h) the use of vegetated open channels next to roads to convey and treat storm water runoff (acting as a bio-filter : allow suspended sediment particles to settle, and to remove pollutants) and resulting in slower discharged velocities;

i) introduce storm water runoff energy breakers in road side drains, eg. grass or rock-lined swales;

j) the use of infiltration systems, eg. cut-off sub-soil drains to minimise the impact of sub-surface ground water, especially at the foot of high cut embankments next to roads and other excavations, if applicable;

k) washing and cleaning of construction plant and equipment should also be done at dedicated demarcated areas at the temporary plant storage area. Berms or lined ponds should be constructed, in order to trap any cement, oils and fuel spillages etc. and to prevent excessive soil erosion at the washing areas.

l) where steep areas exist or will be constructed, eg fill embankments or temporary stockpile heaps, suitable storm water management features and vegetation rehabilitation must be exercised, to prevent soil erosion and prevent any sediment from entering the downstream water courses;

m) Erosion and sedimentation into water courses must be minimised through the effective stabilisation (eg. using Gabions and/or Reno mattresses and/or Soil Saver blankets) and the re-vegetation of any disturbed riverbanks, especially at fresh embankment cuts near (non-perennial) water courses and the stream crossings;

The Developer will be required to provide sufficient and suitable on-site storm water management features as proposed above, and will also be responsible to maintain the storm water and open hard surface infrastructure during the entire operation period of the PV Solar Energy facility.

4 EROSION CONTROL

The lack of storm water planning during Detail Design stage will lead to excessive erosion over time. **The lack of effective erosion control will result in the wash-away of fine material like sand and silt**. This will create unnatural storm water run-off paths, which will developed into erosion channels and later may develop into land slip scars.

If erosion occurs on gravel road surfaces, due to excessive storm water run-off with too high velocities, regular road grading maintenance will be required to solve minor road surface erosion problems, such as rutting, corrugation and potholes. **If regular maintenance is neglected, road surface erosion will develop in more severe problems**, eg. cross-cut channels, which may negatively impact on the accessibility of transport roads.

If erosion occurs on gravel fill embankments, which are generally 'softer' than the compacted hard surfaces or cut face slopes, erosion channels may very soon develop, and transport valuable top soil downstream. Storm water will opt to flow down the path of least resistance, hence, it will discharge via erosion channels,

at higher velocities and causing more severe wash-aways over time. This snow-ball effect may lead to major road damage, which will have major cost implications, if main access roads become inaccessible during the construction or component transportation stages.

It is therefore recommended that fill slopes be covered with topsoil and grass as minimum protection to minimise the development of erosion. Geo-synthetic material such as Kaytech's Soil Saver or similar Geo-synthetic membranes may be used to protect and stabilize fill embankments. At localised sections along the gravel roads or at storm water inlet and outlet ends, it may be necessary to protect the toe of cut embankments from local slip, by anchoring rock-filled gabion cages at road level.

5 STREAM CROSSINGS

5.1 Location of Existing Stream Crossings

No existing water courses (or generally referred to as "***Stream Crossings***"), either perennial or non-perennial, were observed on site, or on the 1:50 000 Topographical or Google Maps, which will be intersected with any of the proposed on-site ring roads or internal roads, in between the arrays of PV solar panels.

The northern section of the Kalkpoort Road will serve as one of the main access roads to the Solar Farm Development. This road is running from the intersection with the Provincial Main Road R369 (at the '***Access No2 to Site'*** position) towards the northern Site Boundary, (refer to Map 2 above). This road runs across three (3) main existing water courses and will provide direct access to Phase 2 (northern development area) of the Kloofsig PV Solar farm. A new site access road will run from this Kalkpoort road, providing access to Phase 1 (central development area).

The co-ordinates of the Kalkpoort Road intersection with the Provincial Main Road R369 are as follow :

Location of "**Access No2 to Site**" :

- Latitude : 29°57'47.12"S and Longitude : 24°35'29.13"E

The basic characteristics of these stream crossings are tabled below :

Table 1 : Locality and Characteristics of the Stream Crossings

Stream Crossing No	Latitude (South)	Longitude (East)	Catchment Area (km^2)	Longest Water Path (km)	Stream Flow Path (km)	Concen-tration Time (hours)	1:10 year Recurrence Flood (m^3/s)
SC1	29°58'03.50"S	24°35'13.05"E	2,97	4,91	2,39	2,86	1,115
SC2	29°58'36.94"S	24°34'24.91"E	6,94	6,83	4,27	3,42	2,405
SC3	29°59'02.60"S	24°33'58.49"E	22,52	9,01	3,13	5,12	5,520

Storm water run-off calculations have been made using the Rational Method (**refer to Table 1 above**), based on the understanding of the site characteristics, to calculate the expected 1:10 year flood peaks at each of the three (3) stream crossings. **It is recommended that the existing stream crossings should at least be sufficient to accommodate this design flood**.

