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EIA REPORT

TITLE:	Engineering Geology: Eskom Nzhelele -Triangle Transmission Project
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1 Introduction

This report gives an overview of the engineering geology of the area covered by the proposed transmission line between the Nzhelele substation in South Africa and the Triangle substation in Zimbabwe. This report covers only the South African part from the Nzhelele substation up to the border between South Africa and Zimbabwe.

2 Study area

The study area is located between the proposed Nzhelele substation (approximately 20km to the west of Tshipise) in the Limpopo Province and the border between South Africa and Zimbabwe. The location of the study area and various alternatives for the alignments are shown in Figure 1.

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] of the study area is shown in Figure 2. The legend in Figure 2 is more or less in stratigraphic order with the oldest rocks at the bottom and the youngest at the top. The geology of the study area consists of three major units [2]: the oldest (> 3400 Ma to 2000 Ma, Ma = million years) are mainly metamorphic rocks of the Beit Bridge Complex and is part of the Central Zone of the Limpopo Mobile Belt.

The second major unit are the rocks of the Soutpansberg Group which consists of volcanic (Sibasa & Stayt Formations) and sedimentary rocks (Wyllies Poort & Stayt Formations) which were intruded by diabase dykes and sills (Mokolian Diabase). Due to hydrothermal alterations the age is difficult to determine – however isotope dating of the rocks below the Sibasa Formation show that at least the lower part of the Soutpansberg Group has an age of between 1800 Ma and 1974 Ma.

The third major unit are the much younger (290 Ma to 190 Ma) sedimentary and volcanic rocks of the Karoo Supergroup, which lie unconformably on the Soutpansberg Group.

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	2653	1.15
Letaba Fm	Karoo Supergroup	12179	5.28
Clarens Fm	Karoo Supergroup	8281	3.59
Bosbokpoort Fm	Karoo Supergroup	1419	0.62
Solitude Fm	Karoo Supergroup	8855	3.84
Mikambeni / Madzaringwe Fm	Karoo Supergroup	8070	3.50
Mokolian Diabase	Soutpansberg Group	1981	0.86
Wyllies Poort Fm	Soutpansberg Group	7521	3.26
Sibasa Fm	Soutpansberg Group	1395	0.61
Stayt Fm	Soutpansberg Group	2904	1.26
Gumbu Grp	Beit Bridge Complex	20598	8.94
Bulai Gneiss	Beit Bridge Complex	13907	6.03
Alldays Gneiss	Beit Bridge Complex	954	0.41
Messina Sui	Beit Bridge Complex	10491	4.55
Malala Drift Grp	Beit Bridge Complex	57217	24.82
Mount Dowe Grp	Beit Bridge Complex	64473	27.97
Sand River Gneiss	Beit Bridge Complex	7625	3.31

Although the Limpopo Belt is not rich in mineral deposits, there are a number of deposits of which the more economical ones are mostly exploited [1] as shown in Figure 3.

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 5 and 10 indicating a dry 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 Mining

The study area has a number of abandoned mines and known mine shaft positions. A severe threat to the pylons of a power line is underground mining activity that occurred close to surface with the possibility of the surface subsiding after the pylons have been placed.

The distance from known mine shaft is used to measure the risk to pylons – with distance the risk diminishes. This was combined with known surface mining operations as shown in Figure 5.

6.2 Flooding Potential

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 river areas and the inland water areas (1: 50 000 topographic data) were used. The distance from known flooding areas is used to measure the risk to pylons – with distance the risk diminishes as shown in Figure 6.

6.3 Unstable Slopes

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 in Figure 7.

6.4 Excavatability

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 [4] 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 in Figure 8.

6.5 Collapsible Soils

Colloidal coatings which adhere to individual grains of residual soil grains provide the soil with an apparent strength. If the soil is under load and becomes saturated the colloidal bridges between the soil particles become lubricated and loos strength immediately leading to a sudden settlement of a foundation. This phenomenon is known as collapsible grain structure [5]

Basalt of the Soutpansberg Group [6] as well as sandstone of the Karroo Supergroup [7] are known to have the potential to form a collapsible grain structure.

The distribution of areas with potential collapsible grain structures is shown in Figure 9.

6.6 Combined factors

The above mentioned factors were combined using fuzzy logic [8] as shown in Figure 10. The highest values represent areas with the highest potential risk to structures.

A comparison of the provided alternatives is given in as follows:

Table 2 Comparison of alternatives

Alternative	Length (km)	Sum of combined factors
Alt 1	53.3	258.2
Alt 2 & 2A	59.3	234.4
Alt 2 & 2B	54.3	147.7

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 90m pixel resolution, the summed cells represent 90m wide corridors.

7 Conclusion

In terms of engineering geological constrain, Alternative 2 & 2B of the provided alternatives is the most suitable.

