MERCURY - PERSEUS 400 kV TRANSMISSION LINE

POTENTIAL IMPACT ON THE SOIL-LANDFORM RESOURCES

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EXECUTIVE SUMMARY

1. This report deals with a desk-top study of the soil-landform resources of the Mercury-Perseus Transmission Line Project with the objective to provide a description of these resources, interpret these features in terms of their suitability for selected land uses, identify the impact landform would have on the project, identify sensitive soils along the proposed corridors, evaluate the impacts on the soils and recommend mitigatory measures and actions to minimise negative impacts.

2. As information base, the land type maps (scale 1:250 000) and accompanying memoirs covering the survey area were used. Aspects on the soils, landform and climate were derived from the land type survey, whereas topographic and other geomorphological data were obtained from the 1:50 000 topographical maps.

3. It must be clearly stated that the land type information is for broad-scale assessment purposes only and that the positioning of pylons and construction camps, for example, will require studies at the detailed level.

4. The land type map (FIGURE 1) shows the spatial distribution of the land types, while TABLE 4.1 summarises the soil and slope components occupying each land type.
   - 4.1 In general, five broad soil-landform systems related to parent material and topography can be distinguished. These are freely drained, red and yellow-brown, fine sandy soils on level topography; fine sandy to loamy soils in plinthic catena on level topography; duplex soils with reddish subsoils on level topography; duplex and other clayey soils of mainly bottomland sites; and very shallow and rocky soils overlying calcrete and hard rock associated with steeper slopes in places.
   - 4.2 Pans are features of some of these broad systems. Because pans are regarded as unique features of the landscape, they warrant special attention in this study.

5. The process of assessment of land suitability was conducted using the soil, slope and climatic parameters for agricultural and soil and slope for non-agricultural uses.
   - 5.1 To rate land for agriculture, the land capability system was employed. The rating of land types into land capability classes as well as the most important attributes limiting the suitability are contained in TABLE 4.2. Class II (moderate - high) and class III (moderate) contain land with arable potential. Of these, areas associated with land types Bc and Bd and occurring solely north-east of Wesselsbron possess the higher potential because of soil pattern and climate with a higher rainfall efficiency. The area south-west of Wesselsbron contains land with a capability of III interspersed with land normally not suited for cropping.
   - 5.2 Suitability classes for uses such as foundations, roads and camping ground are shown in

TABLE 4.3. Because of the swell-shrink properties of subsoils of the duplex component and other associated clay soils, the suitability for foundations is poor. Furthermore the fine sandy and clayey materials have a moderate suitability as roadbed support, whereas some land types, due to a flooding hazard and extreme topsoil textures do limit their suitability as camp sites.

6. The identification of actual risk sources associated with specific components of the landscape for the construction and operation phases are accommodated in TABLE 5.1. All fine sandy soils (<15% clay) are prone to wind erosion when dry and devoid of vegetation during periods of high wind activity. Similarly, these soils are compacted easily by vehicle movement at all soil water contents but especially when wet. Clayey and duplex soils of some of the land types are susceptible to water erosion when exposed. Other risk sources, but of limited extent, are: disturbance of steep river banks can lead to water erosion; disturbance of pan floor materials can lead to wind erosion; and siting of pylons in valley bottons and wetlands of the north-eastern portion can lead to water erosion.

7. Several potential impacts associated with the soil-landform resources are foreseen and summarised in TABLE 6.1. The degree of impact is described without and with management/mitigation measures - the latter shown in TABLE 7.1.

   7.1 Due to the flatness of the landsurface, the landform has no apparent impact on the project. In reality, the few koppies in the south-western portion will more probably be of benefit by masking the visibility of pylons to a degree. This effect, however, is of very limited extent. On the other hand, the fact that the principal rivers lie square on the general strike of the proposed corridors and the presence of only a limited number of wetlands in the north-east, mean that the significance of impact of the final servitude on the landform in general will be low.

   7.2 Regarding the soil component, impacts such as wind erosion, compaction, water erosion will possibly occur during the construction phase. The contention is that the significance of all these impacts will be low-medium or medium without and low with mitigation. Soil compaction will also be evident during the operation phase (maintenance) with similar results as for the construction phase.

   7.3 Class II and to a lesser degree class III land may be, in a certain sense, considered as prime agricultural land, and should ideally be protected for cropping purposes. Any non-agricultural use such as the construction of transmission lines will therefore have a negative impact on the production potential of an area. The final servitude in the survey area is bound to cross arable land, the significance of the impact is regarded to be low-medium without and low with mitigation measures. Possible mitigation can be attained by careful selection of the servitude at the detailed level. In summary, transmission lines only affect very limited areas of the landscape.

