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C O N S U L T I N G

EIA REPORT

TITLE:	Engineering Geology: Eskom Arnot-Gumeni Transmission Project
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1 Introduction

The area between Arnot and Machadodorp, Mpumalanga, is the subject of this engineering geology report of the proposed new 400 kV transmission line between the Arnot and Gumeni substations.

2 Study area

The study area is shown in Figure 1 and has its centre approximately at Y-102278 X+2859789 (WG29). The site was visited during November 2011 as well as February 2012.

The three alternatives for the alignment to be evaluated are shown in Figure 2.

3 Terms of Reference

Engineering geology differs from many other scientific disciplines in that the restrictions or obstacles the environment may pose are determined as opposed to the impact of a proposed development on the environment being assessed.

4 Assumptions and Limitations

The following assumption and limitations are relevant:

- The analyses are based on available data at a scale of 1:250 000 and smaller

5 Geology

The geological map [1, 2] of the study area is shown in Figure 3. The geology of the study area consists of three major groups: the oldest (> 2500 Ma to 1100 Ma, Ma = million years) are mainly sedimentary rocks of the Transvaal Supergroup, which were intruded by igneous rocks of the Bushveld Complex (2060 Ma) and overlain by younger (290 Ma to 190 Ma) sedimentary and volcanic rocks of the Karoo Supergroup. The distribution of the different formations is given in Table 1.

Table 1 Distribution of geological units

Lithostratigraphy	Major Unit	Area (ha)	% Area
Karoo Dolerite Sui	Karoo Supergroup	2310.72	2.35
Vryheid Fm	Karoo Supergroup	46033.20	46.82
Dwyka Grp	Karoo Supergroup	3893.29	3.96
Diabase		5305.19	5.40
Dullstroom Fm	Transvaal Supergroup	3344.76	3.40
Steenkampsberg Fm	Transvaal Supergroup	6611.90	6.72
Lakenvalei Fm	Transvaal Supergroup	910.25	0.93
Vermont Fm	Transvaal Supergroup	1822.94	1.85
Roossenekal Sbsui	Bushveld Complex	579.62	0.59
Dsjate Sbsui	Bushveld Complex	1520.53	1.55
Magaliesberg Fm	Transvaal Supergroup	3818.90	3.88
Lydenburg Shale Memb	Transvaal Supergroup	22126.26	22.50
Machadodorp Memb	Transvaal Supergroup	43.38	0.04

The surface geology is dominated by the Vryheid Formation followed by the Lydenburg Shale Member and the other units.

6 Engineering geology

Generally in areas with a wet climate and the associated climatic N-value [3] of less than 5 (see Figure 4), chemical decomposition is the predominant form of weathering while in drier areas with a climatic N-value of more than 5, physical disintegration is the more dominant form of weathering. For the study area the climatic N-value is between 1 and 2 indicating a very wet climate.

Various baseline datasets were used to determine distribution the five most critical engineering geological factors. The distribution of each factor is shown in Figures 5 to 9. The individual factors were rated and then combined to produce a map showing the combined effect of the engineering geological factors (Figure 10). The engineering geological factors are described below in the order of decreasing severity.

6.1 Mine subsidence

The study area and surrounding area is covered with mining activity, both opencast and underground. A severe threat to the pylons of a power line is underground mining activity that occurred closed to surface with the possibility of the surface subsiding after the pylons have been placed.

As far as it could be determined the areas of undermining and potential subsidence cannot directly be identified using airborne geophysics. Is has however been shown that dykes tend to show on aeromagnetic data and that these areas have not been mined by coal mines [4] as they present a barrier.

Regional aeromagnetic data points, covering the study area (provided by the Council for Geoscience) were gridded and intersected with the extent of the Vryheid Formation which contains, inter alia, the coal bearing strata (see Figure 5). The aim is to infer the areas of potential undermining as follows: An aeromagnetic high indicates the presence of a dyke or sill - where this coincides with the Vryheid Formation the chances for undermining are reduced as the coal mines would not have mined through the dyke or sill.

6.2 Flooding Potential (Inu)

Inundation or flooding is primarily a critical environmental factor, as floods are natural events that need to be considered where development occurs close to stream channels and wetlands. For this factor, the major rivers (ENPAT) and the inland water areas (1: 50 000 topographic data) were used and a 200m buffer added.

When the final alignment has been selected, a more detailed study taking the smaller drainage lines into account will have to be done. The distribution of areas potentially subjected to flooding is shown on Figure 6.

6.3 Unstable Slopes (Slo)

Generally, slopes with an angle of more than 12° make construction difficult and can have significant cost implications. The slopes were derived from a digital terrain model (DTM) that was obtained from the SRTM data. The spatial distribution of potential unstable slopes is given on Figure 7.

6.4 Heave Potential (Act)

Heave potential exist in the areas covered by active, expansive or swelling soils, which undergo volume changes during wetting and drying, potentially causing severe damage to structures (cost implications). Swelling soils containing clays with swelling characteristics (such as montmorillonite) undergo significant changes in moisture condition (wetting and drying) and have to be of sufficient thickness to result in noteworthy movement. Swelling soil is often black, dark grey, red or mottled yellow grey and shows signs of movement such as slickensiding (polished, shiny surface which may contain very fine striations).

Residual soils originating from inter alia the mudrock and dolerite of the Karoo Supergroup (see Figure 3) are known to have swelling characteristics [5]. The distribution of potential swelling soils is shown on Figure 8.

6.5 Excavatability (Exc)

Compared to the abovementioned, the excavatibility of soil or rock is an engineering geological factor that as such does not directly pose any danger to structures (may be except were blasting is required). However, where excavation of ground is difficult, it can have severe cost implications.

The soil depth data (ENPAT) was used to determine the distribution of this factor. Where the soil depth is more than 750mm no significant excavatibility problems are expected.

