

Development of a Spatial Planning Database and Analysis of Agriculture and Tourist Potential in the Strandveld region of the Overstrand Local Municipality

PART 1 Soil survey report

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1 Introduction

The reconnaissance soil survey of the Gansbaai - Baardskeedersbos area was instructed by the Overstrand Municipality.

The boundaries of the study area are shown in Figure 1.

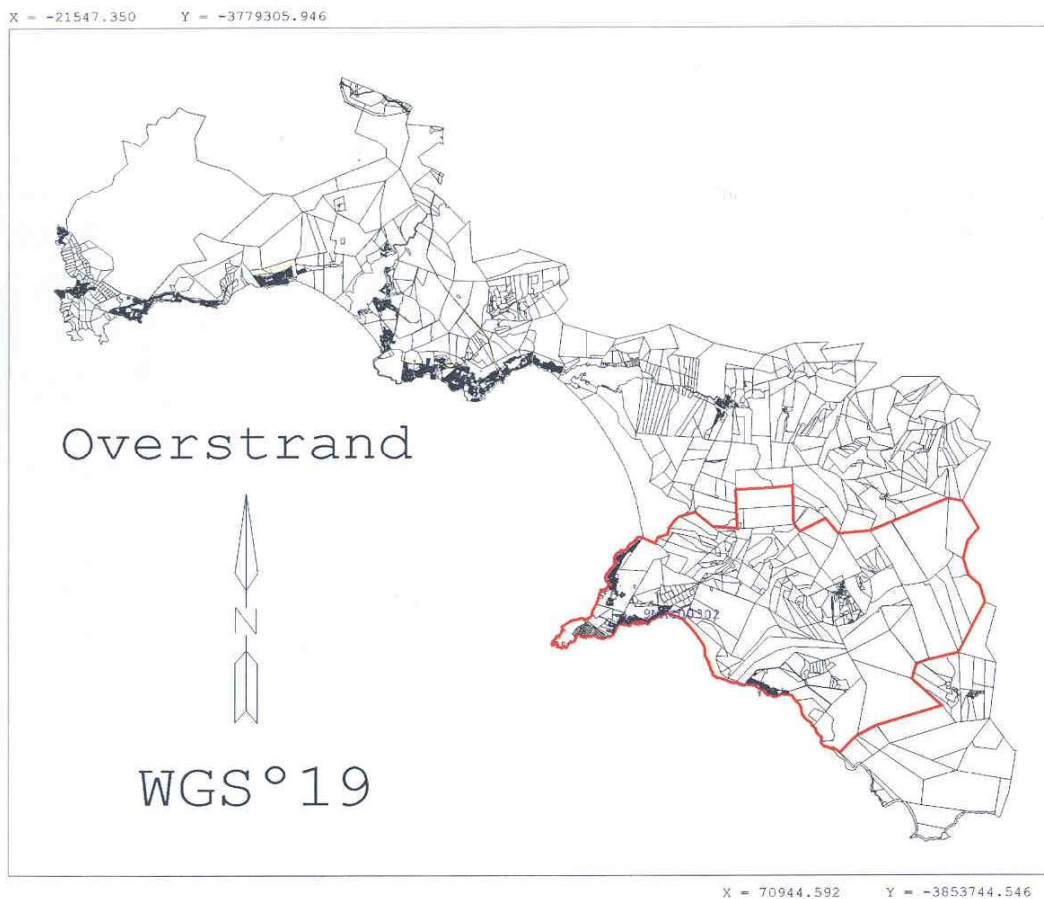


Figure 1 Boundaries of the Overstrand study area as supplied by the Overstrand Municipality (marked in red)

2 Terms of reference

Following a discussion with Prof. H. van der Merwe, Department of Geology, Geography and Environmental Studies, University of Stellenbosch, on the collection of soil data, compilation of a soil map and evaluation of soil potential for selected crops in the study area, the following basic terms of reference were drafted:

- The soil mapping will be a reconnaissance survey with a map legend that will group soils with comparable physical and morphological properties.
- Soil potential will be evaluated for a range of crops for each mapping unit.
- A soils report will be compiled that will describe the soils in terms of limitations for crop production and measures to eliminate or improve the soil specific limitations.
- The map scale will depend on the available base maps and it is envisaged that it will be somewhere between 1 : 20 000 and 1 : 50 000.
- A soil map with one of the above scales will be compiled to show the spatial distribution of the different soil units.

3 Desktop study

Before the field soil survey was initiated a desktop study was undertaken to establish the nature of the available soils information that could be used for this study.

The land type information at a scale of 1 : 250 000 is available for the study area (Land Type Survey Staff, 1985) (see **Figure 2**). According to the land type map the study area is covered with 13 different land types grouped into six (6) broad soil patterns. In **Table 1** the land types grouped according to soil patterns are listed together with a specification of terrain type, percent level land and local relief. In **Table 2** a general description of the associated geology, and locally the terrain, of the land types are given.

Table 1 Land types in the Overstrand study area with a brief description of terrain and geology

Land type		Terrain type		Percent level land	Local relief
General description	Symbol	Symbol	General description		
Prismacutanic and/or pedocutanic and/or gleycutanic horizons dominant.	Db108	B3	Plains with hills/ridges/koppies	50-80% of area has a slope < 8%	100 – 170 m
Glenrosa and/or Mispah forms (other forms may occur). Lime is absent in the landscape.	Fa665	D5	Low mountains	< 20% of area has a slope < 8%	300 - 1000 m
	Fa666	D5			
	Fa667	D3	Hills/ridges/koppies	< 20% of area has a slope < 8%	100 – 170 m
	Fa749	D3			
Glenrosa and/or Mispah forms (other forms may occur). Lime occurs regularly in the landscape.	Fb113	A2	Flat plains with slight relief	> 80% of the area has a slope < 8%	30 - 100 m
Soils with a diagnostic ferrihumic (podzol) horizon (at least 10% of the area). Houwhoek form dominant.	Gb 17	C3	Open hills/ridges/koppies	20-50% of area has a slope < 8%	100 – 170 m
Grey regic sands. Fernwood form dominant. Sandy soils cover >80% of the area.	Ha 17	B2	Uneven plains	50-80% of area has a slope < 8%	30 - 100 m
Grey regic sands. Fernwood form dominant. Sandy soils cover 20-80% of the area.	Hb 35	B3	Plains with hills/ridges/koppies	50-80% of area has a slope < 8%	100 – 170 m
	Hb 36	A2	Flat plains with slight relief	> 80% of the area has a slope < 8%	30 - 100 m
	Hb 37	A2			
	Hb103	A2			
	Hb104	A2			

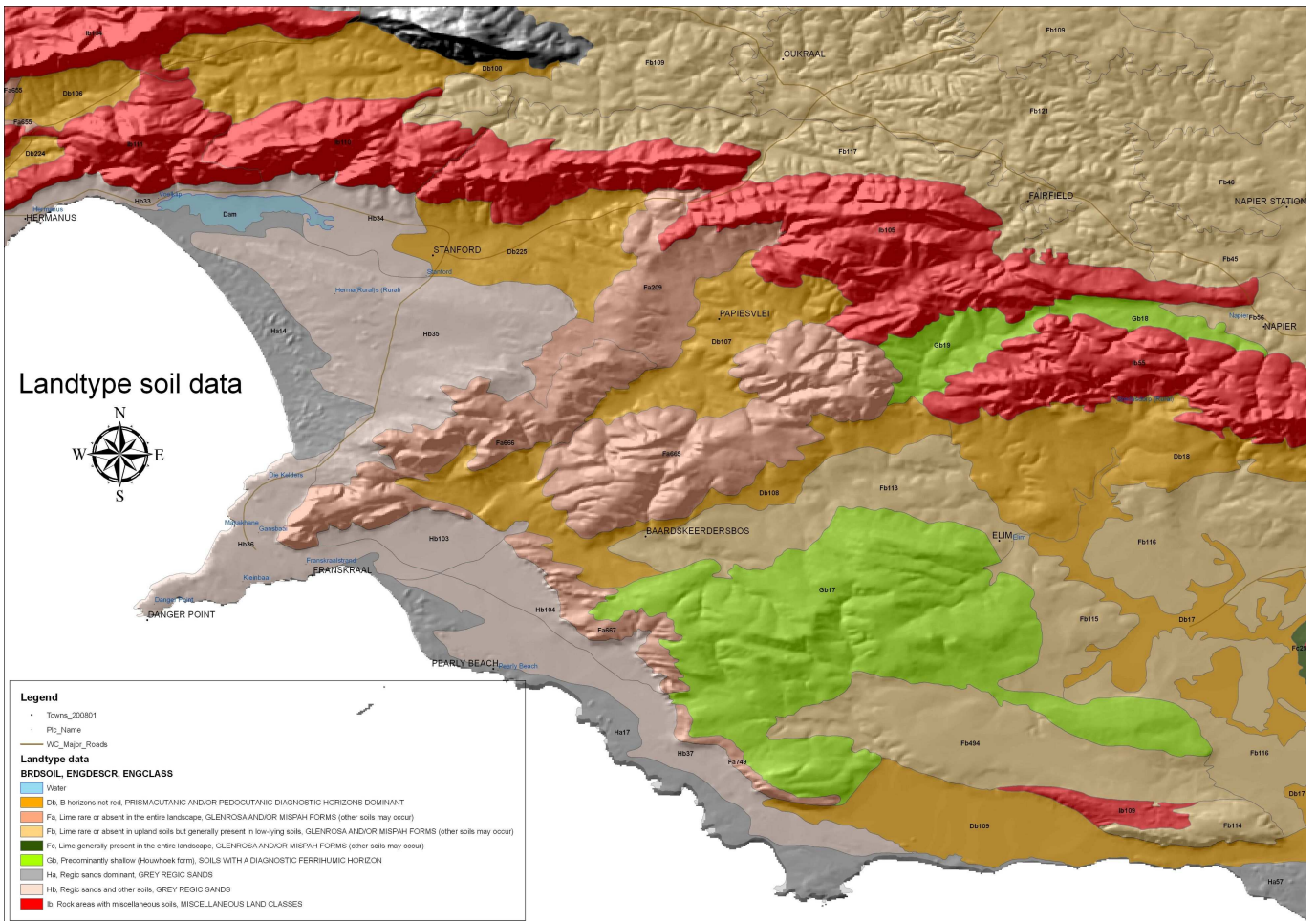


Figure 1 Land types in the Gansbaai – Baardskeerdersbos area

Table 2 General description of the geology, and locally the terrain, associated with the 13 land types in the Overstrand survey area