7.4 The impact on pan environments is mainly confined to visual impact and possible disturbance of valuable sites around the margins, as well as wind erosion of pan floors. The significance of the impacts is regarded as low without and with mitigation.

8. Several other management/mitigation measures have been recommended in this report which apparently will result in a measurable reduction in impact. These include sealing of roads to prevent wind erosion, rip compacted areas, avoid unnecessary trafficking and wet soils to combat compaction, construct soil conservation measures to oppose water erosion, and avoid construction of transmission lines across or in close proximity of pans.

9. With the available information, it is not possible to ascertain the best routing. Due to the unique distribution of the soil-landform resources, no one of the proposed corridors (1 - 3) or variations thereof (a - c) have an apparent better alignment in comparison with regard to impact assessment. They also cross potential arable land (classes II and III) to the same degree. Furthermore, any viable alternative would be confronted by the same spatial distribution of natural resources.

10. Various exercises have been recommended to monitor soil erosion during the construction phase and to see whether ripping was effective after construction and operation phases. Especially the monitoring of crop yield of the areas affected during the different phases is highly recommended.

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1. Introduction

There are many reasons why soils do matter in a land evaluation or an assessment of environmental impact. Soils are major determinants of terrestrial ecosystems or biomes; they are sources, transformers and stores of plant nutrients; they are buffers and filters for pollutants; they are a key link and buffer system in the hydrological system; they determine, amongst others, the agricultural production capacity of the land; they also provide criteria to rate land for its suitability for various non-agricultural uses; and they are a good archive of past climatic conditions and past human influences. In addition, the close interrelationship between soil and landform also necessitates the study of the latter. Landform includes the slope factor and the assemblage of hillslope units.

2. Background and brief

For the purpose of conducting a land evaluation and an environmental impact assessment of the Mercury-Perseus Transmission Line Project, a desk-top study with limited field control was commissioned to examine the key issues relating to the soil-landform factor. The main objectives were to

- i investigate the available information on the soil-landform resources of the study area and provide a description of these resources
- ii interpret these features in terms of their suitability for selected land uses
- iii identify the impact landform would have on the project
- iv identify sensitive soils along the proposed new transmission line corridors and evaluate the impact on the soils and
- v make meaningful recommendations for the implementation of management and mitigatory measures.

3. Study approach

3.1 Information base

The land type maps 2824 Kimberley, 2724 Kroonstad and 2826 Winburg as well as the accompanying memoirs, especially the one dealing with 2724 Kroonstad (Land Type Survey Staff, 1984) constitute the main source of information on the soil-landform factor. Climatic parameters are also available from the above source. Topographic and geomorphological data obtainable from the 1:50 000 topo sheets form the background of the investigation.

3.2 Limitations

The land type survey represents a reconnaissance study which is concerned with the broad inventory of resources and development possibilities at regional scale. The land type boundaries and soil-landform inventories can therefore only be used for the overall assessment of arable potential and environmental impact, whereas the siting of pylons and construction camps, for example, will require studies at the detailed level.

3.3 Glossary of terms

Apedal soil: General term to denote soils with massive or weakly structured materials.

Arable potential: Land with soil, slope and climate components where the production of cultivated crops is economical and practical.

Base status: A qualitative expression of base saturation.

Duplex soil: A soil with a relatively permeable topsoil clearly to abruptly overlying a very slow permeable subsoil.

Hillslope units: The subdivision of the land (terrain) surface into crest, scarp, midslope, footslope and valley bottom, each with its own morphological properties.

Land evaluation: The process of assessment of land performance when used for specified purposes, involving the interpretation of landscape data.

Land type: It denotes an area that can be shown at 1:250 000 scale and that displays a marked degree of uniformity with respect to terrain form, soil pattern and climate.

Local relief: The difference between the highest and lowest points in a landscape. For this study, it is based on 1:50 000 scale.

Plinthic catena: A sequence of soils from the higher to the lower lying sites in the landscape which owe their different characteristics to variation in topography and drainage, e.g. from well-drained Hutton soils through moderately well-drained Avalon soils to somewhat poorly drained Longlands soils.

Soil compaction: Soil becoming dense by blows, vehicle passage or other type of loading. Wet soils compact easier than moist or dry soils.

