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EKO•ENVIRONMENTAL

Desktop Geohydrological study for the proposed solar farm on Portion 4 of the farm Brypaal 134 near the town of Kakamas, Northern Cape Province.

March 2017

Prepared by:
Alré Groenewald

Prepared for:
Boscia Environmental Solutions

1.1.1 DECLARATION OF INDEPENDENCE

EKo Environmental is an independent company and has no financial, personal or other interest in the proposed project, apart from fair remuneration for work performed in the delivery of ecological services. There are no circumstances that compromise the objectivity of the study.

Report Version	Final		
DEA Reference No.	14/12/16/3/3/2/1019		
Report Reference No.	2017/BES/SR/08		
Title	Desktop Geohydrological study for the proposed solar farm on Portion 4 of the farm Brypaal 134 near the town of Kakamas, Northern Cape Province.		
Author	Alré Groenewald		Sept'16

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2 INTRODUCTION

2.1 Location of project

The proposed solar farm is located on Portion 4 of the farm Breipaal 134 near the town of Kakamas, Northern Cape Province. Refer to Figure 1

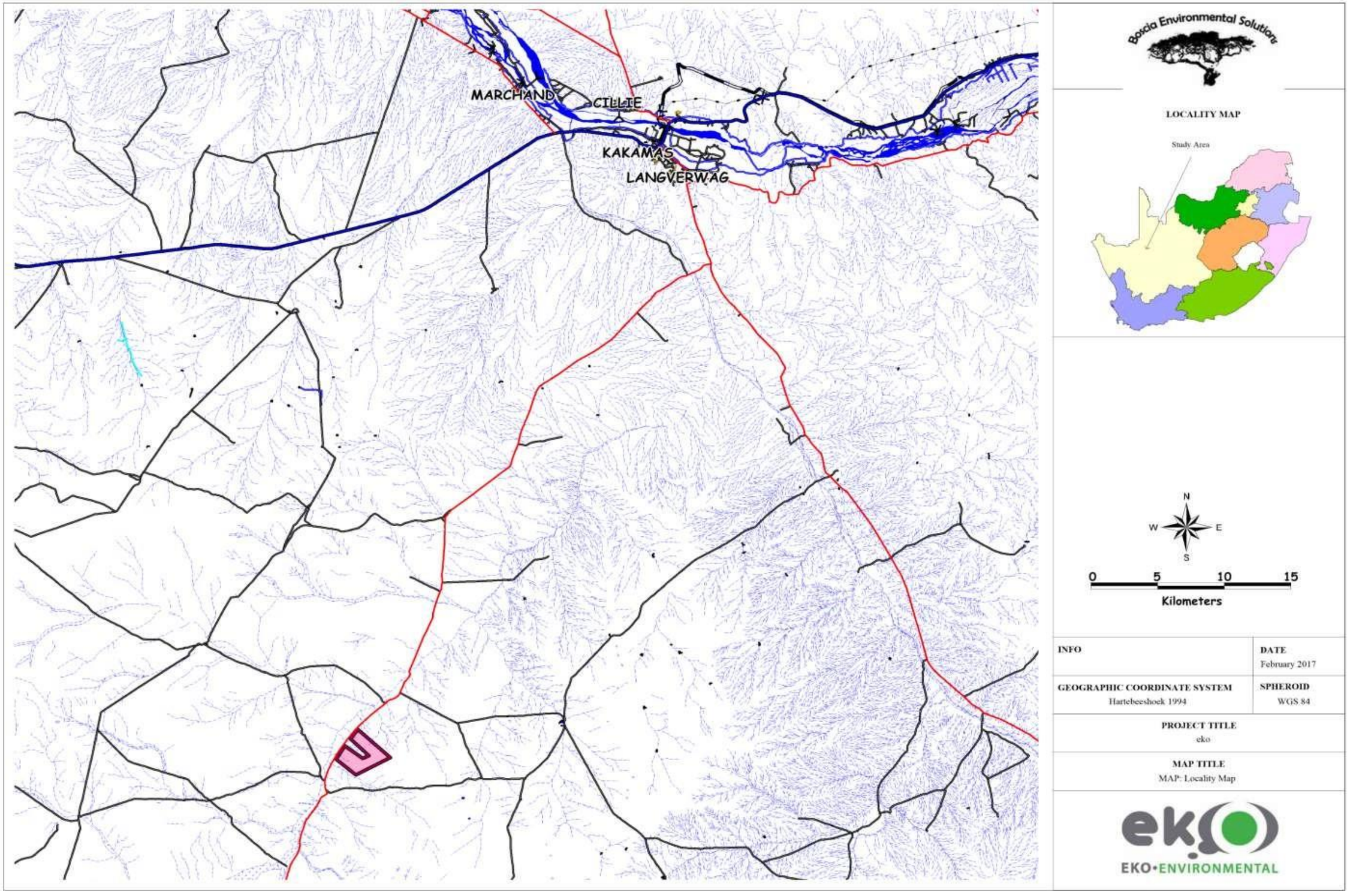


Figure 1. Regional locality of Proposed Solar farm

3 PRESENT ENVIRONMENTAL SITUATION

3.1 Climate

3.1.1 Regional Climate

Proposed solar farm lies within rainfall zone D5N and quaternary sub catchment D53H. The solar farm is located in a semi-arid region, receiving on average 80.5 mm (1940 - 1998) according to the Kakamas Gauging Station, D7E002. Rainfall occurs in the form of showers and thunderstorms, falling in the summer months of October to March and usually peaking in January or March. The summers are very hot and the winters cool.

From Figure 2 the highest average rainfall is experienced in March while the lowest average rainfall occurs during the winter months July and August.

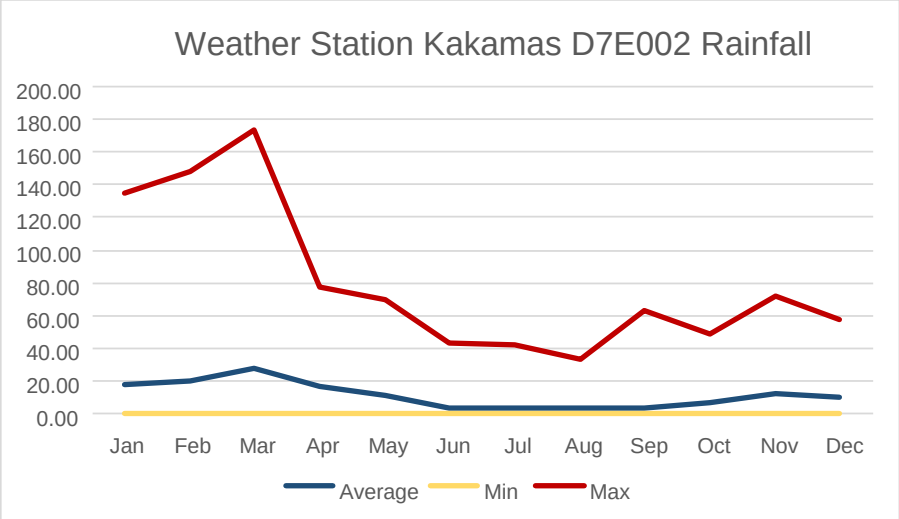


Figure 2. Mean rainfall at Kakamas weather station.

