ENVIRONMENTAL IMPACT ASSESSMENT FOR ESKOM'S NORTHERN KWAZULU-NATAL STRENGTHENING PROJECT

DEA Reference 14/12/16/3/3/2/1036, 1037 and 1038

SPECIALIST REPORT: AGRICULTURAL POTENTIAL IMPACT ASSESSMENT

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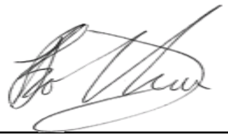
DECLARATION OF SPECIALISTS INDEPENDENCE

Francois Botha and Astrid Hattingh, who are Soil Scientists from ECO SOIL are independent consultants to NAKO ILISO (consultants for ESKOM Holdings SOC Ltd), i.e. they have no business, financial, personal or other interest in the activity, application or appeal in respect of which they were appointed other than fair remuneration for work performed in connection with the activity, application or appeal. There are no circumstances that compromise the objectivity of these specialists performing such work.



	Francois Botha
Signature of Soil Specialist:	Name of specialist

5 March 2018

Date:

ESKOM'S NORTHERN KWAZULU-NATAL STRENGTHENING PROJECT

ENVIRONMENTAL IMPACT ASSESSMENT

APPENDIX E: AGRICULTURAL POTENTIAL IMPACT ASSESSMENT

Title:	Agricultural potential Impact Assessment for Eskom's Northern Kwazulu-Natal Strengthening Project Environmental Impact Assessment
Specialists:	F. Botha and Astrid Hattingh
Project Name:	Eskom's Northern Kwazulu-Natal Strengthening Project: Environmental Impact Assessment
Status of report:	Draft
NAKO ILISO Project Number:	1600048
Date:	5 March 2018

SPECIALIST

Approved for ECOSOIL by:

	5 March 2018
Mr Francois Botha Study Leader	Date

ENVIRONMENTAL ASSESSMENT PRACTIONER

Approved for NAKO ILISO by:

	17 April 2018
Terry Calmeyer Project Leader	Date

Executive summary

NAKO ILISO requested a soil specialist report for the proposed two substation sites (namely Iphiva 3 and Iphiva 6), the proposed Normandie-Iphiva and Iphiva-Duma 400 kV Powerlines as well as six 132 kV Powerlines for Eskom. The purpose of this study is to identify the present soil quality in terms of soils' physical characteristics and to identify obvious highly sensitive areas to be avoided (based on field data and supportive available desk top information).

The investigation of the soils involved the collation of climate, geology, topography information and determining the broad soil groups of the area as background for further interpretation. Properties of the soil groups, soil depth, clay content, soil restrictions as well as land capability classes were considered. The soil investigation for the Eskom's Northern KwaZulu-Natal Strengthening Project: Environmental Impact Assessment was done from a field investigation and additional available information from land type Survey of the Institute of Soil Climate and Water, as well as other relevant information. Approximately 57 485 ha of the Normandie-Iphiva- and 51 665 ha of the proposed Iphiva-Duma Corridors were investigated during this study (Figure 1).

The soils in the project area were then classed in four land capability/potential classes, namely:

- Soils of intermediate suitability for arable agriculture
- Soils not suitable for arable agriculture, but suitable for forestry or grazing
- Soils of poor suitability for arable agriculture
- No dominant class

The present agricultural activities in ranking order within the Normandie-Iphiva-, Iphiva-Duma Corridors and the 132kV Powerlines include:

- Game farming,
- Forestry,
- Subsistence farming,
- Commercial farming including:
  - Maize and other grain crops
  - Sugarcane, sometimes under irrigation,
  - Macadamia
  - Citrus
  - Pineapples
  - Essential oils
  - Subtropical fruit like banana, mango
  - Vegetables

- Communal Activities
- Cattle

Geology: Properties like clay content and erosion susceptibility to erosion is highly dependent on the parent material. In the case of the corridors the mudstone can give rise to soils severely susceptible to erosion when exposed. Exposed surfaces should therefore be limited or prevented. It should be covered with any vegetation even for short periods.

The Iphiva-Duma Corridors are between 32 and 697 m above sea level and the Normandie-Iphiva-Corridors are between 111 to 1 399 m above sea level. The variation in topography is much higher in the case of the Normandie-Iphiva-Corridors. The terrain types vary between low mountainous areas, undulating hills and slightly to moderately undulating plains and dissected low undulating mountains and hills. The terrain has restrictions for arable crop production in many areas.

The climate of the area is typified by warm to hot summers, high evaporation and dry warm winters and a mean annual rainfall between 495 to 1 560 mm. The average rainfall is higher in the western parts next to the hills and is decreasing gradually to the eastern parts further from the hills. Arable crop production is not restricted by the climate of the area, but may become risky in the areas with lower and irregular rainfall patterns. Soil with a high swell-shrink potential, plasticity and stickiness may cause problems during construction in wet periods of the year. Such soils are mainly found in the eastern parts of the Iphiva-Duma Corridors.

Iphiva 3 and 6 Substation Sites

At both Iphiva 3 and 6 Substation Sites the soils are classified as lithosols (shallow soils on hard or weathering rock, classified as Class F according to the land type survey). Soils are less than 450 mm deep, have clay contents between 15 % and 35 %. The soils are freely drained and structureless. At Iphiva 3 the soils are slightly deeper (Hutton 50 cm deep) near the south western boundary. Soils have excessive drainage and a low natural fertility. Surface rock and rocky outcrops cover relatively large areas. These soils have low potential for arable agriculture. Erosion may become a problem when not covered with vegetation. Long term statistics shows that rainfall at the proposed Iphiva 3 and 6 substations are in the order of 800mm.

Normandie-Iphiva and Iphiva-Duma 400kV Corridors

The Fa (19.8%) and Fb (43.5%) broad soil groups occupy large percentages of land in the Normandie-Iphiva 400kV Corridors. The soils are shallow, with or without lime, and are of low agricultural potential. These soils have rock or weathered rock as underlying material.

Both the corridors have high percentages with restricted soil depths and are associated with rockiness (22.5% - Iphiva-Duma Corridors and 31.6% - Normandie-Iphiva Corridors). The southern parts of the Normandie-Iphiva 3-deviation have soil depths between 450 mm and 750 mm and clay contents between 15 and 35%. The north-south running part of the Normandie-Iphiva 3-deviation have soil depths between 450 mm and 750 mm, but clay contents more than 35%, and is presently used for arable crop production. Relatively very small numbers of hectares are occupied with deep (>750mm), high potential soils in both the Normandie-Iphiva and Iphiva-Duma 400kV Corridors. In the eastern parts of the Iphiva-Duma 400kV Corridors the soils are mostly between 450 and 750 mm deep and clay contents are more than 35%, but in the west of these corridors soils are less than 450 mm deep and clay contents are generally between 15 and 35%. Almost 24% of the soils in the Iphiva-Duma Corridors and 10.2% of the Normandie-Iphiva Corridors have clay contents more than 35% and may therefore be susceptible to water erosion. Such soils may have a high swell-shrink potential, plasticity and stickiness, restricted effective soil depth and signs of wetness. Soils should always be kept covered with plants or crops to prevent erosion.

According to this study the soils of the Northern KZN Strengthening Project area there are no areas identified with high potential agricultural value, although small patches of high potential soils may be present in restricted areas if the survey was done on a much smaller scale. The percentage of soils not suitable for arable agriculture, but suitable for forestry or grazing covers the highest percentage of both the proposed corridors, namely 47.7% for the Iphiva-Duma Corridors and 52.2% for the Normandie-Iphiva Corridors respectively. Water bodies cover 0.3% or 152 ha of the Iphiva-Duma Corridors.

- The Normandie-Iphiva 400kV corridor (NI-2) is the preferred route since it has less impact on forestry and agricultural cultivated land and erosion potential is less.
- The Iphiva-Duma West 1 Corridor is preferred since it has less impact on game farms and agricultural cultivated land. Soils in the west in this corridor are classified as Fb and are shallow and of low agricultural potential. These soils have rock or weathered rock as underlying material. Soils in the Iphiva-Duma East 1 Corridor are clayey and

difficult to manage when wet and may have a larger impact on if not handled with care. Slopes are less in Iphiva-Duma West 1 and will therefore have less influence on the erosion potential in both the Iphiva-Duma West 1 and Iphiva-Duma East 1 corridors measurements for erosion control should be implemented and therefore erosion potential should not influence the choice of line.

- The soils are very similar in the west and east of both the deviations in the Iphiva-Duma 400kV Corridor, there is no preference from a soil and land capability perspective.

132 kV Distribution powerlines

The corridors of the Iphiva-Mbazwane double circuit, Iphiva-Pongola-Iphiva-Hluhluwe Double Circuit, the loop to Candover switching station, the Iphiva-Mbazwane and Iphiva-Makhathini Double Circuit and the alternative route for Iphiva-Mbazwane and Iphiva-Makhithini Double Circuit Line have a land capability with soils of intermediate suitability for arable agriculture. The majority of soils in the Iphiva-Pongola 132kV corridor are either:

- Soils not suitable for arable agriculture, but suitable for forestry or grazing (largest part)
- Soils of intermediate suitability for arable agriculture in the north and eastern parts of the corridor and
- Soils of poor suitability for arable agriculture in the north western parts of the corridor

Recommendations

All land disturbed by Eskom should be vegetated and left in the condition it was before the construction of the lines and none of the disturbed areas should be left uncovered to prevent erosion. The powerlines should be constructed on farm boundaries as far as possible, but specifically applicable in areas where land is used for forestry purposes.

It is recommended to restrict the number of roads, and limit the number of passes on the roads in the construction areas. If necessary, measurements should be taken to do control dust during the operational phase.

There are no objections against the Eskom's Northern KZN Strengthening Project from the agricultural and soil potential standpoint. It is recommended to go ahead, as long as the recommendations regarding the suggested line preferences and measurements to limit erosion are implemented.

A summary of preferred substation and powerlines from a soil and agricultural viewpoint is indicated in the following table

Powerlines and substations	**Alternatives**	**Preference**	**Reason**
Substations	Iphiva 3 & 6	Iphiva 6	Soils marginal and more disturbed
400kV Powerlines	Normandie-Iphiva 2 & 3	Normandi Iphiva 2 (N-I2)	Less impact on forestry and cultivated areas
	Iphiva-Duma East and West	West	Less impact on game farms and cultivated areas
Deviations	West 1 and West 2	No preference	Similar soils and land capability potential
	Deviation (Izemvelo Game Reserve)		
132kV powerlines	1.Iphiva Pongola 132 kV Powerline	No alternative	Same corridor as 400kV powerline
	2. Iphiva/Makhathini 132 kV (double circuit with Iphiva/Mbazwane) Alternative route	Iphiva/Makhathini 132 kV (double circuit with Iphiva/Mbazwane) **Alternative route**	Existing servitude and less impact on cultivated land
	3.Iphiva/Makhathini 132 kV (double circuit with Iphiva/Mbazwane)		
	4. Iphiva P236 road (north and south of road)	No preference	Similar soils and land capability potential
	5. Iphiva/Pongola 132 kV powerline to tie into existing line (double circuit with Iphiva/Hluhluwe)	No alternative	To tie into existing line (double circuit with Iphiva/Hluhluwe)
	6. The temporary loop to Candover switching station	No alternative	No agricultural activity (existing game farm)

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ACRONYMS

EIA	Environmental Impact Assessment

ABBREVIATIONS

km	Kilometres
kV	kilo Volts

GLOSSARY OF TERMS GENERAL

Study area:	The area that has been covered by the EIA process within which possible study corridors have been investigated.
No-go area:	An area in which the substation or powerline cannot be constructed due to resulting significant environmental, technical and social impacts.
Corridor:	A corridor, approximately 2 km wide that is feasible for the routing of the proposed Transmission Powerline which will be authorised by DEA. Within this approved corridor a final servitude will be negotiated by Eskom with individual landowners.

GLOSSARY OF AGRICULTURE/SOIL SPECIFIC TERMS

Refer to Van der Watt H.v.H. & van Rooyen T.H. (1995)

A-Horizon: The depth of the topsoil horizon. Topsoil: Is defined as the A-Horizon and a portion of the red and yellow apedal A-Horizon where microbial activity takes place and the majority of the plants hair roots occur.

B-Horizon: The bottom end of the sub-soil horizon.

Restriction layer: It can be rock fragments, soil structure or hydromorphic soil conditions that can limit root development.

Profile available water capacity (PAWC) – It is a calculation between the AWC multiplied with the effective rooting depth (ERD). PAWC values are therefore the most important value to determine an irrigation design and scheduling perspective.

Effective rooting depth (ERD): This is the average depth that roots will develop under irrigation or where they are limited by an impeding layer. The effective rooting depth is the most important from a management perspective, which includes irrigation design, water holding capacity, drainage and nutrition.

Soil Forms: Soil Forms are identified according to the SA Taxonomic Soil Classification system

Land types: A class of land with specified characteristics. In South Africa it has been used as a unit denoting land at 1:250 000scale, over which there is a marked uniformity of climate, terrain form and soil pattern

Mesotrophic: Refers to soil that has suffered moderate leaching, such that the sum of the Ca, Mg, K and Na (base) cations is 5-15cmol/Kg clay. Such a soil is said to have a medium base status

Dystrophic: Refers to soil that has suffered marked leaching, such that the sum of the exchangeable (as opposed to soluble) Ca, Mg, K and Na (base) cations is <5cmol/Kg clay. Such a soil is said to have a low base status

Base status: A qualitative expression of base saturation.

Base saturation: The sum of the exchangeable Ca, mg, K and Na expressed as a percentage of the total cation exchange capacity at a specific pH

Plinthic: A plinthic horizon is a subsurface horizon that consists for 10%or more of an iron-rich, humus-poor mixture of kaolinitic clay with quartz and other diluents, which changes irreversibly to a hardpan or to irregular aggregates on exposure to repeated wetting and drying with free access to oxygen

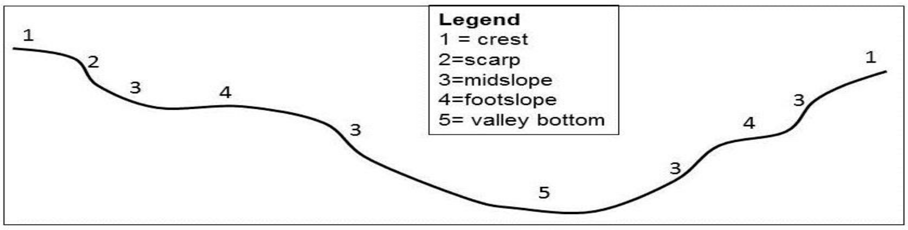
Margalitic: Refers to A-horizons with strongly developed structure that are dark coloured with a high base status, Ca and Mg being the predominant exchangeable cations

Vertic: Dark coloured horizons with high clay content and with swell and shrink properties

Melanic: A dark coloured horizon with a high base status

Duplex: A soil with relatively permeable topsoil abruptly overlying a very slowly permeable diagnostic horizon which is not a hardpan

Catena: A sequence of soils of about the same age and derived from the same parent material. These soils occur under similar macroclimatic conditions, but have different characteristics due only to variation in topography and drainage



Soil Classification and soil forms present in the study area of the Eskom's Northern KZN Strengthening Project:

- **Vertic A-horizon:** A dark-coloured-horizon with high clay content and with shrink-swell properties.
- **Melanic A-horizon:** A dark-coloured horizon with a high base status.
- **Orthic A-horizon:** It is a surface horizon that does not qualify as organic, humic, vertic, or melanic.
- **Arcadia-Ar:** (Vertic A / unspecified): The top soil is vertic. It has high clay contents in the top soil, a strongly developed soil structure, a high plasticity index and usually dark colours. It has a high swelling/shrinking potential which depends on the moisture content of the soil.
- **Bonheim-Bo** (Melanic A / pedocutanic B / unspecified): This is a soil form with some duplex properties, indicating a moderate increase in clay content and degree of structure relative to the top soil. The more developed structure brings along a harder consistency, higher bulk density, more developed cutanic character and a moderate decrease in permeability.
- **Clovelly-Cv** (Orthic A / yellow-brown apedal B / unspecified material without signs of wetness): The B-horizon of these soils has very poor developed structure, or is single grain or granular (apedal). The dominant profile colour is yellow brown, which is an indication that iron (Fe^{2+}) is in a reduced state (less oxygen available than in red soils). These profiles are generally freely draining and do not have water logged conditions. No mottling or signs of drainage impedance are present. The underlying material is unspecified (to be specified by the surveyor), but is usually rock or weathered rock
- **Dresden-Dr** (Orthic A / hard plinthic B): It is a shallow soil form with a top soil, generally approximately 30 cm deep. This soil form does not have a B-horizon. The underlying material in this case is hard plinthite, which is an accumulation of iron oxide to the extent that the whole horizon is hardened. The hard plinthite is generally an impermeable layer and restricts downward movement of water and root development.
- **Glenrosa-Gs** (Orthic A / lithocutanic B): The Glenrosa is generally a shallow soil and the underlying material in this case is lithocutanic, which is a tonguing soil/saprolite

transition. The tongues penetrate the saprolite and are therefore not continuous. It gradually changes to fractured rock and then to hard rock.

- **Hutton-Hu** (Orthic A / red apedal B / unspecified material): The reddish brown colour of these soils is an indication that iron (Fe^{3+}) is in an oxidised state (oxygen rich) and that soils have a slightly dryer moisture regime then yellow soils. The B-horizon of these soils does not have significant structure (apedal). The underlying material in this case is unspecified (to be specified by the surveyor) without signs of wetness, but is usually rock or weathered rock.
- **Mispah-Ms** (Orthic A / hard rock): The Mispah is generally a shallow soil and the underlying material in this case is a continuous hard layer of rock. It cannot be cut with a spade when wet.
- **Oakleaf-Oa** (Orthic A / neocutanic B / unspecified material): The B-horizon has non-homogeneous colours. Its aggregation is weaker than moderately structured, developed from unconsolidated material and is non-calcareous. The sub-soil shows no signs of wetness. The underlying material is unspecified (but should be specified by the surveyor).
- **Mayo-My** (Melanic A / lithocutanic B): The Mayo soil form has dark coloured A-horizon. The soil is generally a shallow soil and the underlying material in this case is lithocutanic, which is a tonguing soil/saprolite transition. The tongues penetrate the saprolite and are therefore not continuous. It gradually changes to fractured rock and then to hard rock.
- **Shortlands-Sd** (Orthic A / red structured B)**:** This soil form has uniform red colours with a strong developed soil structure, due to the type of clay minerals present. This soil form is generally regarded as suitable for agronomic use, but has limitations in dry periods.

1. STUDY INTRODUCTION

1.1 BACKGROUND TO PROJECT

ESKOM Holdings SOC Ltd (Eskom) has commissioned a project to strengthen the supply of electricity in northern KwaZulu-Natal (KZN). The northern KZN network is currently fed at 132 kV by Normandie Substation and Impala Substation. The major load centres are Pongola and Makhathini Flats. Normandie Substation is situated approximately 80 km north-west of Pongola and Impala Substation is situated approximately 180 km south of Makhathini Flats. High voltage drops are experienced in the 132 kV network and the voltages are approaching unacceptable levels as the demand increases. Contingencies on the main 132 kV supplies also lead to thermal overloading of the remaining network.

In order to alleviate current and future network constraints in northern KZN, it is proposed that the Iphiva 400/132 kV Substation be introduced in the area, which will de-load the main sub-transmission network and improve the voltage regulation in the area. Two 400 kV powerlines and six (6) 132 kV powerlines with links to the new substation with the Transmission and Distribution grids are at stake.

The proposed project triggers several activities listed in the National Environmental Management Act (Act 36 of 1998) (NEMA) as requiring environmental authorisation before they can commence. The purpose of this study is to undertake an Environmental Impact Assessment (EIA) process, with associated Public Participation Process (PPP) and specialist studies, to enable the competent authority to decide whether the project should go ahead or not, and if so, then on what conditions. Four application forms are submitted, one each for the following:

1. The Iphiva Substation;
2. The 400 kV powerline from the Iphiva Substation to the Normandie Substation;
3. The 400 kV powerline from the Iphiva Substation to the Duma Substation, and
4. 65 km of 132 kV distribution lines.

The locality of the site referred to in this report is illustrated in Figure 1 to 4.