Land type	Description of the geology
Db108	Mainly quartzitic sandstone of the Peninsula Formation, Table Mountain Group. Phyllite of the Tygerberg Formation, Malmesbury group, occurs on the footslopes. In the western part granite of the Hermanus Pluton, Cape Granite Suite, occurs.
Fa665	Quartzite sandstone of the Peninsula Formation along the south-west and of the Nardouw Group along the north-west, separated by a thin shale band of the Cedarberg Formation, Table Mountain Group.
Fa666	Quartzite sandstone of the Peninsula Formation along the south-western side and of the Nardouw Subgroup along the north-western side, separated by a thin shale band of the Cedarberg formation, Table Mountain Group.
Fa667	Quartzitic sandstone of the Peninsula Formation and of the Nardouw Subgroup, Table Mountain Group.
Fa749	Quartzitic sandstone of the Peninsula Formation and of the Nardouw Subgroup, Table Mountain Group.
Fb113	Phyllite of the Tygerberg Formation, Malmesbury Group, occurs in the northern part, while mudstone, siltstone, shale and feldspathic sandstone of the Gydo Formation, Bokkeveld Group, occur in the south.
Gb 17	In the north mainly quartzitic sandstone of the Nardouw Subgroup. In the south sandstone of the Peninsula Formation. The sandstones are separated by a thin shale band of the Cedarberg Formation; all of the Table Mountain Group.
Ha 17	Dunes and blown sand of the Strandveld Formation, Bredasdorp Group.
Hb 35	Mainly aeolianite (partly calcareous) of the Waenhuiskrans Formation, Bredasdorp Group.
Hb 36	Calcareous aeolianite of the Waenhuiskrans Formation, partially covered by sand and coastal dunes of the Strandveld Formation, Bredasdorp Group.
Hb 37	Calcareous aeolianite of the Waenhuiskrans Formation, partially covered by dunes and coastal sand of the Strandveld Formation, Bredasdorp Group.
Hb103	Calcareous aeolianite of the Waenhuiskrans Formation, covered by sand of the Strandveld Formation, Bredasdorp Group. Alluvium occurs in the lower areas.
Hb104	Calcareous aeolianite of the Waenhuiskrans Formation, partly covered by colluvial sand on the midslopes and alluvium in the valley bottoms.

In **Annexure A: Table 1** the dominant soil forms (listed from most to least common) in occur in land types, combined with a general description in terms of topsoil clay content, sand grade, depth to upper B horizon and depth limiting material of soil forms, are given. In the land type memoirs the soil series number(s) according to MacVicar (1977) was also listed per soil form. Because the soil series number is mostly determined by the topsoil clay content and sand grade that are listed in **Annexure A: Table 1** the soil series numbers are not given in this table.

Although the soils information in the land type memoirs is applicable in terms of general soil types, the map scale and soils detail are too generalized to be used as a guideline for demarcation of physically and morphologically uniform soil units as defined under the terms of reference. The land type soils information and the land type boundaries, however, are use full background information for a more a more refined demarcation of physically and morphologically uniform soil units.

In addition to land type information, more use full data was obtained from locally available reports on detail and semi-detail soil surveys that were done in the study area and adjoining localities. The most use-full reports are the following: Ellis *et al.* (2007), Lambrechts & Ellis (2004), Lambrechts (2007), Lambrechts *et al.* (2007), Saayman *et al.* (1998), Schloms & Lambrechts (1997) and Schloms *et al.* (2000). The map scale used for these surveys range from 1 : 2 500 to 1 : 10 000

and soil observation density from two observations per hectare to one observation per 10 ha. The soils were classified at form-family level according to Soil Classification Working Group (1991) and in most cases similar soil-form units were subdivided into soil phases based on effective soil depth, topsoil texture, gravel content etc. The soil information obtained from these reports was used as background information for the field survey to characterize the soils the soil patterns in the study area.

4 Field soil survey procedure and compilation of a map legend

Based on the soils information obtained from the land type survey and from the detail and semi-detail surveys mentioned above, especially in terms of terrain, parent material and associated soils in the different localities, a field survey was planned for the more refined demarcation of physically and morphologically uniform soil units. It was planned in such a manner that an observation traverse crossed all the terrain type-general elevation-parent material combinations found in the area. These terrain type-elevation-parent material combinations were extrapolated from the 1 : 250 000 scale geology map 3419C & 3419 D Gansbaai dated 1963 and 1 : 50 000 topocadastral maps of the survey area. The selected observation traverses were mainly along secondary and tertiary roads, but where necessary farm gravel roads were also used.

A soil auger was mainly used to study and describe the soils along these selected traverses. Additional soil observations were made along road cuts, in exposed trenches and quarries pits. In total of 35 observations were made. At many observation positions more than one soil type were investigated. For each soil type that was investigated the more important properties described following standard procedures. 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). 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. Soil forms are given locality names, e.g. Augrabies. These names are abbreviated to two-letter symbols, e.g. Ag for the Augrabies soil form. 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. Ag 2110 is family number 2110 of the Augrabies form. In **Annexure A: Table 2** all the soil forms and families that were identified during the field soil survey is listed per observation position. The coordinates of the observation positions are given combined with a brief description of the terrain and parent material and/or underlying geology.

Based on the underlying geology combined with the variation in terrain and general elevation through the study area, 14 geology-terrain-elevation units were defined. For each geology-terrain-elevation unit the dominant soil forms and families in each unit were extracted from soils information collected during the field soil study. The approach followed was to develop a grouping that will accommodate most of the variations in soil properties that might have an effect on soil suitability and potential land use. In **Annexure A: Table 3** the final map legend that was used to demarcate physically and morphologically uniform soil units are explained. The reconnaissance soil map on a scale of 1 : 50 000 is presented in **Annexure B: Figure 1**. The total surface area (in ha) of each soil group is given in **Table 3**.

Table 3 Total surface area of soil groups in the Overstrand survey area

Soil group symbol	Description of Land Unit	Surface area (ha)
A	Mountainous predominantly sandstone rock (80%) with shallow lithosols and podzols	6 544
B	High lying undulating sandstone plateau with podzolic and lithosolic soils	14 880
C	High lying calcrete (60%) hills with shallow calcareous soils on limestone	1 649
D	Lower lying mid and toe slopes of sandstone hills and mountains (soomgebied)	223
E	Slightly undulating low land with duplex and plinthic soils on shales and graywacke	748
F	Undulating hills with duplex (mainly pedocutanic and prismacutanic) soils on shales	5 263
G	Low lying acid sands and duplex soils on the interface zone between the sandstones and shales (sandstone colluvium and alluvium over weathered shales)	3 094
H	Near level silcrete and ferricrete terraces on shales in the undulating duplex landscape	253
I	Low lying acid sands on coastal platform on toe slopes of sandstone mountains adjacent	2072
J	Low lying older consolidated calcareous dunes on coastal flats	5550
K	Low lying young unconsolidated calcareous coastal dunes	1779
L	Low lying near level coastal limestone terrace	10109
M	Low lying vlei areas on coastal platform	1513
N	High lying vlei areas on upland positions	470
Total area		54147

In **Annexure A: Table 4** the soil forms and families that were identified during Overstrand field survey are alphanumerically listed according to the soil family symbol. In addition the diagnostic horizons are given for each soil form and the family criteria are listed. Soil families are further defined in terms of clay content and sand grade in the topsoil, coarse fragments, general pH, degree of wetness, effective depth and depth limitation.

5 Soil limitations

All the profiles investigated during the field survey have one or more soil physical, morphological and/or chemical properties that will negatively effect root development, plant growth and production potential. These properties include *inter alia* the following:

5.1 Dense subsoil clay pans

Many of the soil forms and families associated with Bokkeveld and Malmesbury Formation shale are characterised by a dense subsoil clay pan either as a diagnostic B or G horizon.

In most of these soils the transition between the clay pan and the overlying material is abrupt (sharp) in terms clay content, structure and consistence. Free water generally accumulates in the overlying, lighter textured horizon or material during the rainy season or as a result of over-irrigation. Under conditions of water saturation, reduction and loss of iron can lead to the development of a bleached (pale coloured) E horizon in the less clayey overlying material (e.g. Estcourt, Kroonstad and Klapmuts form). Such horizons normally set hard on drying and have a high soil density. The effective depth of soils with structured subsoil clay layers is therefore limited by the clay layer itself and indirectly by the periodic wetness in the overlying layer with less clay.

