REPORT ON A RECONNAISSANCE SOIL SURVEY OF CERTAIN SELECTED FARMS IN THE BLYDE-OLIFANTS RIVER AREA

UNDERTAKEN FOR

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C O N T E N T S

SUMMARY

1. The total area investigated including all rivers except the Olifants, was 31,034 morgen of which 16,249 morgen is suitable for sugar production under irrigation.

2. Twelve soil series, three alluvial land types and two stony land types have been defined together with depth and stony phases of certain of the series.

3. The series and land types have been classified into three major land capability units with respect to irrigated sugar.

4. A reconnaissance soils map at 1:36,000 scale shows the distribution of soils and land capability classes.

5. Details of the extent of the various land capability classes as extracted from the 1:18,000 compilation maps are summarised in Table 1. The area covered by rivers is not included.

6. The land capability classification is subject to the proviso that due cognisance be taken of the factors which limit productivity and which determine management principles and practices.

TABLE 1 - Areal extent (morgen) of capability classes

Region	Recommended			Marginal	Not Recommended
	Highly Productive	Moderately Productive	Total		
Olifants Farms	2,599	1,247	3,846	1,446	4,179
Blyde Farms	5,732	6,671	12,403	2,039	6,182
TOTAL	8,331	7,918	16,249	3,485	10,361

7. The coarse textures, low available moisture capacities and very rapid permeability and infiltration rates of the majority of upland soils and the sluggishly drained character of many lower slope soils will be the cause of the most difficult management problem in the area viz. the control of soil moisture. The object of irrigation must be to apply water sufficient only to maintain the soil moisture regime at field capacity. Mismanagement of irrigation water will cause crop losses due to drought if too little is applied and losses due to waterlogging and salinization if too much is applied. Furthermore, correct irrigation practices will ensure efficient use of the available water supply.

8. The quality of the irrigation water is good.

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Summary cont'd:

9. To achieve correct land management with respect to irrigated sugar, it is recommended that

   (i) sprinkler irrigation be practised throughout the area;

   (ii) irrigation canals be lined;

   (iii) a detailed soil survey of the land allocated to sugar be undertaken;

   (iv) infiltration rates and available moisture capacities of the various soil horizons be determined as an essential precursor to the design and programming of sprinkler irrigation systems; and

   (v) regular attention be paid to trends and problems arising from irrigation practices.

10. The soils which have been recommended for sugar production under irrigation in the Blyde Skema are equal in potential productivity to the commonly occurring sugar soils in the Natal Sugarbelt.

I N T R O D U C T I O N

During December, 1964, a reconnaissance soil survey of an area known as the Blyde Skema was carried out. The area is situated along the Blyde and Olifants rivers between Hoedspruit and the Abel Erasmus Pass in the Eastern Transvaal. The farms investigated were Margate, Portsmouth and Liverpool on the Olifants river and Richmond, Southampton, Grovedale, Moriah, Glencoe and portions of Jongmansspruit, Chester, Antioch and Driehoek on the Blyde river.

The main object of the survey was to determine whether or not 10,000 morgen of soil suitable for sugar production under irrigation exist in the area investigated. The secondary object was to define the major soil and land types, show their distribution on a map and classify them according to their suitability for sugar production under irrigation.

This report deals with the morphological, physical and chemical properties of the soil series and land types encountered and the principles which govern their management under irrigation. A reconnaissance soil map at 1:36,000 scale shows the distribution of soils and land capability classes.

The report does not cover fertilizer requirements and practices, the amount of water required to irrigate the recommended soils class and the amount of water available for irrigation in the area.

A glossary of technical terms is included at the end of the report.

METHODS OF INVESTIGATION

The investigation was carried out in three phases.

CLASSIFICATION

Fifty one pits were sited, dug, described and sampled. This led to the identification and definition of twelve soil series, three alluvial land types and two stony land types. Each of these units was then classified according to its suitability of sugar production under irrigation (see Table 2).

MAPPING

The area was traversed in a reconnaissance fashion using an auger to identify soils and to place boundaries on aerial photographs. Traversing was made difficult by out of date aerial photography and by large areas which were not readily accessible by motor vehicle.

Due to variations in the complexity of the soil pattern over the area, the different soil series, phases, etc. could not always be separated on the map. While some symbols indicate only one phase of a certain series (e.g. G3), others(R1) include more than one series. Furthermore, it was not possible in many instances to use a single map symbol to represent the soils of certain areas on the map; symbols such as R2 - R3 denote a complex of the soils of units R2 and R3.

The additional qualifying symbols X and S have been used to indicate stony soils which do not possess severe mechanical limitations and saline soils respectively.

It must be appreciated that the symbols on a reconnaissance soils map cannot represent all the soils in the areas delineated. For instance, an area shown as R2 may well include minor areas of soil belonging to unit R1 etc.

Main roads and certain of the minor roads and tracks are shown. Boundaries of rivers have been drawn so as to include in the rivers, not only the permanent water channels, but also low-lying terraces which are periodically flooded.

The soils map was compiled by transferring annotations made on aerial photographs in the field to 1:18,000 Trigonometrical Survey preliminary field sheets and reducing the scale to 1:36,000.

A more detailed survey entailing the compilation of a map at 1:10,000 scale or less would be required for planning the production of sugar on a farm basis.

ANALYSIS

The following determinations were made on all samples:

pH (soil reaction) of the saturated (with water) soil paste using a Metrohm pH meter with glass electrode;

Resistance (Ohms R $60^{o}F$) of the saturated soil paste using a standard Wheatstone bridge;

Electrical conductivity ($EC_e 10^3$/cm $25^{o}C$) of the saturation extract (calculated from resistance).

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The following determinations were made on samples from the more important series and land types:

Mechanical analysis by the hydrometer method.

Permeability (inches per hour) estimated on the basis of the rate of flow through a saturated, undistributed soil core 3 inches in diameter and 3 inches in length using a $\frac{1}{2}$-inch head of water.

Exchange properties and extractable metal cations by the NH_4Cl (soil pH) method using the Eel flame photometer for Na and K and Ca and Mg by the Versenate method. For saline profile No T10, the differences between the total metal cations extracted by the NH_4Cl method and those present in saturated paste extracts were used as estimates of extractable metal cations. Ca and Mg were not estimated in calcareous samples.

ENVIRONMENT

The area has a semi-arid climate. Precipitation occurs in the summer beginning in October when hot, humid conditions prevail. The summers are hot and the winters mild, the entire area being more or less frost free. The mean annual rainfall varies from 16 inches in the east to more than 35 inches in the foothills of the Drakensberg escarpment.

The vegetation is a semi-arid savanna - bushveld type with denser, near-forest vegetation along the river banks. The important trees belong to the Acacia, Sclerocarya and Combretum genera, while important grasses belong to the Digitaria, Themeda, Andropogon, Cymbopogon and Heteropogon genera.

The area is underlain by Archean granite with frequent occurrences of diabase. The granite rocks comprise the source of the alkali metals and the coarser fractions of the soils of the area. It is possible that diabase contributes a large proportion of the fine textured materials (particularly those on freely drained, upland sites) and the free lime.

Few of the soils have been developed in situ from the underlying rock. The area has undergone dissection and planation by the Blyde and Olifants rivers. There is much evidence of high level terraces, particularly alluvial depositions of stones, but the greater proportion of the terrace soil material appears to have been removed leaving behind patches here and there. Many of the soils have developed in local colluvial drift. The result of the planation of the landscape following dissection has been the removal of soil material most rapidly from the tops of slopes resulting in a fairly regular increase in soil depth from the tops of crests to lower slope sites.

