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ADDENDUM TO DESKTOP GEOTECHNICAL SCOPING REPORT
for
MOOKODI INTEGRATION PROJECT, VRYBURG
(Kalplaats to Edwards Dam Substations)

Client: Sivest Date: Sep 2010 Job No:10162/A

C O N T E N T S

APPENDICES

1 INTRODUCTION

In July 2010, and at the request of Sivest, Geostrategies completed a desk top study to assess the geological and geotechnical conditions along Eskom's 132kV electrical distribution line from Bophirima Substation to the proposed Kalplaats Substation.

In September 2010, Sivest requested that the study be extended to assess three potential routes from Kalplaats Substation to the proposed Edwards Dam Substation.

Although much of the information contained in the original report is valid for the extended route, for ease of reading and to ensure that this report can be read as a discrete document, the relevant sections have been repeated in this report.

2 SCOPE OF WORK

The scope of the work was as follows :

2.1 Scoping Phase

Desktop study to determine anticipated geological and geotechnical conditions along the Eskom 132kV electrical distribution line from the proposed Kalplaats Substation to the proposed Edwards Dam Substation (approx 35km) - Alternative routes 1, 2 & 3

2.2 Objective of the Report

The desktop assessment was undertaken to achieve the following objectives :

- Assess the nature of the geology across the powerline routes.
- Attempt to identify geological and geotechnical conditions which may prove to be problematic for the siting of the proposed powerlines.
- Attempt to identify geological and geotechnical conditions which may prove to be problematic for the siting of the proposed substations.

2.3 Method of Investigation

The desktop study involved the investigation of the following sources :-

Study of the published 1:250 000 Geological Survey geology maps, covering the areas under investigation

Study of the relevant 1:50 000 Topographic maps, covering the areas under investigation.

Reference to published literature on the characteristics of the anticipated rock and soils to be encountered, as well as the anticipated foundation solutions in such materials.

Refer to previous geotechnical investigations carried out in similar geotechnical terrains. This will comprise both Geopractica reports, as well as reports compiled by other engineering consultants.

3 GEOLOGY AND ANTICIPATED SOIL TYPES

From the 1:250 000 geological maps (2624 Vryburg & 2724 Christiana) it was determined that the geology along the power lines routes was relatively uniform.

According to the contour map of climatic N values for South Africa compiled by Weinert, the proposed routes fall into the area with an N value of 8.2. This would indicate that the most likely method of weathering of the host 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 moist, wet coastal regions.

Appendix 1 contains an extract from the 1:250,000 geological map onto which the proposed routes have been annotated, while Table 1 below, summarises the geological formations that have been identified along the routes, as well as an indication of the anticipated transported/residual soils types that will be developed from the weathering of the individual host bedrock types.

	Table 1 : Basic Geology of study area		
Route	**Rock Type / Lithology**	**Geological Unit**	**Anticipated main soil types**
Alternative 1	Aeolian sand **overlying** Granite	Gordonia Formation, Kalahari Group, Quaternary Period overlying Mosita Granites	Transported, silty, medium to coarse grained sandy soils
Alternatives 2 & 3	Aeolian sand **overlying** Granite, Granite Gneiss, Migmatite, Schist & Amphibolite	Gordonia Formation, Kalahari Group, Quaternary Period overlying Swazian Intrusives	Transported, silty, medium to coarse grained sandy soils

The following geological terrains will apply to the routes:-

3.1 Kalplaats Substation to Edwards Dam Substation

3.1.1 *Alternative 1*

Aeolian Sand (Gordonia Formation, Kalahari Group, Quaternary Period) overlying Mosita Granites.

The general geology over this section of the route, comprises ancient intrusive rocks which have subsequently been overlain by recent wind blown sands of Aeolian age.

The prevailing geotechnical conditions can therefore be expected to comprise relatively deep and loose silty sands, containing random zones of pedogenic soils (ferricretes and/or calcretes), overlying competent bedrock. The thickness of residual soils derived from the weathering of the parent rock is not anticipated to be significant, while occasional outcrops of granite should be expected in section of the route running northwards from Kalplaats Substation.

Reference to the attached geological map will show that the Mosita Granites outcrops only just intersect the route in four to five places.The extent of this granite bedrock, under the surficial aolian sand cover, is not known.