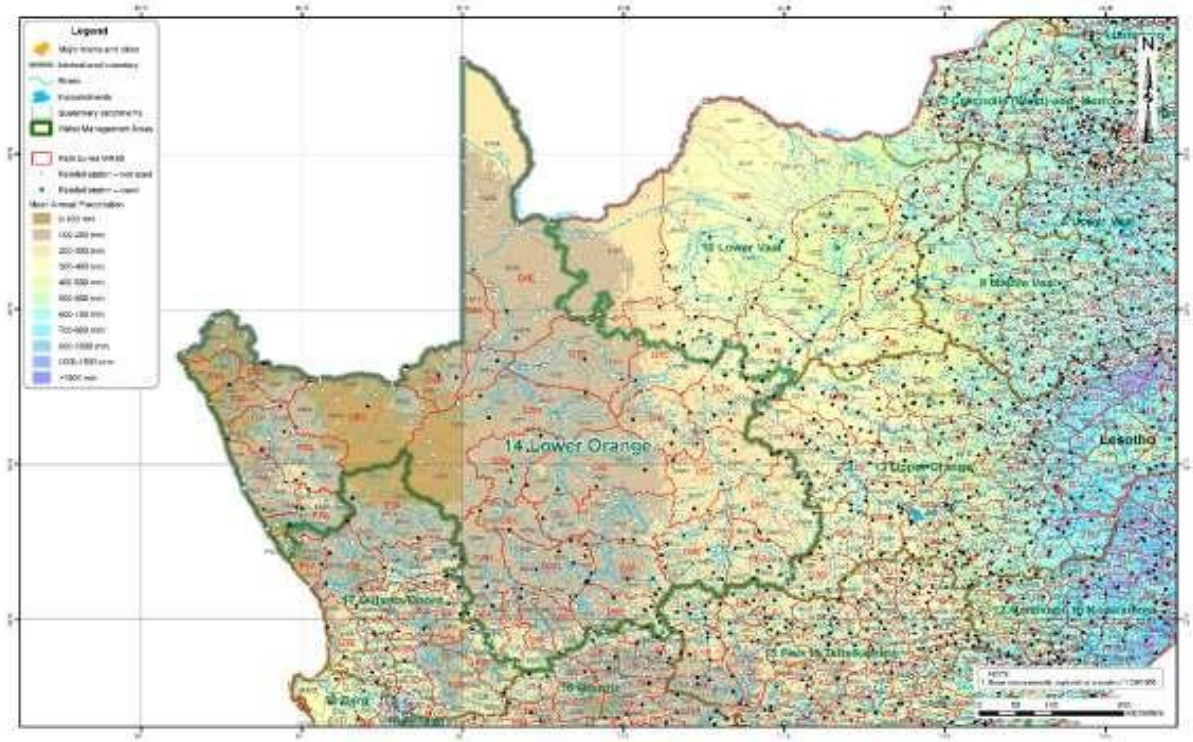


Figure 3. Rainfall zone D5N (Water research commission 2005)

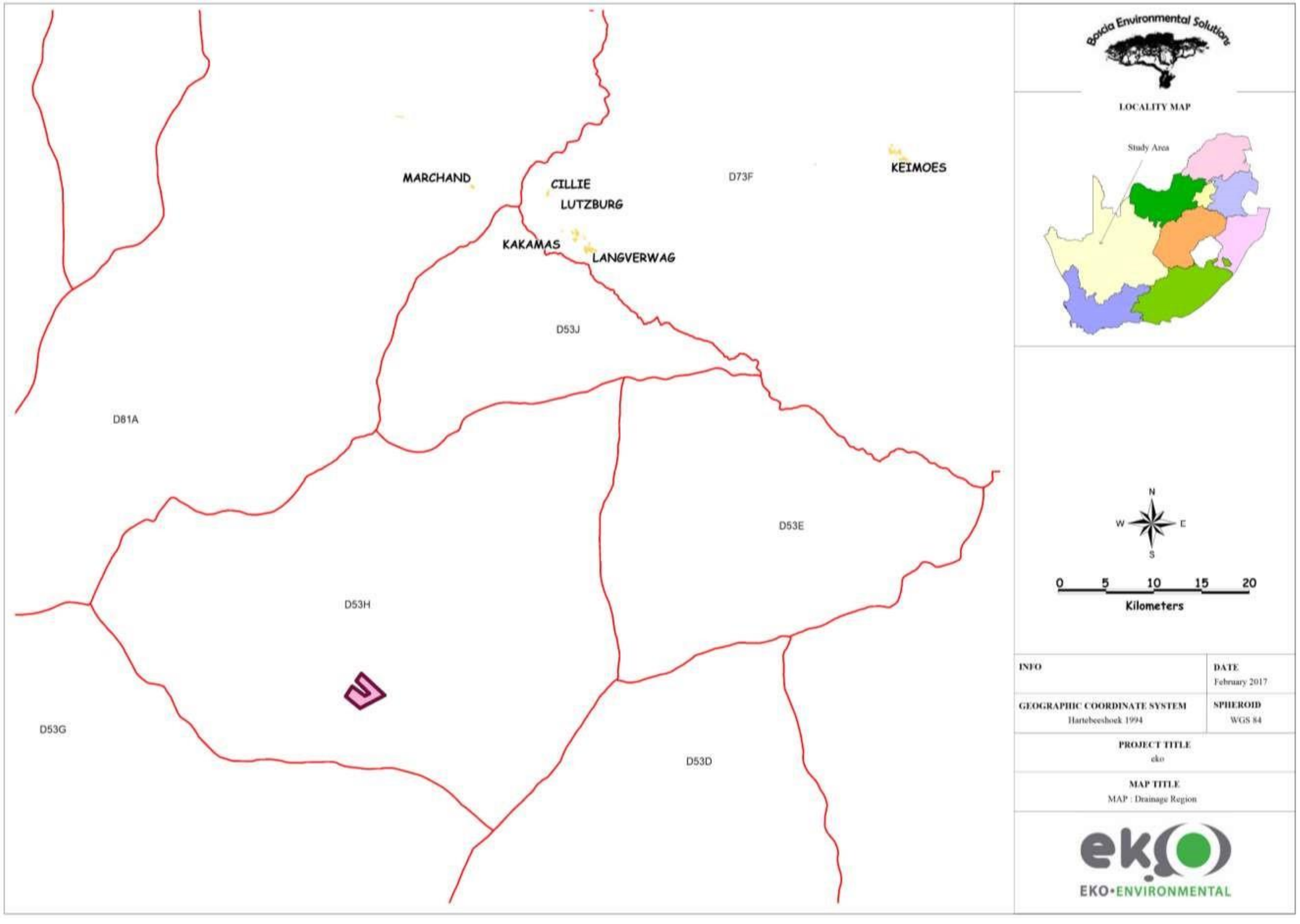


Figure 4. Quaternary sub catchment information

3.1.2 Evaporation

The proposed solar farm lies within evaporation zone 6A, with a mean annual evaporation (S-Pan) >2600mm. Refer to Figure 5

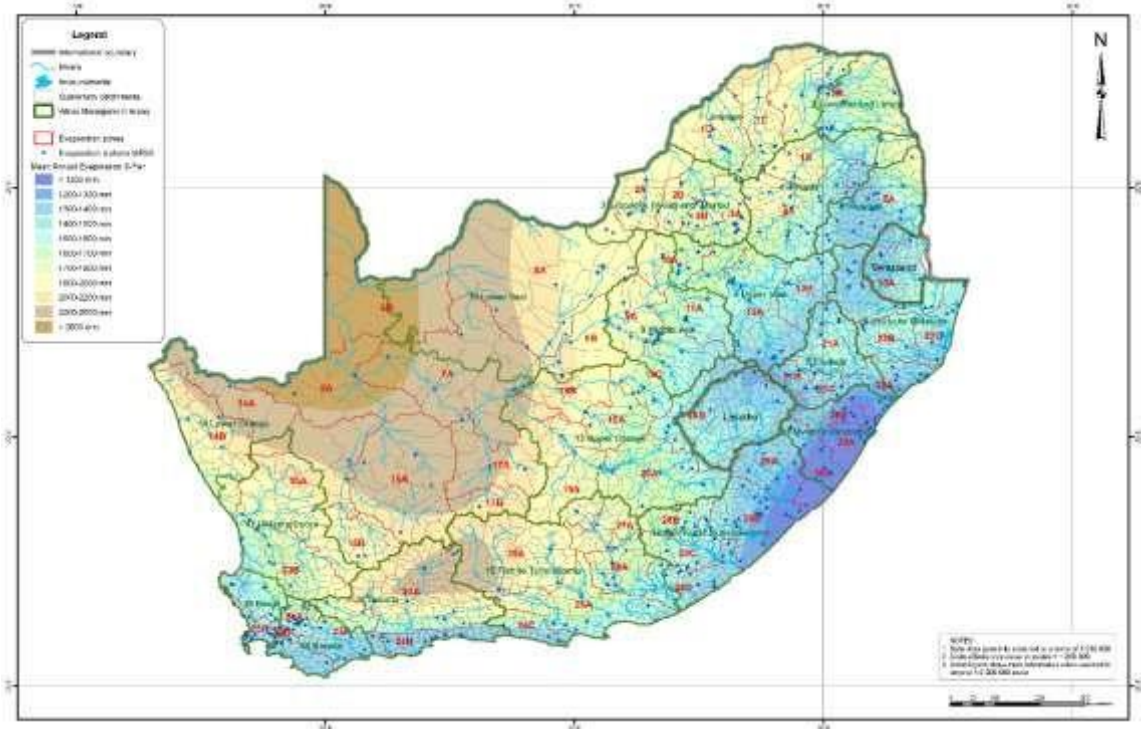


Figure 5. Evaporation zone 6A (Water research commission 2005)

3.1.3 Runoff

It is depicted on map shown in Figure 6 that the proposed site has a mean annual run-off between 0 – 2.5 mm.

