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REPORT

On contract research for

Lidwala Consulting Engineers

TABOR-NZHELELE 400 kV POWER LINE: SOILS AND AGRICULTURAL POTENTIAL

By

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1. TERMS OF REFERENCE

The ARC-Institute for Soil, Climate and Water (ARC-ISCW) was contracted by Lidwala Consulting Engineers to supply information on soils and agricultural potential for the proposed 400 kV power line from Tabor to Nzhelele, in Limpopo Province.

The objectives of the study are;

- To identify all existing sources of soils information,
- To produce the best available soil map of the specified area as well as
- Interpret the map in terms of broad agricultural potential.

2. SITE CHARACTERISTICS

2.1 Location

The study area runs from the Tabor substation, south of Bandelierkop, northward to the proposed Bokmakierie substation, close to the junction of the N1 and R525 roads, north of the Soutpansberg mountains in Limpopo Province (see Figure 1).

The area lies between latitudes 22^o 28' and 22^o 22'S and between longitudes 29^o 35' and 30^o 01' E.

Several potential alternatives were identified, namely;

- Alternative 1 (with deviations 1a and 1b), following approximately the route of the N1 road;
- Alternative 2, south of Makhado (Louis Trichardt) to the west of Route 1;
- Alternative 3, south of Makhado, to the east of Route 1;
- Alternative 4, a western detour through Waterpoort;
- Alternative 5, running eastward from Waterpoort, connecting Route 4 with Route 1.

The location of the routes is shown on the land type map in the Appendix.

