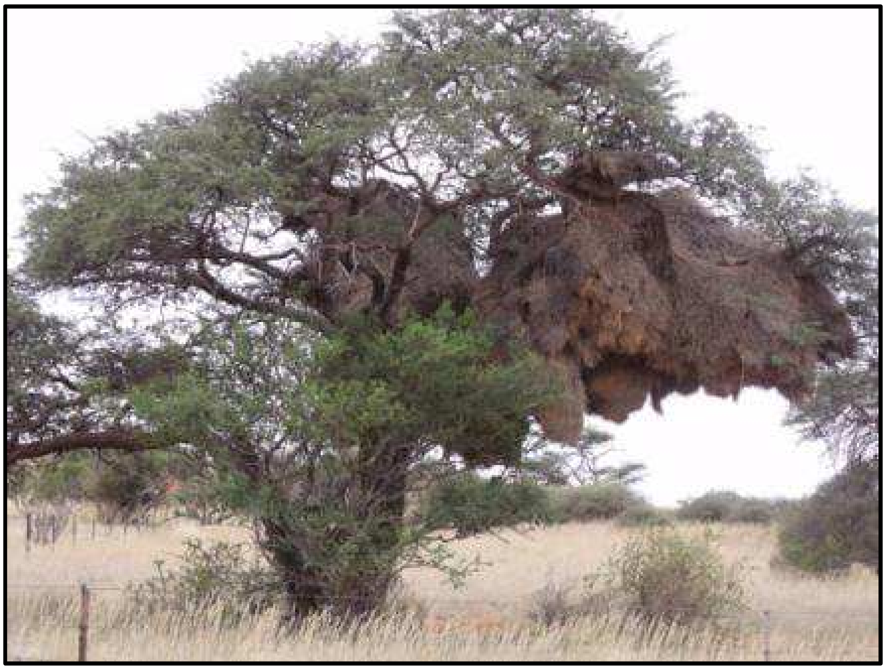

Figure 4-37: ***Acacia erioloba***

Acacia haematoxylon **aka Grey Camel Thorn, Vaalkameeldoring (A) / Mokholo (T)**

A shrub to medium-sized tree, 1.5 – 6m tall with an irregular crown. These trees are characteristic of the semi-desert and desert areas in South Africa. They occur on deep sandy soils and dunes as a shrub and larger specimens are found along drainage lines. These trees although similar in name to the larger Camel Thorn, are significantly smaller, with finer leaves of grey colour. The photo below was taken on site and shown a Grey Camel Thorn in the foreground and a normal Camel Thorn in the background for comparison.

Figure 4-38: Acacia haematoxylon (foreground) and A. erioloba (background)

Boscia albitrunca aka **Shepherd's tree, Witgat (A) / Mohlôpi (NS) / Motlhôpi (T) / Muvhombwe (V) / Umgqomogqomo (X) / Umvithi (Z)**

The Shepard's tree is the one tree in the Kalahari that does not shed its leaves, and hence provides a shady spot for animals and humans (hence the name). This small evergreen tree is characterised by an umbrella-shaped much branched crown and smooth white to grey bark. It is widespread throughout the study area covering almost all habitats (Figure 3-39).

Figure 4-39: Shepard's Tree

Euclea pseudobenus aka **Ebony tree, Ebbeboom (A)**

The Ebony tree is a shrub to medium sized tree with slender drooping branches that is commonly found along watercourses and depressions in semi-desert and desert areas (Figure 4-40 below). The heartwood is pitch black (hence the common name) and used for construction and fuelwood. Twigs can be used for toothbrushes and the tree is browsed by livestock. This tree can be found along the watercourses within the study area, especially the Orange and Hartbees River floodplains.

Figure 4-40: Ebony Tree

***Olea europaea subsp. africana aka* Wild Olive, Olienhout (A), Mohlware (NS, SS), umNquma (Z, X, S), Mutlhwari (V), Motlhware (T)**

The Wild olive is a small to medium-sized evergreen tree with a dense rounded crown and green foliage occurring in a wide variety of habitats as shown below. In the case of the study area a few individuals were identified in the floodplains of the Orange River.

Figure 4-41: Wild Olive

4.7 Surface Water and Wetland

4.7.1 Data Collection and Methodology

The surface water data was obtained from the National Freshwater Ecosystem Priority Area's (NFEPA) database from SANBI (2011). The data used included catchments, river alignments and river names. This information will be ground truthed during the specialist investigation.

4.7.1.1. Riparian Zones vs. Wetlands

Wetlands

The riparian zone and wetlands were delineated according to the Department of Water Affairs (DWA, previously known as the Department of Water Affairs and Forestry - DWAF) guideline, 2003: A practical guideline procedure for the identification and delineation of wetlands and riparian zones. According to the DWA guidelines *a wetland* is defined by the National Water Act (NWA) as:

"land which is transitional between terrestrial and aquatic systems where the water table is usually at or near surface, or the land is periodically covered with shallow water, and which land in normal circumstances supports or would support vegetation typically adapted to life in saturated soil."

In addition the guidelines indicate that wetlands must have one or more of the following attributes:

- Wetland (hydromorphic) soils that display characteristics resulting from prolonged saturation;

- The presence, at least occasionally, of water loving plants (hydrophytes); and
- A high water table that results in saturation at or near surface, leading to anaerobic conditions developing in the top 50 centimetres of the soil.

During the site investigation the following indicators of potential wetlands were identified:

- Terrain unit indicator;
- Soil form indicator;
- Soil wetness indicator; and
- Vegetation indicator.

Riparian Areas

According to the DWA guidelines *a riparian area* is defined by the NWA as:

"Riparian habitat includes the physical structure and associated vegetation of the areas associated with a watercourse which are commonly characterised by alluvial soils, and which are inundated or flooded to an extent and with a frequency sufficient to support vegetation of species with a composition and physical structure distinct from those of adjacent land areas".

The difference between Riparian Areas and Wetlands

According to the DWA guidelines the difference between a wetland and a riparian area is:

"Many riparian areas display wetland indicators and should be classified as wetlands. However, other riparian areas are not saturated long enough or often enough to develop wetland characteristics, but also perform a number of important functions, which need to be safeguarded… Riparian areas commonly reflect the high-energy conditions associated with the water flowing in a water channel, whereas wetlands display more diffuse flow and are lower energy environments."

4.7.2 Regional Description

The surface water features in the study area are dominated by the Orange River, which is the largest river basin in South Africa and also the only perennial river in the study area. All the alternatives have to cross the Orange River and it is anticipated that the majority of the alternative corridors will be determined by this river crossing.

Smaller rivers that also need to be crossed include the Ga-Mogara, Hartbees and Kareeboom rivers and some of their associated tributaries depending on the alternative corridor selected. These rivers are all non-perennial and only flow after storm events.

4.7.3 Site description/delineation

The site was investigated for the occurrence / presence of wetlands and riparian areas, using the methodology described above and described in more detail in the DWA guidelines.

4.7.3.1. Terrain Unit Indicator

The terrain on site varies from 600 metres above mean sea level (mamsl) to 1800 mamsl. Terrain units on site include crest, slope, valley and plains. According to the DWA guidelines the valley bottom is the terrain unit where wetlands/drainage lines are most likely to occur, but the occurrence of wetlands is not excluded from any of the other terrain units.

4.7.3.2. Soil Form Indicator

Of the various soils identified in Section 3.4 above the alluvial soils are the main soil form that can be an indicator of wetlands or drainage areas.

4.7.3.3. Soil Wetness Indicator

The soils on site were subjected to a soil wetness assessment. If soils showed signs of wetness within 50 cm of the soil surface, it was classified as a hydromorphic soil and divided into the following groups:

Temporary Zone

- Minimal grey matrix (<10%);
- Few high chroma mottles; and
- Short periods of saturation.

Seasonal Zone

- Grey matrix (>10%);
- Many low chroma mottles present; and
- Significant periods of wetness (>3 months / annum).

Permanent Zone

- Prominent grey matrix;
- Few to no high chroma mottles;
- Wetness all year round; and
- Sulphuric odour.

The Orange River and its surrounding areas were the only water body that had wetness within the top 50cm of the soil profile. Due to the aridity of the region, none of the other drainage lines or river beds showed signs of wetness, as they are just not saturated long enough to develop these signs.

4.7.3.4. Vegetation Indicator

From the vegetation assessment two vegetation units identified indicate the potential presence of water bodies, pans or wetlands. These include the Lower Gariep Alluvial vegetation and the Southern Kalahari Salt Pans. The Lower Gariep Alluvial vegetation is situated around the permanent water of the Orange River, while the pans are local depressions that collect water in periods of high rainfall, however these periods are very erratic and could be decades apart.

4.7.3.5. Delineated surface water features

According to the methodology that was followed for delineation of wetlands by the DWA, there are three main surface water features present on site. These include:

- Rivers;
- Drainage Lines; and
- Pans.

Figure 4-42 illustrates the surface water bodies identified. It should be noted that although the area has a few rivers identified, the only perennial river is the Orange River. The rest of the study area is very arid, and the bulk of the drainage features are drainage lines with sandy beds that can be identified by the concentration of vegetation in these areas. These areas do not however classify as wetlands as they have no signs of wetness within the top 50cm of the soil profile. Please refer to the photographs below for a view of the Orange River as well as the dry drainage lines found on site.

Figure 4-42: Surface Water features on site.

4.7.3.6. Classification of water bodies

The classification of the water bodies in the study area into different types was based on the method as defined in the National Wetland Classification System for South Africa (Figure 4-43), developed by the Freshwater Consulting Group for SANBI and the Working for Water Group.

This classification system has 6 levels of classification that in the end of level 5 describe the functional wetland/water unit. This identification of the functional unit was the aim of this assessment. The classification of the wetlands on site proceeded as follows:

- Level 1 – System – Inland Ecosystem;
- Level 2 – Bioregion – Nama Karroo / Southern Kalahari
- Level 3 – Landscape Setting
    a) Slope;
    b) Plain; and
    c) Valley floor.
- Level 4 – Hydrogeomorphic unit
    a) Channels; and

    Channel (river, including the banks): an open conduit with clearly defined margins that (i) continuously or periodically contains flowing water, or (ii) forms a connecting link between two water bodies. Dominant water *sources include concentrated surface flow from upstream channels and tributaries, diffuse surface flow or interflow, and/or groundwater flow. Water moves through the system as concentrated flow and usually exits as such but can exit as diffuse surface flow because of a sudden change in gradient. Unidirectional channel-contained horizontal flow characterises the hydrodynamic nature of these units. Note that, for purposes of the classification system, channels generally refer to rivers or streams (including those that have been canalised) that are subject to concentrated flow on a continuous basis or periodically during flooding, as opposed to being characterised by diffuse flow (see unchannelled valley-bottom wetland). As a result of the erosive forces associated with concentrated flow, channels characteristically have relatively obvious active channel banks.*

b) Depressions.

Depression: a landform with closed elevation contours that increases in depth from the perimeter to a central area of greatest depth, and within which water typically accumulates. Dominant water sources are precipitation, ground water discharge, interflow and (diffuse or concentrated) overland flow. For 'depressions with channelled inflow', concentrated overland flow is typically a major source of water for the wetland, whereas this is not the case for 'depressions without channelled inflow'. Dominant hydrodynamics are (primarily seasonal) vertical fluctuations. Depressions may be flat-bottomed (in which case they are often referred to as 'pans') or round-bottomed (in which case they are often referred to as 'basins'), and may have any combination of inlets and outlets or lack them completely. For 'exorheic depressions', water exits as concentrated surface flow while, for 'endorheic depressions', water exits by means of evaporation and infiltration.

- Level 5 – Level of inundation

a) Orange River – Perennial

b) Drainage Lines - Non-perennial – never inundated, saturation unknown; and

c) Pans - Non-perennial - never inundated, saturation unknown.

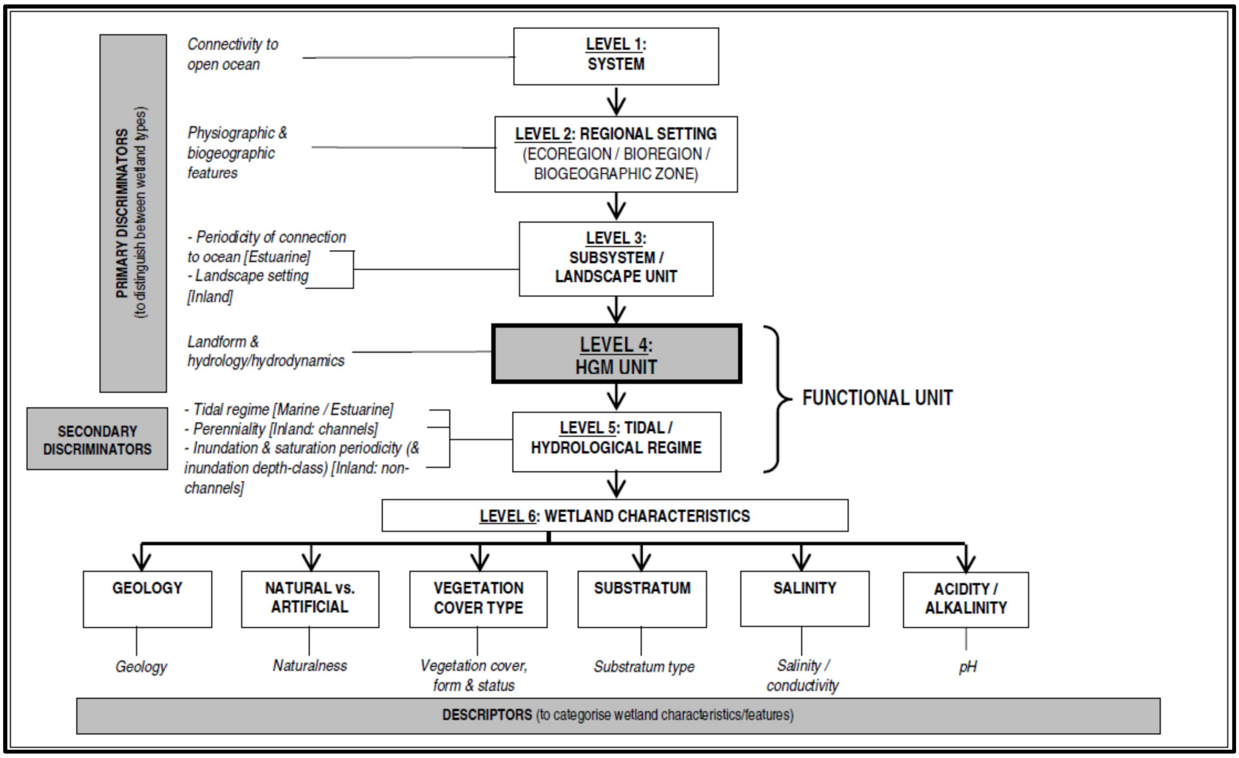

Figure 4-43: National Wetland classification system (SANBI, 2009)

Using the methodology above the following wetland types were identified on site as shown below in Figure 4-44:

- Orange River – Perennial River Channel;
- Drainage Lines (channels) - Non-perennial – never inundated, saturation unknown; and
- Pans - Non-perennial - never inundated, saturation unknown.

4.7.4 Sensitivities

In the arid region of the Northern Cape, all water bodies are seen as highly sensitive and important features. The Orange River is the lifeline in this region and impacts to the river should be avoided as far as possible. Furthermore the drainage lines and pans are features that only hold or transport water in the unlikely event of a rainfall event. These features should also be avoided.

The maps below illustrate the water features identified and also provide a zoomed in view of the potential crossings over the Orange River. In order to determine the best crossing point, a detailed assessment of the crossing points was conducted as described in Section 4.8 below.

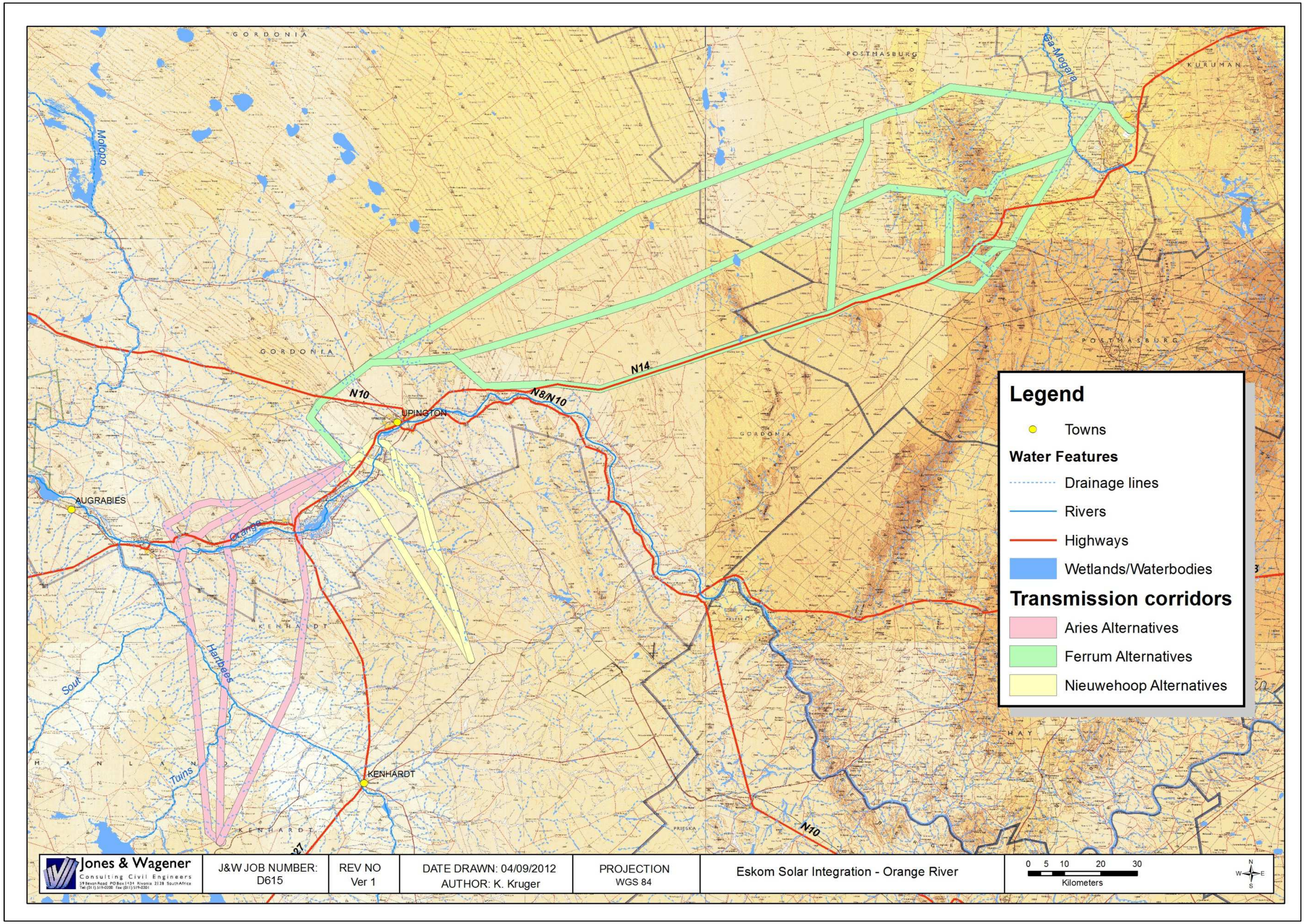

Figure 4-44: Surface Water Features.

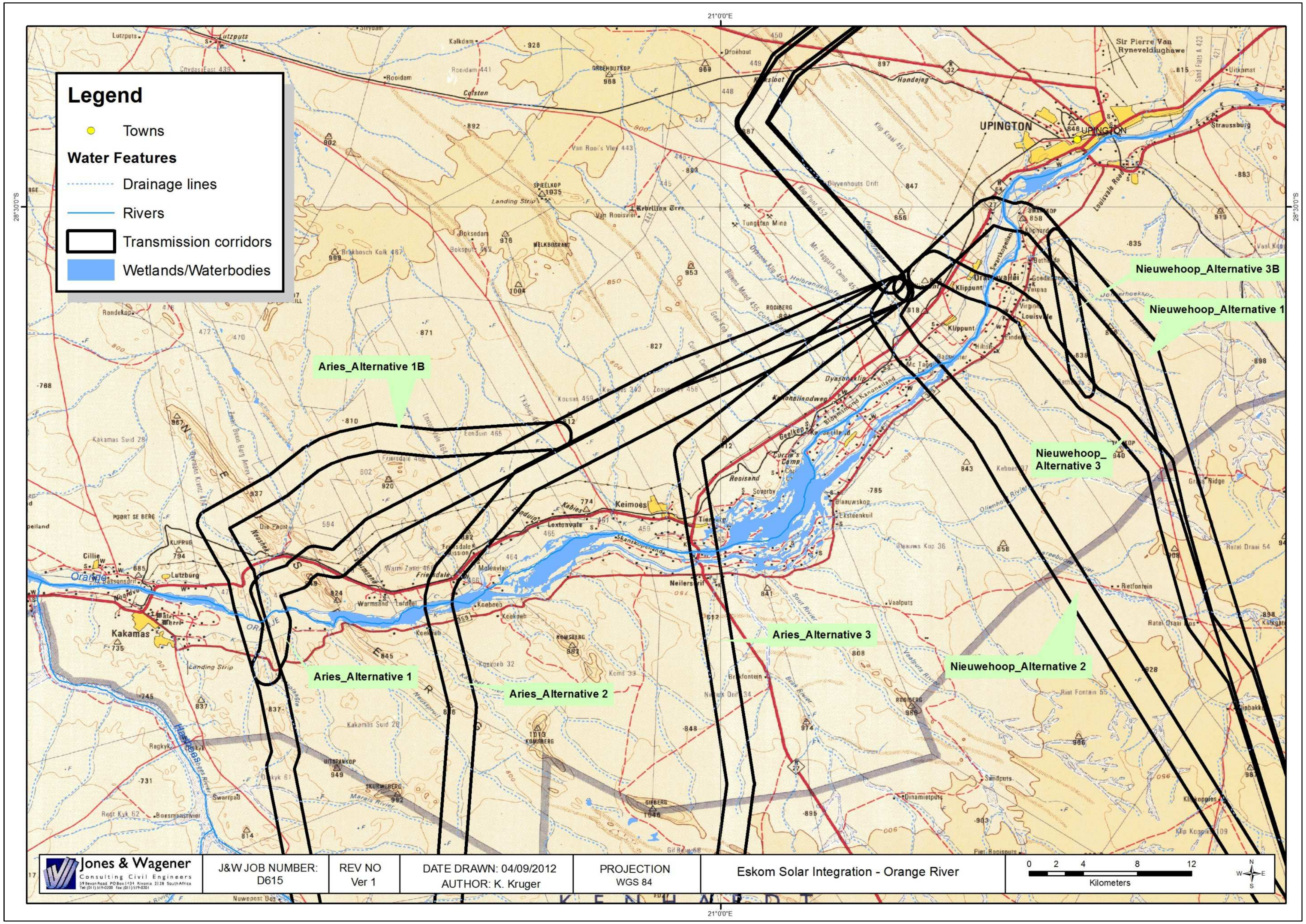

Figure 4-45: Crossing the Orange River.

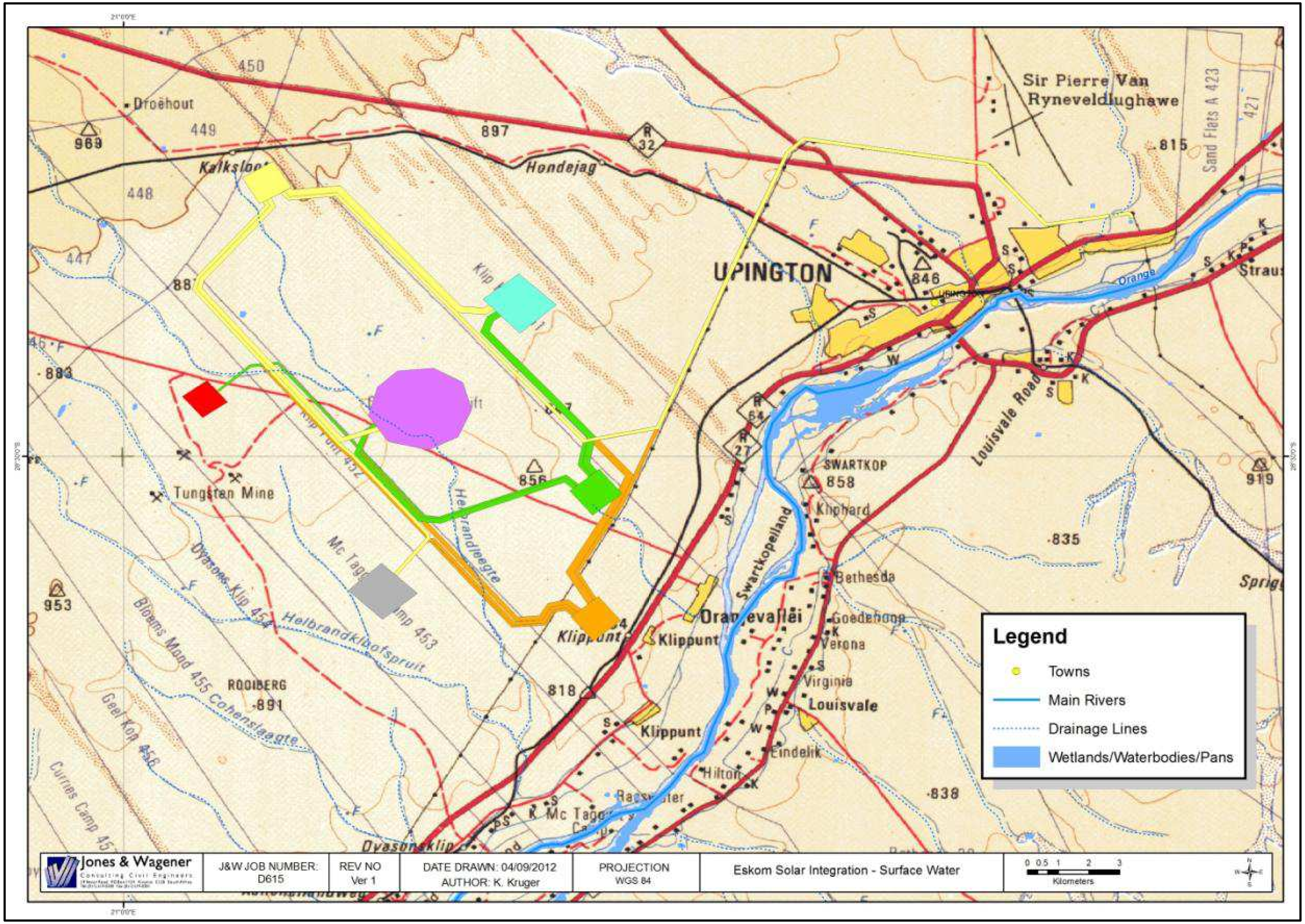

Figure 4-46: Distribution Corridors Surface Water Map

4.8 Aquatic Orange River Crossing Analysis

4.8.1 Data Collection and Methodology

This section of the report is extracted from the specialist report compiled by Scientific Aquatic Services (SAS)[2]. The method of investigation used in this assessment is given below.

4.8.1.1. Visual Assessment

The site was investigated in order to identify visible impacts on the site with specific reference to impacts from surrounding activities. Both natural constraints, placed on ecosystem structure and function, as well as anthropogenic alterations to the system were assessed by observing conditions and relating them to professional experience. Photographs of each site were taken to provide visual indications of the conditions at the time of assessment. Factors which were noted in the site-specific visual assessments included the following:

- instream and riparian habitat diversity;
- stream continuity;
- erosion potential;
- depth flow and substrate characteristics;
- signs of physical disturbance of the area;
- other life forms reliant on aquatic ecosystems;
- signs of impact related to water quality; and
- consideration of suitability for stream crossing purposes.