3.4 Methodology

By means of a desk-top study, information on the soil-landform factor was extracted from the land type maps 2824 Kimberley, 2724 Kroonstad and 2826 Winburg as well as the accompanying memoir for 2724 Kroonstad. A legend containing soil and slope properties was subsequently constructed. The contents and spatial distribution of the land types were checked during a brief field visit. In order to classify land for agricultural use, data on the climatic parameters were also derived from the above memoir. Contours as shown on the 1:50 000 topo sheets were used to demarcate steep and rocky land not indicated on the land type maps.

For the land type survey, the soils were identified, described and classified in accordance with the Binomial system for South African (MacVicar et al., 1977). Subdivision of the landform into hillslope units was also according to this system. The rating of land into land capability classes (mainly for agricultural purposes) was attained by using the system described by Scotney et al. (1987) and for non-agricultural uses according to criteria supplied by Olson (1984).

4. Study area

4.1 Description of the affected environment

This part of the investigation deals with the soil-landform resources of the study area.
In general (scale 1:500 000 and smaller), five broad soil-landform systems related to parent material and topography can be distinguished. These are freely drained, red and yellow-brown, fine sandy soils on level topography; fine sandy to loamy soils in plinthic catena on level topography; duplex soils with reddish subsoils on level topography; duplex and other clayey soils of mainly bottomland sites; and very shallow and rocky soils overlying calcrete and hard rock associated with steeper slopes in places. Pans are features of some of these broad systems.

Within these systems, a variety of soil classes as well as slope classes are accommodated. The components of these classes are summarised in TABLE 1. The distribution of land types is shown in FIGURE 1.

4.1.1 Landform

At a scale of 1:250 000, the landform can be described as plains with slight relief displaying a low-medium drainage intensity and stream frequency (Kruger, 1983). Local relief varies from 20 - 50 m in the north-east to 10 - 40 m in the south-west.

The five broad soil-landform systems have their own recurring landform pattern as represented by the land types. The freely drained, red and yellow-brown, fine sandy soils (land types Ae, Ah and Ai) and the soils of the plinthic catena (land types Bc and Bd) are characterised by a sequence of hillslope units consisting of crests, midslopes, footslopes and valley bottoms with a dominant slope class of less than 3%.The duplex soils with reddish subsoils (land type Da) mainly occupy level (<3%) footslopes, whereas the other duplex soils with associated clayey soils (land types Db and Dc) cover footslopes and valley bottom sites with slopes less than 3%. The very shallow soil system (land type Fc) is comprised of crests, midslopes, footslopes and valley bottoms and displays steeper slopes in places. The latter has been subdivided into steep and rocky land for the 1:50 000 scale synopsis. In many instances, the valley bottoms as mentioned above are in the form of pans.

With the aid of 1:50 000 topographical maps the few steep and rocky areas (land type Ib - not shown on the land type maps) of the south-western portion of the survey area can be demarcated. They include, for example Basberg (local relief of 80 m) as well as Houthaalrand and Erweesrant (local relief 30 m) and are mainly comprised of crests and midslopes with slope classes of 5 - 15 and 15 - 30%. At this scale it is also possible to discern a limited number of wetland sites along drainage lines in the north-eastern area (land types Bc and Bd).

The surface drainage forms part of the Vaal river system. Three secondary river systems, viz the Vals, Sandspruit and Vet cross the area from east to west. The Valsrivier near Bothaville meanders through a wide floodplain (land type Dc6) and is for the most part deeply incised with corresponding steep river banks. The

Sandspruit north of Wesselsbron, however, has a relatively narrow floodplain (land type Db1) and is not as deeply incised. As for the Valsrivier, the Vetrivier south of Wesselsbron meanders through a wide floodplain (land type Dc4), cut-off channels are evident and the channel is also deeply incised into alluvial deposits. All these rivers seem to have stable channels. Large portions of the study area are drained internally by means of pans with no outlets.

Due to the flatness of the landscape, the landform has no apparent impact on the project. In reality, the few koppies in the south-western portion will more probably pose as benefits by masking the visibility of pylons to a degree. This effect, however, is of very limited extent. On the other hand, the fact that the principal rivers lie square on the general strike of the proposed corridors and the presence of only a limited number of wetlands in the north-east, mean that the impact of the final servitude on the landform in general will be minimal.

4.1.2 Soils

The soil component is represented by the land type data at a scale of 1:250 000. These data can also be used at a scale of 1:50 000, but not for detailed planning and design as is expected for the construction phase. The soil information of each land type is depicted in TABLE 1 and the descriptions are self-explanatory.