8 Mitigation measures

General mitigation measures include the following:

- Planned pylon position where there is potential risk of subsidence due to undermining 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.
- Where the planned pylons coincide with soil with a potential collapsible structure, soil samples should be tested for such - 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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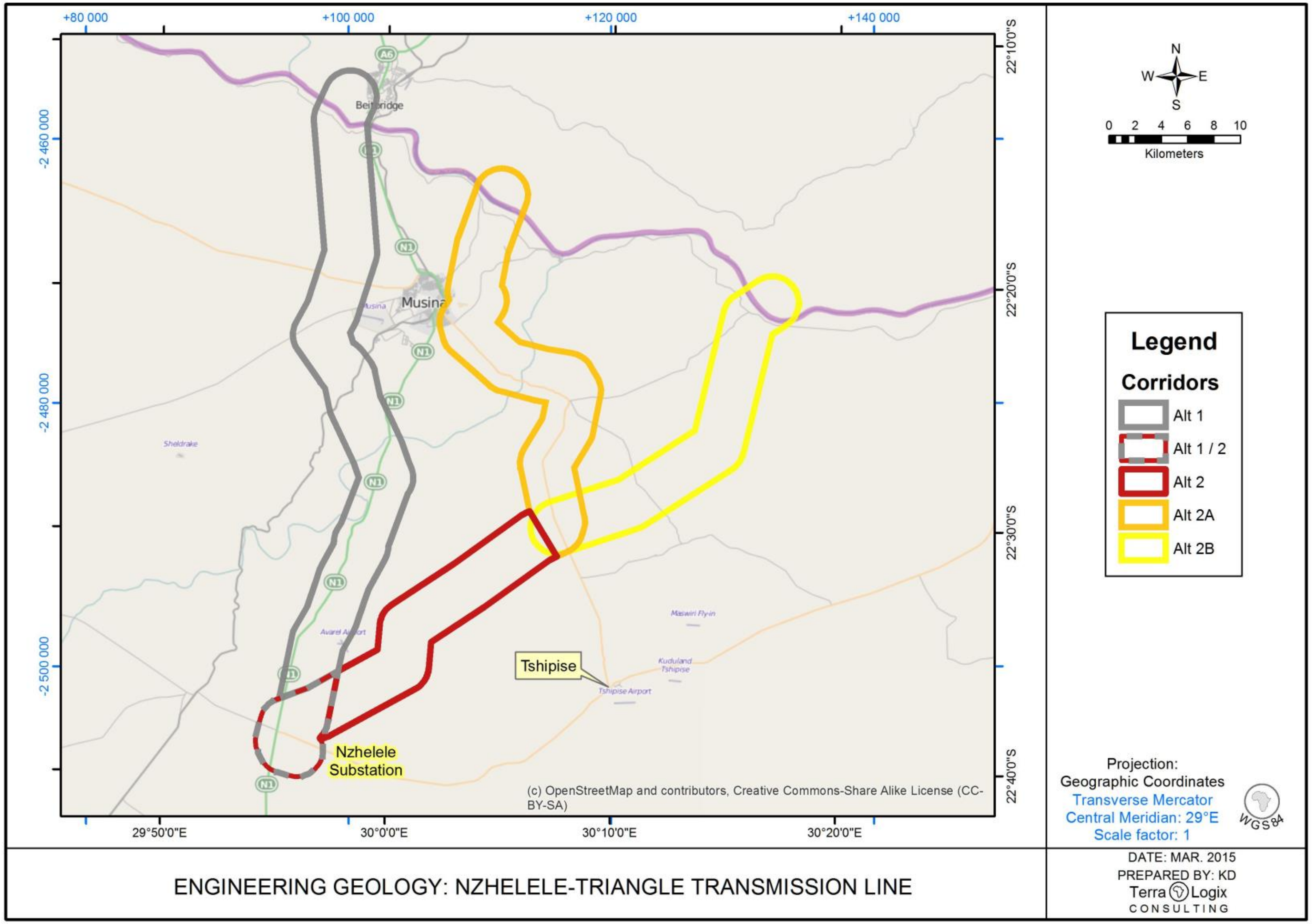