Over the rest of the study area the soil depth varies between 0 (outcrops) and 750mm, leading to potential excavatibility problems, ranging from severe (blasting or power tools) to slight (hand digging).

The spatial distribution of potential difficult excavatibility is shown on Figure 9.

6.6 Combined factors

The above mentioned factors were weighed with the potential mine subsidence having the highest weight and the excavatability having the lowest. The weighted factors were then summed resulting in an engineering geological constrain raster dataset ranging in values from 0 to 5. Current mining activities and potential mineral occurrences [6] were assigned the highest score of 5 and combined with the engineering geological constrain raster data set (see Figure 10).

A comparison of the provided alternatives (June 2012, Figure 2) is given in as follows:

Table 2 Comparison of alternatives

Alternative	Length (km)	Sum of engineering geological constrains
1	56.7	1551
3	59.6	2150
5	52.5	1513

The values in the table above are calculated by summing the engineering geological constrain raster cells that are covered by the respective alternatives. Working with raster datasets with a 100m pixel resolution, the summed cells represent 100m wide corridors.

7 Conclusion

In terms of engineering geological constrain, Alternative 5 of the provided alternatives is the most suitable.

8 Mitigation measures

General mitigation measures include the following:

- Each planned pylon position should be investigated using high definition ground geophysics to determine if the position is undermined.
- Avoid the floodplains of rivers and water bodies.
- Avoid slopes steeper than 12° or stabilize unstable slopes – consult geotechnical engineer.
- Soils with a heave potential should be excavated to bedrock, although it can be expected that a solid concrete foundation for a pylon can accommodate a limited amount of movement. If the soils are too deep to be completely excavated, consult a geotechnical engineer.
- Blasting and / or the use of power tools may be required in areas with excavatibility problems.

9 References

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4. CAMPBELL. G. 2006. High resolution aeromagnetic mapping of “loss-of-ground” features at platinum and coal mines in South Africa. South African Journal of Geology, Volume 109, pp. 439-458.

5. BRINK, A.B.A. 1983. Engineering Geology of Southern Africa, Volume 3, pp. 73-115, 177-209, Building Publications, Pretoria, South Africa.