Regarding parent materials, the fine sandy soils owe their origin to the incursion of aeolian sands from the direction of the Kalahari during arid periods of the Quaternary, while the loamy and clayey soils of floodplains have been derived from alluvial deposits. For the formation of calcrete and red, duplex soils, the significant influence of weathered doleritic material is apparent.

As shown above, soils determine, amongst others, the agricultural production potential of land (see 5). Attributes which can result in soil degradation are the vulnerability of the fine sandy soils to wind erosion, their tendency to compact when used as load by heavy machinery and their poor support for roadbeds. Similarly, the duplex soils are susceptible to water erosion when disturbed, while the clayey soils of land types Db and Dc show swell-shrink properties and are therefore poor support for roadbeds and foundations.

4.1.3 Pans

In a geomorphic sense, pans are equivalent to valley bottoms (Verster et al., 1992). The importance of pans in the landscape can be ascribed to their aesthetic appearance, ability to store runoff water, pan soils and associated materials determining pan ecosystems as well as being good archives from which the Quaternary can be reconstructed and past climatic changes be unraveled, preferential habitation by Stone and Iron Age people and economic deposits such as table salt. Because of these reasons, the construction of pylons in and around pan environments should be avoided.

The percentage of pans occurring in land type units is shown in TABLE 1 of which land types Ah20 (7%), Da1 (5%), Dc9 (22%) and Fc13 (6%) contain the highest share. The soils are mainly dark coloured, loamy to clayey, calcareous, strongly alkaline and exhibiting moderate to strong swell-shrink potential.

4.1.4 Soil-landform resources along the proposed corridors and alternative alignments

With the aid of the land type maps, the soil-landform resources along the proposed routes can be ascertained. Due to the unique distribution of these resources (see FIGURE 1), all the proposed corridors cross the plinthic catena soils (land types B) north-east of Wesselsbron; the freely drained, red and yellow-brown, fine sandy soils (land types A) south-west of Wesselsbron; duplex soils of land types D; and very shallow soils of land type Fc just about in equal amounts.

TABLE 4.1: SOIL AND SLOPE COMPONENTS OF THE LAND TYPES PRESENT IN THE STUDY AREA

General description of land types	**Land type symbol**	**Dominant slope class (%)**	**Brief description of dominant soils, association of soils and rock complexes**
Well-drained, red, apedal soils of the Hutton form; mainly high base status	Ae38	0 - 2	Deep (>1000 mm), fine sand to fine sandy loam
	Ae40	0 - 2	Deep (>1000 mm), fine sand to fine sandy loam; 4% pans
	Ae46	0 - 2	Deep (>1000 mm), fine sand to fine sandy loam in association with shallow soils and rock outcrops
Well-drained, red and yellow-brown, apedal soils of the Hutton and Clovelly forms; mainly high base status	Ah20	0 - 2	Deep (>1000 mm), fine sand to loamy fine sand overlying loam subsoil in association with various clay soils; 7% pans
Well-drained, yellow-brown, apedal soils of the Clovelly form; mainly high base status	Ai5	0 - 3	Deep (>1000 mm), fine sand to loamy fine sand in association with red, fine sand to loamy fine sand
	Ai6	0 - 3	Deep (>1000 mm), fine sand to loamy fine sand in association with red, fine sand to loamy fine sand; 2% pans
Plinthic catena: well-drained, red, apedal soils of the Hutton form are widespread; mainly high base status	Bc23	0 - 4	Shallow (<500 mm), loamy fine sand to loam on loam in association with very shallow soils and rock outcrops
	Bc24 Bc28	0 - 2	Deep (>1000 mm), loamy fine sand to fine sandy loam overlying loam subsoil in association with deep, fine sand to loam soils of the Avalon and Bainsvlei forms; 1-2% pans
	Bc25	1 - 3 3 - 15	Moderately deep to deep (>500 mm), loamy fine sand to loam overlying loam associated with very shallow soils and rock outcrops
	Bc29	0 - 4	Shallow (<500 mm), fine sand to loam on loamy fine sand to loam in association with very shallow soils and rock outcrops