Figure 1 Locality map

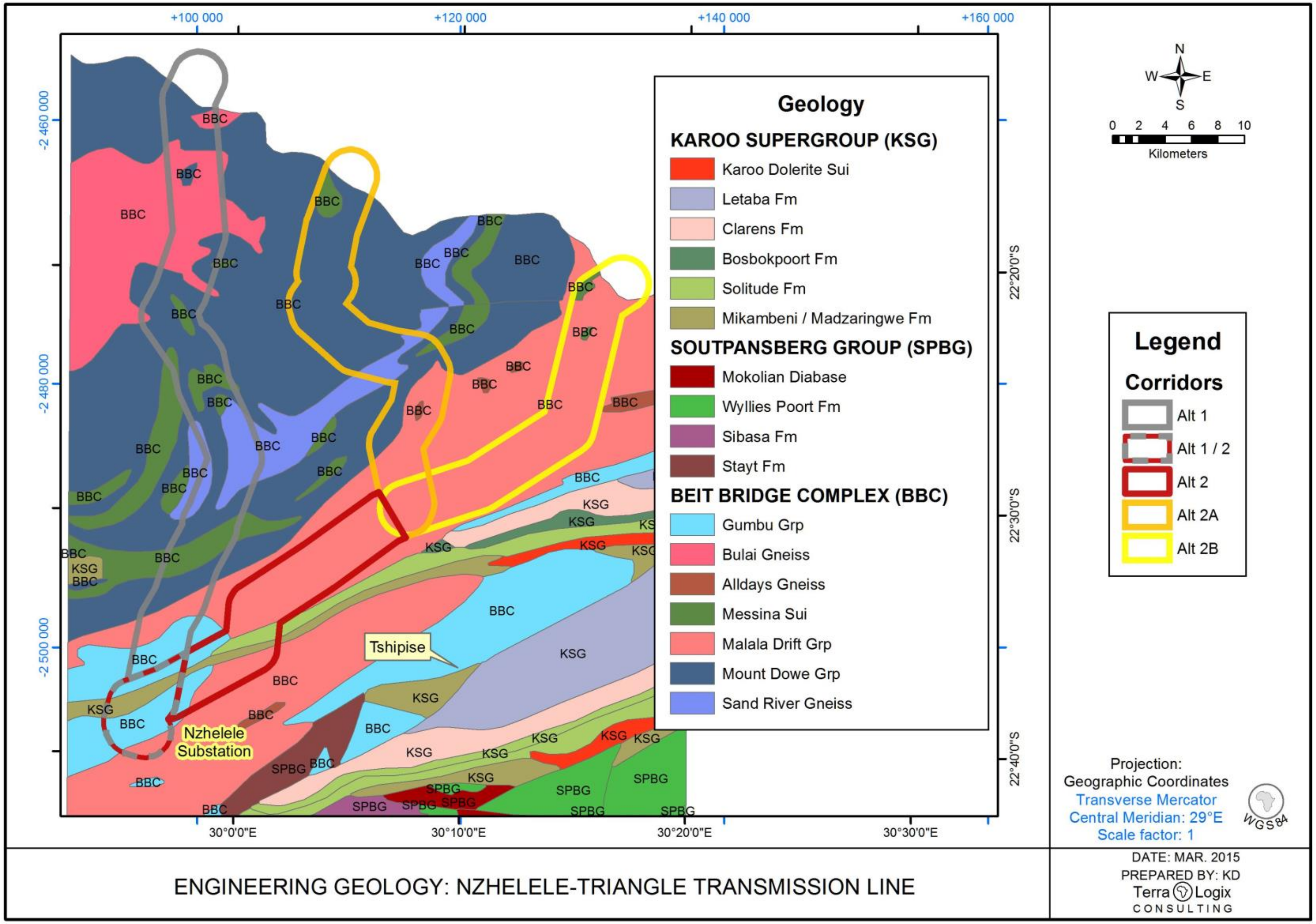

Figure 2 Geological map

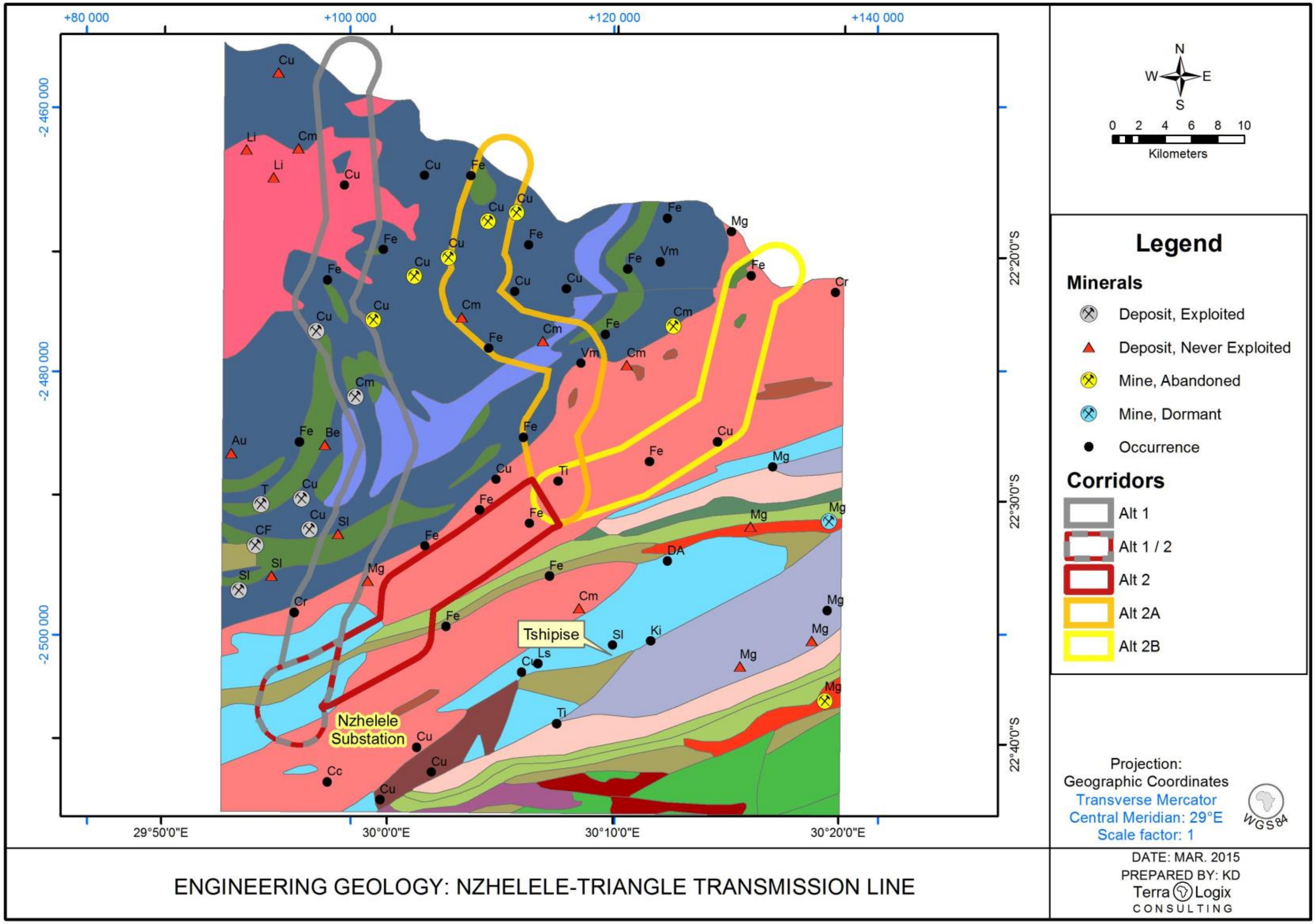