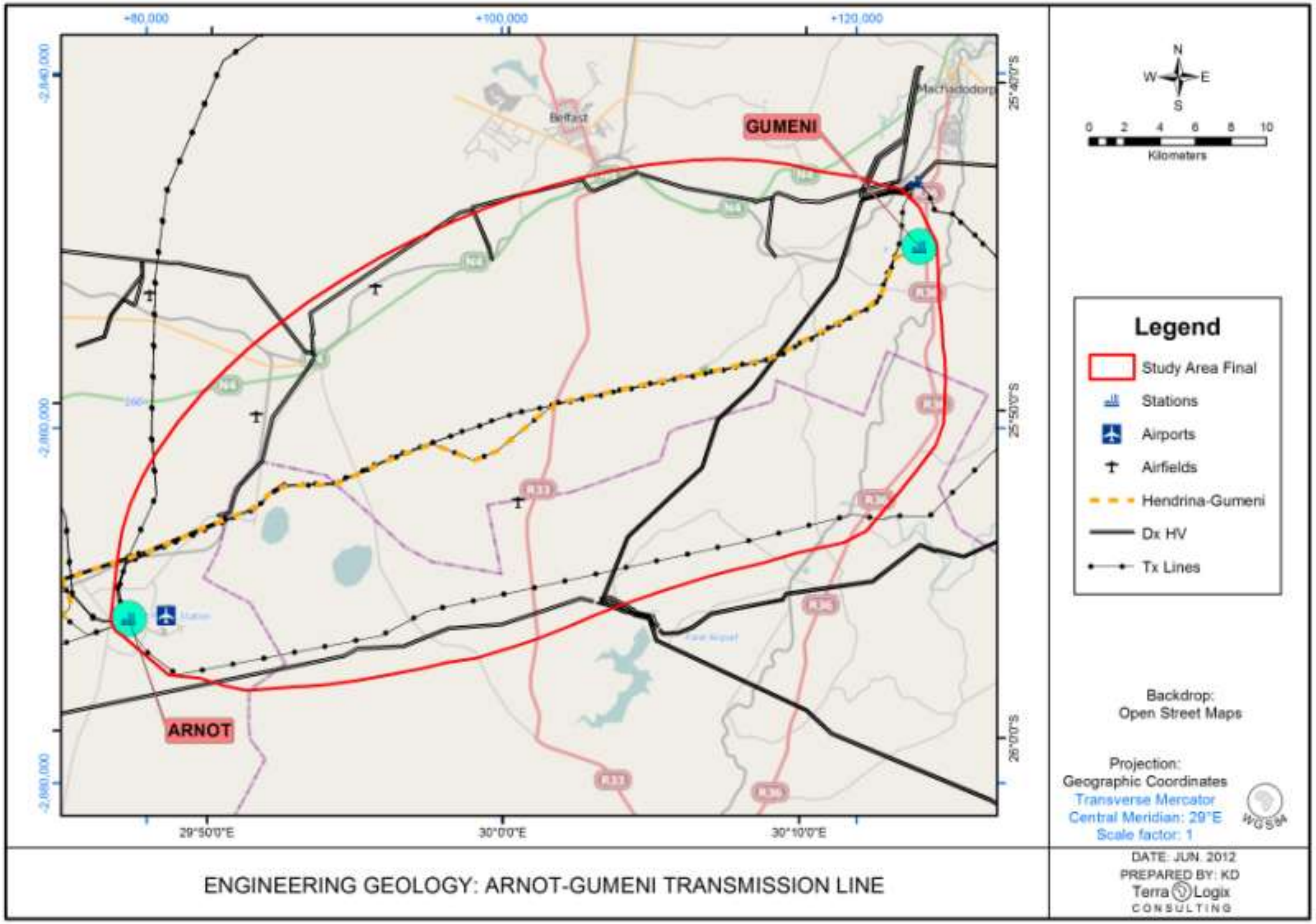

Figure 1 Locality map

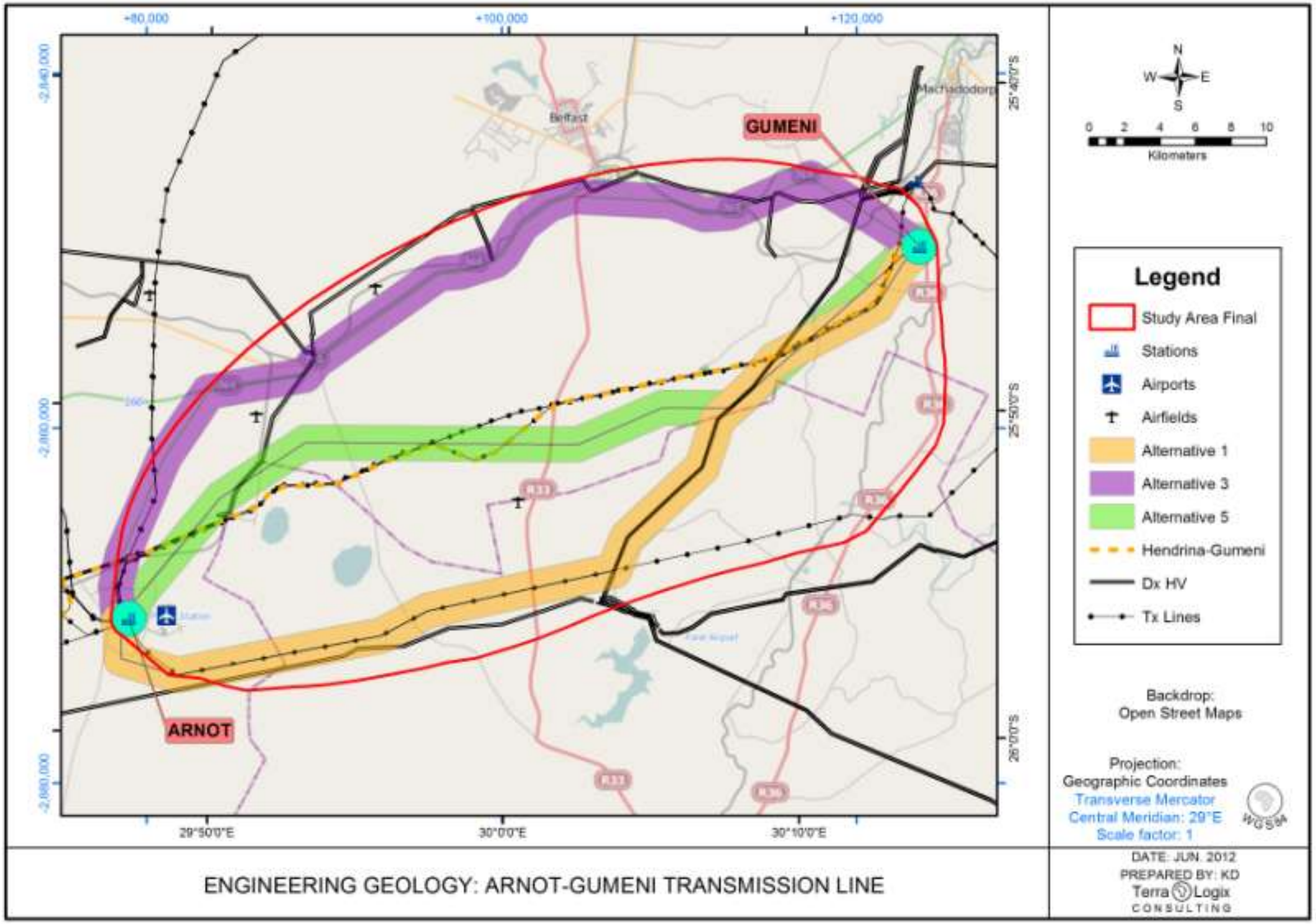

Figure 2 Alignment alternatives

