GEOTECHNICAL ENGINEERING
ENGINEERING SURVEY
SPECIALIST GEOTECHNICAL CONTRACTORS
CONSTRUCTION MATERIALS TESTING FACILITY

P. O. Box 227
Maraisburg
1700
South Africa

Geopractica (Pty) Ltd
Reg Number:- 2004\010151\07
VAT Number:- 4300102060
B-BBEE Status:- Level 4 Contributor

Construction House
1164 Minnie Postma Street
Florida Extension 11
Johannesburg

Tel:- +27 11 674 1325
Fax:- +27 11 6744513
E-mail:-thando@geopractica.co.za

To: **SiVEST**	To: **e-mail**
Attention: **Andrea Gibb**	Time: **4 52 PM**
From: **Thanduxolo Msengana**	Date: **18 July 2016**
Ref: *Z:\Projects 2016\SiVest\Tlisitseng 1 and 2 PV Projects\Tlisitseng Solar 2, Alternative 1&2\Desktop Study\Tlisitseng Solar 2 alternative 1 and 2. (Rev 1).wpd*	
THIS DOCUMENT CONSISTS OF ..7.. SHEETS INCLUDING THIS PAGE	

PROJECT: Lichtenburg Solar PV Projects.
SUBJECT: Geotechnical Desktop Review - Tlisitseng Solar 2, Alternative 1 & 2

1 Introduction

Following the completion of the Geotechnical Desk Top Review, dated April 2016, Geopractica were notified that the original substation alternative site have moved and therefore a revised Geotechnical Desk Top Review would be required.

On the 6th July 2016, a letter of appointment, referenced 13303 was received from Ms. A. Gibb of Sivest, instructing Geopractica to proceed with the revised geotechnical desktop review.

The new alternative sites approximately 2000m apart, and it is assumed that each substation site will be in the order of 1Ha.

This geotechnical desk top review only focuses on Tlisitseng Solar 2, alternative substation sites 1 and 2.

2 Objectives

The objectives of the desktop study was to complete a geotechnical review of the 2 alternative substation sites using the following topics :-

2.1 Climate and weather
2.2 Local Geology
2.3 Site Description
2.4 Topography and Drainage
2.5 Seismicity
2.6 Expected Soil Profile
2.7 General

3 Database and Literary Review

This literary review was conducted on data obtained from the following sources:-

3.0.1 Previous investigations in the area undertaken by Geopractica (Pty) Ltd and Geostrategies c.c.
3.0.2 Previous published investigations in the area undertaken by other consultants.
3.0.3 The 1:250 000 geological map, “No 2626 West Rand” was consulted in order to determine the regional geology in the vicinity of the site.
3.0.4 The 1:50,000 topo-cadastral map “2626 AA Lichtenburg” was assessed for topography and drainage of the site.
3.0.5 Google Earth imagery both current and historical.
3.0.6 Seismic hazard map of South Africa.
3.0.7 Internet.

4 Climate and Weather Conditions

According to the Climatic N value map of South Africa compiled by Weinert, Lichtenburg falls into the transition zone between Sub Humid and Sub Arid having an N value marginally greater than 5.

This would indicate that the most likely method of weathering of the bedrock would be due to mechanical disintegration, as opposed to chemical weathering in the areas of the country having a higher annual rainfall.

The weathering profile in these more arid regions of the country, should therefore favour the generation of a thinner residual soil horizon, than would be the case in the more humid, wetter coastal regions.

The average annual rainfall in this area is between 566mm and 620mm, most of which occurs in heavy isolated falls between November and March.

The average maximum summer temperature of approximately 28,0°C occurs in January with an average maximum of 18°C in June. Frost in winter is relatively common.

5 Local Geology

From available literature, it is evident that the site is underlain by dolomite belonging to the Malmani Subgroup within the Transvaal Sequence.

