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Memorandum

To	**Wynand Loftus**	**From**	**Steven Seymour, Salona Naidoo**
Copy		**Reference**	**1001408**
Date	**2021-08-03**	**Pages (including this page)**	10
Subject	**Geotechnical Desktop Study for the proposed Avondale-Gordonia 132 kV transmission line upgrade, Upington, Northern Cape Province**		

Dear Wynand

This memorandum provides a geotechnical desktop study for the proposed upgrade of the 132 kV transmission line between Avondale and Gordonia, east of Upington, Northern Cape Province. The location of the transmission line is shown in Figure 1. It is understood that the existing transmission line must be upgraded to prevent potential future capacity issues and failure of the infrastructure.

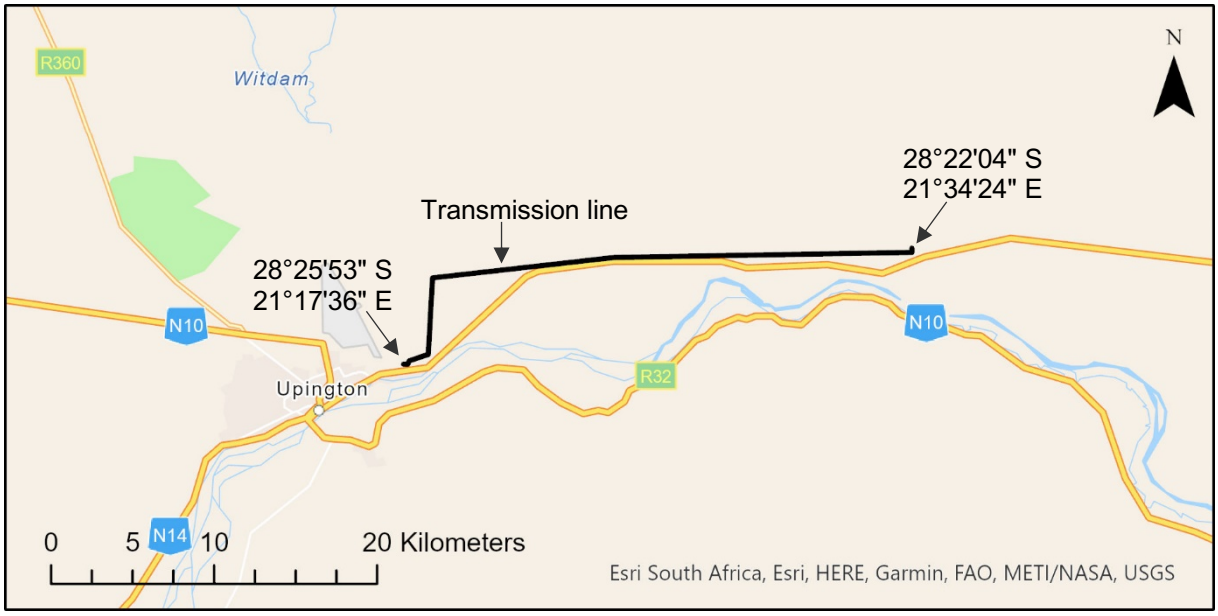


Figure 1: Site location

1 Available Information

The information available for the geotechnical desktop study included:

- Locality KMZ file with the position of the transmission line
- Satellite imagery (Google Earth)
- 1:250 000 geology map (Sheet 2820 Upington)
- Palaeontological Impact Assessment Report:
  Bamford, M. 2021. Palaeontological Impact Assessment for the proposed Avondale-Gordonia

132 kV transmission line upgrade, Upington, Northern Cape Province, Desktop Study (Phase 1). Dated 22 July 2021.

In addition, the following geotechnical investigation reports of previous site investigations in the vicinity of the transmission line route were available:

- Aurecon. 2014. Geotechnical Investigation for the Ilanga Solar Substation near Upington (110554-G1-00). Dated 7 May 2014.
  - Site located approximately 13km south of the transmission line.
  - Scope included a geotechnical desktop study, 2 No. test pits and laboratory testing.
- Aurecon. 2013a. Upington Solar Park: Geotechnical Report (109944-G1-00). Dated 1 November 2013.
  - Site located approximately 18km west of the transmission line.
  - Scope included 60 No. test puts, 12 No. rotary core boreholes and laboratory testing.
- Aurecon. 2013b. Solis Solar Power Plant Site Investigation: Factual Report (109438-G2 Rev B). Dated 31 May 2013.
  - Site located approximately 28km west of the transmission line.
  - Scope included 51 No. test pits, 51 No. down-the-hole percussion boreholes, 20 No. rotary core boreholes, Dynamic Cone Penetration tests, Continuous Surface Wave tests and laboratory testing.