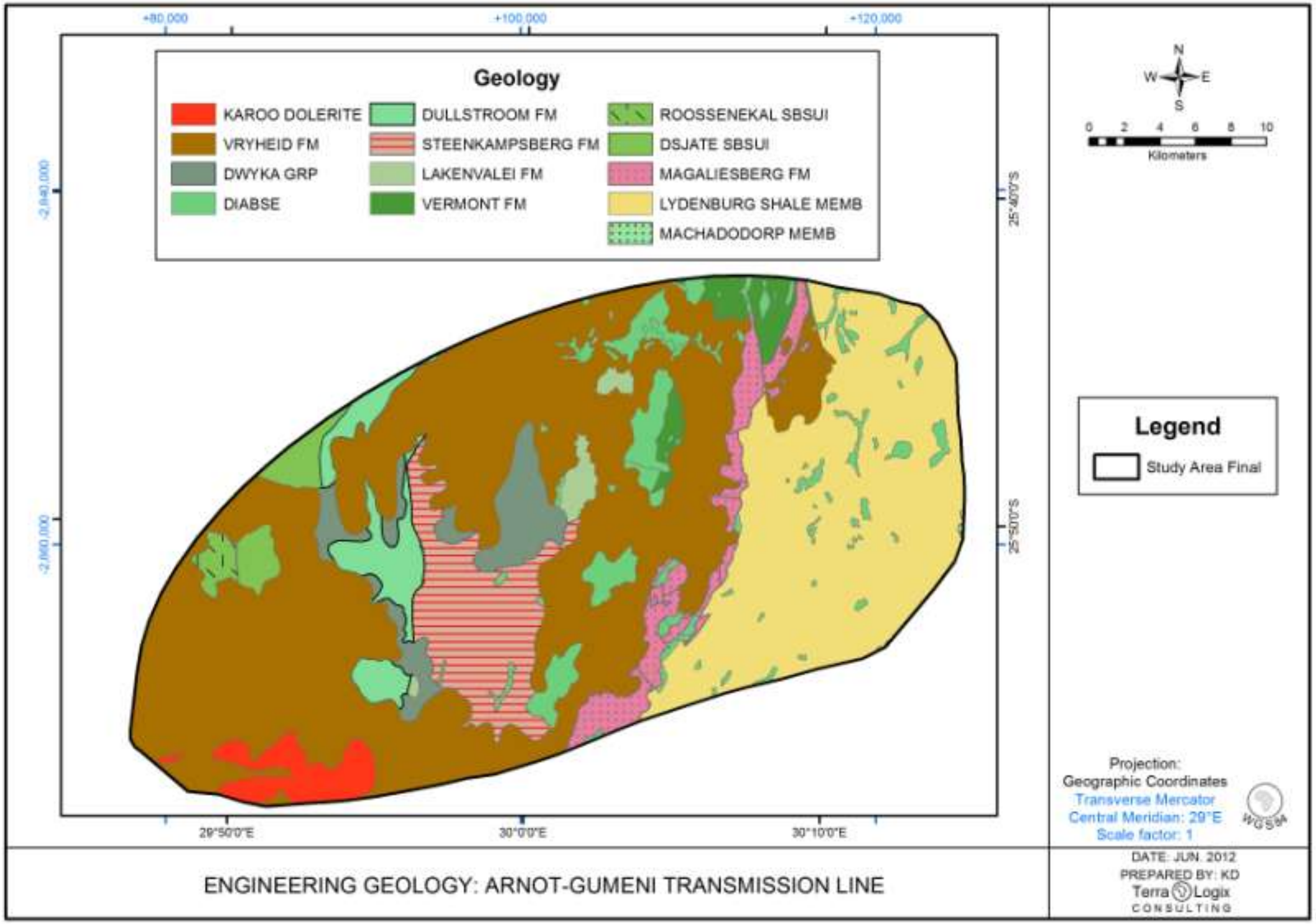

Figure 3 Geological map

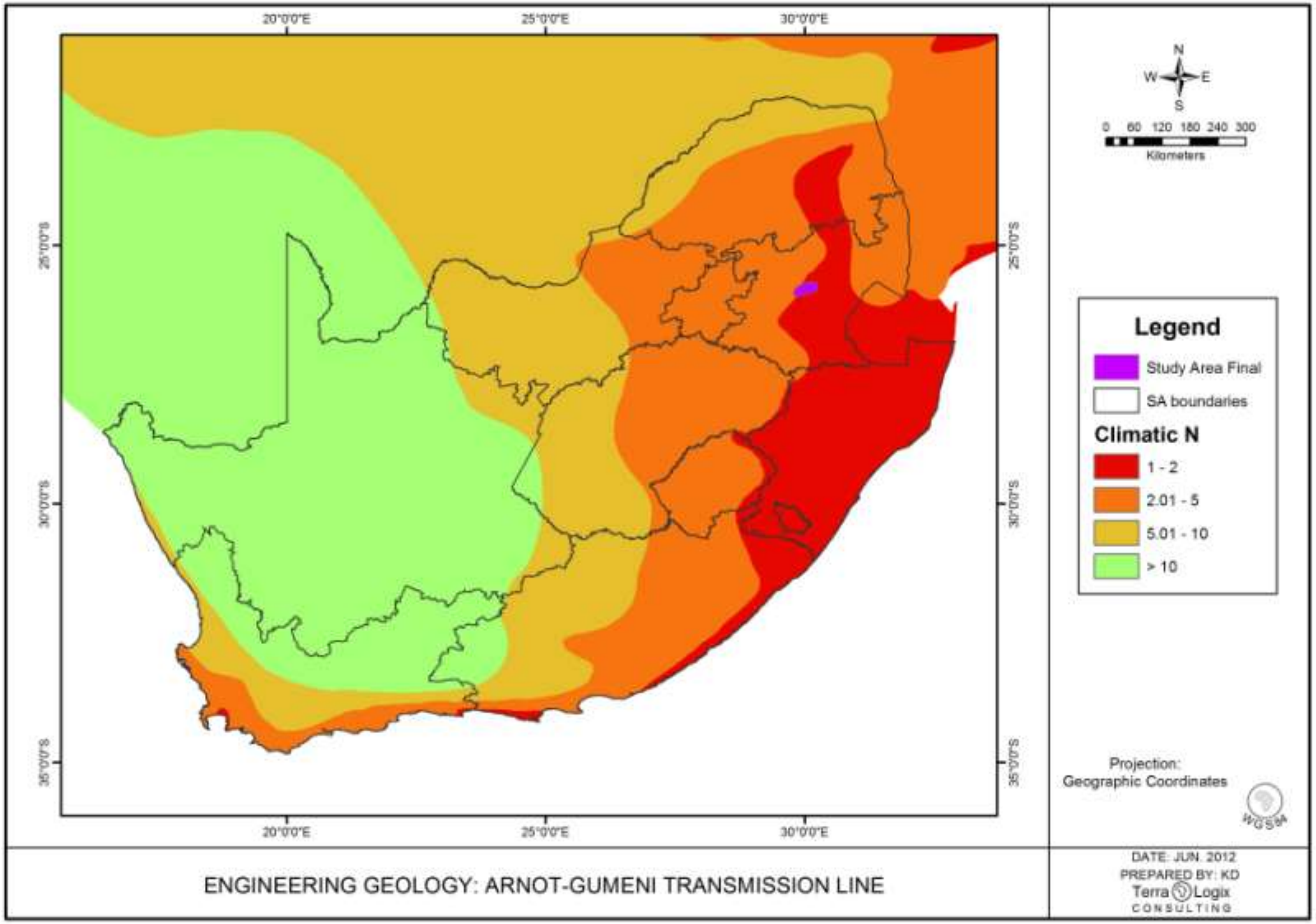

Figure 4 Climatic N-value

