DRAFT REPORT

for

AGRICULTURAL POTENTIAL AND RECONNAISSANCE SOILS ASSESSMENT

for the

THE PROPOSED DEVELOPMENT OF THE DOUBLE CIRCUIT 400 kV POWER LINE FROM ARNOT TO GUMENI SUB STATIONS, MPUMALANGA PROVINCE

July 2012

Revision A

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Attention: **Mr Lordwick Makhura**

RE: FINAL REPORT – AGRICULTURAL POTENTIAL AND RECONNAISSANCE SOILS ASSESSMENT FOR THE PROPOSED DEVELOPMENT OF THE DOUBLE CIRCUIT 400 kV POWER LINE FROM ARNOT TO GUMENI SUB-STATIONS, MPUMALANGA PROVINCE

Dear Lordwick

Attached please find the amended Draft Report for the undertaking of the above project on behalf of yourselves and Eskom in the Machadodorp area, **Mpumalanga Province**.

The area defined in the locality plan as supplied by yourselves, is considered the extent of the Scope of Services (SoS) for this survey, and is limited to the 3 routes indicated. Please do not hesitate to contact us should you require any additional information.

Thanking you again for the opportunity to work with your team on the project.

Yours Sincerely

Paul S Vermaak
[Pr.Sci.Nat]

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LIST OF ACRONYMS

AWC	Available Water Capacity
CEC	Cation Exchange Capacity
DWAF	Department of Water Affairs and Forestry
ERD	Estimated Rooting Depth
EMP	Environmental Management Plan
FAM	Freely Available Moisture
IS	Irrigation Suitability
ISR	Irrigation Suitability Rating
Org Mat	Organic Matter
RSA	South Africa
SAR	Sodium Absorption Ratio
TAM	Total Available Moisture (equivalent to TAWC)
TAWC	Total Available Water Capacity (Equivalent to TAM)
ToR	Terms of Reference

MEASUREMENTS

%	percentage
cm	centimetres
g	grams
ha	hectare
kg	kilograms
km	kilometres
m	meters
m^2	meters squared (area)
me	milli-equivalents
me%	milli-equivalents percent
mg	milligrams
mm	millimetres
mm/hr	millimetres per hour
mm/m	millimetres per meter

CHEMICAL SYMBOLS

Al	Aluminium
Ca	Calcium
Cu	Copper
Fe	Iron
K	Potassium
Mg	Magnesium
Mn	Manganese
N	Nitrogen
Na	Sodium
P	Phosphorus
S	Sulphur
Zn	Zinc

GLOSSARY OF TERMS

Alluvium - Refers to detrital deposits resulting from the operation of modern streams and rivers.

Base status - A qualitative expression of base saturation. See base saturation percentage.

Buffer capacity - The ability of soil to resist an induced change in pH.

Calcareous - Containing calcium carbonate. See chapter 4.

Catena - A sequence of soils of similar age, derived from similar parent material, and occurring under similar macroclimatic conditions, but having different characteristics due to variation in relief and drainage.

Clast - An individual constituent, grain or fragment of a sediment or sedimentary rock produced by the physical disintegration of a larger rock mass.

Cohesion - The molecular force of attraction between similar substances. The capacity of sticking together. The cohesion of soil is that part of its shear strength which does not depend upon inter-particle friction. Attraction within a soil structural unit or through the whole soil in apedal soils.

Concretion – A nodule made up of concentric accretions.

Crumb – A soft, porous more or less rounded ped from one to five millimetres in diameter. See structure, soil.

Cutan – Cutans occur on the surfaces of peds or individual particles (sand grains, stones). They consist of material which is usually finer than, and that has an organisation different to the material that makes up the surface on which they occur. They originate through deposition, diffusion or stress. Synonymous with clayskin, clay film, argillan.

Denitrification – The biochemical reduction of nitrate or nitrite to gaseous nitrogen, either as molecular nitrogen or as an oxide of nitrogen.

Erosion – The group of processes whereby soil or rock material is loosened or dissolved and removed from any part of the earth's surface.

Fertiliser – An organic or inorganic material, natural or synthetic, which can supply one or more of the nutrient elements essential for the growth and reproduction of plants.

Fine sand – (1) A soil separate consisting of particles 0.25-0.1 mm in diameter. (2) A soil texture class (see texture) with fine sand plus very fine sand (i.e. 0.25-0.05 mm in diameter) more than 60 % of the sand fraction.

Fine textured soils – Soils with a texture of sandy clay, silty clay or clay.

Hardpan – A massive material enriched with and strongly cemented by sesquioxides, chiefly iron oxides (known as ferricrete, diagnostic hard plinthite, ironpan, ngubane, ouklip, laterite hardpan), silica (silcrete, dorbank) or lime (diagnostic hardpan carbonate horizon, calcrete). Ortstein hardpans are cemented by iron oxides and organic matter.

Land capability – The ability of land to meet the needs of one or more uses under defined conditions of management.

Land type – (1) A class of land with specified characteristics. (2) In South Africa it has been used as a map unit denoting land, mappable at 1:250,000 scale, over which there is a marked uniformity of climate, terrain form and soil pattern.

Land use – The use to which land is put.

Mottling - A mottled or variegated pattern of colours is common in many soil horizons. It may be the result of various processes *inter alia* hydromorphy, illuviation, biological activity, and rock weathering in freely drained conditions (i.e. saprolite). It is described by noting (i) the colour of the matrix and colour or colours of the principal mottles, and (ii) the pattern of the mottling. The latter is given in terms of abundance (few, common 2 to 20 % of the exposed surface, or many), size (fine, medium 5 to 15 mm in diameter along the greatest dimension, or coarse), contrast (faint, distinct or prominent), form (circular, elongated-vesicular, or streaky) and the nature of the boundaries of the mottles (sharp, clear or diffuse); of these, abundance, size and contrast are the most important.

Nodule – Bodies of various shapes, sizes and colour that have been hardened to a greater or lesser extent by chemical compounds such as lime, sesquioxides, animal excreta and silica. These may be described in terms of kind (durinodes, gypsum, insect casts, ortstein, iron-manganese, lime, lime-silica, plinthite, salts), abundance (few, less than 20% by volume percentage; common, 20 – 50 %; many, more than 50 %), hardness (soft, hard meaning barely crushable between thumb and forefinger, indurated) and size (threadlike, fine, medium 2 – 5 mm in diameter, coarse).

Ped – Individual natural soil aggregate (e.g. block, prism) as contrasted with a clod produced by artificial disturbance.

Pedocutanic, diagnostic B horizon – The concept embraces B horizons that have become enriched in clay, presumably by illuviation (an important pedogenic process which involves downward movement of fine materials by, and deposition from, water to give rise to cutanic character) and that have developed moderate or strong blocky structure. In the case of a red pedocutanic B horizon, the transition to the overlying A horizon is clear or abrupt.

Pedology – The branch of soil science that treats soils as natural phenomena, including their morphological, physical, chemical, mineralogical and biological properties, their genesis, their classification and their geographical distribution.

Slickensides – In soils, these are polished or grooved surfaces within the soil resulting from part of the soil mass sliding against adjacent material along a plane which defines the extent of the slickenside. They occur in clayey materials with a high smectite content.

Sodic soil – Soil with a low soluble salt content and a high exchangeable sodium percentage (usually EST > 15).

Swelling clay – Clay minerals such as the smectites that exhibit interlayer swelling when wetted, or clayey soils which, on account of the presence of swelling clay minerals, swell when wetted and shrink with cracking when dried. The latter are also known as heaving soils.

Texture, soil – The relative proportions of the various size separates in the soil as described by the classes of soil texture shown in the soil texture chart (see diagram on next page). The pure sand, sand, loamy sand, sandy loam and sandy clay loam classes are further subdivided (see diagram) according to the relative percentages of the coarse, medium and fine sand subseparates.

Vertic, diagnostic A horizon – A horizons that have both a high clay content and a predominance of smectitic clay minerals possess the capacity to swell and shrink markedly in response to moisture changes. Such expansive materials have a characteristic appearance: structure is strongly developed, ped faces are shiny, and consistence is highly plastic when moist and sticky when wet.

1 INTRODUCTION

Baagi Environmental Consultancy (Pty) Ltd, on behalf of Eskom Limited (Pty) Ltd commissioned Nepid Consultants CC to undertake an agronomical potential surveys of the three proposed routes for the intended development of a transmission corridor in the district of Machadodorp (**Mpumalanga Province**).

