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Established in 1952

MAINSTREAM RENEWABLE POWER SOUTH AFRICA
A joint venture with Genesis Eco-Energy

STORMWATER MANAGEMENT PLAN

for the

PROPOSED LOERIESFONTEIN PHOTOVOLTAIC (PV) & WIND ENERGY FARM

REPORT N°: 2012/11421/LP Rev 0
April 2012

SiVEST

Document Control

- Project: Stormwater Management Plan for the Loeriesfontein Photovoltaic and Wind Energy Farm
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Checked By:	Richard Hirst	13th April 2012		
Revised By:			**B**	
Checked By:				

LOERIESFONTEIN

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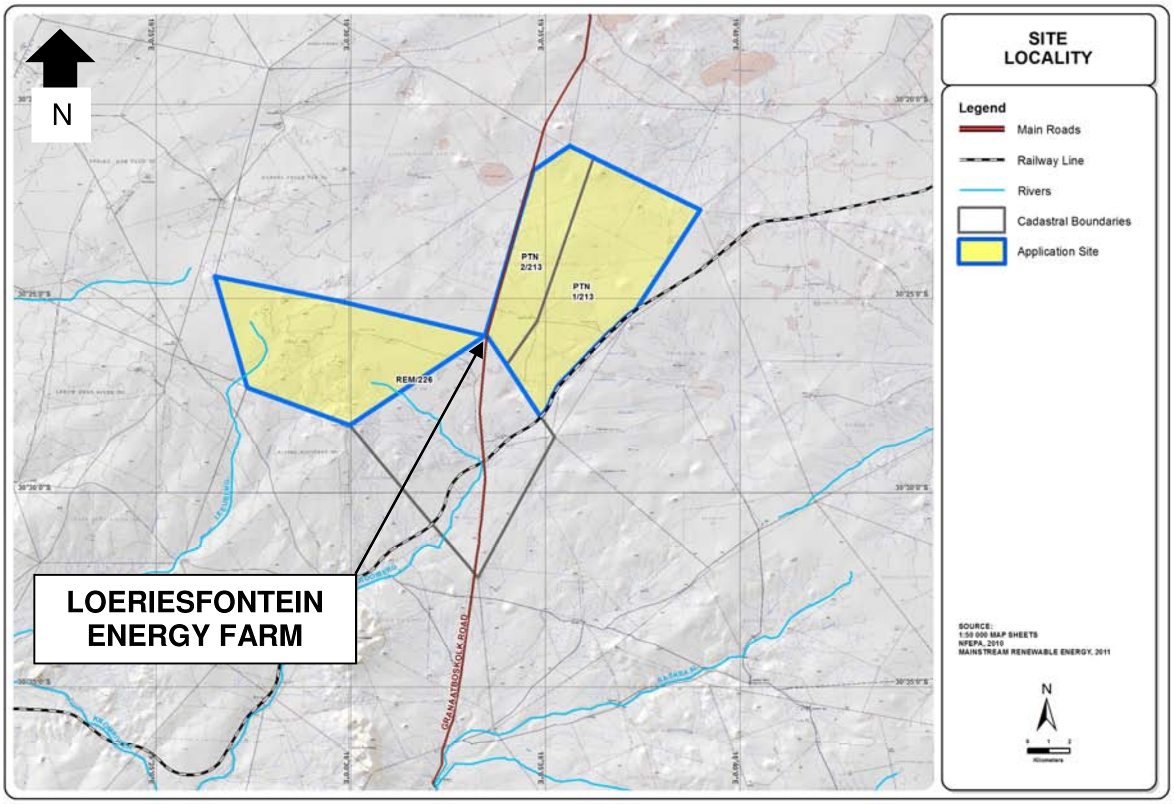
1 Locality Plan



2 Introduction

SiVEST SA (Pty) Ltd was appointed by Mainstream Renewable Power to carry out a desk top study of the surface hydrology on a proposed site for the purposes of establishing a new Photovoltaic (PV) and Wind Energy Farm.

The proposed site is situated on the Remeiander of the Farm Sous 226 and Portion 1 & 2 of the Farm Aan De Karree Doorn Pan 213, in the Northern Cape Province of South Africa, near the town of Loeriesfontein. The sites are bound to the east by the farms; Stoot Vley 188, Bitter K'mas 209 & Brak Pan 212, to the north by the farms; Bitter Puts 187, Buchu Fontein 184 & Karee Doorn Pan 214 and west by the farm; Spring-Bok Tand 215 & Leeuw Berg River 225 and to the south by the farm Kleine Rooiberg 227 and the remainder of Sous 226.

The area of the farms covers a total area of ±15 526.83 ha and it is the intention to utilize ± 6 988.94 ha of the site; the proposed PV component utilizing ±655.12 ha and the proposed wind component utilizing ±6 333.82 ha respectively.

This report therefore serves to outline the related surface, stormwater issues on the proposed site for the purposes of inclusion in the Environmental Management Assessment (EIA) submission.

3 Developer/Client & Consulting Engineer's Details

Client Details

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Consulting Engineers Details for the SURFACE STORMWATER MANAGEMENT

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4 Geotechnical Information

At the time of completion of this report, the soils investigation had not been completed. Therefore, for the purposes of this report, we used the *'SiVEST Draft Soil and Agricultural Assessment Report'* dated 20th February 2012, extracts from this report are included in the appendices to follow. It should however be noted that once the Soil Investigation Report has been completed for this site, we then recommend that the stormwater management report be reviewed to formulate a comprehensive management report.

In summary the proposed site is typically underlain with the following strata levels;-

A - Horizon	-	Topsoil Shallow - Light Brown Calcareous (10-20cm)
B - Horizon	-	Hardpan Carbonate / Neocarbonate

Refer Appendix 'A' – Draft Soil and Agricultural Assessment Report, 20th Feb 2012

5 Stormwater

5.1 Introduction

The proposed site is located on two separate farms, namely 'Sous' and the other 'Aan De Karree Doom Pan'. For the farm 'Sous', a ridge line divides the farm into two drainage areas, the northern area which drains towards the north east and the southern area which drains towards the south west. The remaining farm, 'Aan De Karree Doom Pan' is also divided into two separate catchment areas, namely; the eastern and western catchment. The eastern catchment drains towards the south east and the western catchment drains towards the north west.

The slope on the entire site varies between ±0.5% and ±5.9% with the location of the PV plant located in the area where the slope is between ±0.6% and ±1.3%.

From the information provided it is not clear as to the extent of any possible 1:100 year flood inundation areas. However, these areas appear to exist and are evident on the proposed site. Further studies in this regard will need to be carried out to determine the extent of these affected areas.

5.2 Plant Drainage

Wind Turbines

The 'Final Scoping Report' under Section 1.2 – Technical Description[1], makes reference to a number of individual Wind Turbines constructed in a typical manner across the site. The wind turbine consists of a mast fixed onto a concrete base slab with the turbine and propellers fixed onto the mast. Surrounding the mast will be a gravel "hard standing" surface which will be used as a laydown area.[2]

[1] SiVEST Final Scoping Report *(21st November 2011) – 'Section 2.1'* Technical Description
[2] SiVEST Final Scoping Report *(21st November 2011) – 'Section 2.1'* Technical Description

It is our opinion that the gravel laydown area surrounding the turbine mast should be sloped at a minimum of 2% to allow surface stormwater run-off to migrate off the laydown area. Located at the toe and adjacent to the laydown area, it is proposed to construct a suitably sized swale that is shaped and grass lined, so as to direct the stormwater run-off into a detention pond. The detention pond should be suitably sized to reduce the velocities of the concentrated stormwater and ultimately to deposit any transported eroded sediments, thus controlling / minimizing erosion.

Natural stormwater run-off emanating of the higher lying ground above the wind turbines laying down area should be directed, with the help of grass lined swales, away from the laying down area into the same detention ponds as stated above. This will reduce stormwater build up flowing and across the laydown area.

Photovoltaic (PV) Plant

The PV Plant includes *inter alia* that the natural vegetation of the site should remain and that only the large trees/shrubs should be removed. Furthermore, that the PV panels will be mounted on a central pivot structure, above the natural vegetation and therefore no bulk earthworks will be required.

As no bulk earthworks will be required, we believe that minimal stormwater measures will be required. Furthermore, the Mean Annual Precipitation (MAP) for this site north of the Loeriesfontein area is ±77mm/year[3] which further substantiates the minimal need for stormwater management with natural vegetation intact.

The proposed stormwater measures for the PV Plant includes the draining of each drainage area by means of suitably sized grass lined earth channels positioned within the proposed road reserves. The earth channels will gravitate towards the identified detention areas, where stormwater will be attenuated in order to deposit any transported sediments and reduce the flow velocities.

5.3 Road Drainage

As indicated in the Final Scoping Report[4] surrounding road positions and road types, we have assumed that the bulk of the distribution roads and the main access road to the site will be gravel roads.

To assist with the stormwater run-off, these gravel roads should typically be graded and shaped with a 2% crossfall back into the slope, allowing stormwater to be channelled in a controlled manor towards the, natural drainage lines and to assist with any sheet flow on the site.

Where any proposed roads, intersect the natural, defined drainage lines, it is suggested that either suitably sized pipe culverts or drive through causeways are installed / constructed and should take into account the hydrology criteria for a selected major storm as outlined in section 5.6 below.

Refer Appendix 'B' – 'Study Area' (Dwg No 11421/320)
Refer Appendix 'B' – 'Proposed Site Layout' (Dwg No 11421/321)

[3] Design Rainfall and Flood Estimation in South Africa by JC Smithers & RE Schulze
[4] SiVEST Final Scoping Report *(21st November 2011)* – '*Section 2.1'* Technical Description

Refer Appendix 'B' – 'Pre Development Area' (Dwg No 11421/322)
Refer Appendix 'B' – 'Pre Development Area' (Dwg No 11421/323)
Refer Appendix 'B' – 'Typical Stormwater Details' (Dwg No 11421/324)

5.4 Minor Storm

The minor storm design period should be used, to determine the size of the earth channels. A return period of 1:5 years is applicable which approximates to an average intensity of 17 mm/hour[5].

5.5 Major Storm

The major storm occurrence i.e. 1:25 year, 1:50 & 1:100 year return should be used to calculate culverts in defined drainage lines and to determine flood levels where necessary. Intensities for each occurrence are as follows; 1:25 year – 24.6 mm/hour, 1:50 year – 28.7 mm/hour and 1:100 year – 32.6 mm/hour[6] respectively.

Refer Appendix 'C' – 'Design Rainfall and Flood Estimation in South Africa by JC Smithers & RE Schulze'

6 Conclusion / Recommendation

It should be noted that an indicative site layout and wind turbine description has been used as described in the 'Final Scoping Report'[7]. Further, re-evaluation of this proposal would be required to ensure alignment with the environmental scoping criteria in the event the site layout and details have been finalised.

Furthermore, it should be noted that a detailed 1:100 Year Floodline Analysis will be required prior to the final detailed design being completed.

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[5] Design Rainfall and Flood Estimation in South Africa by JC Smithers & RE Schulze
[6] Design Rainfall and Flood Estimation in South Africa by JC Smithers & RE Schulze
[7] SiVEST Final Scoping Report *(21st November 2011)* – '*Section 2.1'* Technical Description

APPENDIX 'A'

MAINSTREAM RENEWABLE POWER

Proposed Wind and Photovoltaic Energy Facilities Near Loeriesfontein, Northern Cape

Draft Soil and Agricultural Assessment Report

Issue Date: 20th February 2012
Revision No.: 2.0
Project No.: 10777

Date:	20th February 2012
Document Title:	Proposed Wind and Photovoltaic Energy Facilities Loeriesfontein: Draft Soil and Agricultural Assessment Report
Author:	Kurt Barichievy (*Pr.Sci.Nat.*)
Revision Number:	# 2.0
Checked by:	Kelly Tucker
Approved:	Kurt Barichievy (*Pr.Sci.Nat.*)
Signature:	
For:	SiVEST Civil Engineering and Environmental Divisions
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Declaration

I, Kurt Barichievy, declare that I –

- act as an independent specialist consultant in the field of Soil Science and Agricultural Potential for the **soil and agricultural assessment report for the proposed Wind Energy and Photovoltaic Facilities Near Loeriesfontein, Northern Cape Province**;
- do not have and will not have any financial interest in the undertaking of the activity, other than remuneration for work performed in terms of the Environmental Impact Assessment Regulations, 2006;
- have and will not have any vested interest in the proposed activity proceeding;
- have no, and will not engage in, conflicting interests in the undertaking of the activity;
- undertake to disclose, to the competent authority, any material information that have or may have the potential to influence the decision of the competent authority or the objectivity of any report, plan or document required in terms of the Environmental Impact Assessment Regulations, 2006; and
- will provide the competent authority with access to all information at our disposal regarding the application, whether such information is favourable to the applicant or not.

Mr. K. R. Barichievy *Pr.Sci.Nat*
Scientist
SiVEST Civil Engineering Division

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1. INTRODUCTION AND TERMS OF REFERENCE

Mainstream Renewable Power (Pty) Ltd (MRP) requested a baseline assessment of the soil, land use and agricultural characteristics for the area affected by a proposed Wind and Solar Photovoltaic (PV) Energy Facility, near Loeriesfontein in the Northern Cape Province of South Africa.

The primary objective of this assessment is to provide specialist soil and agricultural input into the overarching Environmental Impact Assessment (EIA) Report. In order to achieve this objective a study of the climate, soils, terrain, land capability, geology, current agricultural practices and agricultural potential was carried out. This report serves to summarise such a study and present the relevant results, as well as outline the predicted impacts of the proposed activities on local soil and agricultural resources.

The project is proposed on the following 3 farm portions which are approximately 49 km north of Loeriesfontein:

- Remainder of the Farm Sous No. 226, Calvinia Road, Northern Cape
- Portion 1 of the Farm Aan De Karree Doorn Pan No. 213, Calvinia Road, Northern Cape
- Portion 2 of the Aan De Karree Doorn Pan Farm No. 213, Calvinia Road, Northern Cape

MRP proposes to construct wind and solar facilities using a phased approach.

Phase 1: Construction of a 50 MW wind energy facility.

Phase 2: Construction of a 420 MW wind energy facility connecting to Eskom's 400kV Helios Substation.

Phase 3: Construction of a 100 MW PV Solar facility and associated infrastructure.

It is hoped that this assessment, along with the other specialist studies, will inform infrastructural positioning and minimise the predicted potential impacts on the receiving environment.

1.1 Brief Description of the Project and Study Area

The purpose of this section is to provide basic site information for later reference. Please note that a more detailed description of the site's characteristics is provided in **Sections 3 through 6** of this report.

The Northern Cape Province is considered to be one of the most suitable regions for the establishment of wind farms and PV facilities. Accordingly, land portions located outside of Loeriesfontein have been identified as a potential site. The proposed site is located on the farms Sous and Aan De Karree Doorn Pan, approximately 49km north of Loeriesfontein. The site near Loeriesfontein falls within the boundaries of the Hantam Local Municipality. The site is approximately 10 157 ha in size of which a smaller area will be required for the establishment of the proposed wind and solar facility. The study area is considered to be fairly natural Karoo shrubland with low intensity sheep grazing on the site.. As such the human footprint in most of the area is considered to be relatively low. Vast grazing land is interspersed with seasonal pans and non-perennial streams. The non-perennial streams are located to the southwest of the site. The southern end of the study area contains the existing Helios substation which will be the link between the proposed development and the national electricity grid (**SiVEST, 2011**).

Although limited, the access roads which exist are in a reasonable condition. Water is the major limiting factor to local agricultural enterprises and the assessed area contains no perennial rivers and nor does the project area border a perennial river.

