MERCURY - PERSEUS TRANSMISSION LINE

ENGINEERING GEOLOGICAL ASSESSMENT FOR ROUTE 1

Prepared by:

I KLEINHANS
KNIGHT HALL HENDRY
P.O. Box 72292
Lynnwood Ridge
0040

Prepared for:
STRATEGIC ENVIRONMENTAL FOCUS
P.O. Box 74785
Lynnwood Ridge
0040

SEPTEMBER 2003

MERCURY - PERSEUS TRANSMISSION LINE

ENGINEERING GEOLOGICAL ASSESSMENT FOR ROUTE 1

TABLE OF CONTENTS Page

FIGURES

EXECUTIVE SUMMARY

The goal of this exercise was to produce a geotechnical map of the area along the proposed route using available information and presenting it on a reasonable scale. The zonation map was constructed using geological maps, topographic maps and aerial photo interpretation.

The investigated area was divided into five zones associated with particular geotechnical factors and the possible sources or risk. The possible sources of risk were identified as being the following:

- Inundation associated with perennial and non-perennial drainage features as well as pans along the route
- Aggressive surface water of pans associated with a high salt content
- Collapse of soil structure below foundation due to collapsible soils
- Soil heave caused by thick active clay horizons
- Soil erosion caused by dispersive soils in association with disturbances of the vegetation/topsoil
- Excavations for the exploitation of salt and construction material

This study is of a very broad nature and a quantifiable assessment of the geotechnical constraints along the route can only be made with detailed fieldwork and testing of the materials found on site.

1. INTRODUCTION

Knight Hall Hendry (KHH) was appointed by Strategic Environmental Focus (SEF) to assess the engineering geological properties for the proposed Route 1 (see Figure 1) for the planned 300km Eskom power line from Dealesville to Viljoenskroon in the Free State Province.

2. METHOD OF INVESTIGATION

The proposed route as indicated in the report by KHH was digitized and a geotechnical map constructed with a buffer zone on either side. A Phase 1 geotechnical zonation map for the proposed route was compiled from information based on geological and topographical maps. Some aerial photograph interpretation was done to identify possible areas where geotechnical factors could be problematic. The geotechnical zonation map was produced on a 1:250 000 scale (Figure 3). The zonation map shows the extent of the area for which information was gathered during this investigation.

The following information was used in compiling this report:

- Report by Knight Hall Hendry (DJ Mouton), titled “Mercury-Perseus 400kv Transmission Line. Initial engineering geological assessment for route selection”, dated March 2003.
- 1:250 000 scale Geological maps (Sheets 2824 KIMBERLEY, 2826 WINBURG, 2726 KROONSTAD)
- 1:50 000 scale Topographic maps (all relevant sheets)
- Aerial photographs (Job 1003 of 97, 1:80 000 scale and Job No.’s 755 and 498, 1:30 000 scale).

2.1 Glossary of Terms

Study area: Refers to the entire study area encompassing all the alternative alignments as indicated on the study area map.

Zonation: Refers to the manner in which the area was grouped according to expected geotechnical constraints.

3. GENERAL GEOLOGY

The area investigated is underlain by near-horizontal rocks of the Ecca Group, Karoo Supergroup, which has been extensively intruded by dolerite sills and dykes (see Figure 2). Shale, siltstone and sandstone of the Tierberg Formation occur from Dealesville to Bultfontein. In the proximity of Wesselsbron, mudstone, siltstone and shale of the Volksrust Formation are present and at Bothaville sandstone, siltstone and shale of the Vryheid Formation are found. Calcrete and surface limestone are occasionally present in the southern portion of the study area. Younger aeolian, dune sand and alluvium (Quaternary age) are present along the entire route.

4. ROUTE DESCRIPTION

The topography along the route is predominantly flat-lying with very gentle slopes. Several pans are present along the route, especially in the southern section. A landing strip is traverse by the route near Bultfontein. The Vet River is crossed between Goedehoop and Bessisrut, near Hoopstad, just before the river flows into the Vaal River. There are a few less prominent, non-perennial drainage features along the route, but a more detailed investigation with some ground truthing would be necessary to assess their significance. A few excavations exist in the southern portion of the route. Most of the excavations are quarries in the salt pans for the exploitation of this resource.

5. DESCRIPTION OF RISK SOURCES

After the perusal of geological, topographical maps and an aerial photo interpretation, the following possible risk sources were identified along this route:

- Inundation associated with the Vet River, non-perennial drainage features and pans along the route.
- Aggressive surface water of pans associated with a high salt content.
- Collapse of soil structure below foundation due to collapsible soils
- Soil heave caused by thick active clay horizons
- Soil erosion caused by dispersive soils in association with disturbances of the vegetation/topsoil
- Excavations for the exploitation of salt and construction material

These risks will affect both the construction and operation phases.