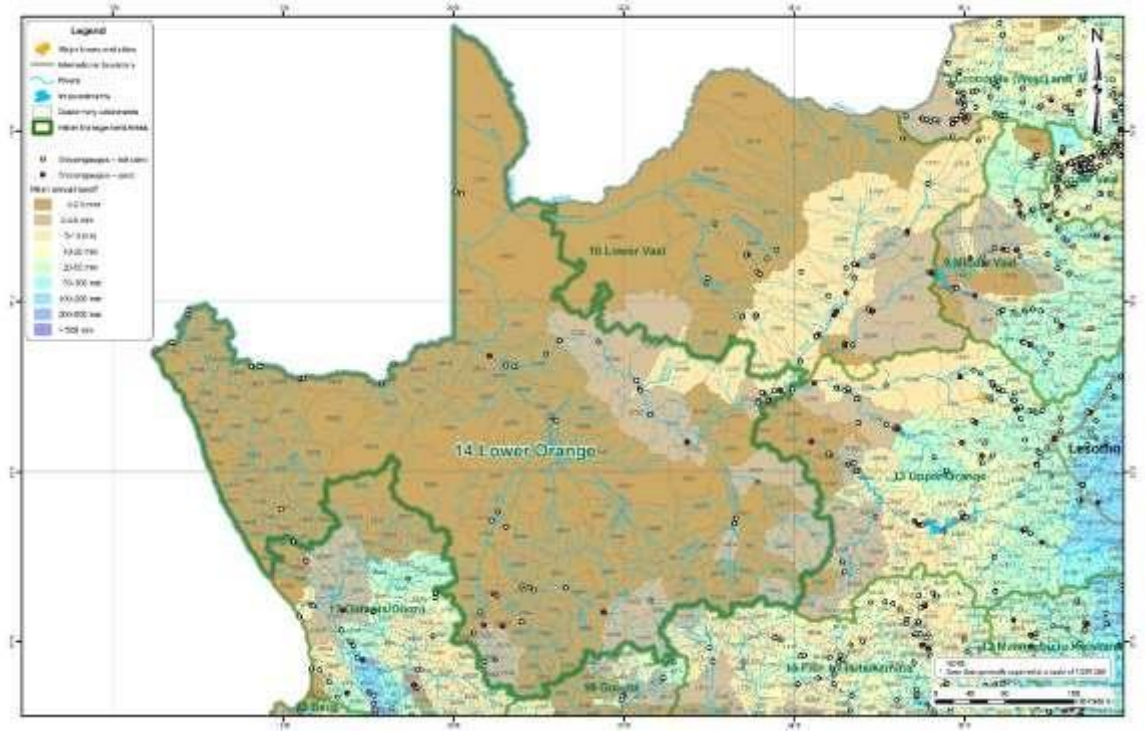


Figure 6. Runoff (Water research commission 2005)

3.1.4 Vegetation

It is indicated on map shown in Figure 7 that the vegetation is classified as Karoo and Karroid types.

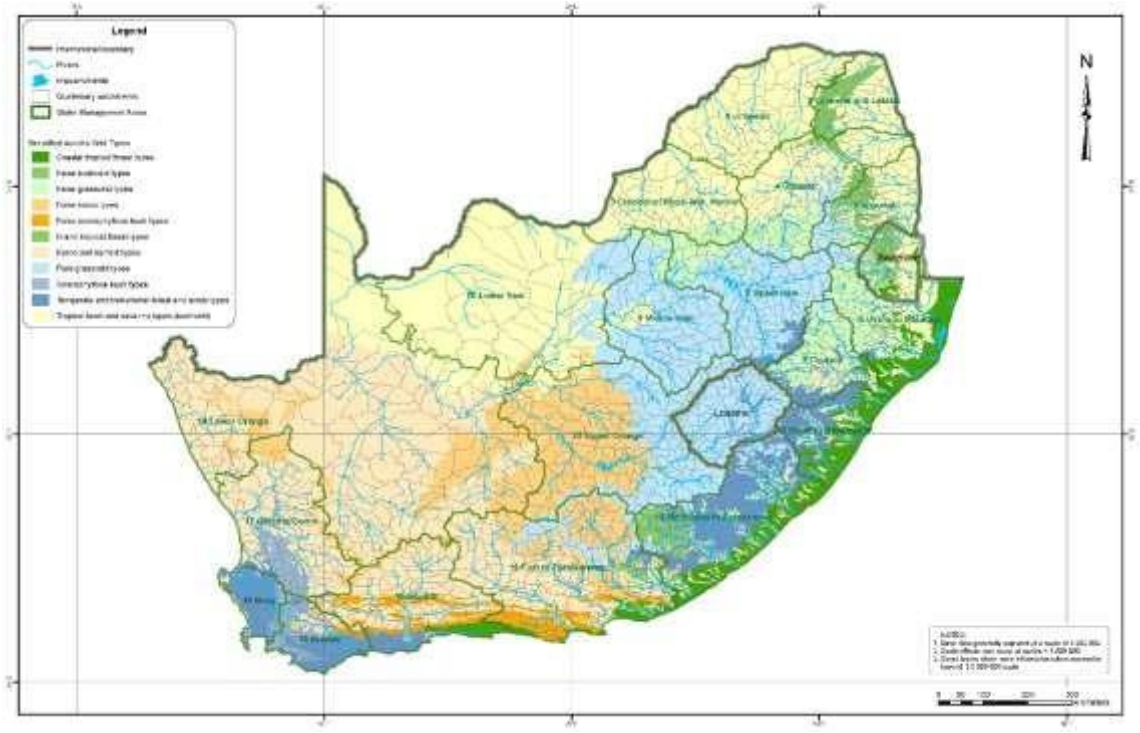


Figure 7. Vegetation (Water research commission 2005)