2 Site Details

Figure 2 shows satellite imagery and an elevation profile of the transmission line route. The route is approximately 32km in length and is situated north of the Orange River. The majority of the route is positioned in an approximately east-west orientation.

The satellite imagery in Figure 2(a) indicates the presence of shallow outcropping rock in portions of the route. The positions of the outcropping rock coincide with the increases in elevation indicated in Figure 2(b). The remaining portion of the route occurs on gently sloping terrain according to Figure 2(b).

Furthermore, *Google Street View* images from the N14 Road running parallel to the transmission line route, shown in Figure 3 to Figure 5, shows the gently sloping nature of the terrain. This imagery also indicates that the site area is covered by typical arid vegetation types such as various tufty grasses and low shrubs.

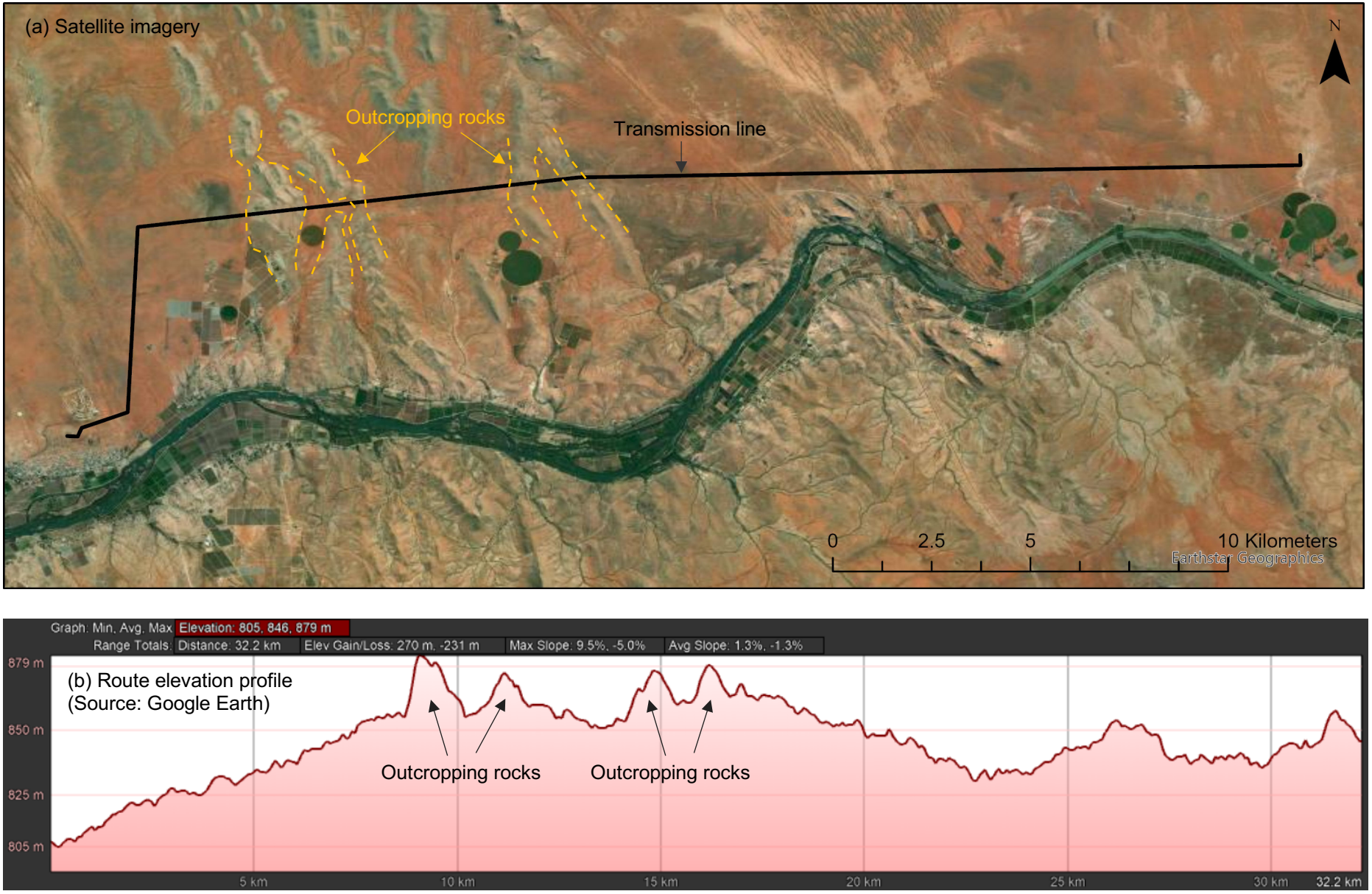


Figure 2: Satellite imagery of site, and elevation profile along transmission line route

