ENVIRONMENTAL IMPACT ASSESSMENT FOR THE PROPOSED MATIMBA-WITKOP NO. 2 400 kV TRANSMISSION LINE, LIMPOPO PROVINCE

SPECIALIST STUDY – GEOHAZARDS

APPENDIX I

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1. INTRODUCTION

The following report presents the results of a desktop study into the potential geohazards within the corridors for the proposed 400 kV Transmission line between the Matimba and Witkop Substations. No fieldwork has, therefore, been carried out to verify the assessments within the report. This limitation should be taken into account when siting towers in the field. The geohazards have been simultaneously assessed in terms of the risk to the Transmission line itself and the impact it may have on the physical environment. Farms which lie within, astride or adjacent to the Waterberg Biosphere Reserve and the Percy Fyfe Nature Reserve have been *highlighted* in the case of the former and *italicised* in the latter.

2. CLIMATE

The area between Lephalale and Polokwane is best described as semi-arid (rainfall 250 mm - 500 mm *per annum*), with mean annual rainfall 435 mm and 478 mm *p.a*. respectively. Both areas are subject to a summer rainfall regime, with a high in December (80 mm) at Lephalale and November (85 mm) in Polokwane. In contrast only 3 mm of rain falls on average in the months of May and July at Lephalale and July at Polokwane.

The mean annual air temperatures (mean monthly maxima - mean monthly minima / 2) are higher at Lephalale (21,9°C) than Polokwane (18,2°C). A similar relative temperature difference is evident for the mean monthly maxima and minima which are higher at Lephalale (monthly maximum, 29,1°C; monthly minimum, 14,6°C) than at Polokwane (monthly maximum, 24,7°C; monthly minimum, 11,7°C). However, the range in mean monthly temperature is slightly greater in Lephalale (14,5°C) than Polokwane (13,0°C). Mean daily maximum and minimum temperatures are highest in January at both Lephalale (daily maximum, 33,0°C; daily minimum, 20,4°C) and Polokwane (daily maximum, 28,1°C; daily minimum, 17,1°C). Mean daily maxima are lowest in June at Lephalale (23,4°C) and Polokwane (19,6°C), while the corresponding figures for the mean daily minima at Lephalale and Polokwane occur in June (6,7°C) and July (4,4°C), respectively. Record highs were measured at Lephalale (40,7°C) on the 11 January 1983 and at Polokwane (36,8°C) on the 24 October 1961, while record lows were obtained at the former on the 10 June 1988 (0,2°C) and at the latter on the 28 June 1964 (-3,5°C). Typically, the higher temperatures and greater range in mean annual temperature at Lephalale relative to Polokwane could be ascribed to the lower elevations of Lephalale in the case of the former and the greater distance of the town from the potentially ameliorating influence of the Indian Ocean in the case of the latter.

At Polokwane the wind tends to blow from the east in summer and the south-west in winter (Schulze, 1965).

2.1. Extreme Events

Future damage to the Transmission line is most likely to result from thunderstorm activity. This may be due to associated lightning strikes, intense rainfall or high wind velocities. Thunderstorm activity occurs on average 44 days a year at Polokwane with most activity concentrated in the summer months when it can be expected more than seven days a month during November, December and January. The least thunderstorm activity occurs in winter, with a low in July (0,4 events per month).

An estimate of the risk of slope failure to the Transmission line can be obtained by applying the formulae presented by Caine (1980) (Equation 1) and Innes (1983) (Equation 2).

Equation 1. $I = 14.82D^{-0.39}$

I = rainfall intensity (mm/hr)
D = rainfall duration (hr)

Debris flows can be expected when $I > 14.82D^{-0.39}$ (Innes, 1983).

Equation 2. $d = 14.82D^{0.61}$

d = rainfall (mm)

The thresholds of slope failure at Polokwane for both of the equations above should be exceeded at intervals of less than 10 years for projected maximum rainfall intensities with return intervals of 15-, 30-, 45- and 60 minutes (see Schulze, 1965, p. 307). The thresholds for Equations 1and 2 over a 24-hour period were exceeded at least once at Lephalale between 1982 and 1990, when 118 mm fell on the 9 December 1989. These 24-hour thresholds (Equation 1 & 2) were not exceeded at Polokwane (Station 0677802A5) between 1961 and 1990, but probably have been prior to 1961 as 130,3 mm was measured at Polokwane (Hosp.) (Station 677/834) before 1956 (Anon., 1956). Using the calculated maximum expected 24-hour rainfall return intervals for this station (677/834) the threshold for slope failure can be expected to be exceeded approximately every 40 years at Polokwane. Based on this evidence there is a moderate rainfall induced slope failure risk to the Transmission line.

