SOIL SURVEY REPORT OF FARM 845, SIR LOWRY'S PASS

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INTRODUCTION

The soil survey of the farm 845, Sir Lowry's Pass was instructed by Guillaume Nel Environmental Consultants during September 2017. Soil profile pits were dug on a grid by machine and the soil survey was done the following week. This soil survey report is an essential document of information needed for possible rezoning of a portion of Farm 845.
The terms of reference regarding the form of the soil survey and report is as follows:

- A detail soil survey of Farm 845 to determine the inherent properties, mainly physical and morphological, of the soils.
- Compilation of a soil map at scale large enough (1: 2500) to describe the natural distribution of the soils.
- Description of the soils in the different map units in terms of their physical and morphological properties.
- Evaluation of the general suitability of the soils in terms of agricultural potential according to the guidelines of Lambrechts *et al* and the National Department of Agriculture published in 2004.

ALLOCATION OF RESPONSIBILITIES

The following individuals were responsible for the various actions during the soil survey:

- The firm Guillaume Nel Environmental Consultants for providing the base map and organising the digging of soil pits. Initially a fixed grid spacing of 100 m x 100 m was recommended but in total 29 profile pits were dug.
- The soil surveyor (soil specialist and compiler of this report) for describing and classifying the soil profiles in the field.
- The surveyor was be responsible for compilation of the soils map and a report on the properties, limitations and relative suitability of the soils for wine grapes. A map with a satellite picture as background supplied by Guillaume Nel Environmental Consultants was used to pin point the exact position of the profile pits.

DESCRIPTION AND CLASSIFICATION OF SOIL PROFILES

A total of 29 profile pits were described during the field study that took place. The soil profiles were investigated in the field and the important properties were described following standard procedures.
Based on recognizable, as well as inferred properties, the soils were classified according to **Soil Classification: A Taxonomic system for South Africa** (Soil Classification Working Group, 1991) into **soil forms and soil families**. This system is based on the recognition of diagnostic soil horizons and materials.
Soil forms are defined in terms of the type and vertical sequence of diagnostic horizons or materials. For communication, soil forms are given locality names, e.g. Kroonstad and Cartref.

These names are abbreviated to two-letter symbols, e.g. Kd for Kroonstad and Cf for Cartref forms.
Soil forms are subdivided into soil families using properties that are not used in the definition of diagnostic horizons or materials. Reference to a soil family is by combining the soil form abbreviation and a four-digit symbol, e.g. Kd 1000 is family number 1000 of the Kroonstad form. In **Tables 2 & 3** all the soil forms and families identified during the soil survey are briefly described according to the soil code.

Depending on the purpose of the soil survey, soil families can be subdivided on an ad hoc basis into **soil phases** using properties such as soil and horizon depths, stoniness etc. Phase subdivision is achieved by detail coding of individual soil profiles (see **Attachment 1: Structure of Soil Code and Explanation of Symbols**).

FIELD SOIL SURVEY

During the survey the sites for soil pitting was selected in the field in such a way that most of the terrain types and terrain morphological units across the alternative sites were covered. The soil profile pits were investigated and described in the field and the important soil properties (e.g. texture, colour, mottling, structure, coarse fragments, horizon depths, etc.) were described following standard procedures prescribed by the ARC – Institute for Soil, Climate and Water, Pretoria. Based on recognizable, as well as inferred properties, the soils were classified according to the South African soil classification system (Soil Classification Working Group, 1991) into soil forms and soil families.
All soil forms and families described during the field soil survey are listed alphabetically according the soil form name in **Table 1**.

Table 1: Soil forms and families described during the field soil survey listed alphabetically according the soil form name

Abbre-viation — **Soil form and vertical sequence of diagnostic horizons and/or materials**

Cf — **CARTREF FORM**

Orthic A
E horizon
Lithocutanic B horizon

SOIL FAMILIES

1000 Colour of E horizon “grey” when moist

1200 B horizon hard

Es **ESTCOURT FORM**

Orthic A
E horizon
Prismacutanic B horizon

SOIL FAMILIES

1000 Colour of E horizon “grey” when moist

 1100 B horizon without black cutans on ped faces

Kd **KROONSTAD FORM**

Orthic A
E horizon
G horizon

SOIL FAMILIES

1000 Colour of E horizon “grey” when moist

 2000 Colour of E horizon “yellow” when moist

Wa **WASBANK FORM**

Orthic A
E horizon
Hard plinthic B horizon

SOIL FAMILIES

1000 E horizon grey when moist

In addition to the standard description the individual profiles were coded in detail according to a system used for detail soil surveys in the fruit and wine industry in the Western Cape (Lambrechts et al., 1978; **Note**: In **Annexure 3** the symbols used during this survey are explained).