Where pedogenic horisons occur, their consistencies can vary from “loose” (soil contains occasional calcrete/ferricrete nodules) to “very soft rock” (hardpan calcrete/ferricrete), depending on the degree of pedogenisis.

Due to their loose nature, the Aeolian Sands can be anticipated to be highly compressible when subjected to foundation loading, while experience has shown that they can possess a potential for collapse settlement.

3.1.2 *Alternatives 2 & 3*

Aeolian Sand (Gordonia Formation, Kalahari Group, Quaternary Period) overlying Swazian Intrusives (Undifferentiated granite, gneiss, migmatite, schist and amphibolite.)

The general geology over this section of the route, comprises ancient intrusive rocks which have subsequently been metamorphosed (altered) by the effects of increasing pressure and temperature within the prevailing geological environment within the Swazian Geological Era. The original intrusive rocks have been changed to produce gneisses, migmatites, schists and amphibolites, and these rocks have subsequently been overlain by recent wind blown sands of Aeolian age.

The prevailing geotechnical conditions can therefore be expected to comprise relatively deep and loose silty sands, containing random zones of pedogenic soils (ferricrete and/or calcretes), overlying competent bedrock. The thickness of residual soils derived from the weathering of the parent rock is not anticipated to be significant.

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4 ANTICIPATED FOUNDING CONDITIONS

The various geological formations that the powerlines will cross contain materials that typically have certain common characteristic geotechnical parameters. Each typical soil/rock type will be discussed below, considering the potential problems which can be anticipated, as well as possible foundation solutions.

4.1 Recent Transported Soil Types

It can be anticipated that the entire route will have a surface cover of recent transported soils. The thickness of this cover can be expected to vary, according to the geological depositional processes that were active at the time. 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 significant settlement under applied foundation loading.

4.1.1 *Wind Blown Aeolian Sands*

These soils have been transported under the action of wind, 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. They are also known to possess the potential for collapse settlement.

Where this sandy surface horizon is thick (>3m), the most appropriate foundation solution would be to excavate to a specified depth, usually 1.5 times the width of the proposed foundation, (depth to be measured from the underside of the foundation), place the soil in a temporary stockpile, and then reinstate it in 150mm thick layers, compacted to between 93 and 95% Mod AASHTO back up to foundation level.

If the horizon is thin, structures could be founded on competent underlying residual soil horizons.

Excavation characteristics will be “soft”, but care must be taken to protect construction personnel working inside the excavations from possible sidewall collapse.

4.2 Pedogenic Formations

4.2.1 *Ferricrete and Calcrete*

Where a fluctuating perched water table has occurred in recent geological time, the near surface permeable soils can become cemented by iron or lime rich solutions to form well cemented ferricrete or calcrete horizons.

Where pedogenic development is complete, the material exhibits properties similar to very soft rock, and consequently provides a good founding medium for structures. However, excavations may require the use of pneumatic tools to provide a level founding surface.

4.3 Igneous Rock Types

These rocks have been derived form liquid volcanic magmas of certain mineralogical content, cooling and solidifying at various depths within the earth.

4.3.1 *Granites*

These are generally hard, coarse grained rocks, which decompose to form gravelly and sandy soils. Where suitably competent, these residual soils produce a suitable founding medium for lightly loaded structures.

The parent rock constitutes a sound foundation for structures although blasting and/or the use of pneumatic tools will be needed in excavations.

4.4 Metamorphic Rock Types

Metamorphic rocks result from the physical and chemical alteration of existing rocks, due to an increase in pressure and temperature on them, induced by a range of geological processes.

4.4.1 *Quartzites, Granite Gneiss's, Migmatites*

These are generally hard, fine or coarse grained rocks, which decompose to form gravelly and sandy soils. Where suitably competent, these residual soils produce a suitable founding medium for lightly loaded structures.

The parent rock constitutes a sound foundation for structures although blasting and/or the use of pneumatic tools will be needed in excavations.

5 ANTICIPATED FOUNDING CONDITIONS FOR THE SUBSTATIONS

From information supplied by the client, it is understood that detailed geotechnical investigations will be carried out at each proposed substation site.

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

5.1 Kalplaats & Edwards Dam Substations

Both of these substations are situated in an area where aeolian sands overly metamorphic rocks such as granite gneiss, quartzites, or schists, and anticipated founding conditions are as discussed in section 4.

6 SEISMIC HAZARD ZONING

The Seismic Hazard Map of South Africa, as presented in Appendix 3, indicates that site falls within the very high risk zone for seismic tremors.