Figure 3 Mineral map

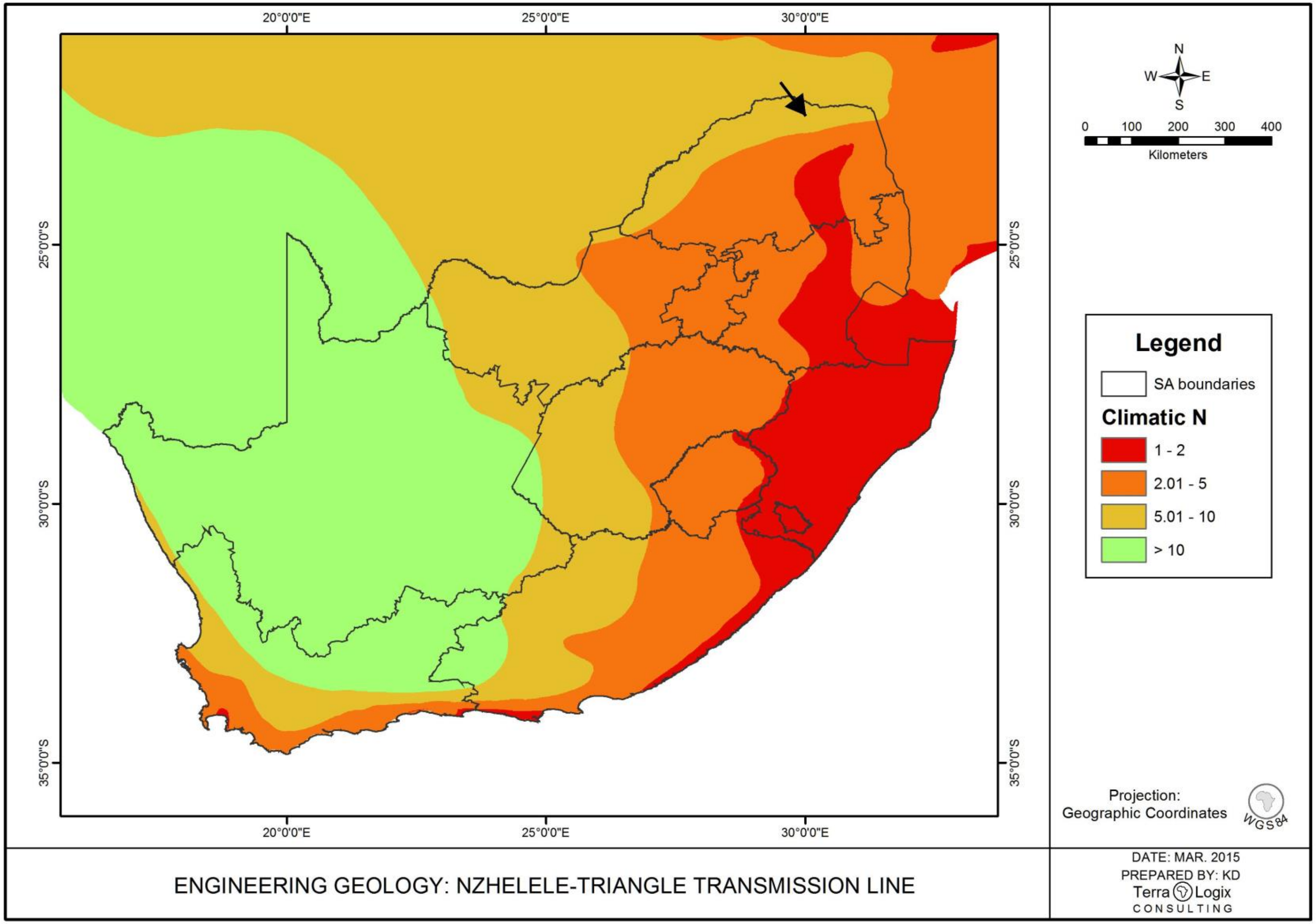

Figure 4 Climatic N-value

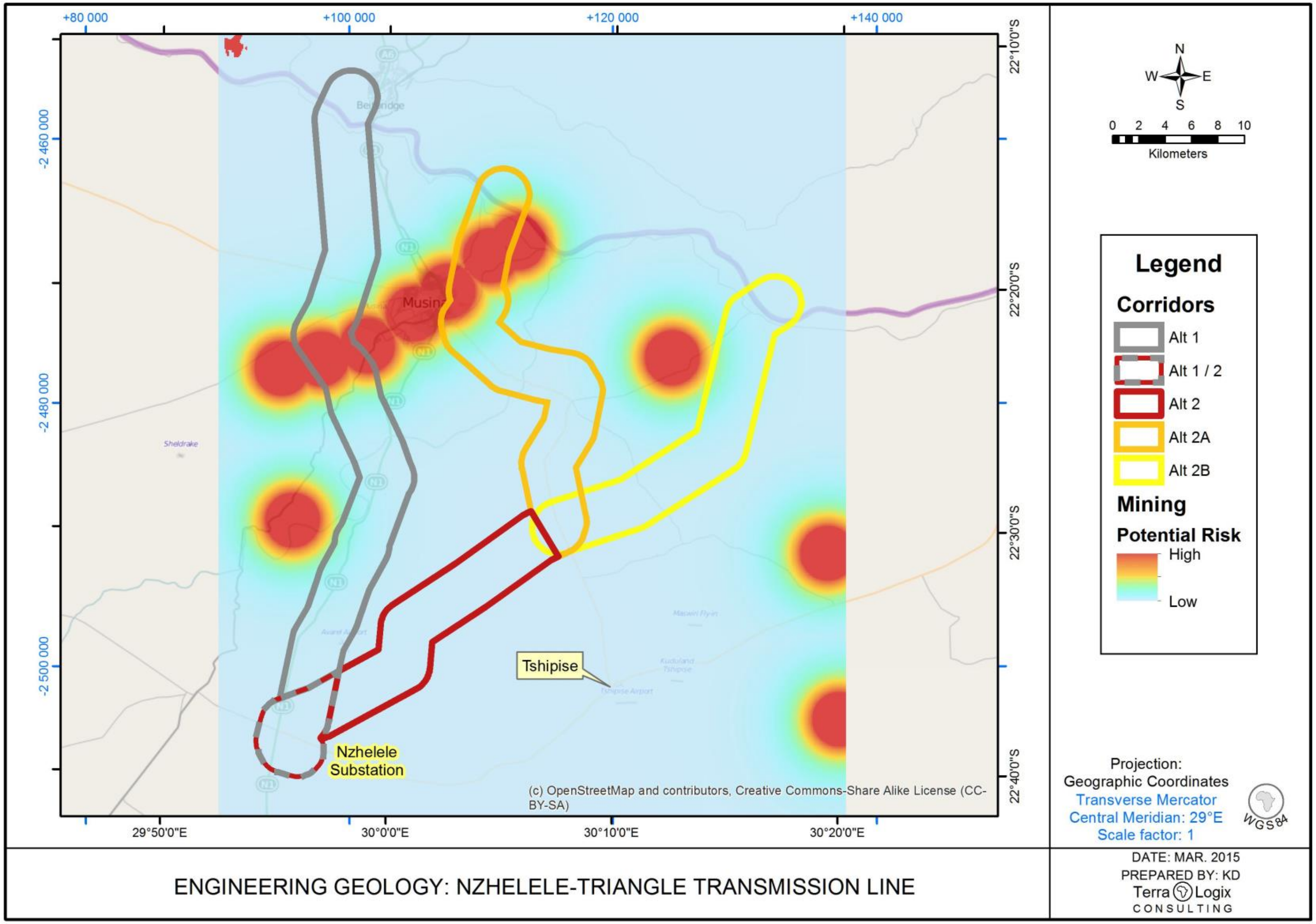