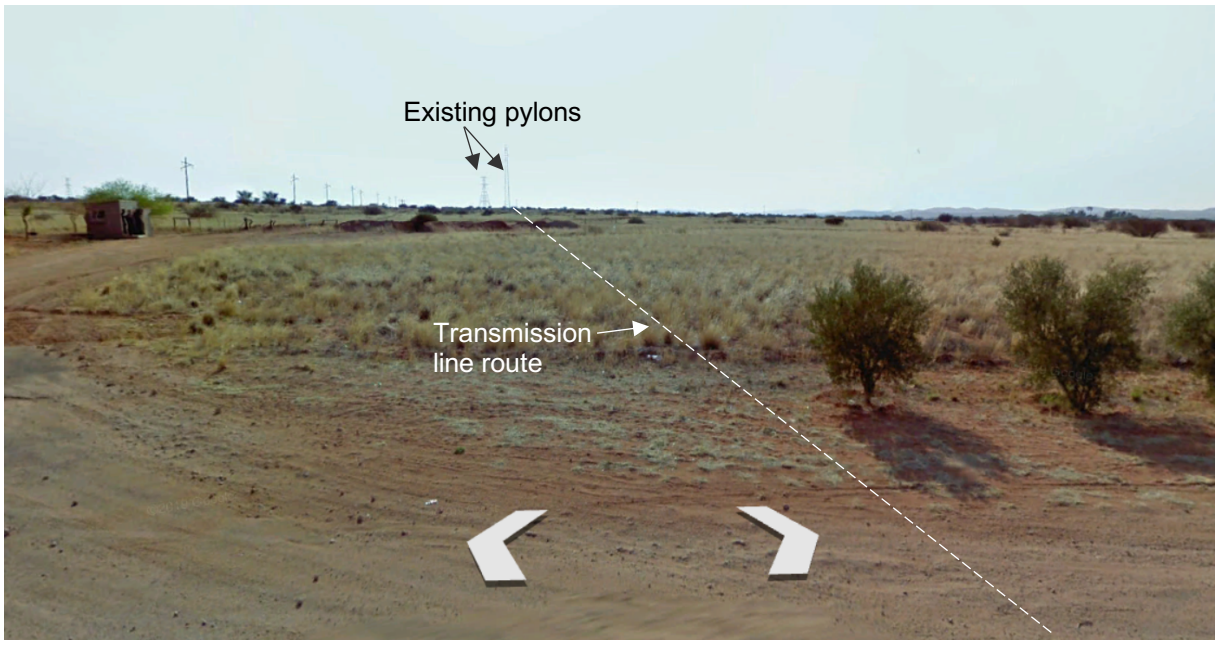


Figure 3: Google Street View imagery at western end of route (facing east) with existing pylons in background (imagery date 10/2010)