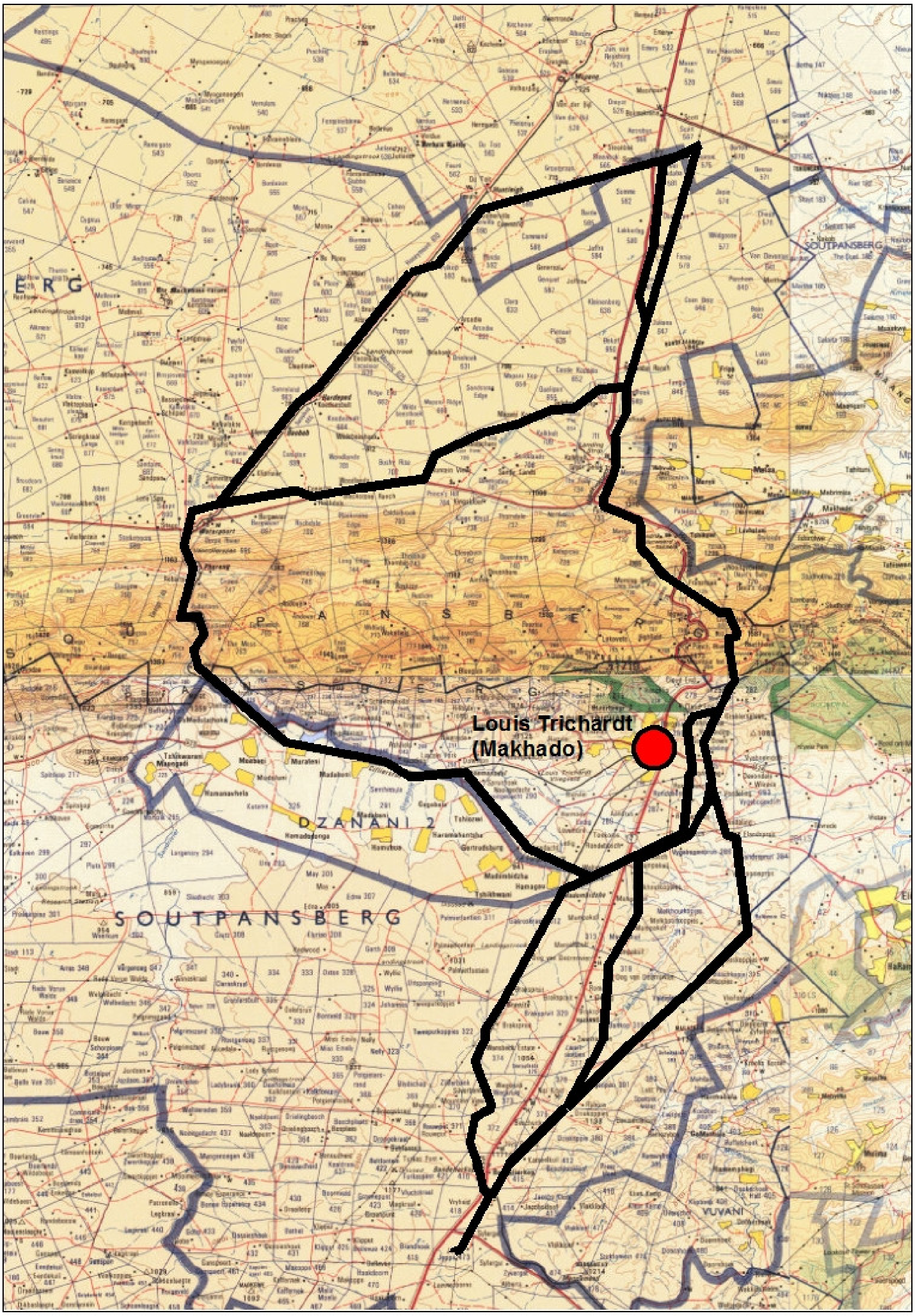

Figure 1: Locality map of the Tabor-Nzhelele study area.

2.2 Terrain

The study area consists of a mixture of terrain. Areas of flatter topography in the north and south ("Plains with moderate relief") are separated by the east-west trending Soutpansberg mountains, with steeper slopes and cliffs in places, according to Kruger (1983). The altitude above sea level varies from around 1 400 to 1 500 m in the higher parts of the Soutpansberg mountains to around 800-1 000 m on the plains.

The area is not drained by any large perennial rivers, with only the Mutamba River, north of the Soutpansberg, of any significance.

2.3 Parent Material

Parent material comprises a mixed lithology (Geological Survey, 1984), with Archaean gniess in the south, basalt and arenite comprising the Soutpansberg mountains and Karoo sandstone and mudstone, along with basalt intrusions, in the north.

2.4 Climate

The climate of the area varies, becoming both warmer and drier from south to north-east, due mainly to the decreasing latitude and drop in altitude. The long-term annual rainfall distribution can be seen in Figure 2.

Rainfall south of the Soutpansberg mountains is in the range 400-600, with the physical barrier of the mountains leading to higher values (as high as 1 000 mm in places), before the rain shadow effect to the north causes the annual average to drop below 400 mm in many areas.

The temperatures will be high (over 40^{o}C in places in summer), but there will be little or no frost, even to the south of Makhado. However, but with the average annual evaporation ranging from around 1 900 mm to over 2 600 mm in the extreme north, the area is problematic for dryland (rain-fed) cultivation.