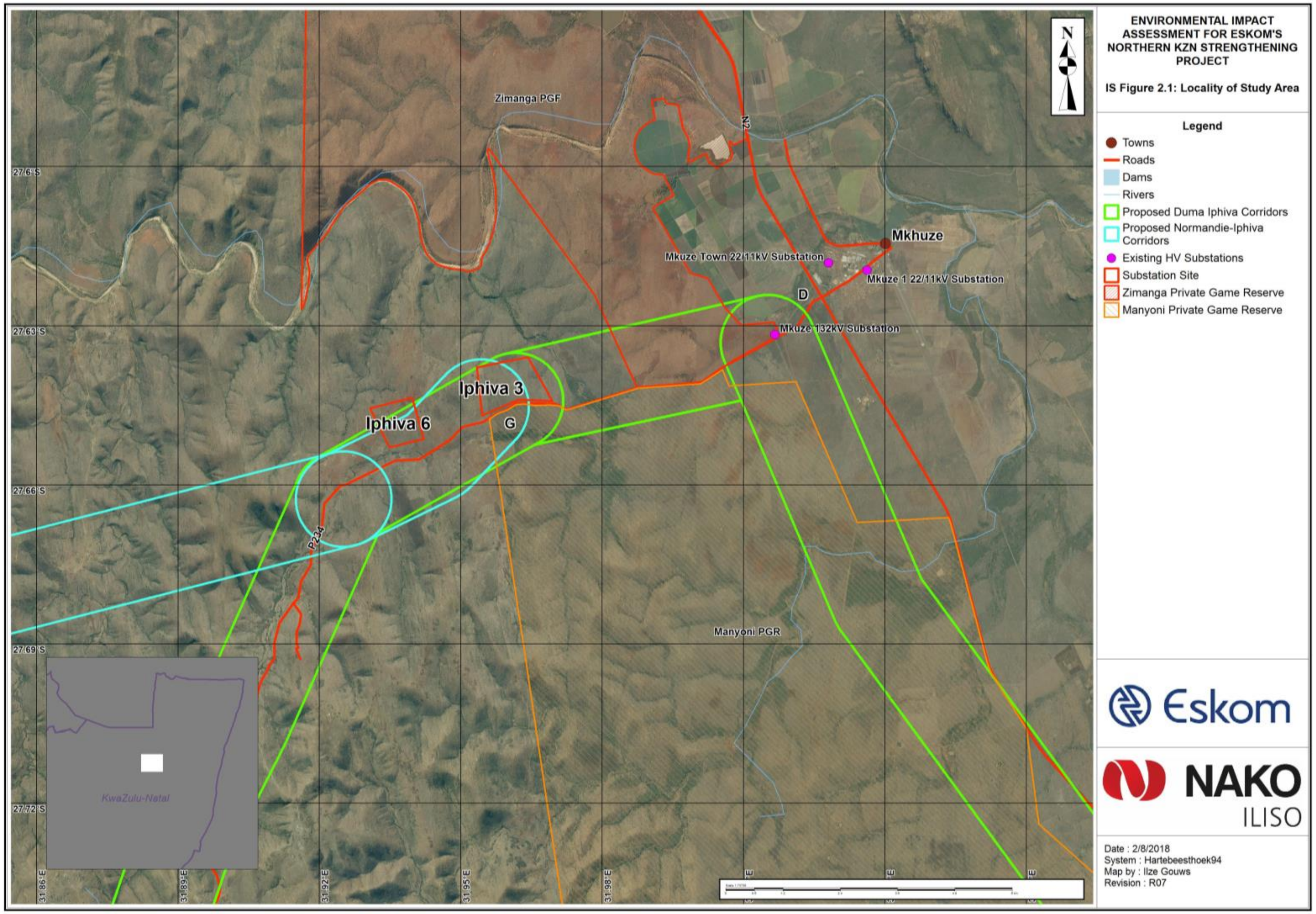


Figure 1. Iphiva Substation Alternatives

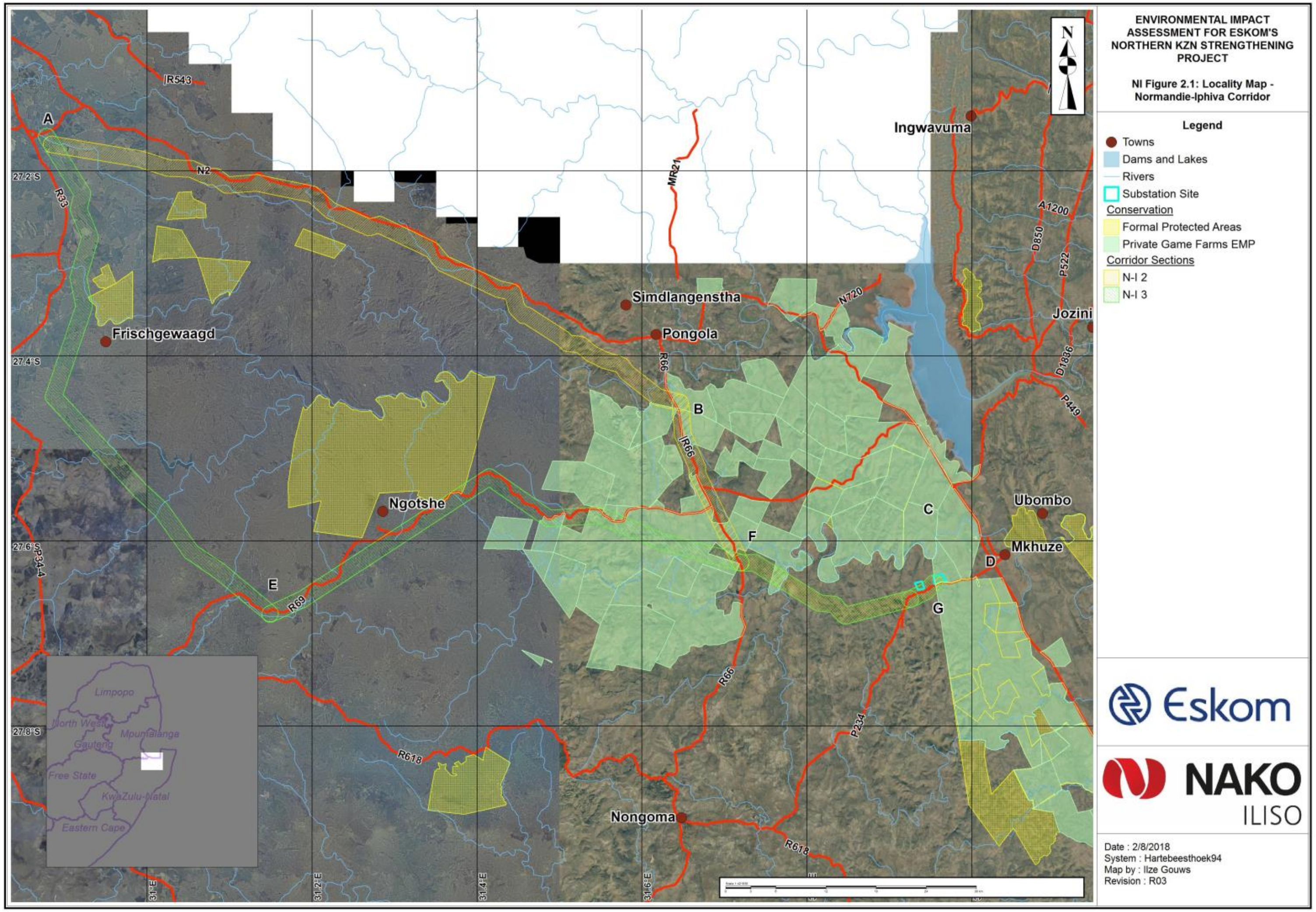


Figure 2. Normandie-Iphiva 400kV Powerline Alternatives

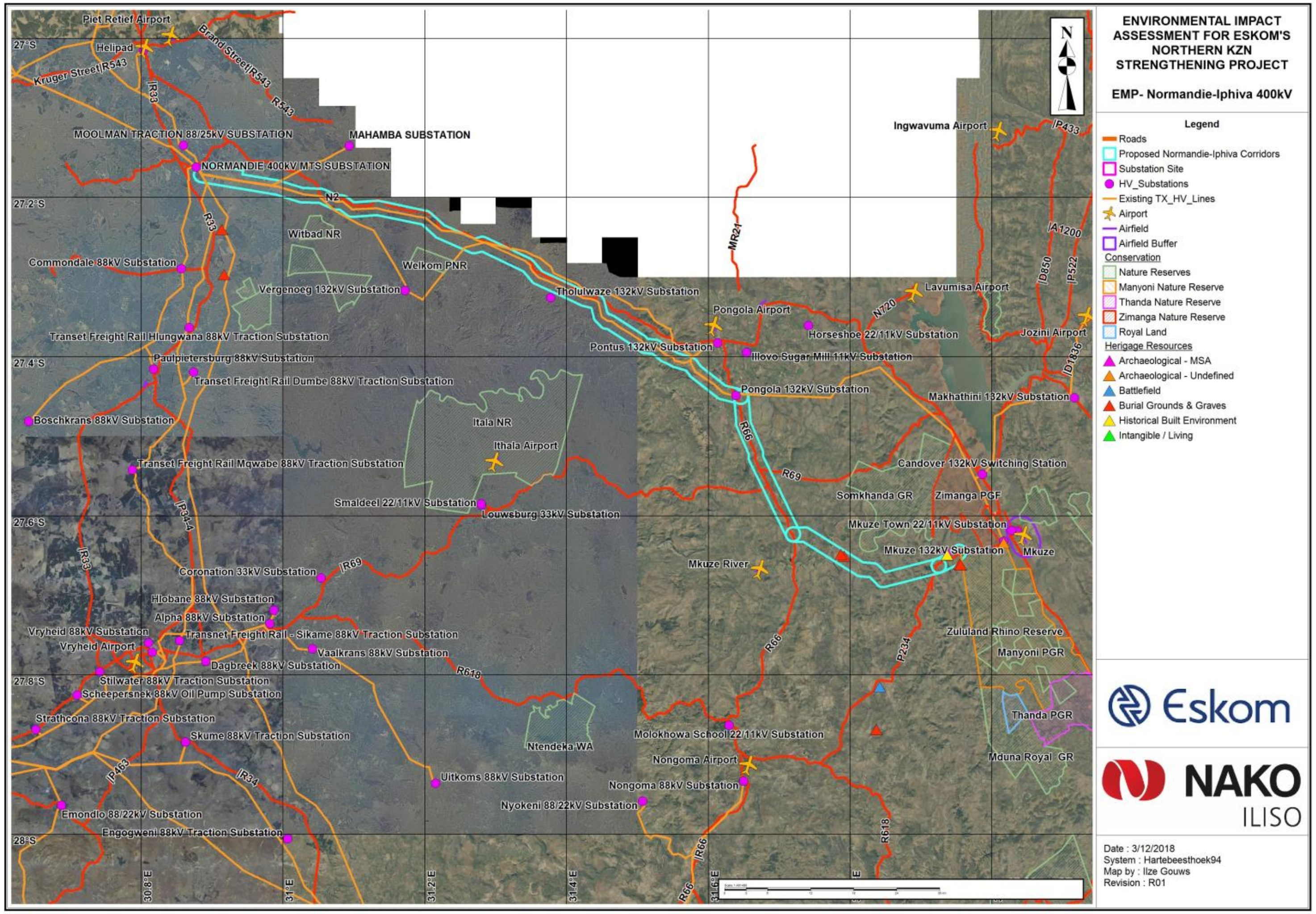


Figure 3. Normandie-Iphiva 400kV Powerline Recommendation

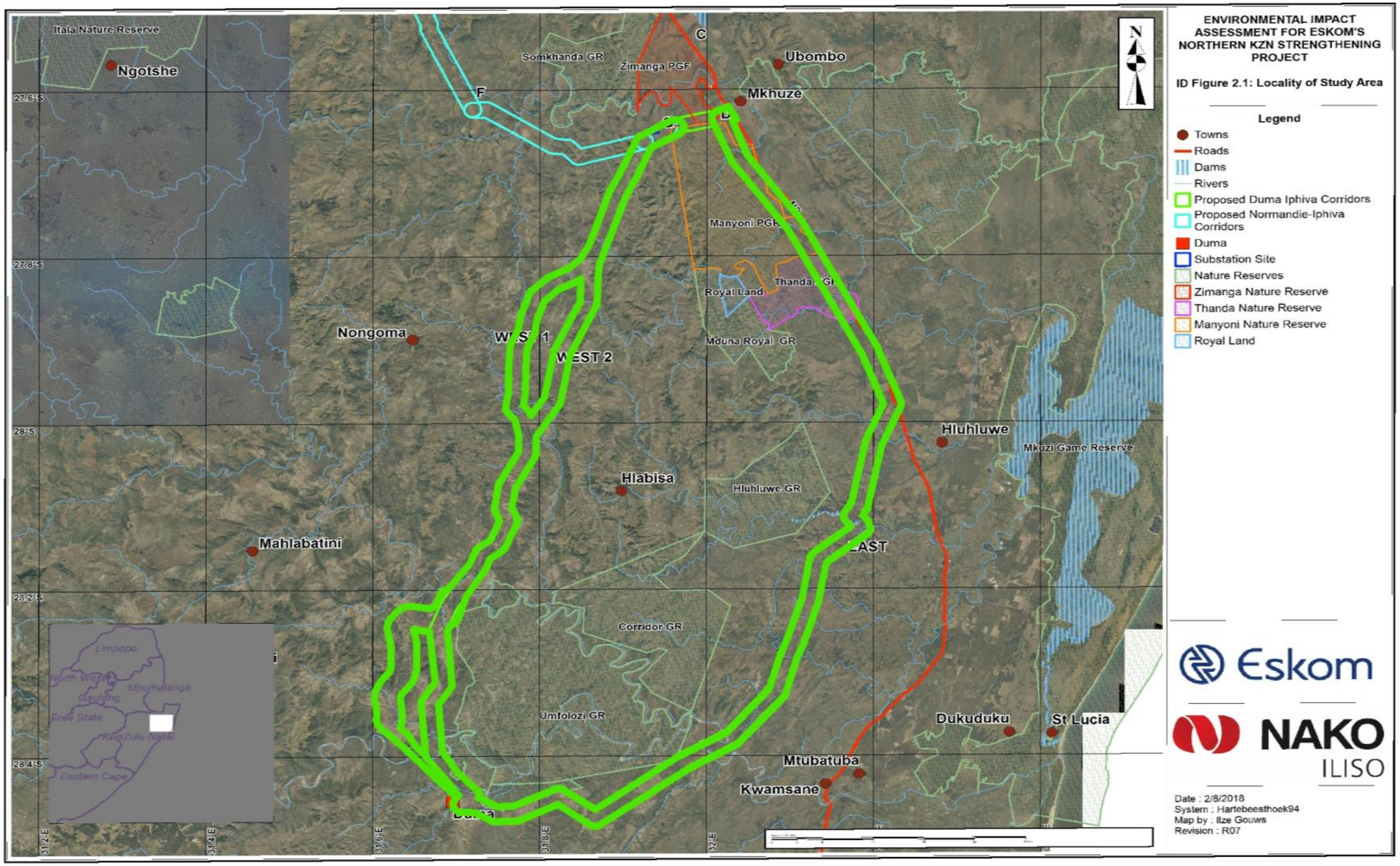


Figure 4. Iphiva-Duma 400kV Powerline Alternatives

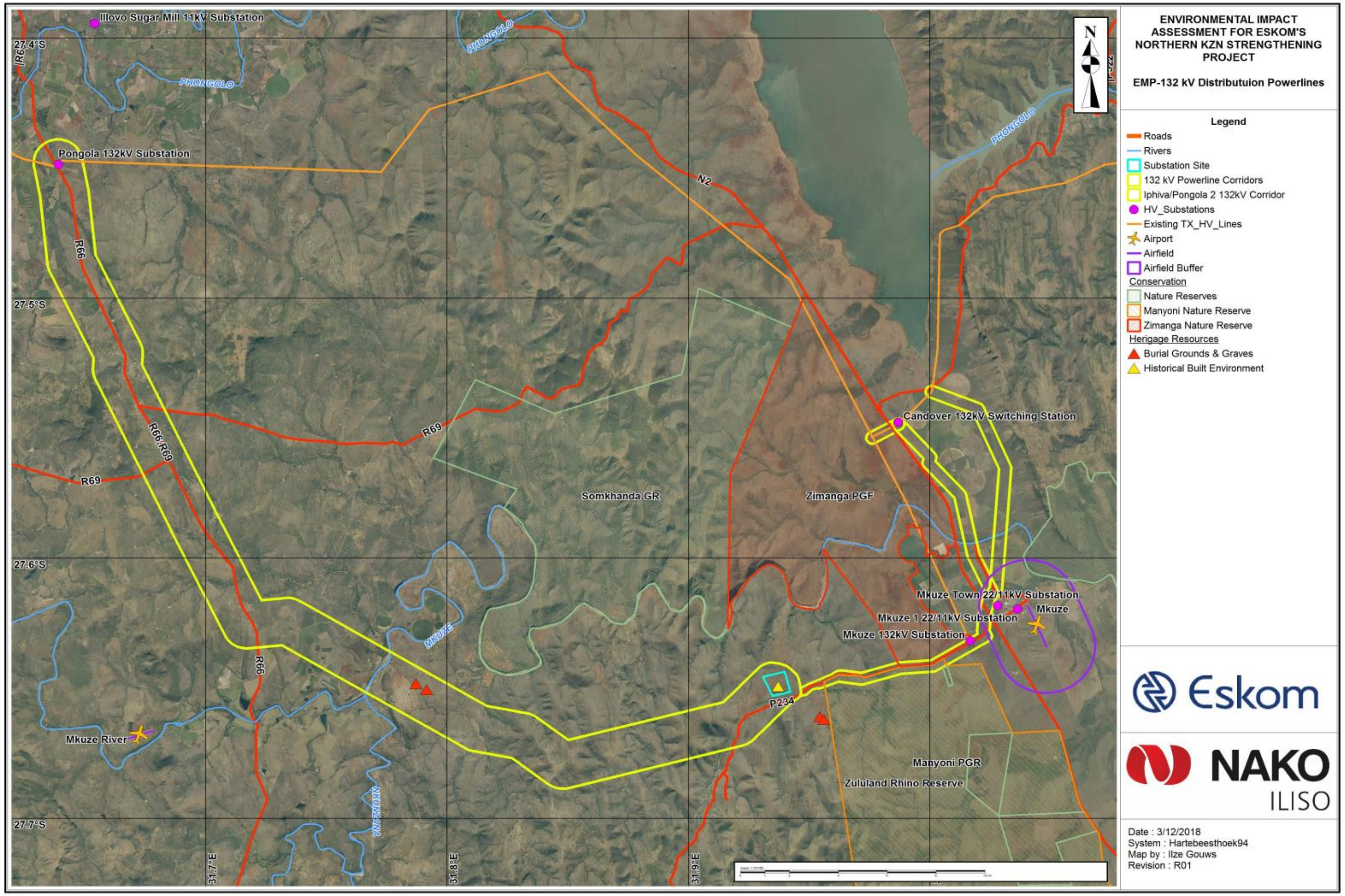


Figure 5. 132kV Distribution Powerline Corridors without Alternatives

NAKO ILISO has appointed ECO SOIL to undertake the Agricultural potential Impact Assessment as part of the EIA.

1.2 STRUCTURE OF THIS REPORT

This specialist study was undertaken in compliance with Appendix 6 of GN 982 of 4 December 2014, as amended by Appendix 6 of GN 326 of 7 April 2017. **Table 1.1** indicates how Appendix 6 has been fulfilled in this report.

Table 1. Indication of compliance with Appendix 6 of GN 326 of 7 April 2017 in this report

Regulatory Requirements	Section of Report
(a) The person who prepared the report; and the expertise of that person to carry out the specialist study or specialised process.	Chapter 2
(b) a declaration that the person is independent	Page 1
(c) an indication of the scope of, and the purpose for which, the report was prepared	Chapter 3
(cA) an indication of the quality and age of base data used for the specialist report	Chapter 4
(cB) a description of existing impacts on the site, cumulative impacts of the proposed development and levels of acceptable change	Chapter 6
(d) the duration, date and season of the site investigation and the relevance of the season to the outcome of the assessment	Chapter 3
(e) a description of the methodology adopted in preparing the report or carrying out the specialised process inclusive of equipment and modelling used	Chapter 4
(f) details of an assessment of the specific identified sensitivity of the site related to the proposed activity or activities and its associated structures and infrastructure, inclusive of a site plan identifying site alternatives	Chapter 6, 7,8
(g) an identification of any areas to be avoided, including buffers	Chapter 6, 7, 8
(h) a map superimposing the activity including the associated structures and infrastructure on the environmental sensitivities of the site including areas to be avoided, including buffers	Chapter 6, 7, 8
(i) a description of any assumptions made and any uncertainties or gaps in knowledge	Chapter 5
(j) a description of the findings and potential implications of such findings on the impact of the proposed activity or activities	Chapter 6, 7, 8
(k) any mitigation measures for inclusion in the EMPr	Chapter 9, 10
(l) any conditions for inclusion in the environmental authorisation	Chapter 9, 10
(m) any monitoring requirements for inclusion in the EMPr or	Chapter 10

Regulatory Requirements	Section of Report
environmental authorisation	
(n) a reasoned opinion— (i) whether the proposed activity, activities or portions thereof should be authorised; (iA) regarding the acceptability of the proposed activity or activities; and (ii) if the opinion is that the proposed activity, activities or portions thereof should be authorised, any avoidance, management and mitigation measures that should be included in the EMPr, and where applicable, the closure plan	Chapter 14
(o) a description of any consultation process that was undertaken during the course of preparing the specialist report	Chapter 11
(p) a summary and copies of any comments received during any consultation process and where applicable all responses thereto	Chapter 12
(q) any other information requested by the competent authority	Chapter 13

2. PROJECT TEAM

Table 2. List of the team members

SPECIALISTS	FUNCTION	QUALIFICATION
F Botha	Soils project leader	B.Sc. (Hon), Pedology
A.M. Hattingh	Soil scientist, GIS Specialist	M.Sc. (Soil Science)

2.1 BIOGRAPHY OF FRANCOIS BOTHA - 2017

Francois obtained a B.Sc Honns in Soil Science in 1988 at North-west University, Potchefstroom, South Africa and an B Comm degree in 12001 from UNISA, South Africa. SACNASP Registration No: 400063/15

He has the following experience:

- Lecturing experience of 13 years in soil science at agricultural colleges.
- 8 years' experience as an extension officer, with the focus on sugarcane production under irrigation in the Malelane region.
- Involved in pedological and geological surveys for Forestek (35 000ha's), ARC and private individuals for forestry, game ranching, farming enterprises and new agricultural developments (350 000ha).
- Functioned as project leader on a number of large scale soil survey projects, e.g.
    - Donkerhoek Agricultural project, Mpumalanga,

- CoAL Greater Limpopo Coal Land Capability study, 80 000ha
    - USAID Rice project, 55 000ha, Kilombero Tanzania
- Pedological specialist studies for environmental impact assessments (EIA's) as well as a number of economic and agronomic feasibility studies for new agricultural developments.
- Consultation on biological and soil health principles on various agricultural projects
- Precision farming sampling and mapping in the maize sugar and industry
- Feasibility studies on new sugarcane and agricultural projects under irrigation in Southern Africa
- Environmental Impact Assessments for mining and new projects
- Rehabilitation of opencast mining soils
- Wetland delineation

2.2 BIOGRAPHY OF ASTRID MAGDALENA HATTINGH - 2017

Astrid Magdalena Hattingh obtained a B.Sc. Honns in Soil Science in 1978 and also an MSc in Soil Science (1983) at North-west University, Potchefstroom, South Africa.

She started her career at the Dept. of Agriculture, Potchefstroom, in 1979 as researcher, where she worked for 18 years and later became Assistant Director (Soil Science). In 1996 she took a severance package and started a greenhouse production for seedlings, tomatoes, cucumber and other vegetables. During that time she also gave part time class at the North-west University and Agricultural College at Potchefstroom. She still occasionally gives class at the North-west University, Potchefstroom and act as moderator for Hons. and MSc students at Potchefstroom and Pretoria University.

She was/is involved in numerous organizing committees' like farmers days, Soil Science- and Precision farming congresses. She is author or co-author of nine publications, more than 100 technical reports, delivered more than 20 presentations at conferences and workshops (local and international).

The need of the combination of Soil Science and GIS became apparent and she took the opportunity in the field of precision farming. Presently she is a private consultant in Soil Science and GIS work. Her work includes numerous reports in investigations all over Africa (South Africa, Nigeria, Tanzania, Swaziland, Zimbabwe, Mozambique, etc.). It includes investigations regarding soil suitability for sugar, rice, maize and other crops under dry land or irrigation systems as well as for mining applications. She works in close relationship with Eco Soil, writing reports for many soil related projects and specialist agricultural EIA's.

Astrid is a member of the International Soil Science Union and Soil Science Society of South Africa. The complete Curriculum Vitae's are summarised in Appendix 2.

3. PURPOSE OF REPORT AND SCOPE OF WORK

The purpose of this study is to identify the present soil quality in terms of soils physical characteristics and to identify obvious highly sensitive areas and high potential soils to be avoided (based on desk top available information).
The ToR for the investigation of soils' impact and agricultural potential on the following areas:

- The two proposed substations at Iphiva (sites Iphiva 3 and Iphiva 6)
- The 400kV powerline from the Iphiva Substation to the Normandie Substation,
- The 400kV powerline from the Iphiva Substation to the Duma Substation and
- 65km of 132 kV distribution lines

To perform the necessary soil impact assessment required to support the applications it should include (as a minimum):

- The identification of the soil physical properties and land capability of the above mentioned areas
- Identification of any obvious highly sensitive areas to be avoided
- Potential impact and quantification thereof (as far as possible) on soils, agricultural land use and land capability

4. METHODOLOGY

4.1 SOIL CLASSIFICATION

A broad soil classification and identification of agricultural potential was done during a field survey and supplemented with desktop information on a) the Iphiva 3 and 6 substation sites consisting of 118 ha and 74 ha respectively, b) the proposed corridors of approximately 58780 ha of the Iphiva-Duma Corridors, including deviations and c) 21996 ha of the Normandie-Iphiva 400 kV Powerline plus 34530 ha of the N-I 3-deviation 400 kV Corridors, as well as the proposed six (6)132 kV Distribution powerlines. The data obtained from the 145 observations during the field trips were used to confirm the information from a Land type survey (desktop information). The site visits on the 400 kV and 132 kV Distribution powerlines were only conducted on limited, but targeted areas and additional information was then obtained from the Land type Information. The land type survey information is available at a 1:250 000 scale.

For the desktop information the broad soil groups of the land type survey of the ISCW (Soil Classification working group, 1991) were obtained. Memoirs: 7 (2730 Vryheid), 6 (2632 Mkuze) were used for obtaining the soil descriptions. At the time of the land type survey classification of soil profiles was carried out using the BINOMIAL SYSTEM FOR SOUTH AFRICA. Soil does not develop during short periods of time and the data of the land type can therefore be regarded as sufficient, because a detail survey on such a large area is not possible considering the time and financial limitations.

The investigation of the soils during the field trip involved the collation of the following soil information using the TAXONOMIC SOIL CLASSIFICATION FOR SOUTH AFRICA (Soil Classification working group, 1991):

- Observations at the Iphiva 3 and 6 substation sites were done on 2 and 3 November 2017.
  - Thirteen (13) at the Iphiva 3 substation site and
  - Sixteen (16) observations were made at the Iphiva 6 substation.
- The Mkuze Area, P234 and Sovane area on the Normandie-Iphiva 400 kV Powerline was visited on the 2nd and 3rd November 2017 and Piet Retief, Paul Pietersburg, Louwsburg to Pongola was visited during 28 to 29 November 2017.
  - Forty observations on the corridor of were made during the above mentioned trip
- The Mkuze, Hluhluwe N2 route was visited on the 30th November 2017
  - Eleven observations was made on the corridor of this Normandie-Iphiva 400 kV Powerline
- The southern deviation in the Iphiva-Duma 400 kV Powerline was visited on 3 March 2018 to verify the data of the Land-type survey.
- The sites of the proposed 132 kV Distribution Powerlines were visited on 28 to 29 November 2017 and
  - Sixty eight observations were made

Soil classification: A linear approach along the corridors was used. A transect on the corridor was surveyed to cover a catena to reflect the influence of topography on soil properties.

A hand augur of the Thompson type, as well as observations at open cuttings was used for identifying the soil types.

Geology, properties of the soil types, soil depth, clay content, estimated profile available water content (PAWC), soil restrictions and strengths, as well as soil potential were determined from the land type information.

- Google EarthTM images; digital images were used to identify areas presently used for agricultural activities. It includes: forestry, commercial and subsistence farming.

Applying the combined information obtained from the field trip and desktop information it was possible to characterize soils based on the limitations of the soils' physical characteristics and site constraints. The data was then used to obtain the land capability and agricultural potential of the soils.

From the gathered information the soils in this study area can be classed in four land capability classes, namely:

- ➢ Soils of intermediate suitability for arable agriculture
- ➢ Soils not suitable for arable agriculture, but suitable for forestry or grazing
- ➢ Soils of poor suitability for arable agriculture
- ➢ Soils with no dominant class

4.2 INFORMATION SYSTEMS

The following sources of information were utilized:

- Initial Figures and shapefiles supplied by NAKO ILISO
- Preliminary site layout plans
- ENPAT: Geology
- Remote sensing information for topography
- For background purposes the topography of the area was obtained from SRTM (1arc) information from Shuttle Radar Topography Mission (SRTM) 1 Arc-Second
- Global, Earth Explorer: U.S. Geological Survey (USGS) Earth Resources
- Observation and Science (EROS) Center. Slope information was calculated from the abovementioned data.
- Climate: Rasters University of Natal
- Google EarthTM image; digital image - Background
- The Dept. of Agriculture's Memoirs was used to determine land types and soil descriptions: Memoirs: 7 2730 (Vryheid), 6 (2632 Mkuze)

4.3 IMPACT RATING

A description of the nature of the impact, any specific legal requirements and the stage (construction / decommissioning or operation) will be given. Impacts are considered to be the same during construction and decommissioning.