The operations are located within a highly impacted and historically mined area, which has developed extensive rural (and peri-urban) and agricultural sectors. The field work was undertaken in November 2011 and April 2012. A total line distance of 294,439.86 m^2 was investigated in the course of the survey.

1.1 Overview

In South Africa, the undertaking of any new development is controlled by the National Environmental Management Act (NEMA) 1998 (Act 107 of 1998). With the promulgation of the new National Environmental Management Act (NEMA) Environmental Impact Assessment (EIA) regulations in August 2010, an Environmental Impact Assessment (EIA) is required in order to apply to the Mpumalanga Department of Economic Development, Environment and Tourism (MDEDET) and/ or the national Department of Environmental Affairs and Tourism (DEAT) for environmental authorisation of this proposed project.

It is required that all upgrades, or additions to existing developments be licensed and have an Environmental Impact Assessment (EIA or exception request) assessment undertaken. In order to qualify for a licence a site owner must submit certain information to the controlling authority. This information must satisfy the authority that the preferred route is environmentally and socially acceptable, is adequately designed and will be managed according to the environmental norms required, and that all mitigation measures prescribed are viable and enforced.

2 AIM OF THE PROJECT

The study has been structured so as to satisfy the requirements of the overall Environmental Management Programme (EMP) as required in terms of the National Environmental Management Act (NEMA), No. 107 of 1998 and guided by the Mineral and Petroleum Resources Development Act (MPRDA) (ACT 28, 2002) as set-out in the Aidé-Memoiré (DMR, 1992).

To this end, a number of soil parameters were mapped and classified using the standard South African Taxonomic Soil Classification System (Mac Vicar *et al*, 2nd edition 1991).

The objectives of the survey were to:

- Provide a permanent record of the present soil resources in the area that are potentially going to be affected in their preconstruction state;
- Assess the nature of the site in relation to the overall environment and its present and proposed utilisation, and
- Provide a base plan from which long-term ecological and environmental decisions can be made, and rehabilitation plans can be formulated.

Historically (pre-activity) the study area has been utilised for either agricultural production, with areas of natural grassland indicative of the regions and utilised as livestock grazing lands. There are regions dominated by wetlands (close to the Crocodile River), and the related hydromorphic soils, and outliers of sandy, less structured soils, related to the more sedimentary geological sequences.

With the ever-increasing competition for land, it has become imperative that the full scientific facts for any particular site are known, and the effects on the land used by any other proposed enterprise be evaluated, prior to the new activity being implemented.

This document describes the in-field methods used to classify and describe the soils, the results of the survey obtained, as well as an interpretation of the field results (iro agricultural potential).

3 METHODOLOGY OF INVESTIGATION

3.1 Soils Data Collection

3.1.1 Review of published reports and maps

The only existing archive data available for the site evaluation is the 1:250,000 scale Land Type maps, sourced from the Department of Agriculture, and historical work conducted by the author in the area.

These maps (land type) are of a small scale, and have been compiled using basic aerial photographic interpretation of the area, with limited field interpretation. They are a good first approximation, and in combination with the geological maps (1:250,000) are useful as a baseline from which to work.

3.1.2 Field Work

The detailed pedological study of the site was performed based on a reconnaissance transect intercept with observation points roughly every 500 m. The key goal was to ascertain the agricultural potential (agronomy), with the knowledge that pylons will have a relatively small physical footprint. The field surveys were undertaken in November 2011 and April 2012. In addition to the catena observations, a representative selection of the soil Forms mapped was chosen, and re-assessed using road cuttings. The soil mapping was undertaken on a 1:50,000 scale (Refer to Figure 6.1: Soils Polygon Map)

A total linear distance of 294,439.86 m^2 was covered in the course of this study.

The majority of observations used to classify the soils were made using a hand operated bucket auger (ϕ 100 mm) with hydromorphic regions surveyed using the Dutch (clay) augers (ϕ 50 mm). Immediately after completing the classification of the profiles, the excavations were backfilled for safety reasons.

Standard mapping procedures and field equipment were used throughout the survey. Initially, geological maps of scale 1:250,000 and topocadastral maps at a scale of 1:50,000 were used to provide an overview of the area, while orthophotographs at a scale of 1:10,000 being used as the base map for the soil survey.

The fieldwork comprised a site visit during which profiles of the soil were examined and observations made of the differing soil extremes. Relevant information relating to the climate, geology, wetlands and terrain morphology was also considered at this stage. This information was obtained from the client and from other consultants involved in these areas of speciality.

The pedological study was aimed at investigating, logging and classifying the soil profiles. Terrain information, topography and any other infield data of significance was also recorded, with the objective of identifying and classifying the area in terms of the soil types to be disturbed/ rehabilitated;

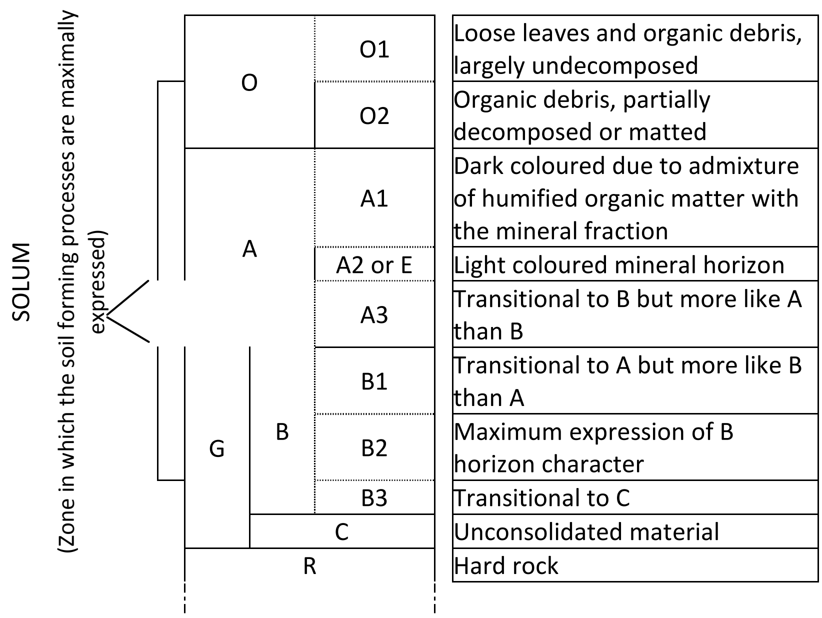
- The soil physical and chemical properties;
- The soil depth;

- The erodibility of the soils; and
- Pre-construction soil utilisation potential;
- The soil nutrient status; and
- Soil Profile Identification and Description Procedure.

The identification and classification of soil profiles were carried out using the South African Taxonomic Soil Classification System (*Mac Vicar et al*, 2nd edition 1991)

The Taxonomic Soil Classification System is in essence a very simple system that employs two main categories or levels of classes, an upper level or general level containing Soil Forms, and a lower, more specific level containing Soil Families. Each of the soil Forms in the classification is a class at the upper level, defined by a unique vertical sequence of diagnostic horizons and materials. All Forms are subdivided into two or more families, which have in common the properties of the Form, but are differentiated within the Form on the basis of their defined properties. Figure 3.1 below illustrates the typical arrangements found.

Figure 3.1: Typical Arrangement of Master Horizons in Soil Profile



In this way, standardised soil identification and communication is allowed by use of the names and numbers given to both Form and Family. The procedure adopted in field when classifying the soil profiles is as follows:

i. Demarcate master horizons (Refer to Figure 6.1);
ii. Identify applicable diagnostic horizons by visually noting the physical properties such as:
    - Depth (below surface)

  - Texture (Grain size, roundness etc.)
  - Structure (Controlling clay types)
  - Mottling (Alterations due to continued exposure to wetness)
  - Visible pores (Spacing and packing of peds)
  - Concretions (cohesion of minerals and/or peds)
  - Compaction (from surface)

iii. Determine from i) and ii) the appropriate Soil Form

iv. Establishing provisionally the most likely Soil Family

3.2 Land Capability Plan

3.2.1 Data Collection

The land capability of the study area was classified into four classes (wetland, arable land, grazing land and wilderness) according to the Chamber of Mines Guidelines (1991). The various criteria for these classifications are set out in Table 3.1 below.