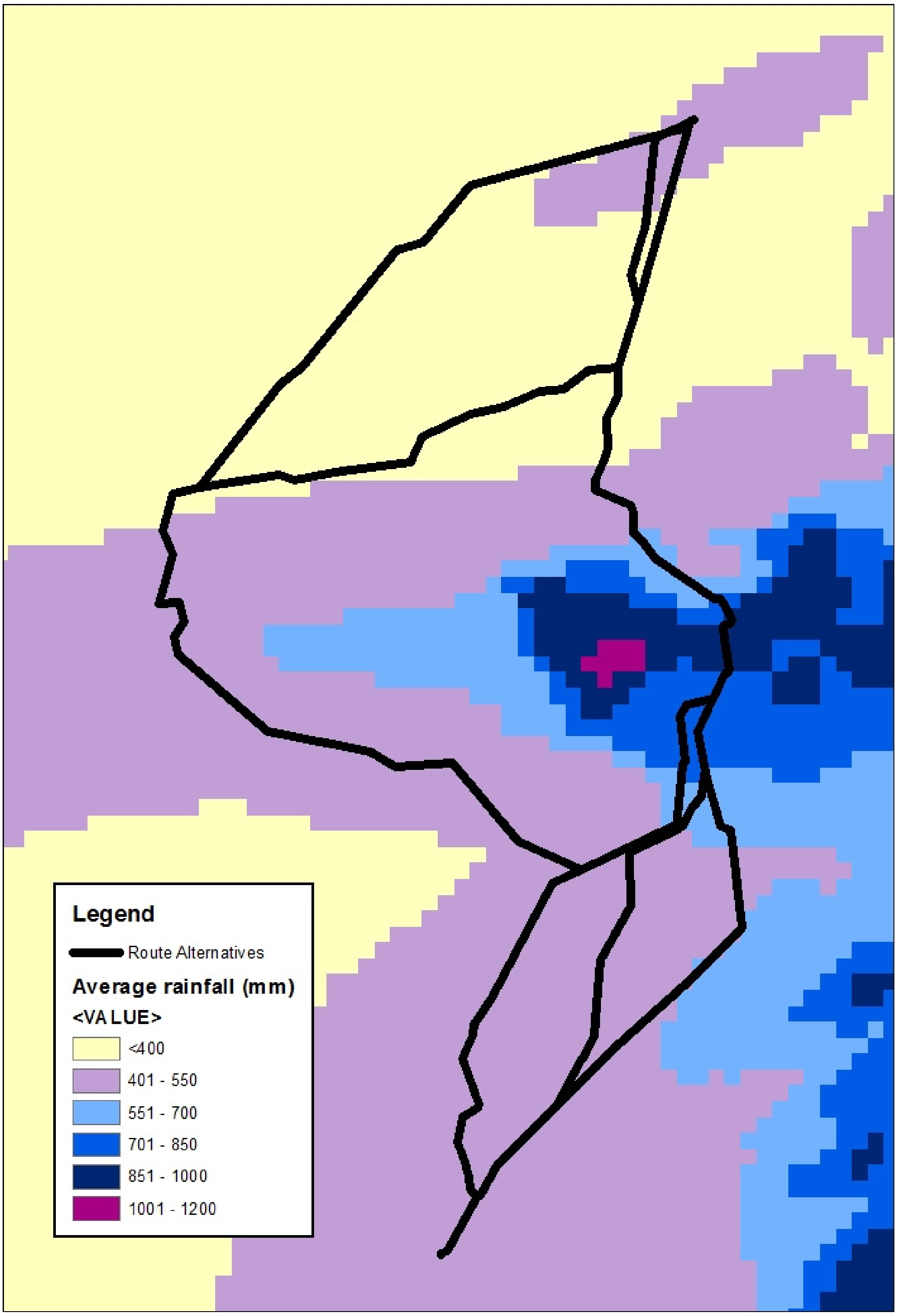

Figure 2 Long-term annual rainfall for Tabor-Nzhelele study area

3. METHODOLOGY

As far as existing soil information is concerned, the area is covered by two land type maps at a scale of 1:250 000, which have been digitized using ArcGIS. The study area falls within the map sheets 2228 Alldays and 2328 Pietersburg.

Each specific land type is a unique combination of broad soil pattern, terrain type and macroclimate. Where any of these changes, a new land type occurs.

Within any specific land type, the soil forms occurring (MacVicar *et al*, 1977) have been summarized according to their dominance, but the locality or distribution of the various soils within a land type cannot be further determined.

4. SOILS AND AGRICULTURAL POTENTIAL

4.1 Soils

As indicated on the land type map in the Appendix, there are a number of separate land types occurring within the study area. These are summarized as follows:

Ab107, Ab109, Ab151, Ab174 (Red, highly weathered, structureless soils)
Ae269, Ae291, Ae250, Ae303, Ae305, Ae310, Ae333 (Red, lightly weathered, structureless soils)
Ag153 (Red, lightly weathered, structureless soils, <300 mm deep)
Ah89 Red and yellow, lightly weathered, structureless soils)
Bc48, Bc50 (Mainly red, slightly weathered, unstructured soils, often on plinthite)
Bd51 (Mainly grey-brown, slightly weathered, unstructured soils, often on plinthite)
Ca102 (Mixed plinthic and clay soils)
Dc58 (Mixed duplex and swelling clay soils)
Fa308, Fa535, Fa641 (Shallow soils, sometimes rocky, little lime)
Fc574 (Shallow soils, sometimes rocky, usually some lime)
Ia135, Ia151, Ia152 (Deep, alluvial soils)
Ib304, Ib312, Ib349, Ib362, Ib394 (Rocky areas [>60% rock], often steep with shallow soils)

The main characteristics of each of the land types are given in Table 1 below (the colours correspond to the map in the Appendix). The soils were classified according to

MacVicar *et al*, (1977), with the dominant **dryland*** agricultural potential class (high, medium or low) within each land type indicated in **bold type**. (*In certain land types, more than one class is approximately equally dominant, so more than one figure appears in bold*)

<u>NOTES</u>:

***dryland** agricultural potential refers to the soil characteristics only and does not take prevailing local climatic conditions/restrictions into account.