TABLE 2 - Summary of soil series and land types

Series and Land Types	Phase	Map Symbol	General Characteristics	Occurrence	Limitations under Irrigation	Capability Class
Series No 1		R1	Reddish brown calcareous sandy loam to sandy clay loam	Infrequent	Nil	Highly productive
Series No 2	(i)	R3	Reddish brown sand to loamy sand on altered granite	Extensive	Very low moisture tension	Moderately productive
	(ii)	R3X	Shallow and stony	Extensive	Very low moisture tension	Moderately productive
Series No 3	(i)	R1	Reddish brown sandy loam to sandy clay loam on altered granite	Infrequent	Nil	Highly productive
	(ii)	R2	Shallow	Extensive	Nil	Highly productive
	(iii)	R2X	Shallow and stony	Extensive	Low available moisture capacity; slight mechanical	Moderately productive
Series No 4	(i)	R1	Reddish brown sandy loam to sandy clay loam on altered basic rock	Infrequent	Nil	Highly productive
	(ii)	R2	Shallow	Infrequent	Nil	Moderately productive
	(iii)	R2X	Shallow and stony	Infrequent	Low available moisture capacity; slight mechanical	Moderately productive

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TABLE 2 cont'd

Series and Land Types	Phase	Map Symbol	General Characteristics	Occurrence	Limitations under Irrigation	Capability Class
Series No 5	(i)	R1	Reddish brown sandy loam to sandy clay loam on very slowly permeable gley	Frequent	Impeded drainage	Highly productive
	(ii)	R2	Shallow	Rare	Impeded drainage	Highly productive
Series No 6		R1	Dark grey brown mottled sandy loam to sandy clay loam on very slowly permeable gley	Rare	Impeded drainage	Highly productive
Series No 7	(i)	G1	Dark grey brown sand to loamy sand on altered granite	Extensive	Very low moisture tension	Moderately productive
	(ii)	G2	Shallow	Extensive	Very low moisture tension	Moderately productive
	(iii)	G2X	Shallow and stony	Frequent	Very low moisture tension; slight mechanical	Moderately productive
Series No 8	(i)	G4	Dark grey brown sandy loam to sandy clay loam on altered granite	Frequent	Low available moisture capacity; slightly impeded drainage	Moderately productive
	(ii)	G4X	Shallow and stony	Frequent	Low available moisture capacity; slightly impeded drainage; slight mechanical	Moderately productive
Series No 9		G3	Dark grey brown sand to loamy sand (less than 15 in. thick) abruptly overlying a very slowly permeable B horizon	Frequent	Low available moisture capacity; severely restricted drainage; salinity; highly erodible	Marginal

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TABLE 2 cont'd

Series and Land Types	Phase	Map Symbol	General Characteristics	Occurrence	Limitations under Irrigation	Capability Class
Series No 10	-	G1	Deep grey brown sand to loamy sand on slowly permeable gley	Infrequent	Very low moisture tension; impeded drainage	Moderately productive
Series No 11 Bonwapitse	-	-	Black sandy clay loam to sandy clay on lime	Rare	Impeded drainage	Highly productive
Series No 12	-	-	Very dark grey to black sandy clay loam to sandy clay overlying a dark brown sandy clay	Rare	Impeded drainage	Highly productive
Alluvial 1 Terrace Flood plain	-	A	Reddish brown sandy loam to sandy clay loam	Frequent	Nil	Highly productive
Alluvial 2	-	A	Young strongly stratified alluvial deposits	Infrequent	Impeded drainage	Moderately to highly productive
Alluvial 3	-	A	Dark grey brown sand abruptly overlying a saline-calcerous sandy clay loam	Infrequent	Salinity; impeded drainage	Not recommended
Stony 1	-	1	Rock with no soil mantle	Infrequent	-	-
Stony 2	-	2	Abundant pebbles and boulders in a coarse textured soil matrix on altered rock	Extensive	Severe mechanical; very low moisture tension	Not recommended

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GENERAL DESCRIPTION OF SOIL SERIES AND LAND TYPES AND THE PRINCIPLES WHICH GOVERN THEIR MANAGEMENT

This section includes a general description of each soil series and land type and an account of its occurrence, relationship with previously defined series, its management and its limitations. Profile descriptions and analytical data to which reference is made in this section are to be found in the Appendix. The particulars of the various series and land types are summarised in Table 2.

SOIL SERIES

REDDISH BROWN SOILS

Series No 1 - see profile No T1

Occurrence

It occurs patchily and not very extensively.

Correlation

It is provisionally included in the Sunvalley series which was first defined during the survey of the soils of the Tugela Basin, Natal by J.J. van der Eyk, C.N. Macvicar and J.M. de Villiers. However, the Sunvalley series tends to be rather more strongly structured and heavier textured. It is a reddish brown, calcareous, semi-arid soil.

Description

It is freely drained with three horizons : a slightly acid to alkaline dark reddish brown A1 horizon slightly darkened by organic matter, a calcareous reddish brown B horizon with more than 10 per cent clay and a calcareous reddish brown to yellowish red C horizon.

The A1 - variable in texture - has a rapid infiltration rate, a friable consistence and a weak blocky structure.

The reddish brown B has a moderate blocky structure, a coarse to medium texture and a friable consistence. Permeability is rapid (more than 2 inches per hour), base status is high and the clay fraction consists of 2:1 lattice (illite) clays and variable amounts of kaolinite. Lime is present as thin veins and nodules.

The C horizon is similar to the B, but is usually yellower and more calcareous.

The series is greater than 20 inches in thickness and hence has not been sub-divided into phases; it is included in map unit R1.

Limitations and Management

There are no serious limitations to the management under irrigation of this soil; it is a permeable soil with a moderately high water holding capacity. However, it occurs in lower slope positions and if the landscape is badly managed (over-irrigation higher up the slope), it will tend to accumulate salts. There is,

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therefore, a slight salinity hazard. Its productivity is considered to be high.

Series No 2 - see profile No T2

Occurrence

Both phases of this series occur extensively.

Correlation

It is closely related to the Joubertina series, which was first defined in the Langkloof, Cape by C.N. Macvicar and R.F. Loxton.

Description

It is freely drained with three horizons : a weakly developed dark reddish brown to dark grey brown A1, a reddish brown B with less than 10 per cent clay and a C horizon of mottled weathering granite.

The infiltration rate of the A1 is excessively rapid; there is no structure (single grain) and little cohesion between textural units.

The B has no structure, consistence is very friable, reaction varies between pH 5.5 - 7.5 and the clay minerals are kaolinite and illite. Base status is low and it is excessively permeable (more than 5.0 inches per hour). The sand fraction is dominated by coarse sand.

The B horizon is usually separated from the weathering granite by a gravel layer - variable in thickness - of colluvial or alluvial origin.

The weathering granite C horizon, in contrast with the predominantly greyish coloured weathering granite of the grey brown soils, is markedly red in colour; it is a mottled red, yellowish red, black and yellowish brown, very gritty material weathering to form a reddish brown soil. The transition from the B to the C is often a tongueing one. Its hardness varies locally according to the degree of weathering and its permeability is rapid.

It has been sub-divided into two phases:

(i) Deep phase : thickness of the A plus B horizons is greater than 20 inches; it is included in map unit R3.

(ii) Shallow and stony phase : thickness of A plus B horizons seldom exceeds 10 inches; the weathering granite or the gravel layer, which lie close to the surface, do not constitute a serious mechanical limitation; it is included in the map unit R3X.

Limitations and Management

The major limitation is one of soil-water relationships. Drainage is excessively rapid and the water holding capacity very low. Applications of large quantities of water would result in water wastage and the flooding of lower slope positions. Irrigation practices must

be limited ... 12/...

be limited to frequent, light applications of water sufficient only to maintain the moisture regime of the rooting zone at field capacity.

The stoniness of the shallow phase constitutes a slight mechanical hazard with respect to wear on implements; it is also the cause of a lower water holding capacity within the rooting zone.

For the purpose of evaluating its potential productivity it may be compared with the Cartref series, which was originally defined by B.E. Beater in the Natal coastal belt. It is considered to be moderately productive.

Series No 3 - see profile No T3

Occurrence

Both phases occur extensively.

Correlation

It has certain properties in common with the Shorrocks series. (Natal coastal belt).

Description

It is freely drained with three horizons : an A1 - variable in texture - slightly darkened by organic matter, a uniformly coloured reddish brown B horizon with more than 10 per cent clay and a C horizon of weathering granite.

The A1 has a moderately rapid to rapid infiltration rate, a weak to moderate blocky structure and a friable consistence.

The B horizon has a weak to moderate blocky structure and a friable consistence. Its permeability is rapid (2.0 - 5.0 inches per hour), base status is moderately high, reaction acid to neutral and its clay minerals are illite and kaolinite.

The B horizon is usually separated from the C by a gravel layer - variable in thickness - of colluvial or alluvial origin.

The weathering granite C horizon, into which the B often tongues, is mottled reddish brown, black, yellowish brown and light grey. It has a very coarse, gritty texture and its hardness varies locally according to the degree of weathering; its permeability is moderate to rapid.

This series has been sub-divided into three phases:

(i) Deep phase : thickness of the A plus B horizons is greater than 20 inches; it is included in map unit R1.

(ii) Shallow phase : thickness of A plus B horizons is 6 - 20 inches; it is included in map unit R2.

(iii) Shallow and stony phase : identical with the shallow phase, but with a degree of stoniness not constituting a serious mechanical limitation; it is more permeable than phases (i) and (ii), but retains less water at field capacity; the stoniness

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is due to the close proximity to the surface of either the weathering granite or colluvial or alluvial gravels; it is included in map unit R2X.

Limitations and Management

Under irrigation there are no limitations attached to the deep phase; its drainage and permeability are good and it has a high available moisture capacity. Its potential productivity with respect to sugar is high.