4.8.1.2. Biota Specific Water Quality

On-site testing of biota specific water quality variables took place. Parameters measured include pH, electrical conductivity, dissolved oxygen concentration and temperature. The results of on-site biota specific water quality analyses were used to aid in the interpretation of the data obtained by the biomonitoring. Results are discussed against the guideline water quality values for aquatic ecosystems (DWAF, 1996 vol. 7).

4.8.1.3. Instream Habitat Integrity

It is important to assess the habitat of the site, in order to aid in the interpretation of the results of the community integrity assessments by taking habitat conditions and impacts into consideration. The general habitat integrity of the site should be discussed based on the application of the Intermediate Habitat Integrity Assessment (IHIA) (Kemper; 1999). The IHIA protocol, as described by Kemper (1999), should be used for site specific assessments. This is a simplified procedure, which is based on the Habitat Integrity approach developed by Kleynhans (1996).

The IHIA is conducted as a first level exercise, where a comprehensive exercise is not practical. The Habitat Integrity of each site should be scored according to 12 different

[2] Aquatic PES Assessment Of The Aquatic Resources On The Orange River In The Vicinity Of A Proposed Power Line Crossing, 2012, REF - SAS 212170

criteria which represent the most important (and easily quantifiable) anthropogenically induced possible impacts on the system. The instream and riparian zones should be analyzed separately, and the final assessment should be made separately for each, in accordance with Kleynhans' (1999) approach to Habitat Integrity Assessment. Data for the riparian zone are, however, primarily interpreted in terms of the potential impact on the instream component.

The assessment of the severity of impact of modifications is based on six descriptive categories with ratings. Analysis of the data should be carried out by weighting each of the criteria according to Kemper (1999). By calculating the mean of the instream and riparian Habitat Integrity scores, an overall Habitat Integrity score can be obtained for each site. This method describes the Present Ecological State (PES) of both the in-stream and riparian habitats of the site. The method classifies Habitat Integrity into one of six classes, ranging from unmodified/natural (Class A), to critically modified (Class F).

Table 4-3: Classification of Present State Classes in terms of Habitat Integrity [Based on Kemper 1999]

Class	Description	Score (% of total)
A	Unmodified, natural.	90-100
B	Largely natural, with few modifications. A small change in natural habitats and biota may have taken place but the basic ecosystem functions are essentially unchanged.	80-90
C	Moderately modified. A loss and change of natural habitat and biota have occurred, but the basic ecosystem functions are still predominantly unchanged.	60-79
D	Largely modified. A large loss of natural habitat, biota and basic ecosystem functions has occurred.	40-59
E	Extensively modified. The loss of natural habitat, biota and basic ecosystem functions is extensive.	20-39
F	Critically modified. Modifications have reached a critical level and the lotic system has been modified completely with an almost complete loss of natural habitat and biota. In the worst instances, basic ecosystem functions have been destroyed and the changes are irreversible.	<20

4.8.1.4. Habitat suitability

The Invertebrate Habitat Assessment System (IHAS) was applied according to the protocol of McMillan (1998) to the Orange River in general with one assessment site being selected to be representative of the entire system. This index was used to determine specific habitat suitability for aquatic macro-invertebrates as well as to aid in the interpretation of the results of the South African Scoring System version 5 (SASS5) scores. Scores for the IHAS index were interpreted according to the guidelines of McMillan (1998) as follows:

- <65% inadequate for supporting a diverse aquatic macro-invertebrate community
- 65%-75% adequate for supporting a diverse aquatic macro-invertebrate community
- >75% highly suited for supporting a diverse aquatic macro-invertebrate community

4.8.1.5. Aquatic Macro-Invertebrates

Aquatic macro-invertebrate communities of the selected sites were investigated according to the method, which is specifically designed to comply with international accreditation protocols. This method is based on the British Biological Monitoring Working Party (BMWP) method and has been adapted for South African conditions by Dr. F. M. Chutter. The assessment was undertaken according to the protocol as defined by Dickens & Graham (2001). All work was undertaken by an accredited SASS5 practitioner.

Interpretation of the results of biological monitoring depends, to a certain extent, on interpretation of site-specific conditions (Thirion *et.al*, 1995). In the context of this investigation it would be best not to use SASS5 scores in isolation, but rather in comparison with relevant habitat scores. The reason for this is that some sites have a less desirable habitat or fewer biotopes than others do. In other words, a low SASS5 score is not necessarily regarded as poor in conjunction with a low habitat score. Also, a high SASS5 score in conjunction with a low habitat score can be regarded as better than a high SASS5 score in conjunction with a high habitat score. A low SASS5 score together with a high habitat score would be indicative of poor conditions. The IHAS Index is valuable in helping to interpret SASS5 scores and the effects of habitat variation on aquatic macro-invertebrate community integrity.

The perceived reference state for the local streams was determined as a SASS5 score of 118 and an Average Score Per Taxon (ASPT) of 6.0 based on general conditions of streams in the Nama Karoo ecoregion and based on local habitat and flow conditions. Interpretation of the results in relation to the reference scores was made according to the classification of SASS5 scores presented in the SASS5 methodology published Dickens & Graham (2001) as well as Dallas 2007.

Table 4-4: Definition of Present State Classes in terms of SASS scores as presented in Dickens & Graham (2001)

Class	Description	SASS Score%	ASPT Score %
A	Unimpaired. High diversity of taxa with numerous sensitive taxa.	90-100 80-89	Variable >90
B	Slightly impaired. High diversity of taxa, but with fewer sensitive taxa.	80-89 70-79 70-89	<75 >90 76-90
C	Moderately impaired. Moderate diversity of taxa.	60-79 50-59 50-79	<60 >75 60-75
D	Largely impaired. Mostly tolerant taxa present.	50 – 59 40-49	<60 Variable
E	Severely impaired. Only tolerant taxa present.	20-39	Variable
F	Critically impaired. Very few tolerant taxa present.	0-19	Variable

4.8.1.6. Fish Community Integrity

Whereas macro-invertebrate communities are good indicators of localized conditions in a river over the short-term, fish being relatively long-lived and mobile;

- are good indicators of long-term influences;
- are good indicators of general habitat conditions;

- integrate effects of lower trophic levels; and
- are consumed by humans (Uys et al., 1996).

The Fish Assemblage Integrity Index (FAII) was applied according to the protocol of Kleynhans (1999). Fish species identified were compared to those expected to be present at the site, which were compiled from a literature survey including Skelton 2007. Fish samples were collected by means of a fixed generator driven electro-fishing device.

Table 4-5: Definition of Present State Classes in terms of FAII scores according to the protocol of Kleynhans (1999)

CLASS	DESCRIPTION	RELATIVE FAII SCORE (% OF EXPECTED)
A	Unmodified, or approximates natural conditions closely.	90-100
B	Largely natural, with few modifications.	80-89
C	Moderately modified. A lower than expected species richness and the presence of most intolerant species.	60-79
D	Largely modified. A clearly lower than expected species richness and absence of intolerant and moderately tolerant species	40-59
E	Seriously modified. A strikingly lower than expected species richness and a general absence of intolerant and moderately intolerant species	20-39
F	Critically modified. An extremely lowered species richness and an absence of intolerant and moderately intolerant species	<20

Table 4-6: Reference List of Fish Species for the site.

SPECIES NAME	COMMON NAME	INTOLERANCE RATING	COMMENTS
Austroglanis sclateri	Rock catfish	2.7	Rare, endemic to the Orange-Vaal system
Barbus paludinosus	Straightfin barb	1.8	Widespread
Barbus anoplus	Chubbyhead barb	2.6	Widespread
Labeobarbus aeneus	Smallmouth yellowfish	2.5	Widespread in the Orange-Vaal system
Labeobarbus kimberleyensis	Largemouth yellowfish	2.5	Widespread in the Orange-Vaal system but is becoming scarce
Labeo capensis	Orange river mud fish	3.2	Widespread in the Orange-Vaal system
Labeo umbratus	Moggel	2.3	Widespread in the Orange-Vaal system
Pseudocrenilabrus philander	Southern mouthbrooder	1.3	Widely distributed in southern Africa
Tilapia Sparrmanii	Banded tilapia	1.3	Widely distributed in southern Africa
Clarias gariepinus	Sharptooth catfish	1.2	Most widely distributed fish in

SPECIES NAME	COMMON NAME	INTOLERANCE RATING	COMMENTS
			Africa.
Cyprinus carpio	Carp	1.4	Widespread alien species
Micropterus salmoides	Largemouth bass	2.2	Widespread alien species
Gambussia affinis	Mosquito fish	2	Widespread

Tolerant: 1-2 moderately tolerant :> 2-3 Moderately Intolerant: >3-4 Intolerant: >4

For the purposes of applying the FAII, species which were considered unlikely to occur at the site due to habitat and cover conditions, flow conditions and due to historic impacts, were excluded from the reference list of fish species for the site.

4.8.1.7. Riparian Vegetation Assessment

A desktop study was undertaken for the study area to determine historic distributions and vegetation type and structure of the riparian area in the vicinity of the proposed crossings. This gave an indication as to what would be expected to occur on each site and, therefore, offer possible explanations for any anomalies that could potentially occur.

The riparian vegetation assessment was conducted according to the procedure described by Kemper, 2001. The selected sites should be chosen to be relevant to the proposed development and to show any impacts that the licensed activity may be having downstream. The site assessment was conducted over a distance of 100m on both banks, in order to assess species composition and community structures and include an assessment with respect to the degree of exotic vegetation encroachment, dominance by recruitment and by biomass.

Table 4-7: Definition of present state classes in terms or RVI-scores, according to the protocol of Kemper (2000).

Class	Description	Score (% of total)
A	Unmodified, natural.	90-100
B	Largely natural, with few modifications. A small change in natural habitats and biota may have taken place but the basic ecosystem functions are essentially unchanged.	80-90
C	Moderately modified. A loss and change of natural habitat and biota have occurred, but the basic ecosystem functions are still predominantly unchanged.	60-79
D	Largely modified. A large loss of natural habitat, biota and basic ecosystem functions has occurred.	40-59
E	Extensively modified. The loss of natural habitat, biota and basic ecosystem functions is extensive.	20-39
F	Critically modified. Modifications have reached a critical level and the lotic system has been modified completely with an almost complete loss of natural habitat and biota. In the worst instances, basic ecosystem functions have been destroyed and the changes are irreversible.	<20

4.8.1.8. Crossing Assessment

The table below presents the characteristics of an ecologically "ideal crossing over a watercourse or river. Each crossing alternative was assessed with these characteristics in mind.

Table 4-8: Characteristics of an ecologically "ideal" river crossing site.

Condition	Reason
Rocky or bedrock substrate	A rocky or bedrock substrate is more likely to withstand impacts and lead to fewer changes in bed characteristics compared to a substrate that may be easily compacted, such as gravel, sand or mud.
Steep river gradient	In stream habitats are likely to recover more rapidly from the impacts where the river gradient is steep and current speeds fast compared to a section of river where there is little or no flow, and where sediments may remain for long periods. A steep river gradient is likely to flush away finer sediments, and sort larger particles.
Stable banks	Stable banks reduce the potential for erosion.
Disturbed banks and riparian zone	The relative impacts of a crossing are likely to be less if the banks and riparian zone are already disturbed. Choosing an area that is already disturbed also improves the potential for rehabilitation.
Width of riparian zone	The wider the riparian and wet zone at the crossing site the more substantial the impact will be on stream continuity, riparian zone continuity and seepage patterns and the more rehabilitation work will be required.
Limited habitat diversity	The impacts of a crossing are likely to be less if the riparian and instream habitat diversity both at, and downstream of, the crossing site is limited.
Flow	The impacts of a crossing on stream flows are likely to increase with the size of the river or stream being crossed, as a large stream is more likely to come down in spate than a small stream. The downstream topography and stream gradient is also likely to affect the extent to which a crossing disrupts stream flows which is potentially greater on larger river sand channels.
Downstream ecological sensitivity should be minimal	A crossing is likely to lead to disturbance downstream, particularly sedimentation. Ecologically important or sensitive areas, such as gravel bed nursery areas, should therefore rather be situated upstream of the crossing, or as far downstream as possible.

4.8.2 Regional Description

The following section details the general ecological status of the Orange River.

4.8.2.1. Physico-Chemical Water Quality

The table below records the biota specific water quality of the assessment site.

Table 4-9: Biota specific water quality data along the main drainage feature

SITE	COND mS/m	D.O. mg/l	pH	TEMP ^{o}C
U/S	34.2	8.78	8.41	21.4
D/S	39.8	8.12	8.34	21.7

- General water quality can be considered fair although some variation from the expected natural condition is deemed likely;
- The impact on water quality is deemed likely to come from both industrial and urban activities as far upstream as Mpumalanga and Gauteng as well as impacts form agricultural runoff into the Vaal River, a major tributary of the Orange River and the Orange River itself;

- Dissolved salts present in the system are slightly elevated from the natural conditions but are not expected to impact on the aquatic community too significantly in terms of osmotic stress;
- Between the upstream and downstream site, conductivity increases by 16.4% which exceeds the DWAF Target Water Quality Range (DWAF TWQR). This suggests that between the sites there is an input of salts, most likely from erosion and agricultural runoff entering the system;
- The pH is slightly alkaline but can be regarded as suitable for supporting a diverse and sensitive aquatic community. The difference in pH between the sites is negligible and falls within the DWAF TWQR for aquatic communities;
- The dissolved oxygen concentration is relatively good and can be regarded as suitable for supporting a diverse and sensitive aquatic community;
- Dissolved oxygen concentrations decrease downstream by 7.5%, this still falls within the DWAF TWQR limit. The dissolved oxygen concentrations can be regarded as suitable for supporting a diverse and sensitive aquatic community; and
- Temperature can be regarded as normal for the time of year and time of assessment. The variation between the upstream and downstream sites can largely be ascribed to natural diurnal variation.

The Orange River can be best described as a strongly flowing river with high flow volumes. Significant variation in flow between the high and low flow seasons is also characteristic of the system. The river structure alternates between pools and glides with slow laminar flow and fast flowing turbulent rapids. Overall there is a wide diversity of instream habitats in the system which allows for a diversity of instream taxa to be supported including mammals such as otters (*Aonyx capensis*) reptiles (*Viranus niloticus*) as well as fish, aquatic macro-invertebrates and riparian vegetation. Some habitat for aquatic vegetation and frogs is also present although the species diversity of these groups is limited.

The riverine habitat on the Orange River has seen some disturbance as a result of agricultural development. In this regard specific mention is made of agricultural activities within the floodplain and the associated construction of levees along the active river channels.

From the results of the application of the IHIA to the crossing alternative sites, it is evident that there are several large impacts on the habitat of the area.

Instream impacts at the site included significant impacts in places from flow and bed modifications. Smaller impacts from water quality and channel modification were also noted.

The largest riparian zone impacts included flow bank erosion, alien vegetation encroachment and vegetation removal. Smaller impacts from flow modification and channel modification on riparian vegetation structures were observed.

The table below is a summary of the results obtained from the application of the IHAS Index to the assessment site in the study area used as a representative site for the Orange River in the vicinity of the proposed project. This index determines habitat suitability, with particular reference to the requirements of aquatic macro-invertebrates. The results obtained from this assessment will aid in interpretation of the SASS5 results.

Table 4-10: A summary of the results obtained from the application of the IHAS index to the assessment site.

SITE	CO3
IHAS score	70%
IHAS Adjustment score (illustrative purposes only)	+13
McMillan, 1998 IHAS description	Habitat diversity and structure is adequate for supporting a diverse aquatic macro-invertebrate community.
Stones habitat characteristics	Good habitat was present at this site providing habitat for suitably adapted macro-invertebrate families.
Vegetation habitat characteristics	Marginal vegetation was present both in and out of current and had a fair amount of leafy material present to provide habitat and cover for suitably adapted macro-invertebrate families.
Other habitat characteristics	There was an abundance of gravel and sand deposits present in the area providing good habitat for suitably adapted macro-invertebrate families.
IHAS general stream characteristics	The river at this point is wide and on average deep although, there is good diversity in depth and flow at the site. The surrounding vegetation consists mainly of reeds and grasses and the dominant activity in the area is agriculture. Some discoloration of the water in the system has occurred.

Habitat diversity and structure was considered adequate for supporting a diverse aquatic macro-invertebrate community and as such a fairly diverse and sensitive aquatic macro-invertebrate community can be expected provided that water quality impacts do not severely affect the system.

4.8.2.2. Aquatic Macro-invertebrates

The results of the aquatic macro-invertebrate assessment according to the SASS5 index are summarised in the tables below for a site assessed which was determined to be representative of the system in the vicinity of the proposed crossing alternatives. Table 14 indicates the results obtained at the site per biotope sampled. Table 15 summarises the findings of the SASS assessment based on the analyses of the data for the site, as well as interpretation of the data for the site.

Table 4-11: Biotope specific summary of the results obtained from the application of the SASS5 index to the CO3 site.

PARAMETER	SITE	STONES	VEGETATION	GRAVEL, SAND AND MUD	TOTAL
SASS5 Score	**CO3**	12	34	60	77
Taxa		1	5	9	12
ASPT		12.0	6.8	6.7	6.4

Table 4-12: A summary of the results obtained from the application of the SASS5 and IHAS indices to the site.

Type of Result	**CO3**
Biotopes sampled	Stones in current, marginal vegetation out of current, mud, sand and gravel.
Sensitive taxa present	*Atyidae; Heptageniidae; Leptophlebiidae;Tricorythidae*
Sensitive taxa absent	*Aeshnidae Chlorolestidae; Perlidae; Psephenidae; Athericidae; Naucoridae; Chlorocyphidae; Hydracarina; Gomphidae*
Adjusted SASS5 score	+13
SASS5 % of reference score	65.3%
ASPT % of reference score	106.7%
Dickens and Graham, 2001 SASS5 classification	Class C: Moderately impaired. Moderate diversity of taxa.
Dallas 2007 classification	Class A

- The SASS data indicates that the aquatic macro-invertebrate community at the site has suffered some loss in integrity when compared to the reference score for pristine Nama Karoo Ecoregion stream.
- It must however be considered that the aquatic assessment site was not necessarily optimum for the assessment of the aquatic macro-invertebrate community due to the abundance of bedrock on the river bed and because of very strong flows in the river making access to all sampling areas difficult.
- At present, the site can be considered as Class C (Moderately impaired) according to the Dickens & Graham (2001) classification system, and as a Class A (Unimpaired) according the Dallas (2007) classification system.
- In this situation the Dallas (2007) classification is likely to be more accurate since it considers the aquatic macro-invertebrate community sensitivity more strongly.
- If a balanced approach is considered between the two classification systems the system can be defined as a Class B system indicating largely natural conditions with few modifications.
- Further impacts on the system could potentially lead to further degradation of the system and, therefore, lead to a deviation from the PES of the system and reduced ecological functioning.
- Careful design and construction will be required to limit the impact on the system from developments in the area. Maintenance will also need to be well managed in the operational phase of the development to prevent impacts on the system from impounding, erosion and altered bed and bank conditions.

4.8.2.3. Fish Community Integrity

The fish community of the site was sampled for a period of one half hour. The table below serves as a summary of the results obtained for the site.

Table 4-13: A summary of the results obtained from the application of the FAII index to the site.

SITE	CO3		
Habitat and cover	Extensive habitat for fish is available at the site. There is a diversity of depth and flow classes, providing excellent diversity of habitat for fish. The most abundant cover type is rocky substrate. Limited amounts of overhanging bankside vegetation are present and some undercut root wads and reeds are present.		
Species present and number of individuals obtained	*Labeobarbus aeneus* *Labeobarbus capensis* *Clarias gariepinus*	*8* *5* *1*	*150mm - 350mm* *180mm – 250mm* *370 mm*
Health and condition	No impairment of fish health observed.		
Expected FAII score	135		
Observed FAII score	34.5		
Relative FAII score	25.6%		
FAII classification (Kleynhans, 1999)	"Class E". Seriously modified. A strikingly lower than expected species richness and a general absence of intolerant and moderately intolerant species		

- The FAII data indicates that the fish community at the site has suffered a serious loss in integrity when compared to the reference score for pristine Nama Karoo Ecoregion stream.
- Extensive habitat for fish is available at the site.
- There is a diversity of depth and flow classes, providing excellent diversity of habitat for fish.
- The lower than expected fish score can be ascribed to limitations in sampling due to the strong currents at the assessment site and the inability to access areas in the river for sampling. It is deemed highly likely that numerous additional species would have been captured if safe access to sampling areas was possible.
- Based on the above consideration, limited loss of diversity and sensitivity of the fish community is deemed likely at the current time despite the low yield (diversity and abundance) of the fish community observed.
- The most abundant cover type is rocky substrate and water column depth. Limited amounts of overhanging bankside vegetation are present and some undercut root wads and reeds are present.

4.8.2.4. Riparian vegetation Integrity

The riverine and bankside vegetation of the Orange River can be considered to be dynamic with the sandy stream banks being constantly shifted during periods of high flow. The unstable nature of the system leads to the proliferation of pioneering vegetation on the stream banks and also leads to constantly changing instream habitat. Alien vegetation encroachment in the area was noticeable with some areas being worse affected than others. Some loss of riparian vegetation due to impacts from agriculture, with special mention of the clearing of areas for agriculture and the construction of levees along the active stream channels was evident.

4.8.2.5. Summary of General System Characteristics

Based on the consideration of the above factors the Orange River can be considered to be a tolerant system that is adapted to constantly changing substrate and bankside conditions as well as constant variation in flow. The system is also tolerant to changes in water quality with special mention of temperatures, dissolved salt and turbidity levels as water constituents change through the system.

The aquatic communities of the system are however still intact with more sensitive aquatic macro-invertebrate and fish populations still present and as such as much as the system is considered to be tolerant it must also be considered to be sensitive to impacts that occur on the system.

It is therefore deemed essential that any proposed activities which could affect the system be comprehensively assessed to define and understand the impacts and in order to ensure that suitable and sufficient mitigation measures are put in place to protect the system throughout the life of the project and associated infrastructure.

4.8.3 Site Description

This section will aim to give a description of each of the crossing alternatives as well as the characteristics of that crossing. The location of each of the five crossing points is shown in the Figure below. The crossings have been labelled C1 to C5 starting at the westernmost edge of the study area.

4.8.3.1. Crossing Alternative 1

Figure 4-47: Crossing Alternative 1.

Visual Assessment

A photographic record of the site was made in order to provide a visual record of the condition of the assessment site as observed during the field assessment. The photographs taken are presented below together with a table summarising the observations for the various criteria.

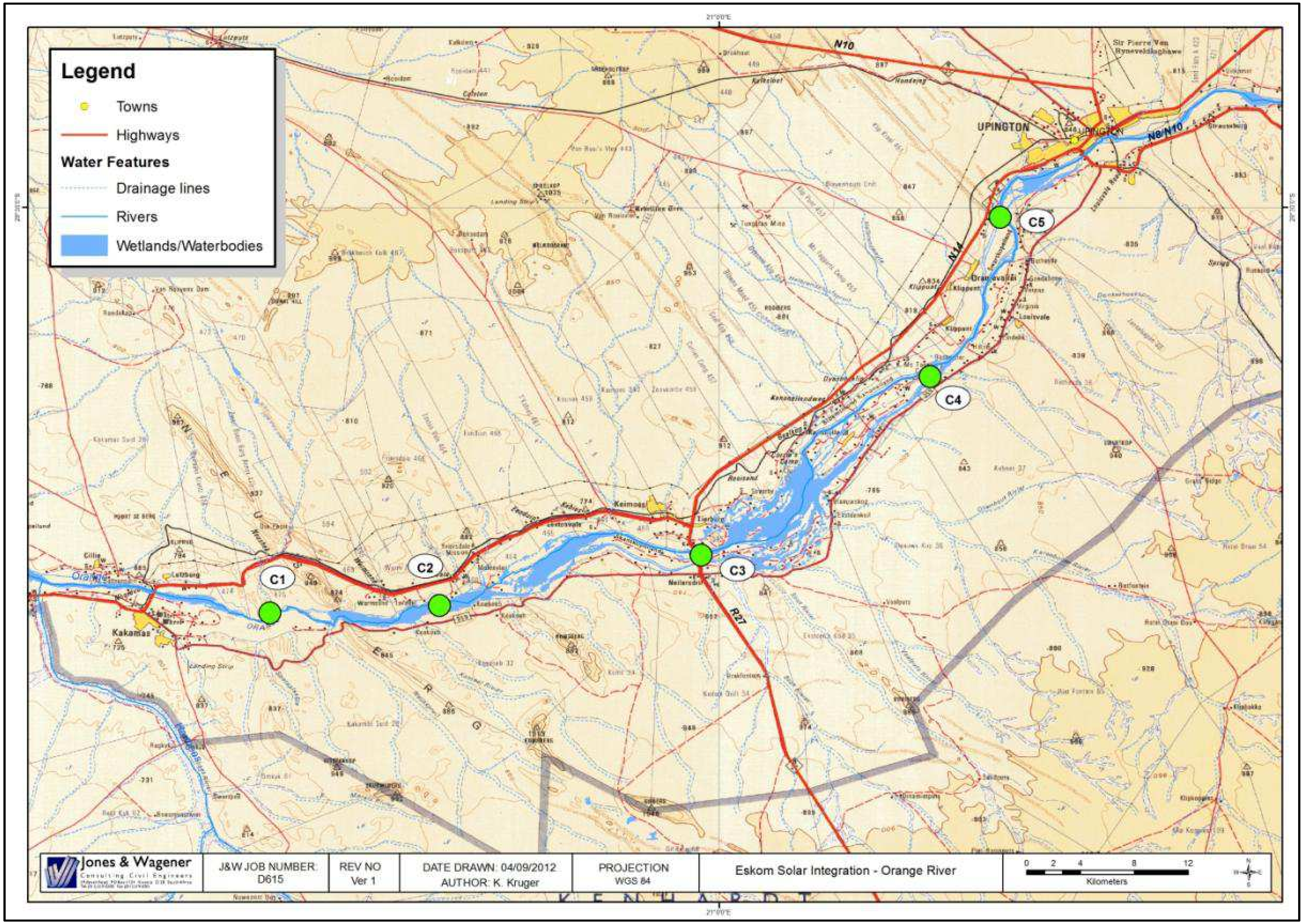

Figure 4-48:Location of the Crossing Sites evaluated

Figure 4-49: C1 site upstream (left) and downstream (right).

- Upstream of the C1 site, extremely fast flowing white water and rocky substrate upstream of the crossing; and
- Downstream view of the C1 site showing the rocky rapids downstream of the crossing and the limited bankside vegetation in some places.

Table 4-14: Description of the C1 Assessment site.

SITE	C1
Braiding of the system	At this point the system mostly consists of one channel, which becomes constricted at points leading to very fast flow in some areas
Riparian zone characteristics	The riparian zone is wide. Some impact from alien vegetation encroachment has occurred. The existing weir causes upstream inundation which alters the vegetation characteristics in this area.
Algal presence	No algal proliferation was evident at the current time.
Visual indication of an impact on aquatic fauna	Water is turbid but not beyond the naturally expected conditions for the area.
Depth characteristics	The stream consists of deep pools, fast flowing rapids and fast glides.
Flow condition	The river at this point is generally fast flowing with extremely fast flowing narrow rapids, fast riffles and glides and slower deeper pool areas and eddies.
Water clarity	Water is discolored but can be considered natural.
Water odor	None
Erosion potential	Under high flow conditions the system will erode rapidly due to the fast flow of the water and the unstable sandy nature of the riparian zone. This can however be regarded as natural for the system in the area.

Habitat Assessment

This section illustrates the scores given to the crossing for habitat integrity for both instream and riparian zone habitats.

Table 4-15: Instream Habitat Integrity Crossing C1.