In addition to the physical limitation of the clay pan on root development, the clay itself is generally physically unstable (disperse in non-saline water) due the high concentration of exchangeable magnesium and sodium relative to calcium. This type of clay is not suitable for mechanical loosening and will re-compact over time as a result of the dispersive nature of the clay particles. In addition the clay pan normally grades with depth into clayey, soft weathering shale with very prominent signs of wetness and low permeability. Drainage would therefore be ineffective to remove free water from the clay pan as well as underlying weathered material. The effective depth of these clay pan soils can therefore not be increased through deep soil cultivation and drainage.

According to Mr Francis Pratt (personal communication), a wine grape producer near Elim, the soil depth to a limiting subsoil clay layer should be at least 50 cm to ensure sustainable growth and production of wine grapes over time. In rare cases soils with a useable depth of 45 cm could be used but never soils with a clay pan shallower than 40 cm (e.g. Sterkspruit and Katspruit form soils). According to **Annexure A: Table 4** the effective depth of the Estcourt, Kroonstad and Klapmuts form soils described during the field survey is medium deep and range from 30 cm to 60 cm. The deeper variants of these soils could therefore be used for irrigated perennial crops (e.g. wine grapes) while the shallower variants are unsuitable. To determine the exact location of the deeper variants would require a detail survey.

The only measure available to increase the effective depth of clay pan soils is through ridging in a down slope direction.

5.2 Iron cemented hardpans

Iron cemented hardpans occur as a diagnostic horizon (hard plinthic B horizon) in the Dresden and Wasbank form soils. In the Dresden soils the hardpan is directly below the topsoil (10-30 cm depth) and varies from very to extremely hard. In the Wasbank an E horizon is present above the iron pan. The depth of the pan ranges from 30 - 60 cm. As depth increases the iron pan generally becomes softer.

Due to its dense and hard nature the iron pan limits root development and could restrict internal permeability with the development of an E horizon. Although the extremely hard variants will be difficult to loosen, ripping with a deep tine implement is commonly used to break the iron hardpan to improve the suitability of these soils. The loosened material will be very gravelly and stony but is usually considered as a good rooting medium and once loosened the broken pan will remain open and porous. Wasbank, and even Dresden, form soils have successfully been ameliorated for wine grape production in the study area.

5.3 Hardpan carbonate horizon

In many soils associated with Tertiary to Recent limestone as parent material the underlying subsoil was classified during the field survey as a diagnostic hardpan carbonate horizon (e.g. Coega and Prieska form soils). Although classified as diagnostic horizon this layer represents the original limestone parent material with secondary accumulation of calcium carbonate in the upper zone and hardening.

The hardpan carbonate horizon is usually more porous and less hard than iron cemented hardpans. Although it may inhibit root development, it is generally porous enough not to prevent drainage of excess soil water.

In the study area carbonate hardpan horizons in Prieska form soils was loosened with a tine implement before establishing wine grapes. Although no production data is available the vegetative growth of the vines appears acceptable.

5.4 Wetness

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

In the study area wetness normally occurs as a perched water table in E horizons above a G horizon (Kroonstad form), prismatic B horizon (Estcourt form) and pedocutanic B horizon (Klapmuts form). Soil families with a "yellow" E horizon are less hydromorphic and have a more

friable consistency than families with a "grey" E. E horizons associated with perched water tables in lithosolic soils (Cartref form soils) on weathering rock.

E horizons in podzolic soils (Houwhoek and Lamotte form soils) and Constantia form soils could also be partially be associated with periodic wetness, although the dominant process in the formation of the E is podzolisation and the removal of iron as a colouring agent.

Another form of wetness develops as a result of low permeability in G horizons (Katspruit form soils). Signs of wetness could also develop in weathering shale and/or sandstone in shallow Cartref and Glenrosa form soils.

The soft plinthic B horizon in Longlands and Westleigh form soils is the result of a fluctuating water table that leads to the absolute accumulation of iron oxides.

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 dieback.
- Various diseases can become epidemic under wet conditions. *Phytophthora* in particular can wipe out sensitive crops/plants.
- As a result of limited volumes of non-wet soil that is available for root growth, 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.

If the surveyed area is going to be planted with wetness sensitive plants (especially deep rooted perennial crops) special attention must be given to the installation of drainage to remove excess soil water especially during spring.

5.5 Low clay content of top- and upper subsoils

All the soils developed from Table Mountain Sandstone as well as most of those associated with coastal limestone have a clay content $\leq 5\%$ in the upper horizons. The organic matter content of these sandy soils is generally also fairly low.

The ability of soils to retain water and plant nutrients for use by plants is determined mainly by the clay and organic matter content. A clay content of $\leq 5\%$ generally associated with a water storage capacity that is low enough to be considered as a limiting factor for crop production.

Therefore under relatively low rainfall conditions with a high monthly variability (typical of the lower lying soil groups in study area) sandy soils have a high risk for the production of annual winter growing crops under dry-land conditions.

Even under irrigation it is difficult to maintain the plant available water at an optimal level during warm summer months and when plants are young with a small leaf canopy.

Other limitations of sandy topsoil with low organic matter content are their susceptibility for water erosion and the high soils temperatures that can develop during summer.

5.6 Coarse fragments in top- and/or subsoils

Most of the soils in the study area that have developed from Table Mountain Sandstones and lesser extent soils developed from shale contain coarse material that qualifies as gravel or stones.

The main limitation of coarse fragments is that an increase in the volume-content of coarse fragments decreases the fine soil (<2 mm) fraction and consequently the water holding capacity. In sandy soils this decrease in water holding capacity is particularly important. The nutrient retention capacity is similarly influenced.

Dry, gravelly soils, therefore, require less water to reach field water capacity but require more regular and lighter irrigations than similarly textured, non-gravelly/stony soils. Fertilizer programs should also be adjusted.

5.7 Underlying weathering rock

Rock in different stages of weathering occurs in various soils as a diagnostic horizon (lithocutanic B: Glenrosa and Cartref form soils) or material (saprolite or hard rock: Mispah and Houwhoek form soils).

Although such materials are always denser and more impervious to air, water and plant roots than the overlying horizons, the degree of weathering and original structure has a great influence on the intensity of the limitation. Non-hard, lithocutanic B horizons on folded shale are normally reasonably open, loose and porous. Hard, horizontally layered sandstone, however, could be very hard. The shallower the rock, the less weathered and the harder it is, the greater is the negative influence on root penetration and development.

As a result of its dense, impermeable nature, weathering rock normally shows signs of wetness in humid environments, or on flat highlands, as well as on concave lower positions in drier

environments.

To improve the permeability of weathering rock and to increase effective soil depth the material can be loosened with a tine implement. Because of the rapid hydraulic conductivity of loosened weathering rock it is essential that cut-off drains are installed.

5.8 Other physical and morphological limitations

Other soil properties that might be considered as a limitation for crop production include the following:

- Pale coloured E horizon directly below the topsoil.
- Bleached topsoils in the dry state.
- Hard-setting and crusting of topsoil horizons with 5-15 % clay and a fine sand grade.

5.9 The presence of free carbonates and alkaline soil pH

The presence of free carbonates [CaCO_3 or $(\text{Ca}, \text{Mg}) \text{CO}_3$] in soils is used in the South African soil classification system to define diagnostic horizons and materials, and as a family criterion.

Presence of free carbonates in soil in equilibrium with the present soil forming conditions is an indication of a low degree of leaching. The associated soil material is base saturated and alkaline ($\text{pH}_{\text{KCl}} \geq 7.5$). Because of the high pH, the solubility of plant nutrients such as phosphorous, zinc, iron, copper, manganese is very low and largely unavailable for plant uptake. The less crystalline and more powdery the carbonates are (e.g. such as in soft carbonate horizons and calcareous soil families), the greater is the negative influence on the solubility. In the hard carbonate horizon the negative influence is lower.

On calcareous soils special attention should given to phosphate fertilisation and trace element deficiencies should be corrected.

The presence of free carbonates, especially in a finely divided state, improves the physical stability of soil materials. Lime containing soils are therefore more friable and porous than non-lime containing soils.

5.10 Very low pH soils

Most of the sandy soils developed from sandstone are very acid and have a pH_{KCl} of ≤ 5.0 . The exchangeable base saturation is therefore low. Because of low clay content the exchangeable aluminium concentration, however, should not be very high.

It is generally accepted that exchangeable aluminium delays or even stops the development of roots. In this way, the effective depth of acid soils is limited. The intensity of the limitation depends

on the acid/aluminium tolerance of the specific crop, as well as the organic matter (OM) content of the soil; the higher the OM, the less detrimental is the aluminium. Certain crops, e.g. lucern, have a very low tolerance for acid soil conditions, while other crops such as potatoes have a relatively high tolerance. Depending on the acid tolerance of the crop, acid soils must be limed to increase the pH to that required by the specific crop.

Acid soils with exchangeable aluminium usually have a high phosphate fixing capacity; to such an extent that applied phosphate fertiliser could become fairly unavailable to plants.

In **Table 4** the classes and symbols that are used in **Annexure A: Table 5** to qualify the chemical and physical limitations of the soil families identified in the Overstrand survey are explained.