There are no serious limitations attached to the shallow phase although care should be taken not to over-irrigate. Its potential productivity is high.

The shallowness and stoniness of the third phase are the cause of a lower water holding capacity; such a soil requires lighter applications of water at more frequent intervals. There is a certain mechanical hazard with regard to wear on implements.

Series No 4 - see profile No T4

Occurrence

It is confined to the fairly frequent intrusions of diabase.

Correlation

It has certain properties in common with the Glendale series (Natal coastal belt).

Description

It is a freely drained soil with three horizons : the A1 and B are identical with those of series No 3. The C horizon consists of mottled weathering diabase which, on weathering, gives rise to a reddish brown sandy clay to clay. Its structure is geogenic and its consistence and texture vary according to the degree of weathering. Base status is higher than that of the weathering granite.

It has been sub-divided into phases identical with those of series No 3.

Limitations and Management

Apart from the fact that the C horizon may be inherently more fertile than that of series No 3, its limitations, management and production potential are identical.

Series No 5 - see profile No T5

Occurrence

It occurs fairly frequently, but in a rather patchy fashion.

Correlation

It is comparable with the Rooikop series (Tugela Basin).

Description .... 14/..

Description

The series suffers a degree of impeded drainage. It has four horizons : an A1 slightly darkened by organic matter, a reddish brown B21 with more than 10 per cent clay, a B22 horizon which is yellowish brown to yellowish red mottled red and black and which abruptly overlies the dark grey mottled yellowish brown, black and red, very slowly permeable, gleyed C horizon; the latter is sometimes referred to as pot clay.

Due to poor local drainage, hydromorphic conditions (waterlogging, either intermittent or permanent) have caused the development of the slowly permeable C in a soil otherwise identical with series Nos 3 and 4. The C horizon is the zone of more or less permanent saturation by water. During wet periods, the water table tends to rise above the C horizon causing the formation of the mottled B22 horizon.

The A1 and B21 horizons are identical with those of series Nos 3 and 4.

The B22 horizon is yellowish brown to yellowish red mottled red, black and dark brown; its structure is weak to moderate blocky and its consistence is friable. Reaction is acid to neutral, base status is moderately high to high and the clay minerals are illite and kaolinite. Its permeability is moderately rapid (1.5 - 4 inches per hour).

A stone line of grits and gravels - usually thin - which presents a bleached appearance due to water draining laterally over the very slowly permeable C horizon, frequently separates the B22 from the C horizon.

The gleyed C has a strong blocky structure and a very firm consistence. Reaction is neutral to alkaline, base status high and the clay minerals are predominantly of the 2:1 lattice type (illitic). It is very slowly permeable (less than 0.2 inches per hour).

It has been sub-divided into two phases:

(i) Deep phase : depth of soil to gleyed C horizon is greater than 20 inches; it is included in map unit R1.

(ii) Shallow phase : depth of soil to gleyed C horizon is 10 - 20 inches; it is included in map unit R2.

Limitations and Management

This soil suffers a degree of poor drainage under virgin conditions; care must, therefore, be taken to ensure that a permanent water table sufficient to inhibit crop growth is not induced by irrigation. The aim must be to irrigate the soil above the gleyed C horizon only. Any water in excess of this will cause a water table to develop on top of the C. Because the A1 and B horizons have a fairly high available moisture content at field capacity, correct irrigation management ought not to present great difficulties.

The shallow phase is comparatively rare; more care must be taken with its management to preclude the development of water tables.

The deep and shallow phases are considered to be highly productive.

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GREY BROWN SOILS

Series No 6 - see profile No T 6

Occurrence

This series occurs infrequently in the Blyde Skema and, therefore, has not been allotted a separate map symbol. The series usually occurs in lower slope positions and down-slope from series Nos 3 - 5.

Correlation

It has certain properties in common with the Longlands and Albany series (Tugela Basin).

Description

This soil suffers a greater degree of impeded drainage (hydromorphism) in its virgin state than series No 5. The result is that the greater proportion of the iron oxides (the cause of red colours) in the entire B horizon have been reduced and removed by drainage leaving the B a mottled dark grey brown colour. The cause of mottling and the removal of iron has been not a permanently high water table, but an intermittent one.

It has three horizons : a weak A1 - variable in texture - darkened by organic matter, a dark grey brown mottled reddish brown and black B2 horizon with more than 10 per cent clay and a dark grey mottled yellowish brown, red and black, very slowly permeable, gleyed C horizon.

The infiltration rate of the A1 horizon is moderately rapid.

The texture of the B varies from a sandy loam to a sandy clay loam and its sand fraction is usually coarse. The horizon has a weak to moderate blocky structure, a friable to firm consistence and it is moderately permeable (0.8 - 4.0 inches per hour). Base status is moderately high to high, reaction acid to neutral and the clay minerals are illite and kaolinite.

The C horizon is dark grey mottled yellowish brown, red and black; structure is strong blocky, consistence very firm and it is very slowly permeable (less than 0.2 inches per hour). Base status is high, reaction neutral to alkaline and the clay minerals are mainly illitic.

Soils belonging to this series in which the C horizon occurs less than 20 inches from the surface were not found; it has been included in map unit R1.

Limitations and Management

In view of its natural tendency to be poorly drained, care must be taken not to permit the development of a high water table. Due cognizance must be taken of the fact that this soil will receive, not only the water used to irrigate it, but also that draining from higher lying positions. If properly managed, its productivity rating is considered to be high.

Series No 7 ..... 16/...

Series No 7 - see profile No T7

Occurrence

The three phases occur fairly extensively, particularly in the southern portion of the Blyde river area.

Correlation

Its clay content is too low for it to qualify for inclusion in the Glenrosa series (Natal coastal belt). It has certain properties in common with the Cartref series.

Description

It is freely drained with three horizons : a weakly developed dark grey brown, to very dark grey brown A1, a brown to grey brown A2 horizon with less than 10 per cent clay and a C horizon of weathering granite.

The A1 has no structure, a very friable consistence and an excessively rapid infiltration rate.

The A2 is structureless, friable (often single grain) and excessively permeable (greater than 5.0 inches per hour). Its texture varies from a coarse sand (often gritty) to a coarse loamy sand; coarse sand dominates the sand fraction. Reaction varies from pH 5.0 - 6.5 and the base status is low. Kaolinite predominates over illite in the clay fraction.

The A2 is frequently separated from the C by a layer - variable in thickness - of colluvial or alluvial gravels.

The colour of the weathering granite C horizon is largely grey brown to light grey with black mottles; red colours are less frequent than in series No 2. The A2 commonly tongues into the C horizon and texture depends on the degree of weathering; it is very gritty and its permeability is moderately rapid to rapid.

The series has been divided into three phases:

(i) Deep phase : the combined thickness of the A1 and A2 horizons exceeds 20 inches; it is included in map unit G1.

(ii) Shallow phase : the combined thickness of the A1 and A2 horizons is less than 20 inches; it is included in map unit G2.

(iii) Shallow and stony phase : soils possessing a degree of stoniness not constituting a serious mechanical limitation; it is included in map unit G2X.

Limitations and Management

Its limitations and the principles governing its management are the same as those for series No 2. It is considered to be moderately productive.

Series No 8 ....17/...

Series No 8 - see profile No T8

Occurrence

It occurs in a patchy fashion and not very extensively.

Correlation

It belongs to the Glenrosa series (Natal coastal belt).

Description

Its drainage is somewhat restricted. It has three horizons : a weakly developed very dark grey brown A1 with a coarse to medium texture, a very dark grey brown B horizon with more than 10 per cent clay and a C horizon of weathering granite giving rise to a dark grey clay.

The A1 horizon is normally coarser in texture (sand to loamy sand with coarse sand dominating the sand fraction) than the B. It is very dark grey brown, structureless to weak blocky and friable with a moderately high infiltration rate. The transition to the B horizon is gradual compared with the abrupt transition in series No 9.

The B is a very dark grey (colour when moist), friable, weak to moderate blocky coarse sandy loam to sandy clay loam in which the sand fraction is dominated by coarse sand. Permeability is moderately slow (0.2 - 2.0 inches per hour). Base status is moderately high, reaction is acid tending to neutrality and the main clay minerals are illite and kaolinite.

The B is frequently separated from the C by a gravel layer of variable thickness.

The C horizon is weathering grey brown granite mottled white (feldspar), yellowish brown, black and yellowish red. It is a very gritty material giving rise, on weathering, to a very slowly permeable, firm, blocky, olive to dark grey clay. The permeability of the horizon as a whole varies with the degree of weathering, but is usually slow. Base status is high, reaction is slightly acid to neutral and the main clay mineral is illite.