The following criteria will be used to evaluate significance:

- **Nature:** This is an appraisal of the type of effect the activity is likely to have on the affected environment. The description includes what is being affected and how. The nature of the impact will be classified as positive or negative, and direct or indirect.

- **Extent:** This indicates the spatial area that may be affected (**Table 4.1**).

Table 3. Geographical extent of impact

Rating	Extent	Description
1	Site	Impacted area is only at the site – the actual extent of the activity.
2	Local	Impacted area is limited to the site and its immediate surrounding area
3	Regional	Impacted area extends to the surrounding area, the immediate and the neighbouring properties.
4	Provincial	Impact considered of provincial importance
5	National	Impact considered of national importance – will affect entire country.

- **Duration:** these measures the lifetime of the impact (**Table 4**).

Table 4. Duration of Impact

Rating	Duration	Description
1	Short term	0 – 3 years, or length of construction period
2	Medium term	3 – 10 years
3	Long term	> 10 years, or entire operational life of project.
4	Permanent – mitigated	Mitigation measures of natural process will reduce impact – impact will remain after operational life of project.
5	Permanent – no mitigation	No mitigation measures of natural process will reduce impact after implementation – impact will remain after operational life of project.

- **Intensity / severity:** This is the degree to which the project affects or changes the environment; it includes a measure of the reversibility of impacts (**Table 5**).

Table 5. Intensity of Impact

Rating	Intensity	Description
1	Negligible	Change is slight, often not noticeable, natural functioning of environment not affected.
2	Low	Natural functioning of environment is minimally affected. Natural, cultural and social functions and processes can be reversed to their original state.
3	Medium	Environment remarkably altered, still functions, if in modified way. Negative impacts cannot be fully reversed.
4	High	Cultural and social functions and processes disturbed – potentially ceasing to function temporarily.
5	Very high	Natural, cultural and social functions and processes permanently cease, and valued, important, sensitive or vulnerable systems or communities are substantially affected. Negative impacts cannot be reversed.

- **Potential for irreplaceable loss of resources:** This is the degree to which the project will cause loss of resources that are irreplaceable (**Table 6**).

Table 6. Potential for irreplaceable loss of resources

Rating	Potential for irreplaceable loss of resources	Description
1	Low	No irreplaceable resources will be impacted.
3	Medium	Resources can be replaced, with effort.
5	High	There is no potential for replacing a particular vulnerable resource that will be impacted.

- **Probability:** This is the likelihood or the chances that the impact will occur (**Table 7**).

Table 7. Probability of Impact

Rating	Probability	Description
1	Improbable	Under normal conditions, no impacts expected.
2	Low	The probability of the impact to occur is low due to its design or historic experience.
3	Medium	There is a distinct probability of the impact occurring.
4	High	It is most likely that the impact will occur
5	Definite	The impact will occur regardless of any prevention measures.

- **Confidence:** This is the level of knowledge or information available, the environmental impact practitioner or a specialist had in his/her judgement (**Table 8**).

Table 8. Confidence in level of knowledge or information

Rating	Confidence	Description
1	Low	Judgement based on intuition, not knowledge/ information.
2	Medium	Common sense and general knowledge informs decision.
3	High	Scientific / proven information informs decision.

- **Consequence:** This is calculated as extent + duration + intensity + potential impact on irreplaceable resources.

- **Significance:** The significance will be rated by combining the consequence of the impact and the probability of occurrence (i.e. consequence x probability = significance). The maximum value which can be obtained is 100 significance points (**Table 9**).

Table 9. Significance of issues (based on parameters)

Rating	Significance	Description
1-14	Very low	No action required.
15-29	Low	Impacts are within the acceptable range.
30-44	Medium-low	Impacts are within the acceptable range but should be mitigated to lower significance levels wherever possible.
	Medium-high	Impacts are important and require attention; mitigation is required to reduce the negative impacts to acceptable levels.
	High	Impacts are of great importance, mitigation is crucial.
81-100	Very high	Impacts are unacceptable.

- **Cumulative Impacts:** This refers to the combined, incremental effects of the impact, taking other past, present and future developments in the same area into account. The possible cumulative impacts will also be considered.

- **Mitigation:** Mitigation for significant issues will be incorporated into the EMPR.

5. ASSUMPTIONS, UNCERTAINTIES AND GAPS IN KNOWLEDGE

- It should be taken in mind that the scale of this survey is very broad due to the large areas to be covered during this survey and therefore relative small patches of deep, highly productive soils may be present in some restricted areas, which might have been missed during this broad scale survey.
- With additional irrigation, some areas may be highly productive for some crops, especially for high value vegetable crop production when good quality irrigation water is used, but has not been taken in consideration in this study.

- The cumulative effect of all external factors such as climate, topography, erosion factors, surface rock and water quality for irrigation need to be considered to determine the actual agricultural potential of each field, but is not possible on such large scale investigations.
- The soil classification of the land types was done on a 1:250 000 scale.
- Visiting all the farm owners, as well as communities have a time and cost implication. It is not always possible to establish all the present agricultural activities of the farmers from desktop information, since it is not possible to distinguish between actual and derelict fields and/or kind of crop on the Google Earth images or by any other remote sensing way. Farmers also do double cropping or crop rotation which cannot be distinguished on images. It is also always not possible to establish whether communal settlements are accompanied with agricultural activities.
- All areas and farms were not accessible due to road restrictions, terrain obstacles and farmers' permission.

6. GENERAL INVESTIGATION AND OBSERVATIONS

6.1 PRESENT LANDUSE

6.1.1 Iphiva 3 and 6 substations

The area demarcated for Iphiva 3 is undisturbed with no agricultural cultivation activity (Figure 5), but the soil is used for grazing purposes by the local community. The people of the community are harvesting wood from this site for household fires.

The area demarcated for Iphiva 6 is seriously impacted by human settlement. Overgrazing and erosion are major problems at this site (Figure 5).

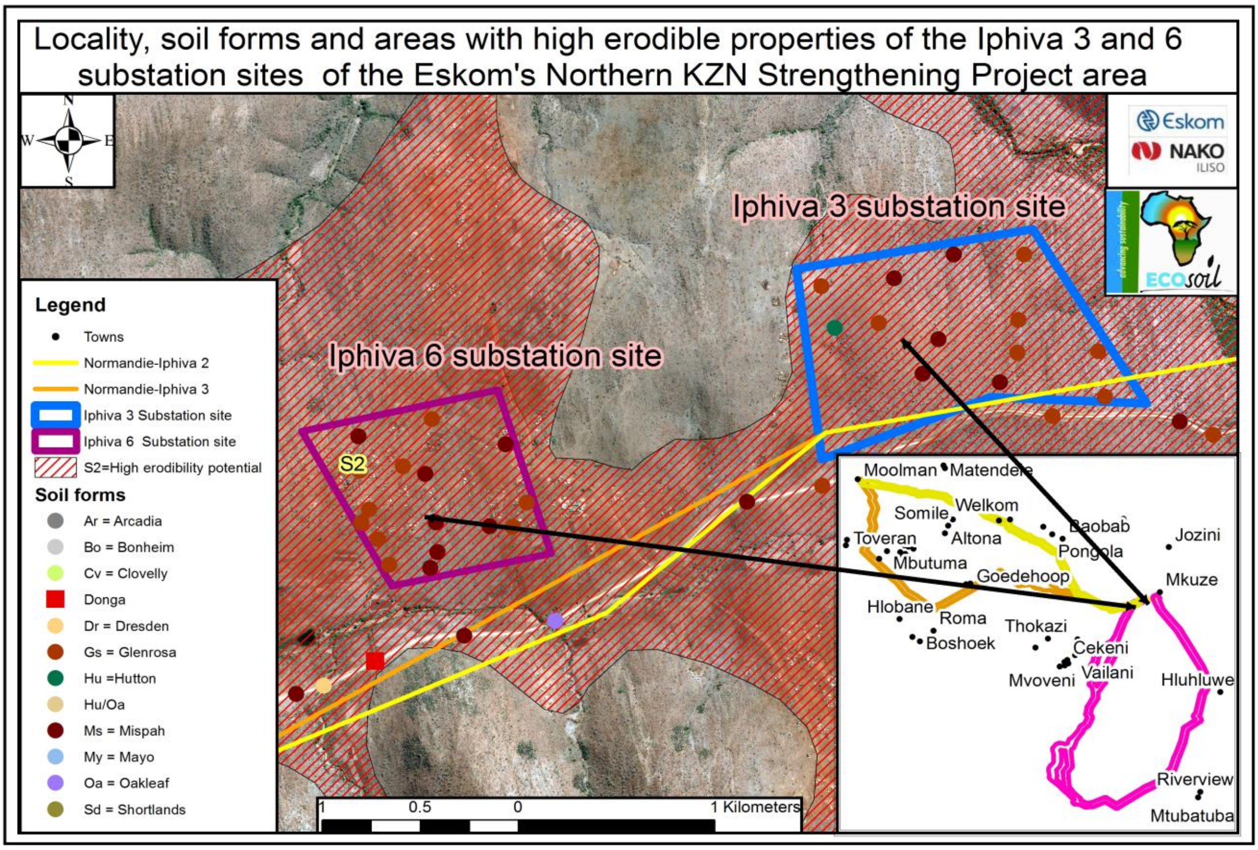


Figure 6. Locality, soil forms and areas with high erosion potential at the Iphiva 3 and 6 substation sites of Eskom's Northern KZN Strengthening Project area

6.1.2 Normandie-Iphiva 400 kV powerline

The areas presently affected for agricultural and forestry purposes and communal activities are indicated in Figure 6. The present agricultural activities in the ranking order within the Normandie-Iphiva 400 kV Powerline Corridors include:

- Game farming
- Forestry
- Commercial farming include:
  - Maize and other grain crops
  - Sugarcane under irrigation
  - Macadamia
  - Citrus
  - Pineapples
  - Essential oils
  - Subtropical fruit like banana, mango
  - Vegetables
  - Cattle, sheep production
- Subsistence farming and Communal Activities
- Natural vegetation for grazing

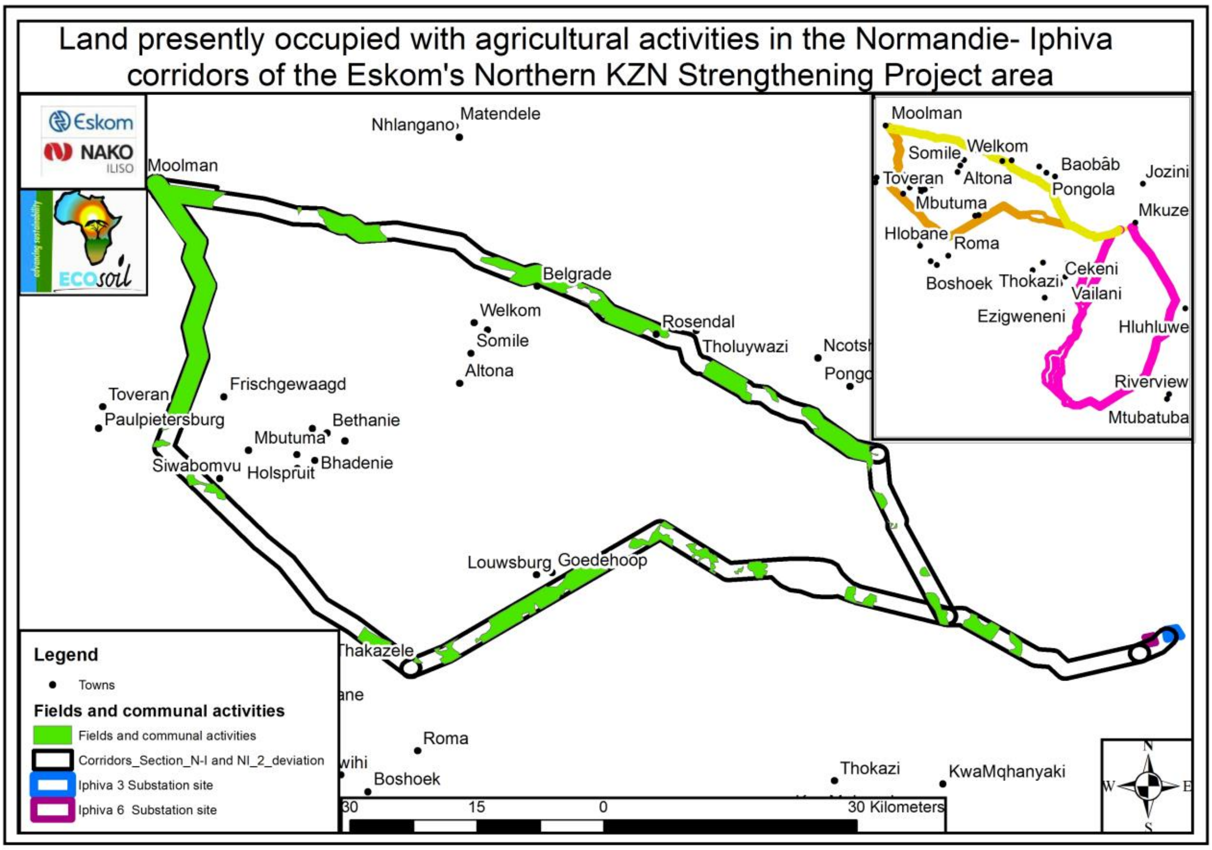


Figure 7. Land presently occupied by agricultural activities in the Iphiva-Normandie corridors of Eskom's Northern KZN Strengthening Project area

6.1.3 Iphiva-Duma 400 kV powerline

The areas presently affected by agricultural purposes and communal activities are indicated in Figure 7. The present agricultural activities in the ranking order within the Iphiva-Duma 400 kV Powerline corridors include:

Game farming,

- Subsistence farming and Communal Activities focussing on cattle ranching
- Commercial farming include:
  - Pineapples
  - Sugarcane, under irrigation,

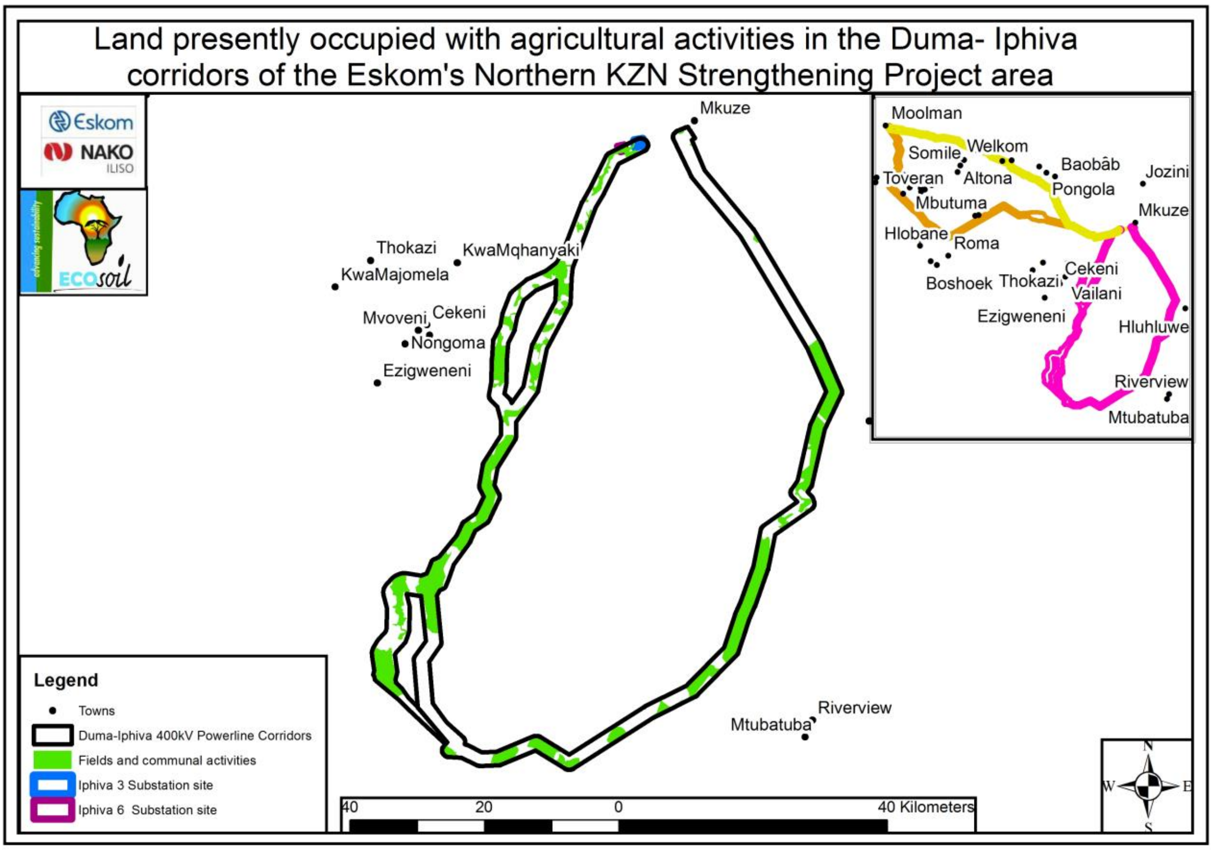


Figure 8. Land presently occupied by agricultural activities in the Duma-Iphiva corridors of Eskom's Northern KZN Strengthening Project area

6.1.4 132 kV Distribution powerlines

The areas presently affected by farming purposes and communal activities are indicated in Figure 8. The present agricultural activities in the ranking order within the 132 kV distribution powerlines include:

- Game farming,
- Forestry,
- Subsistence farming and Communal activities focusing on cattle ranching,
- Commercial farming include:
  - Sugarcane under irrigation,
  - Macadamia
  - Citrus
  - Vegetables

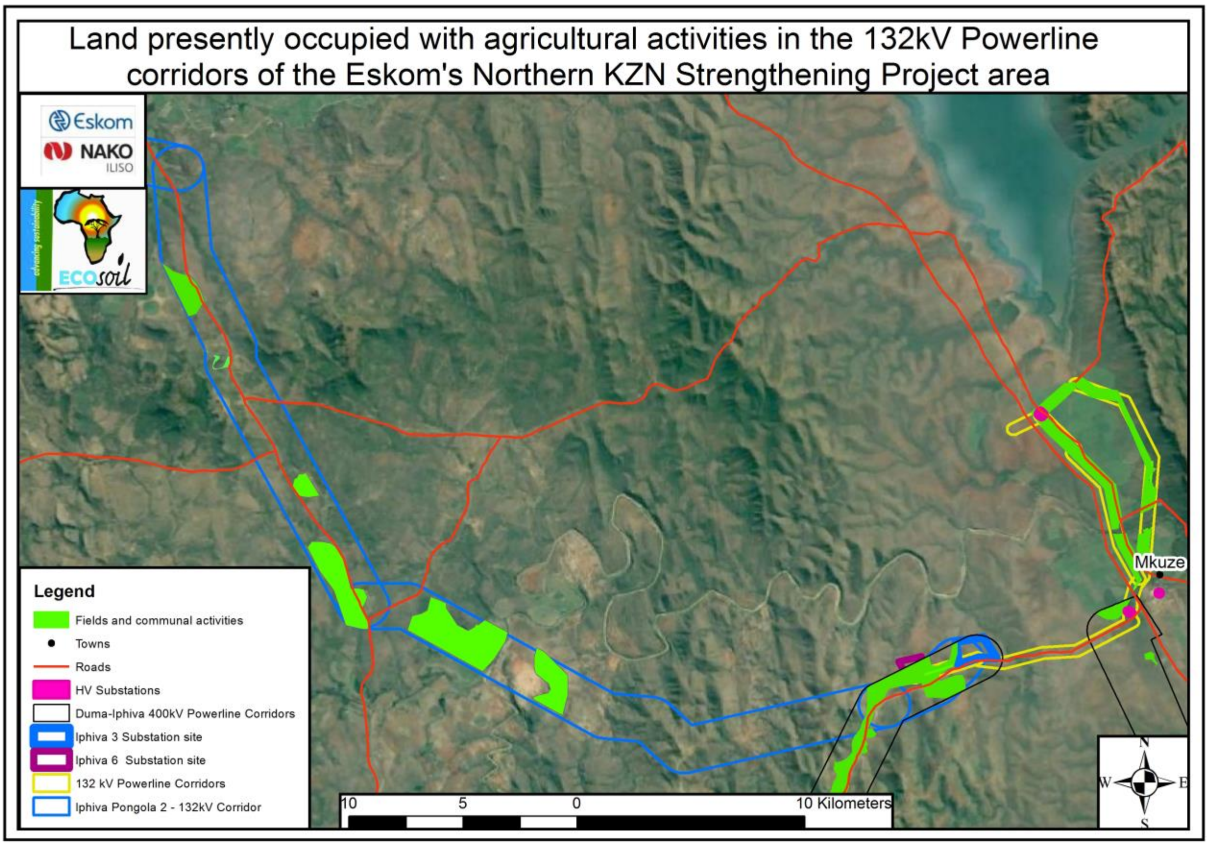


Figure 9. Land presently occupied by agricultural activities in the 132kV Powerline corridors of Eskom's Northern KZN Strengthening Project area

6.2 GEOLOGY

Geological borders generally changes gradually from one lithology to the next and are not sharp transitions as depicted in Figures 9 to 11. In geological time, several phases of uplifting, erosion and deposition have created complex landforms determined by the underlying geology. Properties like clay content and erosion susceptibility to erosion is highly dependent on the parent material. Geology may have a marked influence on soil properties and especially on topography, which in turn influences soil properties.

6.2.1 Geology of the Iphiva 3 and 6 Substations

The parent material in the western parts of both Iphiva 3 and Iphiva 6 Substations is arenite (Figure 9). In the eastern part of the Iphiva 3 Substation the parent material is basalt, but the eastern part of the Iphiva 6 Substation has mudstone and arenite as parent material, which indicates that developing soils may be erosion susceptible.

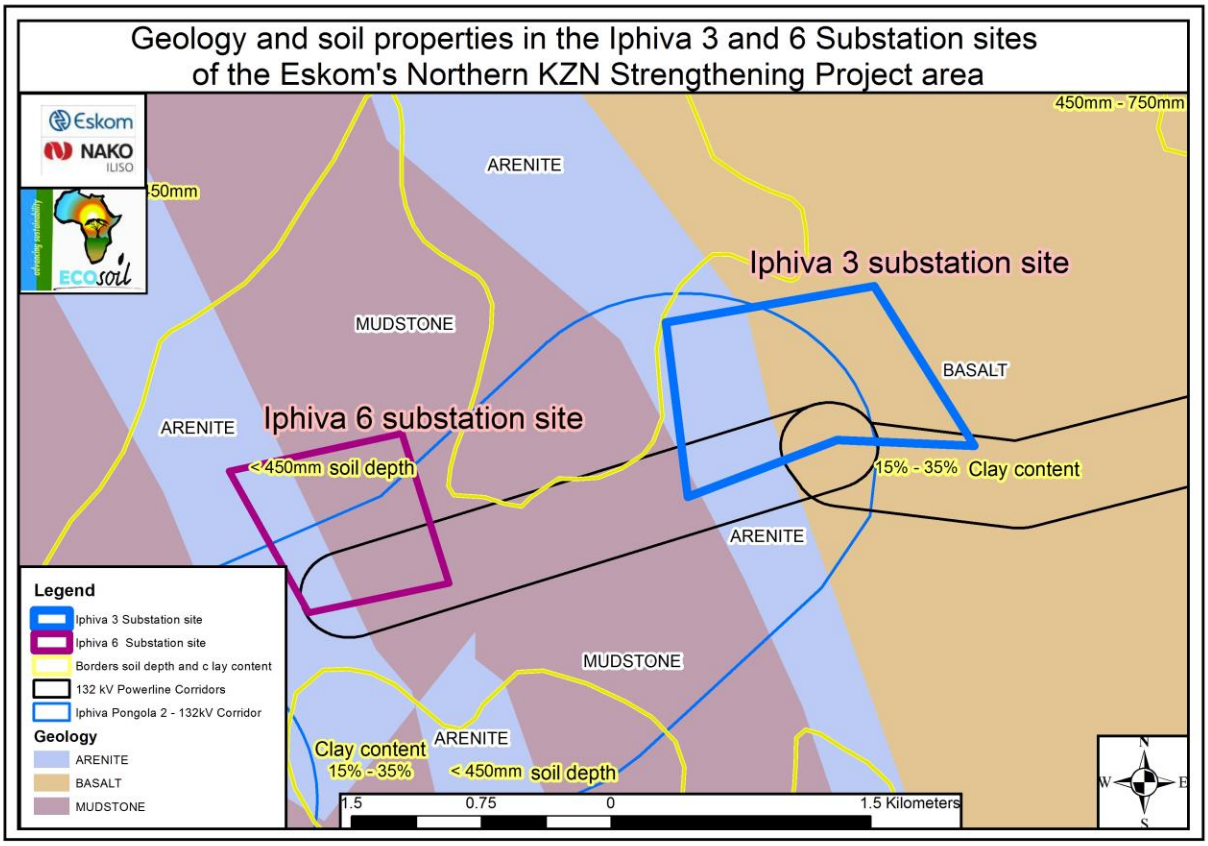


Figure 10. Geology of the Iphiva 3 and 6 Substation sites of Eskom's Northern KZN Strengthening Project area

6.2.2 Geology of the Normandie-Iphiva Corridors

Parent material is:

Arenite

- Arenite, shale and coal
- Arenite, siltstone

Basalt

- Basalt, andesite and quartzite (soils with high clay contents and poor physical properties develops)

Dolerite

- Gabbro
- Gabbro, granite

Granite (developing soils may sometimes be erosion susceptible)

- Mudstone (developing soils may be erosion susceptible – red in Map)
- Mudstone, shale and arenite
- Mudstone, arenite

Quartzite

- Quartzite, shale and hornfels
- Shale (developing soils may be erosion susceptible, orange in Map)
- Shale, arenite, mudstone and coal

- Tillite (developing soils may be erosion susceptible, purple in Map)
- Tillite, arenite, mudstone and shale

A few fault lines are present in the Normandie-Iphiva Corridors.