Weights	14	13	13	13	14	10	9	8	6		
REACH	Water abstraction	Flow modification	Bed modification	Channel modification	Water quality	Inundation	Exotic macrophytes	Exotic fauna	Solid waste disposal	Total Score (%)	Classification
C1 Instream	4	3	0	0	6	0	0	3	0	91.4	A Unmodified

None	Small	Moderate	Large	Serious	Critical

Table 4-16: Riparian Zone Habitat Integrity for Crossing C1.

Weights	13	12	14	12	13	11	12	13		
REACH	Vegetation removal	Alien encroachment	Bank erosion	Water abstraction	Flow modification	Channel modification	Water quality	Inundation	Total Score (%)	Classification
C1	14	18	14	2	3	6	3	0	52.8	D Largely modified

None	Small	Moderate	Large	Serious	Critical

Table 4-17: Integrated Habitat Assessment for C1.

REACH	*INSTREAM HABITAT*	*RIPARIAN ZONE*	*IHIA SCORE*	*CLASS*
C1	91.4	52.8	*72.1*	C Moderately modified

- From the results of the application of the IHIA to the assessment site, it is evident that there are several large impacts on the habitat of the area with specific mention of riparian zone impacts while instream impacts were more limited.
- Instream impacts at the site included moderate impacts from water quality, and water abstraction. Smaller impacts from exotic fauna and flow modification were also noted. Overall, the site achieved a 91.4 % score for in stream integrity. Indicating unmodified (Class A) conditions.
- The largest riparian zone impacts included vegetation removal, alien vegetation encroachment and bank erosion. Smaller impacts from channel modification were observed. The site achieved a 52.8% score for riparian integrity representing largely modified (Class D) conditions.
- The site obtained an overall IHIA rating of 72.1% score for riparian integrity representing moderately modified (Class C) conditions. The site, therefore, falls below the Default Ecological Management Classes (DEMC) for the quaternary catchment from a habitat integrity perspective. Measures to prevent further impacts on the system are therefore required and care should be taken to prevent impacts from any future developments.

Riparian vegetation analyses

On this portion of the Orange River, the river itself is anabranching with isolated small islands in the main channel. The active river channel is approximately 40 meters wide and the potential riparian zone width is approximately 75 meters on the southern bank, 40 meters on the northern bank and 25 meters on the islands. The substrate is dominated by bedrock and gravel and sand. Various bare areas were noted, although this is a feature of the river and a result of its natural flow level fluctuations and sediment deposition.

A list of the floral species observed during the assessment is presented in the following table but is briefly described below. The woody layer of the riparian vegetation was dominated by *Ziziphus mucronata, Searsia lancea* and *Tamarix usneoides*. These species are all indicative of the *Lower Gariep Alluvial Vegetation,* and as such the riparian zone vegetation can be considered natural. The instream vegetation was dominated by *Phragmites australis*. The grass component consists mainly of *Cynodon dactylon* and *Stipagrostis namaquensis.* Alien species included *Nicotiana glauca, Datura stramonium* and *Solanum sisymbrifolium.* Moving downstream, this pattern remains fairly constant, the only readily observable change is the density of vegetation and cover percentage. When comparing the species list (especially trees and grasses) to the vegetation list for *Lower Gariep Alluvial Vegetation,* it becomes clear that the species composition of the riparian zone is still largely intact, even though some impacts are evident due to agricultural practices adjacent to the river. The following table presents a list of vegetation encountered on site.

Table 4-18: Dominant riparian vegetation species noted during the riparian vegetation assessment at C1.

Trees/shrubs	Forbs	Grasses/sedges
Acacia karroo *Nicotiana glauca** *Searsia lancea* *Tamarix usneoides* *Ziziphus mucronata* *Salix babylonica**	*Asclepias fruticosa* *Bidens pilosa** *Datura stramonium** *Solanum sisymbrifolium** *Veronica anagallis-aquatica**	*Cyperus marginatus* *Cynodon dactylon* *Juncus effusus* *Stipagrostis namaquensis* *Panicum maximum* *Phragmites australis* *Setaria verticellata*

* Exotic species

The RVI for this site was 14.7 (out of a possible 20), a value which falls within the boundary of a class C (moderately modified) system. The reason for this site receiving this value is mainly due to the relatively intact representative *Lower Gariep Alluvial* vegetation, the presence of larger woody species and moderately high levels of habitat provision. Although some bare areas are present, it is most likely a natural feature of this highly dynamic system which experiences natural high flow level fluctuation and sediment deposition.

Crossing suitability analyses

The table below presents the advantages and disadvantages of the proposed crossing point.

Table 4-19: Suitability analyses of the C1 crossing alternative.

Advantages	Disadvantages
The river channel is not branched at this point.	The riparian zone substrate is unstable and prone to erosion and as such careful planning of foundations will be required and measures will be required to control erosion.
The river is narrow at this point and will most likely be easily spanned with pylons outside of the riparian zone of the river and therefore no impact on the instream habitat is deemed likely.	Alien vegetation is a problem in the area and measures to control erosion will need to be ensured.
The riparian zone vegetation at this point is a narrow strip along the river banks and impact thereon can be avoided.	

Conclusion

The narrow river channel with limited anabranching and lowered RVI score means that the proposed crossing will have less impact on the receiving riparian environment than most of the other crossing points. Due to the narrow width of the river in this area the risk to the instream habitat and aquatic community is regarded as being limited provided that suitable mitigation is implemented. Based on these characteristics, this crossing point is highly recommended as **the best alternative to cross the Orange River**.

4.8.3.2. Crossing Alternative 2

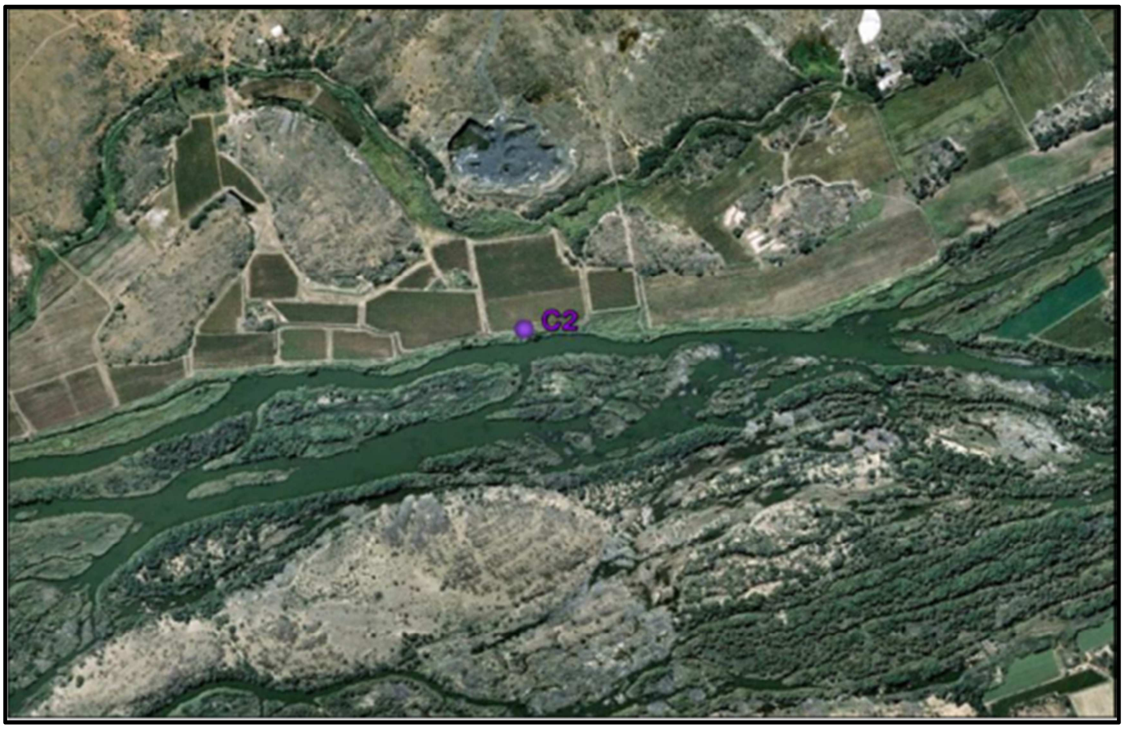

Figure 4-50: Crossing Alternative 2

Visual Assessment

A photographic record of the site was made in order to provide a visual record of the condition of the assessment site as observed during the field assessment. The photographs taken are presented below together with a table summarising the observations for the various.

Figure 4-51: C2 site upstream (left) and downstream (right).

- Upstream view indicating moderately deep system with slow flowing water; and
- Downstream view showing the abundant marginal vegetation at the site.

Table 4-20: Description of the C2 Assessment site.

SITE	C2
Braiding of the system	At this point the system consists of an anabranching channel with a large island splitting two main channels although some smaller channels are also evident. This increases the extent of the riparian areas on the subject property.
Riparian zone characteristics	The riparian zone is narrow due to the encroachment of agricultural activities on the stream bank. This is particularly evident on the northern bank of the River. The riparian vegetation on the island banks is however extensive. Some impact from alien vegetation encroachment has occurred. Visually, the riparian vegetation looks to be in excellent condition.
Algal presence	No algal proliferation was evident at the current time.
Visual indication of an impact on aquatic fauna	Water is turbid but not beyond the naturally expected conditions for the area.
Depth characteristics	The river is dominated by deep relatively fast flowing glides at this point.
Flow condition	The river at this point is generally fast flowing with limited diversity of flow in the area.
Water clarity	Water is discolored but can be considered natural.
Water odor	None
Erosion potential	Under high flow conditions the system will be susceptible to erosion although bankside vegetation cover is good the risk of erosion under high flow conditions can be considered to be a natural characteristic of the system.

Habitat Assessment

This section illustrates the scores given to the crossing for habitat integrity for both instream and riparian zone habitats.

Table 4-21: Instream Habitat Integrity Crossing C2

Weights	14	13	13	13	14	10	9	8	6		
REACH	Water abstraction	Flow modification	Bed modification	Channel modification	Water quality	Inundation	Exotic macrophytes	Exotic fauna	Solid waste disposal	Total Score (%)	Classification
C2	4	2	0	0	6	0	0	3	0	91.9	A Unmodified

None	Small	Moderate	Large	Serious	Critical

Table 4-22: Riparian Zone Habitat Integrity for Crossing C2

Weights	13	12	14	12	13	11	12	13		
REACH	Vegetation removal	Alien encroachment	Bank erosion	Water abstraction	Flow modification	Channel modification	Water quality	Inundation	Total Score (%)	Classification
C2	17	14	14	2	3	13	3	0	46.1	D Largely modified

None	Small	Moderate	Large	Serious	Critical

Table 4-23: Integrated Habitat Assessment for C2

REACH	*INSTREAM HABITAT*	*RIPARIAN ZONE*	*IHIA SCORE*	*CLASS*
C2	91.9	46.1	*69*	C Moderately modified

- From the results of the application of the IHIA to the assessment site, it is evident that there are several large impacts on the habitat of the area with special mention of impacts on the riparian zone while instream habitat impacts are limited.
- Instream impacts at the site included some impacts from water abstraction, and water quality modification. Smaller impacts from exotic fauna and flow modification were also noted. Overall, the site achieved a 91.9 % score for in stream integrity. Indicating an unmodified (Class A) conditions.
- The largest riparian zone impacts included flow bank erosion, alien vegetation encroachment, vegetation removal as well as channel modification. Channel modification is largely as a result of the construction of levees to prevent impacts on adjacent vineyards and orchards. Smaller impacts from flow modification and water quality modification were observed. The site achieved a

46.1% score for riparian integrity representing largely modified (Class D) conditions.

- The site obtained an overall IHIA rating of 69% score for riparian integrity representing moderately modified (Class C) conditions. The site, therefore, falls below the DEMC for the quaternary catchment from a habitat integrity perspective. Measures to prevent further impacts on the system are therefore required and care should be taken to prevent impacts from any future developments.

Riparian vegetation analyses

On this portion of the Orange, the river is anabranching with various islands in the main channel. The active river channel is approximately 45 meters wide and the potential riparian zone is approximately 60 meters on the southern bank, 70 meters on the northern bank and 100 meters on the islands. The substrate is dominated by bedrock, gravel and sand. The riverbanks were vegetated and dominated by woody species and reeds.

A list of the floral species observed during the assessment is presented in the following table but is briefly described below. The woody layer of the riparian vegetation was dominated by *Ziziphus mucronata, Searsia lancea* and *Tamarix usneoides,* although much denser than at C1. These species are all indicative of the *Lower Gariep Alluvial Vegetation,* and as such the vegetation can be considered natural. The instream and bankside vegetation was dominated by *Phragmites australis*. As at C1, the grass component consists mainly of *Cynodon dactylon* and *Stipagrostis namaquensis.* Alien species included *Nicotiana glauca, Datura stramonium* and *Solanum sisymbrifolium.*

This vegetation structure remains constant for a considerable distance up- and downstream, with vegetation density and abundance changing slightly. When comparing the species list (especially trees and grasses) to the vegetation list for *Lower Gariep Alluvial Vegetation,* it becomes clear that the species composition of the riparian zone is still largely intact, even though some impacts are evident due to agricultural practices such as vineyards adjacent to the river. The following table presents a list of vegetation encountered on site.

Table 4-24: Dominant riparian vegetation species noted during the riparian vegetation assessment at C2.

Trees/shrubs	Forbs	Grasses/sedges
Acacia karroo *Nicotiana glauca** *Searsia lancea* *Tamarix usneoides* *Ziziphus mucronata* *Salix babylonica**	*Asclepias fruticosa* *Bidens pilosa** *Datura stramonium** *Solanum sisymbrifolium** *Veronica anagallis-aquatica**	*Cyperus marginatus* *Cynodon dactylon* *Juncus effusus* *Stipagrostis namaquensis* *Panicum maximum* *Phragmites australis* *Setaria verticellata*

* Exotic species

The RVI for this site was 17.3 (out of a possible 20), a value which leads to the area being classified as a class B (largely natural) river segment. The reason for this site receiving this value is mainly due to the moderate to high abundances and diversity of indigenous species and representative Lower Gariep Alluvial vegetation. The dense reed beds provide habitat for a potentially diverse faunal community and also provide valuable flood attenuation and water filtration services.

Crossing suitability analyses

The table below presents the advantages and disadvantages of the proposed crossing.

Table 4-25: Suitability analyses of the C2 crossing alternative.

Advantages	Disadvantages
The river channel branched at this point but support pylons can be constructed on the river banks and the main island which will limit the impact on the instream ecology	The river channel branched at this point and support pylons will have to be constructed on the river banks and the main island which will lead to an impact on the riparian vegetation of the system with special mention of the island vegetation
The riparian vegetation zone on the main river banks is narrow and the impact of the support pylons on the riparian vegetation and habitats can be avoided	Alien vegetation is a problem in the area and measures to control erosion will need to be ensured
The instream habitat sensitivity at this point is limited in diversity and sensitivity and severe impacts on instream habitat is regarded as being limited.	Riparian vegetation at this point is in good condition and impacts could lead to an alteration of the characteristics of the riparian zone vegetation

Conclusion

The anabranching river channel and relatively high RVI score means that this proposed crossing alternative will have a significantly higher impact on the receiving riparian zone environment than most of the other crossing points. Due to the ability to place support pylons on the river banks and islands as well as the limited diversity and sensitivity of the instream habitat the risk to the instream habitat and aquatic community is regarded as being limited, provided that suitable mitigation is implemented. Based on these characteristics, this crossing point is not recommended as a suitable alternative to cross the Orange River unless measures to minimise the impacts on the riparian vegetation can be implemented and that riparian vegetation can be rehabilitated.

4.8.3.3. Crossing Alternative 3

Figure 4-52: Crossing Alternative 3.

Visual Assessment

A photographic record of the site was made in order to provide a visual record of the condition of the assessment site as observed during the field assessment. The photographs taken are presented below together with a table summarising the observations for the various criteria.

Figure 4-53: View upstream (left) and downstream (right) of C3.

Table 4-26: Description of the location of the Assessment site in the study area.

SITE	**C3**
Braiding of the system	At this point the system mostly consists of a single channel to the west of the existing road crossing, while to the east the system is anabranching.
Riparian zone characteristics	The riparian zone is wide. Some impact from alien vegetation encroachment has occurred with special mention of the Kikuyu lawn at the hotel to the east of the existing road crossing.
Algal presence	No algal proliferation was evident at the current time.
Visual indication of an impact on aquatic fauna	Water is turbid but not beyond the naturally expected conditions for the area.
Depth characteristics	The stream consists of deep pools, fast flowing shallower rapids and fast glides of moderate depth.
Flow condition	The river at this point has a diversity of flow present but flow is generally fast. There are fast flowing rapids, fast riffles and glides and slower deeper pool areas and backwaters to the east of the existing bridge crossing.
Water clarity	Water is discolored but can be considered natural.
Water odor	None
Erosion potential	Under high flow conditions the system has the potential to erode due to the fast flow of the water and incised banks of the river. This can however be regarded as natural for the system in the area. Some protection will be afforded by fairly good bankside vegetation cover

Habitat Assessment

This section illustrates the scores given to the crossing for habitat integrity for both instream and riparian zone habitats.

Table 4-27: Instream Habitat Integrity Crossing C3.

REACH	Water abstraction	Flow modification	Bed modification	Channel modification	Water quality	Inundation	Exotic macrophytes	Exotic fauna	Solid waste disposal	Total Score (%)	Classification
Weights	14	13	13	13	14	10	9	8	6		
C3	4	12	7	6	6	0	0	5	0	75	C Moderately modified

None	*Small*	*Moderate*	*Large*	*Serious*	*Critical*

Table 4-28: Riparian Zone Habitat Integrity for Crossing C3.

REACH	Vegetation removal	Alien encroachment	Bank erosion	Water abstraction	Flow modification	Channel modification	Water quality	Inundation	Total Score (%)	Classification
Weights	13	12	14	12	13	11	12	13		
C3	19	17	12	2	9	9	3	0	43.1	D Largely modified

None	*Small*	*Moderate*	*Large*	*Serious*	*Critical*

Table 4-29: Integrated Habitat Assessment for C3.

REACH	*INSTREAM HABITAT*	*RIPARIAN ZONE*	*IHIA SCORE*	*CLASS*
C3	75	43.1	*59.1*	D Largely modified

- From the results of the application of the IHIA to the assessment site, it is evident that there are several large impacts on the habitat of the area with impacts more prevalent in the riparian zone than the instream habitat.
- Instream impacts at the site included large impacts from flow and bed modifications. Smaller impacts from water quality and channel modification were also noted. Overall, the site achieved a 75 % score for in stream integrity. Indicating moderately modified (Class C) conditions.
- The largest riparian zone impacts included flow modification bank erosion, alien vegetation encroachment and indigenous vegetation removal. Smaller impacts from flow modification and channel modification were observed. The site achieved a 43.1% score for riparian zone integrity representing largely modified (Class D) conditions.
- The site obtained an overall IHIA rating of 59.1% score for riparian integrity representing largely modified (Class D) conditions. The site, therefore, falls below the DEMC for the quaternary catchment from a habitat integrity perspective. Measures to prevent further impacts on the system are therefore required and care should be taken to prevent impacts from any future developments. If the crossing was however to take place at this point the impact

on the riverine habitat would be reduced, due to the reduced level of integrity and sensitivity of the riverine habitat.

Riparian Vegetation Analysis

The Orange River at this point is anabranching with islands scattered throughout the main channel to the east of the river crossing but consists largely of a single channel to the west for the bridge. The active river channel is approximately 80 meters wide and the potential riparian zone is approximately 40 meters on the southern bank, 50 meters on the northern bank and 30 meters on the islands to the east of the existing bridge crossing. The substrate is dominated by bedrock, cobbles, gravel and sand. The riverbanks were vegetated and dominated by woody species and reeds, although they were transformed in some areas by landscaping activities and bridge developments.

The woody layer of the riparian vegetation was dominated by *Ziziphus mucronata, Searsia lancea* and *Tamarix usneoides,* in various densities. Although some areas have been transformed by landscaping and bridge development, the overall vegetation composition is indicative of the *Lower Gariep Alluvial Vegetation*. The instream vegetation was dominated by *Phragmites australis*. The grass component consists mainly of *Cynodon dactylon* and *Stipagrostis namaquensis,* although the landscaped section contains the exotic *Pennisetum clandestinum.* Alien species included *Eucalyptus camaldulensis, Nicotiana glauca, Pennisetum clandestinum, Datura stramonium* and *Solanum sisymbrifolium.*

This vegetation structure remains constant for a considerable distance up- and downstream, with vegetation density and abundance changing slightly. When comparing the species list (especially trees and grasses) to the vegetation list for *Lower Gariep Alluvial Vegetation,* it becomes clear that the species composition of the riparian zone is still largely intact, even though some impacts are evident due to landscaping activities and infrastructure construction. The following table presents a list of vegetation encountered on site.

Table 4-30: Dominant riparian vegetation species noted during the riparian vegetation assessment at C3.

Trees/shrubs	Forbs	Grasses/sedges
Acacia karroo *Nicotiana glauca** *Searsia lancea* *Tamarix usneoides* *Ziziphus mucronata* *Salix babylonica** *Eucalyptus camaldulensis**	*Asclepias fruticosa* *Bidens pilosa** *Datura stramonium** *Solanum sisymbrifolium** *Veronica anagallis-aquatica**	*Cyperus marginatus* *Cynodon dactylon* *Juncus effusus* *Stipagrostis namaquensis* *Panicum maximum* *Phragmites australis* *Setaria verticellata* *Pennisetum clandestinum**

* Exotic species

The RVI for this site was 13 (out of a possible 20), a value which falls within the boundary of a class C (moderately modified) system. The reason for this site receiving this value is mainly due to the disturbances associated with the landscaping activities and infrastructure upgrades. However the larger riparian zone is still representative of Lower Gariep Alluvial vegetation.

Crossing Suitability Analysis

The table below presents the advantages and disadvantages of the proposed crossing point.

Table 4-31: Suitability analyses of the C3 crossing alternative.

Advantages	Disadvantages
The river channel to the west of the existing bridge crossing is a single channel which can be spanned with support pylons outside of the riparian zone on each bank.	The river channel branched at this point and support pylons will have to be constructed on the river banks and the main island which will lead to an impact on the riparian vegetation of the system with special mention of the island vegetation.
The river channel branched at this point but support pylons can be constructed on the river banks and the main island which will limit the impact on the instream ecology.	Alien vegetation is a problem in the area and measures to control erosion will need to be ensured.
The riparian vegetation zone on the main river banks is narrow and the impact of the support pylons on the riparian vegetation and habitats can be avoided	Riparian vegetation at this point is in good condition and impacts could lead to an alteration of the characteristics of the riparian zone vegetation
The instream habitat sensitivity at this point is limited in diversity and sensitivity and severe impacts on instream habitat is regarded as being limited.	

Conclusion

The anabranching river channel and relatively high RVI score means that this proposed crossing alternative will have a significantly higher impact on the receiving riparian zone environment than the other crossing points if construction is undertaken to the east of the existing road bridge. If however the crossing is made to the west of the existing bridge crossing the impact on the Orange River ecology can be largely avoided.

If construction takes place to the east of the bridge a pylon will most likely need to be placed on the island which will impact on the riparian vegetation of the system. The riparian vegetation of the islands is in good condition and the pylon will have a significant impact on the island riparian vegetation. The instream habitat in this area is of increased sensitivity in relation to the other sites further downstream as well as in relation to crossing alternative 5 due to increased diversity and sensitivity of the instream habitat and the risk to the instream habitat and aquatic community is regarded as being relatively significant at this point. If this crossing point is selected measures will be required to prevent impacts on the instream habitats and associated communities.

Based on these findings, this crossing point is not recommended as a suitable alternative to cross the Orange River unless it occurs to the west of the existing road crossing. A crossing to the east of the existing road crossing is not deemed suitable unless extensive measures to minimise the impacts on the riparian vegetation and instream habitat can be implemented and that riparian vegetation can be rehabilitated.

4.8.3.4. Alternative Crossing 4

Figure 4-54: Alernative Crossing C4.

Visual Assessment

A photographic record of the site was made in order to provide a visual record of the condition of the assessment site as observed during the field assessment. The photographs taken are presented below together with a table summarising the observations for the various criteria made during the visual assessment undertaken on the site.

Figure 4-55: Views upstream (left) and downstream (right) at C4.

- Upstream view of the C4 site, indicating the impact from inundation caused by a small weir
- Downstream view of the C4 site showing the laminar flows in the system at this point

Table 4-32: Description of the location of the Assessment site in the study area.

SITE	C4
Braiding of the system	At this point the system is braided with two main channels. The main island is large and is under cultivation. The two main river channels are further anabranched with small islands with natural riparian vegetation cover.
Riparian zone characteristics	The riparian zone is narrow on the main stream banks and the large island due to the effects of clearing for agriculture and the construction of levees to protect the adjacent vineyards and orchards. Some impact from alien vegetation encroachment has occurred. The existing weir causes upstream inundation which alters the vegetation characteristics in this area.
Algal presence	No algal proliferation was evident at the current time.
Visual indication of an impact on aquatic fauna	Water is turbid but not beyond the naturally expected conditions for the area.
Depth characteristics	The stream consists of deep pools, fast flowing rapids and fast glides.
Flow condition	The river at this point is generally fast flowing with fast flowing narrow rapids, fast flowing glides.
Water clarity	Water is discolored but can be considered natural.
Water odor	None
Erosion potential	Under high flow conditions the system will erode rapidly due to the fast flow of the water and the unstable sandy nature of the riparian zone. This can however be regarded as natural for the system in the area. The area does have good bankside cover which will protect the banks to some degree.

Habitat Assessment

Table 4-33: Instream Habitat Integrity.

Weights	14	13	13	13	14	10	9	8	6		
REACH	Water abstraction	Flow modification	Bed modification	Channel modification	Water quality	Inundation	Exotic macrophytes	Exotic fauna	Solid waste disposal	Total Score (%)	Classification
C4	4	7	4	8	6	0	0	3	0	83.1	B Largely modified

None	Small	Moderate	Large	Serious	Critical

Table 4-34: Riparian Zone Habitat Integrity.

Weights	13	12	14	12	13	11	12	13		
REACH	Vegetation removal	Alien encroachment	Bank erosion	Water abstraction	Flow modification	Channel modification	Water quality	Inundation	Total Score (%)	Classification
C4	17	14	11	2	3	13	3	0	47.8	D Largely modified

None	Small	Moderate	Large	Serious	Critical

Table 4-35: Integrated Habitat Assessment for C4.

REACH	*INSTREAM HABITAT*	*RIPARIAN ZONE*	*IHIA SCORE*	*CLASS*
C4	83.1	47.8	*65.4*	C Moderately modified

- From the results of the application of the IHIA to the assessment site, it is evident that there are several large impacts on the habitat of the area. Impacts on the riparian zone are particularly significant in relation to those in the instream area.
- Instream impacts at the site included large impacts from flow and channel modifications. Smaller impacts from water quality modification were also noted. Overall, the site achieved an 83.1% score for in stream integrity. Indicating largely natural (Class B) conditions.
- The largest riparian zone impacts included flow bank erosion, vegetation removal, channel modification and alien vegetation encroachment. Smaller impacts from flow modification, and water quality modification were observed. The site achieved a 47.8% score for riparian integrity representing largely modified (Class D) conditions.
- The site obtained an overall IHIA rating of 65.4% score for riparian integrity representing moderately modified (Class C) conditions. The site, therefore, falls below the DEMC for the quaternary catchment from a habitat integrity perspective. Careful planning will be required in order to prevent impacts on this stream segment which would lead to local deterioration of the system.