Figure 5 Potential risk from mining activities

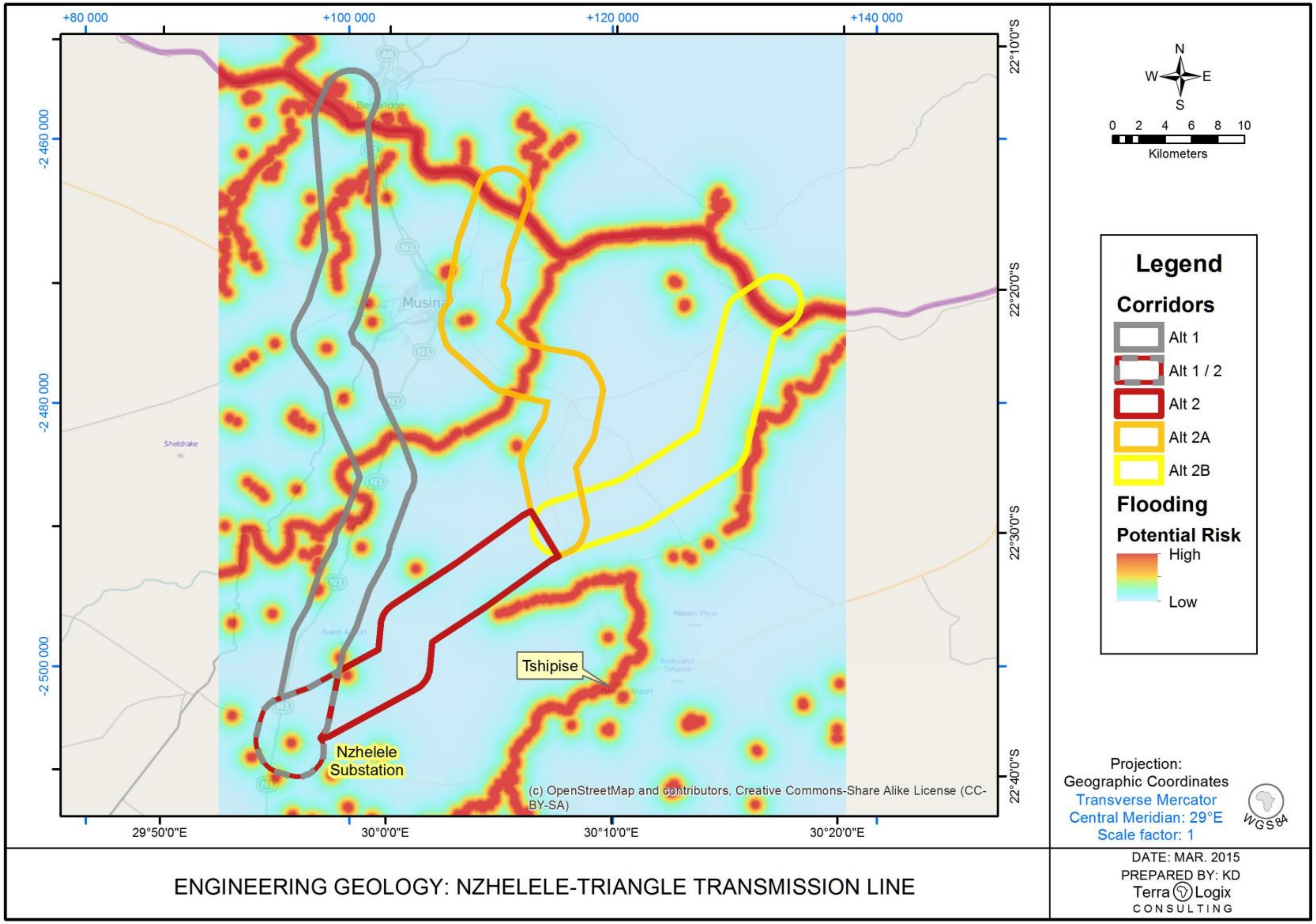