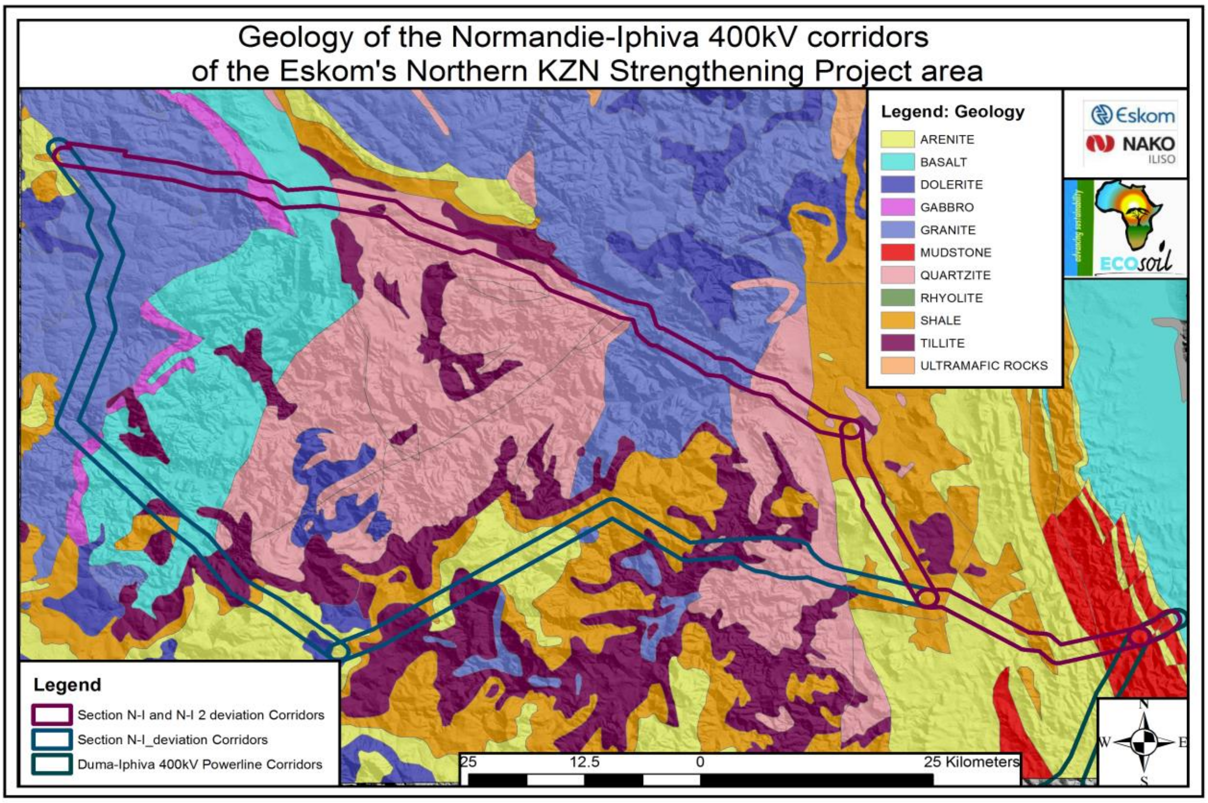


Figure 11. Geology of the Normandie-Iphiva 400kV Powerlines of Eskom's Northern KZN Strengthening Project area

6.2.3 Iphiva-Duma Corridors

Parent material is:

Arenite

- Arenite, shale and coal
- Arenite, siltstone

Basalt (soils with high clay contents and poor physical properties develops)

Dolerite

Mudstone (developing soils may be erosion susceptible)

- Mudstone, shale and arenite
- Mudstone, arenite

Shale (developing soils may be susceptible to erosion)

- Tillite (developing soils may be erosion susceptible)
- Tillite, arenite, mudstone and shale

The mudstone, tillite, siltstone, shale and even granite can give rise to soils severely susceptible to wind and/or water erosion when exposed. Exposed surfaces should therefore be limited or prevented. Soil surfaces should be covered with any vegetation and should not be exposed even for short periods after the actual impact in the operational phase. Other lithology's in the study area are not a problem for either wind or water erosion.

In the case of the Iphiva-Duma Corridors nearly 20% of the soil is underlain by mudstone, while in the case of the Normandie-Iphiva Corridors it is only 3.3%. Basalt as parent material is present in almost 21% of the Iphiva-Duma Corridors and 4.4% of the area of the Normandie-Iphiva Corridors. Basalt give rise to soils with high clay contents and poor physical properties develops.

Several fault lines are present in the Iphiva-Duma Corridors.

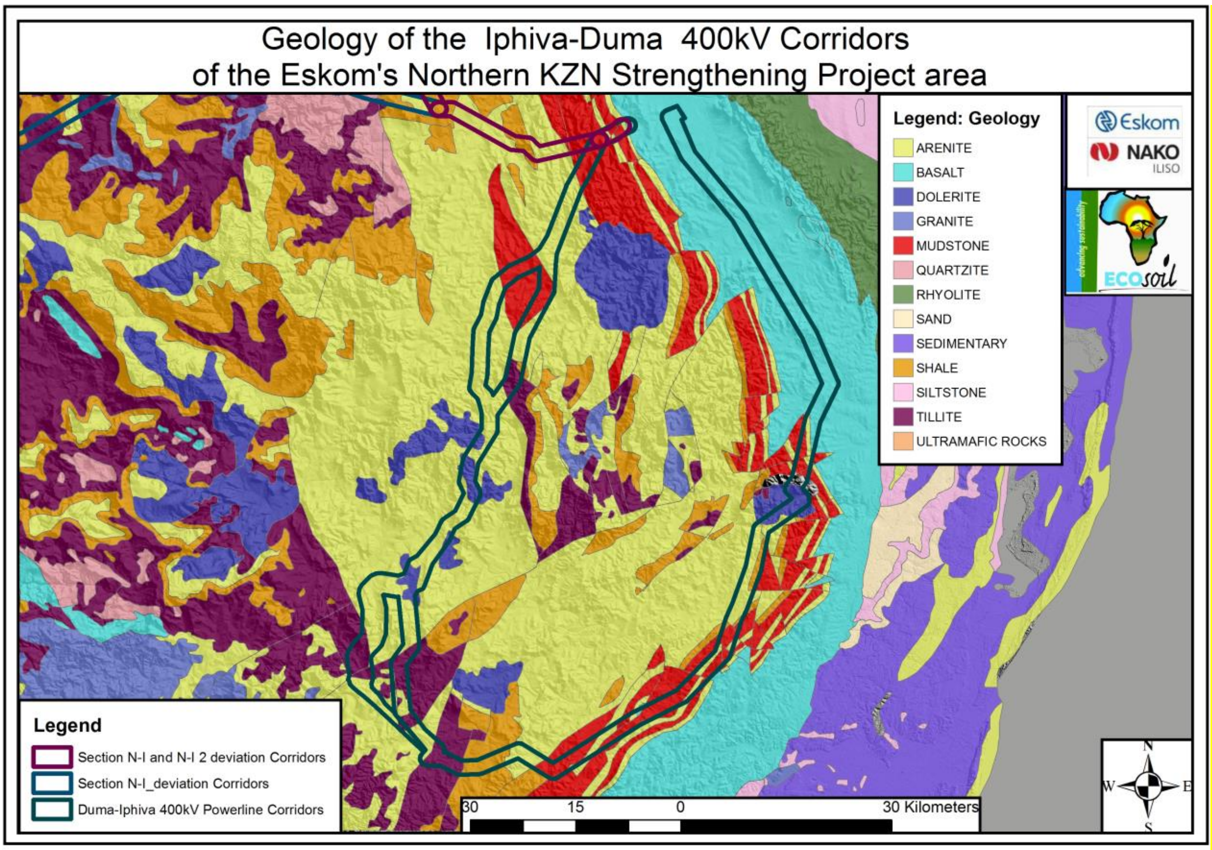


Figure 12. Geology of the Iphiva-Duma 400kV Powerlines of Eskom's Northern KZN Strengthening Project area

6.2.4 Geology of the 132 kV Distribution powerlines

- The corridor of the Iphiva Pongola 2-132kV powerline is generally underlain by arenite and shale, but the eastern parts is underlain by mudstone, which is more prone to erosion.
- The corridors of the Iphiva-Mbazwane double circuit, Iphiva-Pongola-Iphiva-Hluhluwe Double Circuit, the loop in Candover, the Iphiva-Mbazwane and Iphiva-Makhathini Double Circuit and the alternative route for Iphiva-Mbazwane and Iphiva-Makhithini Double Circuit Line are almost entirely underlain by basalt (orange in Figure 12).
- Areas around Substation 3 and 6 and to the west of the substations are underlain by mudstone (Purple in Figure 12) which may give rise to soils susceptible to erosion.

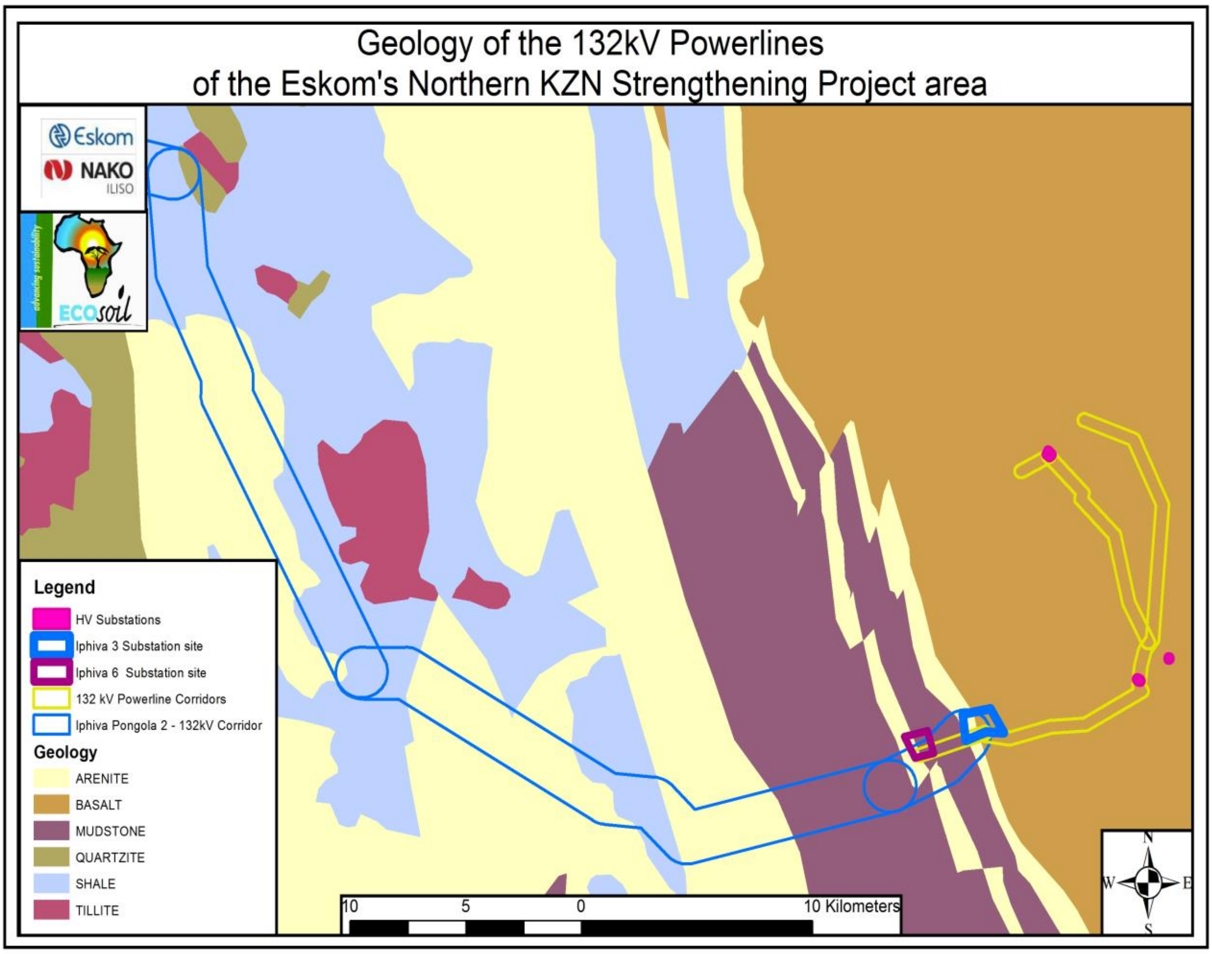


Figure 13. Geology of the 132kV Powerlines of Eskom's Northern KZN Strengthening Project area

6.3 TOPOGRAPHY

Topography and terrain types of the area are illustrated in Figure 13. The height above sea level of the proposed Iphiva-Duma 400kV Powerlines varies between 32 to 697m, Normandie-Iphiva 400kV Powerlines varies between 111 to 1 399m. The variation in topography is much higher in the case of the Normandie-Iphiva Corridors.

The two corridors of the Northern KZN Strengthening Project area exist mainly of six terrain types, namely:

- Low mountains. The majority of the area falls in this class. Almost the entire of the Normandie-Iphiva Corridors, as well as the western parts of the Iphiva-Duma Corridors, are situated in this terrain type.
- Moderately undulating plains: Are present in central eastern parts of the Normandie-Iphiva Corridors, as well as a small part of the most western line of the Iphiva-Duma Corridors
- Slightly undulating plains: In the eastern parts of both the Normandie-Iphiva Corridors and Iphiva-Duma Corridors
- Undulating hills: In the south of the Iphiva-Duma Corridors
- Highly dissected low undulating mountains: In the most southern part of the Iphiva-Duma Corridors
- Undulating hills and lowlands: In the most northern parts of the Normandie-Iphiva Corridors

The terrain properties indicate that there is a variation in properties, but only small areas are restricted for arable crop production in both the Iphiva-Duma Corridors and Normandie-Iphiva Corridors based on terrain properties alone.

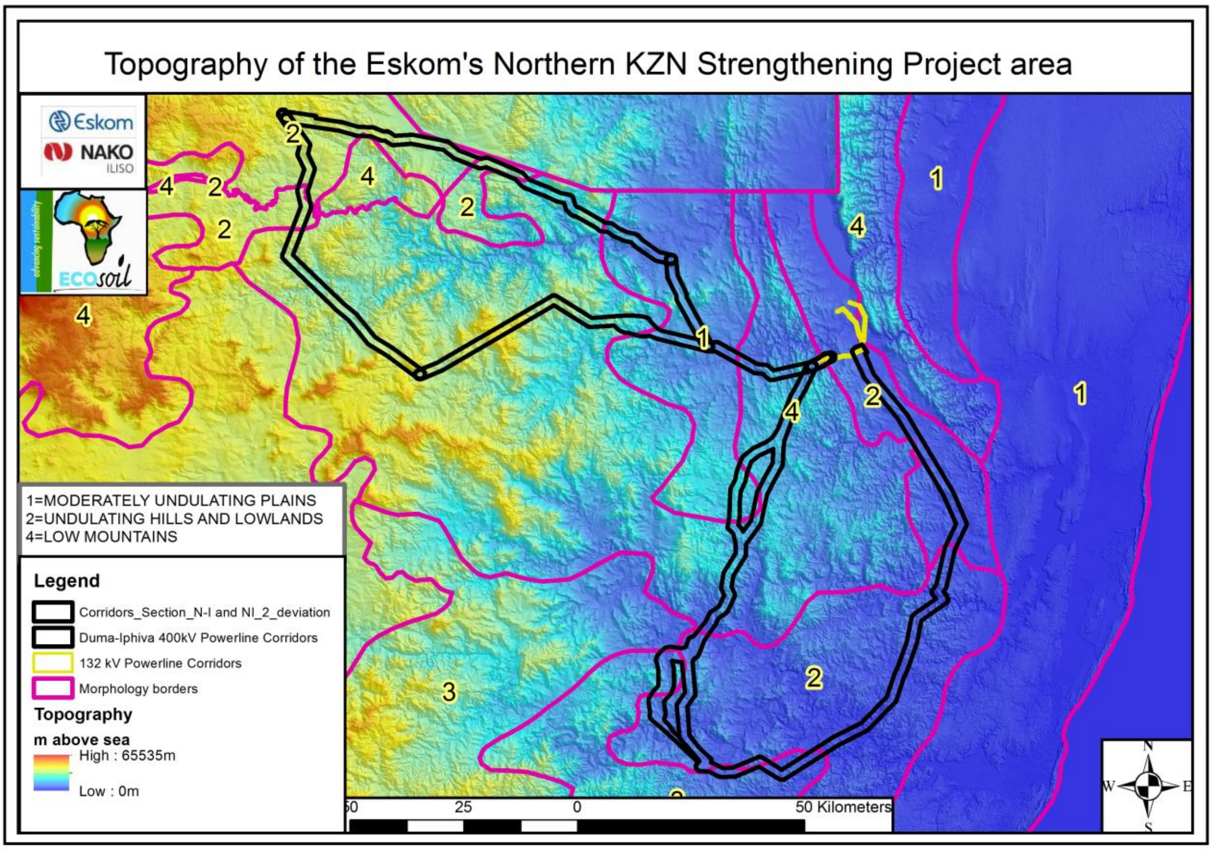


Figure 14. Topography and terrain types of Eskom's Northern KZN Strengthening Project area

6.4 CLIMATE

The climate of the area is typified by warm to hot summers with a variation of high to low rainfall and high evaporation and dry warm winters. The area is generally frost free.

Precipitation is strongly seasonal with about 85% of the yearly rainfall falling in the summer months (October to March). Monthly variations in rainfall throughout the study area are given in Table 3. The highest rainfall is found during December and January. The hills and ridges have a very strong influence on the climatic pattern of the area. An assessment of the long-term rainfall records indicates a mean annual rainfall that varies between 495 to 1 560mm. The highest rainfall is present on the most southern parts of the Normandie-Iphiva Corridors in the area of KwaMajomelo. The rainfall is lowest in the north-eastern parts of the Normandie-Iphiva Corridors in areas next to Baobab. Rainfall is generally higher in the western parts next to the hills and is decreasing gradually to the eastern parts further from the hills.

From the ranges found in Table 3 it can be seen that climate, especially rainfall during the summer, varies considerably throughout the area and also over relatively short distances. Summer temperatures are generally lower in the higher lying mountainous areas in the east. Coldest temperatures are found during July.
These variations have a very large influence on the agricultural potential of the area. The enormous diversity in possible crop and variety selections, as well as climatic needs per crop, makes it difficult to characterize typical adaptive capacities and strategies for the area.

All year round irrigated crop production is possible as the winters are mainly frost free (if topography and soil permits). However the suitability for arable crop production depends highly on quality of irrigation water, terrain- and soil properties. Areas with very low rainfall or either areas with high hills and difficult terrain is not suitable for dry land agriculture. Rainfall distribution patterns are presented in Figure 14.

Table 10. Mean monthly rainfall

Month	Mean Rainfall (mm)
January	63-229
February	58-194
March	49-156
April	25-92
May	0-40
June	0-18
July	0-19
August	0-30
September	12-78
October	40-143
November	59-143
December	48-224
Total ave.	495-1561

Agriculture of this area is not limited by climatic factors except in the north eastern parts where low annual rainfall may become a limiting factor. However, soils indicated as having high swell-shrink potential, plastic and sticky, restricted effective depth, wetness in Figure 21 and 22, may cause problems during construction in wet periods of the year. Soils with such properties are found mainly in the eastern parts of the Iphiva-Duma Corridors, but average annual rainfall is lower in this area under discussion.

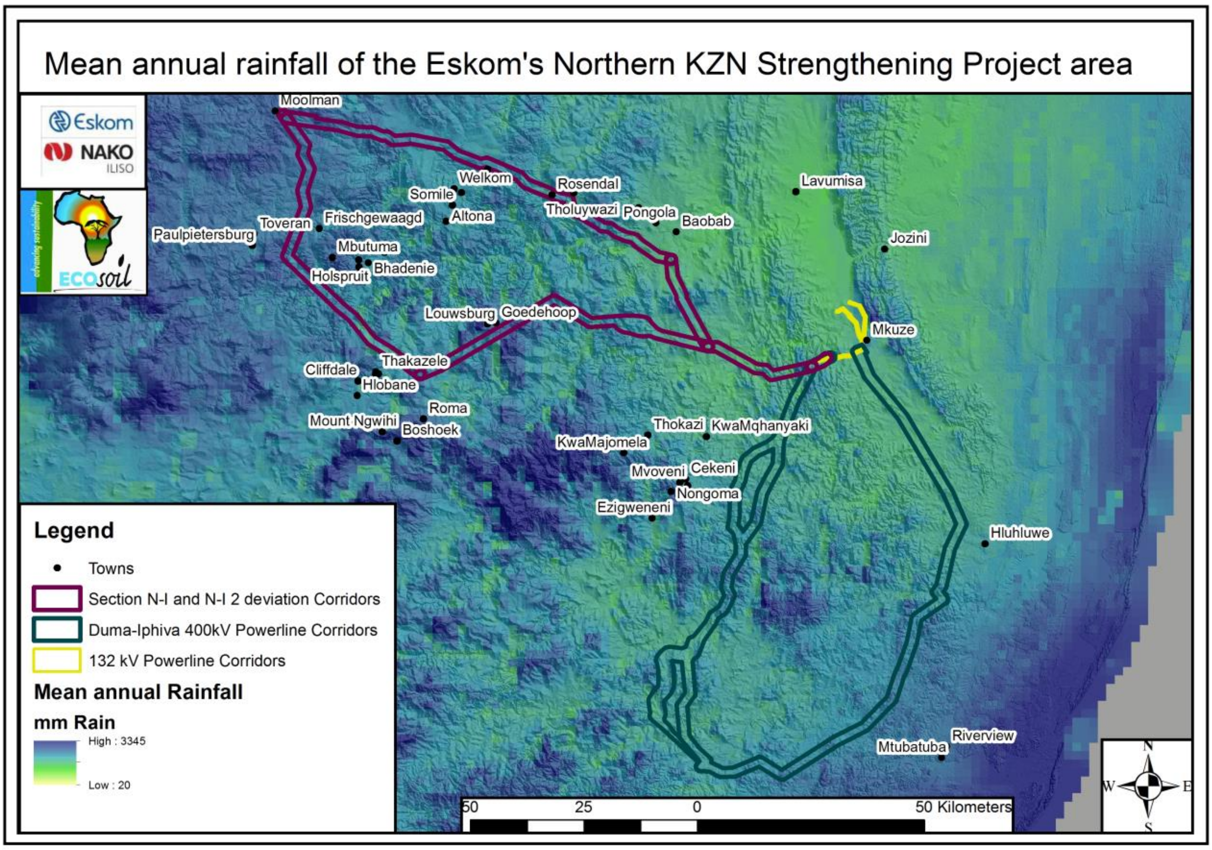


Figure 15. Mean annual rainfall of Eskom’s Northern KZN Strengthening Project area

7. SOIL CLASSIFICATION INVESTIGATION

7.1 SOIL CLASSES

The major soil forms that generally have similar characteristics were grouped together in broad soil groups to simplify the data for interpretation purposes. The soils vary significantly in physical composition over the different areas. They are strongly influenced by the underlying parent material (geology) from which they were derived and the origin of the parent material (in-situ versus colluvium/alluvium derived), as well as by their position in the landscape (catena).

7.1.1 Soil classes of the Iphiva 3 and 6 substations

Soils of the two substation sites were investigated in detail. Figure 5 relates to the results of the soil survey at the substations.

The soils at both Iphiva 3 and 6 Substations are classified as Class F: Lithosols (shallow soils on hard or weathering rock). Surface rock and rocky outcrops cover relatively large areas.

7.1.2 Soil classes of the Normandie-Iphiva and Iphiva-Duma 400 kV Powerlines

Soils of the corridors have been classified from available data of the Land-type survey and verified with field observations. The soil types in a catena have been verified during the field study. The majority of soils in the Normandie-Iphiva and the Duma-Iphiva Corridors are shallow on the crests positions and generally slightly deeper in positions in the foot slope and valley bottoms. The better soils for agriculture purposes are on average found in the lower lying positions of the landscape, while soils on the crests often has limited use for arable agriculture.