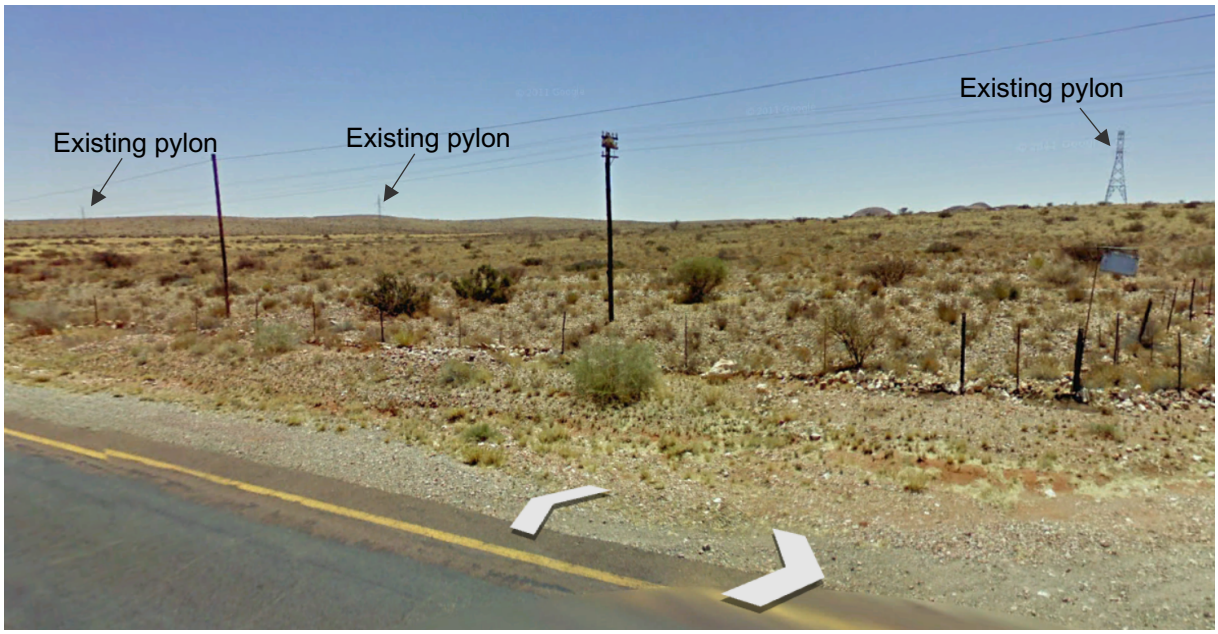


Figure 4: Google Street View imagery in central portion of route (facing northwest) with existing pylons in background (imagery date 10/2010)