3.1.5 Sediment (Erodibility Index)

Erodibility of the proposed site is classified as medium. Refer to Figure 8

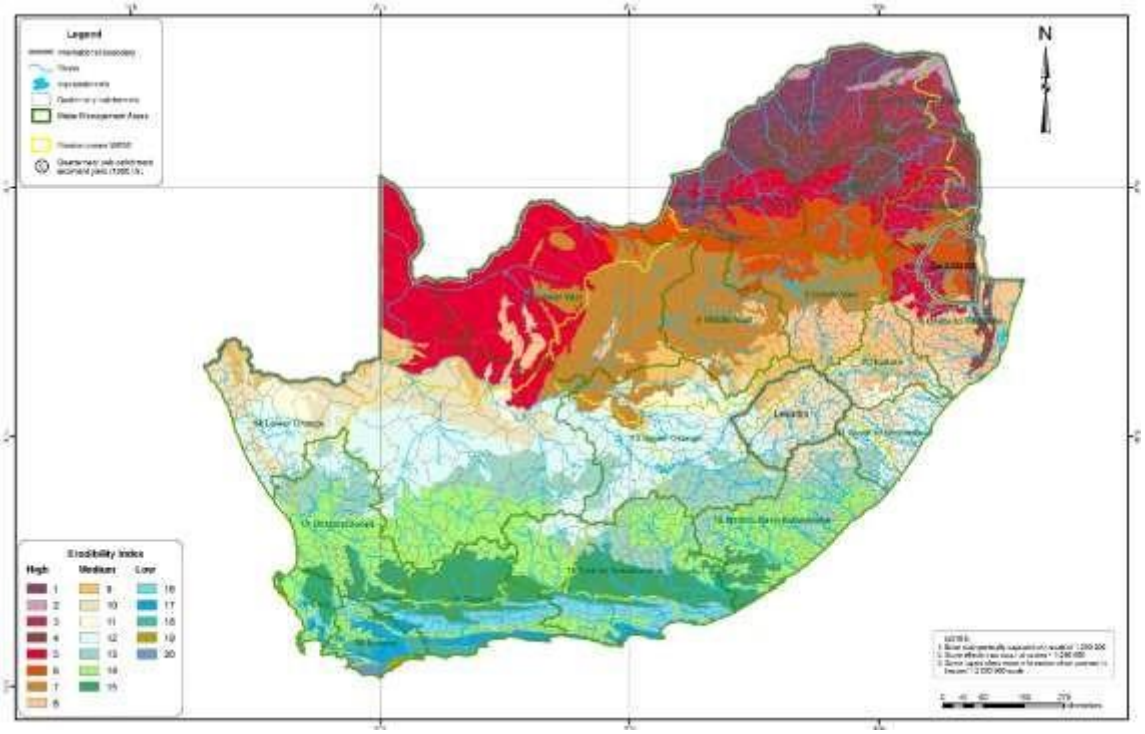


Figure 8. Erodibility Index (Water research commission 2005)

4 DESKTOP GEOHYDROLOGY

4.1 Surface water

The study area is located within the Lower Orange Management Area, Quaternary Drainage Area D53H. The non-perennial Sout river lays to the north-eastern boundary and run-off is in a north -eastern direction towards the Sout river.

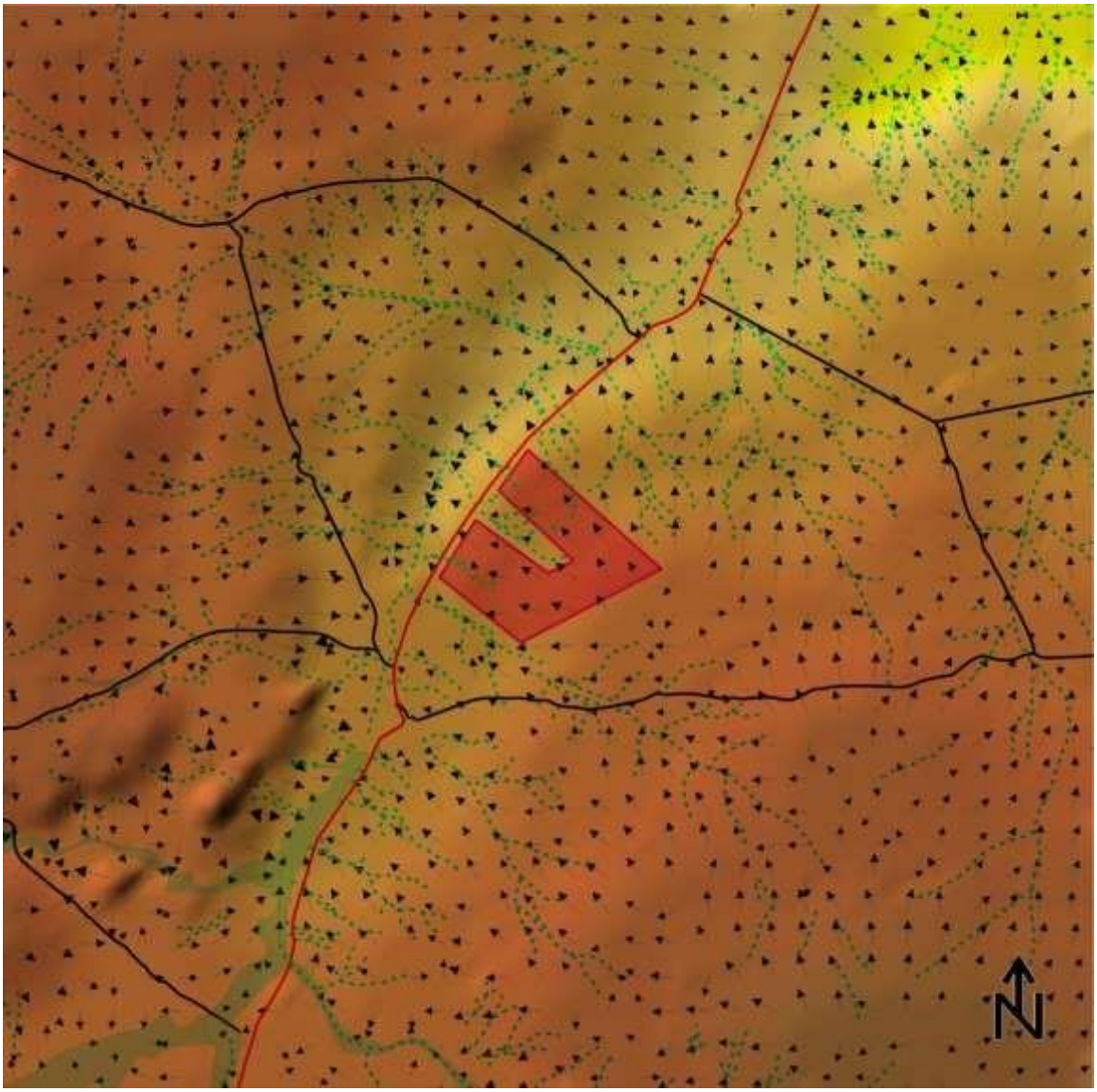


Figure 9. Local topography and drainage in the vicinity of the proposed solar farm.

4.2 Groundwater

4.2.1 Groundwater Occurrences

Groundwater occurs in zones of weathering and in fractures or in the contact zones between different lithology's, such as granodiorite, granite, pegmatite and gneiss of the Keimoes Suite (Me), Yield is generally less than 0.5 l/s.

Groundwater can be exploited from joints and fractures in calcsilicates and sub ordinated quartzites of the Geelvloer Group (Mgv). The calc silicates have known karstic aquifer properties and are not likely to facilitate groundwater occurrence. Refer to Figure 10