High wind velocities have also been known to damage Transmission lines. Strong winds damaged towers in the Fort Beaufort area on the 25 February 2000. An anemometer was toppled after it had measured 39.2 m/s. It is unclear from the report if the damage to the towers occurred prior to this event, but if it is used as a yardstick high wind velocities pose a low risk to the Transmission line. A maximum gust of 39.4 m/s (adjusted to sea level) can be expected every 50 years at Polokwane (Anon., 1975).

3. GEOLOGY

The area traversed by the corridors for the proposed Transmission line includes areas of map sheets 2326 Lephalale, 2328 Polokwane and 2428 Nylstroom produced by the Council for Geoscience. Detailed descriptions of the geology within the corridors can be found within the accompanying explanations for these sheets. Only the most pertinent aspects of the geology are discussed below, namely those related to slope failure, mineral deposits and dolomitic areas. Further aspects of the geology in the area are highlighted within the physiographic description that immediately follows this section.

3.1. Seismically Induced Slope Failure

Globally the lowest Modified Mercalli Intensity (MMI) associated with slope failure has been an intensity of IV, while disrupted slides and falls usually only occur at intensities greater than VI (Keefer, 1984). As nearly all the area west of Polokwane is unlikely to experience an earthquake greater than VI (MMI) in a 100 years (*sensu* Fernandez & Guzman, 1979) the risk of a seismically induced slope failure is low.

3.2. Mineral Deposits

A number of deposits are known from within or immediately adjacent to the corridors. These include active (AcM) and abandoned mines (AbM) and unworked deposits (UwD) (with farm name and current status in parenthesis) for beryllium (Holspruit 732 LS, UwD; Rietfontein 731 LS, UwD, Rotterdam 12 KS), building sand (Werkendam 474 LQ, working mine), feldspar (Holspruit 732 LS, UwD), fluorspar (Grobelaars Hoek 462 LR, UwD), gold (Wildebeestfontein 20 KS, AbM), mica (Holspruit 732 LS, UwD; Rietfontein 731 LS, UwD), platinum - nickel - copper (all three on each of Dorstland 768 LR, UwD; Witrivier 777 LR, UwD; Noord Holland 775 LR, UwD) and stone aggregate (Katberg 481 LR, AcM; Sunnyside 532 LQ, AcM). In addition, "old mine(s)" for the extraction of an unknown resource have been marked on two 1: 50 000 topographical maps, namely on the farms Groothoek 504 LQ (2327DA Lephalale) and Rotterdam 12 KS (2429AA Potgietersrus) both immediately south of the corridor in the far west and east respectively. Care needs to be taken that the proposed Transmission line does not interfere with the potential development of these or other mineral resources.

3.3. Dolomitic/Limestone Areas

Dolomitic material in the form of marble is known from the Bandelierkop Complex and Gumbu Group of the Beit Bridge Complex, while the Chuniespoort Group occurs as serpentinized dolomitic xenoliths within the Bushveld Igneous Complex (Brandl, 1986) (e.g. farms Dorstland 768 LR, Malokongskop 780 LR, Noord Holland 775 LR, Witrivier 777 LR). In addition, a thin limestone unit (thickness = *ca.* 300 mm) has been described from exposures near the Limpopo River from within the Wellington Formation of the Karoo Sequence (Brandl, 1996). None of these units as found within the corridors are expected to facilitate sinkhole formation.

Dolomites and limestones are largely restricted to the Duitschland Formation (Vd) and Malmani Subgroup (Vmd) of the Chuniespoort Group south of Polokwane, neither of which underlie the corridors. Both of these units are however present in close proximity to the south-eastern extremity of the study area (e.g. farms Sukses 37 KS, Vd & Vmd; Zwartkrans 38 KS, Vmd & Makapansgat 39 KS, Vd & Vmd) with two "old lime mine(s)" located on Makapansgat 39 KS.