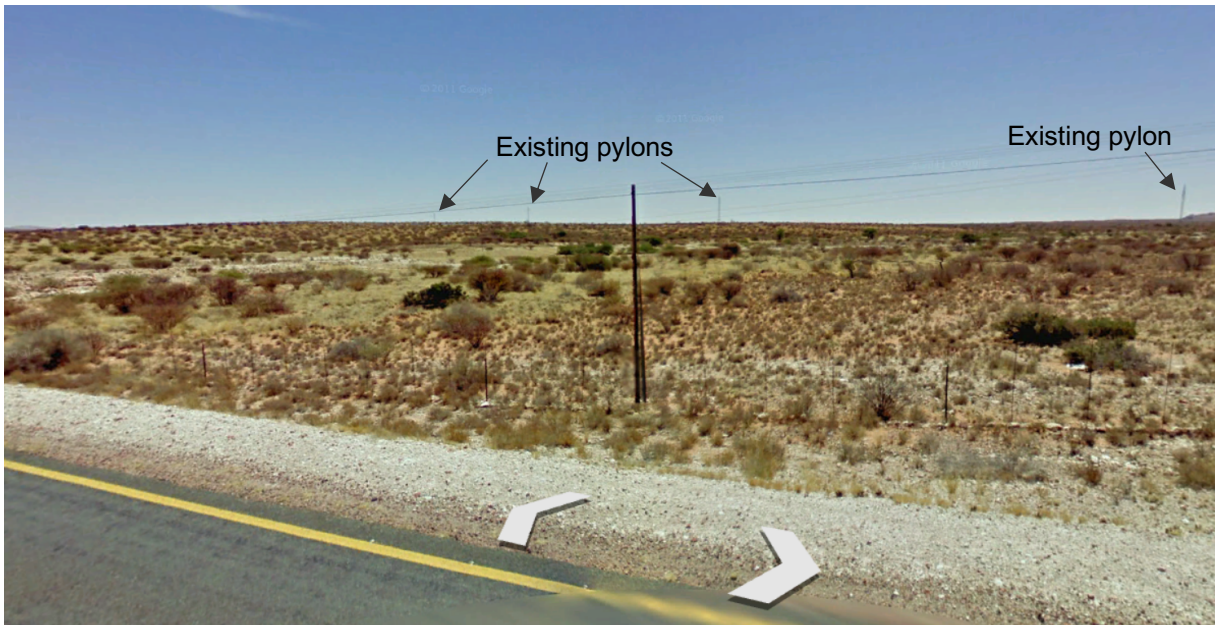


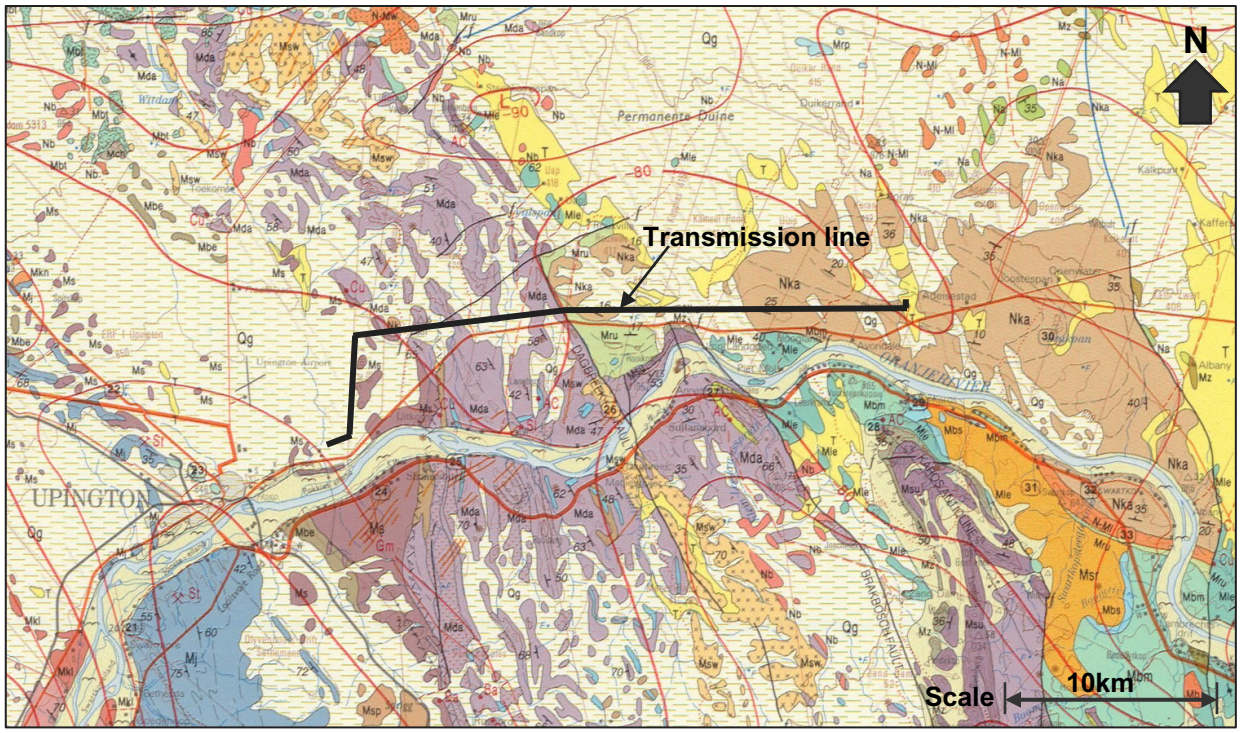
Figure 5: Google Street View imagery at eastern end of route (facing northwest) with existing pylons in background (imagery date 10/2010)

3 Site Geology

The geological setting of the transmission line route is shown in Figure 6. The geology map indicates that the route is largely underlain by the Quaternary-aged Gordonia Formation of the Kalahari Group, comprising red-brown, wind-blown (aeolian) sand and dunes.

Towards the west, the route traverses portions of '*quartzite and schist grading into banded gneiss and migmatite'* of the Vaalkoppies Group, Dagbreek Formation. This rock formation coincides with the outcropping rock noted in the satellite imagery.

Towards the east, the geology map indicates that the route is largely situated on sandstone and conglomerate of the Koras Group, Kalkpunt Formation. Furthermore, as noted in both the geology map in Figure 6 and in Figure 7, the presence of calcrete is expected at the site. Calcrete development is generally sporadic and may range from nodular to hardpan over short distances.



Symbol	Group / Formation	Lithology
Qg	Kalahari Group, Gordonia Formation (Quarternary)	Red-brown, wind-blown sand and dunes
T	(Tertiary)	Calcrete
Nk	Nama Group, Kuibis Fm	Grey and red-brown quartzite, shale, conglomerate
Nka	Koras Group, Kalkpunt Fm	Red-brown sandstone, conglomerate
Mru	Koras Group, Rouxville Fm	Andesitic to basaltic lava, commonly amygdaloidal, pyroclastics
Ms	Keimoes Suite	Weakly foliated biotite granite
Mda	Vaalkoppies Group, Dagbreek Fm	Quartzite and schist grading into banded gneiss and migmatite

Figure 6: Regional geological setting of the site (adapted from published 1:250 000 Geological map; Sheet 2820 Upington, Council for Geoscience, 1988)

The site is situated in an area with a Weinert N-value in the order of N=33 (Weinert, 1980). In general, where the N-value is more than 5, disintegration (mechanical weathering) is the dominant form of weathering, and where the N-value is less than 5, decomposition (chemical weathering) is dominant (Weinert, 1980). Disintegration (mechanical weathering) is therefore the expected mode of weathering at the site.