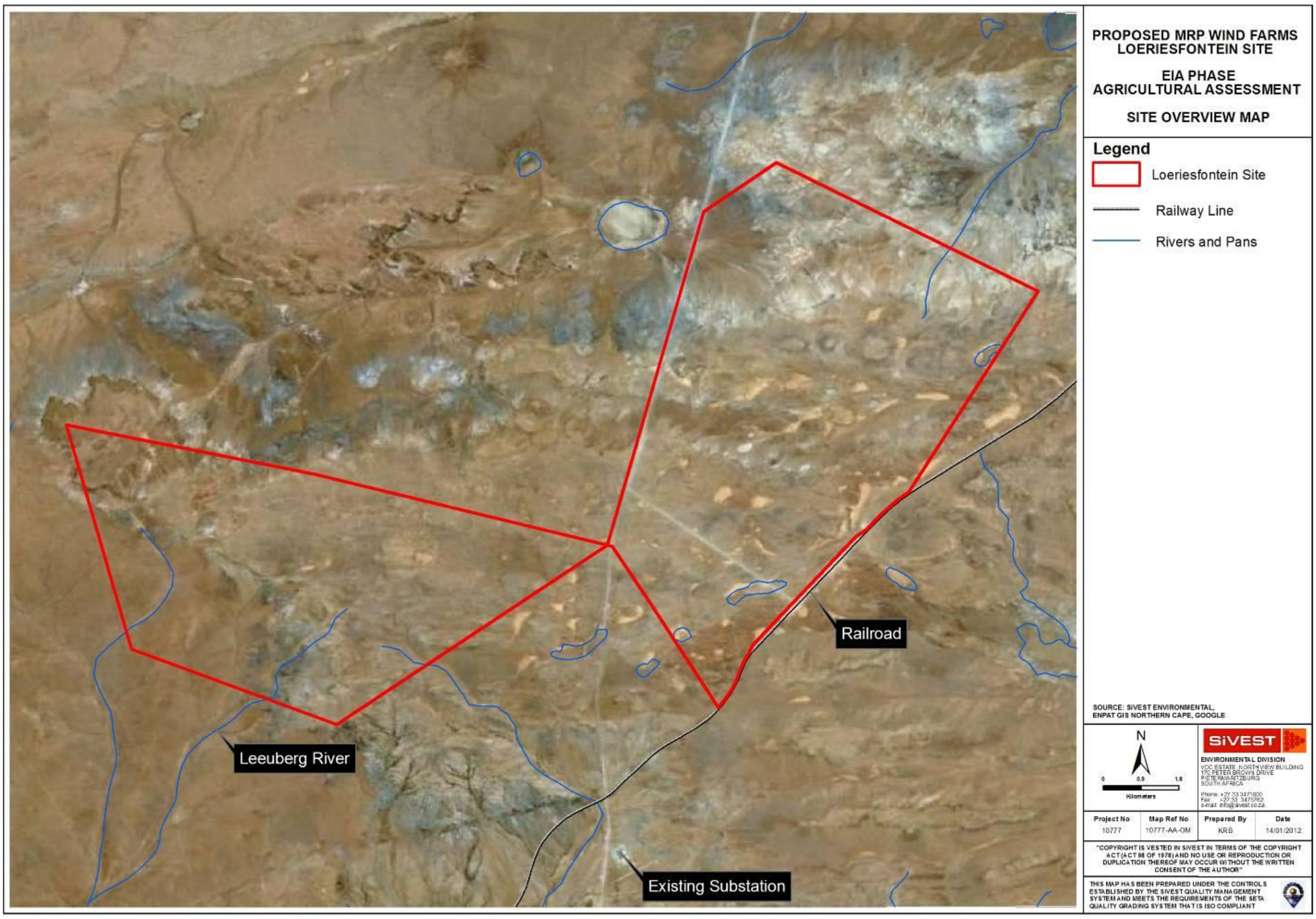

Figure 1: Site overview map

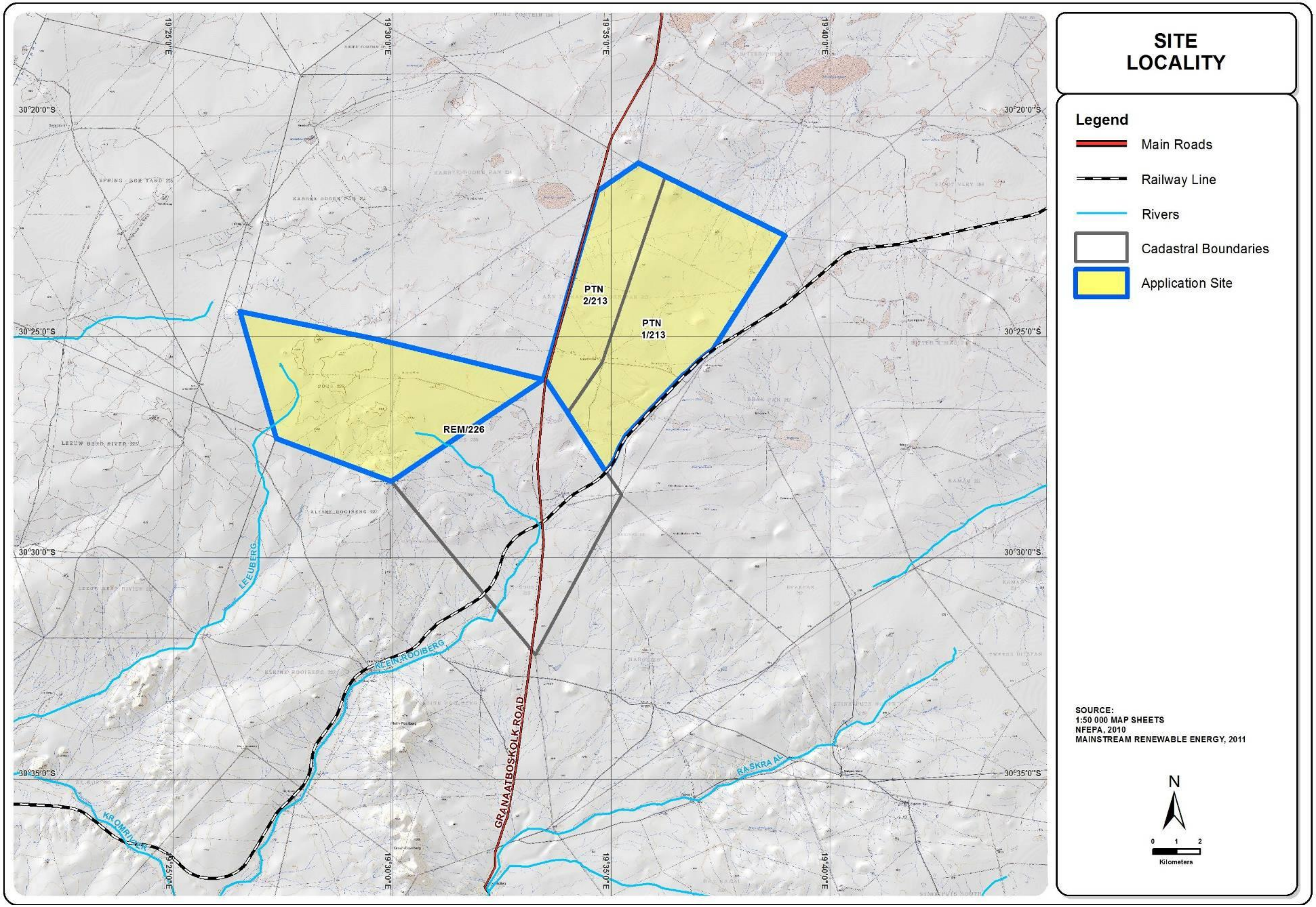

Figure 2: Site Locality Map (**MRP, 2011**)

1.2 Description of Proposed Activities and Technical Details

The technical details provided in this Section are primarily extracted from the Loeriesfontein Final Scoping Report produced by **SiVEST** (**2011**).

The proposed development includes the construction of a wind and solar energy facility.

1.2.1 Wind Energy Facility

The wind energy facility includes the phased construction of approximately 168 wind turbines, connecting transmission lines and the construction of service roads to link the various turbines. Twenty (20) turbines will be erected in Phase 1 while one hundred and forty eight (148) are prposed in Phase 2 of the project. Each turbine is rated at between 1 and 3 MW. It is proposed that the wind turbines will produce around 450 MW. A wind turbine is a rotary device that extracts energy from the wind. The size of the wind turbines will depend on the developable area and the total generation capacity that can be produced as a result. The wind turbines will therefore have a hub height of between 80 to 120m and a rotor diameter of 87 to 120m. The blade rotation direction will depend on wind measurement information received later in the process. The rotation will range from 6 to 20 rpm. The foundation of each wind turbine will be approximately 20m x 20m.

The footprint for each wind turbine will therefore be approximately $400m^2$. A hard standing area of approximately 2 $400m^2$ for crane usage will accompany each wind turbine. Hence, the total footprint for each wind turbine and the associated hard standing area will be 2 $800m^2$. The foundation will be up to 2.5m deep. As already mentioned, it is anticipated at this stage that 180 wind turbines will be constructed. The total area for all the wind turbines for the Loeriesfontein study site will therefore be approximately 546 $800m^2$ (including the hard standing areas) (**SiVEST, 2011**).

1.2.2 Solar Energy Facility

A 100 MW solar energy, covering between 212 and 406 ha is also proposed for the Loeriesfontein site. The proposed solar energy facility will be a Photovoltaic (PV) Plant consisting of a number of panel arrays. The panel arrays are approximately 15m x 4m in area. These are mounted into metal frames which are usually aluminum. Concrete or screw pile foundations are used to support the panel arrays. The arrays are either fixed on a tracking system or tilted at a fixed angle equivalent to the latitude at which the site is located in order to capture the most sun**.** Arrays usually reach up to between 5m and 10m above ground level.

The PV arrays are typically connected to each other in strings and the strings connected to DC to AC inverters. The DC to AC inverters may be mounted on the back of the panels support substructures / frames or alternatively in a central inverter station. The strings are connected to the inverters by low voltage DC cables. Power from the inverters is collected in medium voltage transformers through AC cables. Cables may be buried or pole mounted depending on voltage level and site conditions. The medium voltage transformers can be compact transformers distributed throughout the solar field or alternatively located in a central sub-station. It is likely to be a central substation in this instance (**SiVEST, 2011**).

2. METHODOLOGY

The following methodology was followed in order to ascertain the *status quo* of soil and agricultural resources within the study area. Further, outline the predicted impacts resulting from the proposed development and activities in the Proposed Development Area (PDA).

2.1 Desktop Study

A detailed desktop assessment was undertaken for the project area. The objective of this study is to broadly evaluate the soil and land use of the site and receiving environment by interrogating relevant climate, topographic, landuse and soil datasets. By utilising these data resources one is able to broadly assess the current soil, agricultural and land use characteristics and provide a basis for a more detailed and spatially relevant assessment.

2.2 Soil Survey

A detailed soil survey was conducted for both the three farm portions. At each sample point a hand auger was used to identify and describe the diagnostic horizons to form and family level according to "Soil Classification - A Taxonomic System for South Africa" as well as noting relevant soil characteristics such as depth, texture and limiting layers. At each auger point the relevant soil and land use data was recorded and the location of the auger point captured using a handheld GPS. This information was combined to produce detailed soil polygon maps for the project area.

2.4 Agricultural Potential Assessment

In terms of this study, agricultural potential is described as an area's suitability and capacity to sustainably accommodate an agricultural land use. The soil information gained from the survey along with the land use assessment is combined with climate, water resource, crop information and topographic data in order to provide a spatial classification of the land based on its agricultural potential. A study of local agricultural practises was also carried out.

2.5 Impact Assessment

The impact assessment utilises the findings of the soil survey and agricultural potential assessment in order to determine reference conditions of the soil and agricultural resources. Potential soil and agricultural impacts, as a result of the proposed activities, are described in this section and any major impacts/fatal flaws will be identified for consideration by the pertinent authorities.

3. DESKTOP AGRICULTURAL POTENTIAL ASSESSMENT

The objective of the desktop component of this assessment is to provide broad soil and agriculturally related characteristics of the project area. It should be clearly noted that, since the spatial information used to drive this portion of the assessment is of a reconnaissance nature, only large scale climate, land use and soil details are provided. More detailed and site specific information for the study area are provided in subsequent Sections of this report (**Sections 4, 5 and 6**).

In order to ascertain the broad soil and agricultural potential characteristics of the project area relevant climate, topographic, landuse and soil datasets were sourced and interrogated.

Existing high level GIS data was sourced from National GIS Datasets as well as the Environmental Potential Atlas for South Africa (ENPAT) Database for the Western Cape Province of South Africa, compiled by the Department of Environmental Affairs and Tourism (**DEAT, 2001**).

The main purpose of ENPAT is to proactively indicate potential conflicts between development plans and critical, endangered or sensitive environments. By combining the aforementioned data resources, one is able to broadly assess the site, receiving environment, and its ability to accept change, in the form of development. More agriculturally relevant spatial information was obtained from the AGIS Database.

3.1 Climate

The study area has an arid Mediterranean type climate with winter rainfall regime i.e. most of the rainfall is confined to early autumn and winter. Mean Annual Precipitation (MAP) is approximately 179 mm per year. An MAP of 179 mm is deemed as extremely low remembering that 500 mm is considered the minimum amount of rain required for sustainable dry land farming (**Figure 3** and **Table 1**). Thus without some form of supplementary irrigation natural rainfall for the study area is insufficient to produce sustainable harvests. This is reflected in the lack of dry land crop production within the study area

Average daily temperatures range from 30 ^{o}C in summer to 17 ^{o}C in winter. Average night time temperatures drop to around 2.4 ^{o}C during winter (**Table 2**). Evaporation is estimated to be in the region of 2400 mm per annum and thus the area is subjected to very severe moisture availability restrictions (**AGIS, 2012**).

In summary the climate for the study area is severely restrictive to arable agriculture which is primarily due to the lack of rainfall and high moisture availability restrictions.

Table 1: Mean monthly rainfall for Loeriesfontein (**Source: South Africa's Rain Atlas)**

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Avg
Rainfall (mm)	8.7	11.3	17	20.8	23.3	21.1	18.3	14.3	11.1	9	7	7	14.1

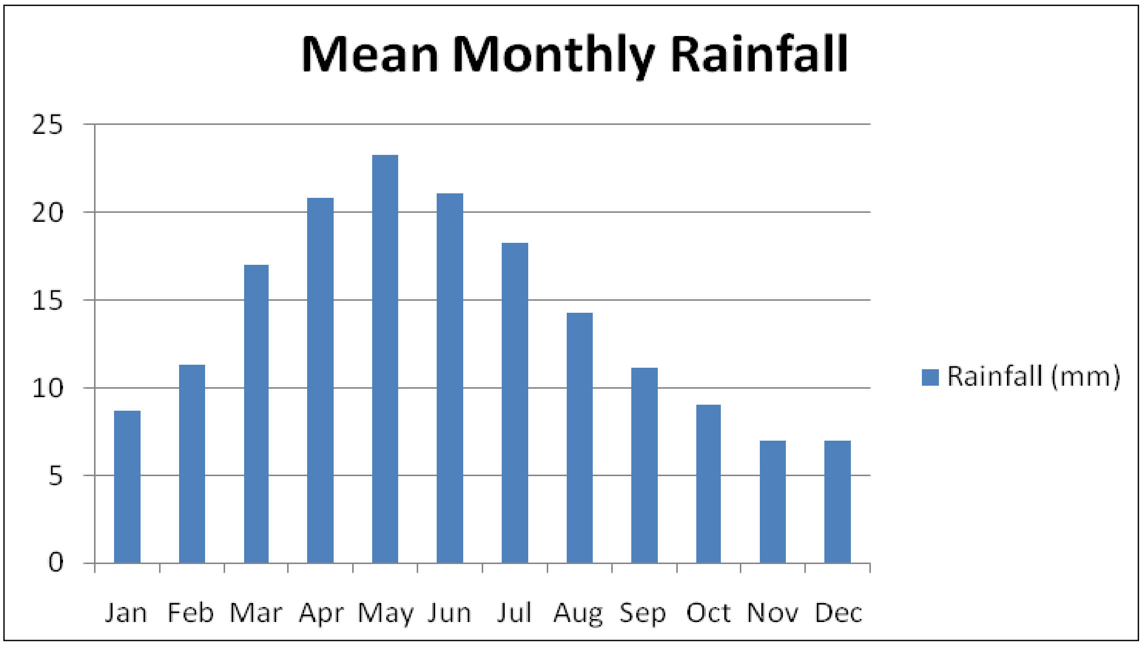

Figure 3: Mean monthly rainfall graph for Loeriesfontein

Table 2: Mean monthly and annual temperature for Loeriesfontein
(Source: http://www.saexplorer.co.za)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Avg
Midday Temp (°C)	21	32	29	25	21	17	17	19	22	25	28	30	24
Night Temp (°C)	31	14	13	9	6	4	2	3	5	8	10	12	8

3.2 Geology

Virtually the entire study area is underlain by a Shale geologic material (**Figure 4**). Shale is a clastic sedimentary rock and is formed by the settling and accumulation of clay rich minerals and other sediments. Due to the settling process this parent material usually takes the form parallel rock layers which lithifies over time. Non-descript sedimentary geologic materials are located along the western border of the study area derived from pre-existing rock and sediments.

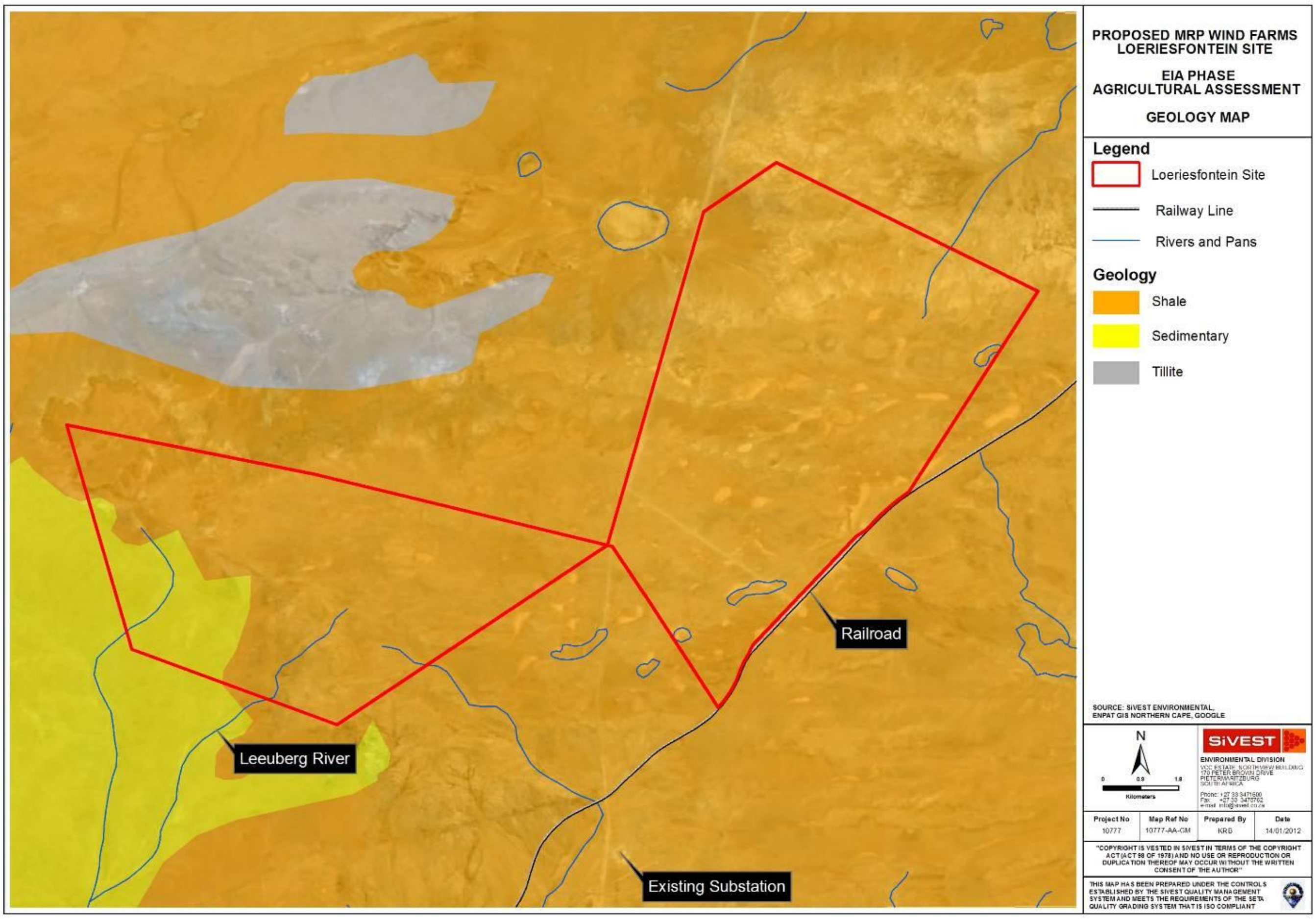

Figure 4: Geological map

3.3 Terrain

Slope or terrain is used to describe the lie of the land. Terrain influences climate and soils characteristics and thus plays a dominant role in determining whether land is suitable for agriculture. In most cases sloping land is more difficult to cultivate and usually less productive than flatland, and is subject to higher rates of water runoff and soil erosion (**FAO, 2007**).