The coded soil information were used to subdivide the soil families on an ad hoc basis into soil types using mainly soil depth limiting properties such as dense subsoil clay layers, weathering rock and hard ortstein layers. Soil types are identified by means of a symbol that consists of the abbreviation for the soil form followed by an Arabic number (e.g. Kd 1). The number suffix has no intrinsic meaning. It only serves as an identifier for different soil types that consist of soils belonging to the same soil form, but differ in one or more important soil properties.

In **Table 2** the soil types that were defined are briefly described in terms of soil form, diagnostic horizons, family criteria, additional features, average soil suitability rating and effective depth before and after possible amelioration of physical limitations. The soil codes are listed Farm 845.

Table 2: Soil codes and potential of profiles on Farm 845, Sir Lowry's Pass

Profile No	SOIL CODE	POTENTIAL	MAP SYMBOL
1	393Kd2000 gc 3f1g // co1 3/6	3,5 - 4	Kd
2	383Kd2000 gc 5f // co1 3/6	3,5 - 4	Kd
3	373Kd2000 gc 4f // 1f co1 6	3,5 - 4	Kd
4	363Cf1200 Rw 4f // co1 3/6 + Rock outcrops	3,5	Cf
5	25/62Cf21/200 sw 2f4g // co1 3	4	Cf
6	Rock + Ms2100	2	R
7	25Kd1000 gc // co1 6/7	3,5	Kd
8	363Kd1000 gc 2f1g // co1 6/7	3,5 - 4	Kd
9	363Kd1000 gc 2f1g // co1 6/7	3,5 - 4	Kd
10	Rock + Ms2100	2	R
11	13Es1100 pr gc // co1 7	3	Es
12	36/73Kd1000 gc 3f3g // co1 6	4	Kd
13	363Kd1000 gc 2f1g // co1 6/7	3,5 - 4	Kd
14	387Kd1000 gc // co1 3/6	4	Kd
15	262Kd1/2000 gc 2f // co1 6	3,5 - 4	Kd
16	363Kd1000 gc 3f2g // co1 6/7	3,5 - 4	Kd
17	25Kd1/2000 gc // co1 6	3,5	Kd
18	14Kd1000 gc // co1 6/7	3	Kd
19	262Kd1000 gc 4f // co1 6	3,5 - 4	Kd
20	262Kd2000 gc 2f2g // co1 3/6	4	Kd
21	13573Wa1000 hp1+4f4g gs+3f2g gc // co1 3/6	4	Wa
22	24Kd1000 gc // co1 7	3	Kd
23	242Kd1000 gc 2f2g // co1 6 >Es	3,5	Kd
24	262Kd1000 gc 4f // co1 6	4	Kd
25	36Cf1200 lw/sw // co1 3/4	4,5	Cf
26	135Es1100 pr gc // co1 6/7	3	Es
27	135Es1100 pr gc // co1 6 >Kd	3	Es
28	262Kd2000 gc 2f2g // co1 3/6	4	Kd
29	135Es1100 pr gc // co1 6 >Kd	3,5	Es

In **Table 3** codes of all the profiles described are listed alphanumerical according to the soil 3map legend.

Table 3: Soil codes and potential of profiles on Farm 845, Sir Lowry's Pass arranged according to Map symbols