Table 4 **Classes used to qualify the chemical and physical limitations of soil families identified in the Overstrand survey area**

Limitation class	Abbreviation
None	(no symbol)
Low	Low
Moderate	Mod
Severe	Sev
Variable	Var

6 **Soil suitability of soil groups in the Overstrand survey area**

The suitability of soils for the production of crops in a specific locality depends mainly on the inherent chemical, physical and morphological properties of the soils combined with prevailing climate, crop requirements, growing season and availability of irrigation water.

The suitability of the different soil families in the Overstrand survey area can be evaluated for different crops. As a first phase it was decided to use two crop types, *viz.* annual dry-land winter growing crops (e.g. small grain; wheat) and irrigated perennial crops (e.g. wine grapes). The suitability rating ranges from 1 to 10, with 1 the lowest and 10 equal to the highest or best suitability. Two evaluators were used to do the initial evaluations.

Table 5 the ratings by the two evaluators are listed for all soil families and two crop types. Based on the ratio between the ratings of the evaluators it is clear that the difference is seldom more than $\pm 20\%$ (a ratio of 0.8 to 1.2). The ratings could therefore be considered as fairly reliable.

The individual soil family ratings were combined with percentages of the different soil families in a soil group to calculate a weighted average suitability for each soil group and crop type (see **Table 6**). From **Table 6** it is evident that soil groups B, D, E, F, G and I are the most for the production of dry-land winter crops (e.g. small grain) with a medium suitability. The soil groups are also best suited for perennial summer growing crops under irrigation. Without irrigation all the soil groups will have a low suitability perennial summer growing crops because of low and unreliable

rainfall during the summer.

Soil groups with a medium suitability can be recommended for the production of crops.

Table 5 Suitability rating of soil families for annual dry-land winter and irrigated summer growing crops by two evaluators and ratios between evaluators

Soil family	Topsoil clay and sand grade	Suitability rating for annual dry-land winter growing crops			Suitability rating for irrigated summer growing crops		
		Evaluator 1	Evaluator 2	Ratio ½	Evaluator 1	Evaluator 2	Ratio 1/2
Ad 1111	≤5%, me	4.0	3.5	1.14	5.0	4.5	1.11
Ad 1112	≤5%, me	4.0	3.5	1.14	5.0	4.5	1.11
Ad 2111	≤5%, me	3.0	3.5	0.86	4.0	4.0	1.00
Ag 1110	≤5%, me	4.0	3.5	1.14	5.0	4.5	1.11
Ag 2110	≤5%, me	3.0	3.5	0.86	4.0	4.5	0.89
Br 1000	≤5%, me	2.0	3.0	0.67	2.0	3.5	0.57
Cf 1100	≤5%, me-co	3.0	3.5	0.86	4.5	4.5	1.00
Cf 1200	≤5%, me-co	3.0	3.5	0.86	3.0	4.0	0.75
Cf 1100	5-15%, fi	4.0	4.0	1.00	5.0	5.0	1.00
Cg 1000	≤5%, me	2.0	2.5	0.80	2.0	2.5	0.80
Cg 2000	≤5%, me	2.0	2.5	0.80	2.0	2.5	0.80
Ct 1100	≤5%, me-co	5.0	4.5	1.11	6.0	5.0	1.20
Ct 1200	≤5%, me-co	5.0	4.5	1.11	6.0	5.0	1.20
Dr 1000	5-15%, fi	3.5	3.5	1.00	4.5	4.5	1.00
Du 1210	≤5%, me	3.0	4.0	0.75	3.0	4.0	0.75
Es 1100	5-15%, fi	4.0	4.5	0.89	5.0	4.5	1.11
Fw 1110	≤5%, me-co	4.0	4.0	1.00	4.5	4.5	1.00
Gs 2121	≤5%, me-co	3.5	3.5	1.00	4.0	4.0	1.00
Gs 2221	≤5%, me-co	3.5	3.5	1.00	4.0	4.0	1.00
Gs 2121	5-15%, fi	4.5	4.5	1.00	5.5	5.5	1.00
Hh 1200	≤5%, me-co	4.0	4.0	1.00	5.0	4.0	1.25
Hh 2100	≤5%, me-co	3.0	4.0	0.75	4.0	4.5	0.89
Ka 1000	5-15%, fi	2.0	2.0	1.00	2.0	2.0	1.00
Ka 2000	≤5%, me-co	2.0	2.0	1.00	2.0	2.0	1.00
Kd 1000	≤5%, me	4.0	4.0	1.00	5.0	4.5	1.11
Kd 1000	5-15%, fi	4.0	4.0	1.00	4.0	4.0	1.00
Km 1110	5-15%, fi	5.0	4.5	1.11	5.0	4.5	1.11
Km 1120	5-15%, fi	4.0	4.5	0.89	5.0	4.5	1.11
Lo 1000	≤5%, me	3.5	4.0	0.88	3.5	4.0	0.88
Lo 1000	5-10%, fi	3.5	4.5	0.78	3.5	4.5	0.78
Lt 1100	≤5%, me-co	5.0	4.5	1.11	6.0	5.0	1.20
Ms 2100	≤5%, me-co	2.0	2.0	1.00	2.0	2.0	1.00
Mu 2110	≤5%, me	3.5	3.5	1.00	5.0	4.5	1.11
Nb 1200	≤5%, me	1.0	1.5	0.67	2.0	2.5	0.80
Pr 1110	≤5%, me	4.0	3.5	1.14	5.0	5.0	1.00
Pr 2110	≤5%, me	4.0	3.5	1.14	5.0	5.0	1.00
Ss 2100	5-15%, fi	3.4	4.0	0.85	3.5	4.0	0.88
Wa 1000	5-15%, fi	5.0	4.5	1.11	6.0	5.5	1.09
We 1000	5-10%, fi	3.0	3.5	0.86	3.0	4.0	0.75
Wf 1100	≤5%, me-co	4.5	4.0	1.13	5.0	4.5	1.11
Silcrete		1.0	1.0	1.00	1.0	1.0	1.00
Rock		1.0	1.0	1.00	1.0	1.0	1.00
Lime stone		1.0	1.0	1.00	1.0	1.0	1.00

Table 6 Weighted average rating and suitability of soil groups for annual dry-land winter and irrigated summer growing crops by two evaluators

Soil group symbol	Annual dry-land winter growing crops			Perennial summer growing irrigated crops		
	Rating evaluator 1	Rating evaluator 2	Suitability	Rating evaluator 1	Rating evaluator 2	Suitability
A	1.4	1.5	Very low	1.4	1.5	Very low
B	4.1	4.1	Medium	4.2	4.6	Medium
C	1.7	1.8	Very low	2.2	2.0	Very low
D	4.2	4.1	Medium	4.4	4.5	Medium
E	4.3	4.3	Medium	4.7	4.7	Medium
F	4.1	4.3	Medium	4.7	4.6	Medium
G	4.3	4.2	Medium	4.7	4.5	Medium
H	3.4	3.3	Medium low	4.0	4.0	Medium low
I	4.1	4.1	Medium	4.4	4.5	Medium
J	2.8	2.8	Low	3.0	3.5	Medium low
K	2.0	2.5	Low	3.2	3.3	Medium low
L	2.7	2.9	Low	3.7	3.3	Medium low
M	2.7	2.8	Low	2.9	3.2	Medium low
N	2.9	3.6	Medium low	2.3	3.7	Medium low

7 Summary

In **Annexure A: Table 6** the surface area (in hectare) of the different soil families grouped by soil form in the individual soil groups are listed. Soil families highlighted in green have a suitability rating for irrigated summer growing crops of >4.0 (medium and higher suitability) and a surface area of at least 300 ha per soil group. From **Annexure A: Table 6** it is evident that the soil groups with the largest surface area of soils potentially suitable for irrigated summer growing crops (e.g. perennial crops such as wine grapes) are:

Group B High lying undulating sandstone plateau at 150 – 250m with podzolic and lithosolic soils. Dominant soil forms are Cartref, Constantia, Houwhoek and Lamotte. The top- and underlying E horizon are sandy ($\leq 5\%$ clay) with a medium to coarse sand grade. The pH is very acid.

Group F Undulating hills at 80 – 160m with duplex (mainly pedocutanic and prismacutanic) soils on shales. Dominant soil forms are Cartref, Estcourt, Glenrosa and Klapmuts. The top- and underlying E horizon are loamy (5-15% clay) with a fine sand grade. The pH is acid.

Group G Low lying acid sands and duplex soils on the interface zone between the sandstones and shales (sandstone colluvium and alluvium over weathered shales) at 100 – 160m. Dominant soil forms are Fernwood and Lamotte. The top- and underlying E horizon are sandy ($\leq 5\%$ clay) with a medium to coarse sand grade. The pH is very acid.

Group J Low lying older consolidated calcareous dunes on coastal flats at 20 – 40m. Dominant soil forms are Addo, Augrabies and Prieska. The top horizon is sandy ($\leq 5\%$ clay) with a medium sand grade. The pH is neutral to alkaline.

Group L Low lying near level coastal limestone terrace at 10 – 30m. Dominant soil forms are Addo, Montagu and Prieska. The top horizon is sandy ($\leq 5\%$ clay) with a medium sand grade. The pH is neutral to alkaline.

Based on the results from detail soil surveys conducted in the study area in the past it is a known fact that the spatial variation in soil types (combinations of soil form – family – effective depth) is extremely high. Detail soil surveys are therefore a prerequisite to determine the exact location of soils suitable for the development of irrigated perennial crop production in the soil groups listed above. The availability of existing water sources (or new sources that could be developed) that could be used for irrigated crop production would determine the broad localities where detail soil surveys would be required.