"High" potential soils; refers to those soils generally more than 900-1200 mm deep, with medium texture, lacking significant structure and without any drainage restrictions.

"Moderate" potential soils; refers to those soils either between approximately 500 mm and 900 mm deep, or with significant restrictions such as soil structure, lack of fertility caused by sandy texture or the like.

"Low" potential soils; these are generally shallow to very shallow, often with rock, or have severely restricting soil structure or occur in wetland areas.

Table 1 Soil properties per land type: Tabor-Nzhelele study area

LAND TYPE	DOMINANT SOIL(S)	DOMINANT DEPTH (mm)	DOMINANT SOIL CHARACTERISTICS	AGRIC. POTENTIAL		
				HIGH	MOD	LOW
Ab107	Hutton 14/24/16/26	300-1200	Red, structureless, loamy soils on rock	**46.7**	26.9	26.4
Ab109	Hutton 17/18	900-1200	Red, structureless, clayey soils on rock	**81.5**	11.4	7.1
Ab151	Hutton 16/17/26/27	600-1200	Red, structureless, loamy/clayey soils on rock	**71.5**	17.0	11.5
Ab174	Hutton 27/28	600-900	Red, structureless, clayey soils on rock	3.0	**59.0**	38.0
Ae269	Hutton 44/46	600-1200	Red, structureless, sandy/loamy soils, usually calcareous, on rock	**72.1**	0.0	27.9
Ae291	Hutton 36/37	500-1200	Red, structureless, loamy/clayey soils on rock	**48.0**	34.4	17.6
Ae303	Hutton 34/35	400-600	Red, structureless, sandy soils on rock	6.5	**87.5**	6.0
Ae305	Hutton 30/31/32	>1200	Red, structureless, sandy soils on rock	24.4	**75.6**	0.0
Ae310	Hutton 36	750-1200	Red, structureless, loamy soils on rock	**45.0**	**48.5**	6.5
Ae333	Hutton 34/35	400-800	Red, structureless, sandy soils on rock	11.0	**64.5**	24.5
Ag153	Hutton 36/37	200-700	Red, structureless, loamy/clayey soils on rock	0.0	6.2	**93.8**
Ag174	Hutton 36/37	300-600	Red, structureless, loamy/clayey soils on rock	0.0	**59.0**	41.0
Ah89	Hutton + Clovelly 36	400-1000	Red & yellow, structureless, loamy soils on rock	10.5	**61.5**	28.0
Bc48	Hutton + Clovelly 36	400-1000	Red & yellow, structureless, loamy soils on rock	7.2	**47.4**	35.4
Bc50	Hutton + Clovelly 36	400-1000	Red & yellow, structureless, loamy soils on rock	7.2	**47.4**	35.4
Bd51	Hutton + Clovelly 36	400-900	Red & yellow, structureless, loamy soils on rock	15.0	**59.0**	26.0
Ca102	Hutton 26/36	400-750	Red, weakly/moderately structured, loamy/clayey soils on rock	0.0	**89.6**	10.4
Dc58	Bonheim + Valsrivier	>1200	Dark brown, structured, clay soils	36.0	**52.0**	12.0
Fa308	Glenrosa + Mispah	100-600	Brown, structureless, loamy soils on rock	0.0	29.5	**70.5**
Fa535	Glenrosa + Mispah	150-250	Brown, structureless, loamy/clayey soils on rock	0.0	33.8	**66.2**
Fa641	Glenrosa + Mispah	150-250	Brown, structureless, loamy soils on rock	0.0	20.0	**80.0**
Fc574	Glenrosa + Mispah	100-600	Brown, structureless, loamy soils, usually calcareous, on rock	6.0	**53.7**	40.3
Ia135	Oakleaf + Valsrivier	900-1200+	Brown, weakly structured, loamy/clayey alluvial soils	**70.0**	17.0	13.0
Ia151	Oakleaf 44/45/46	>1200	Brown, weakly structured, sandy/loamy, calcareous alluvial soils	**78.0**	18.0	4.0
Ia152	Oakleaf 16/25/26	>1200	Brown, weakly structured, loamy, alluvial soils	**59.5**	21.8	18.7
Ib304	Rock + lithosols	100-300	Brown, loamy lithosols on rock	3.3	9.2	**87.5**
Ib312	Rock + lithosols	100-300	Brown, loamy lithosols on rock	4.0	9.5	**86.5**
Ib349	Rock + lithosols	100-300	Brown, loamy lithosols on rock	5.0	8.2	**86.8**
Ib362	Rock + lithosols	100-300	Brown, loamy lithosols on rock	5.0	8.8	**87.2**
Ib394	Rock + lithosols	100-300	Brown, loamy lithosols on rock	5.0	8.0	**87.0**