Riparian vegetation analyses

At this assessment point, the Orange River is anabranching, with islands located in the main channel. The active river channel is approximately 45 meters wide and the potential riparian zone is approximately 60 meters on the southern bank, 60 meters on the northern bank and 60 meters on the islands except for the main island where the extent of the riparian zone is limited due to the agricultural activities on the island. The substrate is dominated by bedrock, cobbles, gravel and sand. The riverbanks were vegetated and dominated by indigenous woody species and reeds, with low levels of disturbance encountered, most notably a weir which has caused low levels of bank erosion.

The woody layer of the riparian vegetation was dominated by *Ziziphus mucronata, Olea europaea* subsp. *africana, Searsia lancea* and *Tamarix usneoides,* and is mostly extremely dense. As a result of the low levels of disturbance, the overall vegetation composition is indicative of the *Lower Gariep Alluvial Vegetation*. The instream vegetation was dominated by *Phragmites australis*. The grass component consists mainly of *Cynodon dactylon* and *Stipagrostis namaquensis* in areas where the woody layer is not very dominant. Alien species included *Nicotiana glauca, Datura stramonium* and *Solanum sisymbrifolium.* The pattern of vegetation structure remains constant for a considerable distance up- and downstream, with vegetation density and abundance changing slightly. When comparing the species list (especially trees and grasses) to the vegetation list for *Lower Gariep Alluvial Vegetation,* it becomes clear that the species composition of the riparian zone is still largely natural. The following table presents a list of vegetation encountered on site.

Table 4-36: Dominant riparian vegetation species noted during the riparian vegetation assessment at C4. Exotic species are marked by an asterisk.

Trees/shrubs	Forbs	Grasses/sedges
Acacia karroo *Nicotiana glauca** *Searsia lancea* *Tamarix usneoides* *Ziziphus mucronata* *Salix babylonica** *Oleae europaea* subsp. *africana'*	*Asclepias fruticosa* *Bidens pilosa** *Datura stramonium** *Solanum sisymbrifolium** *Veronica anagallis-aquatica**	*Cyperus marginatus* *Cynodon dactylon* *Juncus effusus* *Stipagrostis namaquensis* *Panicum maximum* *Phragmites australis* *Setaria verticellata*

'Protected species

The RVI for this site was similar to the C2 site and also calculated as 17.3 (out of a possible 20), which falls within the boundary of a class B (largely natural) system. The reason for this site receiving this value is mainly due to the moderate to high abundances and diversity of indigenous species and representative *Lower Gariep Alluvial* vegetation. The dense reed beds provide habitat for a potentially diverse faunal community and also provide valuable flood attenuation and water filtration services. Although the weir has been constructed, it has only had a low impact on riparian vegetation.

Crossing suitability analyses

The table below presents the advantages and disadvantages of the proposed crossing point

Table 4-37: Suitability analyses of the C4 crossing alternative.

Advantages	Disadvantages
The river channel branched at this point but support pylons can be constructed on the river banks and the main island which will limit the impact on the instream ecology	The river channel branched at this point and support pylons will have to be constructed on the river banks and the main island which has the potential to an impact on the riparian vegetation of the system.
The riparian vegetation zone on the main river banks is narrow and the impact of the support pylons on the riparian vegetation and habitats can be avoided	Alien vegetation is a problem in the area and measures to control erosion will need to be ensured
The instream habitat sensitivity at this point is limited in diversity and sensitivity and severe impacts on instream habitat is regarded as being limited.	Riparian vegetation at this point is in reasonable condition and impacts could lead to an alteration of the characteristics of the riparian zone vegetation

Conclusion

The anabranching river channel and relatively high RVI score means that this proposed crossing alternative will have a significantly higher impact on the receiving riparian zone environment than most of the other crossing points. Due to the ability to place support pylons on the river banks and islands as well as the limited diversity and sensitivity of the instream habitat the risk to the instream habitat and aquatic community is regarded as being limited, provided that suitable mitigation is implemented. Based on these characteristics, this crossing point is not recommended as a suitable alternative to cross the Orange River unless measures to minimise the impacts on the riparian vegetation can be implemented and that riparian vegetation can be rehabilitated.

4.8.3.5. Crossing Alternative C5

Figure 4-56: Alternative Crossing C5.

Visual Assessment of Instream Conditions

A photographic record of the site was made in order to provide a visual record of the condition of the assessment site as observed during the field assessment. The photographs taken are presented below together with a table summarising the observations for the various criteria made during the visual assessment undertaken on the site.

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Consulting Civil Engineers

Figure 4-57: Views upstream (left) and downstream (right) at C5.

- Upstream view of the C5 site, indicating rocky rapids and abundant bankside vegetation cover.
- Downstream view of the C5 site showing the slow flowing river and bankside cover.

Table 4-38: Description of the location of the Assessment site in the study area.

SITE	C5
Braiding of the system	At this point the system is braided with two main channels. The main island is large and is under cultivation. The two main river channels are largely unbranched with small islands with natural riparian vegetation cover.
Riparian zone characteristics	The riparian zone is narrow on the main stream banks and the large island due to the effects of clearing for agriculture and the construction of levees to protect the adjacent vineyards and orchards. Some impact from alien vegetation encroachment has occurred. The existing weir causes upstream inundation which alters the vegetation characteristics in this area.
Algal presence	No algal proliferation was evident at the current time.
Visual indication of an impact on aquatic fauna	Water is turbid but not beyond the naturally expected conditions for the area.
Depth characteristics	The stream consists of deep pools, fast flowing rapids and fast glides.
Flow condition	The river at this point is generally fast flowing with fast flowing narrow rapids, fast flowing glides.
Water clarity	Water is discolored but can be considered natural.
Water odor	None
Erosion potential	Under high flow conditions the system will erode rapidly due to the fast flow of the water and the unstable sandy nature of the riparian zone. This can however be regarded as natural for the system in the area. The area does have good bankside cover which will protect the banks to some degree.

Habitat Assessment

Table 4-39: Instream Habitat Integrity.

Weights	14	13	13	13	14	10	9	8	6		
REACH	Water abstraction	Flow modification	Bed modification	Channel modification	Water quality	Inundation	Exotic macrophytes	Exotic fauna	Solid waste disposal	Total Score (%)	Classification
CO5	4	2	3	0	8	0	0	3	0	89.1	B Largely natural

None	*Small*	*Moderate*	*Large*	*Serious*	*Critical*

Table 4-40: Riparian Zone Habitat Integrity.

Weights	13	12	14	12	13	11	12	13		

REACH	Vegetation removal	Alien encroachment	Bank erosion	Water abstraction	Flow modification	Channel modification	Water quality	Inundation	Total Score (%)	Classification
CO5	8	9	12	2	3	16	3	0	65.6	C Moderately modified

None	Small	Moderate	Large	Serious	Critical

Table 4-41: Integrated Habitat Integrity Assessment.

REACH	*INSTREAM HABITAT*	*RIPARIAN ZONE*	*IHIA SCORE*	*CLASS*
CO5	89.1	65.6	77.3	C Moderately modified

- From the results of the application of the IHIA to the assessment site, it is evident that there are two large impacts on the habitat of the area with impacts on the riparian zone being more significant than those on the instream habitat.
- Instream impacts at the site included some impacts from water abstraction and water quality modification. Smaller impacts from exotic fauna and bed modification were also noted. Overall, the site achieved a 89.1% score for in stream integrity. Indicating largely natural (Class B) conditions.
- The largest riparian zone impacts included flow bank erosion and channel modification. Smaller impacts from indigenous vegetation removal, and exotic vegetation encroachment. The site achieved a 65.6% score for riparian integrity representing moderately modified (Class C) conditions.
- The site obtained an overall IHIA rating of 77.3% score for riparian integrity representing moderately modified (Class C) conditions. The site, therefore, falls below the DEMC for the quaternary catchment from a habitat integrity perspective. Prevention of further impacts in this area is required in order to improve the habitat conditions of the area. Due to the impacts in the area, however the impact of any proposed development in the area is of lower significance than in areas where the habitat is less impacted.

Riparian vegetation analyses

As with all the other assessment points, the Orange River at this point is anabranching however the system is comprised of two main channels at this point, with very few small islands scattered throughout the main channel. The active river channel is approximately 50 meters wide and the potential riparian zone is approximately 30 meters on the southern bank and 30 meters on the northern bank. The main island in the river has been transformed completely by vineyards and other forms of crop cultivation and thus has a very narrow functional riparian zone. The substrate consists of a mixture of bedrock, soil, cobbles, gravel and sand. The river banks have been severely transformed by earthworks and the construction of levees for flood management purposes. This has caused vegetation transformation, erosion, incision and alien floral invasion.

The woody layer of the riparian vegetation was dominated by *Ziziphus mucronata, Searsia lancea* and *Tamarix usneoides.* Invasion by the alien tree species *Eucalyptus* *camaldulensis* was moderate to high. Although some vegetation representative of *Lower Gariep Alluvial Vegetation* was present, it was significantly more transformed than the other proposed crossing sites. The instream vegetation, as with the other proposed crossing sites, was dominated by *Phragmites australis*. The grass component consists mainly of *Cynodon dactylon* and *Stipagrostis namaquensis,* and it was notable that *Cynodon dactylon* was more prevalent than at the other proposed crossing sites due to this species being a known invader in disturbed areas. Alien species included *Eucalyptus camaldulensis, Nicotiana glauca, Datura stramonium* and *Solanum sisymbrifolium.* The vegetation structure changes when moving upstream and downstream due to lower levels of vegetation transformation. The following table presents a list of vegetation encountered on site.

Table 4-42: Dominant riparian vegetation species noted during the riparian vegetation assessment at C5. Exotic species are marked by an asterisk.

Trees/shrubs	Forbs	Grasses/sedges
Acacia karroo *Nicotiana glauca** *Searsia lancea* *Tamarix usneoides* *Ziziphus mucronata* *Salix babylonica** *Eucalyptus camaldulensis**	*Asclepias fruticosa* *Bidens pilosa** *Datura stramonium** *Solanum sisymbrifolium** *Veronica anagallis-aquatica**	*Cyperus marginatus* *Cynodon dactylon* *Juncus effusus* *Stipagrostis namaquensis* *Panicum maximum* *Phragmites australis* *Setaria verticellata*

The RVI for this site was 10.33 (out of a possible 20), a value which falls within the boundary of a class D (largely modified) system. The reason for this site receiving this value is mainly due to the disturbances associated with the earthmoving and levee construction activities. The crop cultivation activities have also largely transformed the island riparian vegetation.

Crossing suitability analyses

The table below presents the advantages and disadvantages of the proposed crossing point

Table 4-43: Suitability analyses of the C5 crossing alternative

Advantages	Disadvantages
The river channel branched at this point but support pylons can be constructed on the river banks and the main island which will limit the impact on the instream ecology	The river channel branched at this point and support pylons will have to be constructed on the river banks and the main island which has the potential to an impact on the riparian vegetation of the system.
The riparian vegetation zone on the main river banks is narrow and the impact of the support pylons on the riparian vegetation and habitats can be avoided	Alien vegetation is a problem in the area and measures to control erosion will need to be ensured
The instream habitat sensitivity at this point is limited in diversity and sensitivity and severe impacts on instream habitat is regarded as being limited.	Riparian vegetation at this point is in reasonable condition and impacts could lead to an alteration of the characteristics of the riparian zone vegetation

Conclusion

The anabranching river channel and relatively low RVI score means that this proposed crossing alternative is the second most suitable crossing point and will have a significantly lower impact on the receiving riparian zone environment than all of the other crossing points except for site C1. Due to the ability to place support pylons on the river banks and island as well as the limited diversity and sensitivity of the instream habitat the risk to the instream habitat and aquatic community is regarded as being limited, provided that suitable mitigation is implemented. Based on these characteristics, this crossing point is recommended as a suitable alternative to cross the Orange River provided that measures to minimise the impacts on the riparian vegetation can be implemented and that riparian vegetation can be rehabilitated.

4.8.4 Summary

Based on the consideration of habitat integrity and the characteristics of the crossing points with special mention of riverine structure and stream braiding, riparian zone integrity and instream habitat, two suitable crossing point alternatives were identified and three sites were identified which were considered less suitable as crossing points as follows:

- C1: highly suitable for proposed crossing;
- C2: not suitable as a crossing point;
- C3: moderately suitable as a crossing point however the crossing should take place to the west of the existing road bridge;
- C4: moderately suitable as a crossing point provided that care is taken with pylon placement to prevent impacts on riparian vegetation; and
- C5: suitable as a crossing point provided that care is taken with pylon placement to prevent impacts on riparian vegetation.

5. POST DRAFT REPORT ADDITIONS

After the review of the draft reports by stakeholders several comments were received and included into this report. This section aims to summaries those additions and to highlight their implications for the overall assessment.

5.1 Kathu Forest and the Ferrum Corridors

Since the draft report was published for comments, stakeholders near Olifantshoek have indicated a preference for another set of route alternatives as shown and described in the project description. The result was the addition of the Ferrum_Alternative 3A-D corridors.

In addition DAFF expressed concerns regarding the location of the Kathu Forest protected area, the Griqualand West centre of endemism and the location of protected species in general.

In Figure 5-1 below the proposed Ferrum-Solar Corridors are shown together with areas of high concentrations of protected species. Please note that these locations indicate general higher concentrations and do not exclude the occurrence of protected species at any other locations. Also note that the proclaimed protected area of the Kathu Forest and its buffer zones are indicated in red on the map and that none of the proposed corridors come within 2 km of the area. The bulk of the Ferrum power line corridors fall within the Griqualand West centre of endemism and succulents are of special concern here.

The additional corridors suggested by the stakeholders largely follow the Ferrum_Alternative 3 alignment and then splits into four different corridors before linking up with the existing Ferrum-Gorona power line. The pros and cons of these corridors are:

- Using the existing N14 highway as the primary alignment and then linking with the existing Ferrum-Gorona power line alignment allows access to the bulk of the corridors and negates the requirement for extensive access road construction. This in turn reduces the impact on fauna and flora as well as the soils.
- Ferrum_Alternative 3A
    - Passes south of the Langeberge outcrops which is technically easier and also avoids the ridges and potential succulents found in the rocky areas;
- Ferrum_Alternative 3B and 3D
    - Crosses over the ridges mentioned above which is not recommended;
- Ferrum_Alternative 3C
    - Uses the same valley as the N14 highway to traverse through the Langeberge. This is however not recommended as there are high concentrations of *Acacia erioloba* and the valley is very narrow with limited space for additional impacts.
- Following the Ferrum-Garona alignment
    - This existing power line runs through Kathu bushveld vegetation and there is a constant presence of *Acacia erioloba* throughout the

landscape although they do not dominate. This patch of bushveld extends over all three main corridors entering the Kathu region. It would be preferred to keep the impacts along existing infrastructure to prevent further fragmentation of the area and hence this section of the corridor is seen as a more preferred option for the last section of the power line.

5.2 Aries_Alternative1B and Orange River Crossings

Along the Orange River DAFF indicated their concerns regarding the crossing of the river and disturbance of the endangered Lower Gariep Alluvial vegetation type. In addition the Square Kilometre Array (SKA) objected to Aries_Alternative 1, as one of their remote satellite stations will be in close proximity to the proposed corridor and they suggested a re-alignment of the route which is shown below as Alternative 1A in Figure 5-2. This alternative in turn required a crossing over the Orange River slightly down stream of the original crossing.

Upon investigation of the Aries_Alternative 1B alignment it was found that an existing 132 kV power line crossing that is not used at present is found crossing the Orange River. This crossing is elevated approximately 20m above the river level. A photo mosaic of the crossing is shown in Figure 5-3 below. Scientific Aquatic Services indicated that even though the Alternative 1B crossing is some 800m downstream from their original C5 crossing point, it should not require any additional work as the sites are so close together.

It should be noted that if this crossing is utilised as per the recommendation of this report, then there should be negligible impacts to the endangered Lower Gariep Alluvial vegetation along the river, as the pylons will be placed on the rocky ridges above the river. A theoretical power line using the two existing pylons on site is shown in yellow.

Furthermore the Nieuwehoop Corridor river crossing suitability was also questioned and this potential crossing is also shown below. At this particular crossing the bulk of the natural vegetation has been disturbed by farming and the two canals with natural vegetation visible on the photograph should be spanned by the power lines and not impacted.

In comparison the other river crossings (Figure 5-4) have relatively large sections of natural Lower Gariep Alluvial vegetation remaining within the corridor and hence the recommendation of this report to rather utilised the two other crossings for the power line. At present the final power line alignment is not available and will only be finalised once the servitude negotiations with each and every landowner is completed. Once that is concluded a detail botany assessment will be undertaken to establish the potential sensitive, protected or endangered species along each power line that will require a permit or require a slight deviation in the power line route.

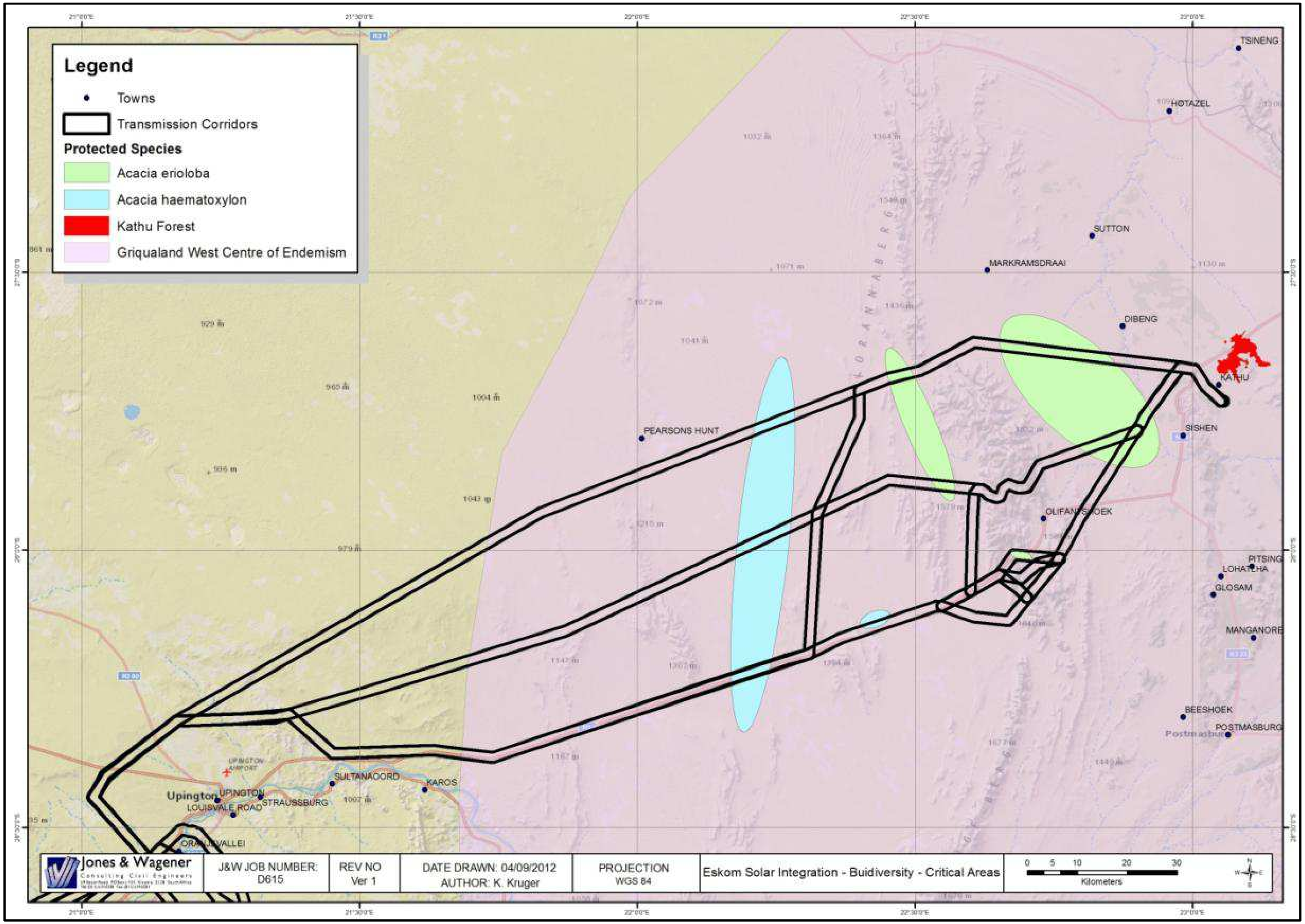

Figure 5-1: Ferrum Corridors and Protected Species

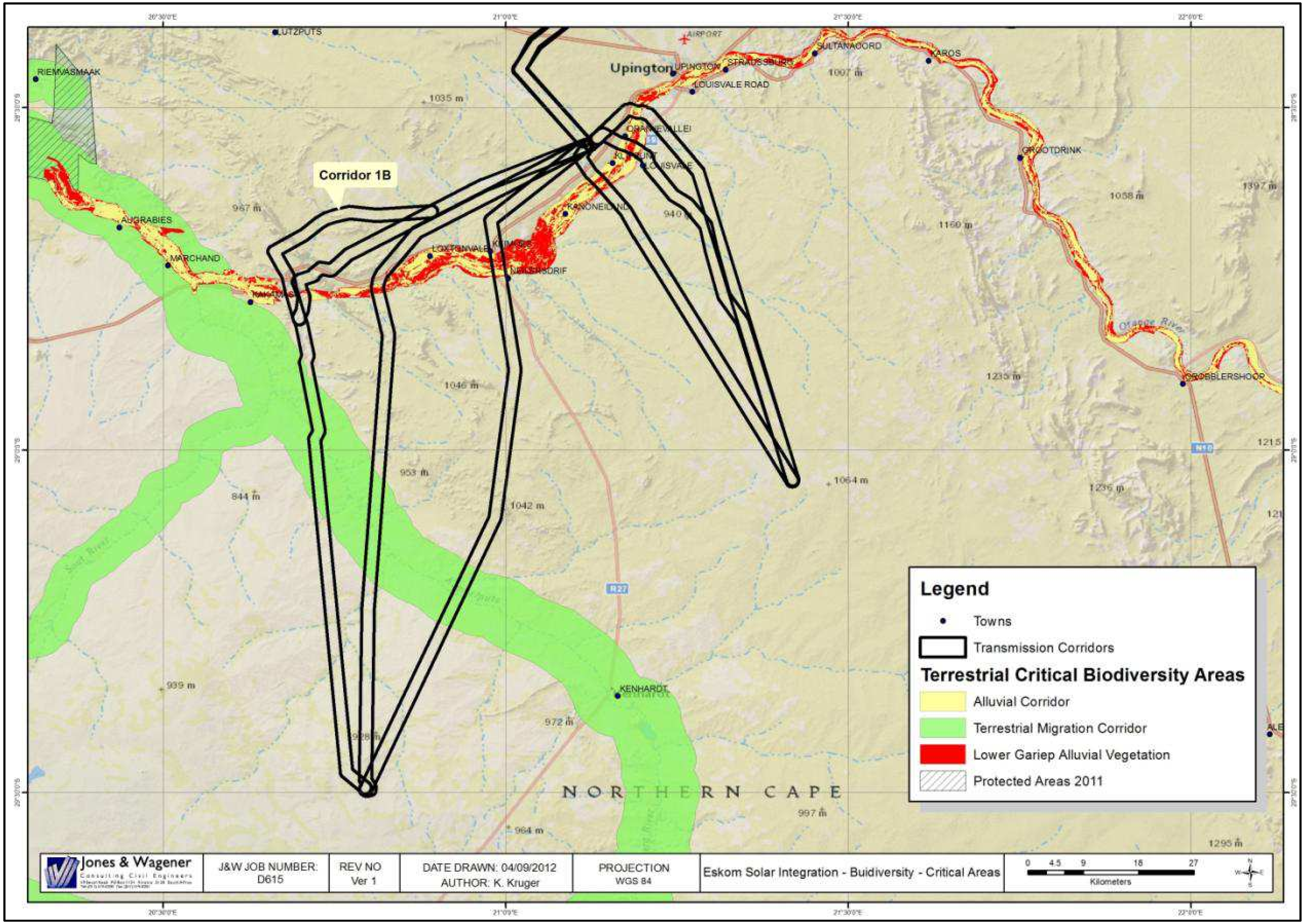

Figure 5-2: Aries and Nieuwehoop Corridors and Sensitivities

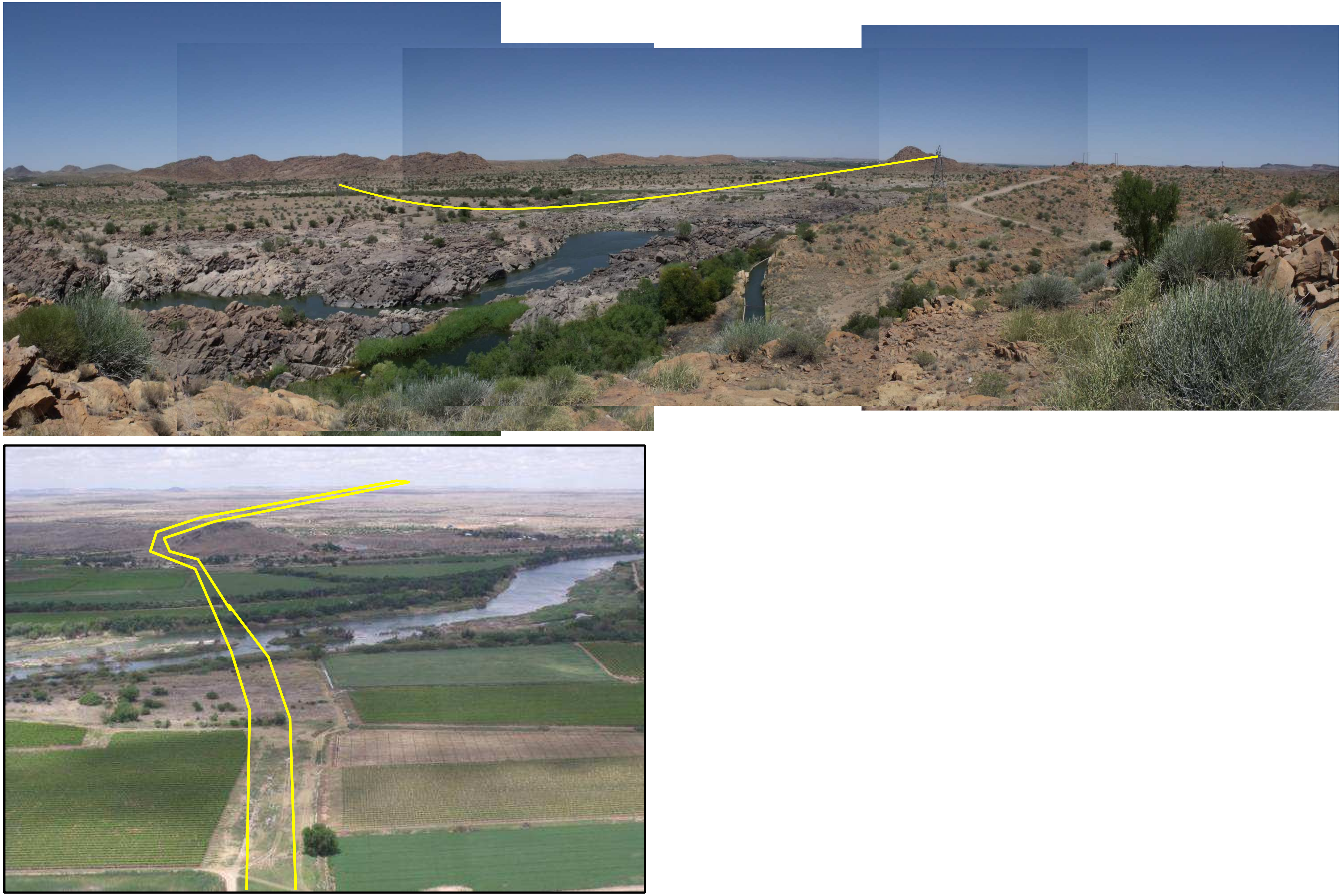

Figure 5-3: Proposed River Crossings (Aries Corridor 1A (top) and Nieuwehoop Corridor 1 (below))

Figure 5-4: Proposed River Crossings not recommended (Aries 2 (top left), Nieuwehoop 3 (top right), Aries 3 (bottom left) and Nieuwehoop 2 (bottom right))

6. IMPACT ASSESSMENT METHODOLOGY

In order to ensure uniformity, a standard impact assessment methodology has been utilised so that a wide range of impacts can be compared. The impact assessment methodology prescribed by Zitholele Consulting is given below.