The estimated peak ground acceleration is estimated to fall within the 0.2 - 0.24 ms range. According to this chart, there is a 10% probability that this peak ground acceleration could be exceeded within a 50 year period.

Eskom needs to take these seismic hazard predictions into account, when designing the power line pylons, as well as their concrete foundations.

REFERENCES

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Jennings, J and Knight, K. (1975). A guide to construction on or with materials exhibiting additional settlement due to “collapse” of grain structure. Proceedings of the Sixth Regional Conference on Soil Mechanics and Foundation Engineering. Durban.

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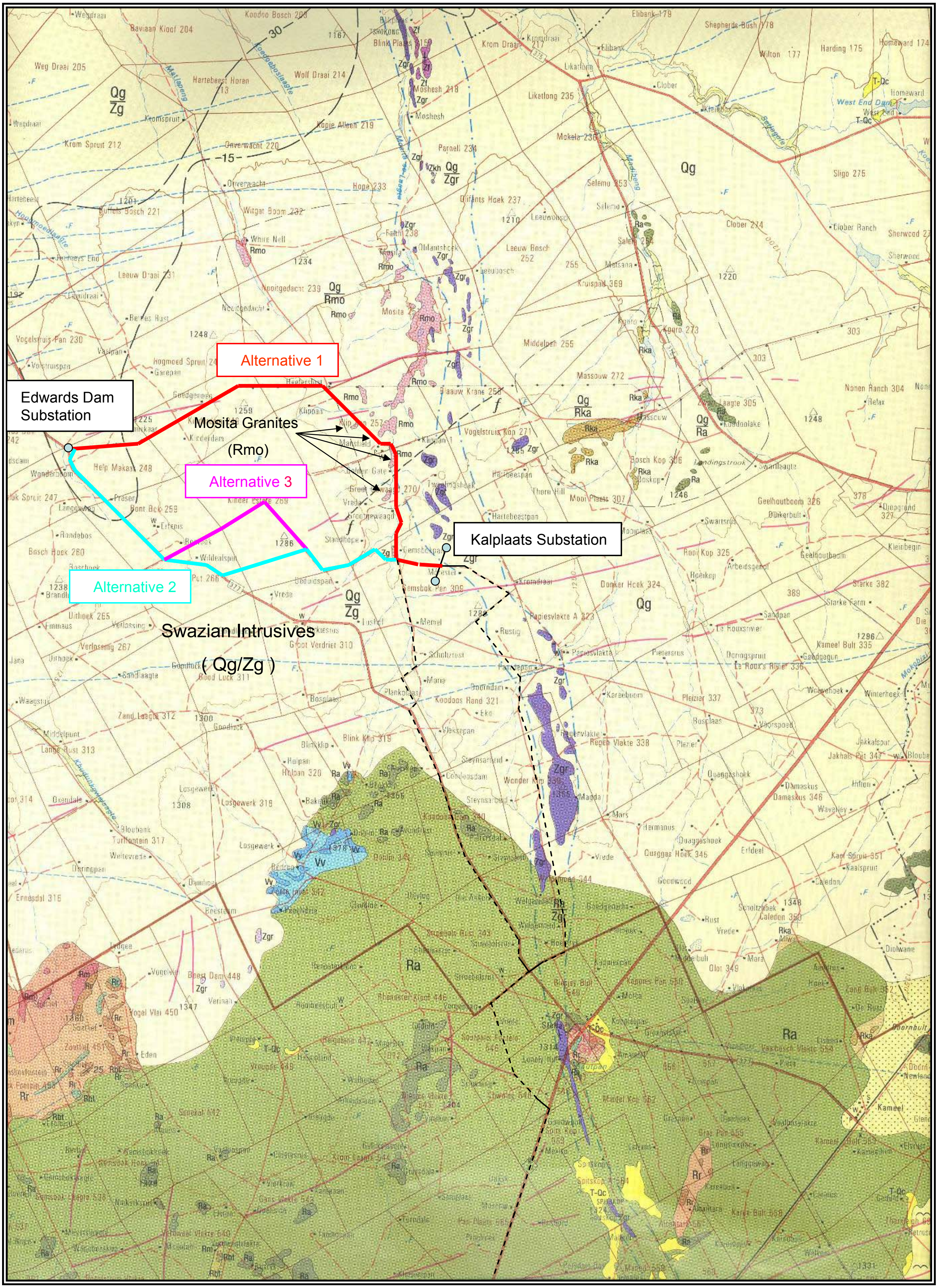
APPENDIX 1