General description of land types	Land type symbol	Dominant slope class (%)	Brief description of dominant soils, association of soils and rock complexes
Plinthic catena: moderately well-drained, apedal soils of the Avalon form are widespread; mainly high base status	Bd13	0 - 3	Deep (>900 mm), fine sand to loamy fine sand on fine sand to loam subsoil in association with fine sand soils of the Hutton and Clovelly forms; 2% pans
	Bd14 Bd18	0 - 2	Deep (>1000 mm), fine sand to loamy fine sand on fine sand to loam subsoil in association with loam soils of the Hutton form and clayey, duplex soils; 1-2% pans
	Bd15	0 - 3	Deep (>900 mm), loamy fine sand to loam in association with clayey, duplex soils
Duplex soils: sand to loam topsoils overlying with a clear to abrupt transition loam to clay subsoils	Da1	0 - 3	Very shallow effective depth (<300 mm), reddish, fine sand to loam on clay associated with shallow soils and rock outcrops and moderately deep, red loam soils of the Hutton form; 5% pans
	Db1 Db3	0 - 3	Very shallow effective depth (<300 mm), dark brown and dark grey brown, fine sand to loam on clay associated with shallow soils and rock outcrops
	Dc4	0 - 2 2 - 15	Very shallow effective depth (<300 mm), dark coloured, fine sand to loam overlying loam to clay in association with shallow soils and rock outcrops and vertic, clay soils of the Arcadia form
	Dc6	0 - 5 5 - 12	Very shallow effective depth (<300 mm), dark coloured, loam on clay associated with shallow soils and rock outcrops and melanic and vertic clay soils
	Dc8	0 - 3	Very shallow effective depth (<300 mm), dark coloured, loam on clay in association with vertic, clay soils of the Arcadia form
	Dc9	0 - 2	Very shallow effective depth (<300 mm), dark coloured, fine sand to loam overlying loam to clay associated with deep, red fine sand to loam and various clay soils; 22% pans
Very shallow soils dominant	Fc13	0 - 5	Calcareous fine sand to loam overlying calcrete or bedrock associated with moderately deep, red loam and various clay soils; 6% pans
Steep and rocky land*	Ib	5 - 15 15 - 30	Very shallow soils in complex association with surface rockiness

*Not shown on the accompanying land type map.

4.2 Land evaluation

4.2.1 Agricultural uses

To rate land for agriculture, the land capability system of Scotney et al. (1987) has been employed. The rating of land types into land capability classes as well as the most important attributes limiting the suitability are contained in TABLE 4.2. This assessment is of a general nature only due to the broad-scale approach of the land type data. Class II (moderate - high) and class III (moderate) contain land with arable potential. Of these, areas associated with land types Bc and Bd and occurring solely north-east of Wesselsbron possess the higher potential because of soil pattern and climate with a higher rainfall efficiency.

Class II and to a lesser degree class III may be considered as prime agricultural land, and should ideally be protected for cropping purposes. Any non-agricultural use such as the construction of transmission lines would therefore have a negative impact on the production potential of an area.

TABLE 4.2: GENERALISED LAND CAPABILITY CLASSIFICATION OF THE STUDY AREA

Land type symbol	**Land capability class**	**Dominant limitation influencing the physical suitability for agricultural use**
Ae38	III	Climate
Ae40	III	Climate
Ae46	III	Climate
Ah20	III	Climate
Ai5	III	Climate
Ai6	III	Climate
Bc23	IV	Climate, limiting soil depth
Bc24, Bc28	II	Climate
Bc25	III	Climate, steepness in places
Bc29	IV	Climate, limiting soil depth
Bd13	II	Climate
Bd14, Bd18	II	Climate
Bd15	II	Climate
Da1	V	Limiting soil depth
Db1, Db3	V	Limiting soil depth, flooding
Dc4	VI	Limiting soil depth, steepness in places, flooding

Land type symbol	Land capability class	Dominant limitation influencing the physical suitability for agricultural use
Dc6	VI	Limiting soil depth, steepness in places, flooding
Dc8	V	Limiting soil depth, flooding
Dc9	V	Limiting soil depth, flooding
Fc13	VI	Limiting soil depth, surface rockiness in places
Ib	VII	Rockiness, steepness

4.2.2 Non-agricultural uses

Evaluation for uses such as foundations, roads and camping ground is based on the soil-landform factor alone. Suitability classes and dominant limitations are shown in TABLE 4.3. Since all these given uses are site-specific and the fact that the land type information is of a general nature, the rating can only be generalised.