In order to be in a position to evaluate the suitability of the soils in the survey area, particularly with regard to their irrigation potential and their usability, a system of land capability rating has been evolved. Ideally, soils use for irrigation should satisfy the following requirements:

- Moderate uniformity
- Good rooting depth (>500 mm)
- Low rockiness hazard (<20%)
- Moderate permeability
- Good supply of available moisture (TAWC >70 mm/m)
- Satisfactory aeration and infiltration rates (>8 mm/hr)
- Moderate resistance to erosion
- Salinity and exchangeable sodium levels should be less than 200 milli-Siemens per meter (mS/m) and 2 milli-equivalents per hundred grams (me/100g).

Table 3.1: Criteria for pre-development land capability

Criteria for Wetland

- Land with organic soils or supporting hygrophilous vegetation where soil and vegetation processes are water determined.

Criteria for Arable land

- Land, which does not qualify as a wetland.
- The soil is readily permeable to a depth of 750 mm.
- The soil has a pH value of between 4.0 and 8.4.
- The soil has a low salinity and SAR.
- The soil has less than 10% (by volume) rocks or pedocrete fragments larger than 100 mm in the upper 750 mm.
- Has a slope (in %) and erodibility factor (K) such that their product is <2.0
- Occurs under a climate of crop yields that are at least equal to the current national average for these crops.

Criteria for Grazing land

- Land, which does not qualify as wetland or arable land.
- Has soil, or soil-like material, permeable to roots of native plants, that is more than 250 mm thick and contains less than 50 % by volume of rocks or pedocrete fragments larger than 100 mm.
- Supports, or is capable of supporting, a stand of native or introduced grass species, or other forage plants utilisable by domesticated livestock or game animals on a commercial basis.

Criteria for Wilderness land

- Land, which does not qualify as wetland, arable land or grazing land.

4 LEGAL REQUIREMENTS

With an understanding of the impacts that this overall project could have on the environment, it is imperative that a full understanding of the environment, that is to be disturbed and affected, is obtained prior to the implementation of any construction or related activities taking place. In addition to the development to be undertaken, there will be a number of surface features/ structures that will impact on the environment (both physical and social), which will need to be assessed and mitigated.

Apart from the more obvious environmental studies (Fauna and Flora, Surface and Ground Water etc.) that need to be undertaken prior to the implementation of a new development, it has become increasingly apparent that the soils need to be investigated in detail if a comprehensive baseline of information is to be available for future reference. A comprehensive pedological investigation at various scales (depending on the degree of disturbance to be implemented), coupled with an interpretation, and understanding of the land capability for the area to be disturbed has been undertaken as part of the overall Social and Environmental Impact Assessment (EIA) process.

4.1 South African Legal Requirements as a Guideline and Best Practice

4.1.1 Analytical Standards

The quantative nature of the soils legislative requirements in South African are governed by the South African Bureau of Standards (www.sabs.co.za) and are generally found to be suitable on an international level. The regional corroborations within SADC, have accepted these guideline standards, with a requirement to augment local criteria(s), should they indeed exist.

4.1.2 Classification

Using the South African Taxonomic Soil Classification System as described above, an accepted standard scientific methodology has been adopted. Extensive work has been completed by, amongst others, the Sugar Cane Growers Association of South Africa (SCGASA) and Forestry South African (FSA) which has made considerable and detailed comparisons between the various Southern African taxonomic classification systems in use. A database of these respective systems collaborations and their equivalent naming in other countries is available on request from the author.

The specific countries' taxonomic systems are listed as; South Africa, Swaziland, Zimbabwe (Rhodesia), Uganda, Tanzania, Mozambique, Kenya and Lesotho. The South African Taxonomic Soil Classification System is thus complete and inclusive, and thus suitable for use on this project.

4.2 International Legal Requirements

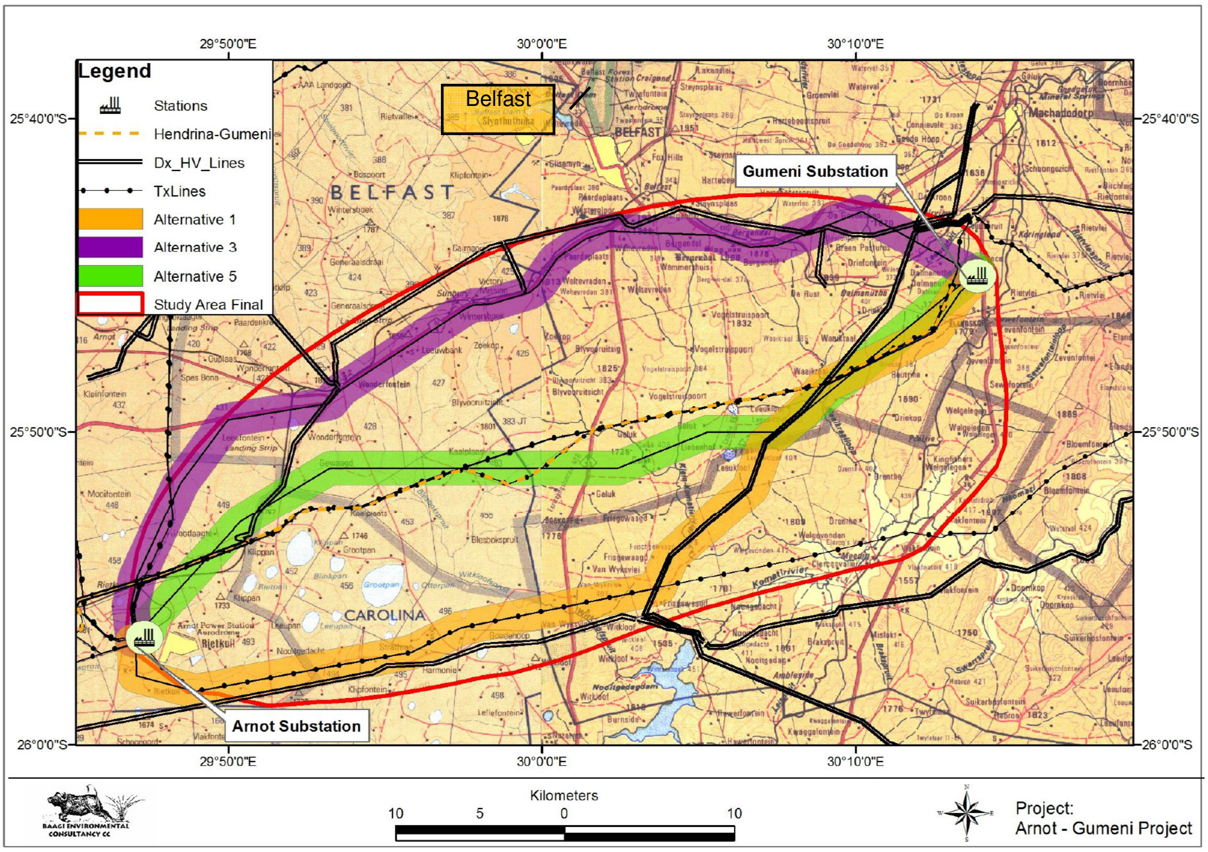
The IFC Policy and Performance Standards on Social and Environmental Sustainability

(2006) list guidelines relevant to the construction and operational procedures. The specific guidelines making direct reference to soils are Performance Standards 3, 4 and 6 . The intention and scope of the standards are listed below in Table 4.1;

5 PHYSIOGRAPHY

5.1 Location

The proposed routes link Arnot Power Station to the Gumeni Sub-station, in the central Mpumalanga region of South Africa. The sites move from the Highveld (coal belt) areas to the upper escarpment (extension of the Drakensburg formation).



*** Source:** Baagi

Figure 5.1: Regional Site Locality Plan

Figure 5.1 above shows the relative position of the site to Belfast. More detailed (higher resolution) plans are presented in Appendix A for further information.

5.2 Topography

The areas of concern investigated are 3 unique routes, a southern (Alt 1), a central (Alt 3) and northern (Alt 5). The routes cross various catchments, geologies, biomes and altitudes.

5.3 Climate

Rainfall, evaporation and temperature figures were obtained from regional DWAF and Weather SA (www.weathersa.co.za) data obtained by the project team.