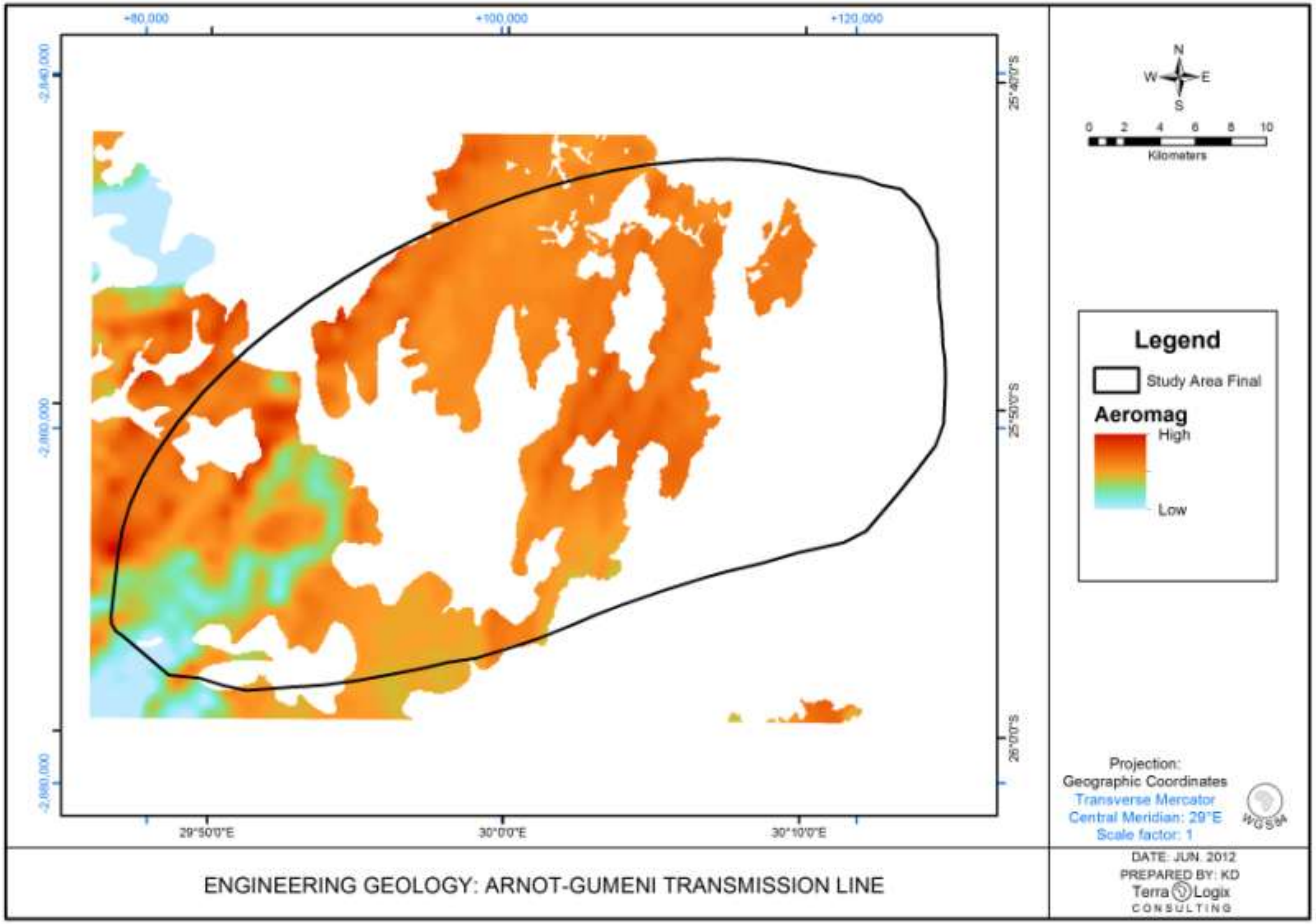

Figure 5 Intersection of aeromagnetic data and the Vryheid Formation

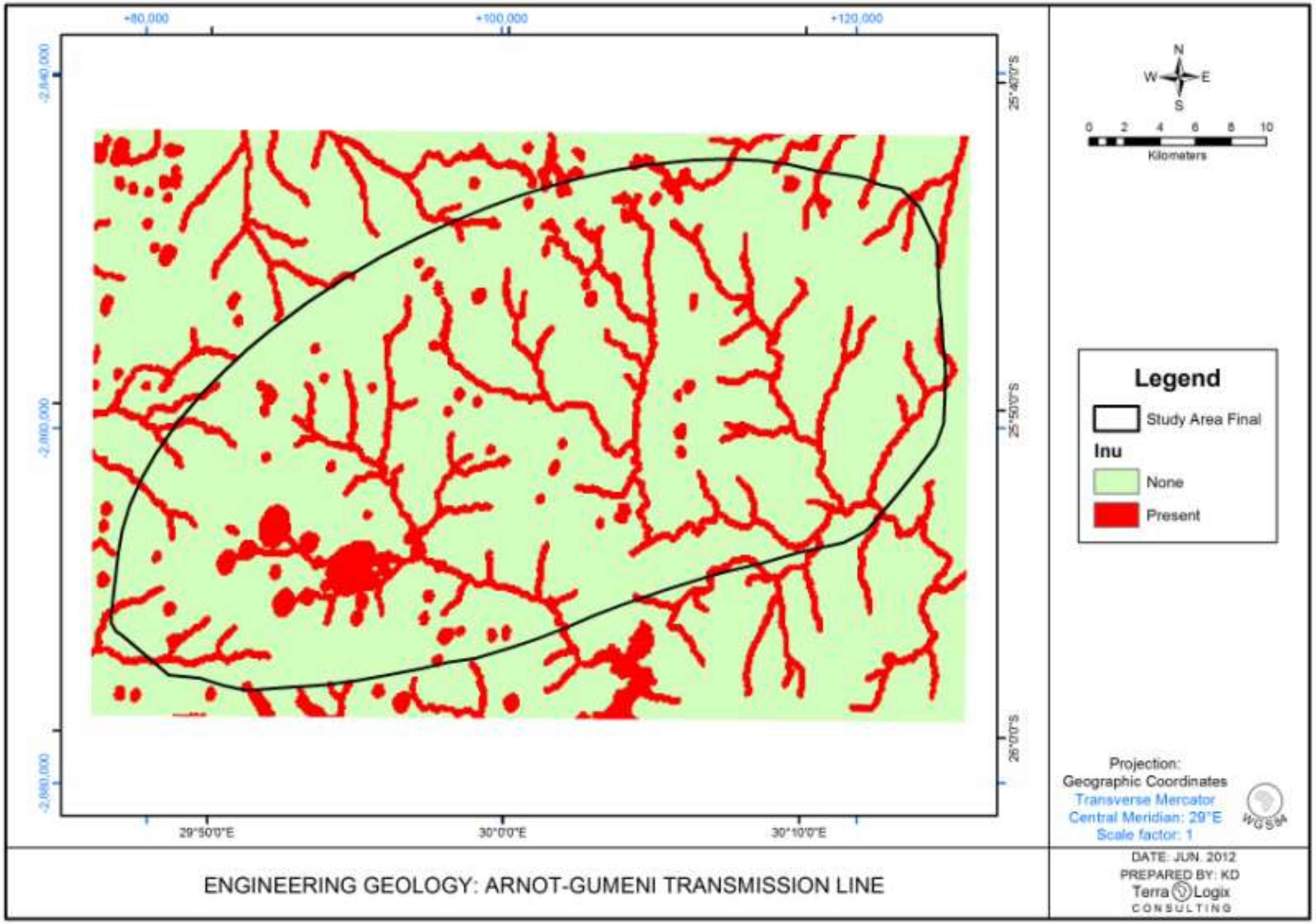