The study area is characterised by flat and gently sloping topography with an average gradient of less than 5% (**Figure 5**).The flat topography also makes this area ideal for the proposed development.

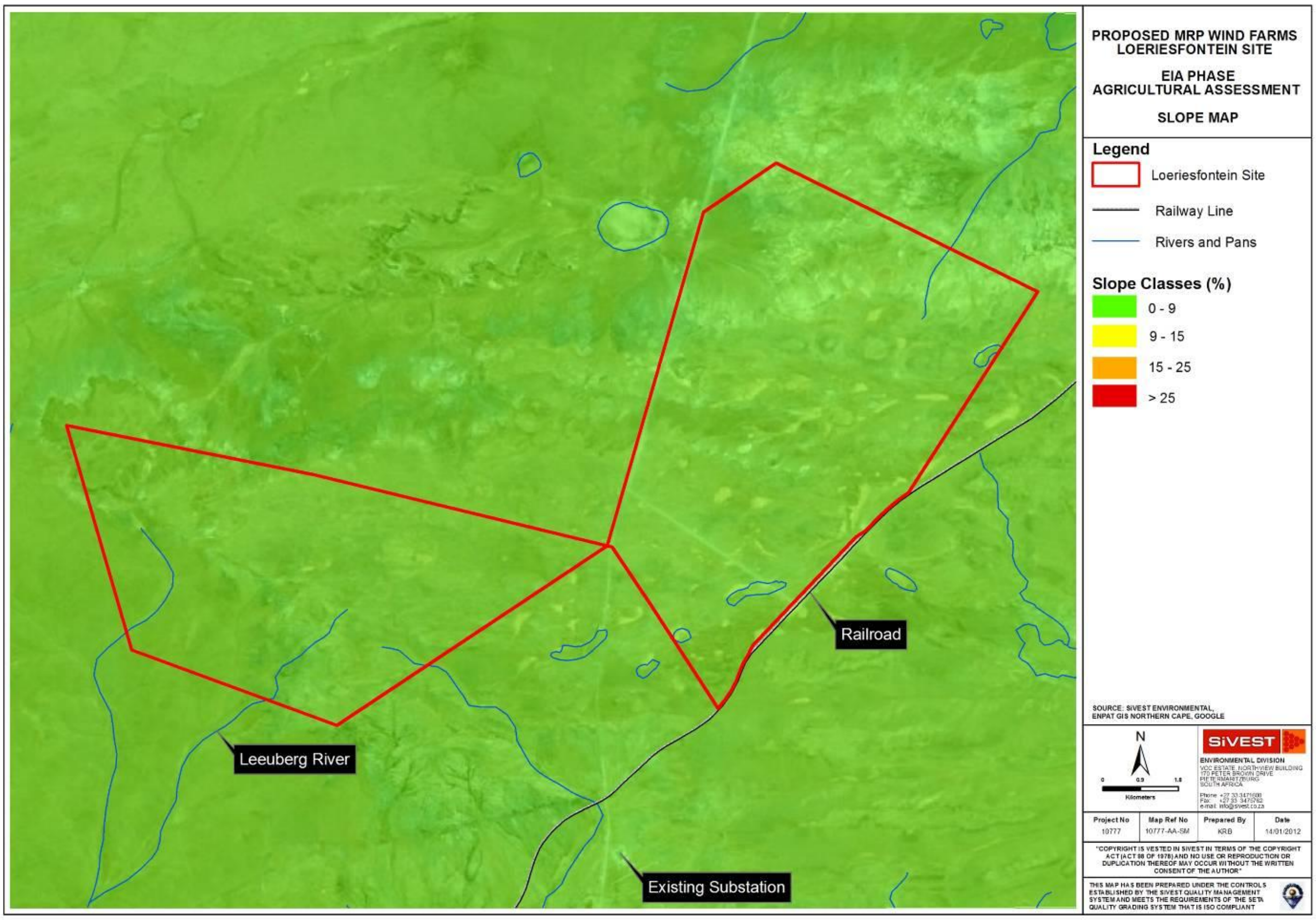

Figure 5: Slope Analysis of the study area

3.4 Land Cover

The study area is classified as natural / vacant and is used as general grazing land for sheep and wildlife (**Figure 6**). Vast grazing land is interspersed with seasonal pans and non-perennial streams. The southern end of the study area contains an existing substation which will be the link between the proposed development and the national electricity grid. Stocking rate for the area is approximately at a low stocking rate of around 1 SSM (small stock unit) per 10 hectares.

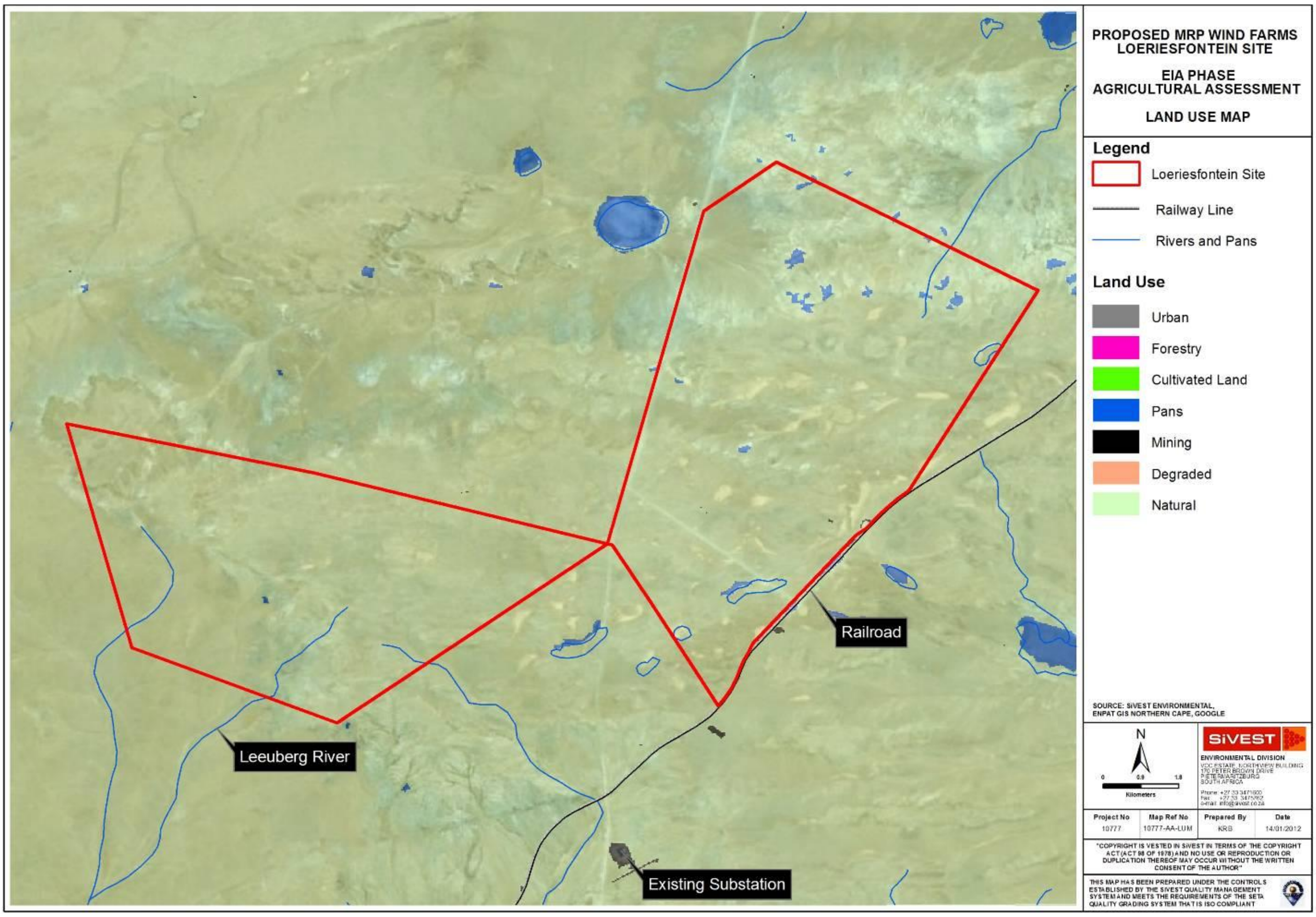

Figure 6: Land Cover Map

3.5 Soil Characteristics

According to the ENPAT database the site is dominated by mix of Glenrosa and Mispah soil forms (**Figure 7**). These soils develop where bands of weathering rock are found close to the soil surface. Glenrosa and Mispah soils generally have an inherently low agricultural potential due to a distinct lack of rooting depth (<0.45 m) (**Figure 8**) and also exhibit moderately high soil erosion hazard ratings; thus soil conservation practices such as minimum tillage and trash blankets should be employed.

A mix of red and yellow apedal soil forms are found near the western border of the site are also associated with a shallow effective soil depth of less than 0.45 m.

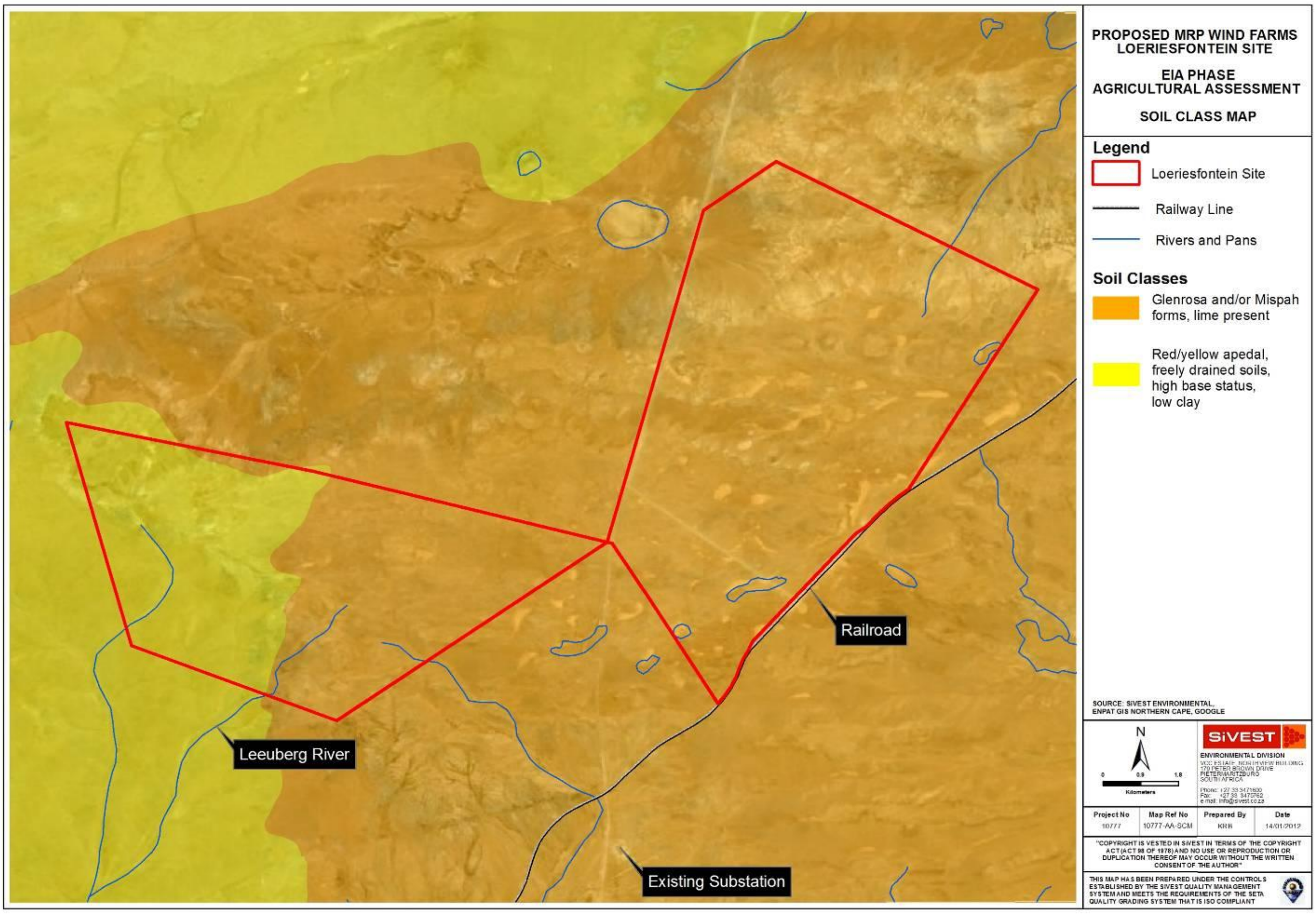

Figure 7: Broad soil type map

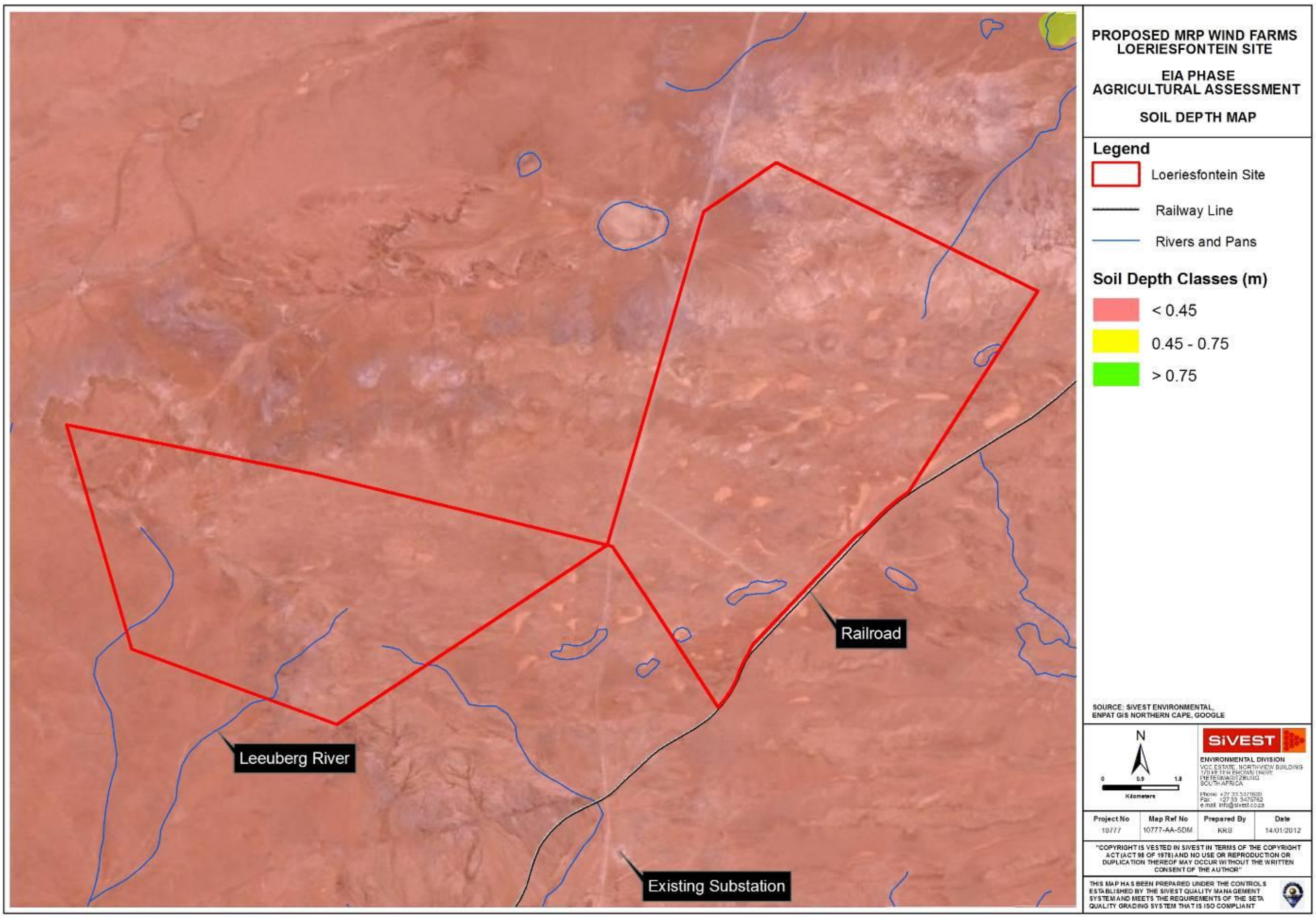

Figure 8: Soil depth map

The ENPAT Database also provides an overview of the study area's agricultural potential based on its soil characteristics, it should be noted this spatial dataset does not take *prevailing climate into account*. Restrictive climate characteristics, due to heat and moisture stress will further reduce the agricultural potential of the area under assessment. The study area is dominated by soils which are not suited for arable agriculture (**Figure 9**) but which can still used as grazing land.