To ensure uniformity, the assessment of impacts is addressed in a standard manner so that a wide range of impacts can be compared with each other. For this reason a clearly defined significance rating scale is provided to assess the significance (importance) of the associated impacts. The scale embraces the notion of extent and magnitude, but does not always clearly define these since their importance in the rating scale is very relative. For example, the magnitude (i.e. the size) of are affected by atmospheric pollution may be extremely large (1000 km^2) but the significance of this effect is dependent on the concentration or level of pollution. If the concentration were great, the significance of the impact would be HIGH or VERY HIGH, but if it were dilute it would be LOW or VERY LOW. Similarly, if 60 ha of a grassland type are destroyed the impact would be VERY HIGH if only 100 ha of that grassland type was known. The impact would be VERY LOW if the grassland type were common.

The potential significance of every environmental impact identified is determined by using a ranking scale, based on the following (the terminology is extracted from the DEAT guideline document on EIA Regulations, April 1998):

Occurrence
- Probability of occurrence (how likely is it that the impact may occur?), and
- Duration of occurrence (how long may it last?)

Severity
- Magnitude (severity) of impact (will the impact be of high, moderate or low severity?), and
- Scale/extent of impact (will the impact affect the national, regional or local environment, or only that of the site?)

In order to assess each of these factors for each impact, the following ranking scales were used:

Probability:
5 – Definite/don't know
4 – Highly probable
3 – Medium probability
2 – Low probability
1 – Improbable
0 – None

Duration:
5 – Permanent
4 - Long-term (ceases with the operational life)
3 - Medium-term (5-15 years)
2 - Short-term (0-5 years)
1 – Immediate

Scale:
5 – International
4 – National
3 – Regional (>5km)
2 – Local (<5km)
1 – Site only
0 – None

Magnitude:
10 - Very high/don't know
8 – High
6 – Moderate
4 – Low
2 – Minor

Once the above factors had been ranked for each impact, the environmental significance of each was assessed using the following formula:

SP = (magnitude + duration + scale) x probability

The maximum value is 100 significance points (SP). Environmental effects were rated as either of high, moderate or low significance on the following basis:
- More than 60 significance points indicated high environmental significance.
- Between 30 and 60 significance points indicated moderate environmental significance.
- Less than 30 significance points indicated low environmental significance.

High = H	Moderate = M	Low = L

Please note that **only negative impact will be ranked**

The degree of certainty of the assessment was judged on the following criteria:

Definite: More than 90% sure of a particular fact.
Probable: Between 70 and 90% sure of a particular fact, or of the likelihood of that impact occurring.
Possible: Between 40 and 70% sure of a particular fact or of the likelihood of an impact occurring.
Unsure: Less than 40% sure of a particular fact or the likelihood of an impact occurring.

Figure 6-1: Impact Assessment Methodology.

7. IMPACT ASSESSMENT

The impact assessment is undertaken for each of the detailed biophysical fields assessed above i.e. soils and land capability, terrestrial ecology and surface water and wetlands. The assessment will aim to describe the impacts of each of the project areas and then also to differentiate between the available alternatives to identify the most suitable alternative for each of the main corridors. Furthermore the assessment will also take cognisance of the expected different project phases i.e. construction and operations. At this stage it is not foreseen that the infrastructure will be decommissioned at any stage and hence this phase is not included in the assessment.

During construction the corridor will be surveyed, pegged and the soil nominations undertaken for each of the potential pylon foundations. The construction team will set up a construction camp in the study area and travel to site each day, transporting steel, workers and equipment to each of the pylon sites. In some cases the power line servitude is cleared of vegetation to ease construction activities and to prevent possible electrical faults with nearby trees. The first step is the excavation of the pylon foundations, the reinforcing thereof and finally the concreting of the foundations. The equipment required to excavate the foundations can be manual labour, a TLB or in the case of hard rock – a drill rig will be required. The concrete will have to be transported via concrete trucks to the required locations.

After the foundations and footings have been installed the construction team will transport the various steel parts of the pylons to the site and start erection of the pylons. This process again requires a lot of manual labour and often mobile cranes are used to assist with the erection of the pylons. Once the pylons are erected the stringing of the conductor cable commences, from pylon to pylon and the line is tensioned as per the requirements.

Once stringing and tensioning is complete the power line is considered constructed, where after it will be tested prior to being commissioned. Once operational the power line will conduct power along the approved corridor to the various substations. Operational and maintenance activities can include inspections via vehicle or helicopter and maintenance and repairs along the power lines.

Each of the proposed corridor alternatives is assessed below. It should be noted that the Gordonia 132 kV power line route is a single corridor with different potential endpoints due to the positioning of the substation that is still to be finalised. Therefore only one assessment is undertaken for the distribution lines.

7.1 Soils and Land Capability

7.1.1 Existing impact

The soils and land capability as described in Section 3 highlight the study area as a sandy/calcrete area with very little cultivation. The area is arid and all the soils have a high base status as a result. The narrow area along the Orange River floodplain has been converted to high value agriculture with the cultivation of grapes, dates and vegetables. This industry is a major source of revenue for the province. The other areas are mainly utilised for grazing of cattle, sheep and goats with a couple of game farms operating in the area as well.

Along the Ferrum corridors the existing impacts are found in the form of opencast iron ore mining at the mines around Kathu, linear structures such as the N14 highway to Upington and the compulsory farm roads. With the exception of the Kathu area, the soils along this corridor are relatively undisturbed. There are isolated cases where farm roads cross over dunes, removing vegetation and resulting in some minor erosion on the dune crests.

The Aries and Nieuwehoop area is similarly undisturbed, with urbanisation around Upington and the agricultural activities around the Orange River affecting the soils in this area. From an agricultural potential perspective the use of soil for agriculture is encouraged, hence the farming around the Orange River is not seen as a negative impact, as it might in the case of the terrestrial ecology assessment.

Around the proposed Eskom CSP site and the 132 kV corridors to Gordonia Substation the bulk of the area is also used for grazing land. There are a few activities along the corridor, such as the Duineveld landfill site, the Upington Airport as well as the town itself that have impacted upon the soils in this area.

The existing impact to soils for all four the study areas are rated as a Moderate Impact as shown in the table below.

Table 7-1: Soil and Land Capability Initial Impact Assessment

Impact	Significance	Spatial Scale	Temporal Scale	Probability	Rating
Impact to Soils	Minor	*Site only*	Medium Term	*Definite*	Moderate
	2	**1**	**3**	**5**	**30**

7.1.2 Additional impact

7.1.2.1. Impact assessment

The additional impact of the proposed power lines will mainly be in the form of the clearing of the vegetation for the pylon sites, excavation of the foundations for the pylons, and the construction of access roads to the pylons (if required). In terms of impact to agriculture, grazing can continue under the power lines and in the servitudes as well as the planting of low growing crops. The activities that are limited are the use of large irrigation systems such as pivots, spraying of crops by planes and the planting of high growing crops such as fruit trees, windbreaks and palms.

The average area of a typical self-supporting pylon footing is estimated at 14 m^2. There are various pylon design alternatives, but for this assessment worst case scenario is assumed which is the self-supporting pylons along the entire corridor. The potential impact to soils was estimated based on pylons being placed every 350m. The potential impact for each corridor alternative is given below.

Table 7-2: Impacts to soils for each corridor alternative.

Corridor Alternative	Length (km)	Foundation Impact to Soils (ha)	Agric Soils in corridor	Shifting Soils in corridor
Ferrum_Alternative 1	212 km	0.85 ha	0 ha	17 683 ha
Ferrum_Alternative 2	245 km	0.98 ha	0 ha	24 146 ha
Ferrum_Alternative 3	279 km	1.12 ha	0 ha	18 032 ha
Ferrum_Alternative 3A	261 km	1.04 ha	0 ha	15 051 ha

Corridor Alternative	Length (km)	Foundation Impact to Soils (ha)	Agric Soils in corridor	Shifting Soils in corridor
Ferrum_Alternative 3B	257 km	1.03 ha	0 ha	15 051 ha
Ferrum_Alternative 3C	258 km	1.03 ha	0 ha	15 051 ha
Ferrum_Alternative 3D	261 km	1.04 ha	0 ha	15 051 ha
Ferrum_Alternative 3E	267 km	1.07 ha	0 ha	15 051 ha
Aries_Alternative 1	131 km	0.52 ha	74 ha	2 739 ha
Aries_Alternative 1B	134 km	0.53 ha	74 ha	2 752 ha
Aries_Alternative 2	121 km	0.48 ha	284 ha	2 450 ha
Aries_Alternative 3	114 km	0.45 ha	651 ha	1 009 ha
Nieuwehoop_Alternative 1	73 km	0.29 ha	327 ha	68 ha
Nieuwehoop_Alternative 2	63 km	0.25 ha	497 ha	0 ha
Nieuwehoop_Alternative 3 and 3B	65 km	0.26 ha	630 ha	0 ha
Gordonia 1	29 km	0.12 ha	0 ha	36 ha

As shown in the table above when considering the potential impacts to soil and agriculture, the consideration is made for the impact to agricultural soils. But in this study area the soils also pose a risk to the potential development. The prevalence of shifting sands provide a potential risk to the stability of the pylons and the power line overall.

In addition to the impact of the pylon foundations the potential impact of an access road must also be considered. It is assumed that the power lines will require an access road for the length of the corridor, hence the longer the corridor the larger the impact. However the Ferrum_Alternative 3 and Ferrum_Alternative 3 A-E corridors are aligned with a major road, the N14 and the Ferrum-Gorona power line and in this case the existing access can be used for the transport of the bulk of the materials. Access roads will still be required from the highway to the specific pylons but this is a major advantage for these corridors. The same applies to the Nieuwehoop_Alternative 3/3B corridor, which is aligned along a provincial dirt road.

Once operational the impacts to the soil will remain, and if the construction activities have not been properly managed, wind erosion will start to occur in this phase. The utilisation and maintenance of roads will become important to limit the impacts.

Considering all the factors mentioned above, the potential impact to soils and agriculture and the potential risks for each of the alternatives are given in the table below.

Table 7-3: Additional impact by the proposed development to the soils and agriculture potential.

Alternative	Significance	Spatial	Temporal	Probability	Rating
Ferrum_Alternative 1	Low	Site	Long Term	Definite	45 - Moderate
Risk	Very High	Local	Long Term	High	64 - High
Ferrum_Alternative 2	Low	Site	Long Term	Definite	45 - Moderate
Risk	Very High	Local	Long Term	High	64 - High
Ferrum_Alternative 3	Minor	Site	Long Term	Definite	35 - Moderate
Risk	High	Local	Long Term	High	56 - Moderate
Ferrum_Alternative 3 A-E	Minor	Site	Long Term	Definite	35 - Moderate
Risk	High	Local	Long Term	High	56 - Moderate
Aries_Alternative 1 and 1B	Low	Site	Long Term	Definite	45 - Moderate
Risk	Moderate	Site	Long Term	High	44 - Moderate
Aries_Alternative 2	Low	Site	Long Term	Definite	45 - Moderate
Risk	Moderate	Site	Long Term	High	44 - Moderate
Aries_Alternative 3	Low	Site	Long Term	Definite	45 - Moderate
Risk	Moderate	Site	Long Term	High	44 - Moderate
Nieuwehoop_Alternative 1	Low	Site	Long Term	Definite	45 - Moderate
Risk	Minor	Site	Long Term	Medium	21 – Low
Nieuwehoop_Alternative 2	Low	Site	Long Term	Definite	45 - Moderate
Risk	Minor	Site	Long Term	Medium	21 – Low
Nieuwehoop_Alternative 3/3B	Minor	Site	Long Term	Definite	35 - Moderate
Risk	Minor	Site	Long Term	Medium	21 – Low
Gordonia_Alternative 1	Minor	Site	Long Term	Definite	35 - Moderate
Risk	Moderate	Site	Long Term	High	44 - Moderate

From the table above it can be seen that the impact to soils and agriculture over the length of each of the alternative corridors is regarded as a Moderate impact. The risk when considering the shifting sands and erosion is rated as a Low impact for the Nieuwehoop power lines and a Moderate to High impact for the rest of the alternatives.

7.1.2.2. Preferred alternatives

It should be noted that the overall scale of the assessment makes it difficult to discern which of the corridors are preferred, as the site conditions over the vast distances covered by these power lines are very similar. Here we attempt to discuss the minor differences between the corridors that the impact assessment table did not show.

Ferrum corridor

The corridors to the Ferrum Substation in the east of the study area have all been rated as Moderate Impacts to soils, however upon closer inspection it can be seen that Ferrum_Alternative 1 and 2 rated as 45, while Ferrum_Alternative 3 and the variations to the corridor rated as a 35. This is due to the fact that the latter corridors have main access roads in place that can be utilised without the need for major access road construction. In addition these corridors are also in an area with a slightly lower risk of shifting sands. Based on these criteria it is recommended that either *Ferrum_Alternative 3, 3A or E be utilised.*

Aries corridor

The Aries and Nieuwehoop power lines cross over the Orange River and the Agricultural soils around the river. This is such a small area in comparison to the rest of the corridors that the assessment cannot distinguish between the alternatives. However when evaluating only the crossings of the agricultural areas, a clearer assessment can be made. Hence this section will aim to address that, and similar sections will also be included in the terrestrial ecology section and surface water section.

As indicated in Table 7-2 above the three Aries alternatives have varying levels of impact to the agricultural soils surrounding the river. Aries_Alternative 1 and 1B has a much smaller impact to agricultural soils than the other two alternatives. This is due to the environment downstream of the Neus-weir. Here the Orange River flows through a number of sandstone outcrops and ridges and very little sediment has been deposited. Due to the smaller impact on the agriculture of the area – *it is recommended that the Aries_Alternative 1 or 1B be utilised.*

Nieuwehoop corridors

As with the Aries corridors above, the Nieuwehoop corridors traverse over the Orange River and the surrounding farmland. From Table 7-2 it can be seen that in the case of the Nieuwehoop corridors, *Nieuwehoop_Alternative 1 has the smallest impact to agriculture and it is recommended to be utilised as the crossing point for the power line.*

7.1.3 Mitigation/management measures

The following measures are proposed to manage and mitigate the potential impacts to soils and agricultural activities along the various corridors:

- Utilise the alternative suggested above;
- Avoid unnecessary removal of vegetation cover;
- Use existing access roads as far as possible;
- If a new road is constructed, ensure that the Eskom erosion prevention guideline is followed and adhere to the Eskom pylon construction specification TRMSCAAC1 Rev 3;

- Take land use into consideration when choosing pylon types, it is recommended that smaller footprint pylons be used in cultivated areas;
- Avoid placement of pylon footings in clay soils as well as on dunes, pylons to be sited in between dunes in the so-called dune-streets where possible;
- Avoid the construction of access roads through dunes;
- Spread absorbent sand on areas where oil spills are likely to occur, such as the refuelling area in the hard park;
- It is recommended that any potential hard park areas be located within areas of existing disturbance, preferably within one of the towns of the study area, and also no hard parks allowed in the dune/riparian areas;
- Oil-contaminated soils are to be removed to a contained storage area and bio-remediated or disposed of at a licenced facility;
- Use berms to minimise erosion where vegetation is disturbed, including hard parks, plant sites and office areas;
- If soils are excavated for the footing placement, ensure that the soil is utilised elsewhere for rehabilitation/road building purposes; and
- Ensure that soil is stockpiled in such a way as to prevent erosion from wind/storm water.

7.1.4 Residual impact

The cumulative impact of the power line construction and operations along with the impacts discussed in Section 5.1.1 slightly raise the impact score to 35, however the impact rating remains a Moderate impact as shown below.

Table 7-4: Soil and Land Capability Cumulative Impact Assessment

Impact	Significance	Spatial Scale	Temporal Scale	Probability	Rating
Impact to Soils	Minor	*Site only*	Long Term	*Definite*	Moderate
	2	**1**	**4**	**5**	**35**

7.2 Terrestrial Ecology

7.2.1 Existing impact

In terms of the existing impact to the terrestrial ecology of the study area, the vegetation has hardly been disturbed in most cases and the area is almost natural in appearance. All the vegetation units with the exception of the Lower Gariep Alluvial Vegetation show less than 5% transformation. Hence the impact on these areas is rated as a Low impact as shown below.

Table 7-5: Vegetation Initial Impact Assessment.

Impact	Significance	Spatial Scale	Temporal Scale	Probability	Rating
Impact to Veg	Minor	*Regional*	Short term	*Definite*	Moderate
	2	**3**	**2**	**5**	**35**

The impact to the Lower Gariep Alluvial Vegetation is a separate matter. Due to the high agricultural value of the soils and the proximity to the Orange River as a water source, this vegetation unit has been largely (50%) transformed by agriculture, to the point that it is endangered. This impact rates as a High impact as shown below.

Table 7-6: Vegetation Initial Impact Assessment – Lower Gariep Alluvial Vegetation.

Impact	Significance	Spatial Scale	Temporal Scale	Probability	Rating
Impact to Veg	Very High	*Regional*	Long Term	*Definite*	High
	10	**3**	**4**	**5**	**85**

7.2.2 Additional impact

The additional impact of the proposed power lines to the terrestrial ecology will be the removal of vegetation within the servitude for the construction of the new power lines and the associated servitude roads. This is standard operating procedure for the construction of power lines. In addition to the impact to the vegetation, the noise and activity might scare local fauna away from the study area. The overall impact of each of the power line corridor alternatives on each vegetation unit is shown in the Table below. Please note that the areas indicated are for the entire corridor (2 km wide), not only the power line.

The impact to vegetation, if the standard operating procedure to clear the vegetation in the servitude is followed, would be rated as a Moderate impact as shown below, even though the significance is rated as a high impact and this rating applies to all the corridor alternatives.

Table 7-7: Vegetation Additional Impact Assessment

Impact	Significance	Spatial Scale	Temporal Scale	Probability	Rating
Impact to Veg	High	*Site only*	Long-Term	*High*	Moderate
	8	**1**	**4**	**4**	**52**

However if considering the impact to the one endangered vegetation unit, the impact is rated as a High impact.

Table 7-8: Vegetation Additional Impact Assessment – Lower Gariep Alluvial Vegetation

Impact	Significance	Spatial Scale	Temporal Scale	Probability	Rating
Impact to Veg	Very High	*Site*	Long Term	*High*	High
	10	**1**	**4**	**4**	**60**

Table 7-9: Vegetation Impact per corridor (ha)

Corridor Alternative	Bushmanland Arid Grassland	Bushmanland Basin Shrubland	Gordonia Duneveld	Gordonia Plains Shrubland	Kalahari Karroid Shrubland	Kathu Bushveld	Koranna-Langeberg Mountain Bushveld	Olifantshoek Plains Thornveld	Southern Kalahari Salt Pans	Lower Gariep Alluvial Vegetation	Lower Gariep Broken Veld
Aries_Alt 1	15505	1616	550		2222					98	2404
Aries_Alt 2	14525	1767	637		1807					313	1339
Aries_Alt 3	15691	1238	969							656	623
Ferrum_Alt 1	837		11385	6382	10572	3999	2995	7943	177		
Ferrum_Alt 2	835		16308	7872	6690	9372	154	2511	3		
Ferrum_Alt 3	840		8208	11353	15820	9367	176	3584	77		
Ferrum_Alt 3A-E	832		7848	8476	15850	4059	2447	7789	59		
Niewehoop_Alt 1	11223		58		798					309	
Niewehoop_Alt 2	10245				15					491	
Nieuwehoop_Alt 3/3B	10518				362					603	
Gordonia_Alt	15		36		108						

Endangered vegetation unit

7.2.2.1. Preferred alternatives

As mentioned in the soils section, the overall scale of the assessment makes it difficult to discern which of the corridors are preferred, as the site conditions over the vast distances covered by these power lines are very similar. Here we attempt to discuss the minor differences between the corridors that the impact assessment table did not show. This information in addition to the location of protected species discussed in Sections 4.6 and 5 was utilised in the discussion below.

Ferrum corridor

From a terrestrial ecology perspective the four alternatives for the proposed Ferrum corridor are very similar in nature. The area is largely natural with little impact to the environment. In terms of the potential impacts it is recommended that either *Ferrum_Alternative 3 or the Ferrum_Alternative 3A or 3E be utilised as the use of existing access roads will significantly reduce the potential impact*.

Aries corridor

The Aries and Nieuwehoop power lines cross over the Orange River and the alluvial vegetation around the river. This is such a small area in comparison to the rest of the corridors that the assessment does not clearly distinguish between the alternatives. However when evaluating only the crossings of the endangered habitats, a clearer assessment can be made.

As indicated in Table 7-9 above the four Aries alternatives have varying levels of impact to the endangered habitat (marked in green). Aries_Alternatives 1 and 1B have a much smaller impact than the other two alternatives. This is due to the environment downstream of the Neus-weir. Here the Orange River flows through a number of sandstone outcrops and ridges and very little riparian vegetation occurs. Due to the smaller impact on the endangered vegetation – it is recommended *that the Aries Alternative 1B corridor be utilised*. For photos of the river crossings please refer to Figure 5-3 and Figure 5-4.

Nieuwehoop corridors

As with the Aries corridors above, the Nieuwehoop corridors traverse over the Orange River and the surrounding endangered habitat. From Table 7-9 it can be seen that in the case of the Nieuwehoop corridors, that *Nieuwehoop Alternative 1 has the smallest impact to the sensitive habitat and it is recommended to be utilised as the crossing point for the power line*. For photos of the river crossings please refer to Figure 5-3 and Figure 5-4.

7.2.3 Mitigation/management measures

The following measures are proposed to manage and mitigate the potential impacts to terrestrial ecology along the various corridors:

- General:
    - No hunting or cooking to be permitted on site;
    - All construction areas should be demarcated prior to construction to ensure that the footprint of the impacts are limited (including areas where vehicles may traverse);
    - All alien invasive species on site should be removed and follow up monitoring and removal programmes should be initiated once construction is completed;
    - Alternative 1 should be considered as the preferred alternative;
    - Adhere to the Eskom vegetation management guideline;

- The Environmental Control Officer should identify any sensitivities along the servitude, particularly large terrestrial species and notify the fauna specialist of these so that advice can be given on how to best deal with the situation;
- The construction of new access roads in particular should be limited to a minimum; and
- All vehicle and pedestrian movement should be restricted to the actual construction site and, in the case of maintenance patrols, to the actual servitude.

- Sensitive habitat/species:
  - Removal of plants should be restricted to only trees that pose a risk to the power line. All other vegetation should not be cleared with the exception of the footprint excavations;
  - Once the corridor is pegged, conduct a detailed botanical assessment to identify all plants that require removal and identify if they require a permit from the DAFF, Northern Cape Nature Conservation Department or in terms of the NEM:BA;
  - The sensitive alluvial vegetation unit should be avoided and construction limited to 50 m from the edge of the endangered habitat if possible; and
  - If construction has to take place inside the CBA, ensure that it takes place in areas that have already been disturbed.

7.2.4 Cumulative impact

If the abovementioned mitigation measures are implemented successfully, then the cumulative impact resulting from the power lines together with the existing impacts should not result in an impact larger than what was assessed for the initial impacts.

7.3 Surface Water and Wetlands

7.3.1 Existing impact

The Northern Cape is a very arid region of the country and hence surface water features are rarely found. For the study area this also holds true with the exception of the Orange River. This River is the main source of fresh water for the irrigated lands within its floodplain as well as the small towns that dot the banks of the river. Existing impacts include several weirs and bridges for road and pipe crossings over the river. In addition numerous canals have been excavated along the banks of the river to provide irrigation to the adjacent cultivation. Additionally some of the water sampling undertook as part of the SAS assessment indicates that the water conductivity is being affected by the agriculture to the point where the DWAF Target Water Quality Range is exceeded. However the river is rated as a tolerant system by SASS and these impacts have not had major effects on the river health.

These existing impacts to the surface water adjacent to the Orange River is rated as a **Moderate** impact as shown in the table below.

Table 7-10: Surface Water Initial Impact Assessment

Impact	Significance	Spatial Scale	Temporal Scale	Probability	Rating
Impact to Water	Moderate **4**	*Regional* **3**	Medium **3**	*Medium* **3**	Moderate **30**

It should be noted that these impacts are limited to the Orange River – the only perennial surface water feature in the study area. The rest of the water features, drainage lines and pans, have been minimally impacted.

7.3.2 Additional impact

Possible impacts that could occur if the Orange River is crossed by the power line corridors include the following:

- Impact on instream flow if pylons are placed in the active channels including vehicle movement and incorrect rehabilitation;
- Impacts due to sedimentation if access roads and power line footings are not adequately designed; inadequately rehabilitated and if erosion occurs;
- Impacts on instream habitat and refuges for aquatic species due to same activities mentioned above;
- Impacts on instream migratory corridors if pylons placed in incorrect locations and if the stream beds are modified;
- Impacts on taxa sensitive to changes in water quality by the activities mentioned above and including potential littering, chemical spills and vegetation clearing;
- Impacts due to inundation by altering the bed and banks of the river, poorly placed access roads or pylons;
- Impacts due to canalisation and erosion by the activities mentioned;
- Alien vegetation encroachment due to poor rehabilitation; and
- Impacts due to increased turbidity by the activities mentioned.

These impacts have been rated by SAS in their report and the ratings are summarised in the table below.

Table 7-11: Additional impact to surface water

No	Impact	Prior to mitigation
1	Impact on instream flow	Low
2	Impacts due to sedimentation	Low
3	Impacts on instream habitat and refugia for aquatic species	Low
4	Impacts on instream migratory corridors	Low
5	Impacts on taxa sensitive to changes in water quality	Low
6	Impacts due to inundation	Very low
7	Impacts due to canalisation and erosion	Low
8	Alien vegetation encroachment	Medium-high

No	Impact	Prior to mitigation
9	Impacts due to increased turbidity	Medium-high

7.3.3 Mitigation/management measures

In order to try and mitigate the impacts identified above, the following measures are proposed:

- No construction camps or pylons to be placed within 50m from the edge of a surface water body, pan, river or non-perennial stream;
- It should be noted that any activity that has the potential to trigger a Section 21 (c) or (i) water use as stipulated in the National Water Act, requires a Water Use License Application;
- Demarcated areas where waste can be safely contained and stored on a temporary basis during the construction phase should be provided at the hard park;
- Hydro-carbons should be stored in a bunded storage area;
- All hazardous materials inter alia paints, turpentine and thinners must be stored appropriately to prevent these contaminants from entering the environment;
- Spill-sorb or similar type product must be used to absorb hydrocarbon spills in the event that such spills should occur;
- Care must be taken to ensure that in removing vegetation adequate erosion control measures are implemented;
- Flow continuity has already been affected due to channel and bed modifications in the form of instream-barriers and the existing Neusberg weir. It is considered essential that flow continuity not be further altered in the Orange River during the construction phase of the proposed development. This is necessary to ensure the ongoing viability of the aquatic communities downstream of the proposed power line crossing, which are dependent on the fair levels of flow in the system;
- The power line crossing design must ensure that the creation of turbulent flow in the system is minimised, in order to prevent downstream erosion. No support pillars should be constructed within the active channel;
- The duration of impacts on the stream should be minimised as far as possible by ensuring that the duration of time in which flow alteration and sedimentation will take place is minimised;
- During construction, erosion berms should be installed to prevent gully formation and siltation of the Orange River. This is necessary to ensure the ongoing viability of the aquatic communities downstream of the proposed crossing which are dependent on cobble substrates and free of sediment deposition. There is already evidence of sedimentation at the site and further degradation of the river in this regard must be minimised and avoided;
- The following points should serve to guide the placement of erosion berms during the construction phase of the power line crossing:
    - Where the track/service road has slope of less than 2%, berms every 50m should be installed;

  - o Where the track/service road slopes between 2% and 10%, berms every 25m should be installed;
  - o Where the track/service road slopes between 10%-15%, berms every 20m should be installed; and
  - o Where the track/service road has slope greater than 15%, berms every 10m should be installed.
- All areas affected by construction should be rehabilitated upon completion of the construction phase of the power line crossing. Areas should be reseeded with indigenous grasses as required;
- During the construction phase, no vehicles should be allowed to indiscriminately drive through the riparian areas;
- No dumping of waste should take place within the riparian zone; No fires should be permitted near the construction area;
- If any spills occur, they should be immediately cleaned up;
- The characteristics of the stream bed are likely to be altered locally. In particular, the rock and rubble created during the construction process is likely to have sharp edges, and not the smooth surfaces that are typically associated with river rocks and pebbles. All rock and rubble must be removed from the active stream channel once construction has been completed;
- All alien vegetation in the riparian zone should be removed upon completion of construction; and
- Throughout the construction phase of the development, biomonitoring, using the same techniques as were used in this baseline report should be implemented in order to monitor the effects of the development on the aquatic systems present. Assessments should be undertaken on a quarterly basis. If the SASS and ASPT scores decrease by more than 15%, it should serve as an indication that the system is being impacted and measures to minimise the impacts should be implemented.