The suitability for the production of annual dry-land winter crops of the soil in the above listed soil groups is generally lower than that for irrigated crops. The main reason is the relatively low winter rainfall of especially the lower elevation groups (e.g. J and L) and the irregular distribution during the winter months. Especially on the sandy variants (all the listed soil groups except group F) the low water holding capacity restricts the suitability for winter dry-land crop production.

In **Table 7** long term average annual rainfall data for two weather stations in the close vicinity of study area and two from the Swartland are listed. Although the average annual rainfall is fairly similar for the four stations, the ratio between the rainfall in the winter months (April to September) and the rainfall in the summer months (October to March) is significantly lower for the study area weather stations (1.8 and 2.2) compared to that of the Swartland stations (3.6 and 4.0). The implication of this difference is that the rainfall security during the winter months should be higher in the Swartland compared to that of the study area. Combined with the low clay content of most of the soils in the suitable soil groups (except group F) the risk for winter dry-land crop production is higher in the study area compared to the risk in the Swartland.

Table 7 Comparison of long term average annual rainfall data for two weather stations in the close vicinity of study area and two from the Swartland

Weather station	Coordinates		Years	Average annual rainfall	Total for different months		Ratio Winter-Summer
	South	East			April-Sept	Oct-March	
Dunghye Park	34°19'	19°31'	1977-1989	494.6	339.4	15 5.2	2.2
Prinskraal	34°38'	20°07'	1973-1989	403.9	261.9	142. 0	1.8
Langgewens	33°17'	18°42'	1931-1989	395.3	309.9	85.4	3.6
Philadelphia	33°40'	18°35'	1918-1989	382.3	305.3	77 .0	4.0

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ANNEXURE A: LIST OF TABLES

Table A1 Dominant soil forms (listed from most to least common) in land types combined with a general description in terms of topsoil clay content, sand grade, depth to upper B horizon and depth limiting material of soil forms

Land type symbol	Dominant soil form or surface material (>7.5%)	Clay content A (and E if present) horizon	Dominant sand grade	Depth (cm) to B1 horizon	Depth limiting material
Db108	Estcourt	2-6	med/cos	20-50	pr
	Kroonstad	0-6	med/cos	>35	gc
	Sterkspruit	2-6	med	>35	pr
Fa665	Rock				R
	Cartref	2-8	med	<25	so
	Houwhoek	0-4	med/cos	25-45	so
Fa666	Rock				R
	Cartref	2-8	med	<25	so
	Houwhoek	0-4	fi/med	25-45	so
Fa667	Rock				R
	Cartref	0-4	med/cos	<25	so
	Lamotte	0-2	cos	45-95	U; R
Fa749	Rock				R
	Cartref	0-4	med/cos	<25	so
	Lamotte	0-2	cos	45-95	U; R
Fb113	Rock				R
	Swartland	8-20	fi	35-55	vp; so
	Cartref	4-8	fi	<25	so
	Mispah	4-10	fi	<15	hp
	Glenrosa	4-18	fi	<25	so
Gb 17	Cartref	0-2	fi/cos	15-25	so
	Fernwood	0-2	med/cos	80-120	U; R
	Houwhoek	0-2	med/cos	25-45	so
	Estcourt	0-2	med/cos	35-55	pr
	Wasbank	0-4	fi	25-30	hp
Ha 17	Fernwood	0-2	fi/me	60-120	ka; U
Hb 35	Fernwood	0-2	fi/me	65-120	U; ka
	Mispah	0-2	fi/me	<35	ka
	Rock				
Hb 36	Fernwood	0-2	fi/me	80-120	ka; U
	Mispah	0-2	fi/me	15-30	ka
Hb 37	Fernwood	0-2	fi/me	80-120	ka; U
	Mispah	0-2	fi/me	<35	ka
	Clovelly	0-2	fi	80-120	ka; R
Hb103	Estcourt	0-2	med	<40	pr
	Kroonstad	0-2	med	<40	gc
	Fernwood	0-2	med	80-120	U; R
	Cartref	0-2	med/cos	15-25	so
	Mispah	0-2	med/cos	15-20	R; ka
Hb104	Estcourt	0-2	med	<40	pr
	Kroonstad	0-2	med	<40	gc
	Fernwood	0-2	med	80-120	U; R
	Cartref	0-2	med/cos	15-25	so
	Mispah	0-2	med/cos	15-20	R; ka

Explanation of abbreviations:

Sand grade:

cos = coarse
 med = medium
 fi = fine

Depth limiting material:

gc = gleyed clay
 hp = hard plinthite
 ka = limestone
 pr = prisma-cutanic horizon

R = hard rock
 so = saprolite/lithocutanic horizon
 U = Unconsolidated material
 vp = pedocutanic horizon

Table A2 Soil, terrain and parent material information collected during the reconnaissance field survey

Observation no	Coordinates		Soil form & family	Other comments	Parent rock and other terrain features
	South	East			
1	34°35' 37.0	19°21' 15.2	Cg 1000 Cg 2000	Plus ≈5% lime outcrops	Calcified dunes
2	34°37' 24.6	19°19' 31.1	Ad 2111 Pr 2110 Ag 2110 Nb 1200	Fine sands	Limestone
3	34°37' 39.8	19°18' 26.5	Ad 2111		Dune
4	34°36' 32.7	19°20' 49.5	Ag 2110 Nb 1200		Weak depression; Deep calcareous sand
5	34°36' 27.2	19°20' 56.1	Ad 1111	Deep; Soft limestone at 90+ cm	Limestone
6.1	34°34' 36.3	19°21' 10.7	Pr 1110	Lower zone; 70 cm to limestone	Limestone
6.2	34°34' 36.3	19°21' 8.9	Ad 1111	Higher zone; Slight dune; 70 cm to soft carbonate	Limestone
6.3	34°34' 34.4	19°21' 14.1	Pr 2110	Common limestone outcrops	Limestone
7	34°36' 01.6	19°23' 39.9	Pr 2110 Mu 2110 Ad 1112	Wetness in carbonate horizon	Vleiland area. Saline
8	34°35' 56.3	19°23' 39.7	Cf 1100 Hh 1200	Common sandstone fragments	Sandstone
9	34°37' 20.2	19°27' 49.6	Cg 2000	General depth <40 cm	Limestone
10	34°39' 48.7	19°29' 34.9	Br 1000 Nb 1200 Pr 1110 Ad 1111		Partially stabilised dunes
11	34°39' 37.7	19°31' 41.0	Cg 2000	General depth <40 cm	Limestone
12	34°42' 04.4	19°34' 57.6	Cg 2000 Pr 1110 Ad 1111	General depth <40 cm	Old dunes
13	34°39' 14.5	19°33' 05.0	Fw 1110 Lo 1000 Lt 1100		Sandstone
14	34°38' 46.2	19°34' 08.8	Gs 21/221 Cf 1100 Hh 1200		Sandstone area
15	34°38' 06.2	19°34' 57.4	Lt 1100 Cf 1100 Hh 1200	Deep	Drift sand area locally on sandstone
16	34°38' 49.6	19°36' 07.2	Ct 1100	30 cm to yellow-brown B	Sandstone
17	34°38' 58.7	19°36' 33.4	Cf 1200	50 cm to lithocutanic B; coarse sand	Sandstone
18	34°40' 43.9	19°38' 41.3	Wa 1000 Kd 1000	40 cm to hard plinthic B; fine sand	Malmesbury shales

Annexure A: Table A2 Continued

Observation #	Coordinates		Soil form & family	Other comments	Parent rock and other terrain features
	South	East			
19	34°37' 26.0	19°34' 41.7	Ct 1200 Gk 1200 Hh 1200	30 cm to yellow-brown B; 65 cm soft/hard sandstone	Sandstone
20	34°35' 05.8	19°36' 03.0	Laterite gravel pit		Shale
21	34°32' 39.6	19°24' 51.1	Ag 1110 Pr 1110	>120 cm deep	High elevation calcified dunes
22	34°33' 03.5	19°25' 35.1	Cg 1000 Cg 2000	Shallow	Hard limestone hills
23	34°33' 32.8	19°26' 52.6	Ad 1111 Br 1000		
24	34°34' 38.9	19°26' 57.4	Lt 1100	Fine/medium sand	Drift sands on old laterite
25	34°34' 51.7	19°26' 09.1	Lt 1100	Dark A and B horizon; Wet	Sandstone
26	34°35' 06.1	19°25' 56.8	Cg 1000		Limestone
27	34°33' 10.5	19°30' 02.9	Lt 1100 Kd 1000		Sandstone
28	34°31' 34.6	19°31' 07.3	Cf 1200 Hh 1200	Sandstone outcrops	Sandstone mountain zone
29	34°32' 36.0	19°30' 29.6	Lo 1000 Tu 2110 Kd 1000	Wet, sandy closer to river	Sandstone colluvium and alluvium
			Wa 1000 Dr 1000	On terrace; lateritic	Shale
30	34°35' 58.4	19°32' 10.7	Tu 2110 We 1000 Lo 1000 Kd 1000 Ka 1000	Vleiland and wet alluvium	Shale
31	34°36' 22.2	19°32' 38.0	Duplex soils Lateritic soil		Shale
32	34°36' 30.8	19°33' 19.4	Duplex soils Lateritic soil		Shale
			Wa 1000 Dr 1000		Sandstone
33	34°36' 53.1	19°33' 57.6	Lt 1100 Lo 1000 Kd 1000 Fw 1110	60 cm to podzol B; medium/coarse sand Deep Deep	Colluvial sands
34	34°36' 32.7	19°33' 53.8		Predominantly ferricrete	Shale
35	34°39' 09.6	19°32' 51.0	Wf 1100 Lt 1100 Lo 1000	±40 cm to podzol B	Sandstone