Figure 6 Flooding potential (Inu)

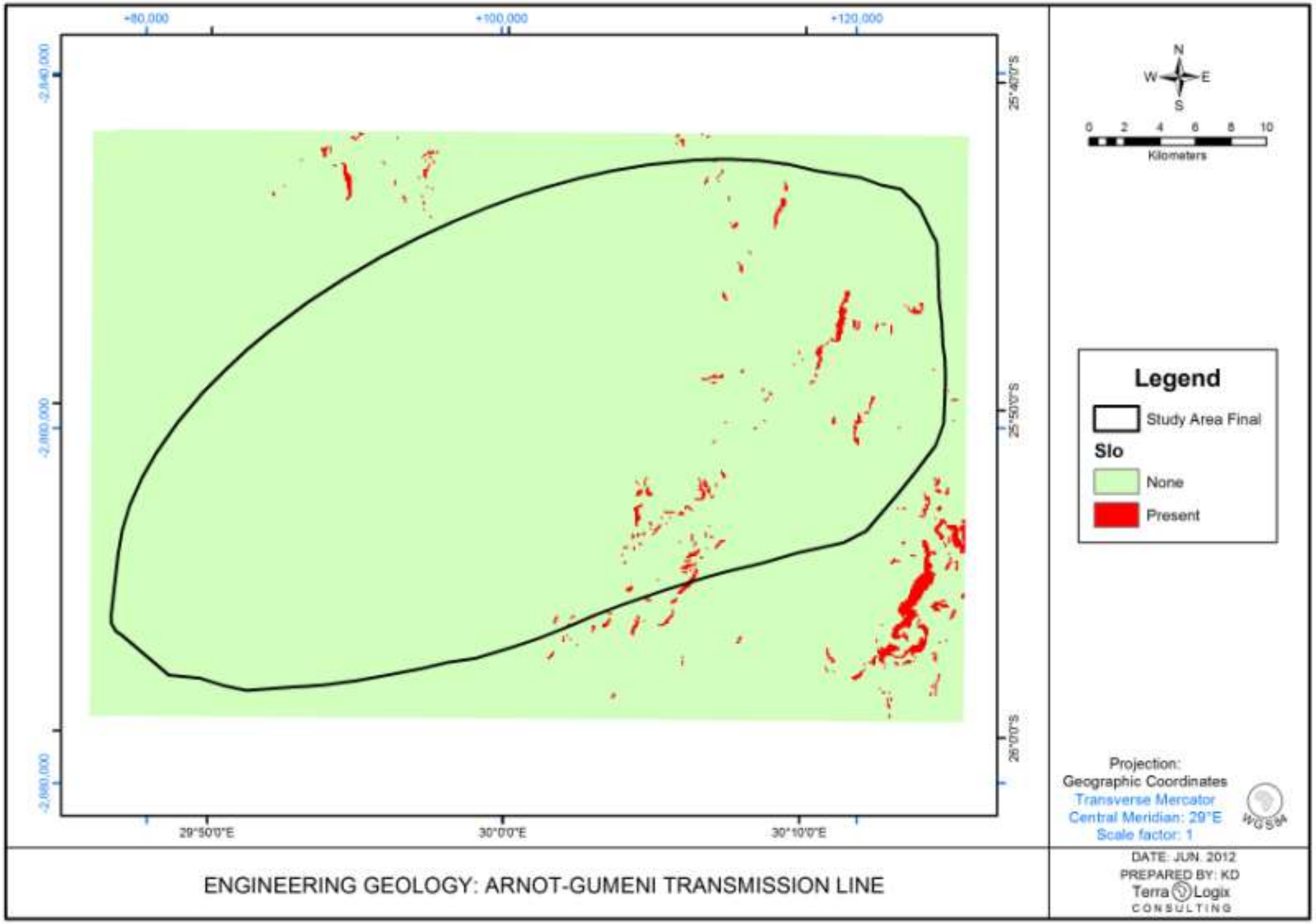

Figure 7 Potential unstable slopes (Slo)