The climate is representative of the cool temperature climatic zone, typical of the Lowveld region of the eastern escarpment of South Africa. Rainfall figures have been interpreted along with the evaporation figures in an attempt at determining the best climatic information for the six wettest years within the last twenty year period.

Approximately 65 - 70% of the area's rainfall occurs during the summer months between October and March, in the form of conventional thunderstorms and showers, and measure between 450 and 750 mm/year.

Evaporation in the area varies between 540 - 720 mm per annum. Even though total yearly rainfall is below the total yearly evaporation, the development of seepage of waste from the ground is possible and provision will need to be made for sufficient area to be set aside for the management of domestic sewage and grey water disposal to the soils if this method is to be considerate.

5.4 Existing Land Use Pattern

In previous years the land use pattern was confined to dryland grazing of various livestock, but more recently overhead (pivot) irrigation has become prevalent in the lower areas. In recent time the use of the land seems to be from such diverse crops as maize (Karoo sediments) soya-beans and legumes (mafic and ultra-basic geological parent material).

The economic viability of farming in this region is dependent on the optimisation of the use of water and fertilisers (input costs). A better understanding of the soil conditions on the properties, and the maximisation of water utilisation will result in increased profit margins, and better productive growth regimes.

6 RESULTS

Although a detailed survey was not undertaken the large groupings of typical soils can be reviewed. Broadly speaking the soil types below were encountered;

- Dry soils;
  - Sandy, apedal soils (Clovelly, Hutton, Griffin etc.);
  - Structured, basic/ mafic or ultra-mafic soils (Swartland, Sterkspruit, Valsrivier etc.); and
- Hydromorphic soils;
  - Sandy hydromorphic (Avalon, Arcadia, Pinedene and Bainsvlei etc.)
  - Structured hydromorphic soils (Westleigh, Bonheim, Katspruit and Longlands etc.)

6.1 Sol Description

Hutton (Hu)

The Hutton Form soils mapped comprise predominantly fine grained sandy, to silty loams or fine to medium grained sandy clay loams, varying from those with a single grained structure, to those with an apedal structure. These soils generally returned pale red brown to yellow red colours in the topsoils and fine to medium grained sandy and silty clay loams, with dark orange reds and dark red colours in the sub soil horizons. The relatively high magnesium and iron content of the parent rocks from which these soils are derived, impart the strong red colours noted. Clay contents generally vary from as low as 10% to 15% in the sandy topsoils. In the topographically lower lying areas, the high clay contents are associated with the colluvial-derived material, generally associated with the wetland areas and flood plain environments. The subsoil clay percentages range from 25% to 35% depending on the position that they occupy in the topographic sequence.

In almost all cases mapped, the soils classify as having a mesotrophic or dystrophic leaching status (moderately to highly leached) and are generally luvic in character. This implies that the soils are only moderately leached (as evidenced by their red colours) and have formed in-situ. These soil forms generally occupy the upper and upper midslopes and are most often found in association with the Griffin and Clovelly Form soils. Effective rooting depths vary from 200mm to greater than 1,500mm.

Chemically, these soils are of the more productive soil forms in the area, the dominant nutrients returning moderate reserves of Ca and Mg, with lower than required reserves of Na and K for most economical agricultural activities. Additions of fertilisers are required if economically sustainable farming is to be undertaken on a long-term basis.

Clovelly (Cv) and Griffin (Gf)

Soils of the Clovelly and Griffin Form have very similar characteristics to the Hutton Form described above and are generally derived from the same parent materials within the same lithological sequence. These soils returned physical and chemical characteristics very similar to the Hutton described before. The physical characteristics of these soils mapped vary in nature, from those with a very fine to medium grained sandy and/or silty loam, with pale grey brown to yellow brown colours and a single grained orthic topsoil ("A" horizon), on a yellow to yellow/red dystrophic "B", to those with a more clay rich sandy clay loam, displaying much darker yellow reds and less leached colours. These soils exhibit a predominantly dystrophic leaching status and luvic characteristics.

Generally, these soils were noted to interface directly on a hard rock contact with only a thin saprolitic layer. This phenomenon is due mainly to the horizontal or sub horizontal bedding of the sandstone parent material from which they are derived. These sandy to-sandy-clay loams are confined predominantly to the midslope and lower midslope positions and often exhibit a thin plough pan layer at approximately 300mm, an indication of the depth to which the soils have generally previously been compacted. The effective rooting depths vary from a minimum of 400mm to greater than 1,500mm where they are inhibited by physical or chemical barriers. Compaction and erosion are physical hazards to be aware of and catered for, when working with these soil types. Chemically, these soils returned results similar to the Hutton soils described above.

Pinedene (Pn), Avalon (Av) and Bainsvlei (Bv)

The Pinedene, Avalon and Bainsvlei Forms mapped fall within the "hydromorphic" category of soils as classified. These soils are generally found associated with and down slope of the dry, sandy loams and sandy clay loams (Clovelly Form soils) and form the transition zone of the moist grasslands.

Chemically, these soils (characteristics are similar within these same forms) are moderately well leached returning significantly lower amounts of Ca and Mg as well as Na, K and P. The leaching of the nutrients from these soils is significant and the pale colours are evidence of the movement of water within the profile.

By definition, these soils vary in the degrees of wetness at the base of their profile. i.e. the soils are influenced by a rising and falling water table, hence the mottling within the lower portion of the profile and the pale background colours.

Depths of utilisable agricultural soil (to top of mottled horizon) vary from 200mm to 1,000mm. The deeper rooting depths (>600mm) are considered potentially utilisable soils, with those less than 400mm being considered to have a wilderness capability. In general, these soils are high in transported clay in the lower "B" horizon with highly leached topsoils and pale denuded horizons at shallow depths. The nutrient status is generally low.

These soils will be more difficult to work due to the wetness factor, both during the operations, as well as on rehabilitation. Compaction is a problem to contend with if these soils are to be worked during the wet months of the year. Stockpiling of these soils should be done separately from the dry soils and greater care is needed with the management of erosion problems during storage. Any strong structure that develops during the stockpiling stage will need to be dealt with prior to the use of this material for rehabilitation.

Westleigh (We)

The Westleigh soil form is by definition a soil with hydromorphic characteristics. It exhibits strong indications of wetness at shallow depths in the form of strong red to yellow/red mottling on a strong grey background.

In general, these soils are high in transported clay in the lower "B" horizon with highly leached topsoils and pale denuded horizons at shallow depths. The nutrient status is generally low.

These soils will be more difficult to work due to the wetness factor, both during the operations, as well as on rehabilitation.

Compaction is a problem to contend with if these soils are to be worked during the wet months of the year.

Stockpiling of these soils should be done separately from the dry soils and greater care is needed with the management of erosion problems during storage. Any strong structure that develops during the stockpiling stage will need to be dealt with prior to the use of this material for rehabilitation.

Glenrosa (Gs) Dresden (Ds) and Mispah (Ms)

The Glenrosa, Dresden, and Mispah soil forms returned effective rooting depths of between 150 and 400mm. The major constraint envisaged with these soils will be tillage, sub surface hindrance and erosion. The restrictive layer associated with these soils is a hard lithocutanic layer in the form of weathered parent material, or rock. The effective soil depth is restricted, resulting in reduced soil volumes and as a result, depletion in the water holding capacity as well as nutrient availability.

Geophysical characteristics of these soils include moderate to high clay percentages (20 to 32%), moderate internal drainage and low water holding capabilities. These are of the poorer land capability units mapped. It is imperative that good management of these soils is implemented, both from the erosion as well as the compaction perspective.

Kroonstad (Kd), and Katspruit (Ka)

The Kroonstad and Katspruit soil Forms are found associated exclusively with the wetland and vlei areas alongside the rivers and around the prominent pan features. The hydromorphic nature of these soils renders them highly susceptible to compaction and erosion.

Re-working of these soils for rehabilitation purposes will need to be undertaken during the dry months of the year, and will require that the structure is broken down if these soils are to be used for topdressing of areas prior to replanting.

Bonheim (Bo)

The Bonheim soil forms are found associated with the more basic derived lithologies found extensively in this area. The often hydromorphic nature and structured texture of these soils renders them highly sensitive to compaction and erosion, which results in the need for re-working of these soils for rehabilitation purposes. This will need to be undertaken during the dry months of the year, and will require that the structure is broken down if these soils are to be used for topdressing of areas prior to replanting.