Table A3 Soil legend for the Overstrand reconnaissance soil survey

Soil group symbol	Description of Land Unit	Parent Material	Elevation	Surface materials and soil forms	Profiles
A	Mountainous predominantly sandstone rock (80%) with shallow lithosols and podzols	Table Mountain Sandstone	100 – 350m	Cartref, Houwhoek, Glenrosa & Mispah soil forms	14
B	High lying undulating sandstone plateau with podzolic and lithosolic soils	Table Mountain Sandstone	150 – 250m	Houwhoek, Lamotte, Constantia (70%) & Cartref (30%)	15, 16, 17, 19, 28
C	High lying calcrete (60%) hills with shallow calcareous soils on limestone	Tertiary limestone of the Bredasdorp Beds	150 – 300m	Limestone outcrops (60%), Coega & Addo (40%)	22, 23
D	Lower lying mid and toe slopes of sandstone hills and mountains (soomgebied)	Table Mountain Sandstone colluvium and alluvium	60 – 120m	Lamotte, Witfontein & Longlands (70%), Ferwood & Kroonstad (30%)	29, 27, 33
E	Slightly undulating low land with duplex and plinthic soils on shales and graywacke	Sheared shale and graywacke of the Malmesbury Formation	80 – 120m	Estcourt, Kroonstad & Wasbank	18
F	Undulating hills with duplex (mainly pedocutanic and prisma-cutanic) soils on shales	Bokkeveld shales	80 – 160m	Klapmuts, Estcourt, Sterkspruit, Kroonstad, Cartref & Glenrosa	30, 31, 32, See report
G	Low lying acid sands and duplex soils on the interface zone between the sandstones and shales (sandstone colluvium and alluvium over weathered shales)	Bokkeveld shales and TMS derived sands	100 – 160m	Kroonstad, Fernwood & Lamotte	See report
H	Near level silcrete and ferricrete terraces on shales in the undulating duplex landscape	Bokkeveld shales	100 – 150m	Silcrete (25%), Cartref, Dresden & Wasbank (75%)	20, 34
I	Low lying acid sands on coastal platform on toe slopes of sandstone mountains adjacent	Table Mountain Sandstone colluvium and alluvium	20 – 40m	Lamotte, Fernwood, Longlands & Kroonstad	13, 24, 25, 35

Annexure A: Table A3 Continued

Soil group symbol	Description of Land Unit	Parent Material	Elevation	Surface materials and soil forms	Profiles
J	Low lying older consolidated calcareous dunes on coastal flats	Tertiary to Recent calcified dune sand	20 – 40m	Limestone outcrops (20%), Coega, Augrabies, Prieska & Addo (80%)	2, 3, 4, 5, 10, 12, 21
K	Low lying young unconsolidated calcareous coastal dunes	Recent unconsolidated sand	20 – 30m	Namib, Brandvlei (80%), Prieska, & Addo (20%)	
L	Low lying near level coastal limestone terrace	Tertiary to Recent limestone of the Bredasdorp Beds	10 – 30m	Coega (60%), Prieska, Montagu & Addo (40%)	1, 6, 8, 9, 11, 26
M	Low lying vlei areas on coastal platform	Tertiary to Recent limestone of the Bredasdorp Beds	5 – 20m	Katspruit, Coega (60%), Prieska, Addo & Montagu (40%)	7
N	High lying vlei areas on upland positions	Bokkeveld shales	80 – 120m	Westleigh, Longlands, Katspruit (60%), Dundee (40%)	

Table A4 General physical and chemical properties of soil families identified during the Overstrand field survey

Soil form and Diagnostic horizons	Soil family	Family criteria	Topsoil clay and sand grade	Coarse fragments ¹	General pH ²	Degree of wetness ³	Effective depth ⁴	Depth limitation
Addo								
Orthic A Neocarbonate B Soft carbonate horizon	Ad 1111	Non-bleached, non-red, non-luvic, no wetness	≤5%, me	None	Neu - Alk	None	Medium	Soft carbonate
	Ad 1112	Non-bleached, non-red, non-luvic, with wetness	≤5%, me	None	Neu - Alk	None	Medium	Soft carbonate
	Ad 2111	Bleached, non-red, non-luvic, with wetness	≤5%, me	None	Neu - Alk	None	Medium	Soft carbonate
Augrabies								
Orthic A Neocarbonate B Unspecified material	Ag 1110	Non-bleached, non-red, non-luvic	≤5%, me	None	Neu - Alk	None	Deep	
	Ag 2110	Bleached, non-red, non-luvic	≤5%, me	None	Neu - Alk	None	Deep	
Brandvlei								
Orthic A Soft carbonate horizon	Br 1000	No wetness	≤5%, me	None-Com	Neu - Alk	None	Shallow	Soft carbonate
Cartref								
Orthic A E horizon Lithocutanic B	Cf 1100	Grey, non-hard	≤5%, me-co	Common	Very acid	Moderate	Medium	Lithocutanic
	Cf 1200	Grey, hard	≤5%, me-co	Common	Very acid	Moderate	Medium	Lithocutanic
	Cf 1100	Grey, non-hard	5-15%, fi	Rare-Con	Acid	Low-Mod	Medium	Lithocutanic
Coega								
Orthic A Hardpan carbonate horizon	Cg 1000	Non-calcareous	≤5%, me	Common	Neu - Alk	None	Shallow	Hardpan carbonate
	Cg 2000	Calcareous	≤5%, me	Common	Neu - Alk	None	Shallow	Hardpan carbonate
Constantia								
Orthic A E horizon Yellow-brown apedal B	Ct 1100	Non-luvic, non-podzolic	≤5%, me-co	None-Com	Very acid	None	Very deep	
	Ct 1200	Non-luvic, podzolic	≤5%, me-co	None-Com	Very acid	None	Very deep	
Dresden								
Orthic A Hard plinthic B	Dr 1000	Non-bleached	5-15%, fi	Common	Acid	Low-Mod	Shallow	Hard plinthite
Dundee								
Orthic A Stratified alluvium	Du 1210	Non-red, with wetness, non-calcareous	≤5%, me	None	Very acid	Mod-Sev	Medium	Wet material
Estcourt								
Orthic A E horizon Prismacutanic B	Es 1100	Grey, non-black	5-15%, fi	Common	Acid	Moderate	Medium	Prismacutanic B

Annexure A: Table A4 Continued

Soil form and Diagnostic horizons	Soil family	Family criteria	Topsoil clay and sand grade	Coarse fragments	General pH	Degree of wetness	Effective depth	Depth limitation
Fernwood								
Orthic A E horizon Unspecified material	Fw 1110	Light coloured, grey, non-lamellic	≤5%, me-co	None	Very acid	Moderate	Very deep	
Glenrosa								
Orthic A Lithocutanic B	Gs 2121	Bleached, non-hard, with wetness, non-calcareous	≤5%, me-co	Com-Abun	Very acid	Low-Mod	Medium	Lithocutanic
	Gs 2221	Bleached, hard, with wetness, non-calcareous	≤5%, me-co	Com-Abun	Very acid	Low-Mod	Shallow	Lithocutanic
	Gs 2121	Bleached, non-hard, with wetness, non-calcareous	5-15%, fi	Rare-Com	Acid	Low-Mod	Medium	Lithocutanic
Houwhoek								
Orthic A E horizon Podzol B Saprolite	Hh 1200	Non-hard, with wetness	≤5%, me-co	Com-Abun	Very acid	Moderate	Medium	Lithocutanic
	Hh 2100	Hard, without wetness	≤5%, me-co	Com-Abun	Very acid	Moderate	Medium	Lithocutanic
Katspruit								
Orthic A G horizon	Ka 1000	Non-calcareous	5-15%, fi	None-Com	Acid	Severe	Shallow	G horizon
	Ka 2000	Calcareous	≤5%, me-co	None-Com	Acid	Severe	Shallow	G horizon
Kroonstad								
Orthic A E horizon G horizon	Kd 1000	Grey	≤5%, me	Common	Acid	Severe	Medium	G horizon
			5-15%, fi	Common	Acid	Severe	Medium	G horizon
Klappmuts								
Orthic A E horizon Pedocutanic B	Km 1110	Grey, non-red, subangular	5-15%, fi	Common	Acid	Low-Mod	Medium	Pedocutanic B
	Km 1120	Grey, non-red, angular	5-15%, fi	Common	Acid	Low-Mod	Medium	Pedocutanic B
Longlands								
Orthic A E horizon Soft plinthic B	Lo 1000	Grey	≤5%, me	None	Very acid	Mod-Sev	Shallow	Soft plinthite
			5-10%, fi	None	Very acid	Mod-Sev	Shallow	Soft plinthite
Lamotte								
Orthic A E horizon Podzol B Unconsolidated material with signs of wetness	Lt 1100	Non-hard, friable	≤5%, me-co	None-Com	Very acid	Moderate	Medium	Wet material
Mispah								
Orthic A Hard rock	Ms 2100	Bleached, non-calcareous	≤5%, me-co	Abundant	Very acid	Low-Mod	Shallow	Hard rock