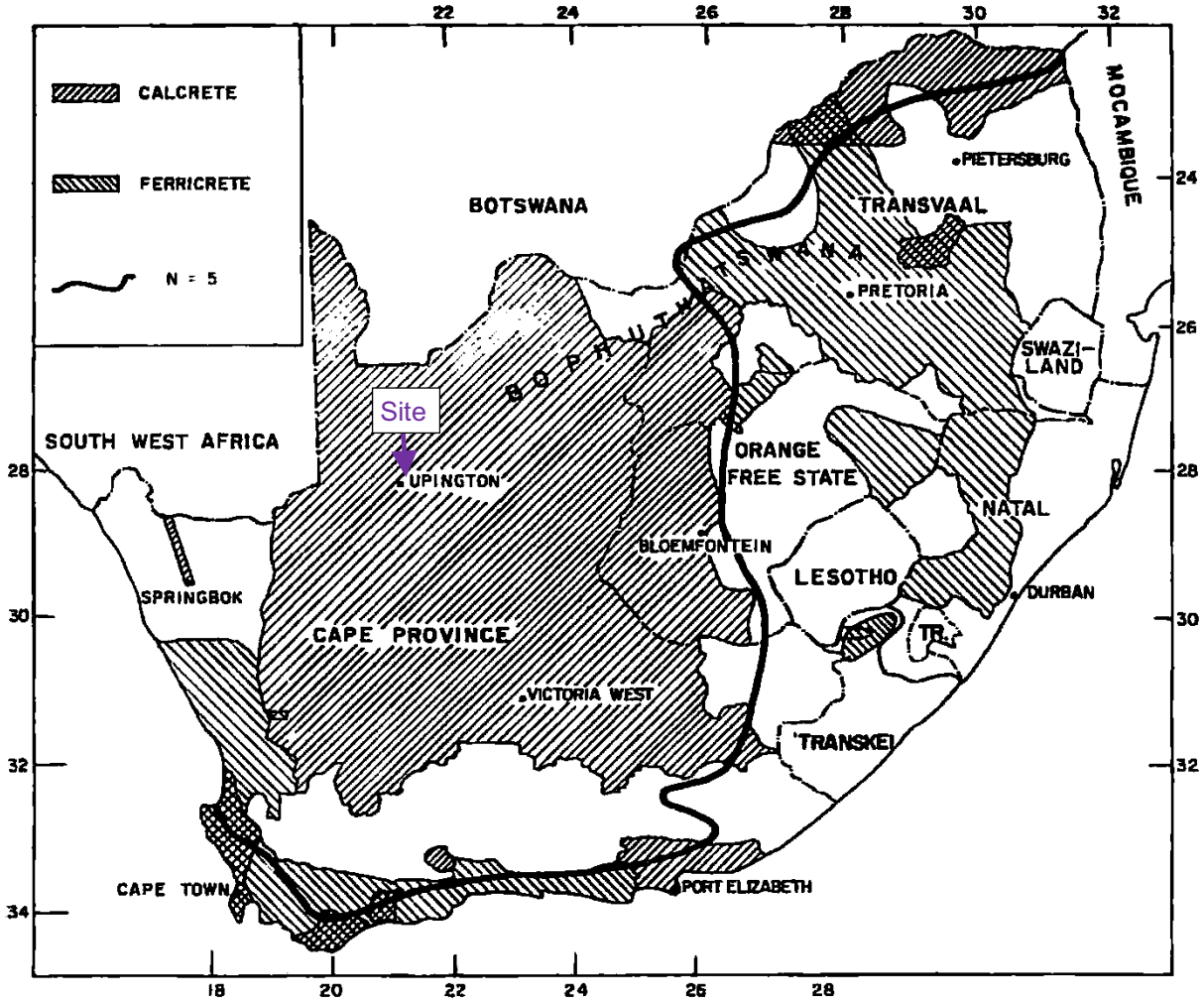


Figure 7: Occurrence of calcrete and ferricrete in relation to the N=5 contour (Weinert, 1980)

4 Seismicity

The South African loading code, SANS 10160-4:2011 (SABS, 2011), suggests that the site is not located in a highly seismic hazard zone (Figure 8). However, as indicated in Figure 8, the site may nonetheless experience a peak ground acceleration in the order of 0.03 m/s^2. The probability of exceedance of this peak ground acceleration is 10% in a 50-year period.