4.2 Agricultural Potential

As can clearly be seen from the above table, there is a great difference between land types in terms of both the soils occurring as well as the associated agricultural potential. There is also a significant difference in the **dominance** of the agricultural potential classes within each land type.

The dominant class of agricultural potential per land type is shown in the Agricultural Potential map in the Appendix. It should be noted that for several land types, there is no one single class which is dominant, so a combination symbol (MH = high and moderate potential soils, ML = moderate and low potential soils).

If the Land Capability map in the Appendix is used, the areas of dominant agricultural potential class per land type (colours as for the map in the Appendix) are as follows:

Table 2 Dominant dryland agricultural potential class per land type

Class	Land Types	Soil characteristics
High	Ab107, Ab109, Ab151, Ae269, Ia135, Ia151, Ia152	Deep, friable, structureless
Moderate to high	Ae291, Ae310	*Mixture of* **High** *and* **Moderate** *soils*
Moderate	Ae303, Ae305, Ae333, Ag174, Ah89, Bd51, Ca102, Dc58	Moderately deep, some structure
Moderate to low	Ab174, Bc48, Bc50, Fc574	*Mixture of* **Moderate** *and* **Low** *soils*
Low	Fa308, Fa535, Fa641, Ib304, Ib312, Ib317, Ib349, Ib362, Ib394	Shallow, rocky and/or clayey with structure. Also wet soils.

From this table and the agricultural potential map in the Appendix, it would appear that a significant number of land types have moderate and/or high potential soils, which would appear to be a very favourable situation. However, when the rainfall map (Figure 2) is taken into consideration, it can also be seen that most of the area has rainfall of less than 550 mm (generally accepted as the absolute minimum for long-term rain-fed cultivation), and the northern portion is below 400 mm per annum.

The main potential for cultivation throughout most of the study is therefore irrigation, using available water sources, but this will be very localized, as no major rivers occur.

4.3 Grazing capacity

The Tabor-Nzhelele study area lies in the north-eastern bushveld, and the grazing capacity (measured in hectares required for one large stock unit) is generally around 10-12 ha/LSU south of the Soutpansberg, rising to around 15-16 ha/LSU in the drier areas to the north (Schoeman & van der Walt, 2004).

This classification does not apply to game farming, where more detailed specialized knowledge is required, mainly in terms of relating plant species composition in both the grass layer and woody layer to the requirements of various grazing and/or browsing species of game.

5 IMPACT ASSESSMENT

The impacts involved in the construction of a power line, substation and associated infrastructure (especially the power line access road) can be severe. The two main aspects are:

- Loss of agricultural land due to the construction activities. This is especially important in areas where high potential land, either for dryland or irrigated cultivation, exists. The prevailing climatic restrictions in the study area make such potential impacts unlikely on a widespread scale, although small areas of irrigation are visible on the Google Earth image at several places along one or other of the routes.
  Mitigation: avoid intensively cultivated areas (especially those under irrigation) wherever possible.
- Increased soil erosion, due to removal of surface vegetation. The main area where this may be applicable would be the construction of an access road along the power line route. Due to the fact that there are significant areas with steep topography (mainly in the Soutpansberg mountain belt), there is a definite potential for serious soil erosion to occur.
  Mitigation: minimize the removal of vegetation wherever possible. In areas where steep topography is unavoidable, road construction measures, such as culverts, berms, cut-off drains etc should be taken to minimize surface run-off. If possible, the steepest sloping areas should be surfaced (concrete or tar) and stabilized to avoid deterioration over time.