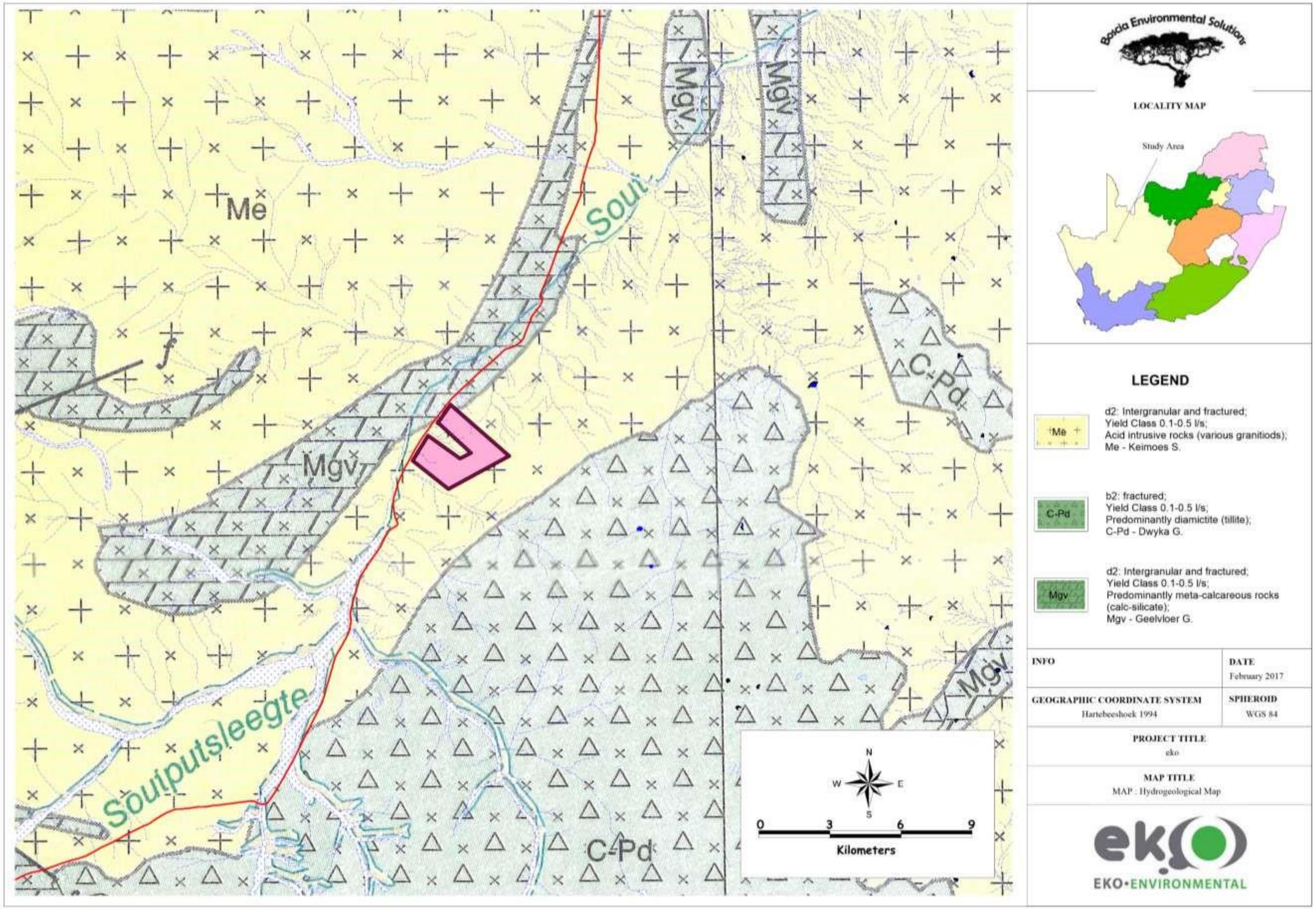


Figure 10. Hydrogeology map

4.3 Desktop Aquifer Classification

4.3.1 Aquifer Classification

The aquifer(s) of the area under investigation is classified as a poor aquifer according to the map of Aquifer Classification of South Africa, 2012 and is depicted in Figure 11. The map indicates the aquifer classification system of South Africa. Blue represents the major aquifer region which is a high yielding system of good water quality. Green represents the minor aquifer region which is moderate yielding aquifer system of variable water quality. Pink represents the poor aquifer region which is low to negligible yielding aquifer system of moderate to poor water quality.

4.3.2 Aquifer Susceptibility

The aquifer susceptibility index is classed as low vulnerability and depicted on the map in Figure 12. The map indicates the qualitative measure of the relative ease with which a groundwater body can be potentially contaminated by anthropogenic activities and includes both aquifer vulnerability and the relative importance of the aquifer in terms of its classification.

4.3.3 Aquifer Vulnerability

The aquifer vulnerability for the study area indicates the least tendency for contamination if pollutants are discharge or leeched over the long term and is depicted on map in Figure 13. The map indicated the tendency or likelihood for contamination to reach a specified position in the groundwater system after introduction at some location above the uppermost aquifer. Green represents the least vulnerable region that is only vulnerable to conservative pollutants in the long term when continuously discharged or leached. Yellow presents the moderately vulnerable region which is vulnerable to some pollutants, but only when continuously discharged or leached. Red presents the most vulnerable region, which is vulnerable to many pollutants except those strongly absorbed or readily transformed in many pollution scenarios.

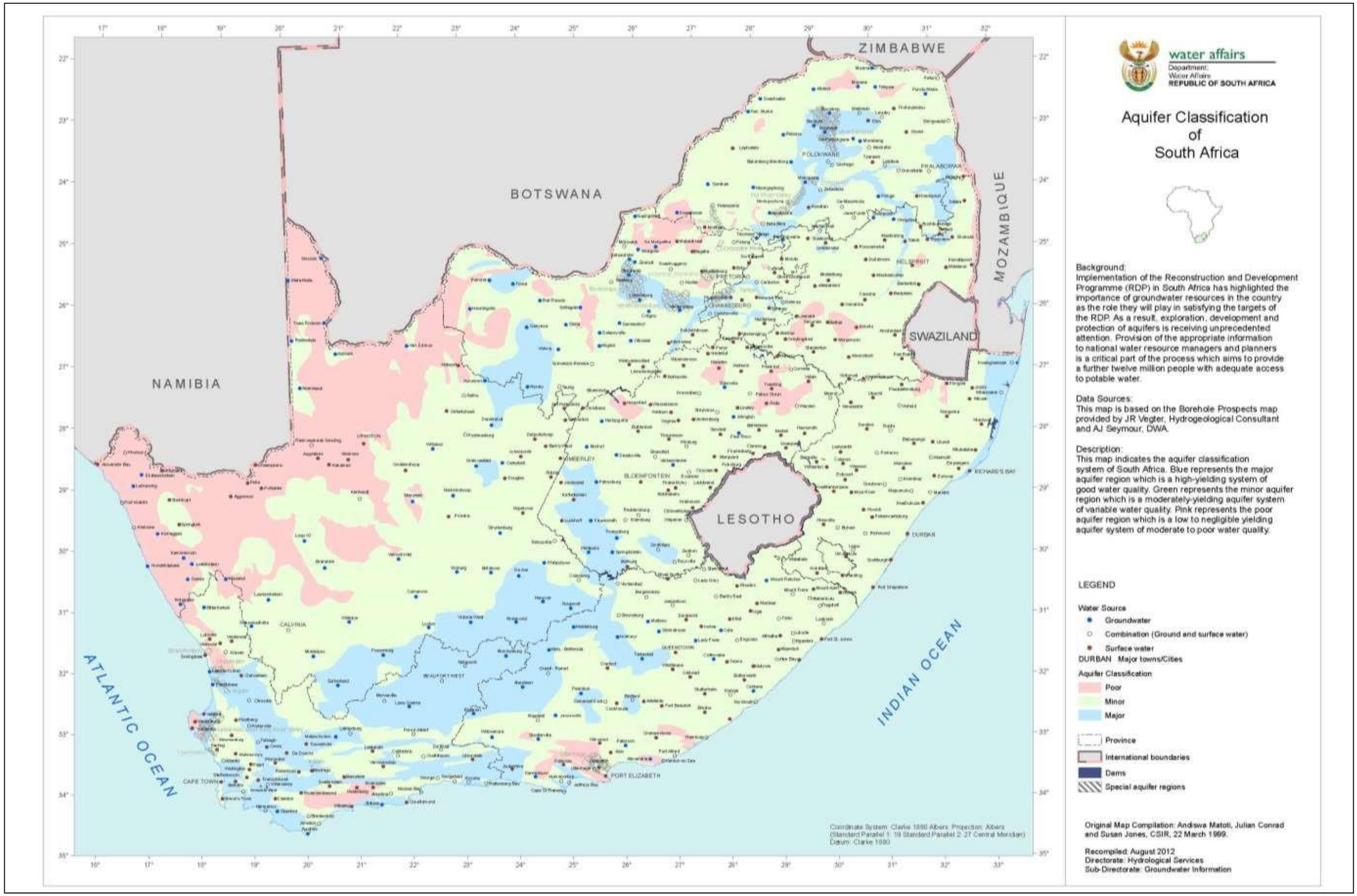


Figure 11. Aquifer Classification of South Africa, 2012.