TABLE 4.3: GENERALISED SUITABILITY* OF LAND TYPES FOR SPECIFIC LAND USES

Uses Map symbol	Foundations for pylons		Construction roads		Camping ground	
	Class	Dominant limitation	Class	Dominant limitation	Class	Dominant limitation
Ae38 Ae40 Ae46 Ah20 Ai5 Ai6	1		37622	Sandy nature of topsoil	37622	Sandy nature of topsoil
Bc23 Bc24/28 Bc25 Bc29 Bd13 Bd14/18 Bd15	1		37622	Sandy nature of topsoil	37622	Sandy nature of topsoil

Uses Map symbol	Foundations for pylons		Construction roads		Camping ground	
	Class	Dominant limitation	Class	Dominant limitation	Class	Dominant limitation
Da1	2	Medium swell-shrink potential	37622	Sandy and clayey soil textures,	3	Flooding, extreme soil textures
Db1/3 Dc4 Dc6 Dc8 Dc9	3	Medium to strong swell-shrink potential	2	Sandy and clayey soil textures, flooding	3	Flooding, extreme soil textures
Fc13	37622	Rockiness	2	Sandy nature of topsoil	37622	Rockiness
Ib	2	Rockiness, steepness	3	Rockiness, steepness	3	Rockiness, steepness

*Suitability classes: 1 = Good
2 = Moderate
3 = Poor

5 ***Identification of sensitive areas/risk sources***

Sensitive areas are those where risks with regard to the utilisation of the soil-landform resources are involved. Since the proposed development may result in either benefits or impacts to the environment relative to the current state, the risks are expressed relative to the current situation. Possible risk sources can be identified for the different phases as presented in TABLE 5.1.

TABLE 5.1: IDENTIFICATION OF RISK SOURCES IN THE STUDY AREA

Phase	Component of the landscape	Possible risk	Source of the risk
Construction	Soil	Actual	Wind erosion - all fine sandy soils (<15% clay) are prone when dry and devoid of vegetation during periods of high wind activity
		Actual	Compaction - all fine sandy soils (<15% clay) are subjected especially when soils are wet

Phase	Component of the landscape	Possible risk	Source of the risk
		Actual	Water erosion - clayey and duplex soils of land types Db and Dc are susceptible when exposed
	Steep river banks	Anticipated	Disturbance of steep river banks with loamy and clayey soils can lead to water erosion
	Pan environments	Anticipated	Disturbance of surface materials can lead to wind erosion
	Valley bottoms and wetlands	Anticipated	Destroying the ecological and hydrological balance can lead to water erosion
Operation	Soil	Actual	Compaction (as for the construction phase)
	Landform	None apparent	
	Pan	None apparent	

6 Impact description and assessment

If any land use activity is not adapted to the potential of the relevant resources, soil-landform degradation commonly represents the negative environmental impact of the activity. Several potential impacts have been recognised and these are summarised in TABLE 6.1.

TABLE 6.1: IMPACTS ON SOIL-LANDFORM RESOURCES OF THE STUDY AREA

CONSTRUCTION PHASE								
Nature of Impact	**Extent**	**Duration**	**Intensity**	**Probability of occurrence**	**Status**	**Confidence**	**Significance without mitigation**	**Significance with mitigation**
Wind erosion (all fine sandy soils and pan floors)	Local - regional	Medium term	Low	Probable	Negative	High	Low-medium	Low
Soil compaction (all fine sandy soils)	Local	Medium term	Low	Highly probable	Negative	High	Medium	Low

CONSTRUCTION PHASE								
Nature of Impact	**Extent**	**Duration**	**Intensity**	**Probability of occurrence**	**Status**	**Confidence**	**Significance without mitigation**	**Significance with mitigation**
Water erosion (clayey and duplex soils)	Site-specific	Medium term	Low	Probable	Negative	High	Low-medium	Low
Water erosion (river banks, valley bottoms, wetlands)	Site-specific	Medium term	Low	Improbable	Negative	Medium	Low-medium	Low
Arable potential (all land types with capability classes II and III)	Local-national	Long term	Medium	Definite	Negative	High	Low-medium	Low
OPERATION PHASE								
Arable potential (as for construction phase)	Local-national	Long term	Medium	Definite	Negative	High	Low-medium	Low
Soil compaction (during maintenance)	Local	Medium term	Low	Highly probable	Negative	High	Medium	Low
Visual (pan environments)	Site-regional	Long term	Low	Probable	Negative	Low	Low	Low

6.1 Wind erosion

All fine sandy soils with less than 15% clay are prone to wind erosion when they are dry and devoid of vegetative cover during periods of high wind activity. It is therefore probable that this type of erosion will affect a large percentage of the soils during the construction phase, especially where disturbed along roads and in and around construction camps. In general, land types that will be impacted on are Ae38, 40, 46; Ah20; Ai5, 6; Bc24, 25, 28; Bd13, 14, 15, 18; Da1; Db1, 3, 4, 9; and Fc13. Similarly the fine sediments of pan floors may be subjected to wind erosion and contribute to the dust problem. All in all, the significance of wind erosion is regarded as low to medium without mitigation and low with mitigation (TABLE 6.1). For the operation phase no negative impacts are foreseen.