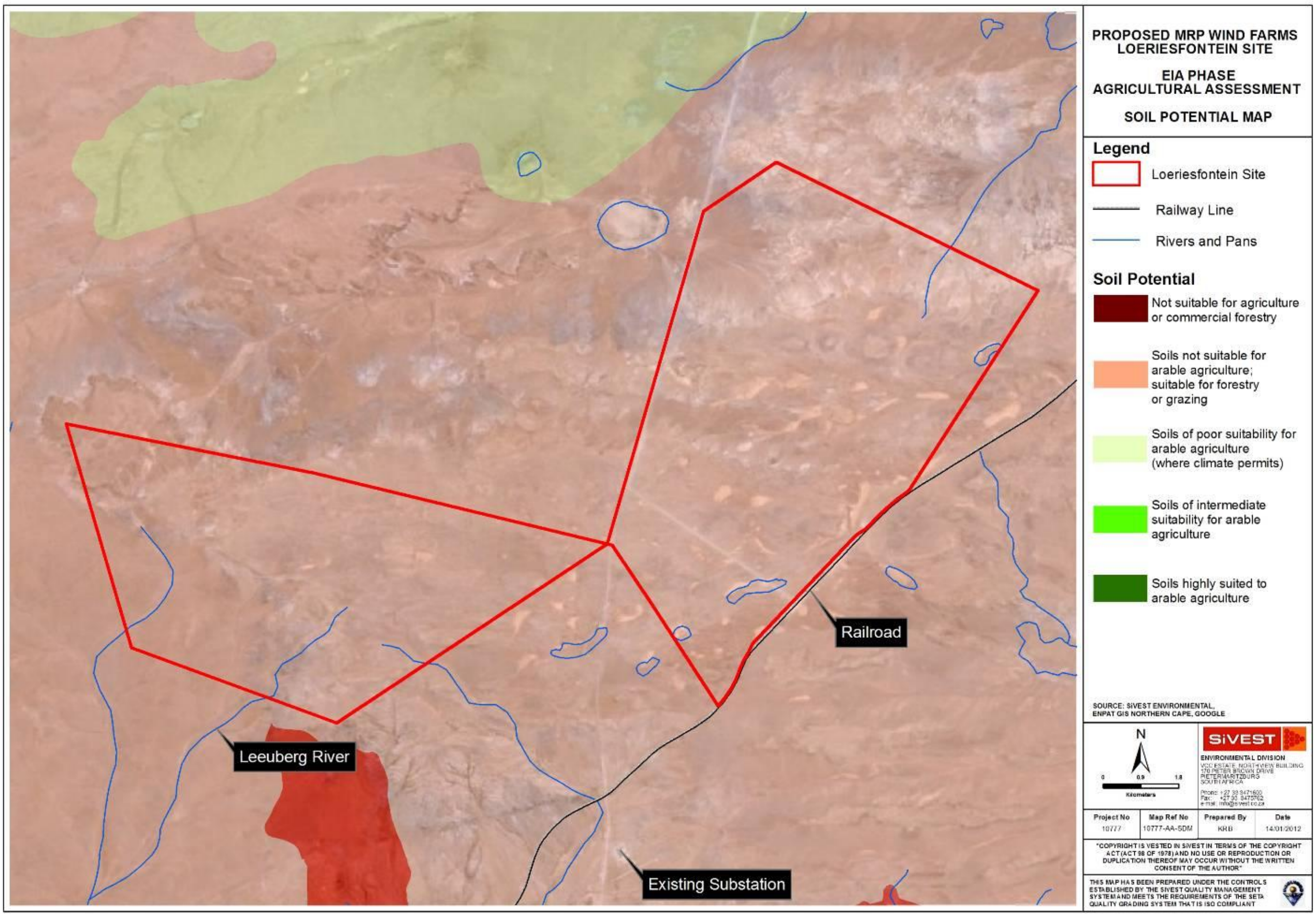

Figure 9: Soil Potential Map

3.6 Desktop Agricultural Assessment: Results Summary

By taking all the site characteristics (climate, geology, land use, slope and soils) into account the agricultural potential for the majority of the study area is classified as being extremely low for crop production while moderately low for grazing. This poor agricultural potential rating is primarily due to restrictive climatic characteristics and soil depth limitations. The site is not classified as high potential nor is it a unique dry land agricultural resource.

4. SOIL SURVEY AND FIELD VERIFICATION

Due to the size of the site (10 157 ha) local agricultural activities (unimproved grazing land) and the nature of the proposed activities, an exploratory soil survey was performed. At each survey point the soil was described to form and family level according to "Soil Classification - A Taxonomic System for South Africa" (**Soil Classification Working Group, 1991**) and the following properties were noted:

- Estimation of 'A' horizon clay content,
- Permeability of upper B horizon,
- Effective rooting depth,
- Signs of wetness,
- Surface rockiness,
- Surface crusting,
- Vegetation cover, and
- Detailed description of the particular area such as slope.

4.1 Soil Descriptions

This Section lists the **major soil forms** encountered during the soil survey along with a site-specific description of each soil form. Other soils encountered during the field verification, which were recorded very sparsely across the site and therefore not fully described include:

- **Brandvlei**
- **Augrabies**

4.1.1 Mispah Form

Soil Family: Mostly 1200 (Non bleached, Calcareous), limited bleached and/or non-calcareous
Diagnostic Horizons and Materials:
A-Horizon: Orthic
B-Horizon: Hard Rock

Site Specific Description:
The Mispah soil form falls within the lithic soil group. Lithic soils are associated with shallow soils where parent rock is found close to the soil surface. The A-horizon varied from brown to ivory in colour and was generally 10-20 cm deep, directly overlying various hard rock materials (**Figure 10**). The Mispah soil form dominates large areas of the study area and surface rocks are common (**Figure 11**). Large portions of the site contain non-contiguous bands of shallow rock and Hardpan Carbonate which lead to areas being classified as a Mispah and Coega complex.

Land Use Capability:
This soil has low agricultural potential due to the distinct lack of rooting depth and as such these soils are generally utilised for grazing land. If ripped and cultivated however precise irrigation scheduling is imperative. These soils also exhibit high soil erosion hazard ratings thus soil conservation practices such as minimum tillage and trash blankets should be employed.

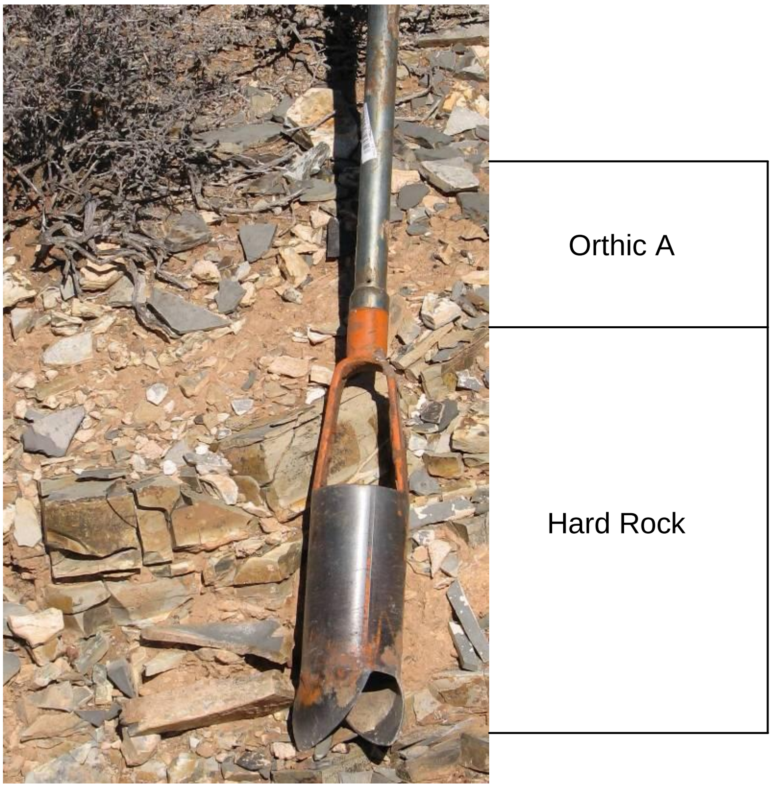

Figure 10: An example of a shallow Mispah Soil Form encountered on the PDA

Figure 11: Shallow, rocky soils dominate large portions the PDA

4.1.2 Coega Form

Family: 2000 (Calcareous A Horizon)
Diagnostic Horizons and Materials:
A-Horizon: Orthic
B-Horizon: Hardpan Carbonate

Site Specific Description:
The Coega form is a type of calcic soil whose profile contains at least one carbonate-rich horizon. Carbonate retention in the soil profile is a result of an arid climate where evaporation far exceeds rainfall. When encountered on the PDA the A-horizon of this soil form was generally light brown, calcareous and lightly structured. This Orthic A-horizon overlies a hard pan carbonate which was limiting to plant growth. The effective soil depth was generally less than 0.2 m. Large portions of the site contain non-contiguous bands of shallow rock and Hardpan Carbonate which lead to areas being classified as a Mispah and Coega complex.

Agricultural Potential:
Calcic soils are associated with arid regions and thus the use of these carbonate rich soils in South Africa is limited. Limitations in terms of sustainable agricultural use include shallow rooting depth, high pH, high salinity and low plant Phosphorus availability (**Fey, 2010**). The distinct lack of rooting depth also reduces the agricultural potential of these soils. Such limitations restrict calcic soils to extensive grazing unless irrigation is available. These soils also exhibit high soil erosion hazard ratings thus soil conservation practices such as minimum tillage and trash blankets should be employed.

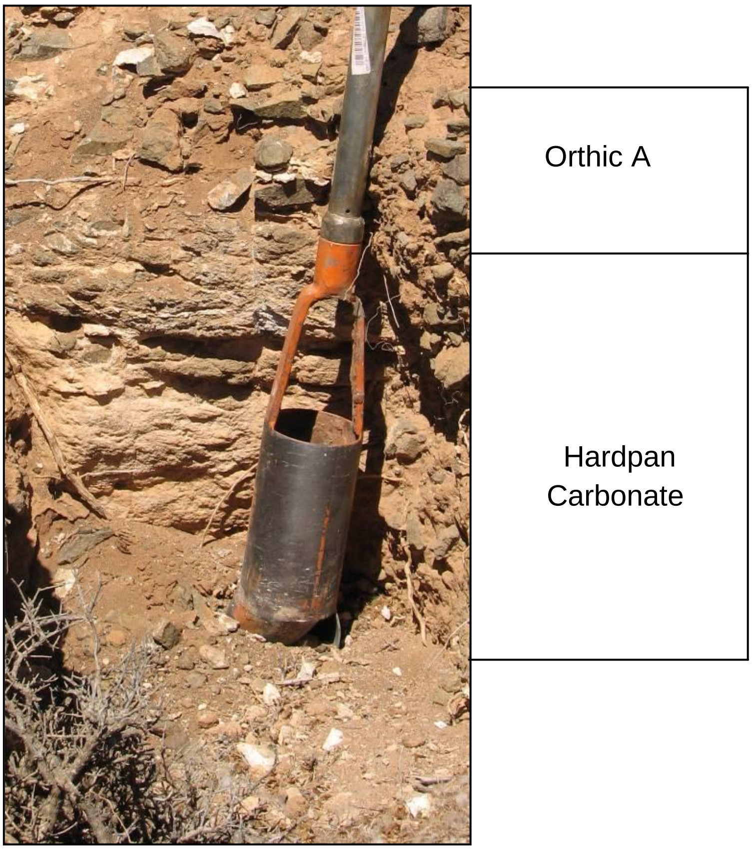

Figure 12: An example of a shallow Coega Soil Form encountered on the PDA

Figure 13: Shallow and surface Hardpan Carbonate is common throughout the PDA

4.1.3 Prieska Form

Soil Family: Generally 1110 (Not bleached, Non-red B, Non Luvic)
Diagnostic Horizons and Materials:
A-Horizon: Orthic
B-Horizon: Neocarbonate
C-Horizon: Hardpan Carbonate

Site Specific Description:
Like the Coega form the Augrabies soil form falls within the calcic soil group whose defining characteristic is the accumulation of calcium carbonate. Carbonate retention in the soil profile is a result of an arid climate where evaporation far exceeds rainfall. When encountered on the PDA the A-horizon of this soil form was light brown and thin. This Orthic A-horizon overlies a Neocarbonate B-horizon which lacked structure other than the porous micro-aggregates and had a uniform ivory colour (**Figure 14**). The Neocarbonate B overlies Hard Pan Carbonate which is limiting to plants. The soil form was generally non-luvic[1] and the pedological depth seldom exceeded 0.5 m. The entire profile tested positive to the presence of carbonates[2] when treated with cold 10% hydrochloric acid.

[1] Clay content did not increase with soil depth.
[2] The soil profile contained carbonates to effervesce visibly when treated with cold 10% hydrochloric acid.

Land Use Capability:

Calcic soils are associated with arid regions and thus the use of these carbonate rich soils in South Africa is limited. Limitations in terms of sustainable agricultural use include high pH, high salinity, low plant available Phosphorus and other trace elements as well as toxic levels of extractable of Boron (**Fey, 2010**). Such limitations restrict calcic soils to extensive grazing unless irrigation is available. These soils also exhibit high soil erosion hazard ratings thus soil conservation practices such as minimum tillage and trash blankets should be employed.

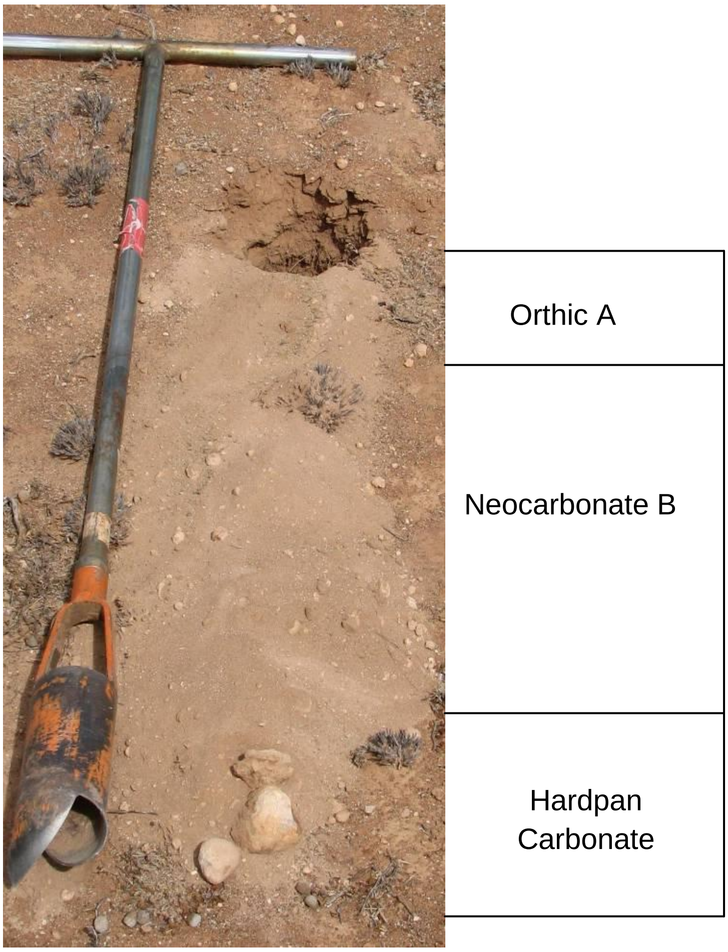

Figure 14: An example of a Prieska encountered the PDA

4.2 Soil Summary

The soils identified on the PDA are predominantly calcic and shallow with a low agricultural potential. Rocky and shallow calcic soils (Mispah and Coega Form) cover 97% of the surveyed area (**Figure 17**). Virtually all the soils encountered on site contained at least one layer that was limiting to plant growth and these layers included rock and hard pan carbonate. The soils' properties identified during the field verification reflect the arid climate in which they were formed.

The location and description of the sample points are provided in **Appendix A: Soil Properties**. This information was used to create a verified soil map showing homogeneous soil bodies (**Figure 16**). Combining the effective depth information (i.e. depth to root limiting layer) and Inverse Distance Weighting one is able to obtain a generalised soil depth for the PDA (**Figure 18**). Soils with an effective depth of greater than 50 cm were rarely observed during the soil survey with most soils exhibiting an effective soil depth of less than 30 cm.