Broad soil groups occurring on the proposed development sites are illustrated in Figure 15 and 16 for the Normandie-Iphiva and the Iphiva-Duma Corridors respectively. Soil groups and forms give an indication of expected soil colour, properties and soil forming processes. Although soil forms can give a slight indication of soil capability, it cannot give a real indication of agricultural potential. Nine broad soil classes were found in the Normandie-Iphiva study area, summarized in Table 11. In the Normandie-Iphiva 400kV Corridor the majority of soils are shallow and/or rocky, often steep and moderately leached broad soil class Fa (some lime, mainly in valleys) and Fb (very little lime) consisting of mainly Glenrosa and/or Mispah forms, but other soils may occur. These soils are shallow and of low potential for arable agriculture and have rock or weathered rock as underlying material.

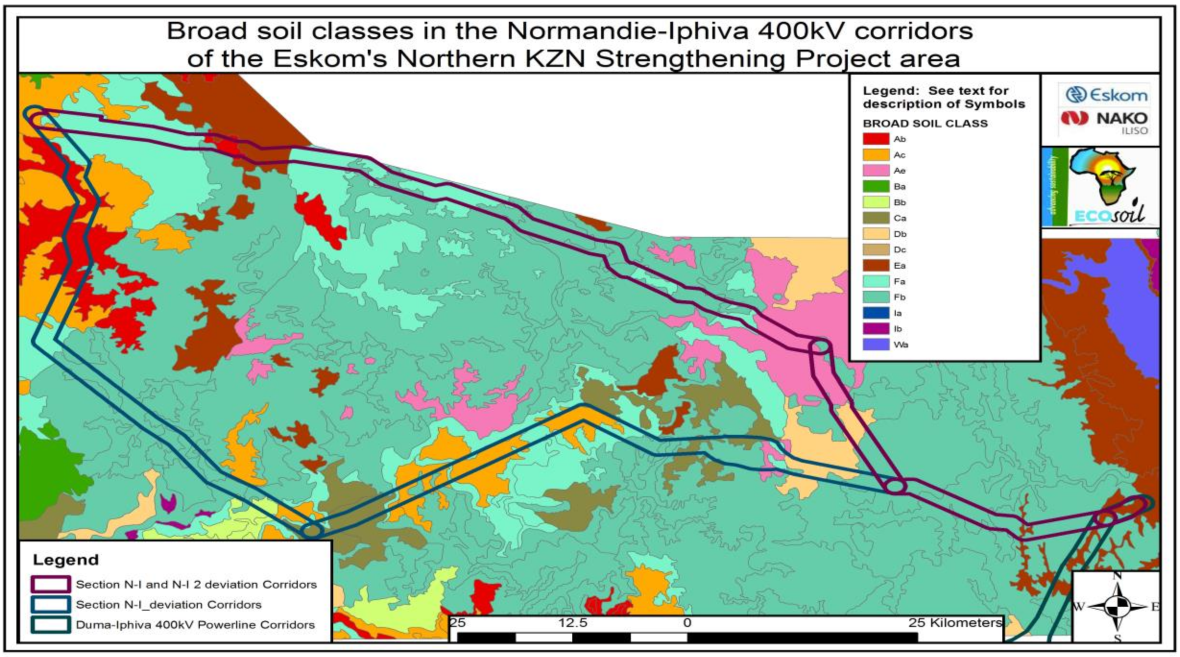


Figure 16. Broad soil classes in the Normandie-Iphiva 400kV corridors

Table 11. Broad soil patterns for the Normandie-Iphiva study area

A: Red and/or yellow, freely-drained soils (Ia, Kp, Ma, Hu, Gf, Cv) dominant (>40%)	
Ab	**Red** (yellow soils <10%); **dystrophic/mesotrophic** > eutrophic
Ac	**Yellow/red** (yellow & red soils each >10%); **dystrophic/mesotrophic** > eutrophic
Ae	**Red** (yellow soils <10%); **eutrophic** > dystrophic/mesotrophic
B: Plinthic catena (Bv, Av, Gc, Wa, We, Ms11) >10%; upland duplex and margalitic soils (Ar, Bo, Tk, My, Mw, Es, Ss, Sw, Va, Kd) <10%	
Bb	**Non-red** (Hu, Bv <33%); **dystrophic/mesotrophic** > eutrophic
C: Plinthic catena (Bv, Av, Gc, Wa, We, Ms11) >10%; upland duplex and margalitic soils (Ar, Bo, Tk, My, Mw, Es, Ss, Sw, Va, Kd) >10%	
Ca	As for **Ba-Bd**, but with >10% **clay soils** (***not*** in valley bottoms)
D: Duplex soils (Es, Ss, Sw, Va, Kd) >50%	
Db	**Non-red** subsoils **>50%** of duplex component
Dc	As for **Da/Db**, but also with **>10% Ea** soils
E: One or more of: vertic (Ar, Rg), melanic (Mw, My, Bo, Ik, Wo) and/or red structured (Sd) soils >50%	
Ea	Dark, blocky **clay** topsoils (often swelling clays) and/or red, structured clays
F: Mainly Glenrosa and/or Mispah forms (other soils may occur as long as land type does not qualify elsewhere)	
Fa	**Shallow**, and/or rocky, often steep, highly leached (very **little lime**)
Fb	**Shallow**, and/or rocky, often steep, moderately leached (**some lime**, mainly in valleys)

In the eastern parts of the Iphiva-Duma 400kV Corridor the majority of soils (41.7%) fall in the Ea group of soils (Figure 16). These soils are vertic, melanic, red structured diagnostic horizons, with swelling and shrinking clay minerals (Table 12). Although the soils are of limited use for dry land crop production, it may have restrictive properties for construction in wet periods of the year and may be highly erosive. In the western parts of the corridors a large percentage (37.4%) is occupied by the Fb soil group (Mispah/Glenrosa soil forms). The soil classes in both the northern and southern deviations in the western part of the Iphiva-Duma 400kV Corridor are very similar.

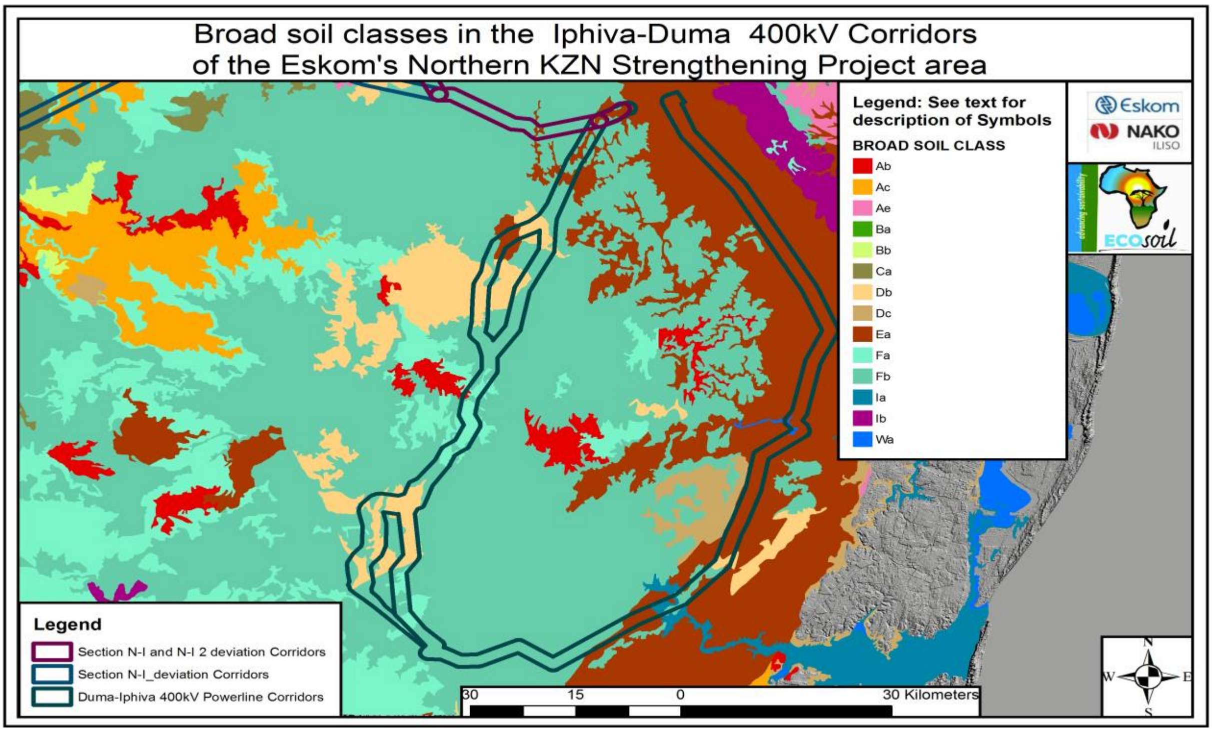


Figure 17. Broad soil classes in the Iphiva-Duma 400kV corridors

Table 12. Broad soil patterns for the Iphiva-Duma study area

A: Red and/or yellow, freely-drained soils (Ia, Kp, Ma, Hu, Gf, Cv) dominant (>40%)	
Ab	**Red** (yellow soils <10%); **dystrophic/mesotrophic** > eutrophic
D: Duplex soils (Es, Ss, Sw, Va, Kd) >50%	
Db	**Non-red** subsoils **>50%** of duplex component
Dc	As for **Da/Db**, but also with **>10% Ea** soils
E: One or more of: vertic (Ar, Rg), melanic (Mw, My, Bo, Ik, Wo) and/or red structured (Sd) soils >50%	
Ea	Dark, blocky **clay** topsoils (often swelling clays) and/or red, structured clays
F: Mainly Glenrosa and/or Mispah forms (other soils may occur as long as land type does not qualify elsewhere)	
Fa	**Shallow**, and/or rocky, often steep, highly leached (very **little lime**)
Fb	**Shallow**, and/or rocky, often steep, moderately leached (**some lime**, mainly in valleys)
I: Miscellaneous land classes	
Ib	**Much rock (60-80%), usually with shallow and/or rocky soils on steep slopes**
Other units	
WA	**Water** bodies (dams and/or lakes)

The broad soil classes in the study area can be described as:

Class A (red-yellow apedal, freely drained soils):

Refers to yellow and red soils without water tables and Hutton, Clovelly, Inanda, Griffin, Kranskop soil forms are typical in this class. This Figure unit refer to land with one or more of the above soil forms and they occupy at least 40% of the area. These soils do not have plinthite.

Soil class Ab: Broad soil class Ab refers to areas where red soils without water tables are dominant and yellow soils occupy less than 10% of the area. These soils are mainly dystrophic and/or mesotrophic, rather than having a high base status properties.

Soil class Ac: Broad soil class Ac indicates that both red and yellow soils without water tables occupy more than 10% of the area. They are dystrophic and/or mesotrophic and occupies higher percentages of land than soils having a high base status.

Soil class Ae: Broad soil class Ae is typified by red soils with a high base status, normally deeper than 300mm and no dunes are present.

Class B: Plinthic catena: upland duplex and margalitic soils are rare

A typical catena (from high lying to low lying) in this class is Hutton, Bainsvlei, Avalon and Longlands soil forms and the valley bottom is occupied by soil with a gley horizon (e.g. Rensburg, Willowbrook, Katspruit, Champaigne forms) In addition the following soils may be present in smaller parts: Glencoe, Wasbank, Westleigh, Kroonstad and Pinedene.

Soil class Bb: The soils in this class are dystrophic and/or mesotrophic and red soils are not widespread. Plinthic soils must cover more than 10% of the area. Red soils occupy more than a third of the area. Duplex (Escourt, Sterkspruit, Swartland, Valsrivier and Kroonstad forms) and margalitic soils (Arcadia, Bonheim Mayo or Milkwood) are absent or occupy less than 10% of the soils present in the area.

Class C: Plinthic catena: upland duplex and margalitic soils are common

Same information than Class B

Soil class Ca: Class Ca indicates land that qualifies as a plinthic catena (as defined for Class B), but has in upland positions margalitic and/or duplex soils that together cover more than 10% of the area (see class Bb for definitions)

Class D: Prismacutanic, pedocutanic and/or gley cutanic diagnostic horizons are dominant

Duplex soils are dominant in Class D. Typical soil forms are the Escourt, Sterkspruit, Swartland, Valsrivier and Kroonstad. After subtraction of exposed rock, stones or boulders, more than half of the remaining land must consist of duplex soils.

Soil class Da: Refers to land where duplex soils (high clay increase between A and B- Horizon) with red B-horizons comprise more than half of the area covered by duplex soils.

Soil class Db: Refers to land where duplex soils with non-red B-horizons comprise more than half of the area covered by duplex soils.

Soil class Dc: Indicates land that qualifies for inclusion in D but, in addition to the duplex soils, more than 10% of the land type is made up by soil forms that have one or more of the vertic, melanic or red structured diagnostic horizons.

Class E: One or more of: vertic, melanic, red structured diagnostic horizons

Soil class Ea: The soils have a high base saturation are dark coloured or red structured. The soils, usually clayey, are associated with basic parent materials. Soil forms with vertic, melanic and red structured soil forms qualify for inclusion in this class.

Class F: Glenrosa and/or Mispah soil forms (but other soils may occur)

This unit represents young landscapes that are not predominantly rock and does not consist of Alluvial or Aeolian properties. It consists mainly of shallow soils of the Glenrosa or Mispah soil forms. The Oakleaf and Tukulu soils forms are accommodated here.

Soil class Fa: This soil class refers to land in which lime in the soil is not encountered regularly in any part of the landscape.

Soil class Fb: This soil class refers to land in which lime in the soil is encountered (even in small amounts) regularly in one or more valley bottoms.

Class I: Miscellaneous land classes

Soil class Ia: It refers to land types with a soil pattern difficult to accommodate elsewhere, at least 60% of which compromises pedological youthful deep (more than 1000mm to underlying rock) unconsolidated deposits. The Dundee and deep Oakleaf soil forms are common.

Table 13 shows the soil forms, depths and GPS co-ordinates of the physical soil survey.

Table 13. Soil forms, depths and GPS coordinates of the soil survey

Number	Form	Depth (cm)	Remark	Lat	Long	Number	Form	Depth (cm)	Remark	Lat	Long
1	Gs	30	Iphiva3	-27.63865835940	31.95454325440	73	My	40		-27.57138333000	32.03070000000
2	Hu	50	Iphiva3	-27.64062826480	31.95514328210	74	Sd	40		-27.56946667000	32.03250000000
3	Gs	30	Iphiva3	-27.64040168680	31.95716657680	75	Sd	40		-27.56840000000	32.03065000000
4	Ms	20	Iphiva3	-27.64116825770	31.95991004860	76	Bo	80		-27.56516667000	32.03023333000
5	Ms	20	Iphiva3	-27.64321826280	31.96272834390	77	Sd	40		-27.56225000000	32.02878333000
6	Gs	30	Iphiva3	-27.64026003550	31.96356992950	78	Sd	70		-27.55963333000	32.02753333000
7	Ms	20	Iphiva3	-27.64282200000	31.95917800000	79	Bo	70		-27.55530000000	32.02543333000
8	Ms	20	Iphiva3	-27.63828000000	31.95786900000	80	Sd	60		-27.55088333000	32.02325000000
9	Ms	20	Iphiva3	-27.63714000000	31.96060500000	81	Bo	80		-27.54736667000	32.02158333000
10	Gs	30	Iphiva3	-27.63713500000	31.96383600000	82	Sd	70		-27.54036667000	32.01820000000
11	Gs	30	Iphiva3	-27.6418200000	31.96352700000	83	Sd	70		-27.53583333000	32.01603333000
12	Gs	30	Iphiva3	-27.64175600000	31.96723900000	84	Bo	70		-27.53815000000	32.01368333000
13	Gs	30	Iphiva3	-27.64391000000	31.96754100000	85	Sd	60		-27.53893333000	32.01006667000
14	Gs	30	Iphiva6	-27.64722001170	31.93535495990	86	Sd	70		-27.53701667000	32.00630000000
15	Gs	30	Iphiva6	-27.64497330800	31.93668163970	87	Sd	150		-27.53566667000	32.00051667000
16	Ms	20	Iphiva6	-27.64617163010	31.94006506910	88	Sd	90		-27.55305000000	31.99035000000
17	Gs	30	Iphiva6	-27.64894997870	31.94103507780	89	Sd	100		-27.55548333000	31.99296667000
18	Gs	30	Iphiva6	-27.65011830440	31.94037839290	90	Sd	100		-27.55985000000	31.99761667000
19	Ms	20	Iphiva6	-27.65007600000	31.93932500000	91	Sd	120		-27.56346667000	32.00141667000
20	Ms	20	Iphiva6	-27.64989600000	31.93686100000	92	Sd	200		-27.58503333000	32.01603333000
21	Ms	20	Iphiva6	-27.65130900000	31.93694100000	93	Sd	150		-27.58040000000	32.01465000000
22	Ms	20	Iphiva6	-27.65206000000	31.93659900000	94	Gs	40		-27.57566667000	32.01353333000
23	Ms	20	Iphiva6	-27.64757900000	31.93638000000	95	Gs	40		-27.57100000000	32.00890000000
24	Ms	20	Iphiva6	-27.64579700000	31.93330300000	96	Gs	40		-27.63801667000	31.77293333000
25	Gs	30	Iphiva6	-27.64744300000	31.93338000000	97	My	40		-27.63421667000	31.76598333000
26	Gs	30		-27.64926700000	31.93380000000	98	My	40		-27.63100000000	31.76463333000
27	Gs	30		-27.65070300000	31.93420900000	99	Ms	20		-27.62715000000	31.75900000000
28	Gs	30		-27.65191400000	31.93472100000	100	Gs	40		-27.62225000000	31.75070000000
29	Gs	30		-27.64991667000	31.93343333000	101	Gs	40		-27.61990000000	31.74558333000
30	Gs	30		-27.62910000000	32.01396667000	102	Gs	40		-27.62341667000	31.73665000000
31	Hu	70		-27.63031667000	32.01740000000	103	Bo	100		-27.62758333000	31.73851667000
32	Sd	70		-27.63275000000	32.01611667000	104	Gs	40		-27.49531667000	31.65253333000
33	Hu	70		-27.63415000000	32.01406667000	105	Gs	40		-27.17461667000	30.92458333000
34	Gs	30		-27.63663333000	32.00830000000	106	Cv	120		-27.17286667000	30.92583333000
35	Gs	30		-27.64053333000	32.00675000000	107	Cv	100		-27.18001667000	30.92128333000
36	Gs	30		-27.64075000000	32.00115000000	108	Dr	20		-27.18258333000	30.91968333000
37	Gs	30		-27.64123333000	31.99541667000	109	Ms	20		-27.18546667000	30.91593333000
38	Gs	30		-27.64138333000	31.99296667000	110	Ms	40		-27.18776667000	30.91423333000
39	Gs	30		-27.64153333000	31.98975000000	111	Ms	40		-27.18963333000	30.90861667000
40	Gs	30		-27.64336667000	31.98140000000	112	Cv	100		-27.18391667000	30.90893333000
41	Dr	10		-27.64421667000	31.97840000000	113	Cv	Rock line		-27.18175000000	30.90836667000
42	Hu	50		-27.64530000000	31.97435000000	114	Cv	50		-27.17788333000	30.90750000000
43	Gs	30		-27.64573333000	31.97251667000	115	G	50		-27.17401667000	30.91258333000
44	Ms	10		-27.64510000000	31.97096667000	116	Gs	30		-27.17421667000	30.91623333000
45	Gs	30		-27.64483333000	31.96513333000	117	Gs	40		-27.16055000000	30.90675000000
46	Oa	120		-27.64691667000	31.95701667000	118	Cv	150		-27.15341667000	30.90021667000
47	Gs	30		-27.64815000000	31.95456667000	119	Gs	30		-27.16065000000	30.88106667000
48	Ms	10		-27.64891667000	31.95113333000	120	Cv	100		-27.16263333000	30.88185000000
49	Oa	120		-27.65458333000	31.94235000000	121	Cv	100		-27.17208333000	30.87896667000
50	Ms	10		-27.65528333000	31.93816667000	122	Cv	100		-27.16598333000	30.87666667000
51	Donga	0		-27.65650000000	31.93408333000	123	Cv	150		-27.15968333000	30.87446667000
52	Dr	10		-27.65766667000	31.93171667000	124	Ms	10		-27.20738333000	30.90653333000
53	Ms	10		-27.65806667000	31.93045000000	125	Cv	150		-27.18333333000	30.88131667000
54	Hu/Oa	120		-27.66026667000	31.92441667000	126	Cv	150		-27.18483333000	30.88438333000
55	Gs	30		-27.66710000000	31.92058333000	127	Cv	100		-27.18318333000	30.88945000000
56	Oa	120		-27.60996667000	32.01951667000	128	Cv	100		-27.22183333000	30.89203333000
57	Hu	150		-27.60490000000	32.02215000000	129	Cv	50		-27.23720000000	30.89938333000
58	Oa	100		-27.60295000000	32.02076667000	130	Cv	50		-27.23733333000	30.89943333000
59	Oa	100	R	-27.59941667000	32.01916667000	131	Gs	40		-27.59775000000	31.28226667000
60	Oa	100	All	-27.59793333000	32.01861667000	132	Gs	40		-27.48286667000	31.64680000000
61	Hu	120		-27.59470000000	32.02791667000	133	Gs	50		-27.63270000000	32.03268333000
62	Hu	120		-27.59673333000	32.02836667000	134	Gs	50		-27.64210000000	32.03868333000
63	Oa	120		-27.59951667000	32.02721667000	135	Gs	50		-27.64598333000	32.04128333000
64	Oa	150		-27.60363333000	32.02893333000	136	Gs	50		-27.65543333000	32.04730000000
65	Oa	150		-27.60600000000	32.02991667000	137	Gs	40		-27.66820000000	32.05596667000
66	Oa	150		-27.60830000000	32.03013333000	138	Gs	40	Old fields	-27.76331667000	32.11701667000
67	Oa	150		-27.60918333000	32.02500000000	139	Bo	60		-27.77281667000	32.12360000000
68	Oa	150		-27.58315000000	32.02748333000	140	Gs	30		-27.83685000000	32.16350000000
69	Bo	150		-27.58265000000	32.03150000000	141	Gs	40	ne apple fiel	-27.92316667000	32.20611667000
70	Bo	70		-27.57886667000	32.03411667000	142	Sd	70		-28.00855000000	32.23766667000
71	Bo	50		-27.57600000000	32.03045000000	143	Hu	60		-28.02976667000	32.17020000000
72	My	40		-27.57416667000	32.02990000000	144	Ar	60		-27.25513333000	31.28475000000
						145	Gs	40		-27.21043333000	31.15055000000

7.1.3 Soil classes of the 132 kV distribution powerlines

According to the Land-type information the Iphiva-Pongola 132kV powerline is largely situated in the Fb broad soil class (Figure 18), which is characterised by mainly Glenrosa and/or Mispah forms. These soils are shallow, and/or rocky, often steep and moderately leached.

The western parts of the Iphiva-Pongola 132kV powerline is situated in the Ae broad soil class, which is characterised by red soils (yellow soils covers less than 10% of the area) and soils are eutrophic (minimal leaching of nutrients). A small area of the Iphiva-Pongola 132kV powerline in the North West is covered by the Db broad soil class in which soils have non-red subsoils duplex properties (soils with a sharp increase of clay content between the top and sub soil).

The corridors of the Iphiva-Mbazwane double circuit, Iphiva-Pongola-Iphiva-Hluhluwe Double Circuit, the loop in Candover, the Iphiva-Mbazwane and Iphiva-Makhathini Double Circuit and the alternative route for Iphiva-Mbazwane and Iphiva-Makhithini Double Circuit Line are almost entirely covered by vertic (Ar, Rg), melanic (Mw, My, Bo, Ik, Wo) and/or red structured (Sd) soils >50% containing dark, blocky clay topsoil (often swelling clays) and/or red, structured clays.

During the field survey the above mentioned information was confirmed. The soil forms in this 132kV Powerlines area are low potential shallow Mispah (Ms) and Glenrosa (Gs) forms (Figure 18) on the Iphiva Pongola 132kV, Iphiva-Mbazwane/ Iphiva-Makhathini Double Circuit Line and the southern (west-east running) parts of the Iphiva Pongola/Hluhluwe Double Circuit 132kV lines. On the south-north running part of the Iphiva-Mbazwane/Iphiva-Makhathini Double Circuit Line the soils are generally of the Bonheim (Bo) and Shortlands (Sd) forms as confirmed from the Land-type information, but the Oakleaf (Oa) form is also found (Figure 18). The soil forms found in this area are mostly classified as low potential for dryland agriculture land and even the Oakleaf (Oa) form is low potential due to its shallowness.