This blue/grey, hard rock dolomite is typically interbedded with of very hard, grey chert, and the upper surface usually weathers insitu to form a dark brown, silty sand with abundant, close packed gravels, cobbles and boulders of both fresh and leached chert and dolomite (residuum).

The bedrock profile within the dolomites is highly variable with hard, steep, dolomite pinnacles with deeply weathered slots (grykes) in between. These hard rock dolomite pinnacle can occur close to surface or at a significant depth, and can be widely separated or closely spaced. These features are due to the fact that dolomites can be easily dissolved by slightly acid ground water, percolating downward from surface, into the underlying formation.

Typically these slots can be filled with wad (a very soft, silt and clay derived from the insitu decomposition of dolomite) and other alluvial debris (dolomite residuum). The collapse of these cavities can result in the formation of sinkholes or doline depressions at the surface.

On the West Rand, most sinkhole and doline formation was related to the drawdown of the local watertable, due to underground mining operations. Human development could also be the triggering mechanism for the formation of sinkholes and dolines, due to the ingress of surface water into the underlying formation due to leaking sewers, water storage ponds, water taps, stormwater drains as well as water services to residential and commercial buildings.

The Malmani Subgroup is subdivided into the Oaktree (lower), Monte Christo (lower middle), Lytleton (upper middle) and Eccles (upper) formations. The Oaktree and Lytleton are chert poor while the Monte Christo and Eccles are generally chert rich. According to the geological map, the site is located within the lower middle Monte Christo (chert rich) Formation.
Typically the chert rich formations tend to be less problematic as the insoluble chert lenses within the dolomite bedrock tend to provide stability to the surrounding soluble dolomite.

A further factor which reduces the risk profile of dolomite terrains, is the presence of a thick and non erodible blanketing soil layer, over the underlying dolomite formation.

The Malmani Subgroup is inturn overlain by quaternary sandy gravel and pedogenic soils in the form of calcrete.

A site geological map has been attached as appendix 3 of this report.

6 Site Description

The proposed Tlisitseng Solar 2 site is located on the southern and south eastern extent of portion 25 of farm Houthaalboomen 31-IP, approximately 8km north west of Lichtenburg in the North West Province. The substation alternative 1 is located adjacent Tlisitseng Solar 1 alternative 1 whilst the proposed substation alternative 2 is located east of the R505 main road.

The individual substation sites are approximately 1Ha in extent and the power line on this site will run in an east west direction, across the R505 main road.

Both proposed substation sites are covered predominantly by tufted veld grass, with scattered shrubs and small indigenous trees.

Numerous excavation are observed both north and south of substation alternative 2. The soil excavated may have been used for construction purposes.

7 Topography and Drainage

7.1 Proposed Substation Alternative 1

Substation alternative 1 is generally flat with minor depression and has no preferential drainage channels. Google Earth imagery suggests that this site may be underlain by well developed, shallow calcrete, which is typically impermeable and thus stormwater ponding could be an issue in this area.

7.2 Proposed Substation Alternative 2

Substation alternative 2 generally slopes gently towards the east at a gradient of between 1% and 2%, which should be sufficient for stormwater runoff, in the form of sheet wash towards the east, after periods of heavy prolonged rainfall. Google Earth imagery also suggests that this site may be overlain by Aeolian sand which is typically free draining, and should accommodate “normal” rainfall via natural percolation.

8 Seismicity

According to the seismic hazard map of South Africa, the site is situated in the area where peak ground acceleration with a 10% probability of being exceeded in a 50 year period falls between 0.12g and 0.16g as seen on the seismic hazard map of South Africa, located in appendix 4.

9 Anticipated Soil Profile

Each typical soil type will be discussed below, considering the potential problems which can be generally anticipated, as well as possible geotechnical solution.

9.1 Recently Transported Soil Types

It can be anticipated that the entire site will have a surface cover of recently transported soils. The thickness of this cover can be expected to vary, according to the recent geological depositional processes that were active at the time. Main critical factors will be the general topography of the areas at the time of the sedimentation cycle as well as the presence of large rivers and lakes. As these transported sediments were laid down in recent geological times, they will not have undergone any significant consolidation. They can therefore be considered to be of a loose consistency, and could experience settlement under applied foundation loading.