Annexure A: Table A4 Continued

Soil form and Diagnostic horizons	Soil family	Family criteria	Topsoil clay and sand grade	Coarse fragments	General pH	Degree of wetness	Effective depth	Depth limitation
Montagu								
Orthic A Neocarbonate B Unspecified material with signs of wetness	Mu 2110	Bleached, non-red, non-calcareous	≤5%, me	None-Com	Neu - Alk	Moderate	Medium	Wet material
Namib								
Orthic A Regic sand	Nb 1200	Non-red, calcareous	≤5%, me	None	Neu - Alk	None	Very deep	
Prieska								
Orthic A Neocarbonate B Hardpan carbonate horizon	Pr 1110	Non-bleached, non-red, non-luvic	≤5%, me	None-Com	Neu - Alk	None	Medium	Hardpan carbonate
	Pr 2110	Bleached, non-red, non-luvic	≤5%, me	None-Com	Neu - Alk	None	Medium	Hardpan carbonate
Sterkspruit								
Orthic A Prismacutanic B	Ss 2100	Bleached, non-red	5-15%, fi	Common	Acid	Low-Mod	Shallow	Prismacutanic B
Wasbank								
Orthic A E horizon Hard plinthic B	Wa 1000	Grey	5-15%, fi	None-Com	Acid	Moderate	Medium	Hard plinthite
Westleigh								
Orthic A Soft plinthic B	We 1000	Non-luvic	5-10%, fi	None	Very acid	Severe	Shallow	Soft plinthite
Witfontein								
Orthic A Podzol B Unconsolidated material with signs of wetness	Wf 1100	Non-hard, friable	≤5%, me-co	None-Com	Very acid	Moderate	Medium	Wet material

Definition of classes used in table:

Coarse fragments topsoil¹:

None <15%
Common 15-50%
Abundant >50%
Very acid <5.0

pH classes²:

Very acid <5.0
Acid 5.0-6.5
Neutral-Alkaline >6.5

Wetness classes³:

None
Low
Moderate
Severe

Effective depth classes⁴:

Shallow <30 cm
Medium 30-60 cm
Deep 50-75
Very deep >75

Abbreviations:

Abun = Abundant
Alk = Alkaline
co = coarse
Com = Common
fi = fine
me = medium
Mod = Moderate
Neu = Neutral
Sev = Severe

Table A5 General physical and chemical limitations of soil families identified during the Overstrand field survey

i) The following classes and abbreviations are used to qualify the physical and chemical soil limitations of soil families:

Class	Abbreviation
None	(no symbol)
Low	Low
Moderate	Mod
Severe	Sev
Variable	Var

ii) Coarse fragments refer to material larger than 2.0 mm in top- and upper subsoil.

iii) The following effective depth classes are used:

Depth class	Abbreviation	Depth
Shallow	SH	<30 cm
Medium deep	MD	30 – 60 cm
Deep	DE	>60 cm

Soil family	High acidity	Free lime	Low water holding capacity	Coarse fragments	Wetness hazard		Subsoil depth limitation					Effective depth class
					Wetness in E horizon	Wetness in G horizon or lower subsoil	Structured subsoil clay pan	Weathering rock	Limestone pan	Iron cemented hardpan	Stratified alluvium	
Ad 1111		Mod-Sev	Mod-Sev						Low			MD-DE
Ad 1112		Mod-Sev	Mod-Sev						Low			MD-DE
Ad 2111		Mod-Sev	Mod-Sev									MD-DE
Ag 1110		Mod-Sev	Mod-Sev									DE
Ag 2110		Mod-Sev	Mod-Sev									DE
Br 1000		Severe	Mod-Sev	None-Mod								SH
Cf 1100 ¹	Moderate		Mod-Sev	Moderate	Moderate	Moderate		Moderate				MD
Cf 1200	Moderate		Mod-Sev	Moderate	Moderate	Mod-Sev		Severe				SH-MD
Cf 1100 ²	Moderate		Low	Low-Mod	Low-Mod	Moderate		Moderate				MD
Cg 1000		Severe	Mod-Sev	Moderate					Severe			SH
Cg 2000		Severe	Mod-Sev	Moderate					Severe			SH
Ct 1100	Mod-Sev		Mod-Sev	Low-Mod								DE
Ct 1200	Mod-Sev		Mod-Sev	None-Mod								DE
Dr 1000				Moderate		Low-Mod				Severe		SH

Annexure A: Table A5 Continued

Soil family	High acidity	Free lime	Low water holding capacity	Coarse fragments	Wetness hazard		Subsoil depth limitation					Effective depth class
					Wetness in E horizon	Wetness in G horizon or lower subsoil	Structured subsoil clay pan	Weathering rock	Limestone pan	Iron cemented hardpan	Stratified alluvium	
Du 1210	Low	Moderate				Mod-Sev					Moderate	SH-MD
Es 1100	Low			Moderate		Moderate	Severe					SH
Fw 1110	Mod-Sev		Mod-Sev		Moderate	Moderate						MD-DE
Gs 2121 ¹	Mod-Sev			Mod-Sev		Low		Moderate				SH
Gs 2221	Mod-Sev			Mod-Sev		Low-Mod		Severe				SH
Gs 2121 ²	Low-Mod			Low-Mod		Low		Moderate				
Hh 1200	Mod-Sev		Mod-Sev	Mod-Sev	Moderate	Low-Mod		Moderate				SH-MD
Hh 2100	Mod-Sev		Mod-Sev	Mod-Sev	Low	Low		Severe				SH-MD
Ka 1000	Low			None-Mod		Severe	Severe					SH
Ka 2000		Moderate	Mod	None-Mod		Severe	Severe					SH
Kd 1000 (≤5% clay)	Low		Mod-Sev	Moderate	Mod-Sev	Severe	Severe					SH-MD
Kd 1000 (5-15%)	Low			Moderate	Mod-Sev	Severe	Severe					SH-MD
Km 1110	Low			Moderate	Low-Mod		Mod-Sev					SH-MD
Km 1120	Low			Moderate	Low-Mod		Mod-Sev					SH-MD
Lo 1000 (≤5% clay)	Mod-Sev		Moderate		Mod-Sev	Severe						SH-MD
Lo 1000 (5-10%)	Mod-Sev				Mod-Sev	Severe						SH-MD
Lt 1100	Mod-Sev		Mod-Sev	None-Mod	Low-Mod	Moderate						MD-DE
Ms 2100	Moderate			Mod-Sev				Severe				SH
Mu 2110		Mod-Sev	Mod-Sev	None-Mod		Low-Mod						MD
Nb 1200		Mod-Sev	Mod-Sev									DE
Pr 1110		Mod-Sev	Mod-Sev	None-Mod					Mod-Sev			MD
Pr 2110		Mod-Sev	Mod-Sev	None-Mod					Mod-Sev			MD
Ss 2100	Low			Moderate			Severe					SH
Wa 1000	Moderate			None-Mod	Low-Mod	Low-Mod				Mod-Sev		SH-MD
We 1000	Mod-Sev					Severe						SH
Wf 1100	Mod-Sev		Mod-Sev	None-Mod		Low-Mod						SH-MD