5.2 Condition of Existing Stream Crossings

These three (3) water courses have all non-perennial flow, with no flowing or ponding water observed on site. The water courses are wide flat open streams, with predominantly sand river beddings. Flow durations are generally very short, limited to a couple of hours up to a few days after very high rainfall events, with wide flow widths, fairly shallow depths and low velocities.

Low storm water run-off volumes generally seeps into the ground, through the sandy soils or fractured rock or pebble bed layers. Higher floods may overtop the storm water infrastructure, but usually abate after a few hours once the peak run-off has passed.

No sign of major flooding or erosion damage has been observed at the existing stream crossings. The existing storm water infrastructure are therefore deemed sufficient and in acceptable condition. However, the capacity needs to be determined after further detail site surveys and during the detail design stage.

Entire access road closures during extreme flood events for extended periods, during the Solar Farm construction and component transportation periods, can be accommodated by using the existing southern section of the Kalkpoort Road, to access the Solar Farm.

5.3 Proposed Upgrading Work at Stream Crossings

The northern road section of the Kalkpoort Access Road will receive minor upgrade, minor road widening work and re-grading work, to accommodate the expected construction vehicles. ***It is therefore not anticipated that any of these three water courses will require any major upgrade work***. The preliminary designs of the stream crossings, to calculate the storm water capacity, fall beyond the scope of this report.

Upgrading work at the existing storm water infrastructure will have to comply with:

- the new 6m wide road widths;
- the flatter vertical gradients, hence the road fill on top of the structures will have to be raised;
- the capacity of structures (openings) will have to be upgraded to accommodate a 1:10 year flood.

This minor upgrading work will not trigger any activities listed as per *GNR 544, Activities 11, 18 and 39 of the National Water Act (Act 1970)*.** It is not expected that any excavations (moving material into or removal of material from a water course – *GNR 544, Activity 18*), within 32m of the water course, will exceed the minimum volume of 5m³. Therefore a WULA Application will not be required, in this instance.

No preliminary designs have yet been made for the required storm water infrastructure. However, it **is expected that the existing storm water infrastructure can** accommodate the calculated 1:10 year design peak flow.

5.3.1 *Practical construction principles*

The following construction work may take place at the stream crossings :

- The bedrock material of the stream crossings may be disturbed to allow for a stable and level foundation and good sub-surface drainage below the structure.
- Imported side fill material will be required to protect or smooth out side gradients.
- Concrete walls or stone-filled gabion cages may be constructed at existing or new head walls and wing walls to protect the storm water structures from under scouring and from erosion on the fill slopes during extreme floods.
- The gravel road surfaces along the approach gradients near the stream crossings, will be exposed to higher wheel ravelling due to breaking and acceleration actions whilst transporting heavy loads. It is therefore recommended that the road surface of the access roads, where they will cross these stream crossings (water courses), should be concrete-lined to prevent ravelling, pothole formation and surface erosion. This will limit future maintenance and negate flood damage on critical areas along the transport routes.

6 RECOMMENDATION

It is recommended that the contents of this report be noted and included as part of the detail planning and design stages, in order to implement these recommendations during the construction, operational and maintenance stages.

1. *This Storm Water Management and Erosion Control Report should be included as an Annexure in the final EIA report, as part of the project Application to DEA;*
2. *An EMPr must be compiled accordingly, to regulate the construction activities, which should include all the recommendations of this report;*
3. *Due care should be taken during construction and operation stages, not to disturb any vegetated areas by unauthorised travelling outside of the demarcated road servitudes;*
4. *That areas which need to be cleared from top-soil for bulk earthwork levelling, be planned carefully and be limited to an absolute minimum;*
5. *That natural vegetation and top-soil be retained undisturbed as far as possible during the construction stage;*
6. *That all temporary construction areas be fully rehabilitated by spreading top-soil and planting of natural indigenous vegetation;*
7. *That any comments and enquiries raised on this Report, be forwarded in writing to AfriCoast Consulting Engineers;*
8. *That this Report be supported and approved by the Developer.*

7 CONCLUSION

AfriCoast Consulting Engineers (Pty) Ltd herewith presents the Storm Water Management and Erosion Control Report to Kloofsig Solar (Pty) Ltd as developer of the Kloofsig PV Solar Energy facility.