Figure 6 Potential risk due to flooding

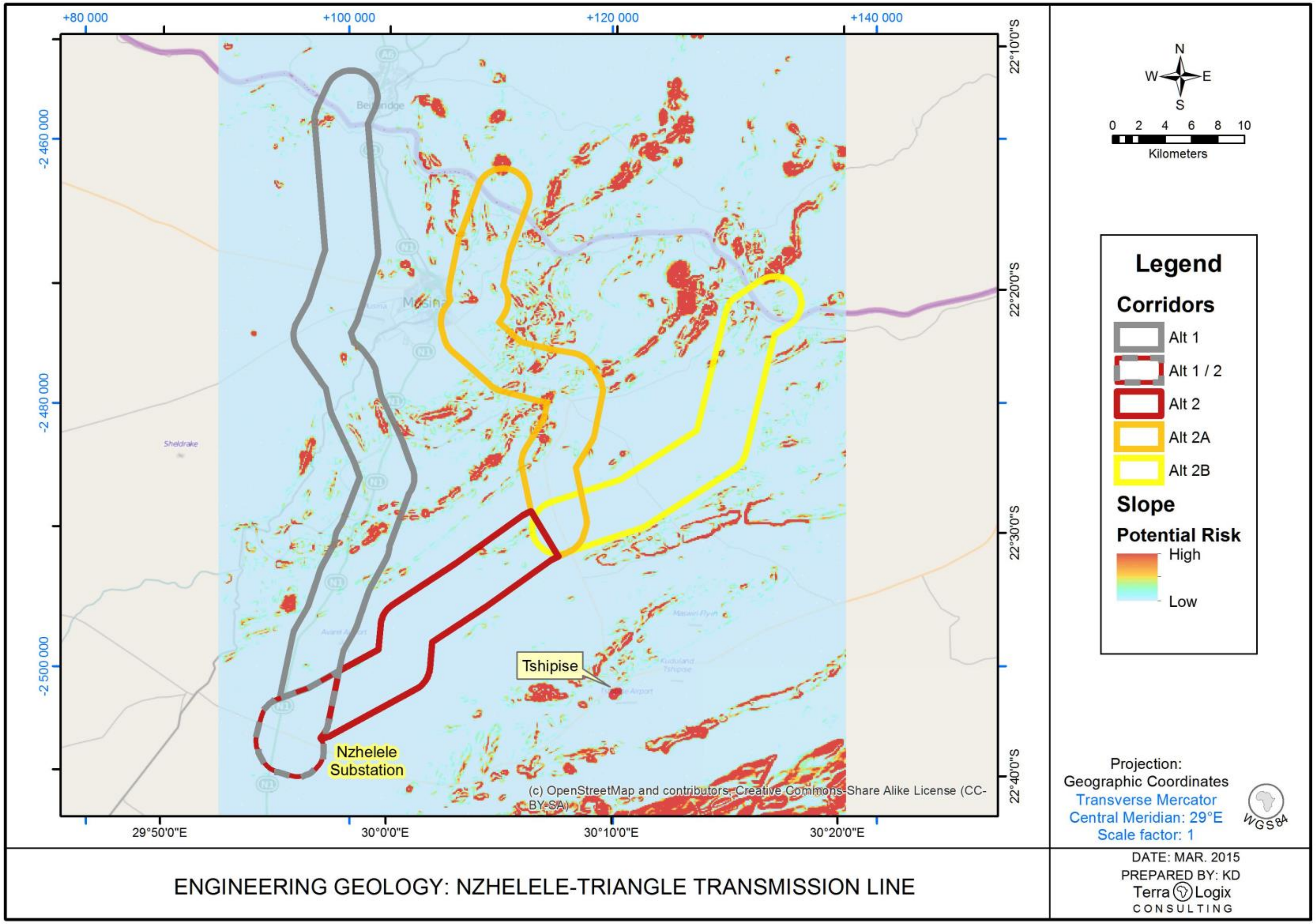

Figure 7 Potential unstable slopes