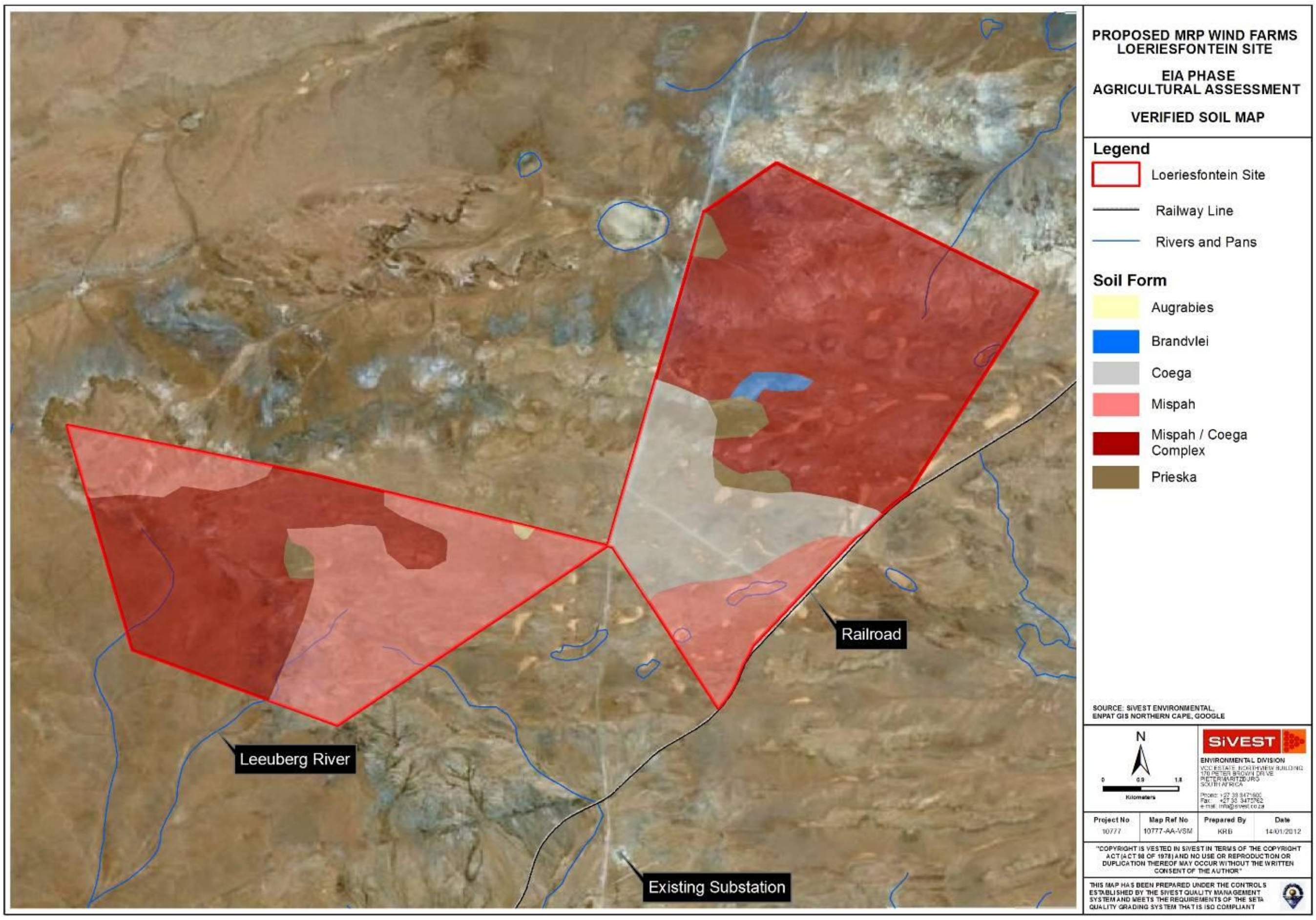

Figure 15: Verified Soil Map for the Plateau East North Site

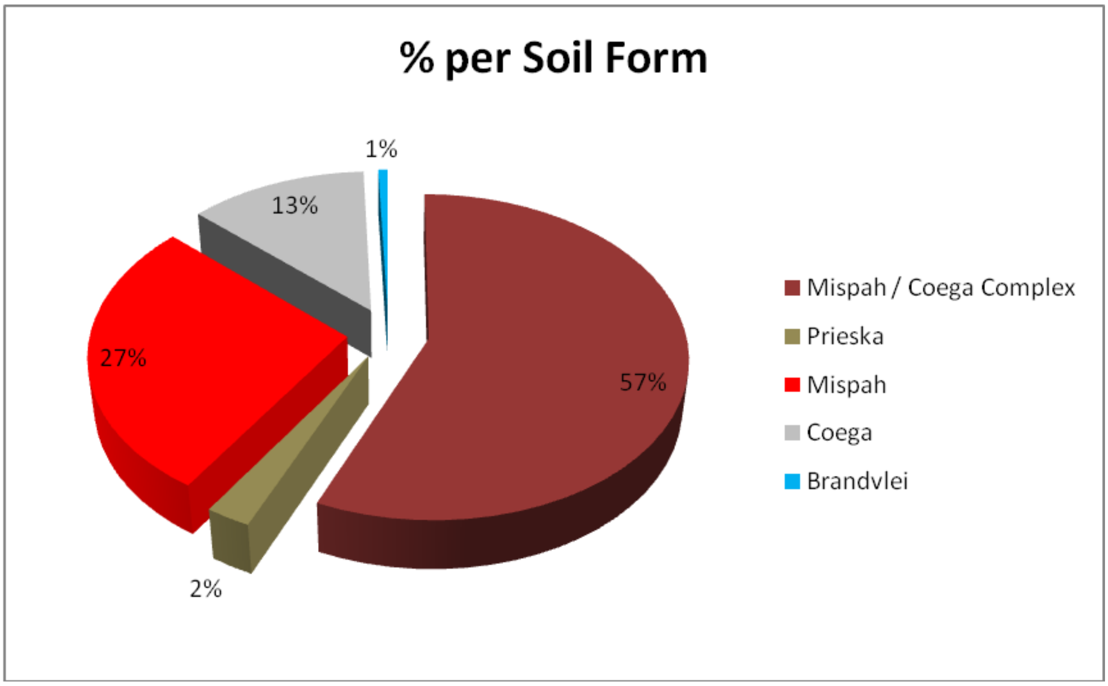

Figure 16: Graph showing the percentage area per soil form for the Plateau East North Site

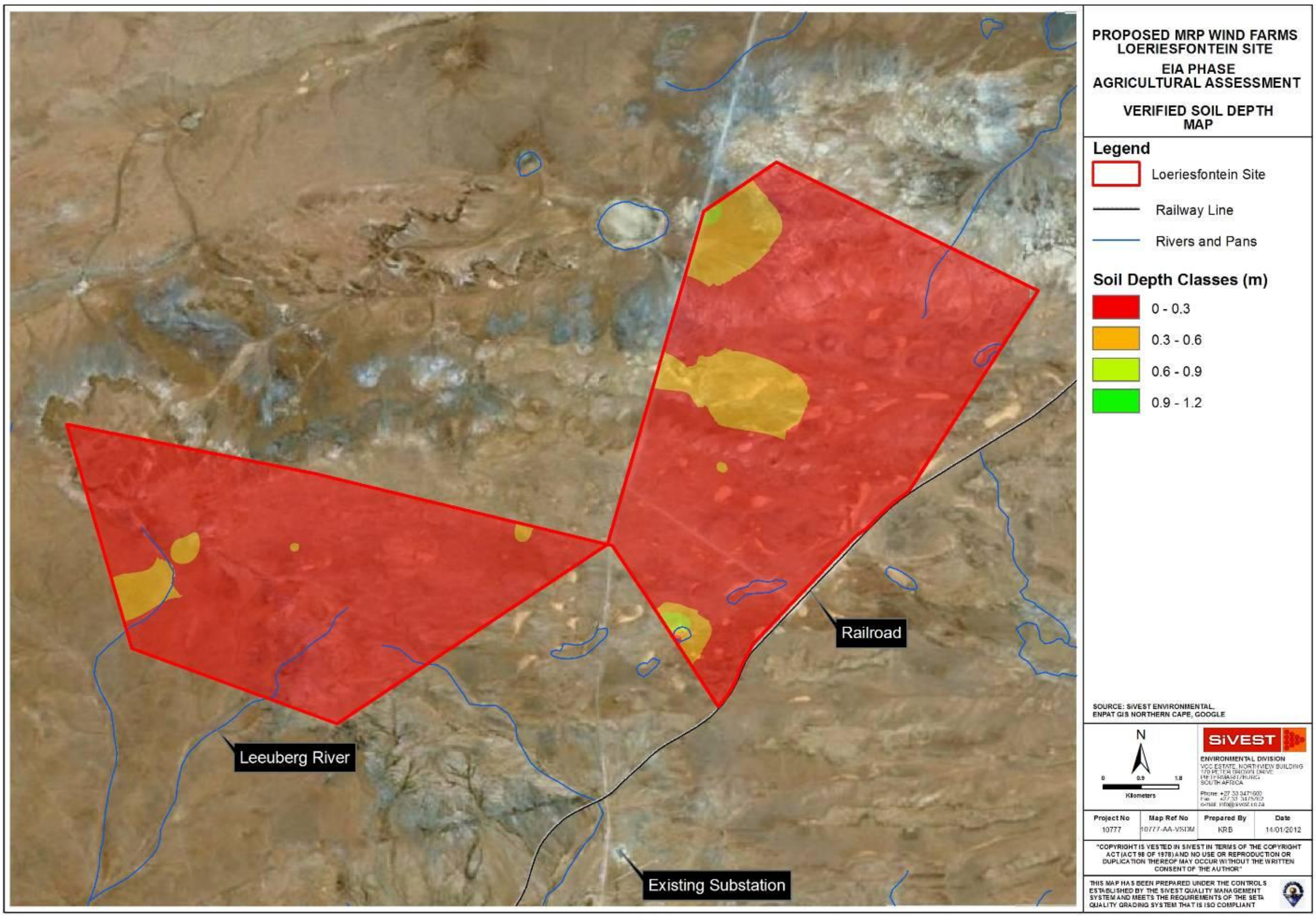

Figure 17: Verified Soil Depth Map

5. AGRICULTURAL POTENTIAL ASSESSMENT

In terms of this study, agricultural potential is described as an area's suitability and capacity to sustainably accommodate an agricultural land use with this potential being benchmarked against crop production.

5.1 Current Situation

The farms which constitute the assessment area for this project are currently used as extensive grazing land for free range sheep production (**Figure 29**). After discussions with the various land owners the stocking rates are estimated at around 1 SSM (small stock unit) per 10 hectares. Water is the major limiting factor to local agricultural enterprises and PDA does not contain nor do they border a perennial river / freshwater impoundment which could be used as a source of irrigation water. The site does not currently accommodate any centre pivots, irrigation schemes or active agricultural fields. Seasonal pans tend to have the highest grazing potential due to the increased plant available water. Drinking water for the animals is sourced from the groundwater resources.

Figure 18: A typical flock of sheep grazing on the Loeriesfontein Site

5.2 Verified Agricultural Potential

Overall agricultural potential is based on assessing a number of inter-related factors including climate, topography, soil type, soil limitations and current land use. In this area climate is the overriding and foremost limiting factor to sustainable agricultural production. The combination of low rainfall and an extreme moisture deficit means that sustainable arable agriculture cannot take place without some form of irrigation. The site does not contain nor is it bounded by a reliable surface water irrigation resource and the use of groundwater for this purpose does not seem agriculturally and economically feasible. This is due to the high cost of borehole installation, the sheer volume of water required for irrigation purposes and the quality of the local groundwater.

Shallow lithic and calcic soils (Mispah and Coega Form) cover approximately 97% of the total survey area. Virtually all the soils encountered had a layer that was limiting to plant growth and are very susceptible to erosion. Effective soil depth rarely exceeded 50 cm. A map indicating agricultural potential in terms of crop production for site is provided in **Figure 19**. The majority of the site has been classified as having low potential for crop production due to an arid climate and highly restrictive soil characteristics. The site is not classified in terms of registering a high agricultural potential and they are not a unique dry land agricultural resource. The PDA is considered to have a moderately low value when utilised as grazing land, its current use.

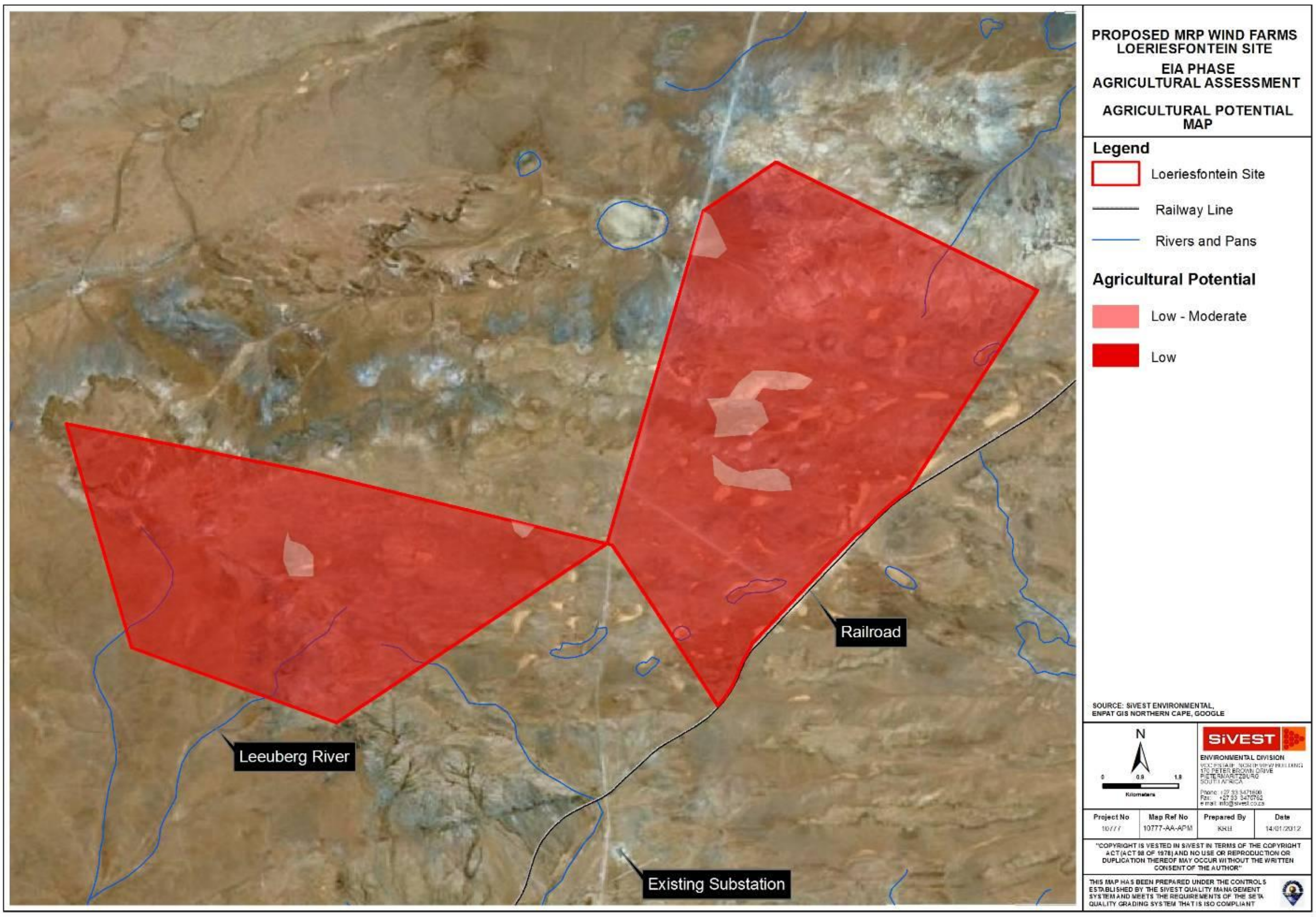

Figure 19: Agricultural Potential Map for the PDA

6. AGRICULTURAL IMPACT ASSESSMENT

From an agricultural perspective the loss of high value farm land and / or food security production, as a result of the proposed activities, is the primary concern of this assessment. In South Africa there is a scarcity of high potential agricultural land, with less than 14% of the total area being suitable for dry land crop production (**Smith, 2006**). Consequently areas which can sustainably accommodate dry land production need to be protected from non-agricultural land uses. The desktop assessment, field verification and agricultural potential assessment (**Sections 3, 4 and 5**) has already shown that the study area is unsuitable for dry land crop production and is dominated by unimproved grazing land. In order to determine the significance of the impacts on agricultural resources an impact rating system was utilised.

6.1 Determination of Significance of Impacts

Significance is determined through a synthesis of impact characteristics which include the context and the intensity of an impact. Context refers to the geographical scale (i.e. site, local, national or global) whereas Intensity is defined by the severity of the impact (e.g. the magnitude of deviation from background or baseline conditions, the size of the area affected, the duration of the impact and the overall probability of occurrence). Significance is calculated as per the example shown in **Table 4**.

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

6.2 Impact Rating System Methodology

Impact assessments must take account of the nature, scale and duration of effects on the environment whether such effects are positive (beneficial) or negative (detrimental).

6.2.1 Rating System Used To Classify Impacts

The rating system is applied to the potential impact on the receiving environment and includes an objective evaluation of the mitigation of the impact. Impacts have been consolidated into one rating. In assessing the significance of each issue, the following criteria (including an allocated point system) is used:

NATURE
Include a brief description of the impact of environmental parameter being assessed in the context of the project. This criterion includes a brief written statement of the environmental aspect being impacted upon by a particular action or activity.
GEOGRAPHICAL EXTENT

This is defined as the area over which the impact will be expressed. Typically, the severity and significance of an impact have different scales and as such bracketing ranges are often required. This is often useful during the detailed assessment of a project in terms of further defining the determined.		
1	Site	The impact will only affect the site
2	Local/district	Will affect the local area or district
3	Province/region	Will affect the entire province or region
4	International and National	Will affect the entire country
PROBABILITY		
This describes the chance of occurrence of an impact		
1	Unlikely	The chance of the impact occurring is extremely low (Less than a 25% chance of occurrence).
2	Possible	The impact may occur (Between a 25% to 50% chance of occurrence).
3	Probable	The impact will likely occur (Between a 50% to 75% chance of occurrence).
4	Definite	Impact will certainly occur (Greater than a 75% chance of occurrence).
REVERSIBILITY		
This describes the degree to which an impact on an environmental parameter can be successfully reversed upon completion of the proposed activity.		
1	Completely reversible	The impact is reversible with implementation of minor mitigation measures
2	Partly reversible	The impact is partly reversible but more intense mitigation measures are required.
3	Barely reversible	The impact is unlikely to be reversed even with intense mitigation measures.
4	Irreversible	The impact is irreversible and no mitigation measures exist.