The combined thickness of the A and B horizons seldom exceeds 20 inches; two phases have been defined:

(i) Stone-free phase : it is included in map unit G4.

(ii) Stony phase : weathering granite or the gravel layer which lie close to the surface, do not constitute a serious mechanical limitation; it is included in map unit G4X.

Limitations and Management

The soil has a moderately high water holding capacity, but is rather shallow. The stony phase holds less water at field capacity than the stone-free phase. Drainage is restricted by the C horizon and care should be taken not to induce waterlogged conditions by over-irrigation.

The close proximity .....18/..

The close proximity to the surface of granite weathering to a clay is a condition which could result in the salinization of the soil if laterally draining waters from elsewhere are continually permitted to supply this series with salts.

If correctly managed, it is considered to be moderately productive.

Series No 9 - see profile Nos T9 and T10

Occurrence

It occurs fairly extensively east of the Blyde river and south of the Hoedspruit-Ohrigstad road; elsewhere it is of limited and patchy occurrence.

Correlation

It is provisionally included in the Uitvlugt series (Tugela Basin) and belongs to the Estcourt family (Tugela Basin) of soils. It has certain properties in common with the Waldene series (Natal coastal belt). It is a solonetzic soil.

Description

Its drainage is severely restricted. It has four horizons : a very dark grey brown coarse sand to loamy sand A1, a dark grey brown coarse sand to loamy sand A2, a very dark grey prismatic sandy clay loam to sandy clay B and a C horizon of a dark grey to olive brown sandy clay loam to sandy clay.

The A1 differs only from the A2 with respect to colour; infiltration rate is high, reaction is acid and base status is low. Due to mixing by ploughing and the thinness of the A1, the A2 is frequently indistinguishable from the A1. The A2 is structureless, very friable and excessively permeable; it contains less than 15 per cent clay. The combined thickness of the A horizons is seldom more than 15 inches. There is an abrupt transition from the A2 horizon to the B.

The B is firm, weak to moderate coarse prismatic and very slowly permeable (less than 0.2 inches per hour). Reaction tends to be neutral, but may exceed pH 8.2. Although not saline in its virgin state, it will rapidly become saline under poor management. The clays are mainly of the 2:1 lattice type.

The C horizon consists of a dark grey mottled olive brown, blocky,firm, very slowly permeable clay which is frequently gleyed; it is usually calcareous. Under virgin conditions it is usually not saline; its base status is high and reaction neutral to alkaline. The clay minerals are of the 2:1 lattice type.

This series has not been sub-divided into phases; it is included in map unit G3.

However, there is a variant of this series (see profile No T10) which is saline. It is morphologically similar to that described above, but it has a high soluble salt (chiefly sodium chloride) content. It occurs in lower slope positions adjacent to stream beds. There is little doubt that these salts have largely been washed in by over-irrigation higher up the slope. It is proof of the problems attached to the irrigation of these landscapes. However, even under natural conditions, members of series No 9

occurring ... 19/..

occurring in the immediate vicinity of stream beds may be saline. A few of these saline areas have been indicated on the map by adding the letter S to the symbol G3. It has not been possible to indicate all such saline sites; this task would be an important feature of a detailed survey.

Limitations and Management

Laterally draining water has accumulated over long periods of time at certain points in the landscape (lower slope positions and sluggishly drained areas occurring locally in upland positions) providing the conditions necessary for the formation of a very slowly permeable, illitic clay. Any additional water (irrigation) over and above natural precipitation will, therefore, rapidly cause this series to become waterlogged if they are not managed with extreme care.

Since these soils are situated in sites receiving drainage waters from the landscape, salts will tend to accumulate and the soil may well become sufficiently saline to damage crops. Furthermore, should the B horizon become so saline as to prevent the successful growth of crops, it is generally not economically feasible to remove these salts.

As is explained in the section dealing with land management, this series is highly erodible and the digging of drains is likely to lead to serious soil losses.

To manage this series correctly under irrigation, water sufficient only to maintain the thin A horizons permanently at field capacity must be applied. Water applied in excess of this requirement will result in waterlogging and salinization. To apply the correct amount of water, a spray delivering a very small quantity of water per hour must be used at very short intervals.

In view of its many shortcomings and the fact that even if carefully managed, salinity problems may arise, it is not safe to predict uninterrupted, long-term economic production from them under irrigation. Its management problems are aggravated if it covers extensive blocks of land. It has, therefore, been classified as marginal with respect to sugar production under irrigation.

Series No 10 - see profile No T11

Occurrence

It occurs infrequently in lower slope positions.

Correlation

It finds no place in any series defined to date. However, it has certain properties in common with soils such as the Avoca series (Natal Coastal belt) which have excessively permeable coarse textured horizons more than 20 inches thick abruptly overlying a very slowly permeable clay.

Description ..... 20/...

Description

The series suffers a degree of restricted drainage. It has three horizons : a weakly developed very dark grey brown A1 with an excessively rapid infiltration rate, a dark grey brown A2 with less than 10 per cent clay and a very slowly permeable, gleyed C horizon.

The dark grey brown A2 horizon has no structure, a very friable consistence and a sand fraction dominated by coarse sand. Its base status is low, its reaction is acid (pH 5.0 - 6.5) and it is excessively permeable (more than 5.0 inches per hour). Its clay minerals are mainly kaolinite and illite. The transition to the C horizon is abrupt.

The gleyed C is blocky, firm, medium to fine textured and very slowly permeable. Its base status is high and its reaction neutral to alkaline. Free lime is sometimes present. Colour is variable : dark grey, olive brown and even greenish hues. Clay minerals are mainly of the 2:1 lattice type.

The series has not been sub-divided into phases; it is included in map unit G1.

Limitations and Management

The key to the management of this series lies in irrigating the A horizons without permitting excess water to cause the build up of water tables on the C horizon or to cause the accumulation of drainage water and salts in downslope positions. Care must be exercised, not only in controlling irrigation at the site, but also in restricting the lateral movement of water and dissolved salts to this series.

It is considered to be moderately productive.

VERY DARK GREY BROWN TO BLACK SOILS

Series No 11 - see profile No T12

Occurrence

It occurs very rarely and is not mappable at the 1:36,000 scale.

Correlation

It cannot be placed in any series defined to date. It has certain properties in common with the Arcadia series (Tugela Basin), but is thought to resemble a rendzina more than a black, montmorillonitic clay.

Description

There are two horizons : a black sandy clay loam to sandy clay A1 and a C horizon of what appears to be altered limestone, but which may be some form of secondary lime.

The A1 (seldom exceeding a thickness of 12 inches) has a weak blocky to crumb structure, a slightly firm consistence and more than 20 per cent of clay. Base status is high, reaction alkaline (usually calcareous) and the clay minerals are of the 2:1

lattice type ..... 21/...

lattice type. Infiltration capacity and permeability are moderately slow.

The C horizon consists of lime or limestone fragments and powder and nodular lime imparting a grey colour to the horizon. Permeability is moderate, base status is very high and reaction alkaline.

Limitations and Management

This soil was found very close to a stream bed where it is hardly likely to be used agriculturally. It has a high water holding capacity, a favourable structure and it is inherently fertile. It would normally be considered highly productive.

Series No 12 - see profile No T13

Occurrence

It occurs infrequently in lower slope positions and is generally unmappable at scales smaller than 1:10,000.

Correlation

It is provisionally included in the Bonheim series (Tugela Basin) which is a fine textured margalitic soil.

Description

This series suffers a moderate to severe degree of restricted drainage. It has two horizons : a very dark grey to black A1 with more than 30 per cent clay and a dark yellowish brown to dark grey brown, slowly permeable C horizon.

The darker coloured A1 has a moderate blocky structure and a friable to firm consistence. Its infiltration capacity and permeability are moderately slow. Base status is high, reaction varies from slightly acid to alkaline and its clay minerals are of the 2:1 lattice type; the presence of montmorillonite is suspected.

The C horizon is usually calcareous. It has a fine texture, a moderate to strong blocky structure, a firm consistence and a slow (less than 0.2 inches per hour) permeability. Base status is high, reaction alkaline and the clay minerals are of the 2:1 lattice type.

Limitations and Management

This soil has a high water holding capacity and can, therefore, be irrigated at relatively infrequent intervals. However, the rate of water application must be slow to prevent run-off. Care must be taken to prevent waterlogging and the development of saline conditions. Under good management, it can be highly productive.

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MISCELLANEOUS LAND TYPES

ALLUVIAL LAND

Three types of recent alluvium have been identified; all have been included in map unit A.

Type 1 - see profile No T14 - Weakly stratified reddish brown sandy clay loam to clay.

This is the most frequently occurring type, particularly along the Blyde and Olifants rivers.