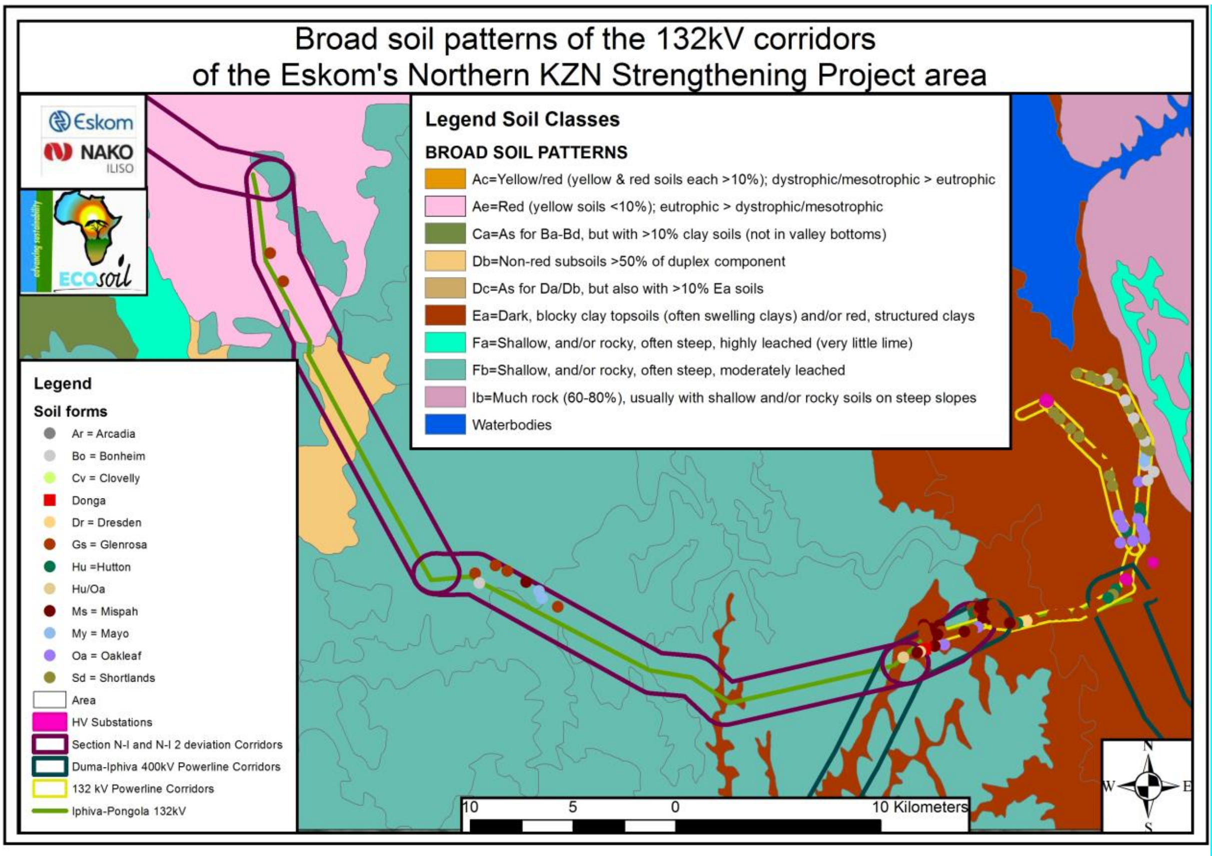


Figure 18. Broad soil classes in the 132kV corridors

Table 14. Broad soil patterns in the 132kV corridors

A: Red and/or yellow, freely-drained soils (Ia, Kp, Ma, Hu, Gf, Cv) dominant (>40%)	
Ac	**Yellow/red** (yellow & red soils each >10%); **dystrophic/mesotrophic** > eutrophic
Ae	**Red** (yellow soils <10%); **eutrophic** > dystrophic/mesotrophic
C: Plinthic catena (Bv, Av, Gc, Wa, We, Ms11) >10%; upland duplex and margalitic soils (Ar, Bo, Tk, My, Mw, Es, Ss, Sw, Va, Kd) >10%	
Ca	As for **Ba-Bd**, but with >10% **clay soils** (***not*** in valley bottoms)
D: Duplex soils (Es, Ss, Sw, Va, Kd) >50%	
Db	**Non-red** subsoils **>50%** of duplex component
Dc	As for **Da/Db**, but also with **>10% Ea** soils
E: One or more of: vertic (Ar, Rg), melanic (Mw, My, Bo, Ik, Wo) and/or red structured (Sd) soils >50%	
Ea	Dark, blocky **clay** topsoils (often swelling clays) and/or red, structured clays
F: Mainly Glenrosa and/or Mispah forms (other soils may occur as long as land type does not qualify elsewhere)	
Fa	**Shallow**, and/or rocky, often steep, highly leached (very **little lime**)
Fb	**Shallow**, and/or rocky, often steep, moderately leached (**some lime**, mainly in valleys)
I: Miscellaneous land classes	
Ib	Much **rock** (60-80%), usually with shallow and/or rocky soils on steep slopes
Other units	
WA	**Water** bodies (dams and/or lakes)

7.2 SOIL DEPTH

Soil depth has a dominant influence on soil potential. Deep soils are a good indication of high potential, while shallow soils indicate soils with a low arable crop potential. It is not recommended that arable crops and especially trees to be cultivated on soils shallower than 500mm. Some vegetable crops can be produced on these shallow soils, but success is mostly limited to small areas and farmer's competency. Variation in soil depth indicates that there will be a variation in yield potential.

7.2.1 Soil depth of the Iphiva 3 and 6 Substations

Most of the area in the Iphiva 3 and 6 Substations sites has soils with a depth of less than 450mm. Soils at Iphiva 3 are slightly deeper (Hutton 500 mm deep) near the south western boundary (Figure 12).

7.2.2 Soil depth of 400kV Powerlines

The soil depth in both the Normandie-Iphiva 400kV 2 and 3 Corridors (Figure 18) is mostly between 450 to 750 mm. Relatively very small numbers of hectares in the northern parts of the Normandie-Iphiva 2-deviation have soils deeper than 750mm.

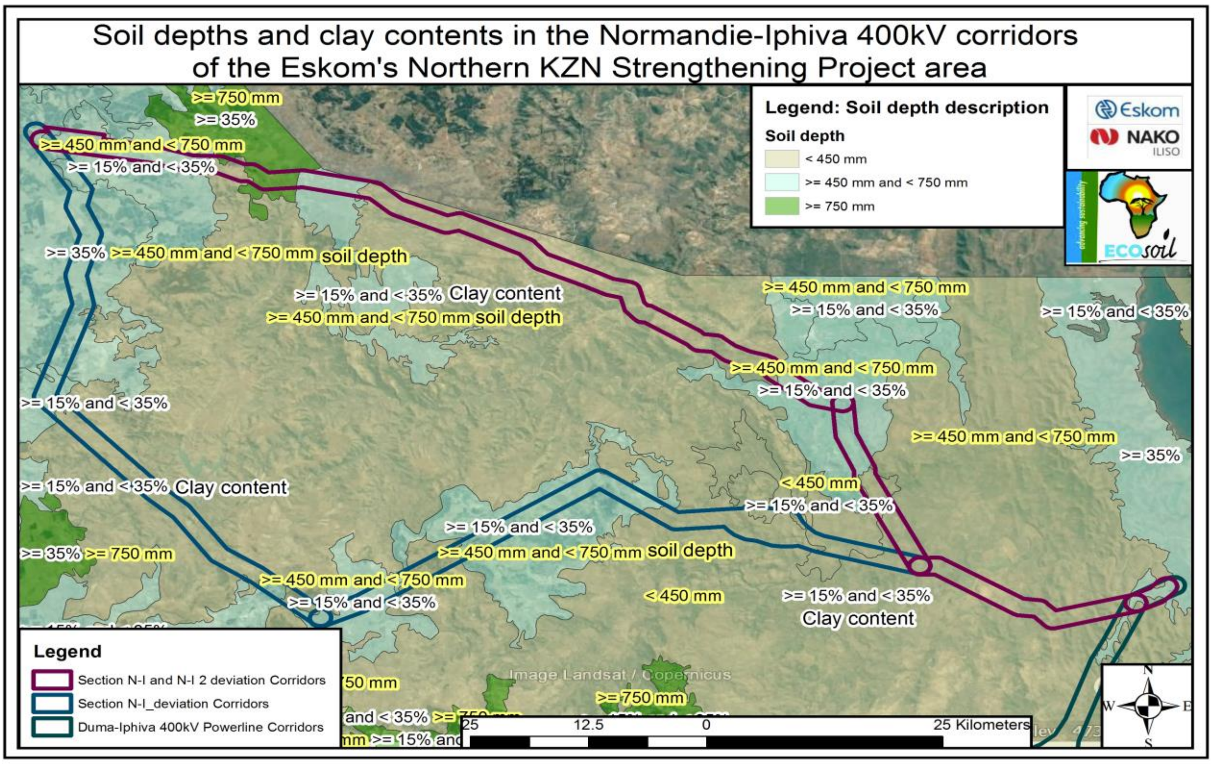


Figure 19. Soil depths and clay contents in the Normandie-Iphiva 400kV corridors

In the eastern parts of the Iphiva-Duma 400kV Corridor (Figure 22) the soil depth in is mostly between 450 to 750 mm, but in the western parts the soils are generally shallower than 450 mm. A very small area between the two deviations in the western part of the corridor has soils deeper than 750mm (but clay contents are high).

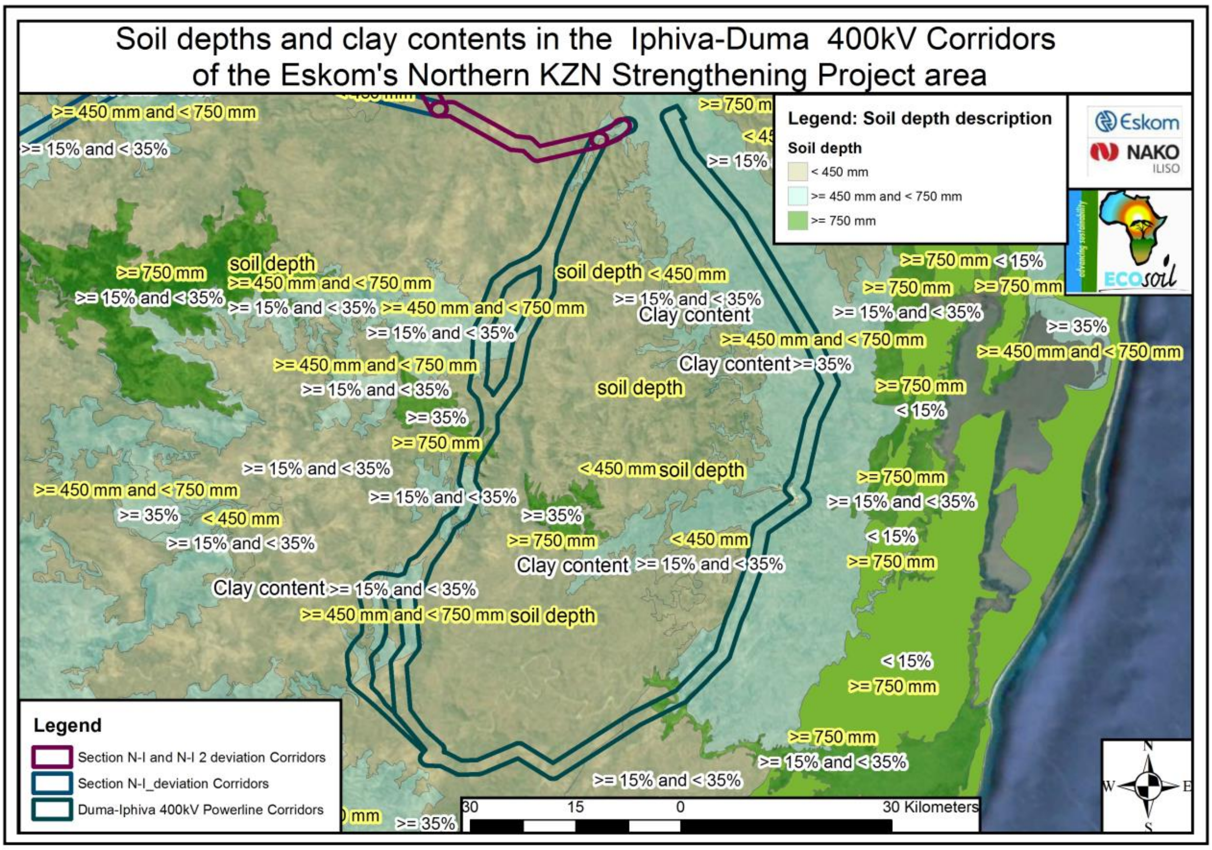


Figure 20. Soil depths and clay contents in the Iphiva-Duma 400kV corridors

7.2.3 Soil depth at the132kV Distribution lines

According to the Land type information the soils of the Iphiva-Pongola 132kV powerline corridor are less than 450 mm deep (Figure 20). The soils within the Iphiva-Pongola-Iphiva-Hluhluwe Double Circuit, the Iphiva-Mbazwane and Iphiva-Makhathini Double Circuit and the alternative route for Iphiva-Mbazwane and Iphiva-Makhithini Double Circuit Line and the loop to Candover switching station have soil depths between 450 and 750 mm.

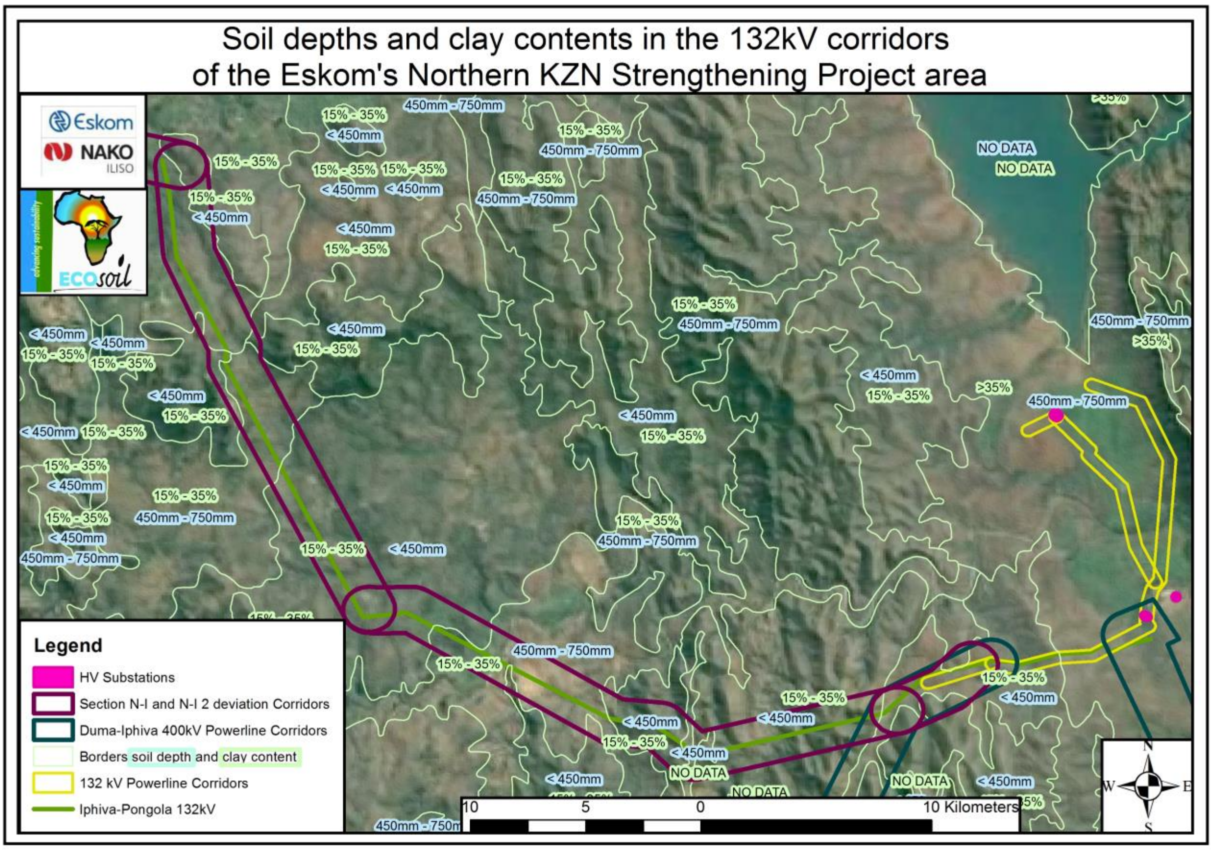


Figure 21. Soil depths and clay contents in the 132kV corridors

7.3 CLAY CONTENT

7.3.1 Clay content of the Iphiva 3 and 6 Substations

The soils in the Iphiva 3 and 6 Substation sites have clay contents varying between 15% and 35% (Figure 12).

7.3.2 Clay content at 400kV Powerlines

Clay content of the top soil (A-Horizon) in the Normandie Iphiva 400kV Corridors is generally between 15 and 35% (Figure 18). Small parts in the north of the Normandie-Iphiva N2 corridor have clay contents higher than 35%. The soils in the eastern parts of the Iphiva-Duma 400kV Corridors (Figure 19 have clay contents higher than 35% in the top soil (A-Horizon), but in the western parts of the corridors the clay content varies mostly between 15 and 35% clay. A very small area between the two deviations in the western part of the corridor the clay content is higher than 35%.

Soils with high clay contents (>35%) have problems with infiltration, crust formation and aeration. Water erosion may therefore become a problem on soils with such high clay contents. Soils should be kept covered with vegetation to prevent erosion.

7.3.3 Clay content of the 132kV Distribution powerlines

According to the Land-type information the soils of the Iphiva-Pongola 132kV powerline corridor have clay contents between 15 and 35% (Figure 20). The corridors of the Iphiva-Pongola-Iphiva-Hluhluwe Double Circuit, the Iphiva-Mbazwane and Iphiva-Makhathini Double Circuit and the alternative route for Iphiva-Mbazwane and Iphiva-Makhithini Double Circuit Line and the loop to Candover switching station have soils with clay contents higher than 35%.

7.4 LIMITATIONS OF BROAD SOIL CLASSES

The limitations of the broad soil classes have also been investigated from available land-type sources. The limitations of the soil can give an indication of the soil properties that may have an impact on the construction of the power lines and the conditions they may find. If there are no other constraints found in one or more of the proposed powerlines, then this information may give the decision makers a good indication of what to expect from a soil perspective. It also indicates the areas where a high risk of erosion can be expected.

7.4.1 Limitations of the broad soil classes of Iphiva 3 and 6 Substation Sites

The soils in the Iphiva 3 and 6 Substation sites have excessive run-off and low natural fertility. Erosion is a problem and poses a high risk for sustainability especially when not covered with vegetation. Special measurements should be implemented during the construction phase to prevent erosion. It will be necessary to rehabilitate the sites with natural vegetation after construction to the natural status of the veld to prevent further erosion.

7.4.2 Limitations of the broad soil classes of the 400 kV Powerlines

The areas with a high erosion potential is hatched or cross-hatched in red in Figures 21 and 22 to illustrate the positions where special attention should be given not to disturb the soil unnecessarily. The soils in the west, as well as smaller patches in the southern parts of the Normandie-Iphiva 3 Corridor, have a high erosion potential (Figure 21).

A large percentage of the soils in the west of the Iphiva-Duma 400 kV Corridors have a high erosion potential (Figure 22). The soils in the east of the Iphiva-Duma 400 kV Corridors have high swell-shrink potential, plastic and sticky, restricted effective depth, signs of wetness (30.1%). These soils are also susceptible to erosion when not vegetated. In the northern deviations of the Iphiva-Duma 400 kV Corridors the soils are similar in both suggested deviations and most soils are very susceptible to erosion. In the southern deviations of the Iphiva-Duma 400 kV Corridors both the deviation have soils with restricted depths, but over grazing by local farmers has led to severe soil erosion. This phenomenon serves to illustrate the high potential for erosion when soils are not covered with vegetation. After the operational phase of the construction the disturbed soils should also be re-vegetated.

Both the Normandie-Iphiva Corridors and Iphiva-Duma 400 kV Corridors have high percentages of soils with a restricted depth associated with rockiness (31.6% and 22.5% respectively). The soil observations (Table 13) during the field trip supported the findings in Figures 21 and 22.

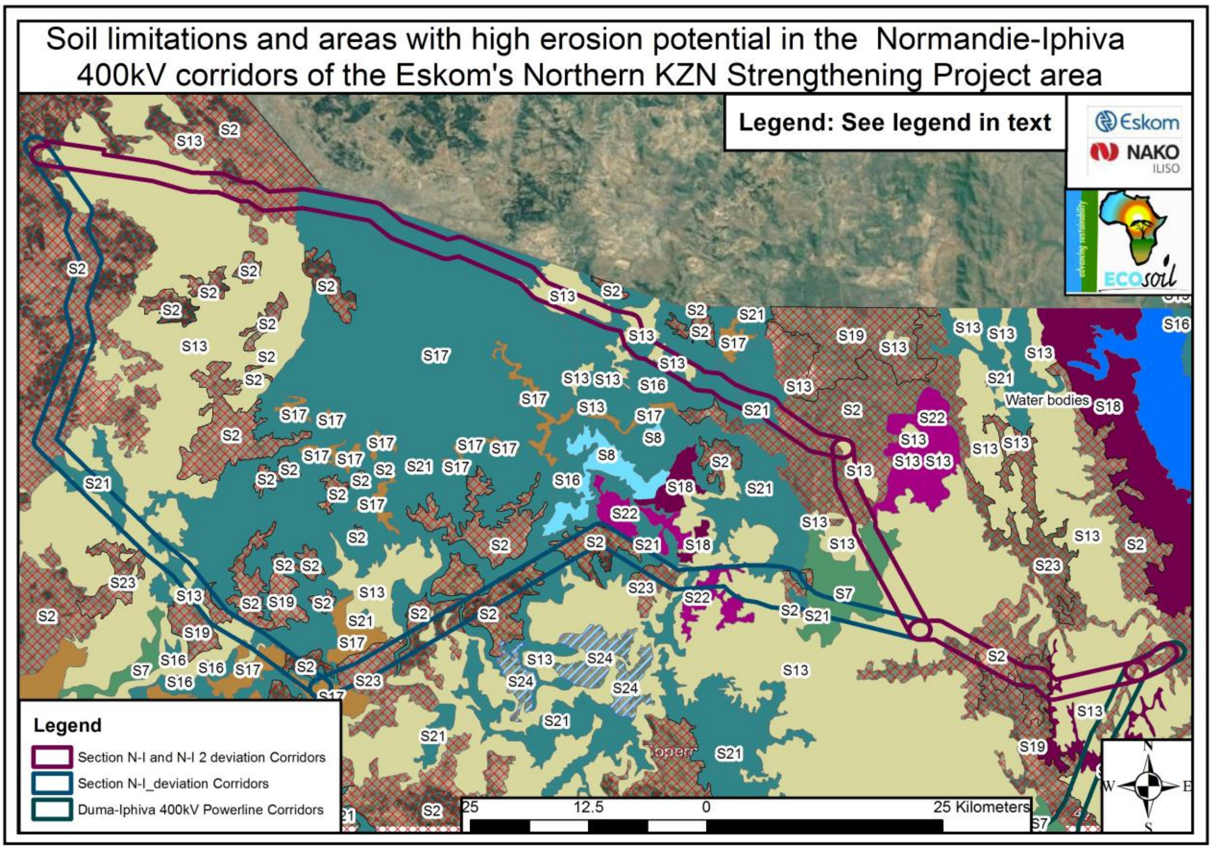


Figure 22. Soil limitations and areas with soils with erosion potential in the Normandie-Iphiva 400kV corridors

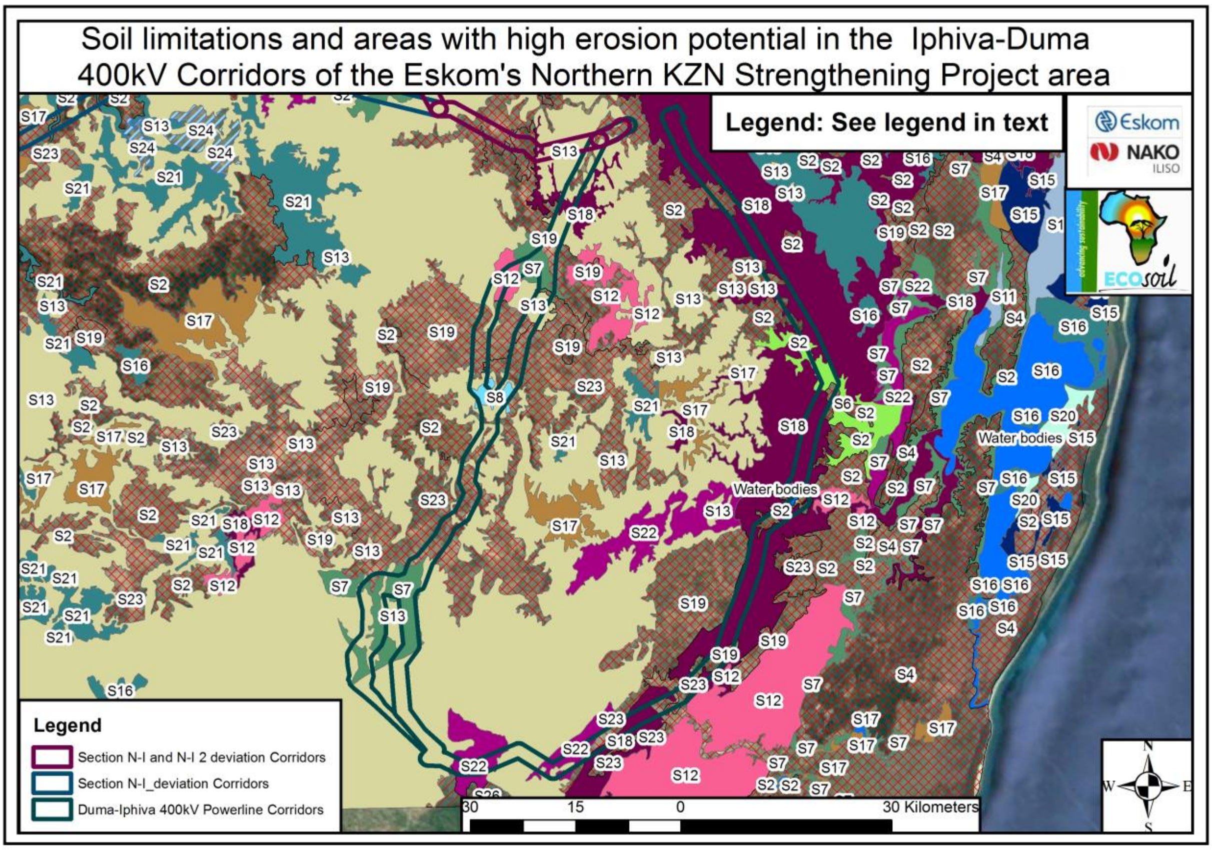


Figure 23. Soil limitations and areas with soils with erosion potential in the Iphiva-Duma 400kV corridors