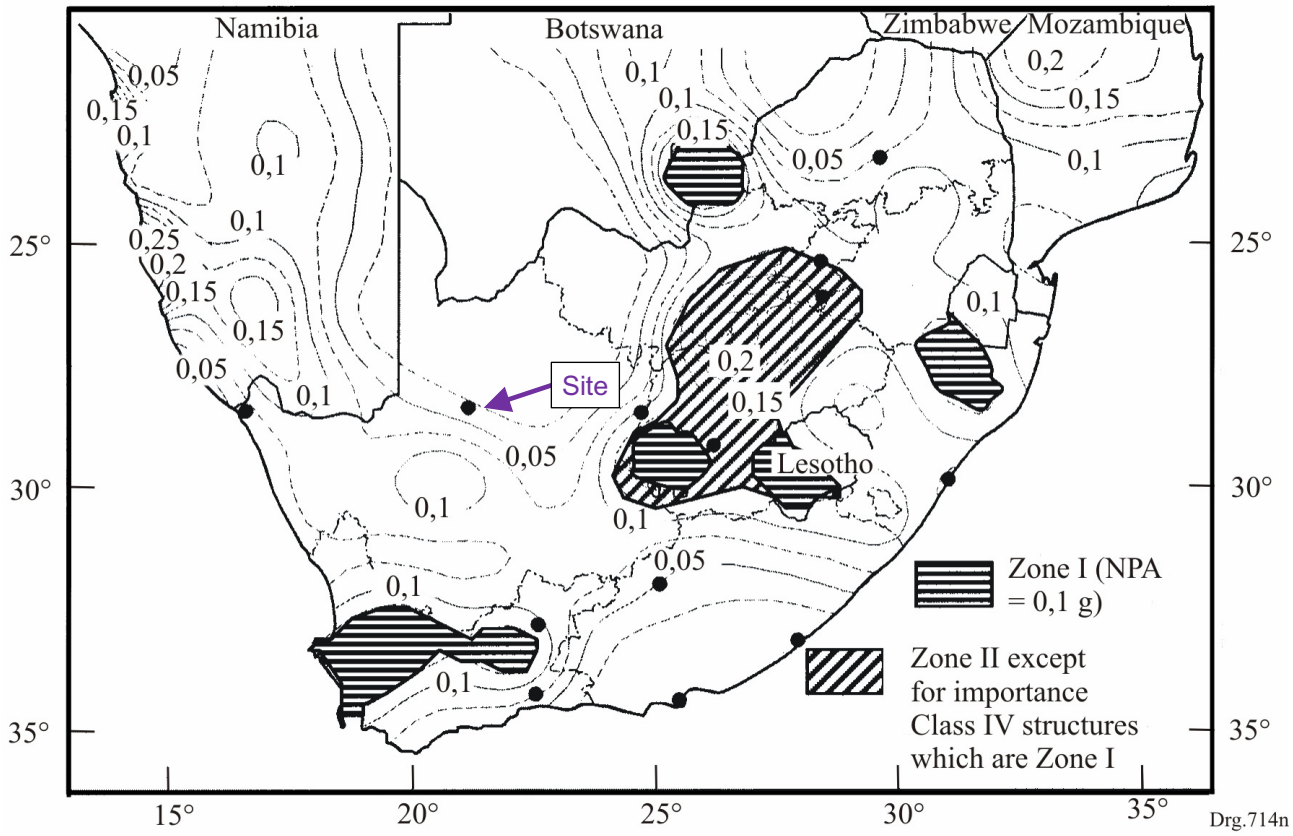


Figure 8: SANS 10160-4:2011 seismic hazard map of South Africa showing peak ground acceleration with 10% probability of being exceeded in a 50-year period (SABS, 2011)

5 Previous Geotechnical Investigations

Reference was made to the reports of three previous geotechnical investigations conducted in the surrounding area, as referenced in Section 1. The locations of these sites ranged from approximately 13km to 28km from the transmission line route. The geology map indicated that portions of these sites were located in similar geology to the transmission line route, particularly with respect to the Quaternary-aged aeolian sands.

5.1 Typical soil profile

Aeolian sands were encountered in almost all the 60 No. test pits from the Aurecon (2013a) investigation, 51 No. test pits from the Aurecon (2013b) investigation, and 2 No. test pits from the Aurecon (2014) investigation. From surface, the depth of the aeolian horizon in all three investigations was generally less than 2m, and frequently less than 1m. The description of the aeolian horizon generally ranged from very loose to medium dense, silty sand to gravelly silty sand. Of particular importance to the aeolian horizon is that can have a collapsible structure, and this was noted in the field observations from the previous investigations. Furthermore, although the depth of the horizon was generally less than 2m from the previous investigations, it is noted that the aeolian deposit can be much deeper in the footprint of dune sands.