It has a weakly defined dark reddish brown A1 horizon with a high infiltration capacity overlying a deep reddish brown to dark brown B horizon with more than 10 per cent clay. The B, which may or may not be calcareous, is weakly structured, friable and moderately permeable; base status is high and reaction neutral.

Since it is situated on the level at the foot of slopes, care must be taken when irrigating higher lying areas to prevent the washing in of salts. Otherwise it has no serious management limitations and is considered to be highly productive.

Type 2 - see profile No T15

This occurs rather less frequently and, at a reconnaissance scale of investigation, cannot be precisely defined due to its variability.

It consists of layers of recent alluvium, each with widely different properties of texture, structure, consistence, base status and permeability.

Each variation will require an individual assessment of its management requirements with particular attention being paid to impermeable layers which could cause the development of water tables.

Type 3 - see profile No T16

This also occurs infrequently. Because of its salinity, it must be carefully mapped during a detailed survey. During this reconnaissance investigation it was identified at only one point where it was included in the map unit A to which the letter S was added to indicate its salinity.

It is considered to be a young form of a solonetzic soil (see series No 9) in which the structural development of the B from a solonchakic parent material has not been great.

The type has three horizons : a thin (less than 15 inches) dark grey brown coarse sand to loamy sand recent alluvial A1 with a high infiltration capacity abruptly overlying a weakly developed medium blocky B horizon with more than 20 per cent clay. The B is saline (very high base status) and calcareous with a reaction greater than pH 8.4 (often greater than pH 9.0). This high reaction is a measure of the degree of influence of the sodium ion (as Na_2CO_3). The C horizon is identical with the B except that it is more weakly structured and more calcareous. The permeability of the B and C horizons is moderately slow to slow.

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Because of its salinity, slow permeability and level topographical situation, it is not recommended for sugar production under irrigation.

Alluvial land types 2 and 3 require detailed investigation and accurate delineation prior to sugar development in this area. Management practices may then be worked out accordingly.

STONY LAND

Two types of stony land have been defined.

Type 1 -

This consists of solid rock with little or no soil covering; its occurrence is patchy and infrequent. This type of land cannot be used intensively and is included in map unit 1.

Type 2 -

In this type is included all land characterised by a degree of stoniness, which renders the use of agricultural machinery generally impracticable. It occurs extensively in the Blyde Skema, particularly to the west of the Blyde river. It consists of gravels, pebbles and boulders (of colluvial and alluvial origin) in a grey brown or reddish brown soil matrix of variable thickness overlying weathering rock.

There are three major limitations attached to the use of this land type:

(a) Without removing a very large proportion of the stones, it is generally impossible to use agricultural implements;

(b) The economic limitation or the increased capitalization of the land in order to render it no more than moderately productive;

(c) Having removed a sufficient proportion of the stones to enable the land to be cultivated, its productivity will only be moderate on account, not only of the coarse texture of the soil matrix, but also of the gravelly nature of the resultant soil body.

It would appear from the amount of clearing that has already been accomplished, that a proportion of this land type will be used for the production of a suitably remunerative crop such as sugarcane should the development of a sugar industry in the Blyde Skema take place.

This land cannot be used without effecting major clearing works; whether such works would prove economically successful cannot be predicted at this stage. It is, therefore, not recommended for sugar production under irrigation.

L A N D M A N A G E M E N T

The principles governing the management of individual soil series and land types have been outlined. The following is a brief account of the principles governing landscape management in the Blyde Skema.

CONTROL OF SOIL MOISTURE AND MOVEMENT OF GROUNDWATER

Because of the excessive permeability of the majority of high-lying soils and the very slow permeability of many low-lying soils, particular care and attention must be paid to the control of groundwater over the whole landscape.

In order to avoid droughty conditions in the coarse textured upland soils, there will be a strong tendency for farmers to over-irrigate and cause the build up of a water table lower down the slope. The system of unlined canals is a further source of excess water in some areas. If such practices are allowed to proceed unchecked, certain areas may well be rendered unsuitable for sugar production.

In terms of water management the objective of the Blyde Skema must be to obtain the highest possible production per inch of irrigation water. It is therefore strongly recommended that, as a means of optimum soil moisture control, sprinkler irrigation be employed where ever possible.

In order to facilitate efficient irrigation planning, the following procedures are recommended:

a) The soil types in the areas to be irrigated must be identified and demarcated on a map; this can be accomplished by a detailed soil survey.

b) The soil moisture properties of each soil type must be accurately determined, including, inter alia, infiltration rates and available moisture capacities.

c) Irrigation canals must be lined in areas where significant seepage losses occur.

If the recommendations of this report are implemented - other conditions being normal - we are convinced that sugar production in the Blyde Skema would be an economically feasible proposition.

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SALINITY

The main source of salts in the Blyde Skema area is not the soil, but the underlying weathering rock, particularly the granitic types, which constitute a ready source of sodium. Water applied in excess of that required for plant growth and evaporation will penetrate the weathering rock, take up salts in solution and tend to salinise lower slope sites. This has already occurred along certain water courses and valley floors. However, there are relatively few naturally saline soils in the area and if the conditions controlling soil moisture are met, soil salinity will not constitute a major problem.

Of the water samples taken from rivers and canals in December, the lowest resistance recorded was greater than 1,000 ohms; irrigation water will, therefore, not be an important source of salts.

EROSION

The rate at which water will cause a soil to erode is largely determined by the frequency and rate of run-off and the ease with which the surface soil is removed by run-off.

Few topsoils (series No 12) have infiltration rates likely to cause severe run-off under good management. The structureless almost single grain nature of the surface horizons of most soils in the area is such that any appreciable run-off will cause sheet and rill erosion.

Once a soil is saturated with water, any additional water applied to it will drain away over the surface. The soils most susceptible to this type of run-off are those with relatively slowly permeable horizons near the surface (series Nos 9, 8 and 12 and to a lesser extent Nos 6, 10 and 11). The topography of much of the area is sufficiently steep to cause a fairly rapid rate of run-off.

Series No 9 is particularly highly erodible : it is easily saturated with water; the A horizons are easily removed by run-off and once the B horizon is exposed, it erodes rapidly due to the dispersing effect of the sodium ion, which constitutes an important proportion of its extractable cations.

It is clear that if the conditions outlined for the control of soil moisture are effectively met, the erosion hazard will be greatly reduced. Moreover, if sugar is planted, its dense growth will significantly reduce the rate of erosion. The interval between the removal of cane and the planting of new cane should be as short as possible.

SERIES NO 1 PROFILE NO T1

PROFILE DESCRIPTION

Kalamazoo

Farm : Richmond

Situation : Near road in maize land; deep mixed colluvial drift between two streams; 2% slope.

Vegetation : Cultivated.

Horizon	Depth (in)	Description
Ap	0 - 15	Moist; dark reddish brown (5 YR 3/2); sand; apedal; very friable; gradual transition.
B	15 - 50	Dry; dark red (2.5 YR 3/6) with dark brown clayskins and a myriad of fine, white mycelium-like $CaCO_3$ accumulations; sandy loam; moderate medium blocky; hard; gradual transition.
C	50 - 74	Dry; yellowish red (5 YR 5/6); frequent mycelial lime; loam; weak medium blocky; slightly hard; colluvial pebbles beneath this horizon.

A variant has a gleyed clay beneath the calcareous B horizon.

A P P E N D I X

SERIES NO 1 — PROFILE NO T1

ANALYTICAL DATA

Depth (in)	0 - 15	15 - 50	50 - 74
Horizon	Ap	B2	C
% Coarse sand (2.0 - 0.5 mm)	22.5	24.1	19.9
% Medium sand (0.5 - 0.2 mm)	29.4	23.2	18.7
% Fine sand (0.2 - 0.02 mm)	32.3	26.9	31.9
% Silt (0.02 - 0.002 mm)	4.3	5.7	13.5
% Clay (- 0.002 mm)	9.8	18.0	13.0
pH (1:1)	6.9	7.7	7.7
Ohms R 60°F	1320	920	600
EC_e 10^3/cm 25°C	- 2	- 2	- 2
Extractable cations (me %)			
Ca	3.12	-	-
Mg	4.93	-	-
K	0.65	0.40	0.43
Na	0.15	0.28	0.33
S - value (me %)	8.85	-	-
C.E.C.Soil (me %)	4.6	8.0	10.9
C.E.C.Clay (me %)	47	43	84

Note: - equals less than

SERIES NO 2 PROFILE NO 2

PROFILE DESCRIPTION

Moriah
op p 40

Farm : Basson Trust, Moriah

Situation : Crest of slope; edge of ploughed land

Vegetation : Virgin grass and tree veld

Horizon	Depth (in)	Description
A1	0 - 9	Moist; dark reddish brown (5 YR 3/2 - 3/3); sand; apedal; very friable; gradual transition.
B2	9 - 18	Dry; reddish brown (5 YR 4/4); sand; apedal; very friable; clear transition.
	18 - 30	Layer of quartz grit and somewhat rounded pebbles and boulders in reddish brown coarse sandy matrix.
C	30 - 36	Red, yellowish red, black and yellowish brown altered granite; permeable.