Arcadia (Ar)

The Arcadia soil form is by definition a highly structured soil on an unspecified base. It exhibits extremely strong structure from surface.

In general, these soils are high in transported clay topsoil and subsoil layers. The nutrient status is generally low, and these soils will be more difficult to work due to the strong vertic structure both during the construction operations, as well as on rehabilitation. Compaction is a problem to contend with if these soils are to be worked during the wet months of the year.

Stockpiling of these soils should be done separately from the less structured and wet based soils, and greater care is needed with the management of erosion problems during storage. Any strong structure that develops during the stockpiling stage will need to be managed prior to the use of this material for rehabilitation.

Katspruit (Ka) and Longlands (Lo)

The Katspruit and Longlands soil Forms are found associated exclusively with the wetland and vlei areas alongside the rivers and around the prominent pan features. The hydromorphic nature of these soils renders them highly susceptible to compaction and erosion.

Re-working of these soils for rehabilitation purposes will need to be undertaken during the dry months of the year, and will require that the structure is broken down if these soils are to be used for topdressing of areas prior to replanting.

6.1.1 Description of the Soil Properties

6.1.2 General Farmland Areas

In general the soil study indicated that the soils vary in depth from between 800 to ≥1,500 mm varying in both physical and chemical composition across the site. Typically the

Soil Forms are strongly influenced by the parent materials from which they are derived, as well as by their position in the topography, and the origin of the soils. Typically the *in-situ* soils are found in the mid and upper slope positions whilst the colluvially derived soils are found in the lower and bottom slope positions.

In the course of the soil survey a number of differing soils were mapped. The soils have been described in terms of the South African Soil Classification System.

The major soil forms encountered are of the structured pedocutanic phase, Swartland, Valsrivier and, along with some hydromorphic forms, including the Sepane Form soils. There are both structured as well as limited non-structured soils of varying strengths associated with the area studied.

These soils range from high quality agricultural soils with extremely good economic potential, to shallow, poor quality soils that are at best useful as grazing lands, as well as wet sensitive soils that are best conserved as wilderness land, and which will require high levels of management if they are going to be affected.

All areas inclusive of waterways have been included in the total area covered, and are depicted in Figure 6.1 (Soil Polygon Map).

Figure 6.1: Soils Polygon Map

6.1.3 Soil Chemical and Physical Characteristics

6.1.3.1 Soil Chemical Characteristics

Sampling of the soils for nutrient status was confined where possible to areas of uncultivated and undisturbed land. However, large parts of the areas has at one time or another been disturbed, and might well have been fertilized or impacted in the past by various activities.

The study was commissioned to determine the overall "sensitivity" of the soils, and as such, the more disturbed areas were assessed to determine the possible impacts associated with the soils and the impacts of on-going and proposed activities.

In general, and for the majority of the area, the soils are chemically and physically representative of the parent materials from which they have formed, either;

- Fine to very fine grained texture, blocky strong structure and poorly drained nature, indicative of the intrusive mafic host geology; or
- Medium to course grained texture, apedal to single grained, moderately to well drained and indicative of the sedimentary Karoo sediments, of the coal Highveld.

Of significance in the understanding of "soils sensitivity" is, its inherent physical and chemical properties, and how these properties are able to cope with added physical and/or chemical impacts.

Some of the aspects of the soils that should be considered include:

- ***Soil acidity/ alkalinity***

  As a rule the soil pH has a direct influence on plant growth in a number of different ways. These include:

  - Through the direct effect of the hydrogen ion concentration on nutrient uptake;
  - Indirectly through the effect on major trace nutrient availability; and by
  - Mobilising of toxic ions such as aluminium and manganese, which restrict plant growth.

  A pH range of between 6 and 7 most readily promotes the availability of plant nutrients. However, pH values below 3 or above 9, will seriously affect the nutrient uptake by a plant.

  Generally soils mapped in this area show alkaline or neutral acidity. The host mafic geology is indicative of these levels returned, and no cause for concern.

- ***Soil salinity/ sodicity***

  In addition, to the acidity/alkalinity of a soil, the salinity is of importance in a soils potential to sustain plant growth.

Highly saline soils will result in the reduction of plant growth caused by the diversion of plant energy from normal physiological processes, to those involved in the acquisition of water under highly stressed conditions.

Salinity levels of <60 mS/m will have no effect on plant growth. From 60 –120 mS/m salt sensitive plants are affected, and above 120 mS/m growth of all plants is severely affected.

In addition soil salinity may directly influence the effects of particular ions on soil properties. The sodium adsorption ratio (SAR) is an indication of the effect of sodium on the soils. At high levels of exchangeable sodium, certain clay minerals, when saturated with sodium, swell markedly. With the swelling and dispersion of a sodic soil, pore spaces become blocked and infiltration rates and permeability are greatly reduced. The critical SAR for;

- Poorly drained (grey coloured) soils is 6;
- Slowly draining (black swelling) clays it is 10; and
- Well drained, (red and yellow) soils and recent sands, 15.

Generally soils mapped in this area show little to no signs of natural salinity. Good management will prevent any future susceptibility to an increase in salinity.

- ***Soil fertility***

The results of the laboratory analysis are representative of the major soil forms mapped in the area on areas that are not presently being used or impacted. The general trend for these soil forms returned moderate to low (insufficient) levels of specifically calcium and magnesium (ratio) and high (excess) levels of potassium, phosphorus and zinc, of the nutrients required for good plant growth.

There are no indications of either toxic elements, or major deficiencies of nutrients that are likely to limit plant growth in the soils mapped within the study area.

- ***Nutrient Storage and Cation Exchange Capacity (CEC)***

The potential of a soil to retain and supply nutrients can be assessed by measuring the cation exchange capacity (CEC).

The lack of organic matter and/or clay minerals, which naturally provide exchange sites that serve as nutrient stores, will result in a low ability to retain and supply nutrients for plant growth.

Low CEC values are an indication of soils lacking organic matter and clay minerals. Typically a soil rich in humus will have a CEC of 300 meq/100g (>30 meq/%), while a soil low in organic matter and clay may have a CEC of 1-5 meq/100g (<5 meq/%).

Generally, the CEC values for the soils mapped in the area are moderate to high in clay, but low in organic carbon.

- ***Soil organic matter***

  The organic matter content of the soils is generally low. "Normal" productive soils have an organic matter content of 1-2%. Within the range of 0% to 4%, soil erodibility tends to decrease appreciably as organic matter increases, and the magnitude of organic matter effect is related to texture.

  Organic matter content of a soil is important in determining the soil erodibility factor K and the N mineralisation potential. It should be noted for this exercise, that the soils mapped are susceptible to erosion as well as compaction, and great care will need to be exercised on any soils that are to be disturbed or impacted by the operation.

6.1.3.2 Soil Physical Characteristics

In general, the soils of the area are relatively deep poorly drained soils, moderate to fine textured silty and clay loams, implying that they can during a construction or development process be difficult to work (drying out should be avoided).

Compaction within the "A" horizon is likely to occur if heavy machinery is used during the wet summer months over unprotected ground. In addition, leaching of these soils, and their erodibility are factors to be considered during any construction or rehabilitation process.

The moderately fine grained texture (where encountered) makes for restricted drainage of these soils along this horizon. This feature is believed to be highly significant to the overall soil water functioning within the profile, and the rapid movement of water through the profile and into the receiving water bodies (streams and dams). The apparent lack of any build-up of contamination in the soils is believed to be directly attributable to the hydrological process within the soils.

The more structured soils (very dark soils) have a moderate blocky structure and are generally associated with the intrusive lithologies (mafic geology) soils. All of these soils will need to be dealt with separately from the better drained materials (if encountered).

The end result is a complex of differing soil forms within a relatively small spatial area.

6.1.4 Characteristics of different Soil Groups

6.1.4.1 Soil Texture

6.1.4.1.1 The Heavy Clay Rich Soils

The majority of the soils with any degree of structure are associated with the mafic intrusions or basic host geologies of the region. The more structured soils generally exhibit slightly expansive properties, with signs of cracking within the soil profile in the dry state, and some evidence of *slick-n-sides* in the wet state. Generally the C-horizons that underlie these horizons are composed of moderately hard weathering rock or directly onto hard rock.