Below the aeolian horizon, refusal was generally encountered on calcrete. The calcrete description typically varied between calcretized aeolian, calcretized residual, nodular calcrete, honeycomb calcrete and hardpan calcrete. The thickness of the calcrete ranged up to approximately 2m.

Residual soils and bedrock pertinent to the underlying geology at the three sites was encountered below the above-mentioned horizons. This included residual granite, residual gneiss, granite, gneiss,

schist and amphibolite rock. The depth to bedrock generally ranged from surface to 3m below ground level.

No soluble rocks (dolomite, limestone) which may result in instability problems (sinkholes and other subsidence) were encountered in the three previous investigations.

5.2 Groundwater

In all three previous geotechnical investigations, groundwater was not encountered in any of the test pits or boreholes. However, it must be noted that the transmission line route is located significantly closer to the Orange River than the three investigation sites. In some portions of the route, the river is as close as approximately 1km. The possibility of a shallower groundwater table must therefore not be excluded. Furthermore, the presence of calcrete or calcretized soil and rock horizons is indicative of a historically variable shallow water regime and a perched water table can be expected in a wet rainy season.

6 Foundation Considerations

Along the proposed transmission line route, the primary risk to the foundations of the pylons is the presence of the aeolian sands. The presence of aeolian sands is evident from the geology map and previous geotechnical investigations in the area. The thickness of the aeolian sand deposits can be variable across the site, and deeper in dune sand areas. The very loose and loose nature of these deposits, as they were frequently described in the previous investigations, make them susceptible to low bearing capacity and large settlement. Furthermore, they are expected to have a collapsible structure, making them further susceptible to collapse settlement. According to the Eskom (2015) soil and rock classifications, the aeolian sands are likely to class as a ‘Type 3’ soil, but potentially also as a ‘Type 4’ soil if a shallow water table is encountered along the route. This should be investigated with an in-situ geotechnical investigation.

If shallow calcrete or rock is encountered at the proposed pylon locations, excavations may class as intermediate to hard excavation according to SANS 1200D. According to the Eskom (2015) soil and rock classifications, where calcrete or rock is encountered at the site, it is likely to classify as ‘soft rock’, or potentially as ‘hard rock’. This should be investigated with an in-situ geotechnical investigation.

The site in not underlain by any soluble bedrock (e.g. dolomite). No mines are located in close proximity to the site, therefore undermining is unlikely.

7 Conclusions and Recommendations

A geotechnical desktop study was conducted for the proposed upgrade of the 132 kV transmission line between Avondale and Gordonia, east of Upington, Northern Cape Province.

From the published geology map of the region, the transmission line is expected to be largely underlain by Quaternary-aged aeolian sand and dunes. The aeolian sands present the largest risk to the foundations of the pylons, as they are likely to be susceptible to low bearing capacity and large settlement due to their frequently-described very loose and loose nature. Previous geotechnical investigations in the area also indicated that the aeolian sands can have a collapsible structure, making them further susceptible to collapse settlement.

Detailed geotechnical investigations are required at the site prior to construction of the transmission line to allow the final design of the pylon foundations to take place.

From an environmental point of view, the proposed development is not expected to have an adverse geotechnical or geological impact.

8 References

Aurecon. 2013a. Upington Solar Park: Geotechnical Report (109944-G1-00). Dated 1 November 2013.

Aurecon. 2013b. Solis Solar Power Plant Site Investigation: Factual Report (109438-G2 Rev B). Dated 31 May 2013.

Aurecon. 2014. Geotechnical Investigation for the Ilanga Solar Substation near Upington (110554-G1-00). Dated 7 May 2014.

Bamford, M. 2021. Palaeontological Impact Assessment for the proposed Avondale-Gordonia 132 kV transmission line upgrade, Upington, Northern Cape Province, Desktop Study (Phase 1). Dated 22 July 2021.

Eskom. 2015. The standard for the construction of overhead powerlines (240-47172520) (TRMSCAAC5.2). Dated 17/09/2015.

SABS. 1988. Standardized specification for civil engineering construction, D: Earthworks (SABS 1200 D-1988). South African Bureau of Standards (SABS): Pretoria.

SABS. 2011. Basis of structural design and actions for buildings and industrial structures, Part 4: Seismic actions and general requirements for buildings (SANS 10160-4:2011 Edition 1.1). South African Bureau of Standards (SABS): Pretoria.

Weinert, H.H. 1980. The natural road construction materials of southern Africa. National Institute for Transport and Road Research: Pretoria.