SERIES NO 2 PROFILE NO T2

ANALYTICAL DATA

Depth (in)	0 - 9	9 - 18	18 - 36
Horizon	A1	B2	C
% Coarse sand (2.0 - 0.5 mm)	25.7	28.8	37.7
% Medium sand (0.5 - 0.2 mm)	29.2	28.6	27.9
% Fine sand (0.2 - 0.02 mm)	35.9	31.8	21.3
% Silt (0.02 - 0.002 mm)	5.2	5.4	6.4
% Clay (- 0.002 mm)	5.2	5.4	6.5
pH (1 : 1)	7.3	7.7	7.0
Ohms R $60^{o}F$	2620	2520	2110
EC_e $10^3/cm$ $25^{o}C$	- 2	- 2	- 2
Extractable cations (me %)			
Ca	2.86	1.56	1.82
Mg	0.00	0.00	1.30
K	0.35	0.18	0.27
Na	0.04	0.04	0.04
S - value (me %)	3.25	1.78	3.43
C.E.C. Soil (me %)	1.0	1.6	3.5
C.E.C. Clay (me %)	19	30	54

Note : - equals less than

SERIES NO 3 PROFILE NO T3

PROFILE DESCRIPTION

Kalamare

Farm : Margate

Situation : Middle of 1% slope

Vegetation : Virgin grass and tree veld

Horizon	Depth (in)	Description
A1	0 - 9	Moist; dark reddish brown (5 YR 3/3); sand; apedal; friable; gradual transition.
B2	9 - 15	Moist; dark reddish brown (5 YR 3/3); sandy loam; weak medium blocky; friable; gradual transition.
C	15 - 30	Slightly moist; red, yellowish red, black and yellowish brown altered granite; permeable.

SERIES NO 3 PROFILE NO T3

ANALYTICAL DATA

Depth (in)	0 - 9	9 - 15	15 - 30
Horizon	A1	B2	C
% Coarse sand (2.0 - 0.5 mm)	21.5	22.3	35.1
% Medium sand (0.5 - 0.2 mm)	22.6	24.5	25.5
% Fine sand (0.2 - 0.02 mm)	41.8	35.2	25.6
% Silt (0.02 - 0.002 mm)	6.9	5.5	7.4
% Clay (- 0.002 mm)	8.9	12.5	8.0
pH (1 : 1)	6.2	6.0	6.5
Ohms R 60°F	2830	2800	2170
EC_e 10^3/cm 25°C	- 2	- 2	- 2
Extractable cations (me %)			
Ca	2.34	4.16	7.53
Mg	0.78	1.04	5.46
K	0.33	0.10	0.06
Na	0.07	0.04	0.15
S - value (me %)	3.62	5.34	13.20
C.E.C. Soil (me %)	3.1	3.6	1.8
C.E.C. Clay (me %)	35	29	22

Note: - equals less than

SERIES NO 4 PROFILE NO T4

PROFILE DESCRIPTION

Farm : Richmond

Situation : Lower 3% slope

Vegetation : Grass and Acacia spp on old land

Horizon	Depth (in)	Description
Ap	0 - 4	Moist; dark reddish brown 5 YR 3/2); gritty coarse sandy loam; weak medium blocky, friable; organic carbon content = 0.66 per cent; gradual transition.
B2	4 - 13	Moist; dark reddish brown (5 YR 3/2); gritty sandy clay loam; weak to moderate fine blocky; very friable; pH 7.4; Ohms R 1650; $EC_e 10^3$/cm 25°C = -2; clear uneven transition.
C	13 - 23 +	Moist; moderately altered yellowish brown, yellowish red and black diabase giving rise to a sandy clay; some tongueing due to weathering along planes of weakness; pH 7.5; Ohms R 1210; $EC_e 10^3$/cm 25°C = -2.

Note: - equals less than

SERIES NO 5 PROFILE NO T5

PROFILE DESCRIPTION

Farm : Grovedale near Barclays Bank D.C.O.

Situation : Edge of cultivated land; middle of 4% slope

Vegetation : Grass (old land)

Horizon	Depth (in)	Description
Ap	0 - 6	Moist; dark reddish brown (5 YR 3/2); gritty coarse sandy loam, apedal to weak blocky; friable; gradual transition.
B21	6 - 24	Dry; dark reddish brown (5 YR 3/4); gritty coarse sandy clay loam; weak to moderate medium blocky; hard; gradual transition.
B22	24 - 33	Dry; brown to yellowish brown (10 YR) mottled red and black; coarse sandy loam; weak medium blocky; hard; clear transition.
	33 - 35	Stone line of quartz grits and granite fragments bleached by reduction.
Cg	35 - 40	Moist; dark olive grey (5 Y 4/2 - 3/2) mottled red, black and yellowish brown; gritty sandy clay loam; strong angular blocky; very firm; calcareous.

SERIES NO 5 PROFILE NO T5

ANALYTICAL DATA

Depth (in)	0 - 6	6 - 24	24 - 33	35 - 40
Horizon	Ap	B21	B22	Cg
% Coarse sand (2.0 - 0.5 mm)	50.5	42.1	31.2	28.7
% Medium sand (0.5 - 0.2 mm)	15.9	13.2	21.1	13.0
% Fine sand (0.2 - 0.02 mm)	16.6	14.1	27.3	19.0
% Silt (0.02 - 0.002 mm)	6.4	8.5	9.8	8.2
% Clay (- 0.002 mm)	10.2	22.0	12.2	28.5
pH (1 : 1)	7.0	5.9	6.0	6.1
Ohms R 60°F	1530	920	910	410
$EC_e 10^3$/cm 25°C	- 2	- 2	- 2	- 2
Extractable cations (me %)				
Ca	5.46	4.42	3.89	-
Mg	1.82	2.86	1.56	-
K	0.86	0.33	0.33	0.50
Na	0.09	0.11	0.28	1.40
S - value (me %)	8.23	7.72	6.06	-
C.E.C. Soil (me %)	2.1	6.1	3.8	12.9
C.E.C. Clay (me %)	20	28	31	45

Note : - equals less than

SERIES NO 6 PROFILE NO T6

PROFILE DESCRIPTION

Farm : Moriah

Situation : Lower 3% slope adjacent to red soil

Vegetation : Cultivated

Horizon	Depth (in)	Description
Ap	0 - 9	Moist; very dark grey brown (10 YR 3/2); sandy loam; weak medium blocky; friable; pH 6.8; Ohms R 1540; EC_e 10^{-3}/cm 25°C = - 2; clear transition.
B2	9 - 23	Moist; mottled dark grey brown (2.5 Y 4/2) and dark reddish brown (5 YR); gritty sandy clay loam; moderate medium subangular blocky with clayskins; slightly firm becoming firmer with depth; pH 6.6; Ohms R 620; EC_e 10^{-3}/cm 25°C = - 2; clear transition.
Cg	23- 33	Dry; dark grey brown (2.5 Y 4/2) and light olive brown (2.5Y 5/6); sandy clay loam; moderate coarse angular blocky with clayskins; extremely hard; pH 6.2; Ohms R 600; EC_e 10^{-3}/cm 25°C = - 2

Note: - equals less than

SERIES NO 7 PROFILE NO T7

PROFILE DESCRIPTION

Farm : Grovedale

Situation : Lower slope adjacent to series No 2

Vegetation : Virgin grass and tree veld

Horizon	Depth (in)	Description
A1	0 - 9	Moist; very dark grey brown (10 YR 3/2); sand; apedal; friable; clear transition.
A2	9 - 26	Moist; brown (10 YR 5/3); loamy sand; apedal; loose to coherent; clear transition.
	26 - 30	Layer of granite grit and pebbles.
C	30 - 40	Grey brown mottled black altered granite with a variable consistence

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SERIES NO 7 PROFILE NO T7

ANALYTICAL DATA

Depth (in)	0 - 9	9 - 26	30 - 40
Horizon	A1	A2	C
% Coarse sand (2.0 - 0.5mm)	24.2	22.6	50.7
% Medium sand (0.5 - 0.2mm)	32.6	36.7	20.1
% Fine sand (0.2 - 0.02 mm)	35.0	29.9	18.2
% Silt (0.02 - 0.002 mm)	5.8	5.0	6.4
% Clay (- 0.002 mm)	4.3	6.5	3.4
pH (1 : 1)	4.9	4.9	5.5
Ohms R $60^{o}F$	6000	7400	1670
$EC_e 10^{3}$/cm $25^{o}C$	- 2	- 2	- 2
Extractable cations (me %)			
Ca	0.78	0.78	2.08
Mg	1.56	0.00	0.78
K	0.18	0.11	0.10
Na	0.07	0.07	0.24
S - value (me %)	2.59	0.96	3.20
C.E.C. Soil (me %)	0.6	1.0	1.5
C.E.C. Clay (me %)	14	16	44

Note : - equals less than

SERIES NO 8 PROFILE NO T8

PROFILE DESCRIPTION

Farm : Grovedale

Situation : Middle of long 3% slope

Vegetation : Cultivated

Horizon	Depth (in)	Description
Ap	0 - 6	Moist; very dark grey brown (10 YR 3/2); loamy sand; weak medium blocky; friable; gradual transition.
B2	6 - 18	Moist; very dark grey (10 YR 3/1); sandy loam; weak to moderate medium blocky; slightly firm to firm; clear transition.
	18 - 24	Layer of quartz grit in a slowly permeable sandy clay loam matrix.
C	24 - 36	Altered white (feldspars), yellowish brown, yellowish red and black granite giving rise to a very slowly permeable, very firm olive sandy clay.