4. PHYSIOGRAPHY

The corridors traverse undulating topography within the Limpopo River catchment, punctuated by koppies (e.g. Tafelkoppe, Height = 1189 m) and inselbergs (e.g. Mamothololo, Height = 1254 m), becoming hilly in the south-east. Four tributaries of the Limpopo River, namely (from west to east) the Mokolo, Lephalala, Mogalakwena and Sand intersect the corridors while draining northwards. Elevations range from 810 m at the confluence of the Makolo and Tambotie rivers in the west to 1614 m in the extreme south-east. The Tafelkoppe and Ga-Mabula in the far west of the study area probably owe their origins at least in part to resistant sediments of the Swartrand Formation (Karoo Sequence). Further east the higher lying areas on the farm Lilie Fontein 506 LR are underlain by the sandstones and conglomerates of the Mogalakwena Formation (Waterberg Group). The same resistant units are associated with the rugged terrain west of "Skrikfontein se Nek" on the farms Schurwepoort 502 LR and Klip Bank 713 LR. To the south-east Mamothololo is underlain by a diabase sill within the Nebo Granite (Lebowa Suite - Bushveld Igneous Complex). The extreme south-eastern segment of the study area1 and/or surrounding area is underlain by the Hout River Gneiss, Mashashane Suite (Lunsklip & Uitloop granites), Turfloop and Geyser granites, diabase dykes and metasediments and volcanics of the Polokwane Group.

4.1. Erosion Risk

Rainfall, slope angle, sediment grain size and vegetation cover interact to determine the erodability of soils. Increases in rainfall intensity/duration and/or slope angle can lead to greater erodability of soils, while a decrease in vegetation cover can have the same effect. Silt and fine sand are generally the most erodable grain sizes (Morgan, 1986), with the cohesive properties of clays and increased weight of larger grain sizes necessitating greater energy for transport of the latter sediments. Excavations and road building activity during the summer rainy season would therefore pose a potentially greater erosion risk than work during the winter months from May to August. Steep slopes should be avoided if at all possible, the most notable areas in this regard are from west to east:

- *Corridor 1 and Corridor 5:*
  - ∗ The upper slopes of the hill (Height = 1010 m) south-east of the farm house on Toulon 495 LQ.
  - ∗ The steep slopes of the Tafelkoppe (Height = 1189 m) (Farms = Cradock 534 LQ, Spider 535 LQ & Smithfield 536 LQ) and adjoining southern slopes of Ga-Mabula (Trig. Beacon No. = 3, Height = 1164,4 m) (Farms = Windsor Castle 493 LQ & New York 490 LQ).
  - ∗ The rugged terrain and saddle on Lilie Fontein 506 LR and adjoining slopes on the western side of Kirstenbos 497 LR.
  - ∗ The slopes to the west and east of the Mothakole River on the farms Kirstenbos 497 LR, Uitspanning 501 LR and Schurwepoort 502 LR.
  - ∗ The hilly topography on the farms Schurwepoort 502 LR, Klip Bank 713 LR and Schrikfontein 715 LR, particularly the descent to the Mogalakwena River *via* "Skrikfontein se Nek".
  - ∗ The upper slopes of Mamothololo (Height = 1254 m) (Farms = Zwartkop 742 LR, Vlakfontein 739 LR, Cleremont 738 LR, Vlakfontein 763 LR, Goede Hoop 762 LR & Elandsfontein 760 LR).
  - ∗ The small hill (Height = 1208 m) in the western reaches of the farm Vlakfontein 763 LR.
  - ∗ The slopes to the west of Ga-Matlapa village and the upper catchments of the Rooisloot and Brak rivers south and east of the aforementioned village (Farms = Aronsfontein 722 LS, Doornfontein 724 LS, Helderfontein 6 KS, Ga-Mashashane, *Elandsfontein 725 LS*, *Suikerboschplaats 727 LS*, Koppie Alleen 726 LS, Drieangel 728 LS, *Paddadorst 729 LS*, Rietfontein 731 LS, Rotterdam 12 KS, Bultfontein 700 LS, Bultfontein 730 LS & Hollandsdrift 15 KS).
  - ∗ The slopes on the hills east of the National Road (N1) (Heights = 1 522 m and 1 614 m) (Farm = Hollandsdrift 15 KS).