6. DESCRIPTION OF RISK SOURCES

The area was studied in terms of its expected geotechnical properties. Five different zones were identified along the route and will be described in terms of their expected geotechnical constraints. These constraints are influenced by Weinert's N value, which is calculated as follows: The Weinert climatic N-value differentiates between the arid western portion and humid eastern portion of South Africa and provides an indication of the dominant mode of weathering of an area (Weinert, 1980). The N-value is based on the following formula:

$$N = 12E_J / P_a$$

where	N	=	Climatic index
	E_J	=	Evaporation of the warmest year in South Africa
	P_a	=	Total annual precipitation

In arid areas, the N-value is >5 and mechanical disintegration of rock is predominant, favouring the development of generally shallow residual soils. In humid areas, the N-value is <5 and chemical decomposition of rock occurs, characterised by deep residual soils (Weinert, 1980). Weinert's N–value for this route area is between 5 and 10 indicating that mechanical disintegration is the dominant mode of weathering.

6.1 Dolerite (Zone 1)

Depicted in red on the accompanying map. This zone comprises areas underlain by dolerite. Difficulty with excavation is expected as the dolerite bedrock may be at shallow depths. Residual soils of dolerite may contain active clays, but since, in this area, the N value is more than 5, this is unlikely. The occurrence of dolerite along this route is not associated, as would be expected, with topographic relief, and only in one instance 27km north of Dealesville on the Dealesville-Bultfontein road, does a koppie with steeper slopes exist. Slope instability and soil erosion (formation of gullies and dongas) could occur in these areas with a higher gradient. Some excavations/quarries were made for the exploitation of dolerite as construction material.

6.2 Sand (Zone 2)

The zone is marked yellow on the map. This zone covers most of the area and consists of Quaternary age aeolian, dune sands and alluvium. The thickness of these sands is not known but it is expected to be less than 5m. These sands are not compacted and may collapse under load with an increase of soil moisture content.

6.3 Karoo Sedimentary Rocks (Zone 3)

Marked brown on the map. These are underlain by the Tierberg, Vryheid and Volksrust Formations and consist of mudstone, sandstone, siltstone and shale. Residual soils derived from mudrocks (siltstone, shale and mudstone) may contain active clay minerals of the smectite group. These soils are potentially expansive and generally fall into the medium to high potential expansiveness categories. The residual soils derived from sandstone are susceptible to collapse and erosion (dispersive soils).

6.4 Pans (Zone 4)

These areas are marked as blue on the map. As indicated on the map, the proposed route traverses a large number of pans. Most of them are salt pans and are associated with thick, soft soils and shallow groundwater. Deep excavations may be required for founding. With the high salt content it is believed that the soils will be aggressive. These soils may also have a high collapse potential.

Areas marked as light blue are areas where small pans were observed on topographic maps and aerial photos (some dry). These also include marshy areas, areas where flooding may take place, as well as areas adjacent to rivers and streams. Excavations exist in some of the pans where the salt is (was) exploited.

6.5 Calcrete (Zone 5)

Indicated on the map as orange. Large areas of calcrete are present along the route, especially in the southern portions. Hard competent layers close to surface will give good foundation.

7. CONCLUSIONS

Geotechnical constraints along this route are limited to inundation, collapse, heave and dispersive soils. The severity of these factors is not known as no field work or laboratory tests were conducted in the course of this investigation. The main constraint can be seen as the presence of the salt pans that are sometimes concentrated on the route. The exact positions of these pans should be surveyed to quantify their importance.

This engineering geological assessment is only based on available information from geological, topographical maps and limited aerial photo interpretation for anticipated geotechnical conditions. Field data should be collected to assess and quantify the severity of the geotechnical constraints and to verify the boundaries of geotechnical zones.

8. REFERENCES

Council for Geoscience, South Africa. 1993. 2824 Kimberley 1:250 000 scale Geological Series.

Council for Geoscience, South Africa. 1998. 2826 Winburg 1:250 000 scale Geological Series.

Council for Geoscience, South Africa. 2000. 2726 Kroonstad 1:250 000 scale Geological Series.

Mouton, D.J. 2003. Report by Knight Hall Hendry (Pty) Ltd, titled *Mercury - Perseus 400kv transmission line. Initial engineering geological assessment for route selection*. March 2003.

South Africa, State Press. 1;50 000 Topographical sheets: 2825DA Elandsfontein, 2726BC Bothaville, 2726CC Vetrivier, 2825DB Dealesville, 2825BD Inkpan, 2826AC Bultfontein, 2826AA Protespan, 2726CD Wesselsbron, 2726CB Losdorings, 2726AD Baviaanskrans, 2726BA Vaalbrug and 2726BB Viljoenskroon.

Weinert, H.H. 1980. *The natural road construction materials of southern Africa*. Academica, Pretoria. 298pp.