SERIES NO 8 PROFILE NO T8

ANALYTICAL DATA

Depth (in)	0 - 6	6 - 18	24 - 36
Horizon	Ap	B2	C
% Coarse sand (2.0 - 0.5 mm)	30.5	33.2	32.9
% Medium sand (0.5 - 0.2 mm)	22.7	22.1	14.5
% Fine sand (0.2 - 0.02 mm)	31.5	26.5	17.3
% Silt (0.02 - 0.002 mm)	6.4	7.4	5.9
% Clay (- 0.002 mm)	10.2	12.0	26.7
pH (1 : 1)	6.7	6.2	5.5
Ohms R 60°F	830	1020	595
EC_e 10^3/cm 25°C	- 2	- 2	- 2
Extractable cations (me %)			
Ca	4.93	4.67	6.49
Mg	1.30	2.08	8.05
K	0.49	0.23	0.23
Na	0.17	0.13	0.07
S - value (me %)	6.89	7.11	14.84
C.E.C. Soil (me %)	8.4	10.2	8.3
C.E.C. Clay (me %)	82	85	31

Note : - equals less than

SERIES NO 9 PROFILE NO T9

PROFILE DESCRIPTION

Farm : Grovedale

Situation : Middle of 3% slope

Vegetation : Cultivated

Horizon	Depth (in)	Description
Ap/A2	0 - 6	Moist; very dark grey (10 YR $^{3}/_{1}$); loamy sand; apedal; friable; abrupt transition.
B2	6 - 17	Moist; very dark grey brown (2.5 Y $^{3}/_{2}$) with few vague diffuse olive brown streaks; sandy clay loam; moderate angular blocky; prismatic when dry; firm; gradual transition.
C	17 - 48	Moist; dark grey brown (2.5Y $^{4}/_{2}$); sandy clay loam; moderate blocky; firm; the very dark clayskins in the B decrease gradually to nil in the C; calcareous.

SERIES NO 9 PROFILE NO T9

ANALYTICAL DATA

Depth (in)	0 - 6	6 - 17	17 - 48
Horizon	Ap/A2	B2	C
% Coarse sand (2.0 - 0.5 mm)	22.0	26.5	26.9
% Medium sand (0.5 - 0.2 mm)	29.0	19.7	20.1
% Fine sand (0.2 - 0.02 mm)	35.6	21.2	22.3
% Silt (0.02 - 0.002 mm)	5.7	5.0	6.6
% Clay (- 0.002 mm)	7.5	26.5	22.4
pH (1 : 1)	5.8	5.9	7.4
Ohms R 60°F	2270	357	368
EC_e 10^3/cm 25°C	- 2	- 2	- 2
Extractable cations (me %)			
Ca	1.82	5.20	-
Mg	0.54	4.16	-
K	0.17	0.14	0.17
Na	0.07	0.96	1.02
S- value (me %)	2.60	10.46	-
C.E.C. Soil (me %)	1.9	20.0	13.5
C.E.C. Clay (me %)	24	75	60

Note : - equals less than

SERIES NO 9 PROFILE NO T10

PROFILE DESCRIPTION

Farm : Grovedale

Situation : On edge of bottomland; lower 3% slope

Vegetation : Cultivated

Horizon	Depth (in)	Description
Ap/A2	0 - 15	Moist; very dark grey (2.5 Y $^{3}/_{2}$ - $^{4}/_{2}$); loamy sand; very weak blocky; friable; abrupt transition.
B2	15 - 24	Moist; olive grey (5 Y $^{4}/_{2}$); sandy clay loam; moderate medium blocky; slightly firm to firm; calcareous; gradual transition.
C	24 - 36	Moist; olive (5Y $^{5}/_{3}$); sandy clay loam; moderate medium blocky; firm to slightly firm; calcareous.
	36	Water table
		This soil is a variant of profile T9 and after more detailed study, it should be defined as a separate series.

SERIES NO 9 PROFILE NO T10

ANALYTICAL DATA

Depth (in)	0 - 15	15 - 24	24 - 36
Horizon	Ap/A2	B2	C
% Coarse sand (2.0 - 0.5 mm)	29.8	18.8	19.2
% Medium sand (0.5 - 0.2 mm)	27.1	14.2	13.3
% Fine sand (0.2 - 0.02 mm)	28.0	20.5	22.4
% Silt (0.02 - 0.002 mm)	3.1	11.6	13.5
% Clay (- 0.002 mm)	10.9	31.0	27.4
pH (1 : 1)	7.0	7.5	7.5
Ohms R 60°F	186	61	45
EC_e 10^3/cm 25°C	6.7	13.3	11.4
Extractable Cations (me%)			
Ca	3.89	-	-
Mg	3.38	-	-
K	0.30	0.27	0.24
Na	1.09	7.19	8.69
S - value (me %)	8.66	-	-
C.E.C. Soil (me %)	4.8	19.7	13.1
C.E.C. Clay (me %)	44	63	48

SERIES NO 10 PROFILE NO T 11

PROFILE DESCRIPTION

Red alfs Kalahari

Farm : Moriah

Situation : Middle of 3% slope

Vegetation : Orange orchard

Horizon	Depth (in)	Description
Ap	0 - 12	Moist; dark grey brown (10 YR 4/2); coarse sand; apedal; friable; pH 5.9; Ohms R 3100; EC 10^{3}/cm 25°C = - 2; gradual transition.
A2	12 - 36	Moist; dark grey brown (10 YR 4/2); coarse sand; apedal; friable; pH 4.9; Ohms R 3200; EC 10^{3}/cm 25°C = - 2; abrupt transition.
Cg	36 - 45	Moist; dark greenish grey (5 GY 4/1); coarse sandy clay loam; apedal; firm; gleyed; pH 6.3; Ohms R 1610; EC 10^{3}/cm 25°C = - 2; water table at 38 inches.

Note: - equals less than

SERIES NO 11 PROFILE NO T 12

PROFILE DESCRIPTION

Farm : Antioch

Situation : Gentle slope between two streams

Vegetation : Virgin bush

Horizon	Depth (in)	Description
A1	0 - 9	Moist; black (10 YR $\frac{2}{1}$ - 7.5 YR $\frac{2}{0}$); gritty sandy clay loam; weak humic blocky breaking to crumb structure; friable to slightly firm; pH 7.3; Ohms R 630; EC_e 10^3/cm 25°C = - 2; gradual transition.
C	9 - 20	Nodular white lime and various rock fragments with lime in powder form imparting a grey colour (10 YR $\frac{6}{1}$) to the material; medium texture; pH 7.6 ; Ohms R 710; EC_e 10^3/cm 25°C = - 2.

Note: - equals less than

SERIES NO 12 PROFILE NO T 13

PROFILE DESCRIPTION

Farm : Moriah

Situation : Lower slope

Vegetation : Virgin grassland; somewhat eroded

Horizon	Depth (in)	Description
A1	0 - 9	Moist; very dark grey (10 YR $^{3}/_{1}$); gritty sandy clay loam; moderate medium subangular blocky; friable; margalitic; pH 5.3; Ohms R 1310; EC$_e$ 10^{3}/cm 25^{o}C = - 2; gradual transition.
C	9 - 32	Moist; dark grey brown (2.5Y $^{4}/_{2}$) with some dark ped faces and yellowish brown mottling; sandy clay loam; very strong angular blocky; very firm; extremely hard; tendency to prismatic; pH 6.3; Ohms R 620; EC$_e$ 10^{3}/cm 25^{o}C = - 2.