Intake rates and drainage of these soils are poor, while the erosion hazard is moderate to high. These soils generally have a moderately good nutrient status, but are subject to serious limitations if the soils are worked too wet or too dry.

6.1.4.1.2 Lighter Textured Soils

The majority of these soils are characterised by an orthic "A" horizon overlying a pale red or red-brown apedal "B" horizon, with indications of mottling within the lower "B" horizons in the case of the hydromorphic soils. The working of these soils as well as the storage (stockpiling) will need to be well managed due to the potential erosion and compaction hazard (separate from the structured soils).

6.1.4.1.3 Shallow Soils

Limited areas can be classified as being associated with moderately shallow soils (≤400mm). However, the resistant nature of the parent material results in an undulating weathering profile and soils that are between 100mm and 400mm deep. Erosion is the main problem that will need to be managed on the shallow soils.

6.1.4.2 Soil Distribution

The distribution of the soils closely linked to the parent materials from which they are derived. The more structured soils associated with the mafic and ultra-mafic parent materials noted in the majority of the study area. Please refer to the soils map (Figure 6.1) for a detailed reference to the soil distribution.

6.1.4.3 Soil Erodibility

The erosion potential of a soil is expressed by an erodibility factor ("K"), which is determined from soil texture, permeability, organic matter content and soil structure. **The Soil Erodibility Nomograph of Wischmeier** *et al* (1971) will be used to calculate the "K" value during the detailed assessment. The index of soil erosion is determined by multiplying the K value by the slope %.

The "K" value can also be used to determine the erodibility of a particular soil form. Erodibility is defined as the vulnerability or susceptibility of a soil to erosion. It is a function of both the physical characteristics of that soil and the treatment of the soil.

Erodibility ratings are:

- Resistant "K" factor = <0.15
- Moderate "K" factor = 0.15-0.35
- Erodible "K" factor = 0.35-0.45
- Highly Erodible "K" factor = >0.45

The erosion indices for the dominant soil forms on the study site are generally moderate. The gentle topography that characterises the study site will aid in reducing the erosion potential.

Good management of these soils for compaction and erosion will be needed throughout any development, during construction and into the operational phase.

The wet and structured soils are more susceptible to compaction, and generally have a higher erosion index. These soils will need to be managed extremely well, both during any stripping operation, or during storage, and at the time of rehabilitation.

Existing erosion problems have for the most part been caused by spills from the existing surrounding facilities or their related infrastructure. The removal of the vegetative cover (by physical or chemical impacts) and disturbance of the topsoil's is all that is needed to initiate the process of erosion.

6.1.4.4 Soil Rooting Depth (Effective Rooting Depth)

The average soil depths of the areas that are proposed to be disturbed were determined using a Dutch Auger (1.5m). The depth of the soils is important in the determination of the agricultural potential of the soils. The rooting depth and total soil depth are different, with all inhibiting layers and restrictions being accounted for in the determination of the ERD. Restrictions can vary from stone lines, plough pans, chemical layering (natural or man induced) etc.

On average, the more silty and clay loams (strongly structured) that make up the majority of the study area returned rooting depths of between 800mm and a deeper than 1,500mm.

It is important to note the author has not only considered soil depths, rather the complex interrelationship that exists between chemical and physical (structure, clay content moisture holding capacity etc.), and the distribution of usable soils, in the context of existing farming practices were considered as key drivers in determining the final rating presented here.

7 IMPACT ASSESSMENT

The impact assessment is summarised below. The impacts, due to the detailed infrastructure, will be covered under the general areas, with the final positions not set yet. The impact assessment methodology is detailed in Appendix B of this document.

7.1 Pre-Construction and Site Development

7.1.1 Soils

7.1.1.1 Impact on soils – Exploration Infrastructure (geotech)

Impact Assessment

The impact on the soils stripped during the construction of the field camp and geotechnical drilling and sampling will probably be **Medium** in the short term. The disturbance of the clay rich and more sensitive soils will lead to the formation of hard clods on drying, and should only be worked in the dry state. These soils are generally moderate to highly susceptible to compaction and erosion.

The area that will be affected by the construction of infrastructure is relatively small (isolated pylon pads, access and trenching), when compared to the total site area. Continuous rehabilitation of areas that have been decommissioned will be ongoing. This will limit the size of the affected area.

The sensitive nature of the soils mapped will need to be managed exceptionally well.

Mitigation/Management

The impacts on the soils may be mitigated with a number of management procedures, including:

Effective soil stripping during the winter months, which will help to maintain the structural integrity of the soils;

Soil replacement and the preparation of a seed bed to facilitate the re-vegetation program and to limit potential erodibility during stockpiling as well as at rehabilitation.

Soil amelioration to enhance the arable capability of the soils, so that they can be used for rehabilitation at the later stages and to maintain the soils viability during temporary storage.

Care will need to be taken to keep all stockpiled soils in storage vegetated and protected from erosion. The soils will need to be stripped in sequence (topsoil and subsoil) and will need to be kept separate from one another if rehabilitation is to be executed successfully and cost effectively. It is suggested that an average topsoil depth of 250 mm be stripped and stockpiled separately from the lower 400 to 500 mm of subsoil where present.

Residual Impact

The above management procedures will probably reduce the significance of the impacts to **Low/Medium** in the short term.

Management	Severity	Spatial Scale	Duration	Probability	Consequence	Significance
Unmanaged	Medium	Localised	Short term	High	Medium	Medium
Managed	Low/Medium	Localised	Short term	High	Medium	Low/Medium

7.2 Construction Phase

7.2.1 Soils

7.2.1.1 Impact on soils – Pylons and Infrastructure

Impact Assessment

The soils covering the pylon footprint and associated infrastructure areas consists predominantly of sandy to sandy-clay loams. These soils are susceptible to compaction and erosion. Stripping of the usable soils during the opening of the footprint site will definitely have a **Moderate** negative impact on soils in the medium term due to the relatively small area that will be affected.

The area to be disturbed, and the relatively small volumes of topsoil and subsoil to be affected establishment and the related infrastructure associated with the project. The soils to be affected are generally sandy loams or sandy clay loams, and are moderately easily worked under a range of climatic conditions, and can be stored for extended periods of time, if the erosion and compaction impacts are managed.

The wet based soils, and those with a heavier structure associated with the stream/ riverine area, will need to be removed and stockpiled separately. These soils will be more difficult to work and manage

Mitigation/ Management

The impacts on the soils may be mitigated with a number of management procedures, including:

Effective soil stripping during the winter months, which will help to maintain the structural integrity of the soils;

Soil replacement and the preparation of a seed bed to facilitate the re-vegetation program and to limit potential erodibility during stockpiling as well as at rehabilitation.

Soil amelioration to enhance the arable capability of the soils, so that they can be used for rehabilitation at closure/ rehabilitation and to maintain the soils viability during storage.

Care will need to be taken to keep any wet soils separated from the dry soils, and to keep all stockpiled soils that are in storage, vegetated and protected from erosion. These soils will be stripped in sequence (topsoil and subsoil) and will need to be kept separate from one another if rehabilitation is to be executed successfully and cost effectively. It is suggested that an average topsoil depth of 250 mm be stockpiled separately from the lower 400 to 500 mm of subsoil where present.

Residual Impact

The above management procedures will probably reduce the significance of the impacts to **Low** in the long term.

Management	Severity	Spatial Scale	Duration	Probability	Consequence	Significance
Unmanaged	Medium	Localised	Medium term	High	Medium	Medium
Managed	Medium	Localised	Long term	High	Medium	Low

7.3 Operational Phase

7.3.1 Soils

7.3.1.1 Topsoil and Subsoil Handling

Impact Assessment

The significance of the impacts of the soils on the proposed operational corridor would generally be differentiated according to the two different categories of soils that occur. For the study area in question the soils are moderately homogeneous, with the basic nature of the parent material having imprinted a strong structure and high clay content to the soils.

- The free draining soils (red and yellow-brown soils);
- The soils associated with a shallow or perched water table (grey and black soils).

The free draining soils are susceptible to compaction in their wet state, however, they are generally easily worked and stockpiled. These soils may also be susceptible to wind and water erosion if adequate drainage and vegetation cover is not considered. On this basis, the significance of disturbing these soils will probably be a **Moderate** negative impact in the medium term.