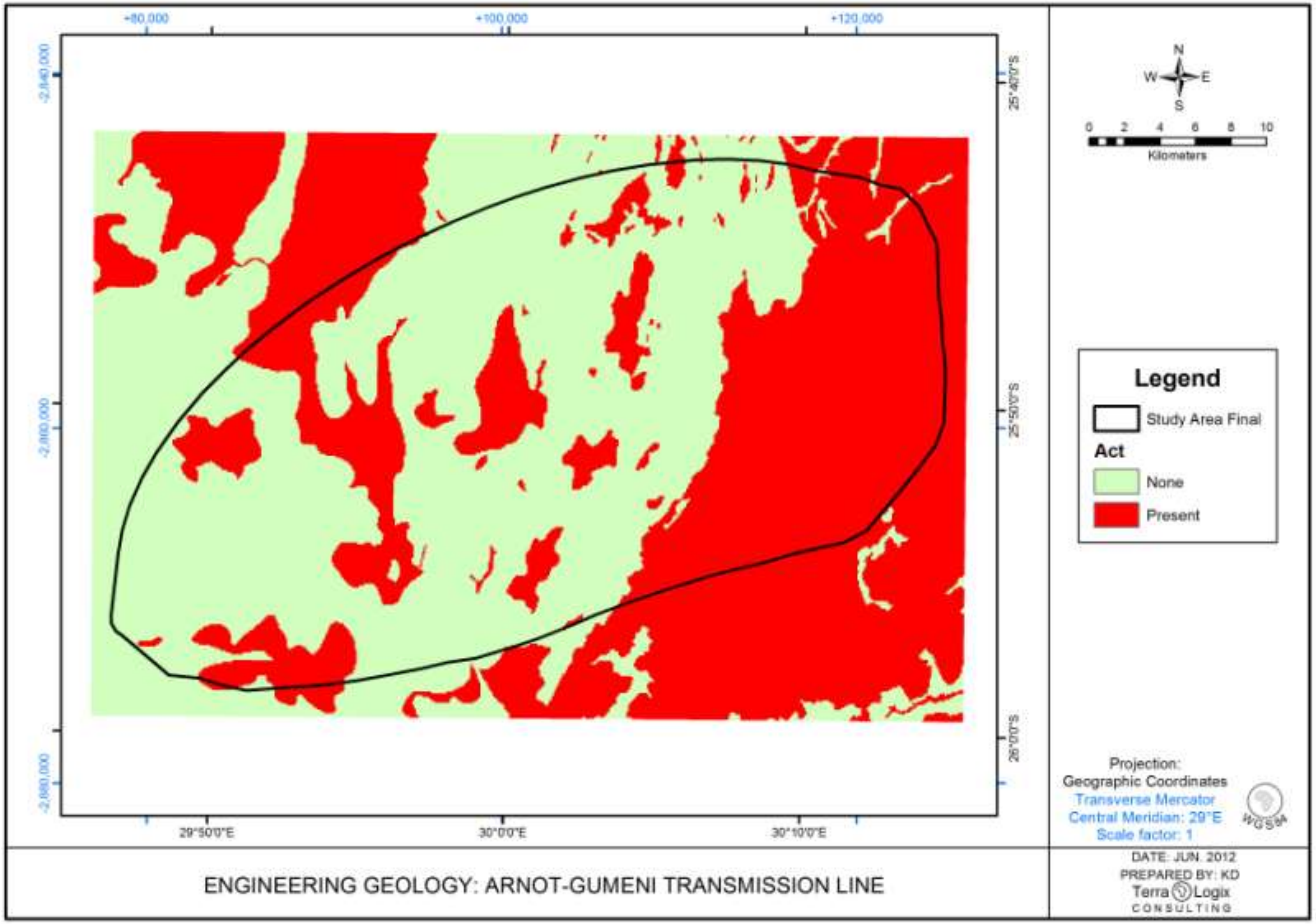

Figure 8 Heave potential (Act)