Note: - equals less than

ALLUVIAL LAND TYPE 1 PROFILE NO T 14

PROFILE DESCRIPTION

Farm : Moriah

Situation : Level recent alluvium

Vegetation : Lucerne

Horizon	Depth (in)	Description
Ap	0 - 9	Moist; dark reddish brown (5 YR 3/2 - 7.5 YR 3/2); sandy loam; very weak blocky; very friable; calcareous; gradual transition.
B21	9 - 26	Moist; dark reddish brown (5 YR 3/3); sandy loam; apedal to very weak blocky; friable; calcareous; gradual transition.
B22	26 - 56	Moist; dark reddish brown (5 YR 3/4) with some dark brown variegations; sandy loam; apedal; friable; calcareous.

ALLUVIAL LAND TYPE 1 — PROFILE NO T 14

ANALYTICAL DATA

Depth (in)	0 - 9	9 - 26	26 - 56
Horizon	Ap	B21	B22
% Coarse sand (2.0 - 0.5 mm)	2.3	2.0	3.3
% Medium sand (0.5 - 0.2 mm)	15.8	17.0	20.4
% Fine sand (0.2 - 0.02 mm)	53.2	48.7	48.8
% Silt (0.02 - 0.002 mm)	11.1	12.0	9.5
% Clay (- 0.002 mm)	18.8	17.5	18.9
pH (1 : 1)	7.5	6.9	7.5
Ohms R 60°F	810	1140	790
EC_e 10^3/cm 25°C	- 2	- 2	- 2
Extractable cations (me %)			
Ca	-	-	-
Mg	-	-	-
K	0.14	0.10	0.10
Na	0.15	0.11	0.20
S - value (me %)	-	-	-
C.E.C. Soil (me %)	13.1	15.1	11.9
C.E.C. Clay (me %)	70	86	63

Note : - equals less than

ALLUVIAL LAND TYPE 2 PROFILE NO T 15

PROFILE DESCRIPTION

Farm : Southampton

Situation : Level stratified alluvium

Vegetation : Cultivated

Horizon	Depth (in)	Description
Ap	0 - 10	Moist; very dark grey (10YR $^{3}/_{1}$); coarse sandy clay loam; weak blocky; friable; pH 6.8 ; Ohms R 1420; EC 10^{3}/cm 25°C = - 2; clear transition.
C1	10 - 22	Moist; very dark grey brown (10 YR $^{3}/_{2}$); coarse sandy clay loam; moderate medium blocky; slightly firm; pH 6.7; Ohms R1050; EC 10^{3}/cm 25°C = - 2; clear transition.
C2	22 - 30	Dry; dark brown (10 YR $^{4}/_{2}$); coarse sandy loam; moderate medium blocky; extremely hard; pH 6.6; Ohms R1110; EC 10^{3}/cm 25°C = -2; clear transition.
C3	30 - 44	Dry;yellowish brown (10YR $^{5}/_{4}$); coarse sand; apedal; slightly hard; pH 5.7; Ohms R 3410; EC 10^{3}/cm 25°C = - 2; clear transition.
C4	44 - 50	Slightly moist; dark grey brown (10 YR $^{4}/_{2}$); sandy clay; moderate coarse blocky; firm; pH 6.5; Ohms R 790; EC 10^{3}/cm 25°C = - 2; clear transition to coarse sand.

Note: - equals less than

ALLUVIAL LAND TYPE 3 PROFILE NO T 16

PROFILE DESCRIPTION

Farm : Glencoe

Situation : Level alluvium

Vegetation : Grass

Horizon	Depth (in)	Description
Ap/A2	0 - 5	Moist; very dark grey brown (10 YR $\frac{3}{2}$); medium sand; apedal; very friable; layer of recent alluvium; pH 6.8; Ohms R 2300; $EC_e 10^3$/cm 25°C = - 2; abrupt transition.
B2	5 - 10	Moist; dark brown (10 YR $\frac{3}{3}$); sandy clay loam; moderate medium angular blocky tending to prismatic; firm; non-calcareous; pH 7.9; Ohms R 152; $EC_e 10^3$/cm 25°C = 3.8; clear transition.
C1	10 - 30	Moist; dark brown (7.5 YR $\frac{4}{4}$) tending to 5 YR $\frac{4}{4}$; sandy clay loam; moderate medium blocky; firm; $CaCO_3$ veins and nodules; pH 9.3; Ohms R 51; $EC_e 10^3$/cm 25°C = 14.0.

Note: - equals less than

GLOSSARY OF SOIL TERMS

Available moisture capacity	:	Difference between field capacity and wilting point.
Base status	:	Refers to the quantity of extractable metal cations in a soil; it is a measure of inherent fertility; the S-value is used as an estimate of base status.
Cations	:	See extractable cations.
C.E.C.	:	Cation exchange capacity or the capacity of a material to adsorb cations electrostatically.
C.E.C. Clay (me %)	:	C.E.C. of 100g clay expressed in milli-equivalents; it is indicative of the nature of the clay minerals.
C.E.C. Soil (me %)	:	C.E.C. of 100g soil expressed in milli-equivalents.
Clay minerals	:	Particles usually less than 0.002 mm in diameter capable of electrostatically adsorbing cations. They are composed of alternate sheets of tetrahedral silica and octahedral alumina. Kaolinite consists of one silica and one alumina sheet (1:1 lattice) Illite, montmorillonite, etc. consist of one alumina sheet between two silica sheets (2 : 1 lattice).
Colluvium	:	Soil parent material originating from erosion in high-lying positions and deposited in lower slope positions.
EC_e 10^3/cm 25°C	:	Electrical conductivity (reciprocal of resistance) expressed as millimhos per centimetre at 25°C; the conductivity of a saturation extract from a saline soil is more than 4 mmhos/cm at 25°C.
Extractable cations	:	Cations (Ca^{++}, Mg^{++}, K^{+}, Na^{+}) extracted from a soil by the NH_4Cl (soil pH) method; such cations include those adsorbed on the soil exchange complex together with those in the soil solution; they are expressed in me % or me/100 g soil.

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Glossary of soil terms cont'd:

Field capacity	:	Amount of water a soil will hold against gravity under conditions of free drainage.
Geogenic	:	Inherited from rocks.
Gley	:	Soil colours of low chromas produced by wet (hydromorphic) soil conditions; when fine textured, gleyed materials are very slowly permeable and are often referred to as pot clay.
Hydromorphic	:	See gley.
Margalitic soils	:	Soils with a dark colour, high base status, medium to fine texture and 2 : 1 clay minerals (usually montmorillonite); the so-called black "turf" soil is the classic example.
Moisture tension	:	A measure of the ability of soil to retain moisture against gravity; low values (sands) indicate low retentive powers.
Mottles	:	Spots or blotches of colour frequently associated with wet soil conditions.
Pedology	:	The study of soils.
pH	:	Measure of the acidity or alkalinity of a solution; it is the negative logarithm of the hydrogen ion concentration; soil reaction.
Phase	:	Soil series may be sub-divided into phases for land use purposes : cold and warm climate phases of a particular series, shallow and deep, stony and stone-free, etc. However, all phases of one series have the same type and number of horizons (see also series).
Rendzina	:	Black, non-margalitic soil developed from limestone.
Saline soils	:	See $EC_e 10^3$/cm 25°C.
Salinization	:	The raising of the soluble salt content.
Saturated soilpaste	:	Particular mixture of soil and water at a water content just below the appearance of free surface water.

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Glossary of soil terms cont'd:

Saturation extract	:	Solution extracted under suction from a saturated soil paste.
Series	:	The soil series is the lowest category in the natural classification of soils; it is the pedological counterpart of the botanical species. All soils within one series possess the same number and type of horizons; the properties of any one horizon do not vary beyond certain narrow limits. For instance, a soil with 5 per cent clay in the A does not belong to the same series as an otherwise identical soil with 25 per cent clay in the A.
Soil reaction	:	See pH.
Solonchak	:	A saline soil with little or no horizonation and usually medium textured throughout; sodium chloride is the main soluble salt.
Solonetz	:	Soil with a coarse textured A abruptly overlying a fine textured, very slowly permeable, strongly prismatic or columnar B horizon in which Na^+ forms a significant proportion of the extractable cations. It is often developed from a solonchak by the eluviation of clay out of the A and into the B, the process being encouraged by the mobilizing effect of sodium; profile No T16 is in the throes of becoming a solonetz.
S - value	:	Total extractable metal cations per 100 g soil. Less than 1.5 me % represents a very low base status, 1.5 - 5 me % is low, 5 - 10 me % is moderately high and more than 10 me % is high.
Wilting point	:	Moisture content of the soil below which plant leaves droop and fail to recover turgidity.