Profile No	SOIL CODE	POTENTIAL	MAP SYMBOL
4	363Cf1200 Rw 4f // co1 3/6 + Rock outcrops	3,5	Cf1
5	25/62Cf21/200 sw 2f4g // co1 3	4	Cf1
25	36Cf1200 lw/sw // co1 3/4	4,5	Cf1
11	13Es1100 pr gc // co1 7	3	Es1
26	135Es1100 pr gc // co1 6/7	3	Es1
27	135Es1100 pr gc // co1 6 >Kd	3	Es1
29	135Es1100 pr gc // co1 6 >Kd	3,5	Es1
7	25Kd1000 gc // co1 6/7	3,5	Kd1
17	25Kd1/2000 gc // co1 6	3,5	Kd1
18	14Kd1000 gc // co1 6/7	3	Kd1
22	24Kd1000 gc // co1 7	3	Kd1
8	363Kd1000 gc 2f1g // co1 6/7	3,5 - 4	Kd2
9	363Kd1000 gc 2f1g // co1 6/7	3,5 - 4	Kd2
13	363Kd1000 gc 2f1g // co1 6/7	3,5 - 4	Kd2
15	262Kd1/2000 gc 2f // co1 6	3,5 - 4	Kd2
16	363Kd1000 gc 3f2g // co1 6/7	3,5 - 4	Kd2
19	262Kd1000 gc 4f // co1 6	3,5 - 4	Kd2
20	262Kd2000 gc 2f2g // co1 3/6	4	Kd2
23	242Kd1000 gc 2f2g // co1 6 >Es	3,5	Kd2
24	262Kd1000 gc 4f // co1 6	4	Kd2
28	262Kd2000 gc 2f2g // co1 3/6	4	Kd2
1	393Kd2000 gc 3f1g // co1 3/6	3,5 - 4	Kd3
2	383Kd2000 gc 5f // co1 3/6	3,5 - 4	Kd3
3	373Kd2000 gc 4f // 1f co1 6	3,5 - 4	Kd3
12	36/73Kd1000 gc 3f3g // co1 6	4	Kd3
14	387Kd1000 gc // co1 3/6	4	Kd3
6	Rock + Ms2100	2	R
10	Rock + Ms2100	2	R
21	13573Wa1000 hp1+4f4g gs+3f2g gc // co1 3/6	4	Wa1

MAP LEGEND AND SOIL MAP

A basic mapping legend was compiled to accommodate the variation in soil properties.

- soil form, and
- diagnostic horizons

Additional soil properties such as:

- family criteria;
- clay content of A horizon (topsoil);
- depth to B horizon;
- depth to and nature of lower subsoil horizons/materials;
- coarse fragments in top-soils and/or upper sub-soil horizons, and
- effective depth

are listed for each map unit. Additional properties may be deduced from the detail soil code. With reference to the accuracy of the soil map, the following aspects should be kept in mind:

- According to the original recommendation the grid spacing of the profile pits should be 100 m x 100 m. This means that the minimum size of a map unit that can be identified is approximately 1.0 ha. Soil units smaller than these limits could therefore be included in larger soil units on the map.
- In situations where the boundaries between map units coincide with relatively prominent changes in slope or other soil surface features, the soil boundaries are should be fairly accurate. On Farm 845 Sir Lowry's, however, the slope changes are usually gradual and the soil boundaries are therefore only approximate divisions.

The soil map units are shown on the Soil Map (**Annexure A**) and are identified by means of a symbol that consists of the abbreviation for the soil form combined with an Arabic number (e.g. Kd1). The number suffix has no intrinsic meaning. It is only serves as an identifier for different map units that consist of soils belonging to the same soil form, but differ in one or more important soil properties.

In **Table 3** the map units are listed alphanumerical according to the soil form symbol.

PHYSICAL SOIL LIMITATIONS

The minimum useable soil depth required for good root development and water and nutrient uptake to ensure healthy and productive plants differ greatly between different plant types and rootstocks. In addition, the tolerance of different plants to soil wetness and soil borne diseases may also vary greatly .In the following paragraphs the most important soil properties on Farm 845 that might affect infiltration, root development, and nutrient and water uptake will be discussed.

LOW CLAY CONTENT IN UPPER PART OF PROFILE

The ability of soils to store water and plant nutrients for use by plants is determined mainly by the clay content, particularly when the soils has a low organic matter content (<1 % organic carbon). At a clay content of less than 8 - 10 % the water storage capacity is already so low that it can be considered a limitation for crop production; the lower the clay content, the greater the limitation.

A low clay content is regarded as a limitation because such soils become very warm and dry out quickly. It is therefore difficult to maintain plant available water at an optimal level during warm summer months and when trees are young with a small leaf canopy. Dry land crops on such soils experience one or more dry stress periods during their growth cycle.

Sandy soils are normally permeable with a very rapid hydraulic conductivity and they are leached very quickly. It is therefore difficult to maintain the concentration of soluble plant nutrients (particularly nitrogen and potassium) at an acceptable level for optimal growth and development.

Another limitation of sandy top soils with low organic matter content is their susceptibility for water and wind erosion; the latter especially when the surface is bare during warm, dry periods. Wind transported sand grains can also cause serious mechanical damage to young plants.