- *Corridor 2:*
  - The northern slopes of Ga-Mabula (Trig. Beacon No. = 3, Height = 1164.4 m) (Farms = Gelyk 491 LQ, New York 490 LQ, Portlock 489 LQ).
  - The northern side of the hill (Height = 1014 m) west of Ga-Rapadi village (Farm = Kafferboom 664 LR).

- *Corridor 4:*
  - The east side of the hill topped by Trig. Beacon 46 (Height = 922.3 m) (Farm = Jacobs Loop 477 LQ).

The anticipated sandy nature of most of the soils within the corridors would make them susceptible to erosion. Sandy soils may have contributed to the development of the gully erosion (e.g. Leeuspruit) on the farm Hollandsdrift 15 KS. In a similar vein, towers should not be constructed on flood plains close to river channels where easily erodable sandy alluvium could lead to the undercutting of tower foundations. This may be a problem within the immediate vicinity of bridges, for example there appears to have been some channel widening downstream of the "old bridge" over the Motse River east of Ga-Rapadi village. Particular attention needs to be taken of the height of flood debris in the branches of riparian vegetation. Towers should not be erected below the upper limit of the flood debris. Lastly, in order to mitigate erosion as much as possible the disturbance of vegetation should be kept to a minimum wherever practical.

5. CONCLUSION

The proposed Transmission line will be exposed to few geohazards of significance, the most important of which are high winds and floods. The former should pose an infrequent threat to the Transmission line while the latter will only be a consideration in close proximity to river channels. These and additional impacts are summarised within Table 1 below. The most important negative impact the proposed Transmission line is likely to have on the physical environment is as a catalyst for hillslope erosion during the construction phase. The ready availability of a Transmission line could also have a positive impact if it facilitates the development of a mineral deposit.

Table 1: Effect of the physical environment on the proposed Transmission line

Nature	Extent	Duration	Probability	Significance	Status
High Winds (> 39.2 m/s)	Regional	Short	High	Medium	Negative
High Rainfall – slope failure	Regional	Short	High	Low	Negative
High Rainfall - floods	Regional	Short	Definite	High	Negative

Nature	Extent	Duration	Probability	Significance	Status
Seismic Activity	Regional	Short	Improbable	Low	Negative
Sinkhole Formation	Local	Long	Improbable	Low	Negative
Erosion	Local	Long	Probable	Low	Negative
Mine Development	Local	Long	Improbable	Medium	Neutral

Table 2: Effect of the proposed Transmission line on the physical environment

Nature	Extent	Duration	Probability	Significance	Status
Erosion	Local	Variable	High	Medium	Negative
Mine Development	Local	Long	Improbable	High	Positive

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ANNEXURE A:
A CHRONOLOGICAL LIST OF EXTREME CLIMATIC EVENTS WHICH MAY HAVE IMPACTED ON THE AREA TO BE TRAVERSED BY THE PROPOSED MATIMBA-WITKOP TRANSMISSION LINE

1933 - JANUARY. Heavy rains in the northern reaches of the former Transvaal cause the Limpopo River to flood its banks.

1944 - FEBRUARY. Flooding reported for the Crocodile and Limpopo rivers.

1966 - 29 SEPTEMBER. Roads and railways were damaged by cloudbursts between Vaalwater and Thabazimbi.

1969 - 22 NOVEMBER. A tornado damaged roofs and buildings in Seshego outside Pietersburg.

1988 - 3 JANUARY. Damaging hailstorm in the Potgietersrus area accompanied by strong winds.

1990 - 6 DECEMBER. Destructive thunderstorm in Seshego and Pietersburg, including damage to powerlines.

1991 - 30 JUNE. Highest daily winter temperature for Ellisras, namely 28.0^{o}C.

1992 - 10 NOVEMBER. Severe storm, with *ca.* 100 mm rainfall at Mankweng east of Pietersburg in the space of five hours.

1995 - 15 NOVEMBER. Severe hailstorm disrupts provision of electricity in Pietersburg.

2000 - 15 to 18 JANUARY. Rain and flood related damage amounting to *ca.* R 200 million is caused in the Limpopo Province.

2000 - 5 to 9 FEBRUARY. Floods related to the passage of a tropical depression affects the Limpopo Province.