IRREPLACEABLE LOSS OF RESOURCES		
This describes the degree to which resources will be irreplaceably lost as a result of a proposed activity.		
1	No loss of resource.	The impact will not result in the loss of any resources.
2	Marginal loss of resource	The impact will result in marginal loss of resources.
3	Significant loss of resources	The impact will result in significant loss of resources.
4	Complete loss of resources	The impact is result in a complete loss of all resources.
DURATION		
This describes the duration of the impacts on the environmental parameter. Duration indicates the lifetime of the impact as a result of the proposed activity		
1	Short term	The impact and its effects will either disappear with mitigation or will be mitigated through natural process in a span shorter than the construction phase (0 – 1 years), or the impact and its effects will last for the period of a relatively short construction period and a limited recovery time after construction, thereafter it will be entirely negated (0 – 2 years).
2	Medium term	The impact and its effects will continue or last for some time after the construction phase but will be mitigated by direct human action or by natural processes thereafter (2 – 10 years).
3	Long term	The impact and its effects will continue or last for the entire operational life of the development, but will be mitigated by direct human action or by natural processes thereafter (10 – 50 years).
4	Permanent	The only class of impact that will be non-transitory. Mitigation either by man or natural process will not occur in such a way or such a time span that the impact can be considered transient (Indefinite).

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

INTENSITY / MAGNITUDE		
Describes the severity of an impact		
1	Low	Impact affects the quality, use and integrity of the system/component in a way that is barely perceptible.
2	Medium	Impact alters the quality, use and integrity of the system/component but system/ component still continues to function in a moderately modified way and maintains general integrity (some impact on integrity).
3	High	Impact affects the continued viability of the system/component and the quality, use, integrity and functionality of the system or component is severely impaired and may temporarily cease. High costs of rehabilitation and remediation.
4	Very high	Impact affects the continued viability of the system/component and the quality, use, integrity and functionality of the system or component permanently ceases and is irreversibly impaired (system collapse). Rehabilitation and remediation often impossible. If possible rehabilitation and remediation often unfeasible due to extremely high costs of rehabilitation and remediation.

SIGNIFICANCE		
Significance is determined through a synthesis of impact characteristics. Significance is an indication of the importance of the impact in terms of both physical extent and time scale, and therefore indicates the level of mitigation required. This describes the significance of the impact on the environmental parameter. The calculation of the significance of an impact uses the following formula: **(Extent + probability + reversibility + irreplaceability + duration + cumulative effect) x magnitude/intensity.** The summation of the different criteria will produce a non weighted value. By multiplying this value with the magnitude/intensity, the resultant value acquires a weighted characteristic which can be measured and assigned a significance rating.		
Points	**Impact Significance Rating**	**Description**
6 to 28	Negative Low impact	The anticipated impact will have negligible negative effects and will require little to no mitigation.
6 to 28	Positive Low impact	The anticipated impact will have minor positive effects.
29 to 50	Negative Medium impact	The anticipated impact will have moderate negative effects and will require moderate mitigation measures.
29 to 50	Positive Medium impact	The anticipated impact will have moderate positive effects.
51 to 73	Negative High impact	The anticipated impact will have significant effects and will require significant mitigation measures to achieve an acceptable level of impact.
51 to 73	Positive High impact	The anticipated impact will have significant positive effects.
74 to 96	Negative Very high impact	The anticipated impact will have highly significant effects and are unlikely to be able to be mitigated adequately. These impacts could be considered "fatal flaws".
74 to 96	Positive Very high impact	The anticipated impact will have highly significant positive effects.

6.2.2 Impact Summary

Once rated, the impacts are summarised and a comparison made between pre- and post mitigation phases. The rating of environmental issues associated with different parameters prior to and post mitigation of a proposed activity will be averaged. A comparison is then made to determine the effectiveness of the proposed mitigation measures and identify critical issues related to the environmental parameters.

5.3 Rating of Predicted Impacts: Loss of Agricultural Land / Production

The proposed development's primary impact on agricultural activities will involve the construction of the wind turbines, a PV field and associated infrastructure. The construction entails the clearing of vegetation around the footprint of the turbines, PV arrays and the crane hardstand, as well as creating service roads (**Section 1.2**).

Normal grazing (the dominant agricultural activity) will be permitted around the turbines and within the PV field. All three farms, which constitute the study area, are dominated grazing land and this activity is considered non-sensitive when assessed within the context of the proposed development. Consequently, the impact of the proposed development on the study area's agricultural potential will be extremely low, with the loss of agricultural land being attributed to the creation of the service roads and around the turbine and array foundations. We re-iterate that this loss is considered inconsequential within the context of this assessment. The construction of these facilities will only influence a portion of assessed area. The remaining land will continue to function as they did prior to the development.

Table 2: Impact rating table for the contamination of local soil and land use resources

IMPACT TABLE		
Environmental Parameter	***Soil and Land Use Resources***	
Issue/Impact/Environmental Effect/Nature	***Loss of agricultural land and / or production as a result of the proposed activities***	
Extent	***Site***: *Impacts will be restricted to the site.*	
Probability	***Definite***: *A marginal loss of grazing land is definitely occur.*	
Reversibility	***Completely Reversible***: *The land can be returned to grazing after construction has been completed.*	
Irreplaceable loss of resources	***Marginal Loss***: *The construction of the turbines, solar field and associated infrastructure will result in a very marginal loss of agricultural land and production.*	
Duration	***Long Term***: *The impact and its effects will continue or last for the entire operational life of the development. The life span of the development is greater than 20 years*.	
Cumulative effect	**Negligible Cumulative Impact**	
Intensity/magnitude	***Low***	
Significance Rating	The anticipated impact will have negligible negative effects and will require little to no mitigation.	
	Pre-mitigation impact rating	Post mitigation impact rating
Extent	1	1
Probability	4	4
Reversibility	1	1
Irreplaceable loss	2	2
Duration	3	3
Cumulative effect	1	1
Intensity/magnitude	1	1
Significance rating	-12 (**low negative**)	-12 (**low negative**)

Mitigation measures	▪ Due to the overarching site characteristics and the nature of the proposed development viable mitigation measures are limited and will most likely revolve around erosion control: ➢ Clearing activities should be kept to a minimum (turbine. Road and PV site footprint). ➢ In the unlikely event that heavy rains are expected activities should be put on hold to reduce the risk of erosion. ➢ If additional earthworks are required, any steep or large embankments that are expected to be exposed during the 'rainy' months should either be armoured with fascine like structures. If earth works are required then storm water control and wind screening should be undertaken to prevent soil loss from the site

There are no centre pivots, irrigation schemes or active agricultural fields which will be influenced by the proposed development. Therefore, from an agricultural perspective, there are no problematic or fatal flaw areas for the site (**Figure 20**).

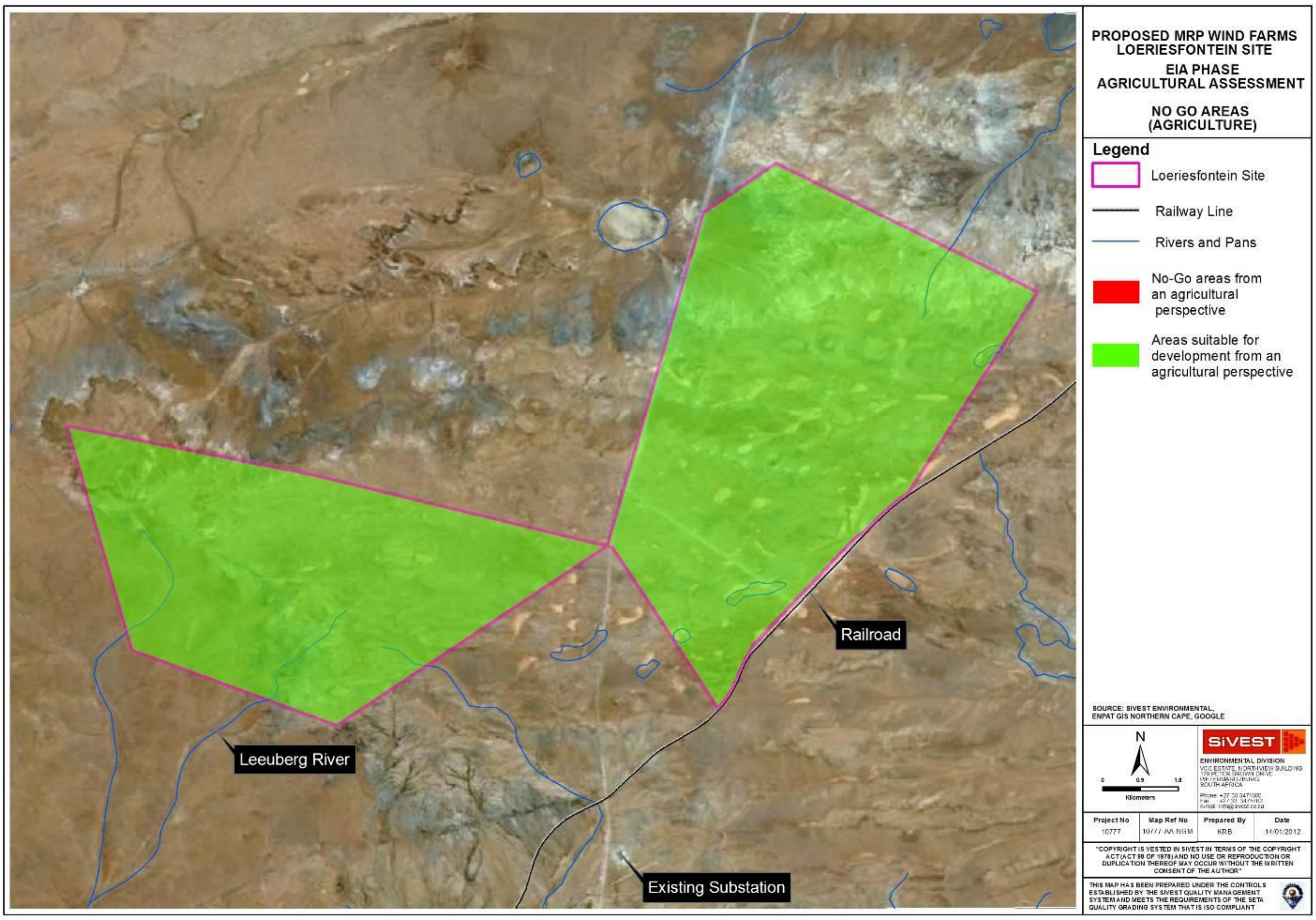

Figure 20: No Go Area Map from an Agricultural Perspective

7. SUMMARY AND RECOMMENDATIONS

Mainstream Renewable Power (MRP) requested a baseline assessment of the soil, land use and agricultural characteristics for the area affected by the proposed Loeriesfontein Wind and Solar Photovoltaic Energy Facility. The primary objective of this assessment is to provide specialist soil and agricultural input into the overarching Environmental Impact Assessment (EIA) Report.

MRP proposes to construct wind and solar facilities using a phased approach.

Phase 1: Construction of a 50 MW wind energy facility.

Phase 2: Construction of a 420 MW wind energy facility connecting to Eskom's 400kV Helios Substation.

Phase 3: Construction of a 100 MW PV Solar facility and associated infrastructure, which will cover 200 ha of the site.

The proposed site is located on the farms Sous and Aan De Karree Doorn Pan and is approximately 10 157 ha in size. The study area is dominated by unimproved unimproved veld which is predominantly utilized as grazing land for sheep.

The study area has an arid Mediterranean type climate with winter rainfall regime i.e. most of the rainfall is confined to early autumn and winter. Mean Annual Precipitation (MAP) is approximately 179 mm per year. The combination of low rainfall and severe moisture deficient means that sustainable arable agriculture cannot take place on the farm without some form of irrigation. The study area is characterised by flat and gently sloping topography with an average gradient of less than 5%. The soils identified on the PDA are predominantly calcic and shallow with a low agricultural potential. Rocky and shallow calcic soils (Mispah and Coega Form) cover 97% of the surveyed area. Virtually all the soils encountered had a layer that was limiting to plant growth and the effective soil depth rarely extended below 50 cm.

The site is not classified as high potential nor is it a unique dry land agricultural resource. The study area has been classified as having an extremely low potential for crop production due to an arid climate and highly restrictive soil characteristics but are considered to have a moderately low value as grazing land, its current use.

Normal grazing (the dominant agricultural activity) will be permitted around the turbines and within the PV field. All three farms, which constitute the study area, are dominated grazing land and this activity is considered non-sensitive when assessed within the context of the proposed development. Consequently, the impact of the proposed development on the study area's agricultural potential will be extremely low, with the loss of agricultural land being attributed to the creation of the service roads and around the turbine and array foundations. There are no centre pivots, irrigation schemes or active agricultural fields which will be influenced by the proposed development. Therefore, from an agricultural perspective, there are no problematic or fatal flaw areas for the site. All alternatives proposed for the project are feasible from an agricultural perspective.

8. REFERENCES

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9. APPENDIX A: SOIL PROPERTIES

Auger Number	Soil Form	Soil Family	Effective Depth (m)	Pedological Depth (m)	Limiting Layer	X	Y
1	Ms	1200	0.20	0.20	Rock	19.502	-30.434
2	Ms	1200	0.20	0.20	Rock	19.501	-30.439
3	Ms	1200	0.10	0.10	Rock	19.501	-30.441
4	Ms	1200	0.20	0.20	Rock	19.500	-30.443
5	Ms	1200	0.20	0.20	Rock	19.503	-30.446
6	Ms	1200	0.20	0.20	Rock	19.505	-30.449
7	Ms	1200	0.20	0.20	Rock	19.503	-30.451
8	Ms	1200	0.20	0.20	Rock	19.501	-30.453
9	Ms	1200	0.20	0.20	Rock	19.499	-30.456
10	Ms	1200	0.20	0.20	Rock	19.499	-30.458
11	Ms	1200	0.20	0.20	Rock	19.498	-30.462
12	Ms	1200	0.20	0.20	Rock	19.502	-30.464
13	Ms	1200	0.10	0.10	Rock	19.505	-30.468
14	Ms	1200	0.10	0.10	Rock	19.508	-30.470
15	Ms	1200	0.10	0.10	Rock	19.510	-30.470
16	Ms	1200	0.10	0.10	Rock	19.512	-30.472
17	Ms	1200	0.10	0.10	Rock	19.516	-30.472
18	Ms	1200	0.10	0.10	Rock	19.518	-30.473
19	Ms	1200	0.10	0.10	Rock	19.523	-30.476
20	Ms	1200	0.10	0.10	Rock	19.500	-30.468
21	Ms	1200	0.10	0.10	Rock	19.499	-30.471
22	Ms	1200	0.10	0.10	Rock	19.497	-30.471
23	Ms	1200	0.10	0.10	Rock	19.490	-30.468
24	Ms	1200	0.10	0.10	Rock	19.498	-30.450
25	Co	2000	0.20	0.20	HPC	19.512	-30.433
26	Co	2000	0.20	0.20	HPC	19.520	-30.435
27	Ms	1200	0.20	0.20	Rock	19.525	-30.437
28	Ms	1200	0.20	0.20	Rock	19.530	-30.438
29	Ms	1200	0.10	0.10	Rock	19.536	-30.440
30	Ms	1200	0.10	0.10	Rock	19.542	-30.441
31	Ms	1200	0.10	0.10	Rock	19.547	-30.443
32	Co	2000	0.20	0.20	HPC	19.551	-30.445
33	Ms	1200	0.10	0.10	Rock	19.553	-30.451
34	Ms	1200	0.10	0.10	Rock	19.556	-30.455
35	Ms	1200	0.20	0.20	Rock	19.443	-30.456
36	Pr	1110	0.40	0.40	HPC	19.430	-30.443
37	Co	2000	0.10	0.10	HPC	19.427	-30.431
38	Co	2000	0.20	0.20	HPC	19.430	-30.423
39	Co	2000	0.20	0.20	HPC	19.432	-30.414
40	Co	2000	0.10	0.10	HPC	19.433	-30.410

Auger Number	Soil Form	Soil Family	Effective Depth (m)	Pedological Depth (m)	Limiting Layer	X	Y
41	Ms	1200	0.10	0.10	Rock	19.435	-30.405
42	Co	2000	0.20	0.20	HPC	19.579	-30.433
43	Co	2000	0.20	0.20	HPC	19.578	-30.437
44	Ms	1200	0.10	0.10	Rock	19.575	-30.444
45	Ms	1200	0.10	0.10	Rock	19.579	-30.444
46	Ms	1200	0.20	0.20	Rock	19.572	-30.444
47	Pr	2110	0.90	0.90	HPC	19.573	-30.450
48	Co	2000	0.20	0.20	HPC	19.572	-30.453
49	Ms	1200	0.10	0.10	Rock	19.571	-30.454
50	Ms	1200	0.10	0.10	Rock	19.570	-30.455
51	Pr	2110	0.80	0.80	HPC	19.567	-30.456
52	Pr	2110	0.70	0.70	HPC	19.578	-30.362
53	Pr	2110	0.50	0.50	HPC	19.577	-30.367
54	Ms	2100	0.30	0.30	Rock	19.575	-30.374
55	Co	2000	0.20	0.20	HPC	19.573	-30.380
56	Ms	1200	0.10	0.10	Rock	19.571	-30.389
57	Pr	2110	0.50	0.50	HPC	19.569	-30.394
58	Co	2000	0.20	0.20	HPC	19.566	-30.405
59	Co	2000	0.20	0.20	HPC	19.568	-30.405
60	Co	2000	0.10	0.10	HPC	19.562	-30.420
61	Co	2000	0.10	0.10	HPC	19.581	-30.421
62	Pr	2110	0.40	0.40	HPC	19.582	-30.416
63	Ms	1200	0.10	0.10	Ms	19.583	-30.415
64	Ms	1200	0.10	0.10	Rock	19.586	-30.412
65	Pr	2110	0.50	0.50	HPC	19.587	-30.405
66	Br	1000	0.50	0.50	HPC	19.590	-30.397
67	Ms	1200	0.10	0.10	Rock	19.592	-30.389
68	Ms	2200	0.10	0.10	Rock	19.595	-30.381
69	Ms	2200	0.10	0.10	Rock	19.602	-30.384
70	Ms	2200	0.20	0.20	Rock	19.613	-30.389
71	Ms	1200	0.10	0.10	Rock	19.618	-30.385
72	Ms	1200	0.10	0.10	Rock	19.620	-30.381
73	Ms	1200	0.10	0.10	Rock	19.622	-30.378
74	Ms	1200	0.10	0.10	Rock	19.614	-30.394
75	Co	2000	0.20	0.20	HPC	19.613	-30.400
76	Co	2000	0.20	0.20	HPC	19.611	-30.408
77	Co	2000	0.20	0.20	HPC	19.611	-30.410
78	Ms	1200	0.10	0.10	Rock	19.610	-30.413
79	Ms	1200	0.10	0.10	Rock	19.609	-30.415
80	Co	2000	0.20	0.20	HPC	19.607	-30.427
81	Ms	1200	0.10	0.10	Rock	19.598	-30.439
82	Ms	1200	0.10	0.10	Rock	19.596	-30.441
83	Ms	1200	0.10	0.10	Rock	19.595	-30.447