7.3.4 Cumulative impact

With the successful implementation of the mitigation measures listed above, the additional impacts from the power line construction and operations will decrease as shown in the table below.

Table 7-12: Impact to surface water after mitigation

No	Impact	Post mitigation
1	Impact on instream flow	Very low
2	Impacts due to sedimentation	Very low
3	Impacts on instream habitat and refugia for aquatic species	Very low
4	Impacts on instream migratory corridors	Very low
5	Impacts on taxa sensitive to changes in water quality	Very low
6	Impacts due to inundation	Very low
7	Impacts due to canalisation and erosion	Very low

No	Impact	Post mitigation
8	Alien vegetation encroachment	Low
9	Impacts due to increased turbidity	Low

With the reduction of the impacts the overall impact on the surface water and especially the Orange River will remain a **Low impact** as rated above.

8. PREFERRED ALTERNATIVES

As part of the impact assessment undertaken in this report, the most suitable alternative for each of the potential corridors was identified. Using the three detailed studies in the report, surface water, terrestrial ecology and soils it was determined that the following are the most preferred corridors for each section:

- Ferrum to Solar Park – Ferrum_Alternative 3 or its variation Ferrum_Alternative 3A or Ferrum_Alternative 3E;
- Aries to Solar Park – Aries_Alternative 1B; and
- Nieuwehoop to Solar Park – Nieuwehoop_Alternative 3B.

The Gordonia corridors to the Solar Park all follow the same alignment along an existing 132 kV power line corridor and therefore no comment can be made on the preferred corridor.

9. CONCLUSION AND WAY FORWARD

In conclusion this report aimed to identify the surface water, terrestrial ecology and soils that could be impacted by the proposed Solar Integration Project. From the detailed assessment it is clear that the majority of the sensitivities in the study area are located adjacent to the Orange River, where the sensitive habitats as well as the main farming activities are located. The Orange River is also the only perennial water body in the area and of utmost importance to the Province.

The corridors to Ferrum provided a different environment with the occurrence of the red Kalahari sands and in some cases dunes. These red sands are susceptible to erosion and also “shifting”, and could be an obstacle during construction.

Overall the study area is devoid of access corridors and access to the alternatives that are far from existing provincial or national roads might be problematic.

The study identified preferred alternatives for each corridor, based on the potential impacts to sensitive features along the corridors. In addition mitigation and management measures have been proposed for each of the criteria assessed and with the successful implementation of these measures, it is the opinion of the consultant that the impacts from this proposed development are within the acceptable range.

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APPENDIX A

SPECIES LISTS

FamilyName	SpeciesName	Category
ACANTHACEAE	Acanthopsis disperma	Plants
ACANTHACEAE	Barleria greenii	Plants
ACANTHACEAE	Barleria lichtensteiniana	Plants
ACANTHACEAE	Barleria rigida	Plants
ACANTHACEAE	Blepharis mitrata	Plants
ACANTHACEAE	Monechma divaricatum	Plants
ACANTHACEAE	Monechma genistifolium subsp. australe	Plants
ACANTHACEAE	Monechma genistifolium subsp. genistifolium	Plants
ACANTHACEAE	Monechma incanum	Plants
ACANTHACEAE	Monechma spartioides	Plants
ACANTHACEAE	Acanthopsis hoffmannseggiana	Plants
ACANTHACEAE	Monechma desertorum	Plants
ACANTHACEAE	Monechma distichotrichum	Plants
ACANTHACEAE	Monechma sp.	Plants
AIZOACEAE	Aizoon asbestinum	Plants
AIZOACEAE	Aizoon schellenbergii	Plants
AIZOACEAE	Galenia africana	Plants
AIZOACEAE	Galenia crystallina	Plants
AIZOACEAE	Plinthus cryptocarpus	Plants
AIZOACEAE	Tetragonia arbuscula	Plants
AIZOACEAE	Tetragonia reduplicata	Plants
AIZOACEAE	Trianthema parvifolia var. parvifolia	Plants
AIZOACEAE	Mesembryanthemum noctiflorum subsp. stramineum	Plants
AIZOACEAE	Aizoon canariense	Plants
AIZOACEAE	Galenia herniariaefolia	Plants
AIZOACEAE	Galenia sarcophylla	Plants
AIZOACEAE	Plinthus karooicus	Plants
AIZOACEAE	Plinthus sericeus	Plants
AMARANTHACEAE	Amaranthus praetermissus	Plants
AMARANTHACEAE	Amaranthus thunbergii	Plants
AMARANTHACEAE	Hermbstaedtia odorata var. odorata	Plants
AMARANTHACEAE	Leucosphaera bainesii	Plants
AMARANTHACEAE	Sericocoma avolans	Plants
AMARANTHACEAE	Amaranthus dinteri subsp. dinteri var. a	Plants
AMARANTHACEAE	Sericocoma pungens	Plants
AMARANTHACEAE	Sericorema remotiflora	Plants
AMARYLLIDACEAE	Haemanthus humilis subsp. humilis	Plants
AMARYLLIDACEAE	Nerine laticoma	Plants
AMARYLLIDACEAE	Crinum bulbispermum	Plants
AMARYLLIDACEAE	Crinum sp.	Plants
ANACARDIACEAE	Rhus lancea	Plants
ANACARDIACEAE	Searsia lancea	Plants
ANACARDIACEAE	Searsia pendulina	Plants
APOCYNACEAE	Adenium oleifolium	Plants
APOCYNACEAE	Cryptolepis decidua	Plants
APOCYNACEAE	Cynanchum orangeanum	Plants

APOCYNACEAE	Gomphocarpus fruticosus subsp. fruticosus	Plants
APOCYNACEAE	Microloma incanum	Plants
APOCYNACEAE	Orbea lugardii	Plants
APOCYNACEAE	Orbea sp.	Plants
APOCYNACEAE	Pergularia daemia var. leiocarpa	Plants
APOCYNACEAE	Sarcostemma viminale subsp. viminale	Plants
APOCYNACEAE	Fockea sinuata	Plants
APOCYNACEAE	Gomphocarpus filiformis	Plants
APOCYNACEAE	Hoodia gordonii	Plants
APOCYNACEAE	Larryleachia dinteri	Plants
APOCYNACEAE	Larryleachia marlothii	Plants
APOCYNACEAE	Lavrania marlothii	Plants
APOCYNACEAE	Stapelia grandiflora var. grandiflora	Plants
APOCYNACEAE	Lavrania sp.	Plants
APOCYNACEAE	Orbea lutea subsp. lutea	Plants
APOCYNACEAE	Sarcostemma pearsonii	Plants
APOCYNACEAE	Tridentea marientalensis subsp. marientalensis	Plants
ASPARAGACEAE	Asparagus lignosus	Plants
ASPARAGACEAE	Asparagus pearsonii	Plants
ASPARAGACEAE	Asparagus stipulaceus	Plants
ASPARAGACEAE	Asparagus exuvialis forma exuvialis	Plants
ASPARAGACEAE	Asparagus suaveolens	Plants
ASPARAGACEAE	Asparagus denudatus	Plants
ASPHODELACEAE	Aloe claviflora	Plants
ASPHODELACEAE	Aloe dichotoma	Plants
ASPHODELACEAE	Aloe dichotoma var. dichotoma	Plants
ASPHODELACEAE	Aloe gariepensis	Plants
ASPHODELACEAE	Aloe hereroensis var. hereroensis	Plants
ASPHODELACEAE	Trachyandra laxa var. laxa	Plants
ASPHODELACEAE	Aloe variegata	Plants
ASPHODELACEAE	Trachyandra jacquiniana	Plants
ASPLENIACEAE	Asplenium cordatum	Plants
ASTERACEAE	Arctotis leiocarpa	Plants
ASTERACEAE	Berkheya annectens	Plants
ASTERACEAE	Berkheya spinosissima subsp. spinosissima	Plants
ASTERACEAE	Dicoma capensis	Plants
ASTERACEAE	Dimorphotheca polyptera	Plants
ASTERACEAE	Eriocephalus microphyllus var. pubescens	Plants
ASTERACEAE	Felicia deserti	Plants
ASTERACEAE	Felicia muricata subsp. cinerascens	Plants
ASTERACEAE	Geigeria ornativa	Plants
ASTERACEAE	Geigeria pectidea	Plants
ASTERACEAE	Gorteria corymbosa	Plants
ASTERACEAE	Helichrysum gariepinum	Plants
ASTERACEAE	Hirpicium echinus	Plants
ASTERACEAE	Ifloga molluginoides	Plants
ASTERACEAE	Kleinia longiflora	Plants

ASTERACEAE	Laggera decurrens	Plants
ASTERACEAE	Leysera tenella	Plants
ASTERACEAE	Litogyne gariepina	Plants
ASTERACEAE	Nolletia arenosa	Plants
ASTERACEAE	Nolletia gariepina	Plants
ASTERACEAE	Osteospermum microcarpum subsp. microcarpum	Plants
ASTERACEAE	Pegolettia retrofracta	Plants
ASTERACEAE	Pentzia argentea	Plants
ASTERACEAE	Pentzia pinnatisecta	Plants
ASTERACEAE	Pentzia spinescens	Plants
ASTERACEAE	Pteronia mucronata	Plants
ASTERACEAE	Pteronia unguiculata	Plants
ASTERACEAE	Rosenia oppositifolia	Plants
ASTERACEAE	Senecio sisymbriifolius	Plants
ASTERACEAE	Tripteris microcarpa subsp. microcarpa	Plants
ASTERACEAE	Ursinia nana subsp. nana	Plants
ASTERACEAE	Amellus epaleaceus	Plants
ASTERACEAE	Amellus strigosus subsp. pseudoscabridus	Plants
ASTERACEAE	Amellus tridactylus subsp. arenarius	Plants
ASTERACEAE	Arctotis sp.	Plants
ASTERACEAE	Athanasia minuta subsp. minuta	Plants
ASTERACEAE	Berkheya spinosissima subsp. namaensis var. namaensis	Plants
ASTERACEAE	Chrysocoma ciliata	Plants
ASTERACEAE	Cineraria lobata subsp. lobata	Plants
ASTERACEAE	Dimorphotheca sinuata	Plants
ASTERACEAE	Eriocephalus ambiguus	Plants
ASTERACEAE	Eriocephalus ericoides subsp. ericoides	Plants
ASTERACEAE	Eriocephalus pauperrimus	Plants
ASTERACEAE	Eriocephalus spinescens	Plants
ASTERACEAE	Felicia clavipilosa subsp. clavipilosa	Plants
ASTERACEAE	Felicia hyssopifolia subsp. hyssopifolia	Plants
ASTERACEAE	Felicia muricata subsp. muricata	Plants
ASTERACEAE	Foveolina dichotoma	Plants
ASTERACEAE	Gazania lichtensteinii	Plants
ASTERACEAE	Geigeria filifolia	Plants
ASTERACEAE	Geigeria vigintisquamea	Plants
ASTERACEAE	Helichrysum herniarioides	Plants
ASTERACEAE	Helichrysum zeyheri	Plants
ASTERACEAE	Lasiopogon glomerulatus	Plants
ASTERACEAE	Nidorella microcephala	Plants
ASTERACEAE	Nidorella resedifolia subsp. resedifolia	Plants
ASTERACEAE	Osteospermum armatum	Plants
ASTERACEAE	Osteospermum muricatum subsp. longiradiatum	Plants
ASTERACEAE	Osteospermum pinnatum var. breve	Plants
ASTERACEAE	Osteospermum pinnatum var. pinnatum	Plants
ASTERACEAE	Osteospermum spinescens	Plants
ASTERACEAE	Othonna sp.	Plants

ASTERACEAE	Pentzia globosa	Plants
ASTERACEAE	Pteronia acuminata	Plants
ASTERACEAE	Pteronia glauca	Plants
ASTERACEAE	Pteronia leucoclada	Plants
ASTERACEAE	Pteronia sordida	Plants
ASTERACEAE	Pteronia sp.	Plants
ASTERACEAE	Rosenia glandulosa	Plants
ASTERACEAE	Rosenia humilis	Plants
ASTERACEAE	Senecio burchellii	Plants
ASTERACEAE	Senecio glutinarius	Plants
ASTERACEAE	Senecio niveus	Plants
ASTERACEAE	Sonchus oleraceus	Plants
ASTERACEAE	Trichogyne paronychioides	Plants
ASTERACEAE	Tripteris sinuata var. linearis	Plants
ASTERACEAE	Tripteris sinuata var. sinuata	Plants
ASTERACEAE	Geigeria ornativa subsp. ornativa	Plants
ASTERACEAE	Bidens bipinnata	Plants
ASTERACEAE	Helichrysum micropoides	Plants
ASTERACEAE	Pentzia sp.	Plants
ASTERACEAE	Senecio consanguineus	Plants
ASTERACEAE	Senecio trachylaenus	Plants
ASTERACEAE	Verbesina encelioides var. encelioides	Plants
AYTONIACEAE	Plagiochasma rupestre var. rupestre	Plants
AZOLLACEAE	Azolla filiculoides	Plants
BIGNONIACEAE	Rhigozum trichotomum	Plants
BIGNONIACEAE	Rhigozum obovatum	Plants
BORAGINACEAE	Codon royenii	Plants
BORAGINACEAE	Ehretia rigida subsp. rigida	Plants
BORAGINACEAE	Heliotropium ciliatum	Plants
BORAGINACEAE	Heliotropium supinum	Plants
BORAGINACEAE	Trichodesma africanum	Plants
BRASSICACEAE	Heliophila carnosa	Plants
BRASSICACEAE	Heliophila minima	Plants
BRASSICACEAE	Heliophila sp.	Plants
BRASSICACEAE	Heliophila trifurca	Plants
BRASSICACEAE	Coronopus integrifolius	Plants
BRASSICACEAE	Heliophila deserticola	Plants
BRASSICACEAE	Heliophila deserticola var. deserticola	Plants
BRASSICACEAE	Heliophila remotiflora	Plants
BRASSICACEAE	Lepidium africanum subsp. africanum	Plants
BRASSICACEAE	Lepidium desertorum	Plants
BRASSICACEAE	Lepidium schinzii	Plants
BRASSICACEAE	Sisymbrium burchellii var. burchellii	Plants
BRYACEAE	Bryum argenteum	Plants
BURSERACEAE	Commiphora gracilifrondosa	Plants
CAMPANULACEAE	Wahlenbergia denticulata var. denticulata	Plants
CAPPARACEAE	Boscia foetida subsp. foetida	Plants

CAPPARACEAE	Cadaba aphylla	Plants
CAPPARACEAE	Cleome angustifolia subsp. diandra	Plants
CAPPARACEAE	Cleome oxyphylla var. oxyphylla	Plants
CAPPARACEAE	Cleome paxii	Plants
CAPPARACEAE	Maerua gilgii	Plants
CAPPARACEAE	Boscia albitrunca	Plants
CAPPARACEAE	Cleome gynandra	Plants
CARYOPHYLLACEAE	Pollichia campestris	Plants
CELASTRACEAE	Gymnosporia linearis subsp. lanceolata	Plants
CHENOPODIACEAE	Atriplex semibaccata var. appendiculata	Plants
CHENOPODIACEAE	Salsola glabrescens	Plants
CHENOPODIACEAE	Salsola kali	Plants
CHENOPODIACEAE	Salsola namibica	Plants
CHENOPODIACEAE	Salsola tuberculata	Plants
CHENOPODIACEAE	Suaeda caespitosa	Plants
CHENOPODIACEAE	Suaeda merxmuelleri	Plants
CHENOPODIACEAE	Bassia salsoloides	Plants
CHENOPODIACEAE	Chenopodium glaucum	Plants
CHENOPODIACEAE	Salsola aphylla	Plants
CHENOPODIACEAE	Salsola barbata	Plants
CHENOPODIACEAE	Salsola rabieana	Plants
CHENOPODIACEAE	Atriplex semibaccata var. typica	Plants
COLCHICACEAE	Colchicum melanthoides subsp. melanthoides	Plants
COLCHICACEAE	Ornithoglossum vulgare	Plants
COLCHICACEAE	Colchicum bellum	Plants
COLCHICACEAE	Ornithoglossum viride	Plants
COLCHICACEAE	Androcymbium melanthioides subsp. melanthioides	Plants
CONVOLVULACEAE	Convolvulus sagittatus	Plants
CRASSULACEAE	Adromischus sp.	Plants
CRASSULACEAE	Cotyledon orbiculata var. orbiculata	Plants
CRASSULACEAE	Crassula muscosa var. muscosa	Plants
CRASSULACEAE	Crassula sericea var. sericea	Plants
CRASSULACEAE	Tylecodon rubrovenosus	Plants
CRASSULACEAE	Crassula corallina subsp. corallina	Plants
CRASSULACEAE	Crassula corallina subsp. macrorrhiza	Plants
CRASSULACEAE	Cotyledon orbiculata var. dactylopsis	Plants
CUCURBITACEAE	Coccinia rehmannii	Plants
CUCURBITACEAE	Cucumis africanus	Plants
CUCURBITACEAE	Citrullus lanatus	Plants
CUCURBITACEAE	Cucumis myriocarpus subsp. leptodermis	Plants
CUCURBITACEAE	Cucumis myriocarpus subsp. myriocarpus	Plants
CUCURBITACEAE	Cucumis sagittatus	Plants
CUCURBITACEAE	Corallocarpus schinzii	Plants
CUCURBITACEAE	Kedrostis capensis	Plants
CYPERACEAE	Cyperus capensis	Plants
CYPERACEAE	Cyperus longus var. tenuiflorus	Plants
CYPERACEAE	Cyperus marginatus	Plants

CYPERACEAE	Scirpoides dioecus	Plants
CYPERACEAE	Cyperus bellus	Plants
CYPERACEAE	Bulbostylis hispidula	Plants
CYPERACEAE	Cyperus fulgens var. contractus	Plants
CYPERACEAE	Cyperus usitatus	Plants
EBENACEAE	Diospyros lycioides subsp. lycioides	Plants
EBENACEAE	Diospyros pallens	Plants
ERIOSPERMACEAE	Eriospermum bakerianum subsp. bakerianum	Plants
ERIOSPERMACEAE	Eriospermum flagelliforme	Plants
EUPHORBIACEAE	Euphorbia avasmontana var. avasmontana	Plants
EUPHORBIACEAE	Euphorbia gariepina subsp. balsamea	Plants
EUPHORBIACEAE	Euphorbia gariepina subsp. gariepina	Plants
EUPHORBIACEAE	Euphorbia glanduligera	Plants
EUPHORBIACEAE	Euphorbia inaequilatera var. inaequilatera	Plants
EUPHORBIACEAE	Euphorbia rudis	Plants
EUPHORBIACEAE	Euphorbia spinea	Plants
EUPHORBIACEAE	Euphorbia avasmontana var. sagittaria	Plants
EUPHORBIACEAE	Euphorbia mauritanica var. mauritanica	Plants
FABACEAE	Acacia erioloba	Plants
FABACEAE	Acacia karroo	Plants
FABACEAE	Acacia mellifera subsp. detinens	Plants
FABACEAE	Cullen tomentosum	Plants
FABACEAE	Cyamopsis serrata	Plants
FABACEAE	Hoffmannseggia lactea	Plants
FABACEAE	Indigastrum argyraeum	Plants
FABACEAE	Indigastrum argyroides	Plants
FABACEAE	Indigofera alternans var. alternans	Plants
FABACEAE	Indigofera heterotricha	Plants
FABACEAE	Indigofera holubii	Plants
FABACEAE	Indigofera pungens	Plants
FABACEAE	Indigofera rhytidocarpa subsp. rhytidocarpa	Plants
FABACEAE	Lebeckia spinescens	Plants
FABACEAE	Lotononis platycarpa	Plants
FABACEAE	Lotononis rabenaviana	Plants
FABACEAE	Melolobium candicans	Plants
FABACEAE	Parkinsonia africana	Plants
FABACEAE	Ptycholobium biflorum subsp. biflorum	Plants
FABACEAE	Tephrosia dregeana var. dregeana	Plants
FABACEAE	Acacia tortilis subsp. heteracantha	Plants
FABACEAE	Lessertia annularis	Plants
FABACEAE	Lessertia sp.	Plants
FABACEAE	Lotononis falcata	Plants
FABACEAE	Lotononis marlothii	Plants
FABACEAE	Melolobium exudans	Plants
FABACEAE	Prosopis glandulosa var. glandulosa	Plants
FABACEAE	Prosopis glandulosa var. torreyana	Plants
FABACEAE	Prosopis sp.	Plants

FABACEAE	Prosopis velutina	Plants
FABACEAE	Requienia sphaerosperma	Plants
FABACEAE	Sutherlandia frutescens	Plants
FABACEAE	Acacia haematoxylon	Plants
FABACEAE	Acacia pendula	Plants
FABACEAE	Adenolobus garipensis	Plants
FABACEAE	Indigofera auricoma	Plants
FABACEAE	Lebeckia linearifolia	Plants
FABACEAE	Lessertia macrostachya var. macrostachya	Plants
FABACEAE	Melolobium macrocalyx	Plants
FABACEAE	Pomaria lactea	Plants
FABACEAE	Senna italica subsp. arachoides	Plants
FABACEAE	Tephrosia burchellii	Plants
FABACEAE	Calobota linearifolia	Plants
FABACEAE	Calobota spinescens	Plants
GERANIACEAE	Monsonia burkeana	Plants
GERANIACEAE	Monsonia luederitziana	Plants
GERANIACEAE	Sarcocaulon patersonii	Plants
GERANIACEAE	Monsonia umbellata	Plants
GERANIACEAE	Pelargonium minimum	Plants
GERANIACEAE	Sarcocaulon crassicaule	Plants
GERANIACEAE	Monsonia glauca	Plants
GIGASPERMACEAE	Chamaebryum pottioides	Plants
GISEKIACEAE	Gisekia pharnacioides var. pharnacioides	Plants
GISEKIACEAE	Gisekia africana var. africana	Plants
HYACINTHACEAE	Dipcadi ciliare	Plants
HYACINTHACEAE	Dipcadi glaucum	Plants
HYACINTHACEAE	Drimia physodes	Plants
HYACINTHACEAE	Ledebouria undulata	Plants
HYACINTHACEAE	Ornithogalum suaveolens	Plants
HYACINTHACEAE	Ornithogalum tenuifolium subsp. tenuifolium	Plants
HYACINTHACEAE	Albuca setosa	Plants
HYACINTHACEAE	Dipcadi brevifolium	Plants
HYACINTHACEAE	Dipcadi gracillimum	Plants
HYACINTHACEAE	Dipcadi viride	Plants
HYACINTHACEAE	Drimia intricata	Plants
HYACINTHACEAE	Ornithogalum juncifolium var. juncifolium	Plants
HYACINTHACEAE	Ornithogalum unifolium	Plants
HYACINTHACEAE	Ornithogalum unifolium var. unifolium	Plants
HYACINTHACEAE	Dipcadi bakerianum	Plants
HYACINTHACEAE	Dipcadi papillatum	Plants
HYACINTHACEAE	Ledebouria sp.	Plants
HYACINTHACEAE	Ornithogalum tenuifolium subsp. aridum	Plants
IRIDACEAE	Gladiolus saccatus	Plants
IRIDACEAE	Ferraria divaricata subsp. divaricata	Plants
IRIDACEAE	Ferraria ferrariola	Plants
IRIDACEAE	Lapeirousia plicata subsp. plicata	Plants

IRIDACEAE	Moraea serpentina	Plants
IRIDACEAE	Moraea speciosa	Plants
IRIDACEAE	Moraea venenata	Plants
IRIDACEAE	Ferraria variabilis	Plants
IRIDACEAE	Moraea pallida	Plants
IRIDACEAE	Moraea polystachya	Plants
LAMIACEAE	Leucas capensis	Plants
LAMIACEAE	Salvia verbenaca	Plants
LECANORACEAE	Lecanora sp.	Plants
LOASACEAE	Kissenia capensis	Plants
LOPHIOCARPACEAE	Lophiocarpus polystachyus	Plants
LORANTHACEAE	Tapinanthus oleifolius	Plants
LORANTHACEAE	Septulina glauca	Plants
MALVACEAE	Hermannia abrotanoides	Plants
MALVACEAE	Hermannia coccocarpa	Plants
MALVACEAE	Hermannia minutiflora	Plants
MALVACEAE	Hermannia modesta	Plants
MALVACEAE	Hermannia spinosa	Plants
MALVACEAE	Hermannia stricta	Plants
MALVACEAE	Hermannia tomentosa	Plants
MALVACEAE	Hermannia vestita	Plants
MALVACEAE	Hibiscus elliottiae	Plants
MALVACEAE	Abutilon angulatum var. angulatum	Plants
MALVACEAE	Abutilon pycnodon	Plants
MALVACEAE	Hermannia bicolor	Plants
MALVACEAE	Hermannia gariepina	Plants
MALVACEAE	Radyera urens	Plants
MALVACEAE	Corchorus asplenifolius	Plants
MALVACEAE	Hermannia sp.	Plants
MALVACEAE	Melhania didyma	Plants
MALVACEAE	Sida rhombifolia subsp. rhombifolia	Plants
MARSILEACEAE	Marsilea macrocarpa	Plants
MELIACEAE	Nymania capensis	Plants
MELIANTHACEAE	Melianthus comosus	Plants
MENISPERMACEAE	Cissampelos capensis	Plants
MESEMBRYANTHEMACEAE	Dinteranthus wilmotianus	Plants
MESEMBRYANTHEMACEAE	Lithops bromfieldii	Plants
MESEMBRYANTHEMACEAE	Mesembryanthemum coriarium	Plants
MESEMBRYANTHEMACEAE	Mesembryanthemum crystallinum	Plants
MESEMBRYANTHEMACEAE	Psilocaulon articulatum	Plants
MESEMBRYANTHEMACEAE	Psilocaulon coriarium	Plants
MESEMBRYANTHEMACEAE	Ruschia barnardii	Plants
MESEMBRYANTHEMACEAE	Ruschia divaricata	Plants
MESEMBRYANTHEMACEAE	Ruschia kenhardtensis	Plants
MESEMBRYANTHEMACEAE	Ruschia sp.	Plants
MESEMBRYANTHEMACEAE	Aptenia geniculiflora	Plants
MESEMBRYANTHEMACEAE	Aridaria noctiflora subsp. straminea	Plants