This Storm Water Management and Erosion Control Report forms an integral part of the supportive documentation required for the Environmental Impact Assessments (EIA) and application to DEA. An Environmental Management Plan (EMP) should be compiled, which incorporating the recommendations of this report, serving as guidelines to the Developer to comply with the requirements of the Environmental Approval documentation.

We trust that all applicable and related storm water aspects were addressed sufficiently for the purpose of the EIA Application for this Development.

We trust that this report meets your approval and remain available for further enquiries or clarification of the contents of this report, if necessary.

Yours faithfully,

SP Schutte B.Eng (Civil)
Manager : Roads and Transportation

Afri Coast Consulting Engineers (Pty) Ltd

ANNEXURE A : MAPS AND DRAWINGS

- Site Layout Map (Drw No. 015)
- Kloofsig Phase 1 Layout
- Site Development Plan – Phase 1 to 3 (Drw R2004-RD-GA-01-PRE-00)

TO ORANIA

PROVINCIAL ROAD (R369)

ACCESS No. 2 TO SITE

TO LUCKHOFF

PROVINCIAL ROAD (R48)

KALKPOORT ROAD

SC 1

SC 2

SC 3

PHASE 1

PHASE 2

PHASE 3

ACCESS No. 1 TO SITE

TO PETRUSVILLE

TO VAN DER KLOOF DAM

10/10

/10

6/10

RE/49

/49

RE/205

RE/203

RE/204

RE/10

RE/18

RE/184

RE/193

RE/194

RE/20

RE/60

TAAYBOSCH POORT 10

KALK POORT 18

3/18

DAMFONTEIN 192

1/192

FARM 193

1/204

4/191

211

NEW KOPPIESDAM 184

1/49

KALKFONTEIN 49

47

6/47

1/50

GOVERNMENTS LEEGTE 50

ALWYN VLAKTE 20

4/62

DOOREN KUILEN 62

14/62

2/61

RHENOSTERFONTEIN 61

12/61

7/191

Damfontein

Kleinplaas

Klootsig

Kalkpoort

Olienberg

Spitskop 1298.5

Baskop 1329.7

Renpoort

Lieberwalt

Orange Grove

Petrusville

Thembinkosi

Petrusville Aerodrome

GENERAL NOTES

STORM WATER OVER LAND FLOW

CATCHMENT AREAS FOR STREAM CROSSINGS

STREAM CROSSINGS

DRAWING NUMBER CODES

DISCIPLINE			SUBDIVISION No.			STATUS		
WAT	=	WATER	LS	=	LONGSECTION	TEN	=	TENDER
RD	=	ROADS	XS	=	CROSS SECTION	PRE	=	PRELIMINARY
SW	=	STORM WATER	DET	=	DETAILS	CON	=	CONSTRUCTION
ELE	=	ELECTRICAL	GA	=	GENERAL ARRANGEMENT	ASB	=	AS BUILT
STR	=	STRUCTURAL						

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PLOT STYLE: std-plot.ctb
PLOT SCALE: 1:1
PAPER SIZE: A1

NO.	DRAWN	DESCRIPTION	REV	DATE
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08				
07				
06				
05				
04				
03				
02				
01				
DRAWN		DRAWN		--/--/----
DESIGNED		DESIGNED		--/--/----
CHECKED		CHECKED		--/--/----

PROJECT DIRECTOR: _____ DATE

PROJECT MANAGER: _____ DATE

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CLIENT:

KLOOFSIG SOLAR (PTY) LTD

PROJECT:

KLOOFSIG PV SOLAR FARM
DEVELOPMENT ON
FARM KALKPOORT, PORTION RE/18

TITLE:

SITE DEVELOPMENT PLAN
WITH STORM WATER RUN-OFF FLOW
(PHASE 1 TO 3)