6.2 Water erosion

Except the duplex and clayey soils of land types Da1; Db1, 3; and Dc4, 6, 8, 9 the water erosion hazard of all the other soils is low. Negative impacts in the form of soil erosion are a probability when the duplex and clayey soils are disturbed during the construction phase. The significance of the erosion impact is assumed to be low to medium without mitigation and with mitigation to be low (TABLE 6.1). If the steep river banks, valley bottoms (in particular those occurring in the north-eastern portion) and the limited number of wetlands in the same area are to be disturbed during the construction process or for the siting of pylons, the environment will be negatively affected. However the probability of occurrence is regarded as improbable. It is important to control soil erosion because of its negative effects on the environment (loss of topsoil, sediments in waterways, reducing the aesthetic quality). See section 7 for the implementation of measures to control water erosion. No negative impacts are anticipated for the operation phase.

6.3 **Soil compaction**

A very hard, compacted soil will limit the ease of landscaping and plant growth, decrease crop yield potential drastically as well as increase water runoff. Due to the fact that the compaction potential of the fine sandy soils (clay content less than 15%) is high, especially when the soils are wet, compaction is a common phenomenon during heavy vehicles passage. It is expected that the following land types will be affected: Ae38, 40, 46; Ah20; Ai5, 6; Bc24, 25, 28; Bd13, 14, 15, 18; Da1; Db1, 3, 4, 9; and Fc13. Despite these negative features, the impact is appraised to be medium without and low with mitigation measures (TABLE 6.1). During maintenance (operation phase) similar conditions will be encountered with similar negative impacts.

6.4 Arable potential

Physical arable potential based on the soil, landform and climate factors is represented by the land capability classes as shown in TABLE 4.2. Of these, class II (land types Bc24, Bc28, Bd13, Bd14, Bd15 and Bd18) as well as class III (land types Ae38, Ae40, Ae46, Ah20, Ai5, Ai6 and Bc25) are suitable for cropping with class II possessing the highest potential. The construction of a transmission line, if crossing land occupied by the above land types will have a permanent (long term according to TABLE 6.1) impact on agricultural production. Notwithstanding the goal to protect prime agricultural land, only relatively small areas will be utilised during the construction phase and even less for the operation phase, with the result that the significance is assessed to be low-medium without and low with mitigation (TABLE 6.1).

6.5 Visual impacts on pan environments

The importance of pan environments has been stated in 4.1.3. Although not strictly relevant to this part of the study, the visual impacts the transmission line will have on pan environments are dealt with here in a preliminary fashion. The significance, however, is expected to be low without and with mitigation measures (TABLE 6.1).

7 Recommended mitigation/management measures

At this stage the environmental planning group is challenged by three proposed corridors (1-3) and additional three short alternatives (a-c). In order to evaluate the environmental impact of the transmission line certain management objectives need to be expressed as measurable targets. For the soil-landform component of the study, the following objectives can be stated:

- avoid class II and to a lesser degree class III agricultural land
- prevent negative impacts such as soil erosion (wind and water) as well as soil compaction which normally result in the degradation of the soil resource

For the several identified impacts relevant to this study, management and mitigation actions will be necessary to minimise degradation of the environment and manage the loss of cropping land (TABLE 7.1)

TABLE 7.1: RECOMMENDED MITIGATION AND MANAGEMENT MEASURES

NEGATIVE IMPACT	**MANAGEMENT/MITIGATION MEASURES**
Wind erosion	Seal roads temporary (also to improve their trafficability); use environment-friendly sealant; keep adjoining areas moist; keep areas in and around construction camps moist; re-vegetate if necessary
Soil compaction	Rip or deep plough compacted areas after construction and maintenance is completed (as guideline: rip to a depth of 30 cm below compacted layer) ; minimise compaction during both phases by avoiding unnecessary trafficking; refrain from movement over soil surface during very wet conditions (as guideline: stop movement of heavy machinery after 20-25 mm rainfall is received); limit trafficking to definite road zones
Water erosion (duplex and clayey soils)	Construct soil conservation measures along roads; avoid bare, disturbed surfaces for long periods; avoid undue storm-water concentration (e.g. construct runoff measures according to soil conservation principles)
Water erosion (steep river banks, valley bottoms and wetlands)	Do not select these areas for construction purposes or pylon siting
Arable potential	Although an impossible task in the survey area, select the final route by avoiding, as far as possible, classes II and III land;
Visual (pan environment)	Avoid construction of transmission lines across or in close proximity of pans

Finally, it is believed that the above-mentioned proposed mitigation will be of importance and consequently will result in a measurable reduction in the significance of the impacts as indicated in TABLE 6.1.