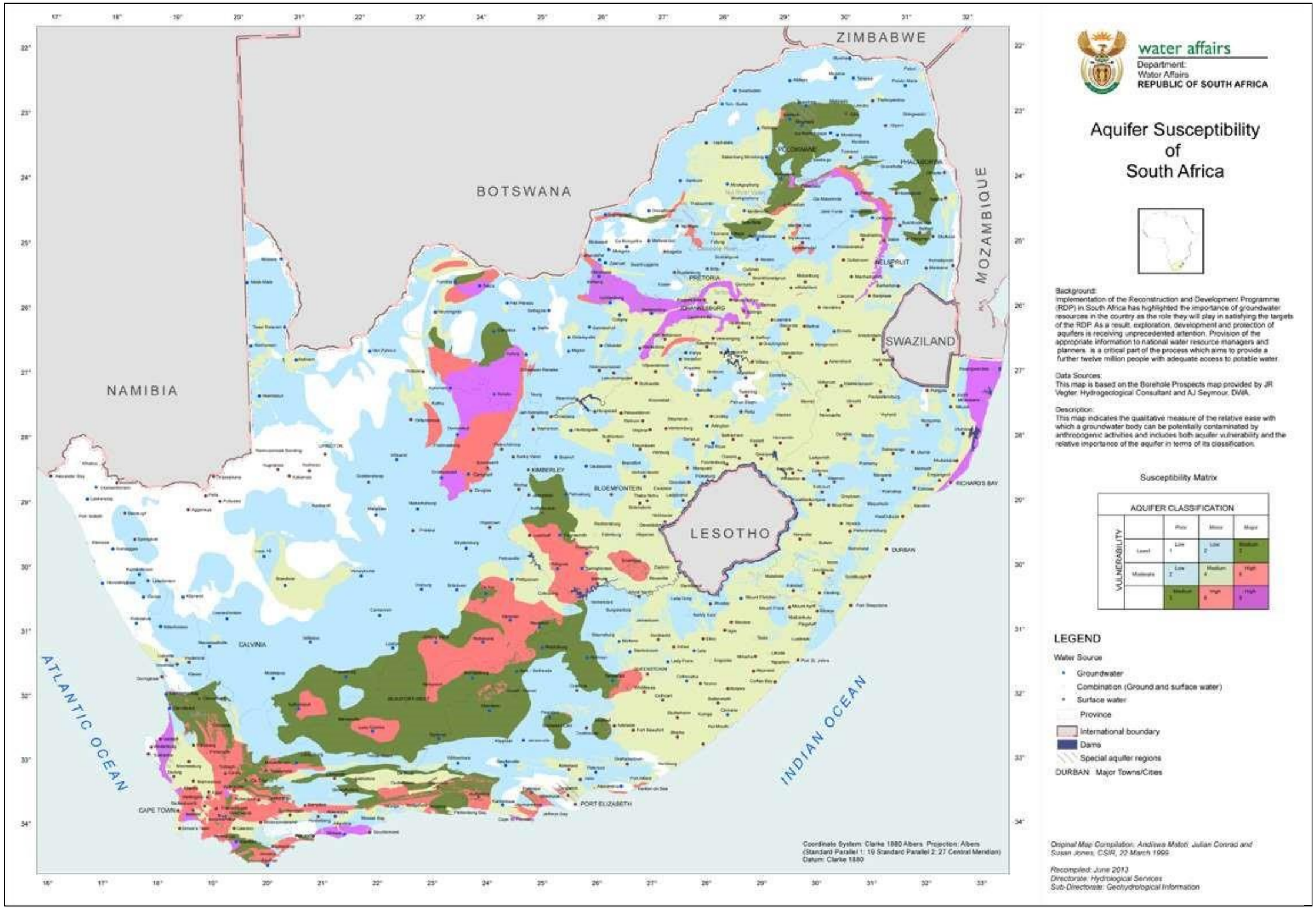


Figure 12 Aquifer Susceptibility of South Africa, 2013.

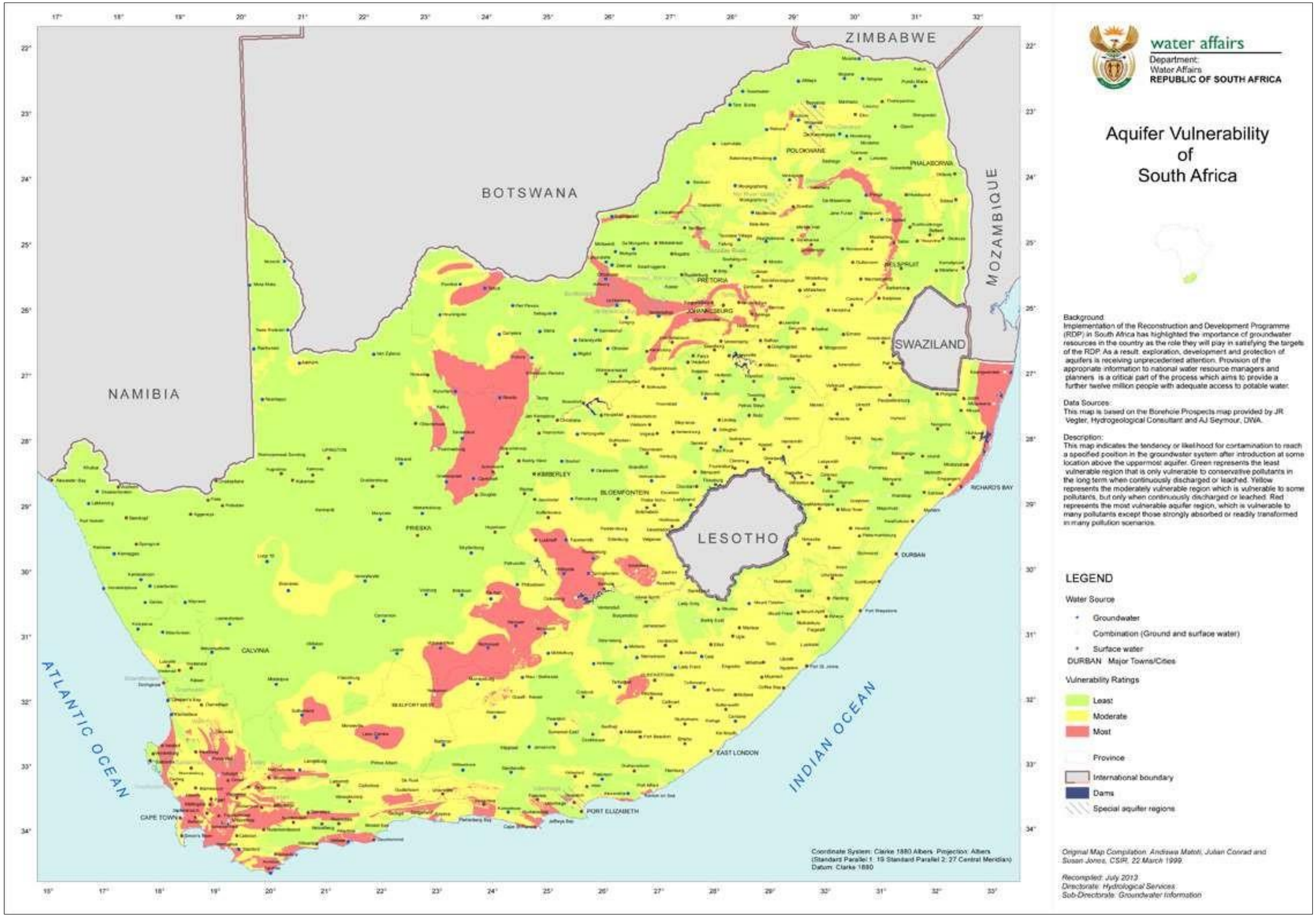


Figure 13. Aquifer Vulnerability of South Africa, 2013.

5 FIELD INVESTIGATION

The field activities involved the locating, surveying, sampling, water level measurement and accumulation of general borehole information.

The following table (refer to Table 1 and Figure 14) contains the general borehole information collected during the field investigation.