GEOLOGICAL ROUTE MAP



Alternative 1
Edwards Dam Substation
Mosita Granites
(Rmo)
Alternative 3
Kalplaats Substation
Alternative 2
Swazian Intrusives
(Qg/Zg)

APPENDIX 2

WEINERTS CLIMATIC ZONES

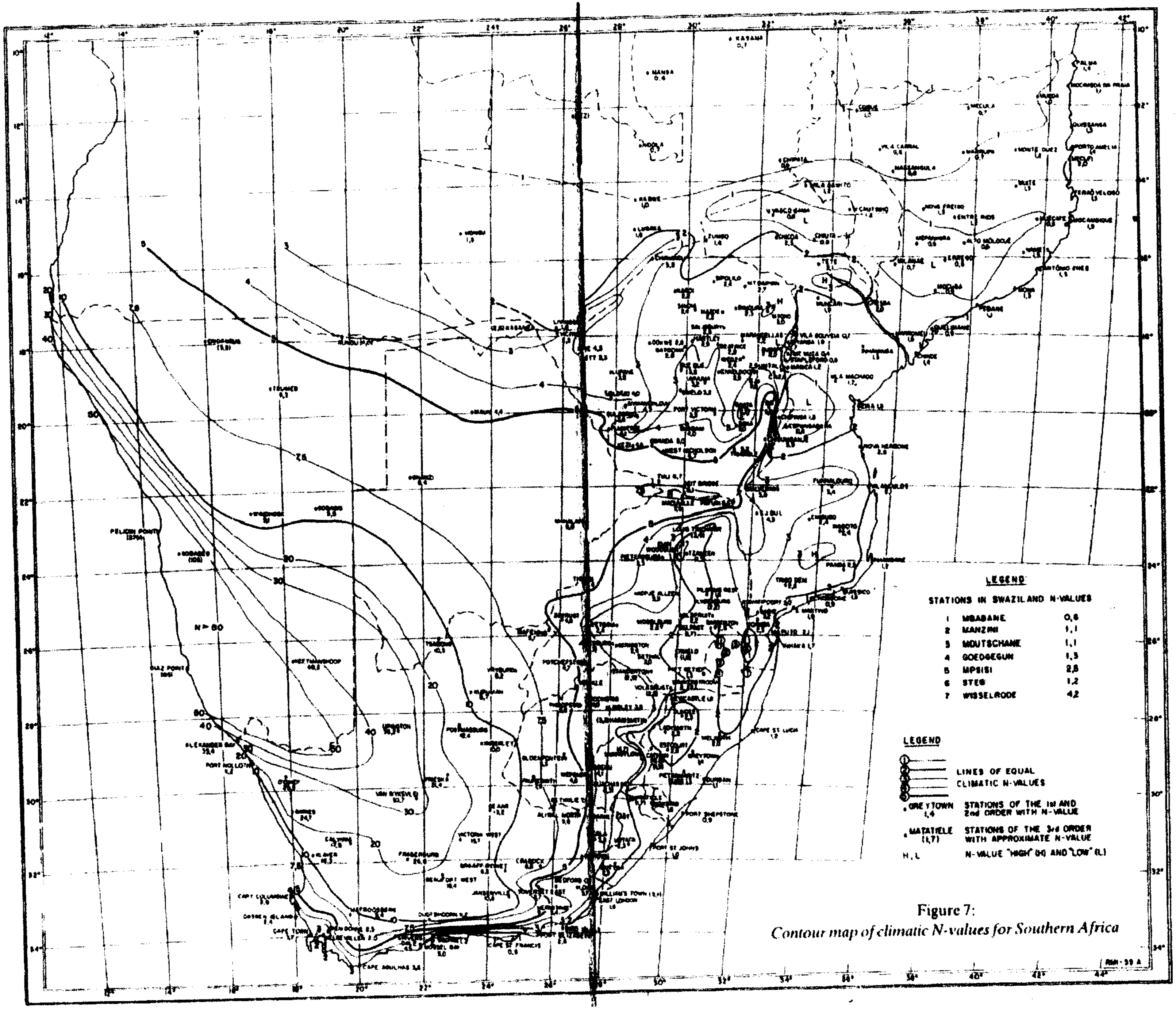
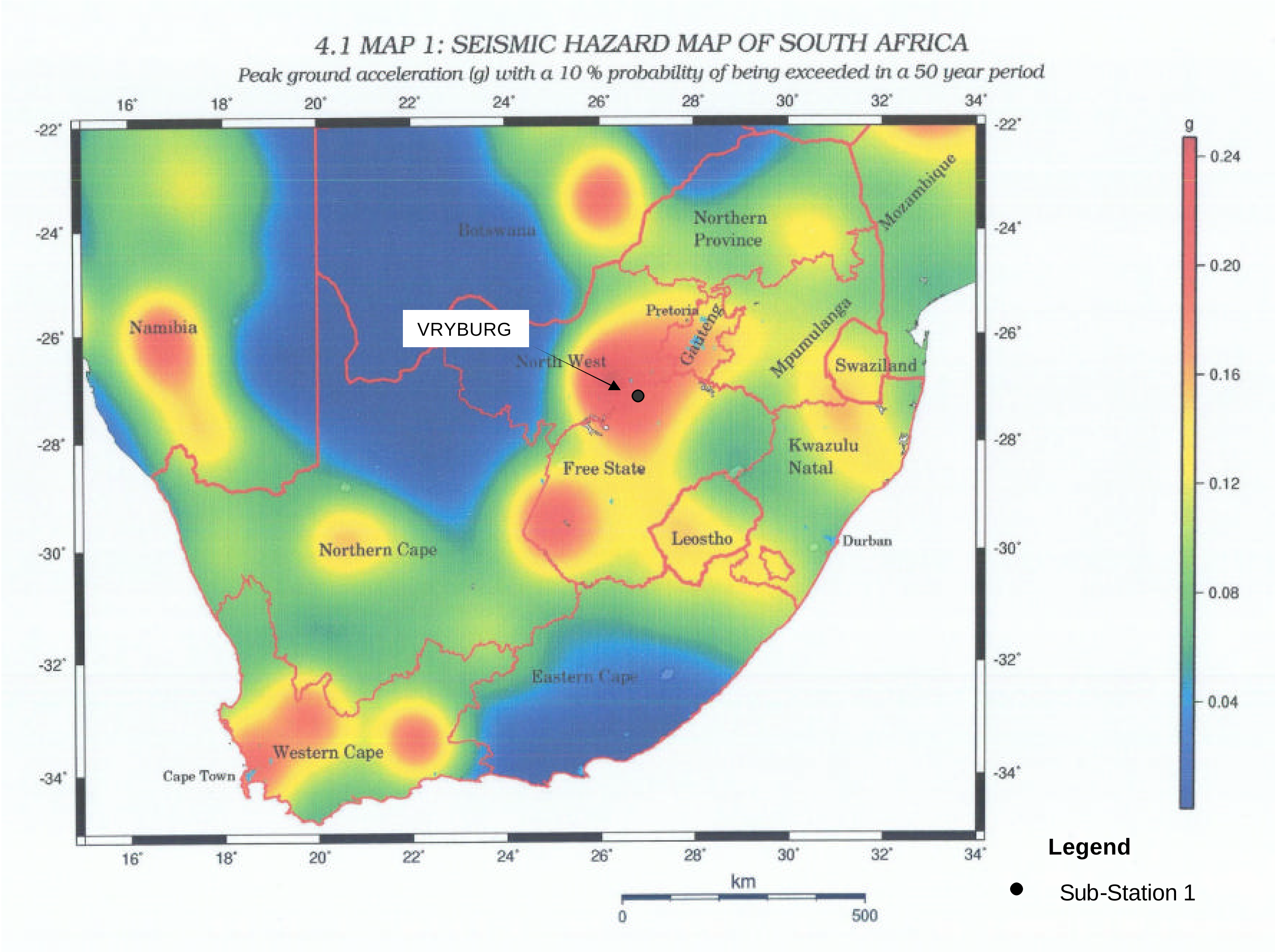


Figure 7:
Contour map of climatic N-values for Southern Africa

APPENDIX 3

SEISMIC HAZARD ZONING


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
VRYBURG
Botswana
Namibia
North West
Pretoria
Gauteng
Northern Province
Mozambique
Mpumalanga
Swaziland
Kwazulu Natal
Free State
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
Sub-Station 1