Legend: Soil limitaions

- No dominance
- S2 = May have restricted soil depth, excessive drainage, high erodibility, low natural fertility
- S4 = Imperfect drainage unfavourable in high rainfall areas
- S4= May be highly erodible
- S6 = Somewhat plastic and sticky
- S7 = Restricted effective depth; may have slow water infiltration
- S8= May be seasonally wet
- S11 = Wetness; very plastic and sticky
- S12 = Restricted soil depth
- S13 = Restricted soil depth; associated with rockiness
- S15 = Excessive wetness
- S16/21 = Restricted land use options
- S17 = One or more of: low base status, restricted soil depth, excessive or imperfect drainage, high erodibility
- S18 = One or more of: high swell-shrink potential, plastic and sticky, restricted effective depth, wetness
- S19 = One or more of: restricted effective depth; slow water infiltration; seasonal wetness; high erodibility
- S20 = Seasonal or excessive wetness
- S23 = Restricted depth, imperfect drainage, high erodibility; slow water infiltration; seasonal wetness
- S22 = Restricted depth, imperfect drainage, wetness, high swell-shrink potential, plastic, sticky.
- S24 = Low base status, restricted depth, imperfect to poor drainage, excessive wetness, high erodibility
- S26 = Low base status, restricted soil depth, excessive or imperfect drainage, high erodibility, restricted land use options
- Water bodies

Figure 24. Legend for Figures 21 and 22

7.4.3 Limitations of the broad soil classes of the 132kV Distribution lines

The areas hatched red in the Figure 24 has a high erosion potential and therefore special care should be given not to enhance erosion (recommendations in point 8) during the construction phase. Large parts of the Iphiva-Pongola 132kV powerline corridor lies in soil limitation unit S2 indicated in Figure 24 and may have one or more of the following properties:

- Restricted soil depth
- Excessive drainage
- High erodibility
- Low natural fertility

The corridors of the Iphiva-Pongola-Iphica-Hluhluwe Double Circuit, the Iphiva-Mbazwane and Iphiva-Makhathini Double Circuit and the alternative route for Iphiva-Mbazwane and Iphiva-Makhithini Double Circuit Line and the loop to Candover switching station have soils in soil limitation unit S18 indicated in Figure 24 and may have one or more of the following properties:

- High swell-shrink potential
- Plastic and sticky
- Restricted effective depth
- Wetness

All other parts not yet described in the Iphiva-Pongola 132kV powerline corridor lies in soil limitation units S7 and S13, which are soils with restricted soil depth, with either associated slow water infiltration or rockiness.

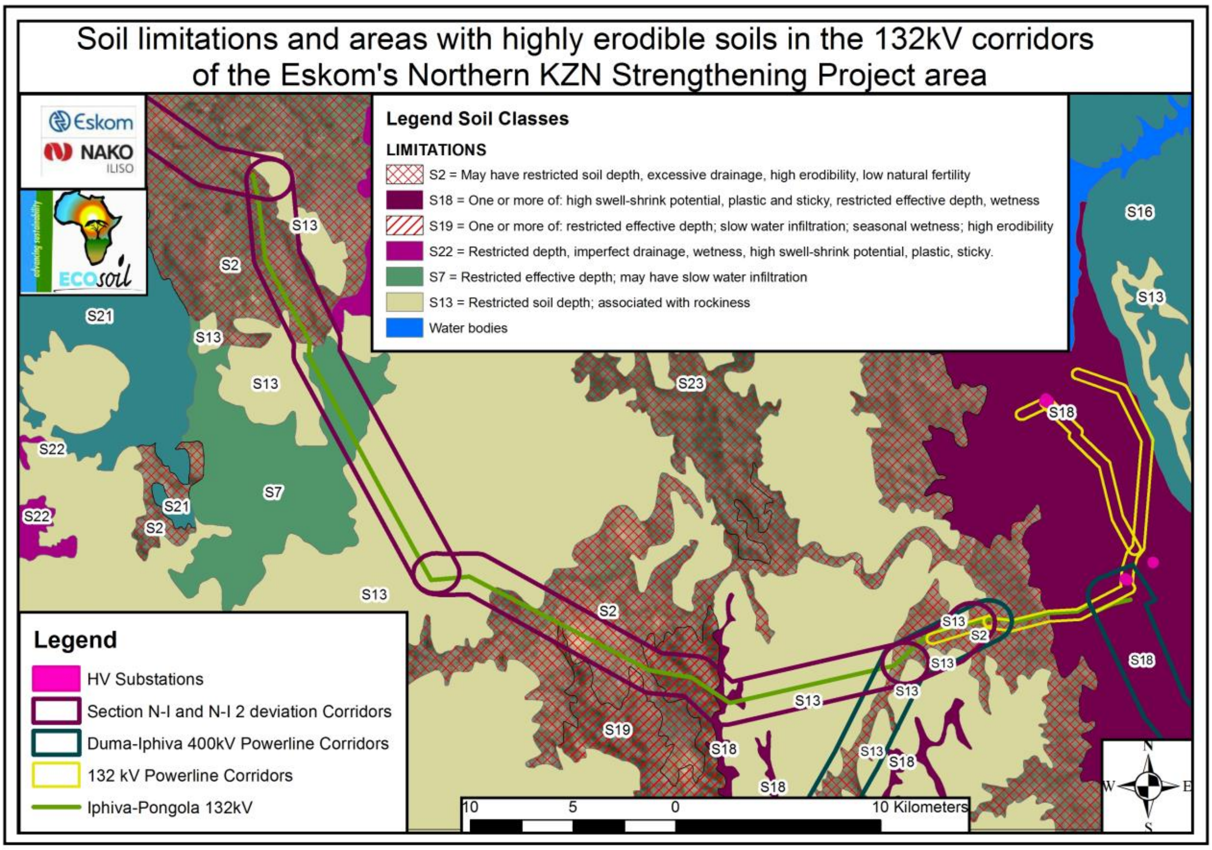


Figure 25. Soil limitations and areas with soils with erosion potential in the 132kV corridors

7.5 SPECIFIC OBSERVATIONS

Since it was not possible to do a soil survey in the corridors of entire study area, the study was made by using the Land-type information, but verification of land in sensitive areas was verified with a field survey. During this field survey it was found that the Land-type information is correct and useful for this study. However, some specific remarks are given in this section.

7.5.1 Specific observations in the corridors of the 132kv powerlines:

- No access was allowed to the Zimange Private Game Reserve. The soil forms of the present loop temporary powerline to Candover switching station are extrapolated from land-type information and from adjacent areas that was accessible.

- Access was allowed on the sugarcane farm to investigate soils on the 132kV powerline option from Iphiva to Mbaswane/Makhathini double circuit line, which is the preferred route for Mr Senekal.
- Alternative option along the railway line to small sub-station was also investigated.
    - Sugarcane yields on fields along both potential routes range from 100-120 t/ha for overhead dragline irrigation and 120-140 t/ha for centre pivot and drip irrigation.
    - There are some small sections where shallower soils occur but the soils on both potential lines can be viewed as high potential arable land suitable for irrigation.
- Soil observations were made in the servitude area between the Manyoni Private Game Reserve on the south and Zimange Private Game Reserve on the north of the P236 road
    - The soils are generally very shallow (20-40 cm deep) with surface rocks and rocky outcrops dominating the landscape. Soils are highly vulnerable to erosion and should be managed in ways to prevent erosion. This area is classified as soils with low potential for arable agriculture, but rather suitable for grazing and wilderness.

8. LAND CAPABILITY

8.1 LAND CAPABILITY OF THE IPHIVA 3 AND 6 SUBSTATIONS

At the Iphiva 3 and 6 Substations the soils are not suitable for arable agriculture, but rather suitable for grazing (Figure 12) from an agricultural viewpoint. When not covered with vegetation the soils have a high risk for erosion.

8.2 LAND CAPABILITY OF THE NORMANDIE-IPHIVA AND IPHIVA-DUMA 400 KV POWERLINES

The soils of both the Normandie-Iphiva and Iphiva-Duma Corridors are mainly of low to marginally low suitability for arable agriculture (Figure 25 and 26 respectively). No soils with highly suitable potential for arable agriculture were identified. External factors like climate, topography, crop type, erosion factors and water quality for irrigation should however be considered to determine the actual agricultural potential and therefore some of the individual farmers may consider their soils to be of high potential value for themselves.

According to this study the percentage of soils not suitable for arable agriculture, but suitable for grazing covers the highest percentage of the Normandie-Iphiva (Figure 25, 58.9%) and for the Iphiva-Duma 400kV Corridors (Figure 26, 47.7%). In the east of the Iphiva-Duma 400kV Corridors soils have an intermediate suitability for arable agriculture in areas where climate permits. None of the soils in the Normandie-Iphiva- or the Iphiva-Duma 400kV Corridors have soils with high potential for arable crops.

The soils in both southern and northern deviations in the Iphiva-Duma 400kV Corridors are very similar and from a soils' viewpoint there is no definite choice between western or eastern deviations.

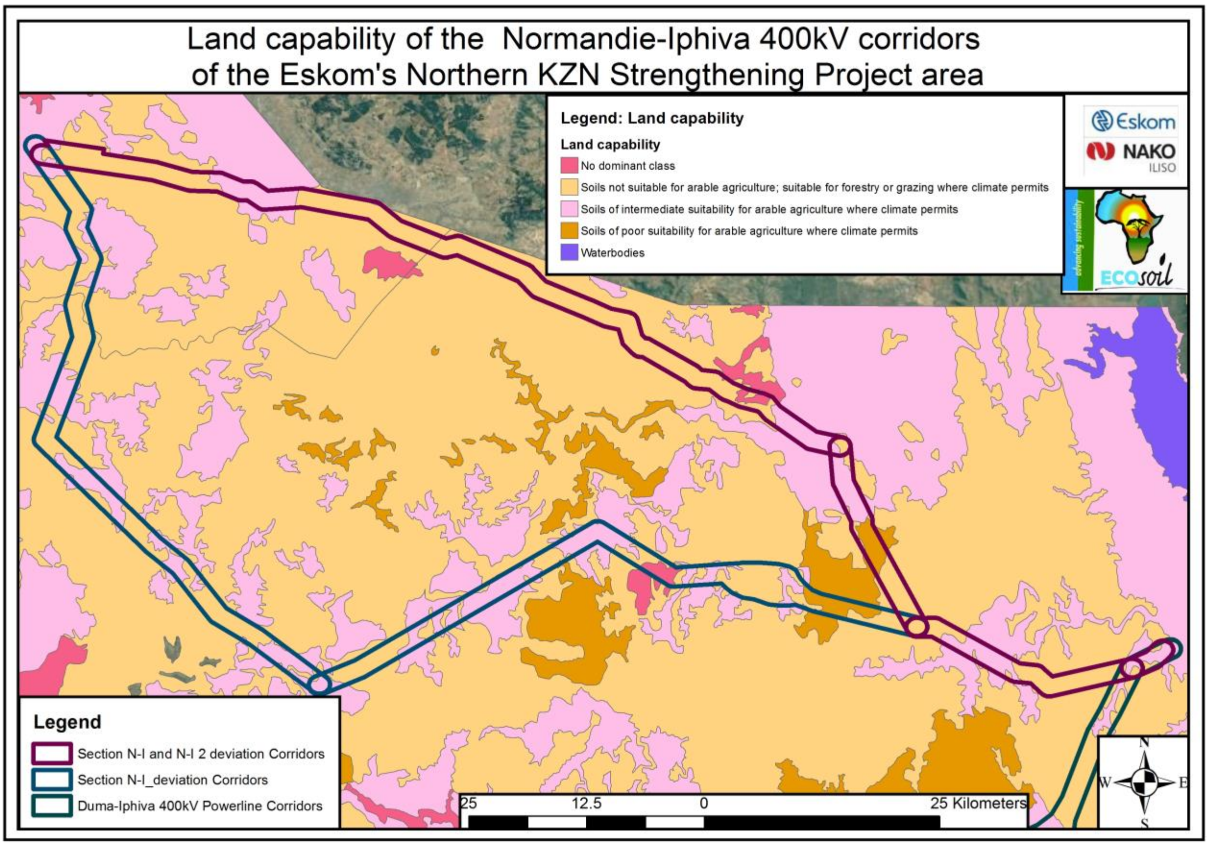


Figure 26. Land capability for arable agricultural production purposes in the Normandie-Iphiva 400kV corridors

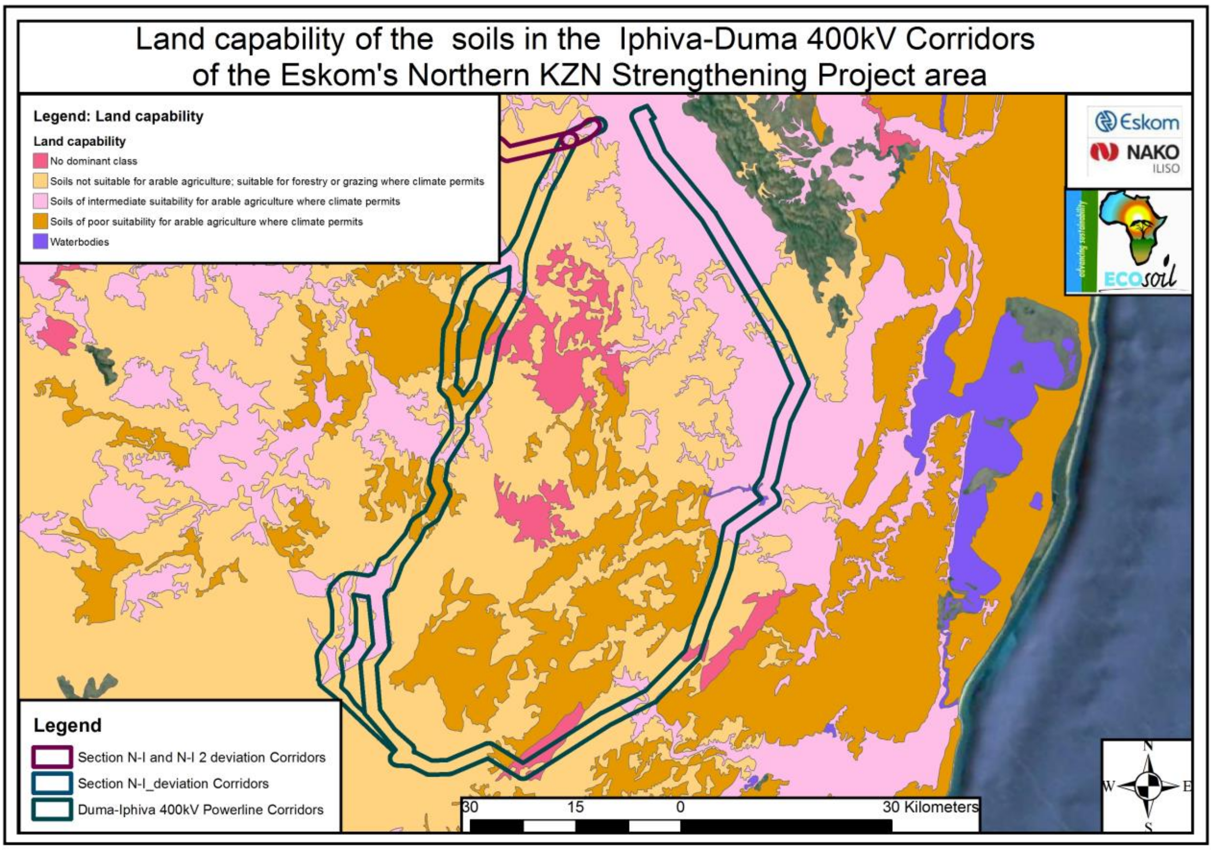


Figure 27. Land capability for arable agricultural production purposes in the Iphiva-Duma 400kV corridors

8.3 LAND CAPABILITY OF THE 132 KV DISTRIBUTION POWERLINES

The corridors of the Iphiva-Pongola-Iphiva-Hluhluwe Double Circuit, the Iphiva-Mbazwane and Iphiva-Makhathini Double Circuit and the alternative route for Iphiva-Mbazwane and Iphiva-Makhithini Double Circuit Line and the loop to Candover switching station, have a land capability with soils of intermediate suitability for arable agriculture (Figure 27). The majority of soils in the Iphiva-Pongola 132kV corridor are either:

- Soils not suitable for arable agriculture, but suitable for forestry or grazing (largest part)
- Soils of intermediate suitability for arable agriculture in the north and eastern parts of the corridor and
- Soils of poor suitability for arable agriculture in the north western parts of the corridor

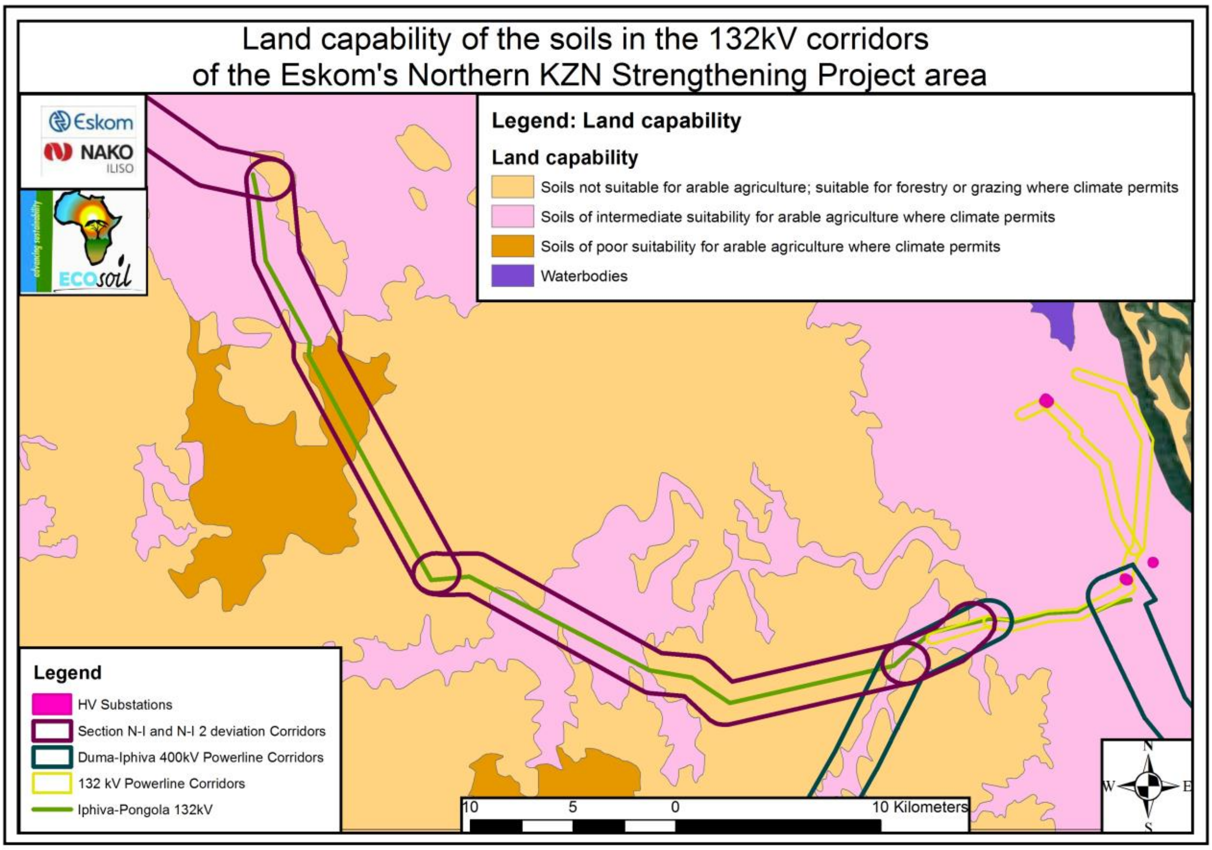


Figure 28. Land capability for arable agricultural production purposes in the 132kV corridors

9. IMPACT ASSESSMENT

Tables 9 to 22 shows the impact assessment and mitigation measures of the construction and operational phases of the substation sit, 400kV Powerlines and the 132distribution lines

Table 15: Planning and Construction Phase of Iphiva Substation

Impact Description: Disturbance of topsoil in construction phase. Footprint of substation			**Mitigation**						
			Avoid: Construction of unnecessary roads and generation of dust						
			Minimise: Excessive removal of vegetation						
			Restore/Rehabilitation: Revegetate disturbed areas with natural vegetation. Install surface water drainage structures to minimise erosion						
			Compensate/Offset:						
	Nature	Extent	Duration	Intensity	Potential for irreplaceable loss	Probability	Confidence	Consequence	Significance
Iphiva 3 with Iphiva-Duma West									
Without Mitigation	1	1	1	2	3	5	3	7	35
With Mitigation	1	1	1	2	3	5	3	7	35
Iphiva 6 with Iphiva-Duma West									
Without Mitigation	1	1	1	2	3	5	3	7	35
With Mitigation	1	1	1	2	3	5	3	7	35

Table 16: Operational Phase of Iphiva substation

<table>
<tr><td colspan="3" rowspan="5">Impact Description: Disturbance of topsoil in operational phase.</td><td colspan="7">Mitigation</td></tr>
<tr><td colspan="7">Avoid:</td></tr>
<tr><td colspan="7">Minimise:</td></tr>
<tr><td colspan="7">Restore/Rehabilitation: Revegetate disturbed areas with natural vegetation. Install surface water drainage structures to minimise erosion</td></tr>
<tr><td colspan="7">Compensate/Offset:</td></tr>
<tr><td></td><td>Nature</td><td>Extent</td><td>Duration</td><td>Intensity</td><td>Potential for irreplaceable loss</td><td>Probability</td><td>Confidence</td><td>Consequence</td><td>Significance</td></tr>
<tr><td colspan="10">Iphiva 3</td></tr>
<tr><td>Without Mitigation</td><td>1</td><td>1</td><td>1</td><td>2</td><td>3</td><td>5</td><td>3</td><td>7</td><td>35</td></tr>
<tr><td>With Mitigation</td><td>1</td><td>1</td><td>1</td><td>2</td><td>3</td><td>5</td><td>3</td><td>7</td><td>35</td></tr>
<tr><td colspan="10">Iphiva 6</td></tr>
<tr><td>Without Mitigation</td><td>1</td><td>1</td><td>1</td><td>2</td><td>3</td><td>5</td><td>3</td><td>7</td><td>35</td></tr>
<tr><td>With Mitigation</td><td>1</td><td>1</td><td>1</td><td>2</td><td>3</td><td>5</td><td>3</td><td>7</td><td>35</td></tr>
</table>

Table 17: Planning and Construction Phase Normandie-Iphiva 400kV Powerline

Impact Description: Disturbance of topsoil with construction of roads and footprint of towers			**Mitigation**						
			Avoid:						
			Minimise: Generation of dust						
			Restore/Rehabilitation: Revegetate disturbed areas with natural vegetation. Install surface water drainage structures to minimise erosion						
			Compensate/Offset:						
	Nature	Extent	Duration	Intensity	Potential for irreplaceable loss	Probability	Confidence	Consequence	Significance
Normandie-Iphiva 2 (ABFGD)									
Without Mitigation	1	1	1	2	3	4	3	7	28
With Mitigation	1	1	1	2	3	3	3	7	21
Normandie-Iphiva 3 (AEFGD)									
Without Mitigation	1	1	1	2	3	4	3	7	28
With Mitigation	1	1	1	2	3	3	3	7	21