The black and grey coloured gleyed soils are, however, highly susceptible to disturbance. Working of these soils, in the wet state may cause long term damage to soil structure. On drying the high clay content will lead to the formation of strong blocky structures (clods) that are difficult to work. The soils are also highly susceptible to erosion and compaction. The significance of the impact will probably be **High** negative in the medium term

There will be a definite **moderate** to **high** negative impact on the soils in the long term due to construction phases.

Mitigation/ Management

The impacts on the soils may be mitigated with management procedures including:

- Effective soil stripping during the dry winter months. This will help to maintain the structural integrity of the structured soils;
- Soil replacement and the preparation of a seed bed to facilitate the re-vegetation program and to limit potential erosion, and

- Soil amelioration to enhance the capability of the soils and sustain the soils ability to retain oxygen and thus sustain vegetative material during the storage stage.

These two categories should be stockpiled separately and managed accordingly

Residual Impact

In the long term, the above mitigation measures will probably reduce the impact of topsoil and subsoil handling on both the topsoil as well as the more structured subsoils to a **Medium** impact.

Management	Severity	Spatial Scale	Duration	Probability	Consequence	Significance
Unmanaged	Medium	Localised	Medium term	High	Medium	Medium
Managed	Low	Localised	Short term	High	Low	Low

7.4 Closure Phase

7.4.1 Soils

7.4.1.1 Rehabilitation

Impact Assessment

Ongoing rehabilitation during the decommissioning phase of the project will probably bring about a long-term positive impact on the soils. The initial impact will be **High** but mitigation will ensure a **Medium** since the chemical and physical properties of the soils will improve through rehabilitation works.

Residual Impacts

On closure the long-term negative impact on the soils will probably be of **Medium** significance if the management plan set out in Environmental Plan is effectively implemented to reinstate current soil conditions.

Chemical amelioration of the soils will possibly have a **Low** impact on the nutrient status (only) of the soils in the medium term.

Management	Severity	Spatial Scale	Duration	Probability	Consequence	Significance
Unmanaged	Medium	Localised	Long term	High	Medium	High/Medium
Managed	Low	Localised	Long/ Medium term	High	Medium	Medium/Low

8 MANAGEMENT PLAN

Eskom has a standardised rehabilitation plan and procedure for the handling of vegetation and soils. This EMP is a combination of these elements and considered best practice as recommended by the author, as a specialist within the discipline field. The significance rating of the site before and after mitigation is detailed above, and these results are used to make recommendations in this section. This section is legally binding on the client and has significance to the financial status and provision that will be incurred and which will need to be provided. With this in mind, the proposed management and mitigation measures detailed herein will need to be adhered to.

8.1 Construction and Operational Phase

8.1.1 Vegetation of the Stockpiles and Berms

OBJECTIVE

To stockpile the soils removed from the construction areas that are to be disturbed, and to create a feature that emulates the existing landscape as closely as possible, and does not adversely impact on the area in general.

ACTION

8.1.1.1 Soils

Soil Handling and Removal

The sandy clay and sandy clay loams from the topsoils, will be stockpiled and used to create berm structures upslope of each Pylon bed, while the upper portion of the more structured subsoil, and overburden material (where removed) can be stored as separate stockpiles close to the areas where they will be required for rehabilitation.

The soils removed from the servitudes routes etc. must be stored along with existing stripped soils to be easily used for rehabilitation of the infrastructure at closure. All the soils should be stripped to a depth of approximately 450 mm or until hard rock where applicable. The base to the structures to be constructed should be founded on stabilised material, the soils having been stripped to below the topsoil contact (250 mm).

It will be necessary to differentially strip the topsoil and subsoil horizons, while every endeavour should be made not to disturb or work the soils during the wet summer months due to their susceptibility to compaction.

The shrubland soils should be fertilised with super phosphate prior to being stripped. This will ensure that the fertiliser is well mixed into the soil during the stripping operation and will reduce the amount of fertiliser required during the rehabilitation program.

Soil Replacement and Land Preparation

It is proposed that the construction of the berms and soil storage stockpiles is undertaken in a series of 500 mm lifts if the storage facilities are to be greater than 500 mm high. Some of the topsoils can be utilised to top dress the stockpiles if required, while the heavier subsoil's can best be used to form the base of the berm structure. Utilising the soil in this manner will maximise the beneficial properties of each material, and help to reduce erosion of the stored soils.

It is imperative that if the topsoils are used to cap the berm/ stockpile structure, that they are well protected from erosion and compaction. These topsoils must be adequately vegetated as soon after construction as possible and maintained throughout the life of project. It is recommended that the following actions be implemented:

- During the construction phase (stripping of soils)
    - Strip and stockpile the topsoil from the pylons and associated infrastructure separately from the subsoils and overburden (if encountered) from the deeper foundations. The soil storage facility and berms should comprise a series of 500 mm terraces if the height required is >1,500 mm, at an angle of 1:6 (9.5^0). The topsoils should then be spread evenly over the top and sides of these structures if required,
- During the construction phase
    - Disc the area using a large disc harrow
    - Add the fertiliser and manure if required (see fertiliser recommendations). The fertiliser and manure should be added using a standard industrial spreader
    - Harrow the area again to ensure adequate mixing has occurred. The area can now be seeded with the recommended seed mix.
- On rehabilitation the soils will need to be replaced in order

If the soils are stripped in their dry state it will not be necessary to cultivate the topsoil. However, if the soils are stripped when wet then ripping and discing of the topsoil prior to stripping is recommended before to seeding of the soils in order to break up any structure that might have developed and obtain a well mixed material that can be stored for an extended period of time.

It is imperative, where possible, that the slopes of the stockpile berm facility are constructed to 1:6 (9.5^0) or shallower. This will minimise the chances of erosion of the topsoil. However, prior to the establishment of vegetation, it is recommended that erosion control measures, such as the planting of Vetiver Grass hedges, or the construction of benches and cut-off drains be included in the stockpile/ berm design. These actions will limit the potential for uncontrolled run-off and the subsequent erosion of the unconsolidated soils, while the vegetation is establishing itself, and throughout the life of the project.

<u>Fertilisers and Soil Amendments</u>

For soil amelioration, it is necessary to distinguish between the initial application of fertilisers or soil amendments and maintenance dressings. Basal or initial applications are required to correct disorders that might be present in the *in situ* material and raise the fertility status of the soil to a suitable level prior to seeding. The initial application of fertiliser and lime to the disturbed soils is necessary to establish a healthy plant cover as soon as possible. This will prevent erosion. Maintenance dressings are applied for the purpose of keeping up nutrient levels. These applications will be undertaken only if required, and only after additional sample analysis has been undertaken.

Fertiliser

It is recommended that prior to soil stripping, super phosphate fertiliser should be added to the sandy loams and sandy clay loams (yellow-brown and red soils) at a rate of about 200 kg/ha if they have not previously been fertilised or cultivated.

The soils mapped are generally deficient in zinc, phosphorus and potassium. It is therefore recommended that a standard commercial fertiliser be added to the soil before re-vegetation. The fertiliser should be added to the soil in a slow release granular form at a rate of approximately 200 kg/ha.

It will be necessary to re-evaluate the nutrient status of the soils at regular intervals to determine the possibility of needing additional fertiliser applications.

The following maintenance is required:

- The area must be fenced, and all animals kept off the area until the vegetation is self sustaining
- Newly seeded/planted areas must be protected against compaction and erosion.
- Traffic should be limited were possible while the vegetation is establishing itself.
- Plants should be watered and weeded regularly;
- Check for pests and diseases at least once every two weeks and treat if necessary;
- Replace unhealthy or dead plant material;
- Fertilise, hydro seeded and grassed areas with 200 kg/ha ammonium sulphate 4-6 weeks after germination, and
- Repair any damage caused by erosion;

8.1.2 Maintenance of Rehabilitated and Planted Areas

Stockpiles/ berms and rehabilitation ground

OBJECTIVE

To create indigenous grass cover that will stabilise the soils in the short term, and re-create the natural grassland in the long term.

ACTION

8.1.2.1 Soils

Soil handling and Removal

The topsoil and sub-soil horizons must be stripped separately since the physical, biological and chemical characteristics of the topsoil are generally more suitable for the germination, survival and growth of vegetation. The depth-limiting horizon, for most of the soils on the site, is either the saprolitic C- horizon or rock (R), or the structured B- horizon. However, in the case of the more clay rich and structured soils associated with the more basic parent materials, the strong structure associated with the soil B- horizon is the limiting factor in determining the depth of rooting.