MESEMBRYANTHEMACEAE	Brownanthus ciliatus subsp. ciliatus	Plants
MESEMBRYANTHEMACEAE	Dinteranthus pole-evansii	Plants
MESEMBRYANTHEMACEAE	Drosanthemum hispidum	Plants
MESEMBRYANTHEMACEAE	Drosanthemum lique	Plants
MESEMBRYANTHEMACEAE	Lithops julii subsp. fulleri	Plants
MESEMBRYANTHEMACEAE	Mesembryanthemum guerichianum	Plants
MESEMBRYANTHEMACEAE	Mesembryanthemum nodiflorum	Plants
MESEMBRYANTHEMACEAE	Mesembryanthemum stenandrum	Plants
MESEMBRYANTHEMACEAE	Psilocaulon granulicaule	Plants
MESEMBRYANTHEMACEAE	Psilocaulon subnodosum	Plants
MESEMBRYANTHEMACEAE	Ruschia ferox	Plants
MESEMBRYANTHEMACEAE	Ruschia vulvaria	Plants
MESEMBRYANTHEMACEAE	Lithops sp.	Plants
MESEMBRYANTHEMACEAE	Prenia tetragona	Plants
MESEMBRYANTHEMACEAE	Psilocaulon sp.	Plants
MESEMBRYANTHEMACEAE	Ruschia canonotata	Plants
MESEMBRYANTHEMACEAE	Ruschia hamata	Plants
MESEMBRYANTHEMACEAE	Ruschia ruralis	Plants
MOLLUGINACEAE	Limeum aethiopicum subsp. aethiopicum var. aethiopicum	Plants
MOLLUGINACEAE	Limeum argute-carinatum var. argute-carinatum	Plants
MOLLUGINACEAE	Limeum myosotis var. confusum	Plants
MOLLUGINACEAE	Limeum sulcatum var. gracile	Plants
MOLLUGINACEAE	Hypertelis salsoloides var. salsoloides	Plants
MOLLUGINACEAE	Mollugo cerviana var. cerviana	Plants
MOLLUGINACEAE	Limeum fenestratum var. fenestratum	Plants
MONTINIACEAE	Montinia caryophyllacea	Plants
MORACEAE	Ficus cordata subsp. cordata	Plants
NEURADACEAE	Grielum humifusum var. humifusum	Plants
NEURADACEAE	Grielum humifusum var. parviflorum	Plants
NYCTAGINACEAE	Phaeoptilum spinosum	Plants
OPHIOGLOSSACEAE	Ophioglossum sp.	Plants
OXALIDACEAE	Oxalis haedulipes	Plants
OXALIDACEAE	Oxalis beneprotecta	Plants
OXALIDACEAE	Oxalis lawsonii	Plants
PANNARIACEAE	Psoroma hypnorum	Plants
PAPAVERACEAE	Argemone mexicana forma mexicana	Plants
PARMELIACEAE	Lichen sp.	Plants
PASSIFLORACEAE	Adenia repanda	Plants
PEDALIACEAE	Harpagophytum zeyheri subsp. sublobatum	Plants
PEDALIACEAE	Pterodiscus luridus	Plants
PEDALIACEAE	Rogeria longiflora	Plants
PEDALIACEAE	Sesamum capense	Plants
PEGANACEAE	Peganum harmala	Plants
PHYLLANTHACEAE	Phyllanthus humilis	Plants
PHYLLANTHACEAE	Phyllanthus maderaspatensis	Plants
PLUMBAGINACEAE	Dyerophytum africanum	Plants
POACEAE	Anthephora pubescens	Plants

POACEAE	Aristida adscensionis	Plants
POACEAE	Aristida congesta subsp. barbicollis	Plants
POACEAE	Aristida engleri var. engleri	Plants
POACEAE	Aristida vestita var. vestita	Plants
POACEAE	Brachiaria glomerata	Plants
POACEAE	Cenchrus ciliaris	Plants
POACEAE	Centropodia glauca	Plants
POACEAE	Digitaria eriantha	Plants
POACEAE	Digitaria sanguinalis	Plants
POACEAE	Echinochloa holubii	Plants
POACEAE	Echinochloa stagnina	Plants
POACEAE	Enneapogon cenchroides	Plants
POACEAE	Enneapogon desvauxii	Plants
POACEAE	Enneapogon scaber	Plants
POACEAE	Eragrostis annulata	Plants
POACEAE	Eragrostis biflora	Plants
POACEAE	Eragrostis curvula	Plants
POACEAE	Eragrostis lehmanniana var. lehmanniana	Plants
POACEAE	Eragrostis nindensis	Plants
POACEAE	Eragrostis porosa	Plants
POACEAE	Eragrostis rotifer	Plants
POACEAE	Eriochloa fatmensis	Plants
POACEAE	Melinis repens subsp. grandiflora	Plants
POACEAE	Panicum arbusculum	Plants
POACEAE	Schmidtia kalahariensis	Plants
POACEAE	Setaria appendiculata	Plants
POACEAE	Setaria pumila	Plants
POACEAE	Setaria verticillata	Plants
POACEAE	Stipagrostis amabilis	Plants
POACEAE	Stipagrostis ciliata var. capensis	Plants
POACEAE	Stipagrostis namaquensis	Plants
POACEAE	Stipagrostis obtusa	Plants
POACEAE	Stipagrostis uniplumis var. neesii	Plants
POACEAE	Stipagrostis uniplumis var. uniplumis	Plants
POACEAE	Tragus berteronianus	Plants
POACEAE	Tragus racemosus	Plants
POACEAE	Triraphis ramosissima	Plants
POACEAE	Urochloa panicoides	Plants
POACEAE	Aristida congesta subsp. congesta	Plants
POACEAE	Aristida diffusa subsp. burkei	Plants
POACEAE	Chloris virgata	Plants
POACEAE	Dichanthium annulatum var. papillosum	Plants
POACEAE	Eragrostis brizantha	Plants
POACEAE	Eragrostis echinochloidea	Plants
POACEAE	Eragrostis homomalla	Plants
POACEAE	Eragrostis lehmanniana var. chaunantha	Plants
POACEAE	Eragrostis macrochlamys var. macrochlamys	Plants

POACEAE	Eragrostis macrochlamys var. wilmaniae	Plants
POACEAE	Eragrostis obtusa	Plants
POACEAE	Eragrostis procumbens	Plants
POACEAE	Eragrostis x pseud-obtusa	Plants
POACEAE	Fingerhuthia africana	Plants
POACEAE	Leptochloa fusca	Plants
POACEAE	Leucophrys mesocoma	Plants
POACEAE	Microchloa caffra	Plants
POACEAE	Oropetium capense	Plants
POACEAE	Panicum lanipes	Plants
POACEAE	Schismus barbatus	Plants
POACEAE	Schmidtia pappophoroides	Plants
POACEAE	Sporobolus ioclados	Plants
POACEAE	Sporobolus nervosus	Plants
POACEAE	Stipagrostis anomala	Plants
POACEAE	Stipagrostis hochstetteriana var. secalina	Plants
POACEAE	Tricholaena capensis subsp. capensis	Plants
POACEAE	Triraphis purpurea	Plants
POACEAE	Aristida vestita	Plants
POACEAE	Digitaria sp.	Plants
POACEAE	Dinebra retroflexa	Plants
POACEAE	Eragrostis aspera	Plants
POACEAE	Melinis repens subsp. repens	Plants
POACEAE	Melinis sp.	Plants
POACEAE	Phalaris canariensis	Plants
POACEAE	Setaria italica	Plants
POACEAE	Setaria sp.	Plants
POACEAE	Stipagrostis hochstetteriana var. hochstetteriana	Plants
POLYGALACEAE	Polygala seminuda	Plants
POLYGALACEAE	Polygala leptophylla var. armata	Plants
POLYGONACEAE	Oxygonum alatum var. alatum	Plants
PORTULACACEAE	Anacampseros baeseckei	Plants
PORTULACACEAE	Anacampseros filamentosa subsp. filamentosa	Plants
PORTULACACEAE	Anacampseros filamentosa subsp. namaquensis	Plants
PORTULACACEAE	Avonia albissima	Plants
PORTULACACEAE	Portulaca hereroensis	Plants
PORTULACACEAE	Portulaca pilosa	Plants
PORTULACACEAE	Portulaca quadrifida	Plants
PORTULACACEAE	Talinum arnotii	Plants
PORTULACACEAE	Avonia ustulata	Plants
PORTULACACEAE	Portulaca oleracea	Plants
PORTULACACEAE	Talinum tenuissimum	Plants
PORTULACACEAE	Anacampseros filamentosa subsp. tomentosa	Plants
PORTULACACEAE	Portulaca kermesina	Plants
RESEDACEAE	Oligomeris dipetala var. dipetala	Plants
RHAMNACEAE	Ziziphus mucronata subsp. mucronata	Plants
RICCIACEAE	Riccia albornata	Plants

RICCIACEAE	Riccia okahandjana	Plants
RUBIACEAE	Kohautia cynanchica	Plants
RUBIACEAE	Kohautia ramosissima	Plants
RUBIACEAE	Kohautia caespitosa subsp. brachyloba	Plants
SALICACEAE	Salix mucronata subsp. mucronata	Plants
SANTALACEAE	Thesium lineatum	Plants
SANTALACEAE	Thesium hystricoides	Plants
SCROPHULARIACEAE	Anticharis senegalensis	Plants
SCROPHULARIACEAE	Aptosimum albomarginatum	Plants
SCROPHULARIACEAE	Aptosimum elongatum	Plants
SCROPHULARIACEAE	Aptosimum lineare	Plants
SCROPHULARIACEAE	Aptosimum lineare var. lineare	Plants
SCROPHULARIACEAE	Aptosimum marlothii	Plants
SCROPHULARIACEAE	Aptosimum procumbens	Plants
SCROPHULARIACEAE	Aptosimum spinescens	Plants
SCROPHULARIACEAE	Jamesbrittenia argentea	Plants
SCROPHULARIACEAE	Jamesbrittenia aridicola	Plants
SCROPHULARIACEAE	Jamesbrittenia glutinosa	Plants
SCROPHULARIACEAE	Peliostomum leucorrhizum	Plants
SCROPHULARIACEAE	Antherothamnus pearsonii	Plants
SCROPHULARIACEAE	Cromidon minutum	Plants
SCROPHULARIACEAE	Diascia engleri	Plants
SCROPHULARIACEAE	Diascia sp.	Plants
SCROPHULARIACEAE	Hebenstretia integrifolia	Plants
SCROPHULARIACEAE	Jamesbrittenia sp.	Plants
SCROPHULARIACEAE	Lyperia tristis	Plants
SCROPHULARIACEAE	Manulea nervosa	Plants
SCROPHULARIACEAE	Manulea schaeferi	Plants
SCROPHULARIACEAE	Nemesia fleckii	Plants
SCROPHULARIACEAE	Selago albida	Plants
SCROPHULARIACEAE	Selago divaricata	Plants
SCROPHULARIACEAE	Veronica anagallis-aquatica	Plants
SCROPHULARIACEAE	Zaluzianskya diandra	Plants
SCROPHULARIACEAE	Aptosimum junceum	Plants
SCROPHULARIACEAE	Jamesbrittenia atropurpurea subsp. pubescens	Plants
SCROPHULARIACEAE	Jamesbrittenia integerrima	Plants
SCROPHULARIACEAE	Selago paniculata	Plants
SOLANACEAE	Lycium bosciifolium	Plants
SOLANACEAE	Lycium cinereum	Plants
SOLANACEAE	Lycium oxycarpum	Plants
SOLANACEAE	Lycium pumilum	Plants
SOLANACEAE	Nicotiana glauca	Plants
SOLANACEAE	Solanum capense	Plants
SOLANACEAE	Lycium schizocalyx	Plants
SOLANACEAE	Solanum burchellii	Plants
SOLANACEAE	Solanum tomentosum var. tomentosum	Plants
TAMARICACEAE	Tamarix usneoides E.Mey. ex Bunge x T. ramosissima Ledeb.	Plants

TECOPHILAEACEAE	Cyanella lutea	Plants
THYMELAEACEAE	Gnidia polycephala	Plants
UNKNOWN	Unknown sp.	Plants
URTICACEAE	Forsskaolea candida	Plants
VAHLIACEAE	Vahlia capensis subsp. vulgaris var. longifolia	Plants
VERBENACEAE	Chascanum garipense	Plants
VERBENACEAE	Chascanum pumilum	Plants
VERBENACEAE	Chascanum incisum	Plants
VERBENACEAE	Chascanum pinnatifidum var. pinnatifidum	Plants
ZYGOPHYLLACEAE	Tribulus cristatus	Plants
ZYGOPHYLLACEAE	Tribulus pterophorus	Plants
ZYGOPHYLLACEAE	Tribulus terrestris	Plants
ZYGOPHYLLACEAE	Tribulus zeyheri subsp. zeyheri	Plants
ZYGOPHYLLACEAE	Zygophyllum dregeanum	Plants
ZYGOPHYLLACEAE	Zygophyllum flexuosum	Plants
ZYGOPHYLLACEAE	Zygophyllum gilfillanii	Plants
ZYGOPHYLLACEAE	Zygophyllum rigidum	Plants
ZYGOPHYLLACEAE	Zygophyllum simplex	Plants
ZYGOPHYLLACEAE	Zygophyllum sp.	Plants
ZYGOPHYLLACEAE	Augea capensis	Plants
ZYGOPHYLLACEAE	Sisyndite spartea	Plants
ZYGOPHYLLACEAE	Zygophyllum lichtensteinianum	Plants
ZYGOPHYLLACEAE	Zygophyllum retrofractum	Plants
ZYGOPHYLLACEAE	Zygophyllum suffruticosum	Plants
ZYGOPHYLLACEAE	Fagonia sinaica var. minutistipula	Plants

FamilyName	SpeciesName	Category
Agamidae	Agama anchietae	Animals
Anostostomatidae	Henicus monstrosus	Animals
Apidae	Megachile sp.	Animals
Apidae	Meliturgula sp.	Animals
Apidae	Nomia sp	Animals
Apidae	Thyreus brachyaspis	Animals
Apidae	Thyreus calceatus	Animals
Araneidae	Gea infuscata	Animals
Baetidae	Unidentified Baetidae	Animals
Baetidae	Centroptilum sp.	Animals
Baetidae	Pseudocloeon magae	Animals
Braconidae	Iphiaulax dodsi	Animals
Buprestidae	Lampetis ocelligera	Animals
Buprestidae	Lampetis albomarginata chalcophoroides	Animals
Buprestidae	Lampetis amaurotica	Animals
Buprestidae	Lampetis amaurotica fuksai	Animals
Buprestidae	Lampetis comorica	Animals
Buprestidae	Lampetis limbalis	Animals
Buprestidae	Ptosima sexmaculata	Animals
Buprestidae	Sphenoptera vinosa	Animals
Caenidae	Unidentified Caenidae	Animals
Cambalidae	Julomorpha fortis	Animals
Carabidae	Geobaenus ingenuus	Animals
Carabidae	Macrocheilus hybridus	Animals
Carabidae	Phloeozetus cordiger	Animals
Carabidae	Scarites sexualis	Animals
Carabidae	Trechodes babaulti	Animals
Chrysopidae	Italochrysa gigantia	Animals
Clariidae	Clarias gariepinus	Animals
Colubridae	Dasypeltis scabra	Animals
Colubridae	Dipsina multimaculata	Animals
Colubridae	Lycophidion capense	Animals
Cordylidae	Cordylus polyzonus	Animals
Coreidae	Homoeocerus trabeatus	Animals
Curculionidae	Platycopes gonopterus	Animals
Curculionidae	Porpacus cornirostris	Animals
Curculionidae	Hipporhinus subvittatus var.cinerascens	Animals
Cyprinidae	Labeobarbus kimberleyensis	Animals
Diapriidae	Ferrieropria	Animals
Eresidae	Gandanomeno depressus	Animals
Erirhididae	Hyposomus bevinsi	Animals
Eucoilidae	Gronotoma nitida	Animals
Euschmitiidae	genus ign. nr Penichrotes	Animals
Gekkonidae	Pachydactylus laevigatus	Animals
Gekkonidae	Pachydactylus montanus	Animals
Gekkonidae	Pachydactylus purcelli	Animals
Gekkonidae	Pachydactylus serval	Animals
Gekkonidae	Pachydactylus capensis	Animals
Gekkonidae	Pachydactylus latirostris	Animals

Gekkonidae	Pachydactylus mariquensis	Animals
Gekkonidae	Chondrodactylus angulifer	Animals
Gekkonidae	Pachydactylus turneri	Animals
Gekkonidae	Ptenopus garrulus	Animals
Gnaphosidae	Zelotes cronwrighti	Animals
Gnaphosidae	Zelotes gooldi	Animals
Gyrinidae	Aulonogyrus alternatus	Animals
Hesperiidae	Alenia sandaster	Animals
Hesperiidae	Pyrgus fritillarius fritillum	Animals
Hesperiidae	Spialia mafa mafa	Animals
Histeridae	Exorhabdus marshalli	Animals
Histeridae	Hister stercorarius	Animals
Histeridae	Hister sulcimargo	Animals
Histeridae	Saprinus pseudocyaneus	Animals
Ichneumonidae	Triclistus	Animals
Ichneumonidae	Paracollyria	Animals
Keptageniidae	Heptagenia sulphurea	Animals
Lacertidae	Pedioplanis lineoocellata	Animals
Lacertidae	Pedioplanis undata	Animals
Leptoceridae	Unidentified Leptoceridae	Animals
Leptoceridae	Leptecho sp.	Animals
Leptoceridae	Oecetis sp.	Animals
Leptophlebiidae	Adenophlebia peringueyella	Animals
Libellulidae	Trithemis arteriosa	Animals
Liopteridae	Paramblynotus hirsutebumus	Animals
Lycaenidae	Azanus ubaldus	Animals
Lycaenidae	Chilades trochylus	Animals
Lycaenidae	Aloeides arida	Animals
Lycaenidae	Aloeides barklyi	Animals
Lycaenidae	Aloeides molomo molomo	Animals
Lycaenidae	Brephidium metophis	Animals
Lycaenidae	Cacyreus lingeus	Animals
Lycaenidae	Iolaus (Stugeta) bowkeri bowkeri	Animals
Lycaenidae	Trimenia macmasteri macmasteri	Animals
Lycaenidae	Tylopaedia sardonyx peringueyi	Animals
Lycaenidae	Zizula hylax	Animals
LYCAENIDAE	Aloeides damarensis subsp. mashona	Animals
LYCAENIDAE	Chrysoritis pan subsp. lysander	Animals
LYCAENIDAE	Leptotes pirithous subsp. pirithous	Animals
Lycaenidae	Aloeides damarensis damarensis	Animals
Lycaenidae	Cigaritis namaqua	Animals
Lycaenidae	Cigaritis phanes	Animals
Lycaenidae	Iolaus (Stugeta) subinfuscata reynoldsi	Animals
LYCAENIDAE	Aloeides simplex	Animals
LYCAENIDAE	Stugeta bowkeri subsp. bowkeri	Animals
LYCAENIDAE	Stugeta subinfuscata subsp. reynoldsi	Animals
LYCAENIDAE	Tarucus sybaris subsp. linearis	Animals
Lycosidae	Lycosa cretata	Animals
Lygaeidae	Spilostethus pandurus militaris	Animals
Lygaeidae	Spilostethus taeniatus	Animals

Megachilidae	Fidelia braunsiana	Animals
Melittidae	Meganomia binghami	Animals
Membracidae	Oxyrhachis subserrata	Animals
Muscidae	Unidentified Muscidae	Animals
Naucoridae	Laccocoris sp.	Animals
Nemestrinidae	Prosoeca robusta	Animals
Nymphalidae	Henotesia perspicua	Animals
Nymphalidae	Tarsocera namaquensis	Animals
NYMPHALIDAE	Acraea neobule subsp. neobule	Animals
NYMPHALIDAE	Acraea trimeni	Animals
NYMPHALIDAE	Danaus chrysippus subsp. orientis	Animals
Nymphalidae	Neptis jordani	Animals
NYMPHALIDAE	Acraea stenobea	Animals
Pamphagidae	Transvaaliana draconis	Animals
Perlidae	Neoperla transvaalensis	Animals
Pieridae	Belenois aurota aurota	Animals
Pieridae	Catopsilia florella	Animals
Pieridae	Colotis eris eris	Animals
Pieridae	Pontia helice helice	Animals
Pieridae	Colotis agoye bowkeri	Animals
Pieridae	Colotis agoye agoye	Animals
PIERIDAE	Colotis euippe subsp. mediata	Animals
PIERIDAE	Pinacopteryx eriphia subsp. eriphia	Animals
Plumariidae	Myrmecopterina minor	Animals
Pompilidae	Priocnemis clypeatus	Animals
Pompilidae	Priocnemis fumipennis	Animals
Pselaphidae	Reichenbachia sulcicornis	Animals
Pteromalidae	Mesopolobus fasciiventris	Animals
Ranidae	Unidentified Ranidae	Animals
Reduviidae	Rhincoris rufigenu	Animals
Salticidae	Festicula australis	Animals
Salticidae	Menemerus rubicundus	Animals
Scarabaeidae	Proagoderus gemmatus	Animals
Scarabaeidae	Microtochalus plagiger	Animals
Scarabaeidae	Liatongus quadripunctatus	Animals
Scarabaeidae	Onitis confusus	Animals
Scarabaeidae	Onthophagus orthocerus	Animals
Scarabaeidae	Oocamenta rufiventris	Animals
Schendylidae	Schendylurus caledonicus	Animals
Scincidae	Acontias lineatus	Animals
Scincidae	Mabuya sp.	Animals
Scincidae	Mabuya sulcata	Animals
Scincidae	Mabuya occidentalis	Animals
Silphidae	Silpha (Silpha) peringueyi	Animals
Simuliidae	Simulium bovis	Animals
Sisyridae	Unidentified Sisyridae	Animals
Solpugidae	Solpuguna collinita	Animals
Sphecidae	Tachytes labilis	Animals
Sphecidae	Laphyragogus pictus	Animals
Staphylinidae	Zyras (Camonia) conifera	Animals

Stenopelmatidae	Sia (Maxentius) pallidus	Animals
Syrphidae	Paragus (Pandasyopthalmus) punctatus	Animals
Tabanidae	Mesomyia (Perisilvius) redunda	Animals
Tabanidae	Mesomyia(Mesomyia) aurantiaca	Animals
Tabanidae	Mesomyia(Mesomyia) costata	Animals
Tabanidae	Mesomyia(Mesomyia) namaquina	Animals
Tachinidae	Winthemia quadrata	Animals
Tenebrionidae	Strongylium lautum	Animals
Tenebrionidae	Strongylium muata	Animals
Tenebrionidae	Hypomelus vulpinus	Animals
Tenebrionidae	Eutrapela bicolor	Animals
Tenebrionidae	Strongylium perturbator	Animals
Testudinidae	Psammobates tentorius	Animals
Tetragnathidae	Nephila inaurata	Animals
Tettigoniidae	Hemihetrodes bachmanni	Animals
Thomisidae	Oxyptila	Animals
Tricorythidae	Tricorythus discolor	Animals
Tricorythidae	Unidentified Tricorythidae	Animals
Typhlopidae	Typhlops sp.	Animals
Unidentified Trichoptera	Unidentified Trichoptera	Animals
Viperidae	Bitis caudalis	Animals

APPENDIX A

SPECIES LISTS

SOLAR – FERRUM SPECIES LIST

FamilyName	SpeciesName	Category
ACANTHACEAE	Barleria macrostegia	Plants
ACANTHACEAE	Barleria rigida	Plants
ACANTHACEAE	Justicia puberula	Plants
ACANTHACEAE	Justicia thymifolia	Plants
ACANTHACEAE	Monechma divaricatum	Plants
ACANTHACEAE	Monechma incanum	Plants
ACANTHACEAE	Barleria irritans	Plants
ACANTHACEAE	Monechma genistifolium subsp. genistifolium	Plants
ACANTHACEAE	Blepharis mitrata	Plants
ACANTHACEAE	Barleria macrostegia	Plants
ACANTHACEAE	Blepharis integrifolia var. integrifolia	Plants
ACANTHACEAE	Blepharis marginata	Plants
ACANTHACEAE	Blepharis sp.	Plants
ACANTHACEAE	Glossochilus burchellii	Plants
ACANTHACEAE	Hypoestes forskaolii	Plants
AIZOACEAE	Aizoon schellenbergii	Plants
AIZOACEAE	Plinthus karooicus	Plants
AIZOACEAE	Plinthus sericeus	Plants
AIZOACEAE	Tetragonia saligna	Plants
AIZOACEAE	Trianthema parvifolia var. parvifolia	Plants
AMARANTHACEAE	Aerva leucura	Plants
AMARANTHACEAE	Hermbstaedtia odorata var. odorata	Plants
AMARANTHACEAE	Sericorema remotiflora	Plants
AMARANTHACEAE	Alternanthera pungens	Plants
AMARANTHACEAE	Gomphrena celosioides	Plants
AMARANTHACEAE	Kyphocarpa angustifolia	Plants
AMARANTHACEAE	Pupalia lappacea var. lappacea	Plants
AMARANTHACEAE	Sericorema sericea	Plants
AMARYLLIDACEAE	Boophone disticha	Plants
AMARYLLIDACEAE	Haemanthus humilis subsp. humilis	Plants
ANACARDIACEAE	Searsia burchellii	Plants
ANACARDIACEAE	Searsia ciliata	Plants
ANACARDIACEAE	Searsia tridactyla	Plants
ANACARDIACEAE	Searsia tenuinervis	Plants
ANTHERICACEAE	Chlorophytum fasciculatum	Plants
APIACEAE	Deverra burchellii	Plants
APOCYNACEAE	Acokanthera oppositifolia	Plants
APOCYNACEAE	Fockea angustifolia	Plants
APOCYNACEAE	Piaranthus decipiens	Plants
APOCYNACEAE	Sarcostemma viminale subsp. viminale	Plants
APOCYNACEAE	Stapelia olivacea	Plants
APOCYNACEAE	Gomphocarpus tomentosus	Plants
APOCYNACEAE	Gomphocarpus tomentosus subsp. tomentosus	Plants
APOCYNACEAE	Microloma armatum var. burchellii	Plants
APOCYNACEAE	Pergularia daemia subsp. daemia	Plants
APOCYNACEAE	Raphionacme velutina	Plants