It is important that irrigation systems on such soils are well designed and must be able to supplement water loss during periods with exceptionally high evapotranspiration. With regular soil water monitoring, above average irrigation management and other measures such as organic mulches, these limitations can largely be overcome. The same comments are applicable to fertilization.

Another problem of sandy top soils is that topsoil structures, e.g. ridges are extremely unstable and need regular maintenance. Sandy ridges dry our very quickly and become extremely warm.

DENSE SUBSOIL CLAY LAYERS

Dense clay layers occur as moderately to strong structured gleycutanic horizons (e.g. Kroonstad form (Kd)).

With a clear to abrupt (sharp) increase in clay from the overlying horizon to the clay layer, free water generally accumulates in the overlying, lighter textured horizon during the rainy season or as a result of over-irrigation. Under conditions of water saturation, reduction and loss of iron leads to the development of a bleached E horizon in the overlying sandy material (e.g. Kroonstad form). Such horizons can set hard on drying and have a high soil density.

The effective depth of soils with dense subsoil clay layers is therefore limited by the clay layer itself and indirectly by the periodic wetness in the overlying layer with less clay.

The dispersive nature of the clay due to high exchangeable magnesium + sodium to calcium ratios may also have a negative effect on the long-term loosening effect of mechanical amelioration measures such as deep soil tillage with a tine implement.

WETNESS

This refers to the presence of free water at varying depths in a soil profile.

On Farm 845 wetness occur mostly as **perched water tables**. This refers to the accumulation of free water in E horizons that may develop above a G horizon (Kroonstad form) and seasonal ground water tables which develop during the wet winter months especially in the Kroonstad soils in the lower lying area. Soil families with a "yellow" E horizon are generally less hydromorphic and have a more friable consistency than families with a "grey" E horizon

During the field survey the soil water condition in individual soil profiles was evaluated according to the wetness classification that was developed for soils in the winter rainfall region (refer to **Attachment 1**). This wetness classification is based on the number of days during the year and depth of saturation with water. Profile morphology is used to determine the depth of water saturation and the maximum height of signs of wetness is used as depth limit. Climate, locality, aspect, vegetation and water conditions during the survey as well as profile morphology were used to evaluate the duration of water saturation. The expected number of days of saturation during the rainy season in "wet" years is used to determine duration. It is essential for free water to occur in the profile continuously for at least seven (7) days. However, the total number of days with free water need not be continuous. The wetness rating for individual profiles is listed in **Table 2 and Table 3**.

Wetness during active root respiration results in a low oxygen concentration with an increased carbon dioxide concentration. This causes reduction of iron oxides/hydroxides and leaching of the reduced iron. As the iron content decreases soil density increases and very large soil strengths can develop when the soil dries out.

Other adverse effects of wetness are:

- Toxic concentrations iron (Fe^{2+}), manganese (Mn^{2+}), sulfides, nitrites, ethylene and volatile organic acids can develop. In certain plants a moderate degree of wetness will only have a negative influence on growth without dieback of the plants. Sensitive plants, however, can die back.
- Various diseases can become epidemic under wet conditions. *Phytophthora* in particular can wipe out sensitive crops/plants.
- As a result of limited volume of non-wet soil that is available for root development, plants have a restricted root system during the wet season. Crops with a high water requirement may show drought stress during warm and/or dry spells if water content becomes very low.

SUITABILITY OF SOIL TYPES FOR CROP PRODUCTION

The most common limitations for crop production of the soils in the study area are the following:

- low clay content
- dense subsoil clay layers;
- wetness

During the field soil survey the individual soil pits were evaluated by the surveyors in terms of its suitability for the commercial production of irrigated perennial crop, e.g. vines.

The suitability rating ranges from 1 to 10, with 1 the lowest and 10 equal to the highest or best suitability. The suitability rating refers to vigour and potential production potential without considering product quality. Although fairly subjective, suitability ratings by experienced soil scientists with many years of field experience are a handy tool to group soil types into production potential classes and for land use recommendations. The ratings can be interpreted according to the guidelines in **Table 4**.

Table 4 Interpretation of suitability ratings

Rating	General suitability	
≤2	Very low	Not recommended
>2 - ≤3	Low	
>3 - ≤4	Low-medium	Marginally recommended
>4 - ≤5	Medium	Conditionally recommended
>5 - ≤6	Medium-high	Recommended
>6	High	Highly recommended

The suitability ratings for irrigated perennial crops largely depend on limiting soil properties/features such as dense subsoil clay pans, seasonal wetness, cemented hardpans, low clay content in top- and upper subsoil and coarse fragments. The average rating for each map unit in **Table 5** was calculated from the individual profile ratings.