Auger Number	Soil Form	Soil Family	Effective Depth (m)	Pedological Depth (m)	Limiting Layer	X	Y
84	Ms	1200	0.10	0.10	Rock	19.588	-30.455
85	Ms	1200	0.10	0.10	Rock	19.587	-30.457
86	Ms	1200	0.10	0.10	Rock	19.586	-30.459
87	Ms	1200	0.10	0.10	Rock	19.557	-30.433
88	Ms	1200	0.20	0.20	Rock	19.553	-30.432
89	Ms	1200	0.20	0.20	Rock	19.545	-30.430
90	Ms	1200	0.20	0.20	Rock	19.544	-30.430
91	Ag	1110	0.40	0.40	Rock	19.540	-30.429
92	Ms	1200	0.20	0.20	Rock	19.536	-30.428
93	Ms	1200	0.10	0.10	Rock	19.531	-30.426
94	Ms	1200	0.10	0.10	Rock	19.528	-30.425
95	Ms	1200	0.20	0.20	Rock	19.525	-30.424
96	Ms	1200	0.20	0.20	Rock	19.519	-30.423
97	Ms	1200	0.10	0.10	Rock	19.516	-30.423
98	Ms	1200	0.10	0.10	Rock	19.513	-30.422
99	Ms	1200	0.20	0.20	Rock	19.512	-30.422
100	Co	2000	0.10	0.10	HPC	19.507	-30.421
101	Co	2000	0.10	0.10	HPC	19.506	-30.424
102	Co	2000	0.10	0.10	HPC	19.505	-30.427
103	Ms	1200	0.20	0.20	Rock	19.505	-30.429
104	Ms	1200	0.20	0.20	Rock	19.503	-30.432
105	Ms	1200	0.10	0.10	Rock	19.499	-30.432
106	Ms	1200	0.10	0.10	Rock	19.495	-30.433
107	Pr	1110	0.40	0.40	HPC	19.491	-30.433
108	Co	2000	0.20	0.20	HPC	19.487	-30.433
109	Co	2000	0.20	0.20	HPC	19.486	-30.434
110	Co	2000	0.20	0.20	HPC	19.485	-30.434
111	Co	2000	0.20	0.20	HPC	19.480	-30.434
112	Ms	1200	0.10	0.10	Rock	19.476	-30.433
113	Ms	1200	0.10	0.10	Rock	19.473	-30.431
114	Pr	1110	0.60	0.60	HPC	19.468	-30.432
115	Ms	1200	0.10	0.10	Rock	19.467	-30.430
116	Co	2000	0.20	0.20	HPC	19.464	-30.426
117	Co	2000	0.10	0.10	HPC	19.463	-30.424
118	Ms	1200	0.20	0.20	Rock	19.462	-30.421
119	Ms	1200	0.10	0.10	Rock	19.479	-30.431
120	Co	2000	0.20	0.20	HPC	19.482	-30.431
121	Co	2000	0.20	0.20	HPC	19.485	-30.431
122	Ms	1200	0.10	0.10	Rock	19.491	-30.432
123	Ms	1200	0.10	0.10	Rock	19.495	-30.432
124	Ms	1200	0.20	0.20	Rock	19.498	-30.432

SiVEST Civil Engineering

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Email info@sivest.co.za
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Contact Person: Kurt Barichievy
Cell No.: 084 5549442
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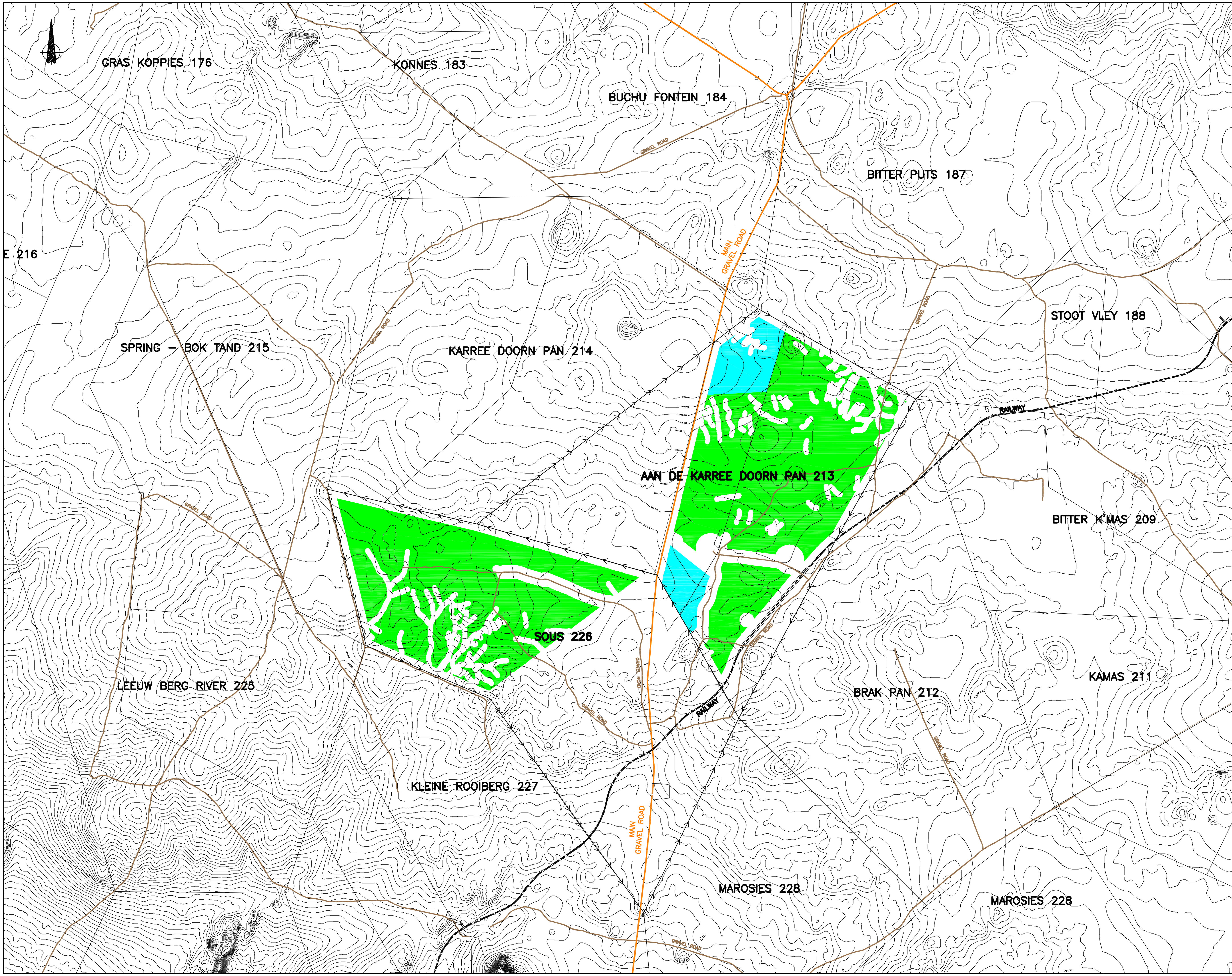
APPENDIX 'B'



THIS DRAWING HAS BEEN PREPARED UNDER THE CONTROLS ESTABLISHED BY THE SiVEST QUALITY MANAGEMENT SYSTEM AND MEETS THE REQUIREMENTS OF THE SETA QUALITY GRADING SYSTEM THAT IS ISO COMPLIANT

GENERAL NOTES

1. THIS DRAWING PROVIDES INFORMATION RELATED TO THE FORM OF THE WORK WHEN COMPLETED TOGETHER WITH GUIDANCE, WHERE FUNDAMENTAL TO THE DESIGN, FOR THE SEQUENCE OF CONSTRUCTION. THIS DRAWING DOES NOT PURPORT TO INCLUDE ANY NECESSARY PRECAUTIONS, ITEMS OR COMPONENTS REQUIRED FOR CONSTRUCTION SAFETY. ALL SUCH PRECAUTIONS MUST BE TAKEN AND ITEMS OR COMPONENTS SUPPLIED BY THE CONTRACTOR.
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3. ONLY WRITTEN DIMENSIONS SHALL BE USED.
4. ALL DIMENSIONS ARE IN ....

REFERENCE DRAWINGS

xxxxxxxx

Revision Details	By / Chk	Date	Rev
ISSUED FOR INFORMATION	GPK	04.04.12	A

51 WESSEL ROAD
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JOHANNESBURG
SOUTH AFRICA

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Fax : +27 11 803 7272
e-mail : info@sivest.co.za

Project Title
MAINSTREAM RENEWABLE ENERGY
-
LOERIESFONTEIN SITE

Drawing Title
STUDY AREA

Scale 1:40000 — ON ORIGINAL PLAN 0 10 20 30 40 50

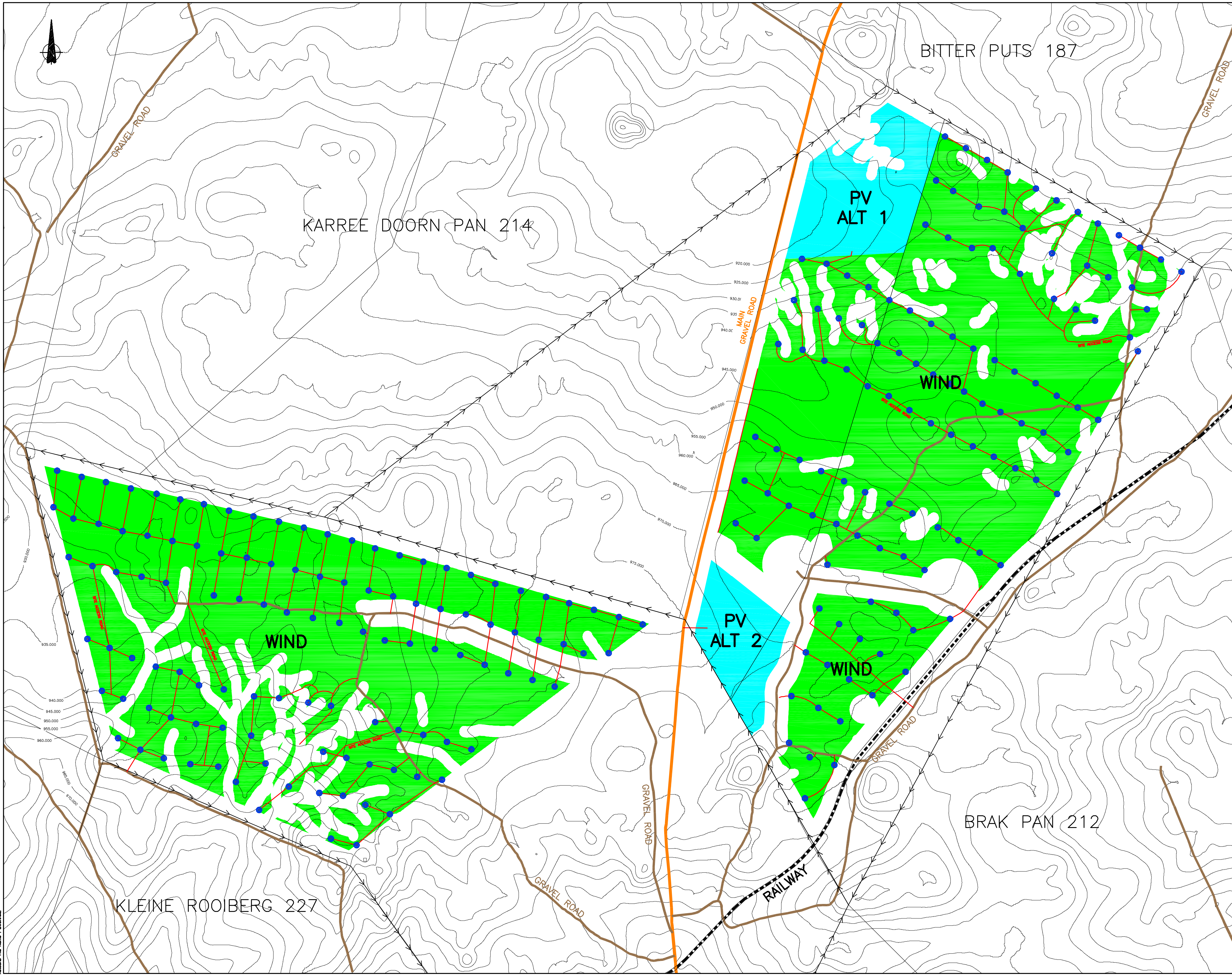
DRAWN
BY : GP KAWAMBA — DATE: 04.04.12

DESIGNED
BY : M LE MAITRE — Pr No: *
SIGNATURE : — DATE :

CHECKED ON BEHALF OF SiVEST
BY : * — Pr No: *
SIGNATURE : — DATE :

SiVEST Project Number	SiVEST Drawing Number	Revision
11421	320	A

AutoCAD File Name : DWGNAME



GENERAL NOTES

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LEGEND

WIND TURBINE

REFERENCE DRAWINGS

xxxxxxxxx

Revision Details	By / Chk	Date	Rev
ISSUED FOR INFORMATION	GPK	04.04.12	A

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Project Title

MAINSTREAM RENEWABLE ENERGY - LOERIESFONTEIN SITE

Drawing Title

PROPOSED SITE LAYOUT

Scale 1:20000 — ON ORIGINAL PLAN 0 10 20 30 40 50

DRAWN BY : GP KAWAMBA DATE: 04.04.12

DESIGNED BY : M LE MAITRE Pr No: *

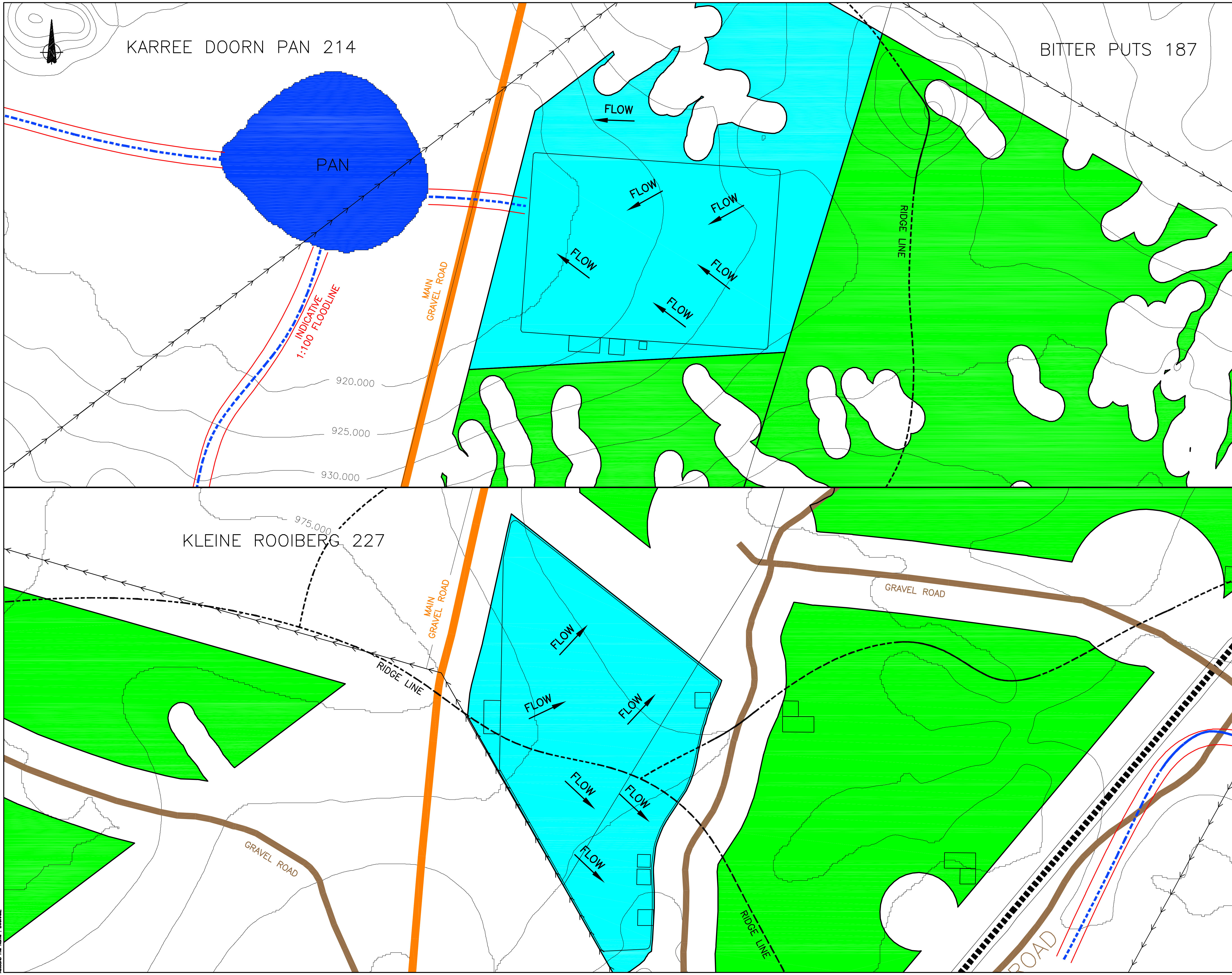
SIGNATURE : DATE :