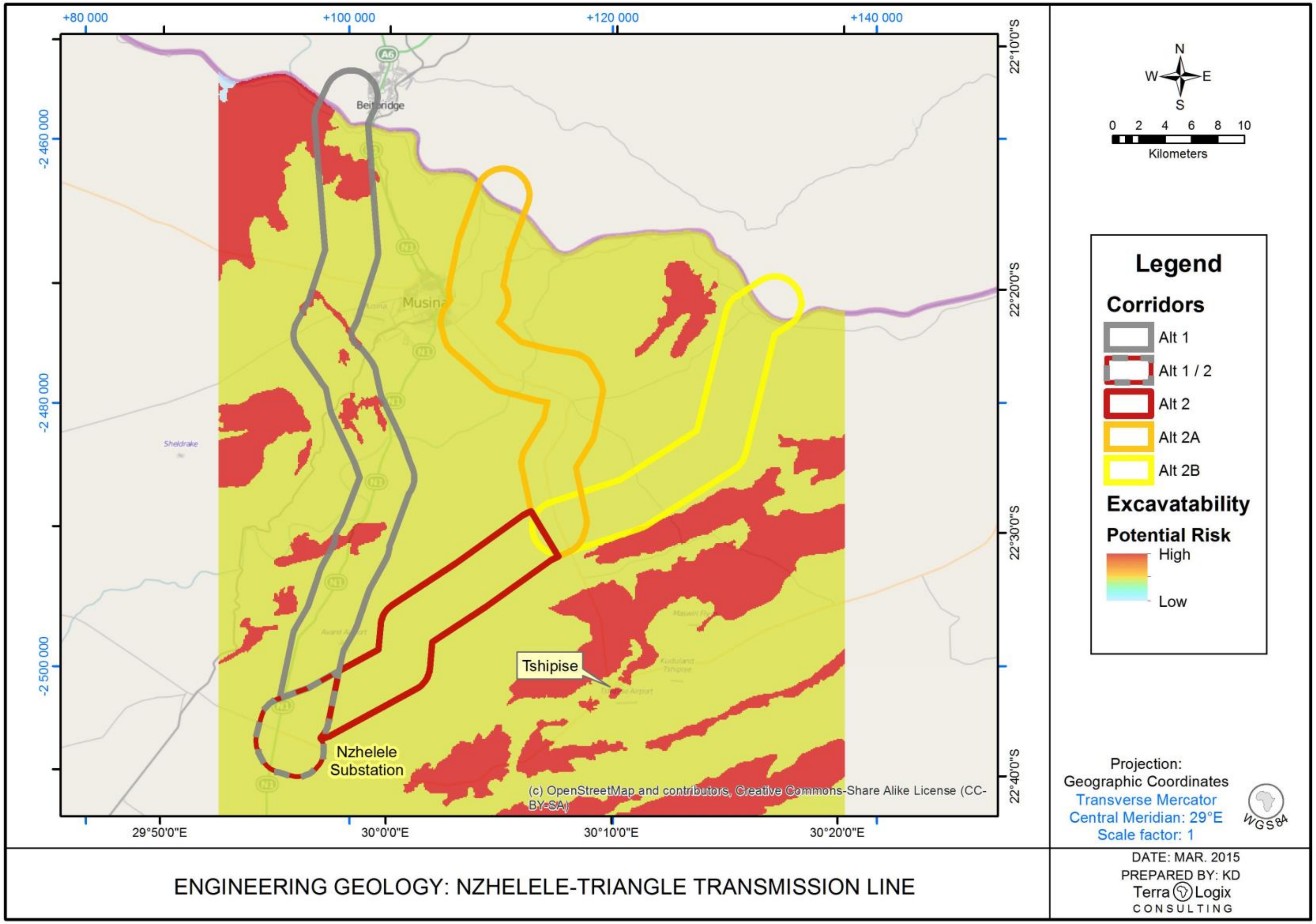

Figure 8 Potential risk due to excavatability

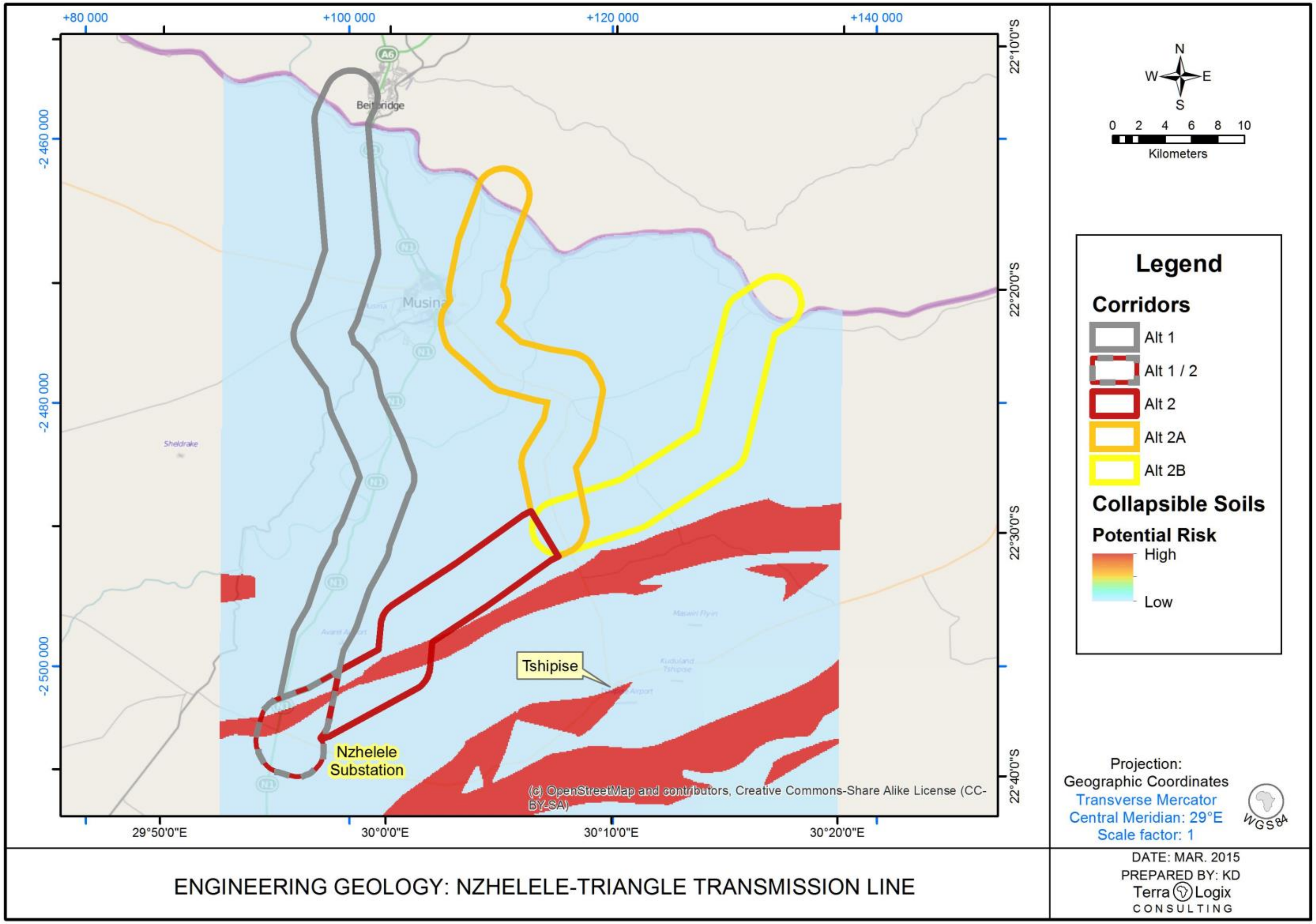