Table 5 Average suitability rating (Lambrechts) of soil types on Farm 845 for the production of supplementary irrigated wine grapes

Map symbol	Number of profiles	Average suitability	Recommendation for irrigated wine grapes
Cf1	**3**	**4**	**Marginally recommended**
Es1	**4**	**3,1**	**Marginally recommended**
Kd1	**4**	**3,25**	**Marginally recommended**
Kd2	**10**	**3,8**	**Marginally recommended**
Kd3	**5**	**3,85**	**Marginally recommended**
R	**2**	**2**	**Not recommended**
Wa1	**1**	**4**	**Marginally recommended**

AGRICULTURAL LAND POTENTIAL (NATIONAL DEPARTMENT OF AGRICULTURE)

The National Department of Agriculture published a report in which the criteria for high potential agricultural land in South Africa were defined (Schoeman, 2004). In the report a number of concepts and terminology applicable to the evaluation of agricultural land potential were defined. These definitions include inter alia the following:

- **Agricultural** means land zoned for agricultural use.

- **Land** means the total natural environment of the exposed part of the earth's surface, including atmosphere, climate, soils, vegetation and the cultural environment.
- **Arable** means land that can produce crops requiring tillage; land so located and constituted that production of cultivated crops is economical and practical.
- **Effective soil depth** means the depth of soil material that plant roots can penetrate readily to obtain water and plant nutrients; the depth to a layer that differs sufficiently from the overlying material in physical or chemical properties to prevent or seriously retard the growth of roots.
- **High potential** means prime or unique.
- **Permanent irrigation** means the availability for, and regular artificial application of, water to the soil for the benefit of growing crops. Application may be seasonal.
- **Prime** means the best land available, primarily from the national perspective, but with allowance of provincial perspectives; land best suited to, and capable of, consistently producing acceptable yields of a wide range of crops (food, feed, forage, fibre and oilseed), with acceptable expenditure of energy and economic resources and minimal damage to the environment (and is available for these uses);
- **Topsoil clay content** means the average percentage clay-sized material (<0.002 mm) in the uppermost part of the soil; that is, the part ordinarily moved in tillage, or its equivalent in uncultivated soils, ranging in depth from about 100 to 300 mm; frequently designated as the plough layer or the Ap horizon;
- **Unique agricultural land** means land that is or can be used for producing specific high-value crops. It is usually not prime, but important to agriculture due to a specific combination of location, climate or soil properties that make it highly suited for a specific crop when managed with specific farming or conservation methods. Included is agricultural land of high local importance where it is useful and environmentally sound to encourage continued agricultural production, even if some or most of the land is of mediocre quality for agriculture and is not used for particularly high-value crops.

Schoeman (2004) defined a range of soil forms for the Western Cape that qualify for high potential agricultural land. A minimum effective depth of 30 cm and a topsoil clay content of

>5 - <35 % were used as additional criteria for the identification of high potential agricultural land.

In the agricultural land potential evaluation system of Schoeman (2004), only one minimum effective depth (viz. >30 cm) is specified irrespective of the growing season of the crop. The effective depth of most soils with an E horizon on a clayey B horizon will be restricted to the topsoil (A horizon) during the rainy winter months when the E horizon is water saturated. The anaerobic conditions in saturated horizons are unsuitable for root development. During summer the effective depth of these soils will depend on the depth of the subsoil clay layer. For this reason the agricultural land potential of map units was evaluated for winter and summer growing crops.

In **Table 6** the map units on Farm 845 were evaluated according to these guidelines and compared with the field suitability rating for irrigated perennial crops.

According to Schoeman (2004; refer to Table 9 in the Schoeman report) to qualify as high potential agricultural land a minimum effective soil depth of 30 cm is required and the topsoil clay must be more than 5 %.

Table 6: Land potential rating of map units according to Schoeman (2004) in comparison to the field suitability rating for irrigated perennial crops

Map symbol	Potential	Suitability
Cf1	Unique	Marginally recommended
Es1	Unique	Marginally recommended
Kd1	Unique	Marginally recommended
Kd2	Unique	Marginally recommended
Kd3	Unique	Marginally recommended
R	Low	Not recommended
Wa1	Unique	Marginally recommended

Combining soil form - effective soil depth and top soil texture, the soil suitability ranged from low to marginally recommended.

8 REFERENCES

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