CHECKED ON BEHALF OF SiVEST BY : * Pr No: *

SIGNATURE : DATE :

SiVEST Project Number	SiVEST Drawing Number	Revision
11421	321	A

AutoCAD File Name : DWGNAME



THIS DRAWING HAS BEEN PREPARED UNDER THE CONTROLS ESTABLISHED BY THE SiVEST QUALITY MANAGEMENT SYSTEM AND MEETS THE REQUIREMENTS OF THE SETA QUALITY GRADING SYSTEM THAT IS ISO COMPLIANT

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xxxx/xxxx

Revision Details	By / Chk	Date	Rev
ISSUED FOR INFORMATION	GPK	04.04.12	A

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SiVEST

Project Title: MAINSTREAM RENEWABLE ENERGY - LOERIESFONTEIN SITE

Drawing Title: PRE DEVELOPMENT AREA

Scale: 1:17500 — ON ORIGINAL PLAN: 0 10 20 30 40 50

DRAWN BY: GP KAWAMBA DATE: 04.04.12

DESIGNED BY: M LE MAITRE Pr No: *

SIGNATURE: DATE:

CHECKED ON BEHALF OF SiVEST BY: * Pr No: *

SIGNATURE: DATE:

SiVEST Project Number	SiVEST Drawing Number	Revision
11421	322	A

AutoCAD File Name : DWGNAME

THIS DRAWING HAS BEEN PREPARED UNDER THE CONTROLS ESTABLISHED BY THE SiVEST QUALITY MANAGEMENT SYSTEM AND MEETS THE REQUIREMENTS OF THE SETA QUALITY GRADING SYSTEM THAT IS ISO COMPLIANT

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Revision Details	By / Chk	Date	Rev
ISSUED FOR INFORMATION	GPK	04.04.12	A

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Project Title
MAINSTREAM RENEWABLE ENERGY - LOERIESFONTEIN SITE

Drawing Title
POST DEVELOPMENT AREA

Scale 1:17500 — ON ORIGINAL PLAN 0 10 20 30 40 50

DRAWN BY : GP KAWAMBA DATE: 04.04.12

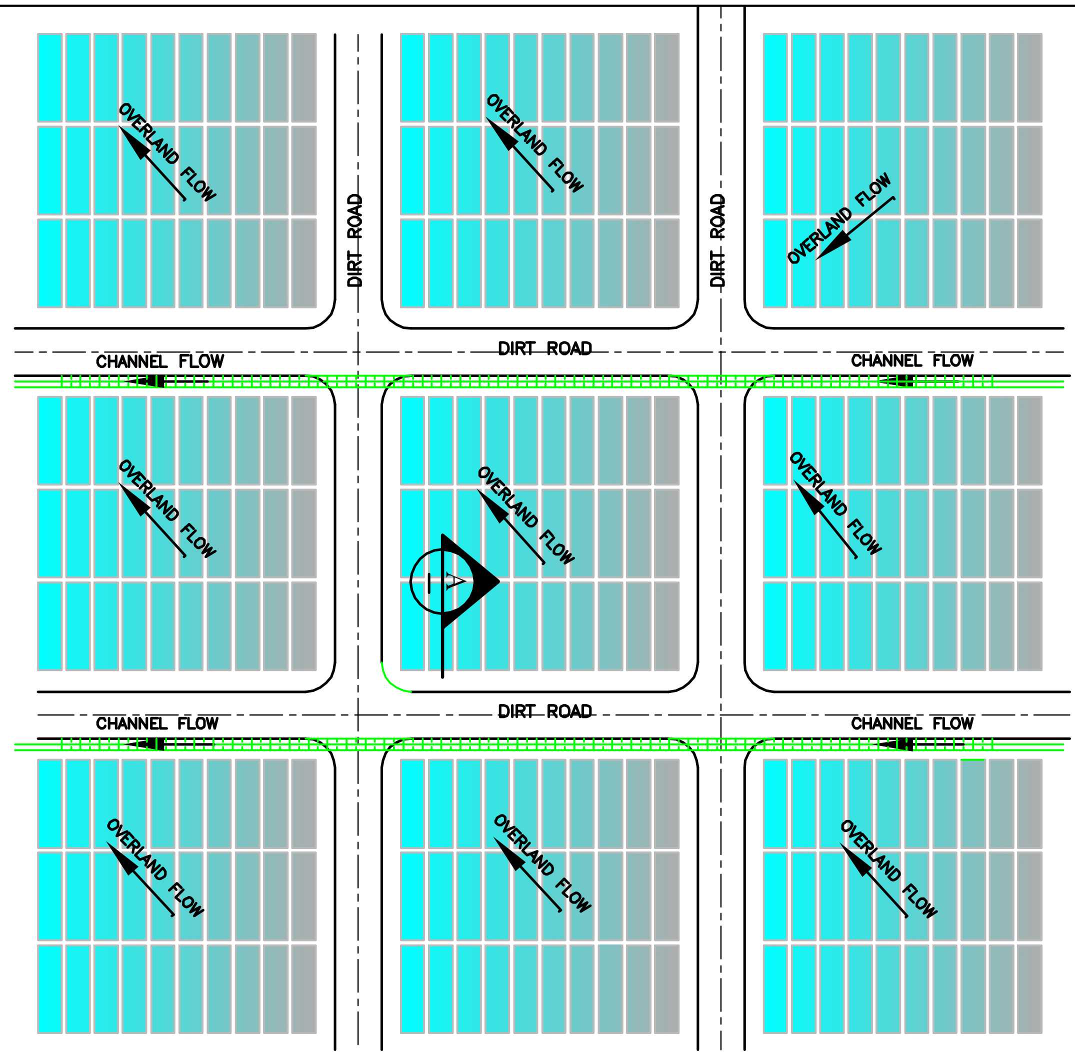
DESIGNED BY : M LE MAITRE Pr No: *

SIGNATURE : DATE :

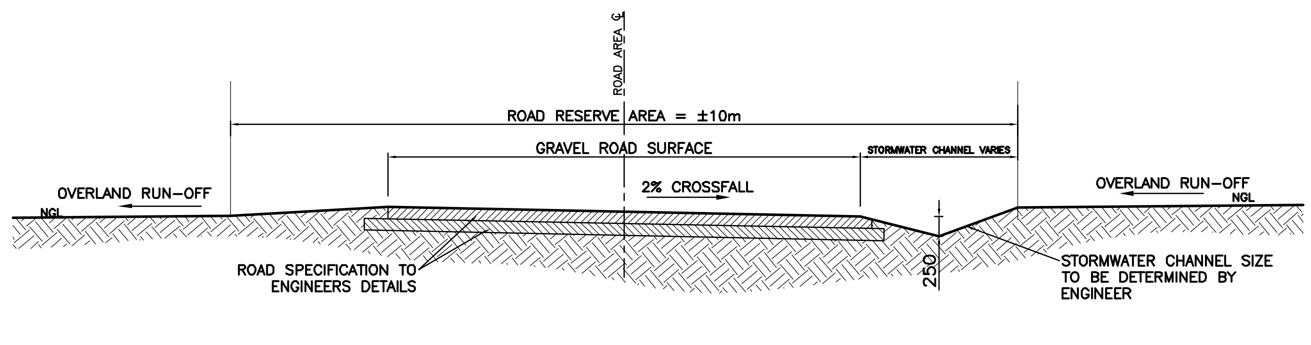
CHECKED ON BEHALF OF SiVEST BY : * Pr No: *

SIGNATURE : DATE :

SiVEST Project Number	SiVEST Drawing Number	Revision
11421	323	A



TYPICAL WIND TURBINE LAYOUT



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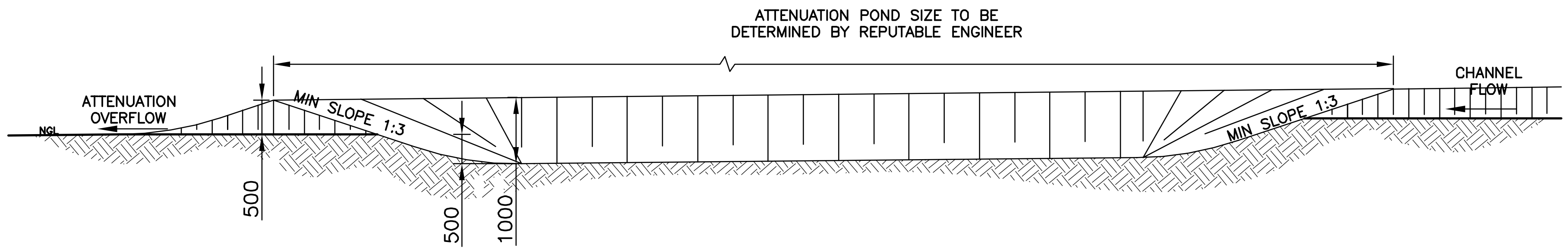
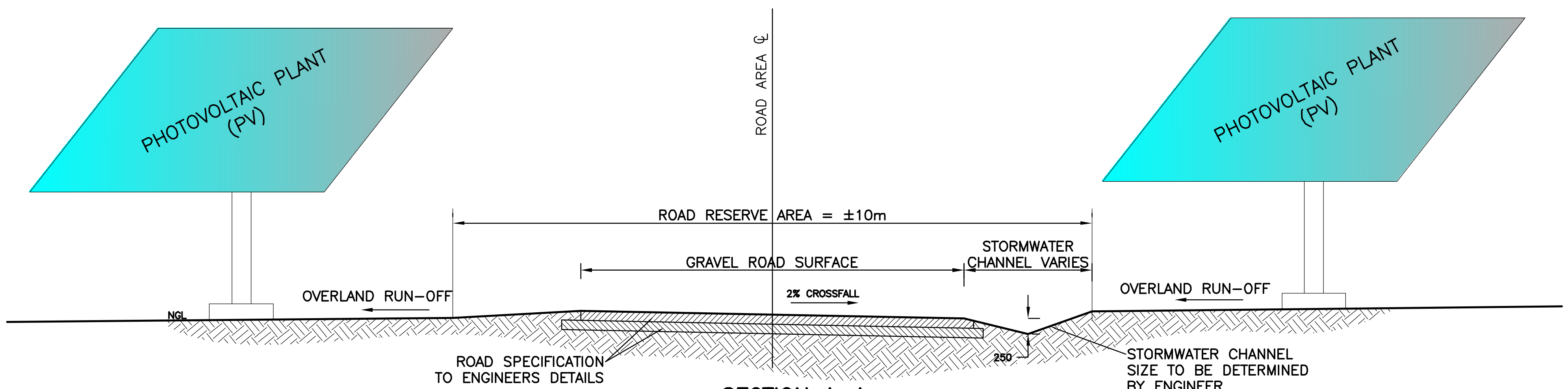


TYPICAL DETENTION AREAS



SECTION A–A
TYPICAL ROAD LAYOUT

GENERAL NOTES

1. THIS DRAWING PROVIDES INFORMATION RELATED TO THE FORM OF THE WORK WHEN COMPLETED TOGETHER WITH GUIDANCE, WHERE FUNDAMENTAL TO THE DESIGN, FOR THE SEQUENCE OF CONSTRUCTION. THIS DRAWING DOES NOT PURPORT TO INCLUDE ANY NECESSARY PRECAUTIONS, ITEMS OR COMPONENTS REQUIRED FOR CONSTRUCTION SAFETY. ALL SUCH PRECAUTIONS MUST BE TAKEN AND ITEMS OR COMPONENTS SUPPLIED BY THE CONTRACTOR.
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4. ALL DIMENSIONS ARE IN ....

REFERENCE DRAWINGS

xxxx/xxxx

Revision Details	By / Chk	Date	Rev
XXX	GGG	00.00.00	X

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Project Title: MAINSTREAM RENEWABLE ENERGY - LOERIESFONTEIN SITE

Drawing Title: TYPICAL WIND AND PHOTOVOLTAIC STORMWATER DETAILS

Scale: NTS — ON ORIGINAL PLAN 0 10 20 30 40 50

DRAWN BY: GP KAWAMBA DATE: 04.04.12

DESIGNED BY: M LE MAITRE Pr No: *

SIGNATURE: DATE:

CHECKED ON BEHALF OF SiVEST BY: * Pr No: *

SIGNATURE: DATE:

SiVEST Project Number	SiVEST Drawing Number	Revision
11421	324	A

AutoCAD File Name : DWGNAME

APPENDIX 'C'

User selection has the following criteria:
Coordinates: Latitude: 30 degrees 26 minutes; Longitude: 19 degreess 33 minutes
Durations requested: 1 h, 1 d
Return Periods requested: 5 yr, 20 yr, 50 yr, 100 yr
Block Size requested: 1 minutes

Data extracted from Daily Rainfall Estimate Database File
The six closest stations are listed

Station Name	SAWS Number	Distance (km)	Record (Years)	Latitude (−)	(')	Longitude (−)	(')	MAP (mm)	Altitude (m)	Duration (m/h/d)	Return Period (years) 5	5L	5U	20	20L	20U	50	50L	50U	100	100L	100U	100L	100U
LOERIESFONTEIN - POL	0160807_A	56.8	82	30	57	19	27	202	885	1 d	43	42.2	43.6	61	58.2	64.4	73.6	68.2	80.8	83.6	75.3	95	75.3	95
LOERIESFONTEIN (POL)	0160807_W	56.8	91	30	57	19	27	202	885	1 d	41.3	40.6	41.9	58.6	55.9	61.9	70.7	65.6	77.7	80.3	72.4	91.3	72.4	91.3
BLINKKLIP	0134671_W	88.6	25	31	11	19	53	172	900	1 d	36.7	36.5	37	53.4	52.4	54.6	64.8	63	67	73.8	71.3	77	71.3	77
GROOT TOREN	0134378_W	93.2	64	31	17	19	42	205	840	1 d	38.4	37.7	38.9	54.5	52	57.5	65.7	60.9	72.2	74.7	67.3	84.9	67.3	84.9
MANELSFONTEIN	0134854_W	98.3	35	31	14	19	59	174	1020	1 d	38.8	38	39.2	60.4	57.3	62.9	76.8	70.5	82.7	90.6	80.9	100.1	80.9	100.1
NELSKOP	0162784_W	98.3	31	30	34	20	27	115	926	1 d	37.5	37	37.8	57.9	55.7	59.7	72.7	68.3	76.5	84.9	78.1	90.7	78.1	90.7

Gridded values of all points within the specified block

Latitude (−)	(')	Longitude (−)	(')	MAP (mm)	Altitude (m)	Duration (m/h/d)	Return Period (years) 5	5L	5U	20	20L	20U	50	50L	50U	100	100L	100U
30	25	19	32	88	985	1 h	16.8	13.5	20.1	23.8	18.6	29.6	28.7	21.8	37.2	32.6	24.1	43.8
						1 d	30.1	17.5	43	42.7	24.1	63.6	51.5	28.2	79.8	58.6	31.1	93.8
30	26	19	32	77	978	1 h	16.8	13.4	20.2	23.8	18.5	29.8	28.7	21.7	37.4	32.6	24	43.9
						1 d	29.4	16.7	42.3	41.7	23	62.5	50.3	26.9	78.5	57.1	29.7	92.3
30	26	19	33	77	976	1 h	16.8	13.4	20.2	23.8	18.5	29.8	28.7	21.7	37.4	32.6	24	43.9
						1 d	29.3	16.7	42.3	41.6	23	62.5	50.2	26.9	78.5	57.1	29.7	92.2
30	25	19	33	77	972	1 h	16.8	13.4	20.2	23.8	18.5	29.8	28.7	21.7	37.4	32.6	24	44
						1 d	29.3	16.7	42.3	41.6	23	62.4	50.2	26.9	78.4	57	29.7	92.1
30	25	19	34	78	961	1 h	16.8	13.4	20.2	23.8	18.5	29.8	28.7	21.7	37.4	32.6	23.9	44
						1 d	29.4	16.7	42.3	41.7	23	62.5	50.3	27	78.5	57.1	29.8	92.2
30	26	19	34	74	968	1 h	16.8	13.4	20.2	23.8	18.5	29.8	28.7	21.7	37.4	32.6	23.9	44
						1 d	29.1	16.4	42.1	41.3	22.7	62.1	49.8	26.6	78	56.6	29.3	91.7
30	27	19	32	72	962	1 h	16.8	13.4	20.2	23.8	18.5	29.8	28.7	21.6	37.5	32.6	23.9	44
						1 d	29	16.3	42	41.2	22.5	62	49.7	26.4	77.9	56.5	29.1	91.6
30	27	19	33	69	960	1 h	16.8	13.4	20.2	23.8	18.4	29.9	28.7	21.6	37.5	32.6	23.9	44.1
						1 d	28.8	16.1	41.8	40.9	22.2	61.7	49.3	26	77.5	56	28.7	91.1
30	27	19	34	70	960	1 h	16.8	13.4	20.2	23.8	18.4	29.9	28.7	21.6	37.5	32.6	23.9	44.1
						1 d	28.8	16.2	41.8	40.9	22.3	61.8	49.4	26.1	77.5	56.1	28.9	91.1