5.1 Route Preference

Due mainly to the fact that there is an existing power line along much of Alternative 1, so that a new access road would not need to be constructed, this is the recommended route.

Route 4 involves a route along a river valley, where no power line currently exists, although there is a railway line, with servitude, but it is not clear whether part of this servitude can be used for a new power line.

The ranking is thus as follows:

Route 1:	**Preferred**
Route 1a:	Acceptable
Route 1b:	**Preferred**
Route 2:	Acceptable
Route 3:	Acceptable
Route 4:	**Not preferred**
Route 5:	Acceptable

6. REFERENCES

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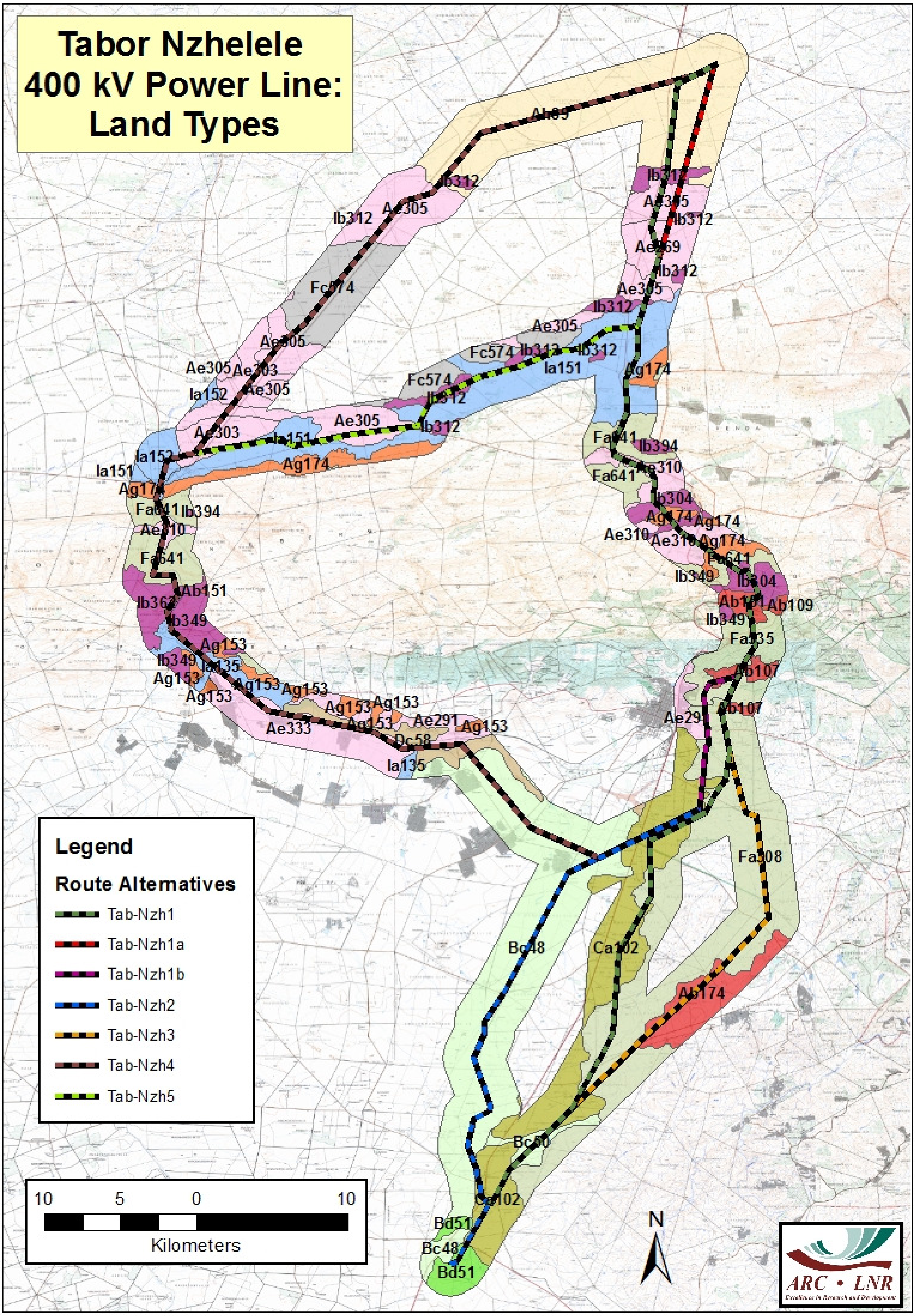
APPENDIX:

MAPS


Tabor Nzhelele
400 kV Power Line:
Land Types
Legend
Route Alternatives
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Tab-Nzh1a
Tab-Nzh1b
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Tab-Nzh4
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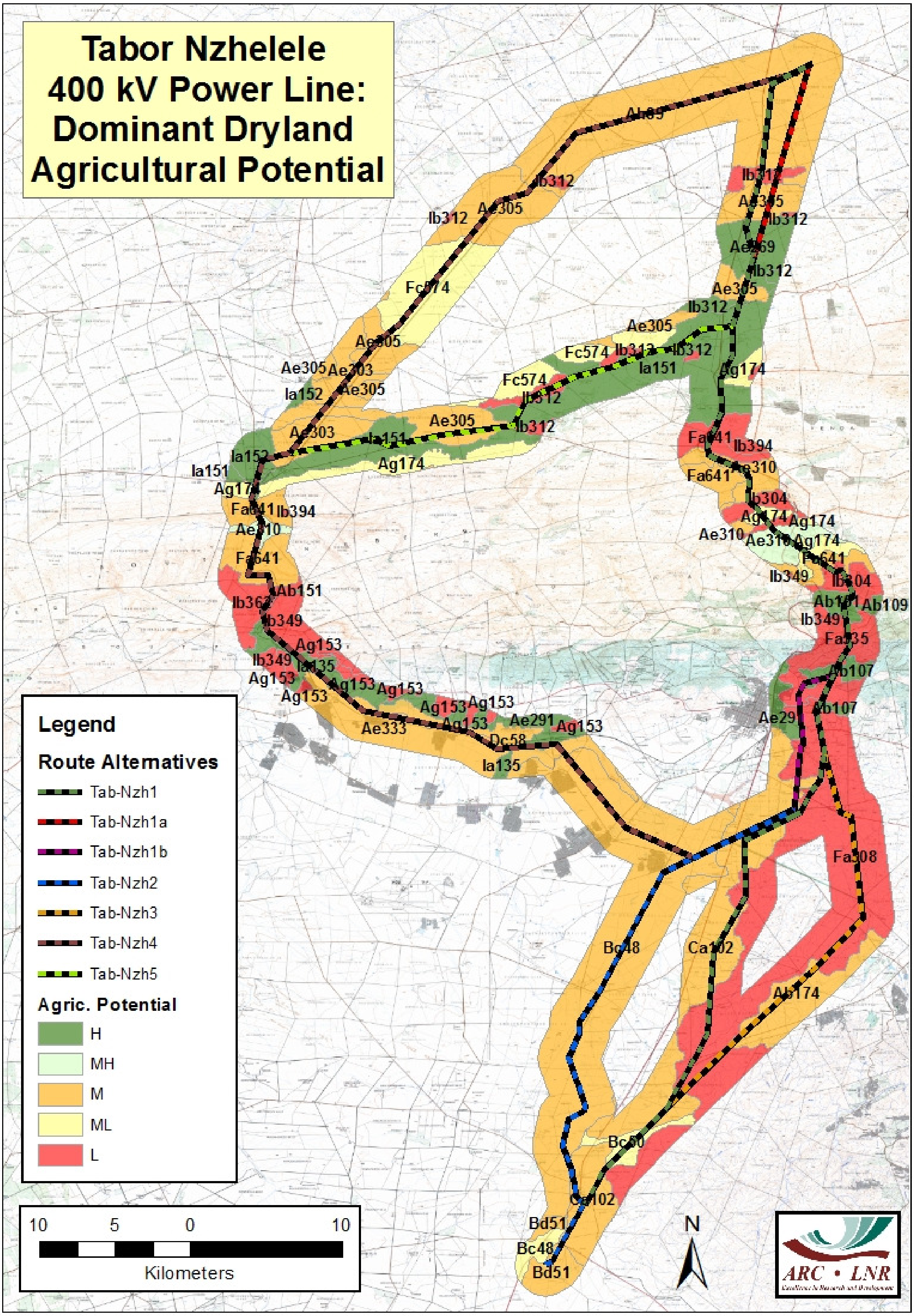

Tabor Nzhelele
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