Figure 9 Potential risk due to collapsible soils

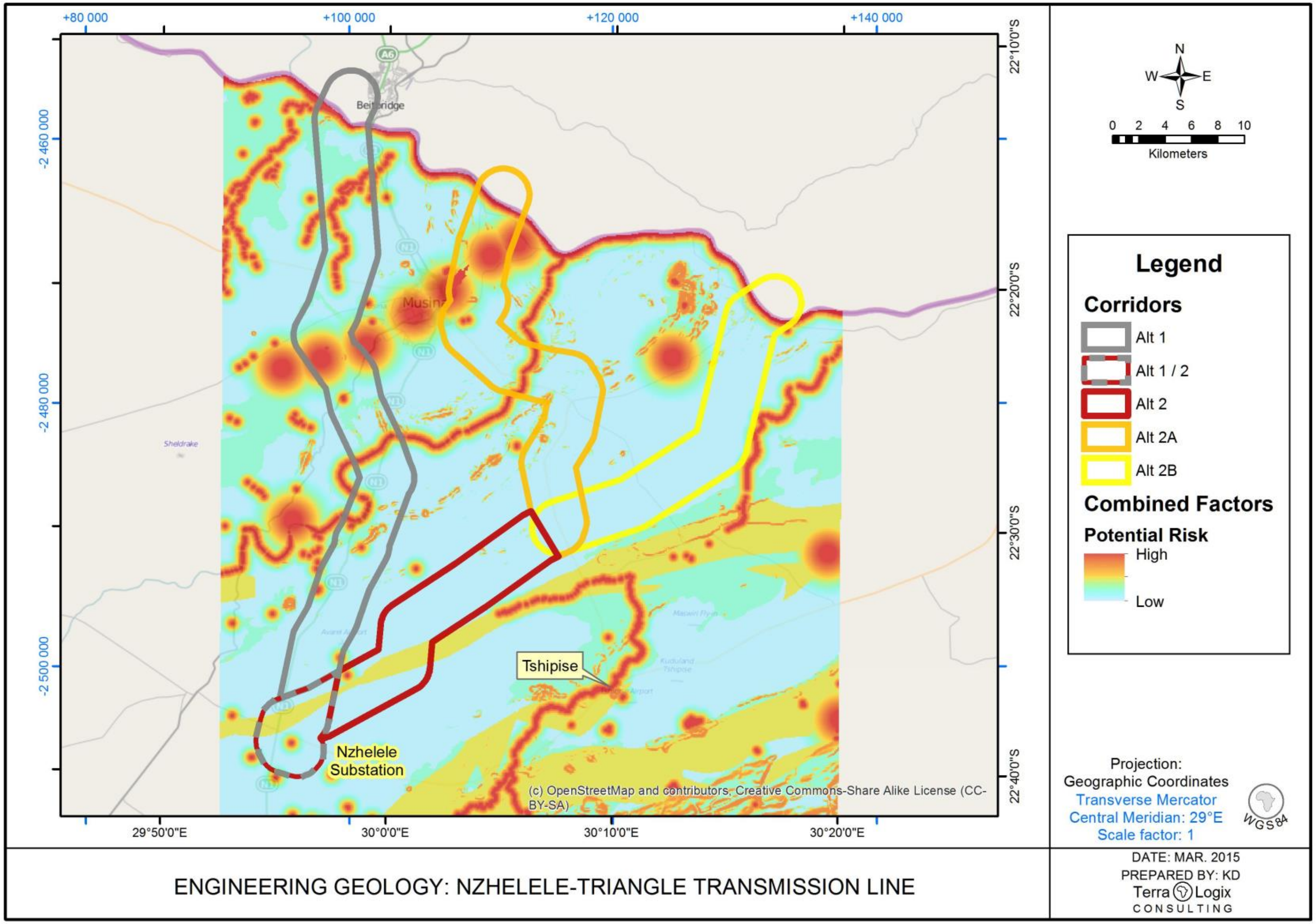

Figure 10 Potential risk: combined factors