Site Name	Type	Sampled	Latitude X	Longitude Y
Breipaal I	Borehole sampled at Dam	Yes	20.36258	-29.20427
Breipaal II	Borehole	Yes	20.33964	-29.18306
Breipaal III	River	Yes	20.36193	29.19806

Table 1. Sampled site near Proposed solar farm

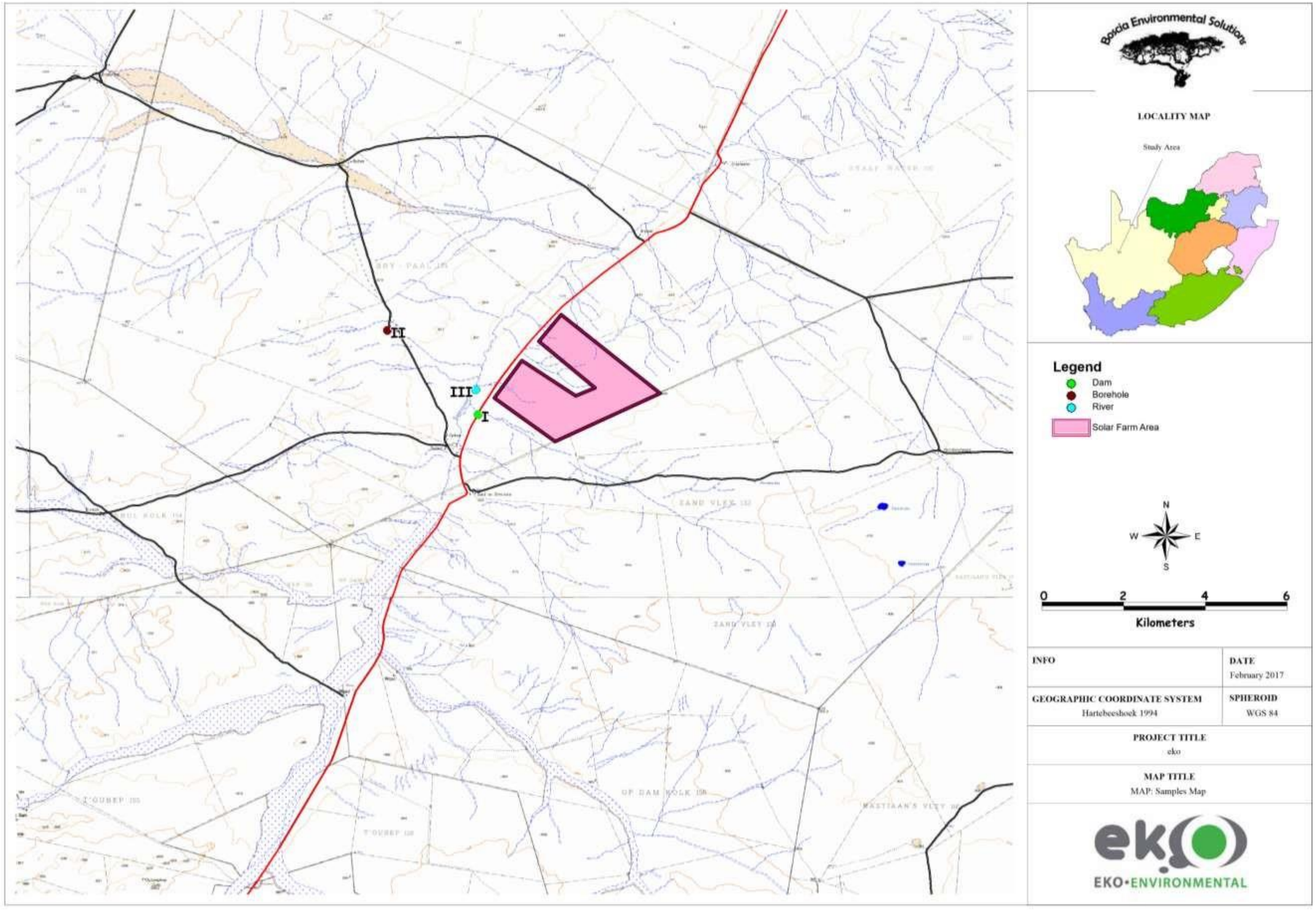


Figure 14. Location of sampled sites.

6 WATER QUALITY

Surface- and groundwater samples taken during the current monitoring phase were submitted to the IGS Laboratories for analyses of the different parameter concentrations. The results of the analyses are presented in this section by various graphical means and observations regarding the contamination status of the surface- and groundwater are made.

6.1 Analysis Reliability

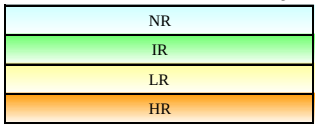
The most common way to evaluate the reliability of an analysis is an ion balance calculation. For any water analysis, the cations and anions should balance. Evaluation is done by calculation and the result is referred to as the ion balance error. A negative value indicates that anions predominate in the analysis and a positive value shows that the cations are more abundant. For the analysis to be considered reliable the ion balance error should not be greater than |5%|. A value outside this figure indicates that some major constituent or constituents were not analysed for or that there was an analytical error. Therefore, a full analysis is necessary. Exceptions to the above rule are found, especially in water with very low TDS. In this circumstance, an ion balance error may be due to the mathematical rounding-off of decimal values.

6.2 Data Tables and Water Quality Tables

6.2.1 Water Quality Tables

In this tables the water samples from each monitoring site are classified according to the "South Africa Water Quality Guidelines, Volume 1: Domestic Use, DWAF, First Edition 1993" and the "South Africa Water Quality Guidelines, Volume 1: Domestic Use, DWAF, Second Edition 1996", as well as according to the publication
"Quality of Domestic Water Supplies, DWAF, Second Edition 1998" as well as "The South African National Standard (SANS 241:2006 Edition 6.1, SANS 241-1:2011 Edition 1 and SANS 241-1:2015 Edition 2)"according to the publication a description of the various classes is given in. A description of the various classes is given in Table 2.

Table 2. Classification system used to evaluate water quality classes



1993,1996 South Africa Water Quality Guidelines, Volume 1: Domestic Use, DWA&F, First Edition 1993 & Second Edition 1996 - **Target water quality range** - No risk.

- **Good water quality** - Insignificant risk. Suitable for use, rare instances of negative effects. -

Marginal water quality - Allowable low risk. Negative effects may occur in some sensitive groups -

Poor water quality - Unsuitable for use without treatment. Chronic effects may occur.

2006

SABS South Africa National Standard: Drinking Water, SANS 241:2006 Edition 6.1 - **Recommended operational limit** - Suitable for lifetime use.

- **Maximum allowable limit** - Suitable for limited duration use only.
- **Above maximum allowable limit** - Unsuitable for human consumption.

2011

SABS South Africa National Standard: Drinking Water, SANS 241-2:2011 Edition 1 - **Recommended standard limit** - Suitable for lifetime use.

- **Above recommended standard limit** - Unsuitable for lifetime human consumption.

2015

SABS South Africa National Standard: Drinking Water, SANS 241-1:2015 Edition 2 - **Recommended standard limit** - Suitable for lifetime use.

- **Above recommended standard limit** - Unsuitable for lifetime human consumption.

Table 3. Water quality of sampled sites.

Site No.	Quality Class				pH	EC mS/m	TDS mg/L	Na mg/L	Ca mg/L	Mg mg/L	K mg/L	Cl mg/L	SO4 mg/L	F mg/L	NO_2N mg/L	NO_3N mg/L	PO_4 mg/L	Fe mg/L	Mn mg/L	As mg/L	Cu mg/L	Al mg/L	Zn mg/L	B mg/L	Ba mg/l	U mg/l	MALK mg/L	PALK mg/L	Calcium Hardness mg/L	Magnesium Hardness mg/L	Total Hardness as $CaCO_3$ mg/L	Bromide mg/L
Reference Standard:	**1993,1996**	**2006**	**2011**	**2015**														**2015**	**2015**	**2015**					**2015**	**2015**						
Breipaal I		AMA	Class 1	ARS	**2015**	**2015**	**2015**	**2015**	**2006**	**2006**	**2006**	**2015**	**2015**	**2015**	**2015**	**2015**	<2				**2015**	**2015**	**2015**	**2015**			86	0	1101	180	1281	11
	NR				6.7	896	6098	1710.0	441	44	26	2552.0	1195.0	1.81	0.20	7.92		0.034	0.006	0.010	0.05	0.12	0.3	2.09	0.010	0.010						
Breipaal II		AMA	Class 1	ARS													<2										97	0	1018	163	1181	11
	NR				6.7	880	5594	1588.0	407	40	23	2310.0	1080.0	1.52	0.20	9.05		0.028	0.002	0.010	0.04	0.12	0.3	1.93	0.010	0.010						
Breipaal III		AMA	Class 1					10707.0				18511.0					<10										276	0	3283	1505	4788	68
	NR			ARS	7.2	4770	35942		1313	367	213		4522.0	1.01	1.00	5.00		0.018	0.008	0.010	0.05	0.10	0.0	10.84	0.054	0.010						

* (Ae) - Aesthetic standards.