ASPARAGACEAE	Asparagus suaveolens	Plants
ASPARAGACEAE	Asparagus bechuanicus	Plants
ASPARAGACEAE	Asparagus laricinus	Plants
ASPARAGACEAE	Asparagus exuvialis forma exuvialis	Plants
ASPARAGACEAE	Asparagus retrofractus	Plants
ASPHODELACEAE	Aloe hereroensis var. hereroensis	Plants
ASPHODELACEAE	Aloe sp.	Plants
ASPHODELACEAE	Bulbine narcissifolia	Plants
ASTERACEAE	Arctotheca calendula	Plants
ASTERACEAE	Arctotis leiocarpa	Plants
ASTERACEAE	Chrysocoma ciliata	Plants
ASTERACEAE	Chrysocoma obtusata	Plants
ASTERACEAE	Cineraria lyratiformis	Plants
ASTERACEAE	Cineraria vallis-pacis	Plants
ASTERACEAE	Dicoma anomala subsp. gerrardii	Plants
ASTERACEAE	Dicoma capensis	Plants
ASTERACEAE	Dicoma macrocephala	Plants
ASTERACEAE	Dimorphotheca sinuata	Plants
ASTERACEAE	Eriocephalus ericoides subsp. griquensis	Plants
ASTERACEAE	Euryops multifidus	Plants
ASTERACEAE	Felicia muricata subsp. cinerascens	Plants
ASTERACEAE	Felicia muricata subsp. muricata	Plants
ASTERACEAE	Gazania krebsiana subsp. serrulata	Plants
ASTERACEAE	Helichrysum argyrosphaerum	Plants
ASTERACEAE	Helichrysum cerastioides var. cerastioides	Plants
ASTERACEAE	Helichrysum pumilio subsp. pumilio	Plants
ASTERACEAE	Helichrysum zeyheri	Plants
ASTERACEAE	Hertia pallens	Plants
ASTERACEAE	Ifloga glomerata	Plants
ASTERACEAE	Leysera tenella	Plants
ASTERACEAE	Lopholaena cneorifolia	Plants
ASTERACEAE	Metalasia trivialis	Plants
ASTERACEAE	Nolletia ciliaris	Plants
ASTERACEAE	Osteospermum muricatum subsp. muricatum	Plants
ASTERACEAE	Pentzia incana	Plants
ASTERACEAE	Pentzia viridis	Plants
ASTERACEAE	Senecio consanguineus	Plants
ASTERACEAE	Tarchonanthus camphoratus	Plants
ASTERACEAE	Tarchonanthus obovatus	Plants
ASTERACEAE	Verbesina encelioides var. encelioides	Plants
ASTERACEAE	Geigeria ornativa subsp. ornativa	Plants
ASTERACEAE	Arctotis virgata	Plants
ASTERACEAE	Berkheya ferox var. tomentosa	Plants
ASTERACEAE	Dimorphotheca polyptera	Plants
ASTERACEAE	Eriocephalus ambiguus	Plants
ASTERACEAE	Eriocephalus microphyllus var. pubescens	Plants
ASTERACEAE	Felicia fascicularis	Plants

ASTERACEAE	Felicia hirta	Plants
ASTERACEAE	Foveolina dichotoma	Plants
ASTERACEAE	Helichrysum spiciforme	Plants
ASTERACEAE	Hirpicium echinus	Plants
ASTERACEAE	Othonna ramulosa	Plants
ASTERACEAE	Pentzia globosa	Plants
ASTERACEAE	Senecio radicans	Plants
ASTERACEAE	Geigeria pectidea	Plants
ASTERACEAE	Senecio sophioides	Plants
ASTERACEAE	Dicoma schinzii	Plants
ASTERACEAE	Gazania krebsiana subsp. arctotoides	Plants
ASTERACEAE	Geigeria brevifolia	Plants
ASTERACEAE	Kleinia longiflora	Plants
ASTERACEAE	Parthenium sp.	Plants
ASTERACEAE	Pegolettia retrofracta	Plants
ASTERACEAE	Rosenia humilis	Plants
ASTERACEAE	Senecio inaequidens	Plants
AYTONIACEAE	Plagiochasma rupestre var. rupestre	Plants
BIGNONIACEAE	Rhigozum brevispinosum	Plants
BIGNONIACEAE	Rhigozum obovatum	Plants
BIGNONIACEAE	Rhigozum trichotomum	Plants
BORAGINACEAE	Ehretia rigida subsp. rigida	Plants
BORAGINACEAE	Ehretia sp.	Plants
BORAGINACEAE	Heliotropium ciliatum	Plants
BORAGINACEAE	Trichodesma africanum	Plants
BORAGINACEAE	Heliotropium nelsonii	Plants
BRYACEAE	Bryum capillare	Plants
BRYACEAE	Bryum dichotomum	Plants
BUDDLEJACEAE	Buddleja saligna	Plants
CAMPANULACEAE	Wahlenbergia sp.	Plants
CAPPARACEAE	Boscia foetida subsp. foetida	Plants
CAPPARACEAE	Cleome kalachariensis	Plants
CAPPARACEAE	Cleome angustifolia subsp. diandra	Plants
CAPPARACEAE	Cleome monophylla	Plants
CAPPARACEAE	Cleome rubella	Plants
CARYOPHYLLACEAE	Corrigiola litoralis subsp. litoralis var. litoralis	Plants
CARYOPHYLLACEAE	Pollichia campestris	Plants
CELASTRACEAE	Putterlickia pyracantha	Plants
CELASTRACEAE	Putterlickia saxatilis	Plants
CELASTRACEAE	Gymnosporia buxifolia	Plants
CHENOPODIACEAE	Chenopodium carinatum	Plants
CHENOPODIACEAE	Chenopodium hederiforme var. undulatum	Plants
CHENOPODIACEAE	Exomis microphylla var. axyrioides	Plants
CHENOPODIACEAE	Salsola sp.	Plants
CHENOPODIACEAE	Atriplex suberecta	Plants
COLCHICACEAE	Colchicum melanthoides subsp. melanthoides	Plants
COLCHICACEAE	Ornithoglossum vulgare	Plants

COMBRETACEAE	Terminalia sericea	Plants
CONVOLVULACEAE	Evolvulus alsinoides	Plants
CONVOLVULACEAE	Ipomoea bolusiana	Plants
CONVOLVULACEAE	Ipomoea oenotheroides	Plants
CONVOLVULACEAE	Convolvulus multifidus	Plants
CONVOLVULACEAE	Convolvulus ocellatus var. ocellatus	Plants
CONVOLVULACEAE	Ipomoea hackeliana	Plants
CONVOLVULACEAE	Xenostegia tridentata subsp. angustifolia	Plants
CONVOLVULACEAE	Convolvulus boedeckerianus	Plants
CONVOLVULACEAE	Ipomoea obscura var. obscura	Plants
CONVOLVULACEAE	Seddera capensis	Plants
CUCURBITACEAE	Coccinia rehmannii	Plants
CUCURBITACEAE	Kedrostis crassirostrata	Plants
CUCURBITACEAE	Momordica balsamina	Plants
CUCURBITACEAE	Peponium caledonicum	Plants
CUCURBITACEAE	Acanthosicyos naudinianus	Plants
CUCURBITACEAE	Corallocarpus triangularis	Plants
CUCURBITACEAE	Cucumis africanus	Plants
CUCURBITACEAE	Cucumis myriocarpus subsp. myriocarpus	Plants
CYPERACEAE	Bulbostylis hispidula subsp. pyriformis	Plants
CYPERACEAE	Cyperus congestus	Plants
CYPERACEAE	Isolepis sepulcralis	Plants
CYPERACEAE	Isolepis setacea	Plants
CYPERACEAE	Schoenoplectus muricinux	Plants
CYPERACEAE	Schoenoplectus muriculatus	Plants
CYPERACEAE	Cyperus atriceps	Plants
CYPERACEAE	Bulbostylis burchellii	Plants
CYPERACEAE	Bulbostylis hispidula	Plants
CYPERACEAE	Cyperus difformis	Plants
CYPERACEAE	Cyperus margaritaceus var. margaritaceus	Plants
CYPERACEAE	Cyperus marlothii	Plants
CYPERACEAE	Cyperus squarrosus	Plants
CYPERACEAE	Fuirena pubescens var. pubescens	Plants
CYPERACEAE	Lipocarpha rehmannii	Plants
CYPERACEAE	Cyperus decurvatus	Plants
DIPSACACEAE	Scabiosa buekiana	Plants
DRACAENACEAE	Sansevieria aethiopica	Plants
EBENACEAE	Euclea undulata	Plants
EBENACEAE	Diospyros lycioides subsp. lycioides	Plants
ERIOSPERMACEAE	Eriospermum corymbosum	Plants
EUPHORBIACEAE	Clutia affinis	Plants
EUPHORBIACEAE	Croton gratissimus var. gratissimus	Plants
EUPHORBIACEAE	Euphorbia avasmontana var. avasmontana	Plants
EUPHORBIACEAE	Euphorbia inaequilatera var. inaequilatera	Plants
EUPHORBIACEAE	Euphorbia juttae	Plants
EUPHORBIACEAE	Euphorbia rectirama	Plants
EUPHORBIACEAE	Euphorbia mauritanica var. mauritanica	Plants

EUPHORBIACEAE	Tragia physocarpa	Plants
FABACEAE	Acacia erioloba	Plants
FABACEAE	Acacia erioloba E.Mey. x A. haematoxylon Willd.	Plants
FABACEAE	Acacia haematoxylon	Plants
FABACEAE	Acacia hebeclada subsp. hebeclada	Plants
FABACEAE	Acacia karroo	Plants
FABACEAE	Crotalaria damarensis	Plants
FABACEAE	Cullen tomentosum	Plants
FABACEAE	Cyamopsis serrata	Plants
FABACEAE	Indigofera alternans var. alternans	Plants
FABACEAE	Indigofera daleoides var. daleoides	Plants
FABACEAE	Indigofera damarana	Plants
FABACEAE	Indigofera heterotricha	Plants
FABACEAE	Indigofera rhytidocarpa subsp. rhytidocarpa	Plants
FABACEAE	Indigofera sessilifolia	Plants
FABACEAE	Leobordea platycarpa	Plants
FABACEAE	Listia heterophylla	Plants
FABACEAE	Lotononis crumanina	Plants
FABACEAE	Lotononis parviflora	Plants
FABACEAE	Melolobium calycinum	Plants
FABACEAE	Melolobium candicans	Plants
FABACEAE	Melolobium canescens	Plants
FABACEAE	Melolobium humile	Plants
FABACEAE	Pomaria burchellii subsp. burchellii	Plants
FABACEAE	Ptycholobium biflorum subsp. biflorum	Plants
FABACEAE	Senna italica subsp. arachoides	Plants
FABACEAE	Sutherlandia frutescens	Plants
FABACEAE	Sutherlandia humilis	Plants
FABACEAE	Sutherlandia microphylla	Plants
FABACEAE	Tephrosia dregeana var. dregeana	Plants
FABACEAE	Acacia mellifera subsp. detinens	Plants
FABACEAE	Crotalaria spartioides	Plants
FABACEAE	Indigofera vicioides var. vicioides	Plants
FABACEAE	Lessertia pauciflora var. pauciflora	Plants
FABACEAE	Parkinsonia africana	Plants
FABACEAE	Requienia sphaerosperma	Plants
FABACEAE	Tephrosia burchellii	Plants
FABACEAE	Calobota spinescens	Plants
FABACEAE	Indigofera alternans	Plants
FABACEAE	Calobota linearifolia	Plants
FABACEAE	Crotalaria orientalis subsp. orientalis	Plants
FABACEAE	Crotalaria podocarpa	Plants
FABACEAE	Elephantorrhiza elephantina	Plants
FABACEAE	Indigastrum argyraeum	Plants
FABACEAE	Indigofera sp.	Plants
FABACEAE	Melolobium exudans	Plants
FABACEAE	Melolobium macrocalyx var. macrocalyx	Plants

FABACEAE	Melolobium villosum	Plants
FABACEAE	Rhynchosia confusa	Plants
FABACEAE	Rhynchosia totta var. totta	Plants
FABACEAE	Rhynchosia venulosa	Plants
FABACEAE	Tephrosia longipes subsp. longipes var. longipes	Plants
FABACEAE	Tephrosia purpurea subsp. leptostachya var. leptostach	Plants
FABACEAE	Calobota cuspidosa	Plants
FISSIDENTACEAE	Fissidens sciophyllus	Plants
FISSIDENTACEAE	Fissidens submarginatus	Plants
GERANIACEAE	Monsonia luederitziana	Plants
GISEKIACEAE	Gisekia africana var. africana	Plants
GISEKIACEAE	Gisekia pharnacioides var. pharnacioides	Plants
GISEKIACEAE	Gisekia africana var. pedunculata	Plants
HYACINTHACEAE	Ledebouria undulata	Plants
HYACINTHACEAE	Dipcadi gracillimum	Plants
HYACINTHACEAE	Drimia physodes	Plants
HYACINTHACEAE	Dipcadi crispum	Plants
HYACINTHACEAE	Albuca sp.	Plants
IRIDACEAE	Moraea pallida	Plants
IRIDACEAE	Lapeirousia littoralis subsp. littoralis	Plants
IRIDACEAE	Ferraria glutinosa	Plants
IRIDACEAE	Lapeirousia littoralis subsp. caudata	Plants
JUNCACEAE	Juncus dregeanus subsp. dregeanus	Plants
LAMIACEAE	Acrotome inflata	Plants
LAMIACEAE	Ocimum americanum var. americanum	Plants
LAMIACEAE	Salvia namaensis	Plants
LAMIACEAE	Salvia verbenaca	Plants
LAMIACEAE	Stachys burchelliana	Plants
LAMIACEAE	Leucas capensis	Plants
LAMIACEAE	Stachys spathulata	Plants
LOBELIACEAE	Lobelia erinus	Plants
LOPHIOCARPACEAE	Corbichonia decumbens	Plants
LOPHIOCARPACEAE	Lophiocarpus polystachyus	Plants
LORANTHACEAE	Tapinanthus oleifolius	Plants
LORANTHACEAE	Tapinanthus forbesii	Plants
MALVACEAE	Abutilon austro-africanum	Plants
MALVACEAE	Grewia flava	Plants
MALVACEAE	Hermannia burkei	Plants
MALVACEAE	Hermannia comosa	Plants
MALVACEAE	Hermannia desertorum	Plants
MALVACEAE	Hermannia erodioides	Plants
MALVACEAE	Hermannia quartiniana	Plants
MALVACEAE	Hermannia sp.	Plants
MALVACEAE	Hermannia vestita	Plants
MALVACEAE	Malva pusilla	Plants
MALVACEAE	Melhania rehmannii	Plants
MALVACEAE	Sida cordifolia subsp. cordifolia	Plants

MALVACEAE	Waltheria indica	Plants
MALVACEAE	Hermannia abrotanoides	Plants
MALVACEAE	Hermannia burchellii	Plants
MALVACEAE	Hermannia linearifolia	Plants
MALVACEAE	Hermannia pulverata	Plants
MALVACEAE	Hermannia spinosa	Plants
MALVACEAE	Hermannia tomentosa	Plants
MALVACEAE	Radyera urens	Plants
MALVACEAE	Sida chrysantha	Plants
MALVACEAE	Hermannia jacobeifolia	Plants
MALVACEAE	Hermannia linnaeoides	Plants
MALVACEAE	Hibiscus ludwigii	Plants
MALVACEAE	Hibiscus pusillus	Plants
MALVACEAE	Melhania burchellii	Plants
MALVACEAE	Melhania virescens	Plants
MALVACEAE	Pavonia burchellii	Plants
MALVACEAE	Sida ovata	Plants
MALVACEAE	Sida pseudocordifolia	Plants
MELIACEAE	Nymania capensis	Plants
MENISPERMACEAE	Cissampelos capensis	Plants
MESEMBRYANTHEMACEAE	Mestoklema arboriforme	Plants
MESEMBRYANTHEMACEAE	Ruschia sp.	Plants
MESEMBRYANTHEMACEAE	Trichodiadema pomeridianum	Plants
MOLLUGINACEAE	Limeum myosotis var. myosotis	Plants
MOLLUGINACEAE	Limeum viscosum subsp. transvaalense	Plants
MOLLUGINACEAE	Mollugo cerviana var. cerviana	Plants
MOLLUGINACEAE	Limeum aethiopicum subsp. aethiopicum var. aethiopic	Plants
MOLLUGINACEAE	Limeum argute-carinatum var. argute-carinatum	Plants
MOLLUGINACEAE	Limeum aethiopicum var. intermedium	Plants
MORACEAE	Ficus cordata subsp. cordata	Plants
NEURADACEAE	Grielum humifusum var. parviflorum	Plants
NYCTAGINACEAE	Phaeoptilum spinosum	Plants
ORCHIDACEAE	Disperis macowanii	Plants
OXALIDACEAE	Oxalis lawsonii	Plants
OXALIDACEAE	Oxalis haedulipes	Plants
PEDALIACEAE	Sesamum capense	Plants
PEDALIACEAE	Harpagophytum procumbens subsp. procumbens	Plants
PEDALIACEAE	Sesamum triphyllum var. triphyllum	Plants
PHYLLANTHACEAE	Phyllanthus maderaspatensis	Plants
PHYLLANTHACEAE	Phyllanthus parvulus var. parvulus	Plants
PLUMBAGINACEAE	Dyerophytum africanum	Plants
POACEAE	Agrostis lachnantha var. lachnantha	Plants
POACEAE	Anthephora pubescens	Plants
POACEAE	Aristida congesta subsp. barbicollis	Plants
POACEAE	Aristida congesta subsp. congesta	Plants
POACEAE	Aristida diffusa subsp. burkei	Plants
POACEAE	Aristida engleri var. engleri	Plants

POACEAE	Aristida vestita	Plants
POACEAE	Brachiaria marlothii	Plants
POACEAE	Brachiaria nigropedata	Plants
POACEAE	Cenchrus ciliaris	Plants
POACEAE	Chloris virgata	Plants
POACEAE	Cynodon dactylon	Plants
POACEAE	Cynodon incompletus	Plants
POACEAE	Diandrochloa namaquensis	Plants
POACEAE	Diandrochloa pusilla	Plants
POACEAE	Digitaria eriantha	Plants
POACEAE	Digitaria glauca var. bechuanica	Plants
POACEAE	Digitaria seriata	Plants
POACEAE	Echinochloa sp.	Plants
POACEAE	Enneapogon scaber	Plants
POACEAE	Enneapogon scoparius	Plants
POACEAE	Eragrostis curvula	Plants
POACEAE	Eragrostis echinochloidea	Plants
POACEAE	Eragrostis gummiflua	Plants
POACEAE	Eragrostis lehmanniana var. lehmanniana	Plants
POACEAE	Eragrostis nindensis	Plants
POACEAE	Eragrostis obtusa	Plants
POACEAE	Eragrostis porosa	Plants
POACEAE	Eragrostis rigidior	Plants
POACEAE	Eragrostis rotifer	Plants
POACEAE	Eragrostis trichophora	Plants
POACEAE	Eragrostis x pseud-obtusa	Plants
POACEAE	Hyparrhenia hirta	Plants
POACEAE	Melinis nerviglumis	Plants
POACEAE	Melinis repens subsp. repens	Plants
POACEAE	Oropetium capense	Plants
POACEAE	Panicum gilvum	Plants
POACEAE	Panicum impeditum	Plants
POACEAE	Panicum kalaharense	Plants
POACEAE	Panicum schinzii	Plants
POACEAE	Pogonarthria squarrosa	Plants
POACEAE	Schmidtia kalahariensis	Plants
POACEAE	Schmidtia pappophoroides	Plants
POACEAE	Stipagrostis ciliata var. capensis	Plants
POACEAE	Stipagrostis uniplumis var. uniplumis	Plants
POACEAE	Tragus berteronianus	Plants
POACEAE	Tragus koelerioides	Plants
POACEAE	Trichoneura grandiglumis	Plants
POACEAE	Urochloa panicoides	Plants
POACEAE	Anthephora argentea	Plants
POACEAE	Aristida meridionalis	Plants
POACEAE	Centropodia glauca	Plants
POACEAE	Enneapogon desvauxii	Plants

POACEAE	Eragrostis annulata	Plants
POACEAE	Eragrostis brizantha	Plants
POACEAE	Eragrostis cylindriflora	Plants
POACEAE	Eragrostis lehmanniana var. chaunantha	Plants
POACEAE	Eragrostis truncata	Plants
POACEAE	Merxmuellera sp.	Plants
POACEAE	Sporobolus sp.	Plants
POACEAE	Stipagrostis obtusa	Plants
POACEAE	Tragus racemosus	Plants
POACEAE	Triraphis purpurea	Plants
POACEAE	Sporobolus ioclados	Plants
POACEAE	Andropogon chinensis	Plants
POACEAE	Andropogon schirensis	Plants
POACEAE	Aristida adscensionis	Plants
POACEAE	Aristida engleri var. ramosissima	Plants
POACEAE	Aristida stipitata subsp. spicata	Plants
POACEAE	Brachiaria brizantha	Plants
POACEAE	Cymbopogon caesius	Plants
POACEAE	Cymbopogon pospischilii	Plants
POACEAE	Digitaria polyphylla	Plants
POACEAE	Digitaria sanguinalis	Plants
POACEAE	Eleusine coracana subsp. africana	Plants
POACEAE	Elionurus muticus	Plants
POACEAE	Enneapogon cenchroides	Plants
POACEAE	Eragrostis barrelieri	Plants
POACEAE	Eragrostis biflora	Plants
POACEAE	Eragrostis mexicana subsp. virescens	Plants
POACEAE	Eragrostis pallens	Plants
POACEAE	Eragrostis viscosa	Plants
POACEAE	Eustachys paspaloides	Plants
POACEAE	Fingerhuthia africana	Plants
POACEAE	Heteropogon contortus	Plants
POACEAE	Lamarckia aurea	Plants
POACEAE	Leptochloa fusca	Plants
POACEAE	Melinis repens subsp. grandiflora	Plants
POACEAE	Panicum coloratum var. coloratum	Plants
POACEAE	Panicum maximum	Plants
POACEAE	Setaria verticillata	Plants
POACEAE	Sporobolus fimbriatus	Plants
POACEAE	Stipagrostis uniplumis var. neesii	Plants
POACEAE	Urochloa stolonifera	Plants
POLYGALACEAE	Muraltia alopecuroides	Plants
POLYGALACEAE	Polygala leptophylla var. leptophylla	Plants
POLYGALACEAE	Polygala leptophylla var. armata	Plants
POLYGALACEAE	Polygala seminuda	Plants
POLYGONACEAE	Emex australis	Plants
POLYGONACEAE	Persicaria limbata	Plants

PORTULACACEAE	Talinum arnotii	Plants
PORTULACACEAE	Talinum caffrum	Plants
PORTULACACEAE	Talinum crispatulum	Plants
PORTULACACEAE	Portulaca hereroensis	Plants
PORTULACACEAE	Portulaca kermesina	Plants
POTTIACEAE	Trichostomum brachydontium	Plants
PROTEACEAE	Leucadendron rubrum	Plants
PTERIDACEAE	Cheilanthes hirta var. brevipilosa	Plants
PTERIDACEAE	Cheilanthes multifida var. multifida	Plants
PTERIDACEAE	Pellaea calomelanos var. calomelanos	Plants
RANUNCULACEAE	Clematis brachiata	Plants
RHAMNACEAE	Helinus spartioides	Plants
RHAMNACEAE	Ziziphus mucronata subsp. mucronata	Plants
RHAMNACEAE	Phylica sp.	Plants
RICCIACEAE	Riccia cavernosa	Plants
RICCIACEAE	Riccia okahandjana	Plants
RICCIACEAE	Riccia cupulifera	Plants
RUBIACEAE	Anthospermum rigidum subsp. rigidum	Plants
RUBIACEAE	Kohautia cynanchica	Plants
RUBIACEAE	Kohautia virgata	Plants
SANTALACEAE	Thesium hystricoides	Plants
SANTALACEAE	Thesium lineatum	Plants
SANTALACEAE	Thesium hystrix	Plants
SCROPHULARIACEAE	Aptosimum junceum	Plants
SCROPHULARIACEAE	Jamesbrittenia integerrima	Plants
SCROPHULARIACEAE	Jamesbrittenia sp.	Plants
SCROPHULARIACEAE	Peliostomum leucorrhizum	Plants
SCROPHULARIACEAE	Selago mixta	Plants
SCROPHULARIACEAE	Aptosimum albomarginatum	Plants
SCROPHULARIACEAE	Aptosimum marlothii	Plants
SCROPHULARIACEAE	Jamesbrittenia atropurpurea subsp. pubescens	Plants
SCROPHULARIACEAE	Peliostomum origanoides	Plants
SCROPHULARIACEAE	Selago divaricata	Plants
SCROPHULARIACEAE	Selago welwitschii var. australis	Plants
SCROPHULARIACEAE	Aptosimum elongatum	Plants
SCROPHULARIACEAE	Aptosimum spinescens	Plants
SCROPHULARIACEAE	Aptosimum lineare var. lineare	Plants
SCROPHULARIACEAE	Jamesbrittenia atropurpurea subsp. atropurpurea	Plants
SCROPHULARIACEAE	Sutera griquensis	Plants
SOLANACEAE	Lycium cinereum	Plants
SOLANACEAE	Lycium hirsutum	Plants
SOLANACEAE	Withania somnifera	Plants
SOLANACEAE	Lycium pumilum	Plants
SOLANACEAE	Solanum burchellii	Plants
SOLANACEAE	Solanum lichtensteinii	Plants
SOLANACEAE	Solanum panduriforme	Plants
SOLANACEAE	Solanum supinum var. supinum	Plants

SOLANACEAE	Solanum tomentosum var. tomentosum	Plants
TAMARICACEAE	Tamarix parviflora	Plants
THYMELAEACEAE	Gnidia kraussiana var. kraussiana	Plants
THYMELAEACEAE	Gnidia polycephala	Plants
URTICACEAE	Laportea peduncularis subsp. peduncularis	Plants
VAHLIACEAE	Vahlia capensis subsp. vulgaris var. linearis	Plants
VAHLIACEAE	Vahlia capensis subsp. vulgaris var. vulgaris	Plants
VERBENACEAE	Chascanum pinnatifidum var. pinnatifidum	Plants
VERBENACEAE	Lantana rugosa	Plants
VERBENACEAE	Chascanum adenostachyum	Plants
VERBENACEAE	Chascanum hederaceum var. hederaceum	Plants
VERBENACEAE	Chascanum schlechteri	Plants
VISCACEAE	Viscum rotundifolium	Plants
ZYGOPHYLLACEAE	Tribulus terrestris	Plants
ZYGOPHYLLACEAE	Zygophyllum flexuosum	Plants
ZYGOPHYLLACEAE	Zygophyllum incrustatum	Plants
ZYGOPHYLLACEAE	Tribulus zeyheri subsp. zeyheri	Plants
ZYGOPHYLLACEAE	Zygophyllum leptopetalum	Plants
ZYGOPHYLLACEAE	Tribulus excrucians	Plants
ZYGOPHYLLACEAE	Zygophyllum pubescens	Plants

FamilyName	SpeciesName	Category
Agamidae	Agama atra	Lizards
Agamidae	Agama aculeata	Lizards
Apidae	Amegilla niveata	Animals
Apidae	Allodapula sp.	Animals
Apidae	Chalicodoma sp	Animals
Apidae	Heriades sp	Animals
Apidae	Meliturgula sp.	Animals
Apidae	Nomia sp	Animals
Apidae	Nomioides sp	Animals
Apidae	Pasites appletoni	Animals
Apidae	Unknown	Animals
Chrysopidae	Italochrysa gigantia	Animals
Colletidae	Colletes capensis	Animals
Colletidae	Colletes fascicularis	Animals
Hesperiidae	Kedestes lepenula	Animals
HESPERIIDAE	Spialia secessus	Animals
Lacertidae	Heliobolus lugubris	Animals
Lacertidae	Pedioplanis lineoocellata	Animals
Lycaenidae	Aloeides damarensis damarensis	Animals
Lycaenidae	Aloeides molomo molomo	Animals
Lycaenidae	Cigaritis ella	Animals
Lycaenidae	Crudaria leroma	Animals
Lycaenidae	Tylopaedia sardonyx peringueyi	Animals
LYCAENIDAE	Aloeides damarensis subsp. mashona	Animals
LYCAENIDAE	Aloeides molomo subsp. krooni	Animals
LYCAENIDAE	Stugeta bowkeri subsp. bowkeri	Animals
Nemopteridae	Nemopterinae	Animals
NYMPHALIDAE	Acraea stenobea	Animals
NYMPHALIDAE	Vanessa cardui	Animals
Pieridae	Belenois aurota aurota	Animals
Pieridae	Colotis agoye bowkeri	Animals
Scarabaeidae	Pachycnema crassipes	Animals
Scincidae	Mabuya spilogaster	Animals
Scincidae	Mabuya variegata	Animals
Testudinidae	Psammobates oculiferus	Animals

APPENDIX B

OTHER