8 Alternatives

Due to the distribution of land types and the occurrence of pans, no meaningful suggestions can be made for alternatives at the scale relevant to this study. At detailed level, however, the siting of pylons may be shifted to have less impact on the environment, for example to avoid valley bottoms, wetlands and pan environments or to impact on arable potential.

9 Conclusions and recommendations

With the aid of a desk-study, the soil and landform resources of the project have been identified by means of the land type survey (scale of 1:250 000). It must be clearly stated that this broad-scale information is only appropriate for the scoping level of this study, and consequently not to be used for detail planning and design purposes.

9.1 Land evaluation

For agricultural purposes, the land capability classification has been employed to assess the cropping potential. The portion north-east of Wesselsbron and represented by land types Bc24, Bc28, Bd13, Bd14, Bd15 and Bd18, covers the majority of the survey area, has been rated as class II and hence possesses a moderate to high production potential. According to the management objectives stated in section 7, this is the type of land which should be avoided for non-agricultural uses. The portion south-west of Wesselsbron contains land with a capability of III (moderate production potential) interspersed with land normally not suited to cropping, resulting in areas with more siting choices.

The land types have also been evaluated for other uses relevant to transmission line construction, viz pylon foundations, construction roads and camping grounds. Because of the swell-shrink properties of subsoils of the duplex component and other associated clay soils (land types Da1, Db1, Db3, Dc4, Dc6, Dc8 and Dc9), the suitability for foundations is poor. Furthermore the fine sandy and clayey materials have a moderate suitability as roadbed support, whereas some land types, due to a flooding hazard and extreme topsoil textures do limit their suitability as camp sites. Although this evaluation is of a general nature only, areas covering certain land types can be identified where specific problems could be expected.

9.2 Impact description and assessment

Several impacts such as soil erosion by wind and water, soil compaction, diminishing arable potential and decreasing the visual aspects and uniqueness of pan environments have been identified.

The vulnerability of the fine sandy soils to wind erosion, their tendency to compact when used as load by heavy machinery and the susceptibility of duplex soils to water erosion when disturbed, all will play a role to enhance degradation of the soil resource. The impact of the transmission line on the soil resource will, nevertheless, be low to medium without and low with mitigation.

Although the loss of arable land because of non-agricultural uses should be guarded against, it can be stated that the significance of impact of a transmission line, in a regional context, will be low.

Due to the flatness of the landscape, the landform has no apparent impact on the project. The few koppies in the south-western portion will more probably pose as a benefit by masking the visibility of pylons to a degree. This effect, however, is of very limited extent. On the other hand, the fact that the principal rivers lie square on the general strike of the proposed corridors and the presence of only a limited number of wetlands in the north-east, mean that the impact of the final servitude on the landform in general will be minimal.

The impact on pan environments is mainly confined to visual impact and possible disturbance of valuable sites around the margins, as well as wind erosion of pan floors. The significance of the impacts is regarded as low without and with mitigation.

9.3 Management/mitigation measures

On account of the negative impacts, management/mitigation actions have been recommended. It is evident that the proposed mitigation would be of definite value, resulting in a reduction in, for example, the soil erosion and compaction impacts in order to ensure sustainable use of the relevant natural resources.

9.4 Selection of final alignment

Due to the unique distribution of the soil-landform resources, no one of the proposed corridors (1 - 3) or variations thereof (a - c) have an apparent better alignment in comparison with regard to impact assessment. They also cross potential arable land (classes II and III) to the same degree. Furthermore, any viable alternative would be confronted by the same spatial distribution of natural resources.

9.5 Monitoring

The negative impacts that need to be monitored are soil erosion (wind and water) as well as soil compaction. It is recommended that soil erosion is monitored at the construction site after the mitigation measures have been implemented in order to determine whether mitigation actions are effective. Also monitor the crop yield of the areas affected during the construction phase or after maintenance to ascertain whether the ripping process has been effective.

10 References

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