Most structures in this area are therefore typically founded at the base of these recently transported materials, on the more competent pedogenic or residual soil horizons.

Alternatively, these loose, potentially collapsible and consolidating soils are removed down to a specified depth, and replaced with well compacted, inert, granular fill materials, which provide a competent base for the proposed structures.

9.1.1 *Wind Blown Aeolian Sands*

These soils have been transported under the action of wind. They usually form relatively deep horizons, and at surface display characteristic undulating sand dune features.

Due to their method of deposition, these sandy soils are generally of low cohesion and consistency, and can be expected to settle under foundation loading.

Where this sandy surface horizons is thick, the most appropriate geotechnical solution would be to excavate to a specified depth, and re-compact the removed soils back up to foundation level. This solution is referred to as constructing an engineered soil mattress.

If the horizon is thin, structures could be founded on competent underlying pedogenic (calcrete) or residual soil horizons.

This material is also popular and used as plaster sand in building constructions and may be more prominent on areas around alternative 2.

9.1.2 *Water Transported Hillwash*

These hillwash soils have been transported by water, generally over fairly short distances, from higher ground down to lower lying areas.

They usually form more cohesive soils than the aeolian sands, but are also of generally low consistency.

A further characteristic of these soils is that over time, downward percolating of rain water carrying dissolved cementing solutions, can create bridges between the individual soil particles. On saturation and loading of these soils, the soil bridges can break down, resulting in collapse settlement.

The geotechnical solution to founding in such soils is to place the foundation on an engineered soil mattress.

9.1.3 *Water Transported Alluvium*

Alluvium are sediments that have been deposited from rivers, either after overflowing their banks in periods of flooding, or as alluvial fans entering lakes and lagoons, as well as bottom sediments dropped as the velocity of the river was impeded and reduced.

These sediments can include boulders, gravels and sands, as well as fine silts and clays.

The coarse gravel and sandy soils are often suitable as a founding medium, provided they are not immediately underlain by very soft silt or clayey soils.

The alluvial clays can however be problematic, as they could exhibit settlement or expansive behaviour. Where materials of high plasticity are present at founding elevation, it is recommended that they be excavated out, and replaced with well compacted, inert, granular materials.

9.2 Pedogenic Formations

9.2.1 *Ferricrete and Calcrete*

Where a fluctuating perched water table occurs, the near surface permeable soils can become cemented by iron or lime (calcium) rich solutions, to form well cemented ferricrete or calcrete horizons.

Due to the increase consistency and competence of these soils, they provide a potentially good founding medium for light to medium loaded structures, depending upon the thickness and degree of cementation.

This material may be prominent in areas around alternative 1 of the site.

9.3 Monte Christo Formation (Residual Soils and Bedrock Geology)

9.3.1 *Dolomites*

These rocks are formed due to biological synthesis and inorganic precipitation, in an ancient inland sea.

As these rocks are highly soluble by slightly acidic ground waters, under these conditions the possibility exists for the formation of sinkholes and doline depressions.

These features generally only occur where static or flowing water is present, such as human settlements, dams, commercial farming using intensive irrigation and poor stormwater facilitation.

Large scale dewatering processes also escalates the formation of these features.

Where none of these are present, the risk of sinkholes are considerably reduced.

The sandy and gravelly composition of soils derived from the weathering of dolomite and chert, are typically suitable as a founding medium for light to medium loaded structures. Only if the area has been classified as a suitably stable dolomite environment.

10 Comments

The comments made below are general, and based on anticipated geological and geotechnical conditions.

In terms of SANS 1936:2012 parts 1 to 4 “Development on Dolomite Land” a two phase (feasibility and design level) geotechnical and dolomite stability investigation will be needed to be undertaken on the chosen site.