Soil stockpiling will be required for all areas that are to be affected by the infrastructure. All foundations, or “Pad” areas will need to be stripped of the valuable topsoil and a proportion of the subsoils in order that there is sufficient soil available at closure to rehabilitate the disturbed areas (roads, plant, offices etc.), or to top dress the features that will remain permanently in place (tailings dams etc.). The soils so stockpiled must be minimised as far as possible, utilising as small an area as is practical, without compromising the integrity of the soil stored. The soils will best be stored as berm structures upslope of the area, small soil piles along the servitudes, and for the construction of the dam walls (if suitable) for the storm water control dams. However, excess soil from the subsoil horizons, and the soft saprolitic layer might need to be stockpiled in larger amounts. These soils should then be stockpiled in a series of 500 mm lifts, as terraces to a maximum of 15m.

Vegetation (grass and small shrubs) should not be cleared from the site prior to stripping. The maintenance of the vegetative matter will provide additional organic nutrients to the soil, which will aid the soils during the rehabilitation process, and will help to preserve the soil structure while stockpiled.

In general it is recommended that 200 kg/ha of fertiliser be added to the soil prior to stripping. This will ensure that the fertiliser is well mixed into the soil during the stripping operations and will reduce the amount of fertiliser that will be needed on rehabilitation.

Soil Replacement and Land Preparation

Soil replacement depths are controlled by the pre-construction soils available, and all soils should be replaced to a similar depth as was encountered prior to the operation, but at least to a depth that will sustain grazing (400 mm) land capability.

Stones and boulders, encountered on the site during the stripping operation should be stockpiled with the overburden, and should be buried as deep in the soft overburden as possible, so that they do not interfere with the preparation of the seedbed during either the stockpiling stage, or the rehabilitation stage.

The action of soil stripping causes the material to expand in volume, a process known as bulking. This is followed by a degree of natural compaction as the material settles after replacement. Induced compaction may lead to the following problems:

- Differential subsidence causing the development of hollows where water may collect and result in the water logging of materials;
- Drainage impedance leading to a high water table, restricted rooting depth, water logging and an increased potential for flooding; and
- Prevention of proper root development.

Limiting the access of vehicles onto the rehabilitated land may reduce induced compaction. Tracked vehicles or those with high floatation tires should be used in preference to normal wheeled vehicles in the levelling operations. Ripping of the topsoil just prior to planting may also alleviate the effects of over-compaction.

The areas rehabilitated will be levelled so as to emulate the pre-construction contours, and soils should, ideally, not be placed on slopes with a gradient greater than 6% to limit the potential for erosion. A shallow slope is preferable to enhance sub-surface drainage. Adequate sub-surface drainage will limit the potential for salinisation of the soils and should enhance the potential of the soils.

In order to further limit erosion, prior to the establishment of vegetation, it is recommended that erosion controls be placed the required intervals over the rehabilitated land, using either Vetiver grass or contour ridges. This should limit the effect of uncontrolled run-off onto the unconsolidated soils.

It is recommended that the soils should be prepared as follows:

- Replace overburden from stockpiles, followed by the subsoils. Spread the soils evenly over the rehabilitated area to achieve pre-construction topography and compacted.
- In the case of the structured soils (Swartland, Sterkspruit etc.) that might have been disturbed, they should be levelled, ripped and diced to break up any induced structure (soil clods). Ripping is only recommended for the wet based and clay rich soils (dark or grey structured soils). A moderately deep rip is recommended as this helps to break up any compacted layers and clods, improves water infiltration and drainage, increases root penetration and aerates the soil. However, care must be taken not to rip the soils excessively since over-ripping may hasten the oxidation of organic material in the soil and may break down stable soil aggregates;
- Add the topsoils and cultivate, the fertiliser should be added using a standard fertiliser spreader and should be applied in small quantities at regular intervals.
- The area is now ready for seeding.

<u>Fertilisers and Soil Nutrition</u>

Fertiliser requirements reported herein are based on the sampling of the soils at the time of the baseline survey. These levels will change during the stockpiling period due to a number of physical and chemical processes. The fertiliser requirements should thus be re-evaluated at the time of rehabilitation. It is recommended that a qualified person be employed to establish the lime, organic matter and fertiliser requirements that will be applied, prior to the starting of the rehabilitation process.

<u>Fertiliser</u>

Application of fertilisers should be carried out in small quantities at regular intervals so as to avoid any contamination of the surface water or groundwater environs.

Analysis of the soils on the site returned deficiencies of zinc, phosphorus and potassium. A standard commercial fertiliser should be added to the soil in a slow release granular form at a rate of approximately 200 kg/ha before re-vegetation (These results must be verified prior to rehabilitation commencing).

It will be necessary to re-evaluate the soil conditions of the site at regular intervals to determine if additional fertiliser applications are required.

<u>Soil Sampling</u>

During the rehabilitation exercise preliminary soil sampling should be carried out to determine the fertiliser requirements. Additional soil sampling should also be carried out annually until the levels of nutrients, specifically phosphorus and potassium, are at the required level (approximately 20 and 120 mg/kg respectively). Once the desired nutritional status has been achieved, it is recommended that the interval between sampling be increased. An annual environmental audit should be undertaken. If growth problems develop, ad hoc, sampling should be carried out to determine the problem.

Sampling should always be carried out at the same time of the year and at least six weeks after the last application of fertiliser.

All of the soil samples should be analysed for the following parameters:

- pH (H_2O);
- Electrical conductivity;
- Calcium mg/kg;
- Magnesium mg/kg;
- Potassium mg/kg;
- Sodium mg/kg;
- Cation exchange capacity;
- Phosphorus (Bray I);
- Zinc mg/kg;
- Clay% and;
- Organic matter content (C%).

9 CONCLUSIONS

In summary then the following is noted;

Table 9.1: Comparison table for alternative 400kV powerline routes;

Alternative 1	Alternative 3	Alternative 5
Moderate to high potential agricultural soils • Good Agricultural Potential o Apedal, low structure o Predominantly red and yellow/red soils o Moderate clays o Suitable drainage/ permeability's o Gently sloping terrain • Poor Agricultural Potential o Ferricrete and plough-pans in areas (≥300mm) o Relatively highly developed farming areas o Limited hydromorphic soils (wetlands &	Moderate potential agricultural soils • Good Agricultural Potential o Predominantly red and yellow/red soils o Suitable drainage/ permeabilities o Gently to moderate sloping terrain • Poor Agricultural Potential o Ferricrete and plough-pans in areas (300-400mm) o Well highly developed farming areas o Apedal to moderate structures o Moderate to high clays o High prevalence of hydromorphic soils	Moderate to high potential agricultural soils o Good Agricultural Potential o Predominantly red and yellow/red soils o Suitable drainage/ permeabilities o Gently sloping terrain • Poor Agricultural Potential o Ferricrete and plough-pans in areas (300-400mm) o Well highly developed farming areas o Apedal to low soil structure o Moderate clay content o Limited hydromorphic

drainage zones)	(wetlands zones)	soils (wetlands & drainage zones)

Alternative 1, is thus the preferred option when considering the impacts on the region (un-impacted), lands in the areas. It is wise to note that the use of already altered lands (existing works, lay-down areas, etc.), should be prioritised (and thus ranked higher), over the un-impacted lands assessed in this report. This recommendation is made due to the high costs (time and money) associated with rehabilitation and recovery of viable arable lands (yield and natural recoverability),

Thus the ranking (in terms of suitability for the proposed location of the beneficiation plant is as such;

Alternative 1

- Existing corridor (50% of distance)
- Moderate to high potential soils

Alternative 5

- Existing corridor (20% of distance)
- Moderate to high potential soils

Alternative 3

- Existing corridor (≤10% of distance)
- Moderate potential soils

It is important to note the author has not only considered soil depths, rather the complex interrelationship that exists between chemical and physical (structure, clay content moisture holding capacity etc.), and the distribution of usable soils, in the context of existing farming practices were considered as key drivers in determining the final rating presented here.

Appendix A: Detailed Plans/ Figures

Appendix B: Impact Methodology