Table 18: Operational Phase Normandie-Iphiva 400kV Powerline

Impact Description: Disturbance of topsoil with construction of roads and footprint of towers			**Mitigation**						
			Avoid:						
			Minimise:						
			Restore/Rehabilitation: Revegetate disturbed areas with natural vegetation. Install surface water drainage structures to minimise erosion. Maintain roads						
			Compensate/Offset:						
	Nature	Extent	Duration	Intensity	Potential for irreplaceable loss	Probability	Confidence	Consequence	Significance
Normandie-Iphiva 2 (ABFGD)									
Without Mitigation	1	1	1	1	1	2	3	4	8
With Mitigation	1	1	1	1	1	2	3	4	8
Normandie-Iphiva 3 (AEFGD)									
Without Mitigation	1	1	1	1	1	2	3	4	8
With Mitigation	1	1	1	1	1	2	3	4	8

Table 19: Planning and Construction Phase Iphiva-Duma 400kV Powerline

Impact Description: Disturbance of topsoil with construction of roads and footprint of towers			**Mitigation**						
			Avoid:						
			Minimise: Generation of dust						
			Restore/Rehabilitation: Revegetate disturbed areas with natural vegetation. Install surface water drainage structures to minimise erosion						
			Compensate/Offset:						
	Nature	Extent	Duration	Intensity	Potential for irreplaceable loss	Probability	Confidence	Consequence	Significance
Iphiva-Duma West 1(ABFGD)									
Without Mitigation	1	1	1	2	3	4	3	7	28
With Mitigation	1	1	1	2	3	3	3	7	21
Iphiva-Duma West 2(ABFGD)									
Without Mitigation	1	1	1	2	3	4	3	7	28
With Mitigation	1	1	1	2	3	3	3	7	21
Iphiva-Duma Deviation (Izemvelo Game Park)									
Without Mitigation	1	1	1	2	3	4	3	7	28
With Mitigation	1	1	1	2	3	3	3	7	21
Iphiva –Duma (No deviation)									
Without Mitigation	1	1	1	2	3	4	3	7	28
With Mitigation	1	1	1	2	3	3	3	7	21
Iphiva-Duma East (AEFGD)									
Without Mitigation	1	1	1	2	3	4	3	7	28
With Mitigation	1	1	1	2	3	3	3	7	21

Table 20: Operational Phase Iphiva-Duma 400kV Powerline

Impact Description: Disturbance of topsoil with construction of roads and footprint of towers			**Mitigation**						
			Avoid:						
			Minimise: Dust generation						
			Restore/Rehabilitation: Revegetate disturbed areas with natural vegetation. Install surface water drainage structures to minimise erosion						
			Compensate/Offset:						
	Nature	Extent	Duration	Intensity	Potential for irreplaceable loss	Probability	Confidence	Consequence	Significance
Iphiva-Duma West 1(ABFGD)									
Without Mitigation	1	1	1	1	1	2	3	4	8
With Mitigation	1	1	1	1	1	2	3	4	8
Iphiva-Duma West 2(ABFGD)									
Without Mitigation	1	1	1	1	1	2	3	4	8
With Mitigation	1	1	1	1	1	2	3	4	8
Iphiva-Duma Deviation (Izemvelo Game Park)									
Without Mitigation	1	1	1	1	1	2	3	4	8
With Mitigation	1	1	1	1	1	2	3	4	8
Iphiva –Duma (No deviation)									
Without Mitigation	1	1	1	1	1	2	3	4	8
With Mitigation	1	1	1	1	1	2	3	4	8
Iphiva-Duma East (AEFGD)									
Without Mitigation	1	1	1	1	1	2	3	4	8
With Mitigation	1	1	1	1	1	2	3	4	8

Table 21: Planning and Construction Phase 132kV Powerlines

Impact Description: Disturbance of topsoil with construction of roads and footprint of towers			**Mitigation**						
			Avoid:						
			Minimise: Dust generation						
			Restore/Rehabilitation: Revegetate disturbed areas with natural vegetation. Install surface water drainage structures to minimise erosion						
			Compensate/Offset:						
	Nature	Extent	Duration	Intensity	Potential for irreplaceable loss	Probability	Confidence	Consequence	Significance
1. Iphiva-Pongola 132 kV powerline									
Without Mitigation	1	1	1	2	3	4	3	7	28
With Mitigation	1	1	1	2	3	3	3	7	21
2. Iphiva-Pongola 132 kV powerline to tie into existing line, double circuit with Iphiva-Hluhluwe 132 kV powerline									
Without Mitigation	1	1	1	2	3	4	3	7	28
With Mitigation	1	1	1	2	3	3	3	7	21
3. Iphiva-Makhathini 132 kV powerline double circuit with Iphiva-Mbazwane 132 kV powerline									
Without Mitigation	1	1	1	2	3	4	3	7	28
With Mitigation	1	1	1	2	3	3	3	7	21
4. Iphiva-Makhathini 132 kV powerline double circuit with Iphiva-Mbazwane 132 kV powerline Alternative									
Without Mitigation	1	1	1	2	3	4	3	7	28
With Mitigation	1	1	1	2	3	3	3	7	21
5. Temporary loop from Existing 132 kV powerline to the Candover Switching Station									
Without Mitigation	1	1	1	2	3	4	3	7	28
With Mitigation	1	1	1	2	3	3	3	7	21

Table 22: Operational Phase 132kV Powerlines

Impact Description: Disturbance of topsoil with construction of roads and footprint of towers			Mitigation						
			Avoid:						
			Minimise: Dust generation						
			Restore/Rehabilitation: Revegetate disturbed areas with natural vegetation. Install surface water drainage structures to minimise erosion						
			Compensate/Offset:						
	Nature	Extent	Duration	Intensity	Potential for irreplaceable loss	Probability	Confidence	Consequence	Significance
1. Iphiva-Pongola 132 kV powerline									
Without Mitigation	1	1	1	1	1	2	3	4	8
With Mitigation	1	1	1	1	1	2	3	4	8
2. Iphiva-Pongola 132 kV powerline to tie into existing line, double circuit with Iphiva-Hluhluwe 132 kV powerline									
Without Mitigation	1	1	1	1	1	2	3	4	8
With Mitigation	1	1	1	1	1	2	3	4	8
3. Iphiva-Makhathini 132 kV powerline double circuit with Iphiva-Mbazwane 132 kV powerline									
Without Mitigation	1	1	1	1	1	2	3	4	8
With Mitigation	1	1	1	1	1	2	3	4	8
4. Iphiva-Makhathini 132 kV powerline double circuit with Iphiva-Mbazwane 132 kV powerline Alternative									
Without Mitigation	1	1	1	1	1	2	3	4	8
With Mitigation	1	1	1	1	1	2	3	4	8
5. Temporary loop from Existing 132 kV powerline to the Candover Switching Station									
Without Mitigation	1	1	1	1	1	2	3	4	8
With Mitigation	1	1	1	1	1	2	3	4	8

10. RECOMMENDED MITIGATION MEASURES

- The powerlines should be constructed on farm boundaries as far as possible, but specifically applicable in areas where land is used for forestry purposes. Since farmers are forced by law to establish firebreaks on farm boundaries the existing firebreaks can be extended to prevent fire to or sometimes even originating from the powerlines. For forestry purposes a firebreak of at least 50m is compulsory.
- Positions with centre pivot activities should be avoided as far as possible.
- Erosion control should be maintained during the entire construction phase as pointed out in 8.1 to 8.3. After the construction phase the land should be vegetated like the status it was before construction.
- From a soils' viewpoint the powerlines should be established on the crest positions of the landscape, since soils are shallower in these positions and will have less impact on the environment.
- Where powerlines run over sugarcane fields, alternatives harvesting methods may need to be implemented by the farmers as burning of sugarcane under the powerlines is not always permitted.

10.1 EROSION AND DUST CONTROL

It is recommended to restrict the number of roads, and limit the number of passes on the roads in the construction areas. If necessary, measurements should be taken to do control dust, especially on unpaved roads in the areas with low clay contents next to cultivated fields. The leaves of citrus, mangos and other valuable tree crops are highly susceptible to dust on their leaves, which may cause crop losses. However it is impossible to give exact areas where these crops are presently grown in the targeted Eskom's project area. Surface areas should not be left bare for extended periods of time, but should always be vegetated or covered with suitable coverage to prevent dust formation.

10.2 SOIL STRIPPING IN CONSTRUCTION PHASE

The soil depths range from 300 -700 mm, but are generally shallower than 700 mm. If soil stripping is necessary, it is recommended to strip only 400-600 mm of the soil. These estimates take into consideration a possible 10% topsoil loss through compaction and allow the rehabilitated areas to be returned to the pre-construction land capability. The stripped soils should be stockpiled upslope of areas of disturbance to prevent contamination of stockpiled soils by dirty runoff or seepage. All stockpiles should also be protected to prevent erosion of stockpiled material and deflect water runoff. The duration of the stockpiles phase should be limited to a minimum period of time.

10.3 ROADS INFRASTRUCTURE

Traffic on unpaved roads should be limited, especially regarding heavy vehicles, but especially in erosion sensitive areas indicated in Figures 21 to 23 and in the substation sites. Periods of rain, especially heavy rain, may cause erosion on roads in areas susceptible to erosion. Where erosion trenches are caused due to Eskom's activities on unpaved roads the trenches should be rehabilitated.

10.4 REVEGETATION

All land disturbed by Eskom should be vegetated and left in the condition it was before the construction of the lines and none of the disturbed areas should be left uncovered to prevent erosion.

11. CONSULTATION PROCESS

Mr F Botha visited Mr C Senekal on the 2nd November 2017.
A meeting between some members of the Moolman Farming association and Mr F Botha was held on 28th November 2017 at the Normandie Station. Mr Klopper (chairman), Keeve (TWK), De Waal (Lodewykslust) and Du Toit were present. Mr De Waal highlighted some areas of concern on the farm Lodewykslust.

12. COMMENTS RECEIVED

A meeting was held on 28th November at Normandie Station with members of the Moolman Farming association. Mr Klopper (chairman), Keeve (TWK), De Waal (Lodewykslust) and Du Toit were present. The farm boundaries were demarcated. Mr De Waal defined points of concern on the farm Lodewykslust.

Mr de Waal is the owner of the farm Lodewyksrust. The present powerline is running in front of his house, which has a visual impact. In addition Mr de Waal recently planted and intends to plant high value crops, namely essential oils, along the present proposed lines. During the soil survey of that area it was established that the soils of the farm has potential for irrigation purposes. The information is also confirmed by the land-type survey. It is therefore proposed to make a deviation from the Iphiva 2 Powerline to accommodate the concerns of this farmer. The suggested deviation is illustrated in Figure 28.

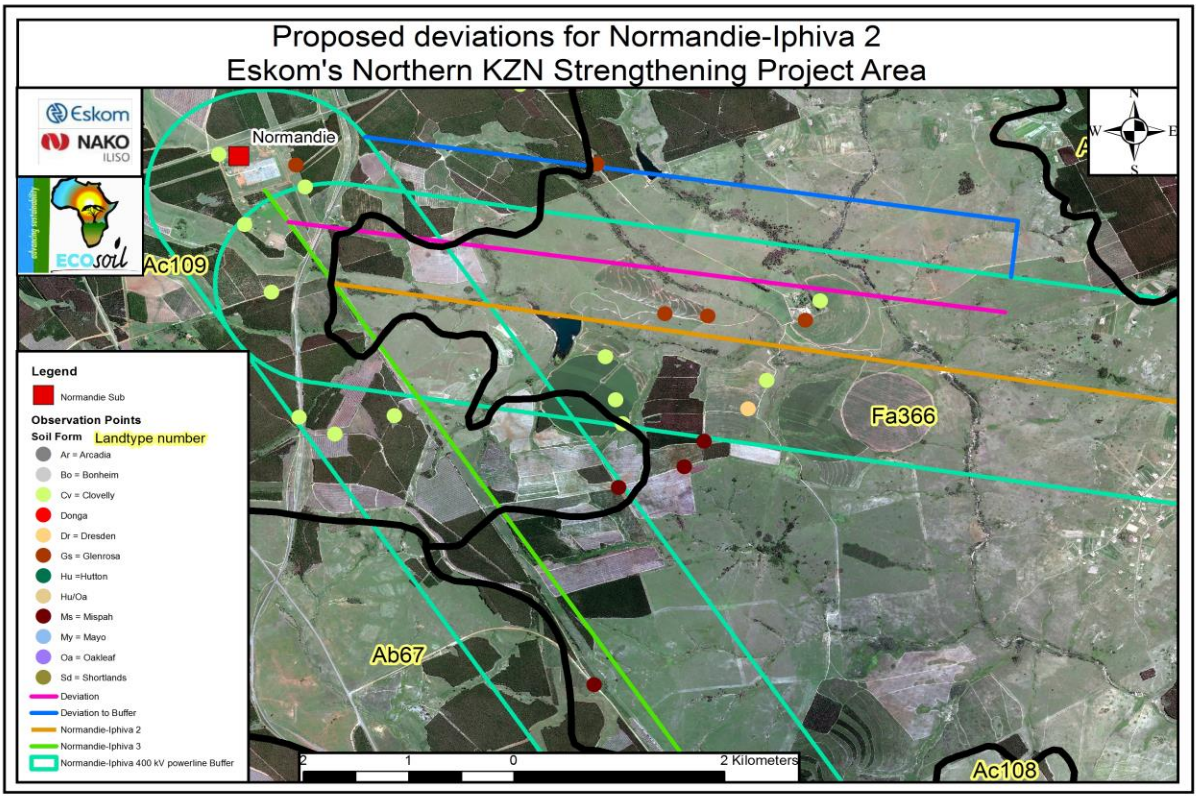


Figure 29. Soil forms and broad soil classes identified in the Normandie-Iphiva 2 deviation at Lodewykslust

Table 23: Broad soil patterns in the Normandie-Iphiva 2 deviation at Lodewykslust

A: Red and/or yellow, freely-drained soils (Ia, Kp, Ma, Hu, Gf, Cv) dominant (>40%)	
Ab	**Red** (yellow soils <10%); **dystrophic/mesotrophic** > eutrophic
Ac	**Yellow/red** (yellow & red soils each >10%); **dystrophic/mesotrophic** > eutrophic
F: Mainly Glenrosa and/or Mispah forms (other soils may occur as long as land type does not qualify elsewhere)	
Fa	**Shallow**, and/or rocky, often steep, highly leached (very **little lime**)

13. OTHER INFORMATION REQUESTED BY THE AUTHORITY

None

14. CONCLUSION AND ROUTE RECOMMENDATIONS

According to this agricultural and soil potential study there are no objections against the Eskom's Northern KZN Strengthening Project and it is recommended to go ahead, as long as the recommendations regarding the suggested deviations and measurements to limit erosion are implemented.

14.1 IPHIVA 3 AND 6 SUBSTATIONS

- The Iphiva 6 option is preferred since the site is already disturbed; it has low agricultural potential and is classified as an area with Grazing/Wilderness potential.
- The site is however seriously eroded and erosion control measures will have to be implemented. This site should not be left uncovered from vegetation for long periods.
- The topography of this site is more suitable for construction purposes than the Iphiva Substation site 3.

14.2 NORMANDIE-IPHIVA 400 kV POWERLINE

- The Normandie-Iphiva 400kV corridor 2 is the preferred route since it has less impact on forestry and agricultural cultivated land.
- There are less areas with a high erosion potential on this route.
- A short deviation of the corridor on the NI-2 on the farm Lodewykslust is recommended. The reason being the present corridor runs directly over the property owners house

14.3 IPHIVA-DUMA 400 kV POWERLINE

- The Iphiva-Duma West corridor is preferred since it has less impact on game farms and agricultural cultivated land.
- The areas with a high erosion potential is almost the same, but the soils in the east are clayey and difficult to manage when wet and may have a larger impact on if not handled with care.
- Topography is lower in Iphiva-Duma West 1 and will therefore have less influence on the erosion potential in areas with steep slopes. In both the Iphiva-Duma West 1 and Iphiva-Duma West 2 corridors measurements for erosion control should be implemented and therefore erosion potential should not influence the choice of line.
- There is no preference from a soil and land capability perspective on the original route or the deviation near Izemvelo Game Park.

14.4 THE 132 kV DISTRIBUTION POWERLINES

- The Iphiva- Pongola 2 (IP2) corridor is the preferred corridor for the 132kV line
- The alternative route (West routing) to the Iphiva-Mbazwane and Iphiva-Makhithini double circuit line is preferred since it runs along a road and railway servitude, is a shorter distance to the switching station and will impact less on established high potential agricultural land
- Iphiva/Hluhluwe 132 kV powerline to tie into exiting line (double circuit with Iphiva/Hluhluwe).
- There are no specific preference based on soil and land capability where the powerlines will run along the P236 road from Iphiva 6 to the Iphiva-Mbazwane and Iphiva-Makhatini double circuit line and the Iphiva/Hluhluwe double circuit line.
- The temporary loop on Zimange Game Farm to Candover switching station does not impact on any agricultural land as area is presently a game farm.

Table 24: Summary of preferences for substation and powerlines

<table>
<tr><th>Powerlines and substations</th><th>Alternatives</th><th>Preference</th><th>Reason</th></tr>
<tr><td>Substations</td><td>Iphiva 3 & 6</td><td>Iphiva 6</td><td>Soils marginal and more disturbed</td></tr>
<tr><td rowspan="2">400kV Powerlines</td><td>Normandie-Iphiva 2 & 3</td><td>Normandi Iphiva 2 (N-I2)</td><td>Less impact on forestry and cultivated areas</td></tr>
<tr><td>Iphiva-Duma East and West</td><td>West</td><td>Less impact on game farms and cultivated areas</td></tr>
<tr><td rowspan="2">Deviations</td><td>West 1 and West 2</td><td rowspan="2">No preference</td><td rowspan="2">Similar soils and land capability potential</td></tr>
<tr><td>Deviation (Izemvelo Game Reserve)</td></tr>
<tr><td rowspan="6">132kV powerlines</td><td>1.Iphiva Pongola 132 kV Powerline</td><td>No alternative</td><td>Same corridor as 400kV powerline</td></tr>
<tr><td>2. Iphiva/Makhathini 132 kV (double circuit with Iphiva/Mbazwane) Alternative route</td><td rowspan="2">Iphiva/Makhathini 132 kV (double circuit with Iphiva/Mbazwane) Alternative route</td><td rowspan="2">Existing servitude and less impact on cultivated land</td></tr>
<tr><td>3.Iphiva/Makhathini 132 kV (double circuit with Iphiva/Mbazwane)</td></tr>
<tr><td>4. Iphiva P236 road (north and south of road)</td><td>No preference</td><td>Similar soils and land capability potential</td></tr>
<tr><td>5. Iphiva/Pongola 132 kV powerline to tie into existing line (double circuit with Iphiva/Hluhluwe)</td><td>No alternative</td><td>To tie into existing line (double circuit with Iphiva/Hluhluwe)</td></tr>
<tr><td>6. The temporary loop to Candover switching station</td><td>No alternative</td><td>No agricultural activity (existing game farm)</td></tr>
</table>

15. AUTHORISATION

Authorisation is given from a soils and land capability perspective to continue with the project

16. REFERENCES

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MACVICAR, C.N., et al, 1977. Soil Classification, a Binomial System for South Africa.

Soil classification working group. 1991. Soil classification. A Taxonomic system for South Africa. Department of Agricultural Development. Pretoria.

Land Type Survey Staff. 1972 – 2006. Land types of South Africa: Digital Figure (1:250 000 scale) and soil inventory datasets. ARC-Institute for Soil, Climate and Water, Pretoria

Van der Watt H.v.H. & van Rooyen T.H. (1995) a Glossary of Soil Science, 2nd Edition. The Soil Science Society of South Africa, Pretoria.

17. APPENDIX: CURRICULUM VITAES

17.1 CURRICULUM VITAE OF F. BOTHA

PERSONAL DETAILS

- **Name:** Botha, F
- **Date of Birth:** 9 June 1959
- **ID Number:** 59 06095074087
- **Marital Status:** Married
- **Cell number:** 0849005933
- **Email address:** fbecosoil@gmail.com

FORMAL QUALIFICATIONS

- B.Sc. (Pedology) from PU for CHE, 1984
- B.Sc. (Hon) Pedology) from PU for CHE, 1988
- B. Comm. (Economics and Business Economics) from UNISA, 2001.

PROFFESIONAL AFFILIATIONS

- Soil Science Society of South Africa
- South African Soil Surveyors association
- Land Rehabilitation Association of SA (formation in process)
- SA Irrigation Institute

EMPLOYMENT HISTORY

- 1984-1988, Trans-Agric, College of Agriculture, Senior Lecturer in Soil Science.
- 1988-1991, ICI-Kynoch Agrochemicals, Training Co-coordinator
- 1991-1996, Lowveld College of Agriculture, Senior Lecturer in Soil Science.
- 1997-2004, SA Sugar Association, Senior Extension Officer, Malelane region.
- 2004-2007, Advanced Nutrients SA, Technical Director.
- 2007-Present, Private Consultancy and Director of Eco Soil.

WORK EXPERIENCE AND PROJECTS

- 8 years' experience as an extension officer, with the focus on sugarcane production under irrigation in the Malelane region.
- Initiated and Assisted SASRI research Dept. with various trials related to sugarcane production.
- Involvement in pedological and geological surveys for Forestek (35 000ha's), ARC and private individuals for forestry, game ranching, farming enterprises and new agricultural developments (150 000ha).
- Functioned as project leader on a number of large scale soil survey projects, e.g. Donkerhoek Agricultural project, Mpumalanga
- Pedological specialist studies for environmental impact assessments (EIA's) as well as a number of economic and agronomic feasibility studies for new agricultural developments.
- 13 Years lecturing experience in soil science at agricultural colleges.
- Consultation on biological and soil health principles on various agricultural projects
- At present consulting on the following Precision farming sampling and consultation in the maize sugar and industry
- Feasibility studies on new sugarcane and agricultural projects under irrigation in Southern Africa
- Environmental Impact Assessments for mining and new projects
- Rehabilitation of opencast mining soils

17.2 CURRICULUM VITAE OF A.M. HATTINGH

PERSONAL DETAILS

- **Name:** Hattingh, A. M.
- **Date of Birth:** 9 December 1956
- **ID Number:** 5612090077089
- **Marital Status:** Married
- **Cell number:** 0828536228
- **Email address:** astridhattingh@yahoo.com

FORMAL QUALIFICATIONS

- BSc Pedology, PU for CHE, 1977
- BSc (Hon) Pedology, PU for CHE, 1978
- MSc Pedology, PU for CHE, 1983

MEMBERSHIP

- Soil Science Society of South Africa.
- International Soil Science Society.

EMPLOYMENT HISTORY

- 1979 –1993 Dept. of Agriculture (Highveld Region) as Researcher.
- 1993-1996 Assistant Director Soil Science.
- 1997-1998 Part time lecturer at PU for CHE in clay mineralogy, soil physics, irrigation, drainage, soil chemistry.
- 1997 Part time at REHAB. Soil consultant
- 1998-2002 Own business: Handrid Flora: Seedlings and vegetable production.
- 2002- 2003 Own Business in participation with Africa Plus Projects and Geoquip. Irrigation scheduling and soil consultant.
- 2004 Consultant Techniland. Precision farming.
- 2006 GCI- ARC. Researcher

- 2007 –2008 Africa Geo Environmental Services (AGES) GIS specialist, Soil Scientist
- 2009-2010 Part time Lecturer at Potchefstroom University and Agricultural College Potchefstroom. Private consultation.
- 2011-present. Precision Farming Own Business. EIA's for agricultural potential, Africa and mine Projects with GIS interpretation of soil and land capability studies.

WORK EXPERIENCE AND PROJECTS

- Reports and GIS work for Africa (Tanzania, Mozambique) Projects: Basanza/Lugufu, Kigoma, Kilombero, Kasulu, Mopeia, Rufiji.
- Management Plan for Vredefort World Heritage Site: GIS and agriculture
- Geotechnical reports and GIS work.
- Planning and research of various projects
- Research: Water holding capacity – Influence of clay content and mineralogy
- Determination of field capacity and wilting point.
- Water conservation practices
- Stubble mulching
- Evaluation of cultivation practices
- Recompaction rate of soils with different clay contents.
- Cone penetrometer studies.
- Water consumption of maize at different plant densities.
- Calibration of neutron water meters and gamma density meters.
- "Basin cultivation"
- Handling of research plots: plant, herbicides and pesticides, cultivation, harvesting, soil water and compaction monitoring etc.
- Nitrogen transfer
- Organic growing of vegetables
- Fertilisation of vegetables
- Water conservation and irrigation for small-scale vegetable farming.
- Soil acidity
- Fertilisation of pasture
- Phosphorus studies.
- Head of soil analysis laboratory:

  - Soil, plant, water, lime, in vitro analysis --- supervisor
  - Interpretation and approval of results
  - Fertiliser recommendations- grain, pasture and vegetables.

POSITIONS HELD AND COMMITTEE PARTICIPATION

- Assistant Director Soil Science. Dept. Of Agriculture Northwest Province (Administration, supervision of junior researchers, technicians and head of laboratory).
- WRC steering committee projects.
- 1994 Secretary of SSSSA Congress organising committee.
- Member of research steering committee Highveld Region.
- Soil interest group of Western Transvaal: Founder member and Secretary and Chairlady-several times.
- Combined Soil, Crop Science, Crop protection Congress: Organizing committee 1996 and 2012
- Organizing convenor: Precision Farming Congress for 2013 and 2016