10.1 General Anticipated Founding Solutions

10.1.1 *Proposed Alternative 1 of Tlisitseng Solar 2*

Alternative 1 is possibly underlain by shallow dense pedogenic material or chert residuum. These material are likely to be suitable as founding medium for lightly to medium loaded structures.

10.1.2 *Proposed Alternative 2 of Tlisitseng Solar 2*

Alternative 1 is possibly underlain by deeper Aeolian sands which may be possibly collapsible and loose in consistency as discussed in sections 9.1.1 and 9.1.2 above. This material is generally not considered suitable as a founding medium and thus the structures in this are would probably need to be founded on an engineered soil matrass.

10.2 General

Due to fact that this entire site is underlain at depth by dolomite, it is a legal requirement that a Dolomite Stability Investigation (DSI) be undertaken in accordance with the South African National Standards SANS 1936-Parts 1 to 4 Development of Dolomitic Land.

For the substation, build on a 1 hectare property, this DSI will comprise a gravity survey and the drilling of a minimum of 3 boreholes for a feasibility level (Phase 1) investigation.

It is also evident from the Topographical maps and Google Images that a water borehole is present near the both Alternative 1 and 2 - sites. These boreholes are probably used for irrigation purpose and as mentioned in section 9.3.1above, dewatering has a significant effect on the underlying dolomite stability.

10.3 Construction Problems

The removal of large hard rock chert boulders and or hardpan calcretre, could be problematic, on both sites, when undertaking the bulk excavation or deep trenches for the installation of services.

10.4 Construction Materials

It is likely that relatively competent construction materials will be available on both site (calcrete gravels), whilst a dolomite aggregate quarry is located some 5km south of the sites.

10.5 Geotechnical Site Classification

10.5.1 *Proposed Alternative 1 of Tlisitseng Solar 2*

The site is likely to be allocated a Geotechnical Site Classification Designation of P/R, in terms of the NHBRC requirements.

10.5.2 *Proposed Alternative 2 of Tlisitseng Solar 2*

The site is likely to be allocated a Geotechnical Site Classification Designation of P/C1, in terms of the NHBRC requirements.

Based upon the assessment of the data gathered during this literary review, it is our opinion that both alternative sites exhibit the same geotechnical suitability.