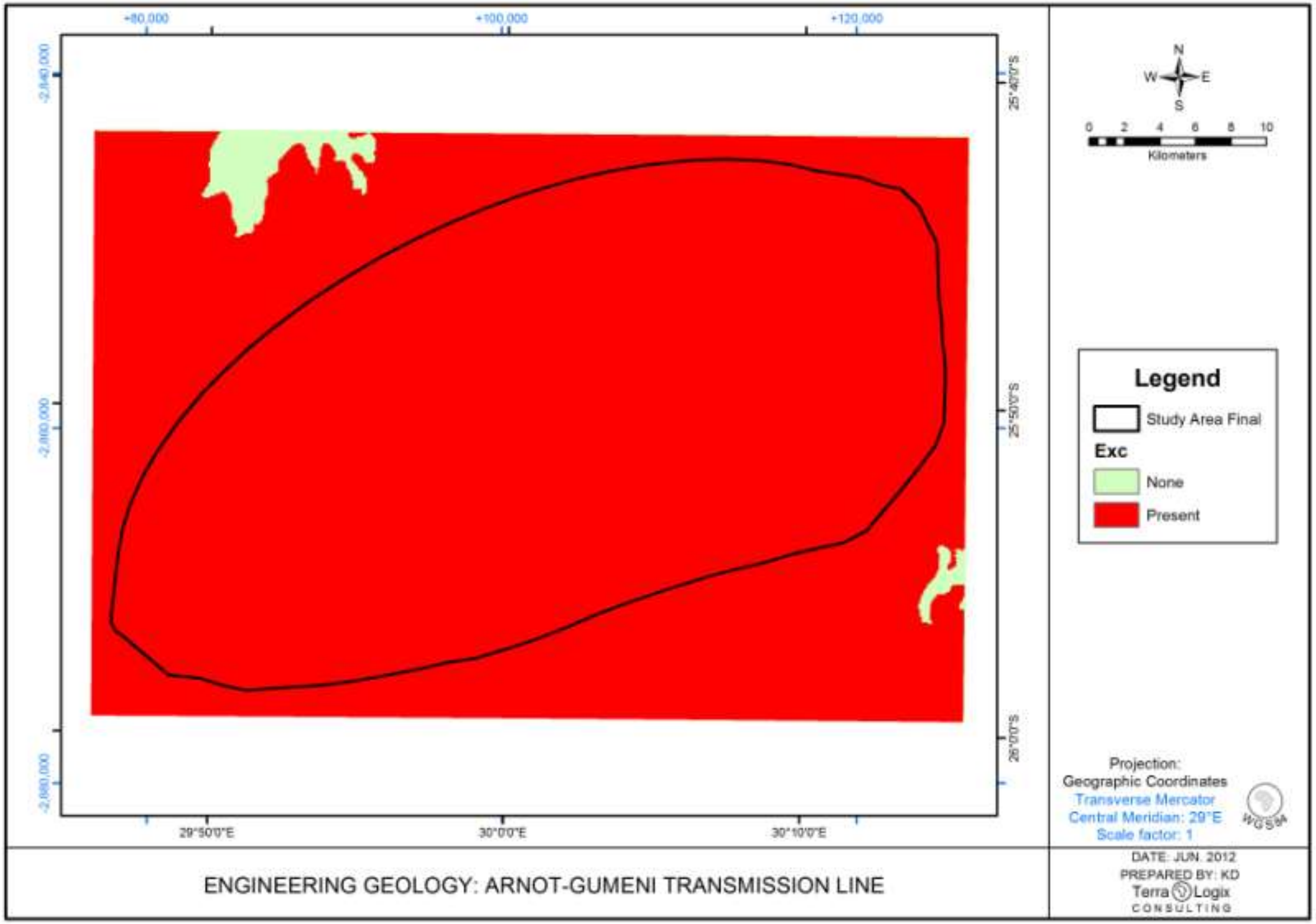

Figure 9 Potential excavatabilty problems (Exc)

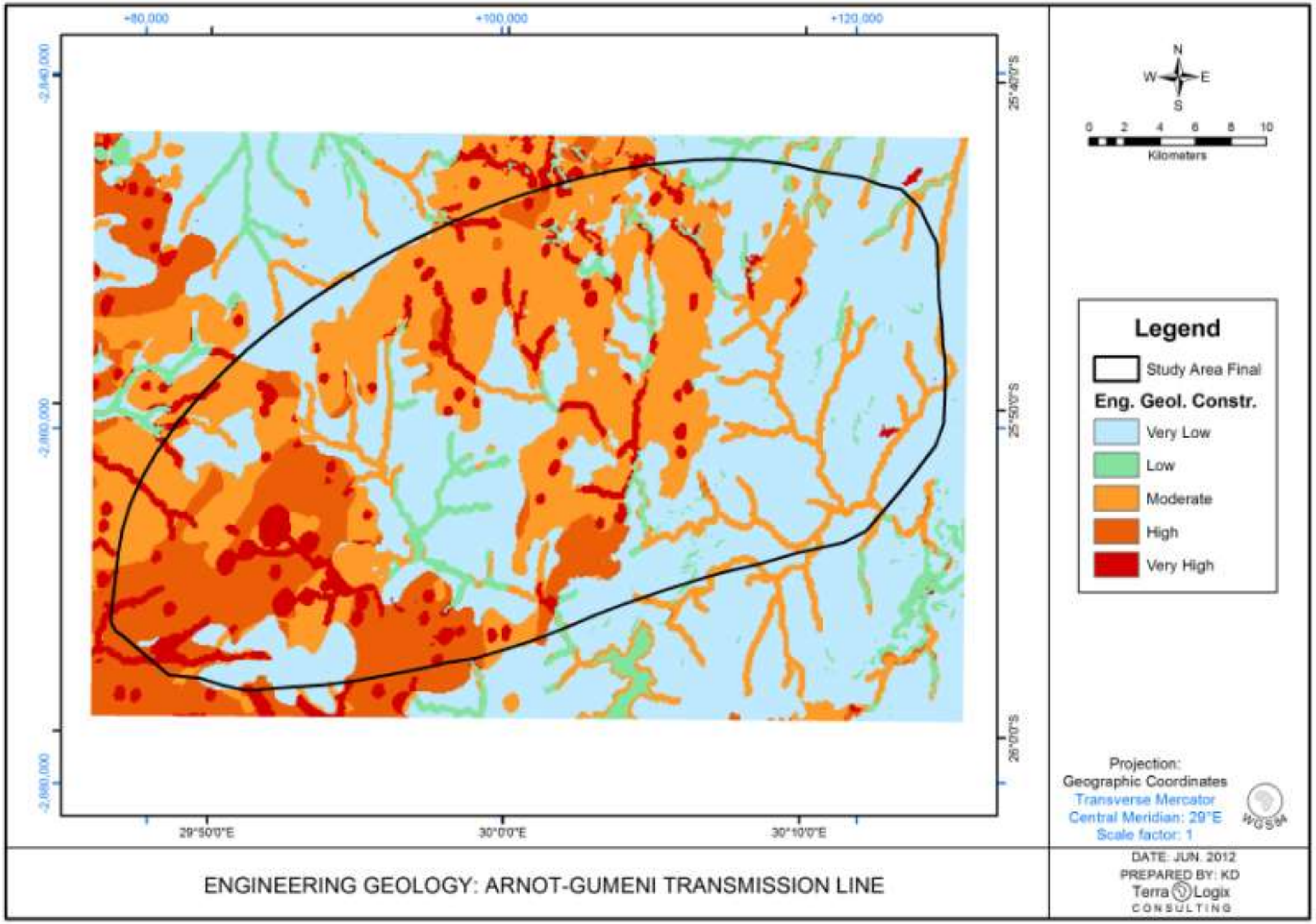

Figure 10 Engineering geological constrain