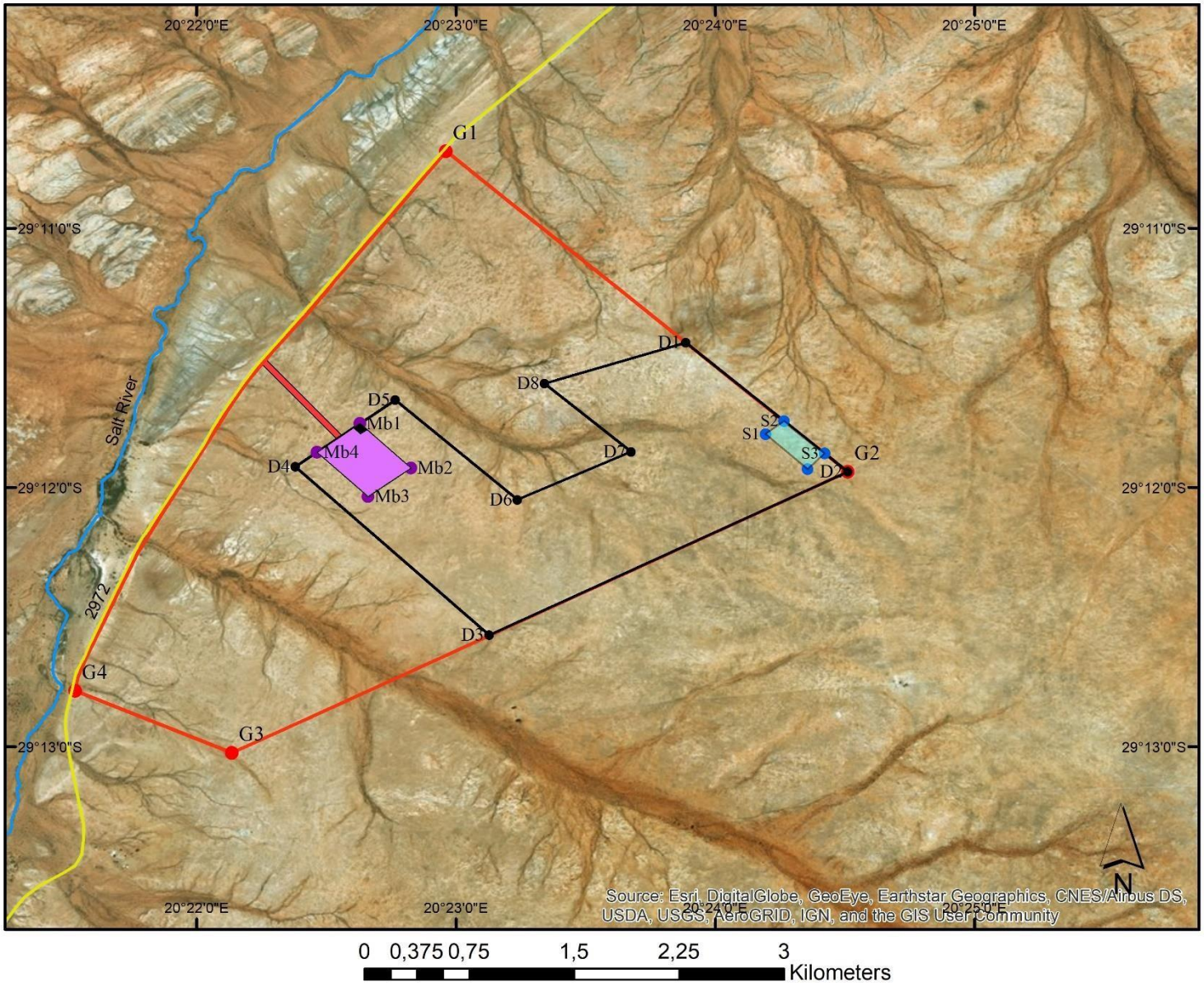
7 CONCLUSION

- The study area is located within the Lower Orange Management Area, Quaternary Drainage Area D53H. The non-perennial Sout river lays to the north-eastern boundary and run-off is in a north -eastern direction towards the Sout river.
- Groundwater occurs in zones of weathering and in fractures or in the contact zones between different lithology's, such as granodiorite, granite, pegmatite and gneiss of the Keimoes Suite (Me), Yield is generally less than 0.5 l/s. Groundwater can be exploited from joints and fractures in calcsilicates and sub ordinated quartzites of the Geelvloer Group (Mgv). The calc silicates have known karstic aquifer properties and are not likely to facilitate groundwater occurrence. Refer to Figure 10
- The aquifer(s) of the area under investigation is classified as a poor aquifer according to the map of Aquifer Classification of South Africa, 2012 and is depicted in Figure 11.
- The aquifer susceptibility index is classed as low vulnerability and depicted on the map in Figure 12.
- The aquifer vulnerability for the study area indicates the least tendency for contamination if pollutants are discharge or leeched over the long term and is depicted on map in Figure 13.
- The water quality of sampled sites Breipaal I, Breipaal II and Breipaal III is classified as above the recommended standard and are not suitable for human consumption. These sites are classified above the recommended standard due to very high EC, TDS, Na, Ca,Cl, S04 and F concentrations.

AMENDMENT

After carefully considering all the impacts associated with this development (as identified and mitigated according to all specialist reports), it was concluded that the 320 ha development and footprint area remains in the south-eastern section of the farm, as indicated in Map 1 of this Amendment. The location of the sub-station was selected near the eastern boundary in order to ensure the shortest possible distance from the sub-station to the transmission power-line, and consequently minimise the visual impact thereof. The location of the laydown area was selected as follows, in order to ensure minimal environmental disturbance as well as minimal dust generation. This proposed development area corresponds to all specifications and recommendations as prescribed by all the accompanying specialist reports.

Development Area



Legend

River
Road
Access Road
Farm Boundary
Sub-Station
Lay-Down Area
Monitoring Building
Preposed Development Area

Sub-Station Coordinates

- S1-29°11'47.59"S_ 20°24'11.58"E
- S2-29°11'44.57"S_ 20°24'15.86"E
- S3-29°11'52.08"S_ 20°24'25.28"E
- S4-29°11'55.68"S_ 20°24'21.32"E

Lay-Down Area Coordinates

- Mb1- 29°11'45.16"S_ 20°22'37.75"E
- Mb2- 29°11'55.44"S_ 20°22'49.53"E
- Mb3- 29°12'02.08"S_ 20°22'39.63"E
- Mb4- 29°11'51.79"S_ 20°22'27.79"E

Preposed Development Area Coordinates

- D1- 29°11'26.48"S_ 20°23'52.89"E
- D2- 29°11'56.31"S_ 20°24'30.59"E
- D3- 29°12'34.69"S_ 20°23'6.68"E
- D4- 29°11'59.82"S_ 20°22'23.02"E
- D5- 29°11'43.04"S_ 20°22'49.89"E
- D6- 29°12'2.78"S_ 20°23'14.21"E
- D7- 29°11'51.69"S_ 20°23'40.48"E
- D8- 29°11'35.89"S_ 20°23'20.44"E

Farm Boundary Coordinates

- G1-29°10'42.11"S_ 20°22'57.67"E
- G2-29°11'56.30"S_ 20°24'30.59"E
- G3-29°13'1.33"S_ 20°22'8.13"E
- G4-29°12'47.01"S_ 20°21'31.85"E

Map 1: Final proposed development area.