Yours faithfully
For:- **Geopractica (Pty) Ltd**

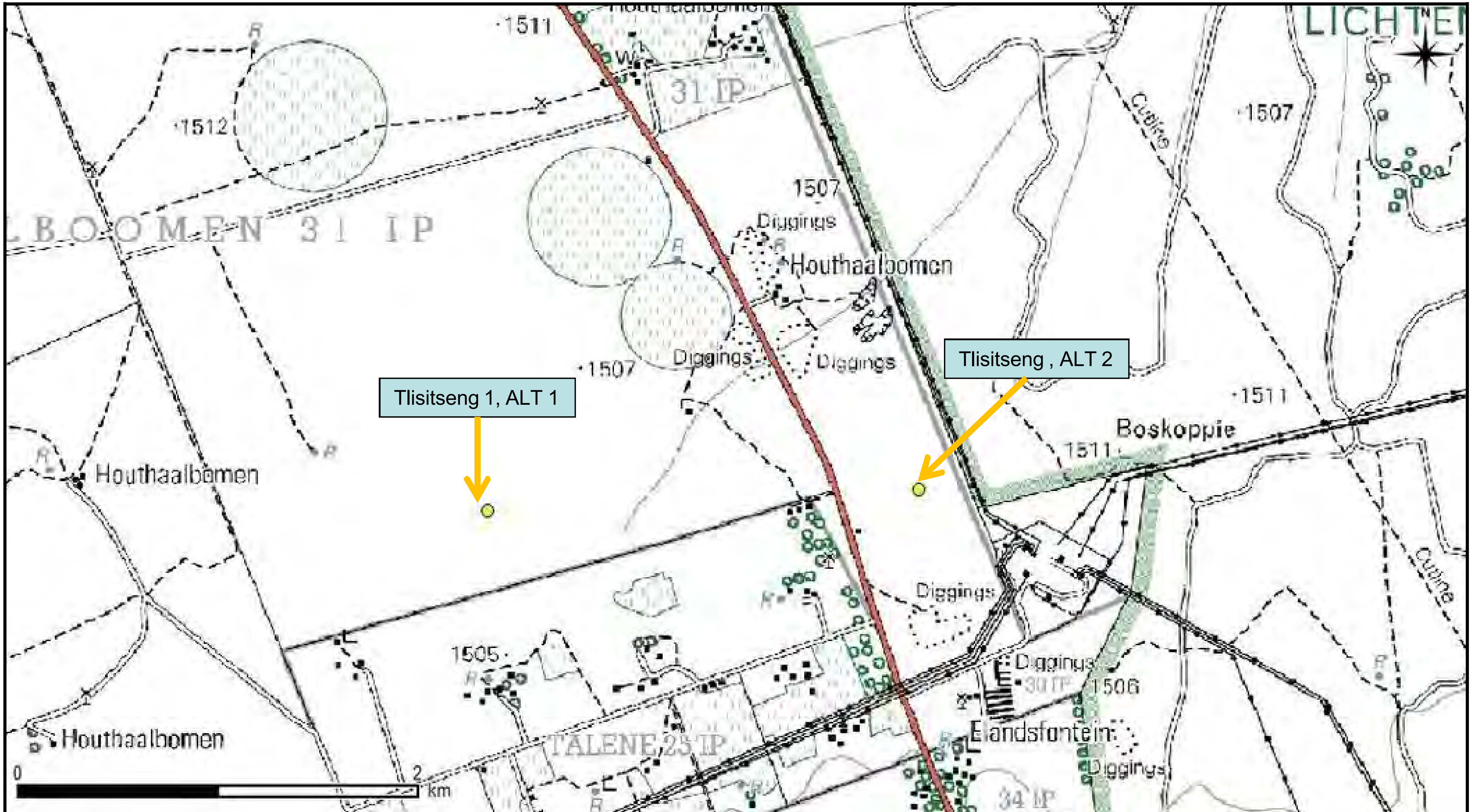
Colin Dalton (Principal)

Thanduxolo Msengana (BSc Geology)

APPENDIX 1
SITE PLAN

Geopractica	**SITE PLAN** **SIVEST** **TLISITSENG SOLAR 2, ALTENETIVE 1 & 2 – LICHTENBURG**	**DATE: July 2016** **Job No: 16082/1** **Figure: 1**

APPENDIX 2
TOPOGRAPHICAL MAP



Geopractica	**TOPOGRAPHICAL MAP**	**DATE : July 2016**
	SIVEST	**Job No : 16082/1**
	TLISITSENG SOLAR 2, ALTENETIVE 1 & 2 – LICHTENBURG	**Figure : 2**