¹ ≤5% clay² 5-15% clay

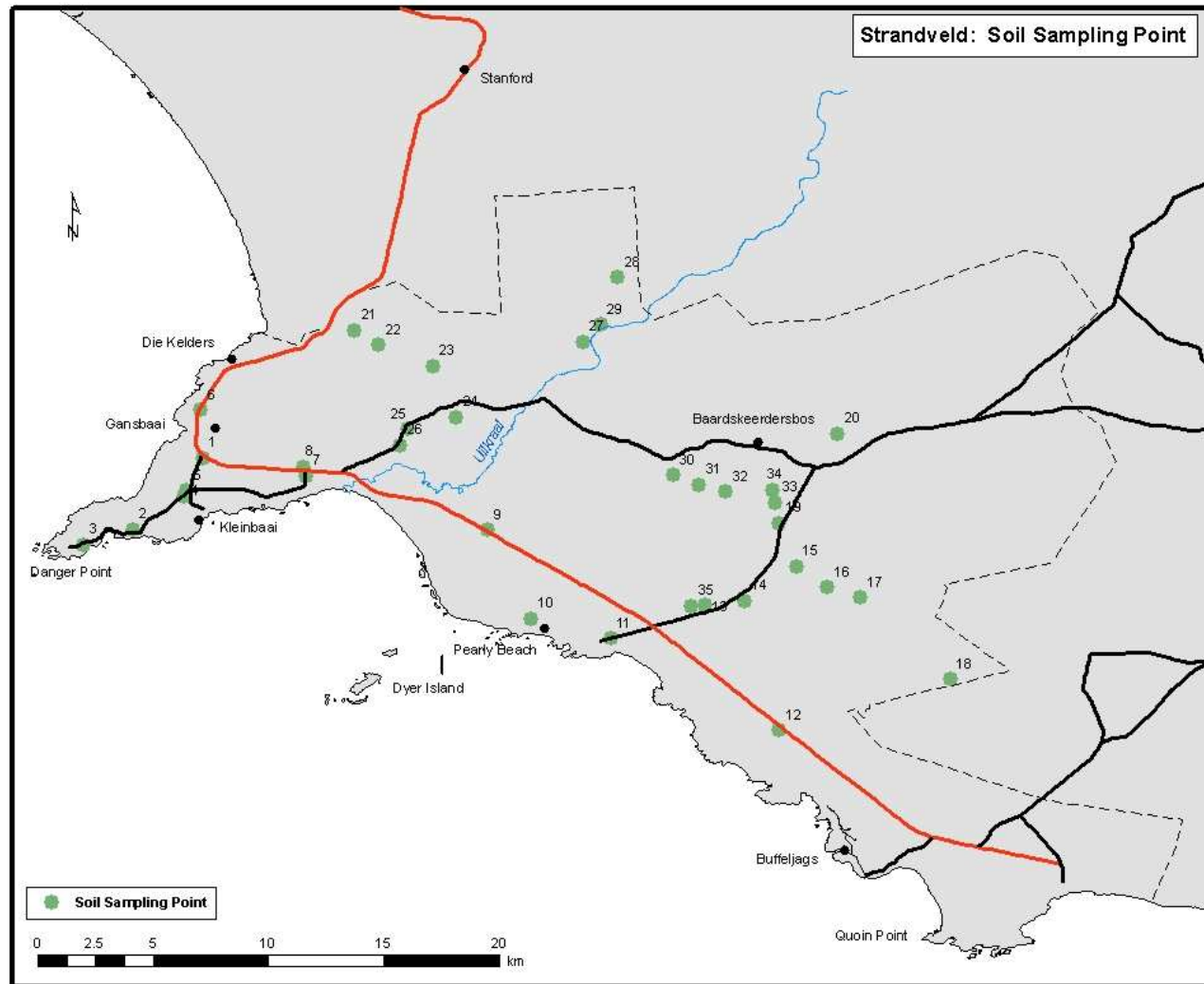
Table A6 Surface area (in hectare) of the different soil families grouped by soil form in the individual soil groups. Soil families highlighted in green have a suitability rating for irrigated summer growing crops of >4.0 (medium and higher suitability) and a surface area of at least 300 ha per soil group

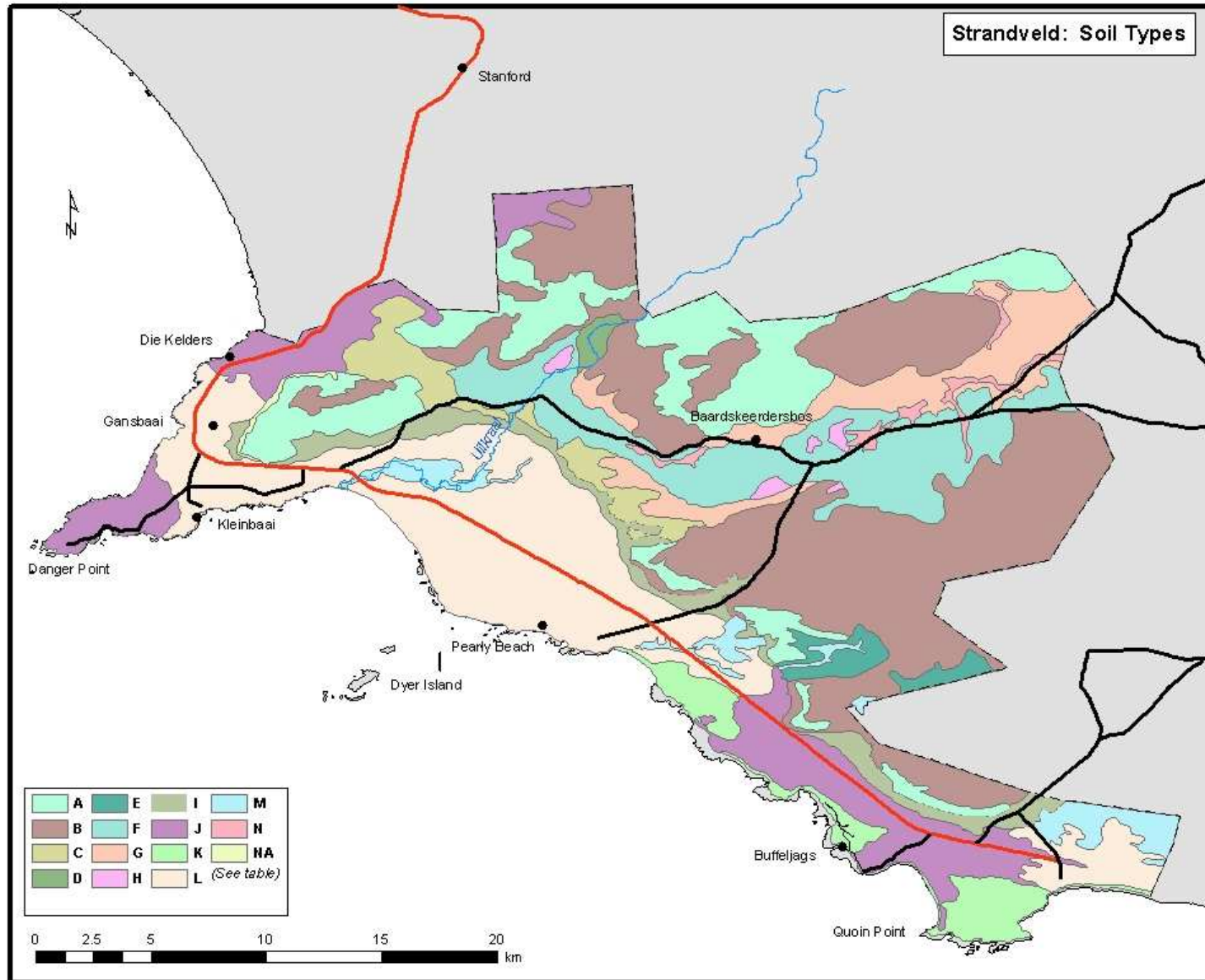
Soil family	Topsoil clay & sand grade	Average rating two evaluators		Soil group													
		Annual dry-land winter crops	Irrigated summer growing crops	A	B	C	D	E	F	G	H	I	J	K	L	M	N
Ad 1111	≤5%, me	3.8	4.8			330							743	57	1 218	110	
Ad 1112	≤5%, me	3.8	4.8														
Ad 2111	≤5%, me	3.3	4.0														
Ag 1110	≤5%, me	3.8	4.8										371				
Ag 2110	≤5%, me	3.3	4.3														
Br 1000	≤5%, me	2.5	2.8											229			
Cf 1100	≤5%, me-co	3.3	4.5	314	4 238												
Cf 1200	≤5%, me-co	3.3	3.5														
Cf 1100	5-15%, fi	4.0	5.0						877		63						
Cg 1000	≤5%, me	2.3	2.3			330							743		5 480	248	
Cg 2000	≤5%, me	2.3	2.3														
Ct 1100	≤5%, me-co	4.8	5.5		3 296												
Ct 1200	≤5%, me-co	4.8	5.5														
Dr 1000	5-15%, fi	3.5	4.5								63						
Du 1210	≤5%, me	3.5	3.5														188
Es 1100	5-15%, fi	4.3	4.8					83	877								
Fw 1110	≤5%, me-co	4.0	4.5				33			1 031		350					
Gs 2121	≤5%, me-co	3.5	4.0	314													
Gs 2221	≤5%, me-co	3.5	4.0														
Gs 2121	5-15%, fi	4.5	5.5						877								
Hh 1200	≤5%, me-co	4.0	4.5	314	3 296												
Hh 2100	≤5%, me-co	3.5	4.3														
Ka 1000	5-15%, fi	2.0	2.0														94
Ka 2000	≤5%, me-co	2.0	2.0													248	

Annexure A: Table A6 Continued

Soil family	Topsoil clay & sand grade	Average rating two evaluators		Soil group													
		Annual dry-land winter crops	Irrigated summer growing crops	A	B	C	D	E	F	G	H	I	J	K	L	M	N
Kd 1000	≤5%, me	4.0	4.8				33							350			
Kd 1000	5-15%, fi	4.0	4.0					83	877	1 031							
Km 1110	5-15%, fi	4.8	4.8						877								
Km 1120	5-15%, fi	4.3	4.8														
Lo 1000	≤5%, me	3.8	3.8				52						350				
Lo 1000	5-10%, fi	4.0	4.0														94
Lt 1100	≤5%, me-co	4.8	5.5		3 296		52			1 031		350					
Ms 2100	≤5%, me-co	2.0	2.0	314													
Mu 2110	≤5%, me	3.5	4.8												1 218	110	
Nb 1200	≤5%, me	1.3	2.3											229			
Pr 1110	≤5%, me	3.8	5.0										743	57	1 218	111	
Pr 2110	≤5%, me	3.8	5.0														
Ss 2100	5-15%, fi	3.7	3.8						877								
Wa 1000	5-15%, fi	4.8	5.8					83			63						
We 1000	5-10%, fi	3.3	3.5														94
Wf 1100	≤5%, me-co	4.3	4.8				52										
Silcrete		1.0	1.0								63						
Rock		1.0	1.0	5 027													
Lime stone		1.0	1.0			989						743					
Total				6 284	14 125	1 649	223	248	5 263	3 094	253	1 401	3 713	573	9 134	828	470

ANNEXURE B

Figure B1 Reconnaissance soil map of the Overstrand study area on a scale 1 : 50 000 (original); Soil legend: See **Table A3**



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