DRAWING NUMBER : R2004- RD - GA - 01

SCALE: 1:30 000

PRE - 00

PROJECT No. | DISCIPLINE | SUB No. | DWG No. | STATUS | REVISION

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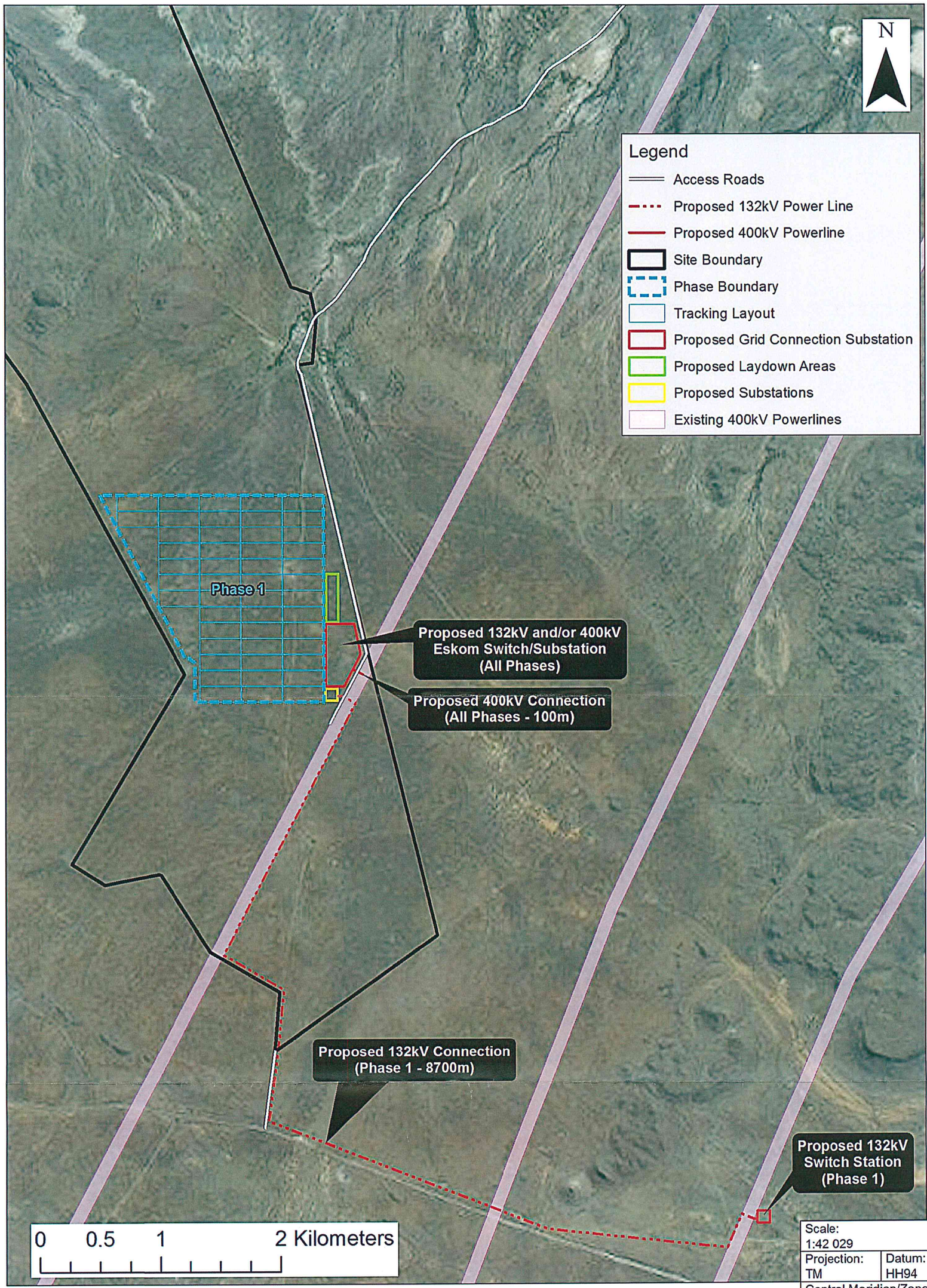

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Projection: TM	Datum: HH94	
Central Meridian/Zone: Lo25		
Date: 04/08/2016	Compiled by: VERJ	
Project No. 486618	Fig No. 006	

srk consulting

Kloofsig
Phase 1 Layout

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Revision: A Date: 00 00 2015