APPENDIX 3

REGIONAL GEOLOGICAL MAP

Geopractica

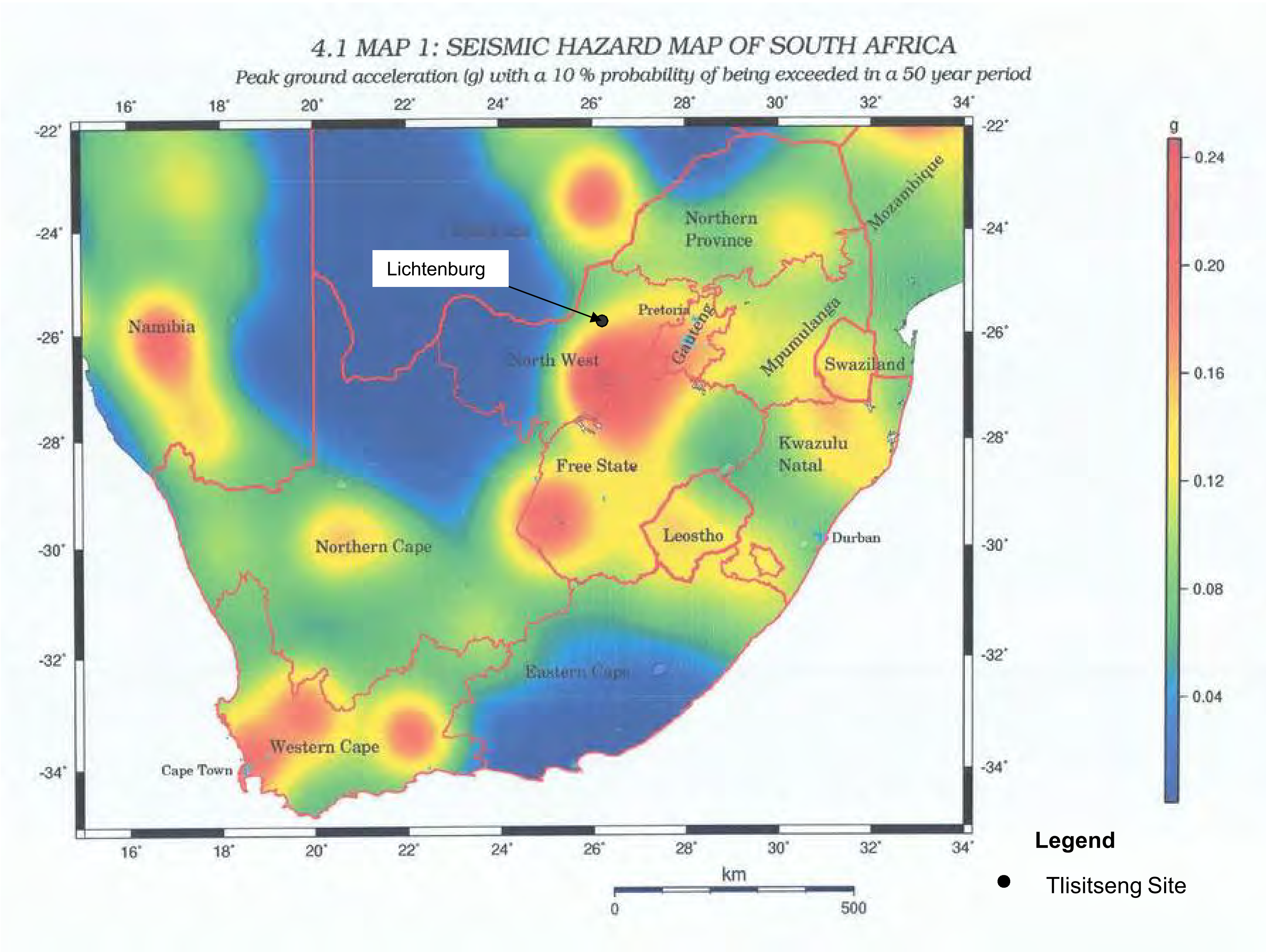
REGIONAL GEOLOGY PLAN

SIVEST

TLISITSENG SOLAR 2, ALTENETIVE 1 & 2 – LICHTENBURG

DATE : July 2016	
Job No : 16082/1	
Figure : 3	

APPENDIX 4
SEISMIC MAP


4.1 MAP 1: SEISMIC HAZARD MAP OF SOUTH AFRICA
Peak ground acceleration (g) with a 10 % probability of being exceeded in a 50 year period
Lichtenburg
Namibia
Northern Province
Mozambique
Pretoria
Gauteng
Mpumulanga
Swaziland
North West
Free State
Kwazulu Natal
Leostho
Durban
Northern Cape
Eastern Cape
Western Cape
Cape Town
g
0.24
0.20
0.16
0.12
0.08
0.04
km
0
500
Legend
Tlisitseng Site