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# THE SOILS OF THE BEVERFORD EXTENSION TO THE WOORINEN SETTLEMENT

## *(Swan Hill Irrigation and Water Supply District)*

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# TABLE OF CONTENTS



### LIST OF TABLES

## 1. GENERAL

### *1. Locality*

This report covers the soils of a natural drainage basin at Beverford in the north-west portion of the Swan Hill Irrigation and Water Supply Districts.

The area of about 1,900 ac. is situated about nine miles north-west of Swan Hill and lies between the Murray Valley Highway and the Murray River. It adjoins the north-east corner of the Woorinen Settlement.

### *2. Purpose and Nature of the Survey*

Churchward, Division of Soils, C.S.I.R.O. (1960) has recently resurveyed the Woorinen area which was covered originally by Taylor and Penman (1930). As far as practicable, Churchward's mapping units have been used in the present survey.

The survey was undertaken to provide soils data relevant to the planning of a communal deep drainage scheme for agricultural and horticultural use. Sixteen hundred acres have been surveyed in detail while an extension of 300 ac. to the north has been covered only broadly.

### *3. Earlier Surveys and Investigations*

The following surveys deal with adjacent areas: -

(i) Woorinen and Speewa. Taylor and Penman (1930)
(ii) Woorinen. Churchward (1960, in the press)
(iii) Nyah, Tresco, etc. Taylor et al (1933)

Investigations dealing with the irrigation and drainage characteristics of some of these soils have been carried out by Penman, Skene and Walters (1937) and Tisdall and Lyon (1942).

### *4. Landscape*

Four broadly defined landscape units can be recognised and are shown on the soil map. These units are: -

(i) Large dune-lunette masses (approx. 680 ac.)
(ii) Smaller east-west dunes and swales lying between the large dune masses (approx. 70 ac.)
(iii) Grey clay plain of aeolian origin (approx. 690 ac.)
(iv) Lower grey clay plain being part of (iii) on the river frontage and showing various modifications due to river action (approx. 400 ac.)

The area is this a transitional zone between the wholly aeolian grey and brown soils of Woorinen and the wholly grey and possibly alluvial soils of the Swan Hill Flats represented at Speewa.

### *5. Method of Survey*

The soils were examined to a depth of seven feet in most cases (ten or more feet at a few sites) using a six inch auger, and the usual morphological featured were recorded (including the moisture profile).

At each site samples were taken for sodium chloride determination in the surface 6 in. and in the subsoil at 3-4 ft.

At a few selected sites, pH values of the above samples were determined.

### *6. Interpretation of Data.*

(i) Soils - data recorded has been interpreted in three ways:
  (a) as indicating an array of layers, in each of which soil formation has taken place to some degree before burial, or truncation, or both, during a subsequent erosive period.
  (b) as conventional soil horizons
  (c) from (a) and (b) fifteen soil units, which included several phases and variants, have been defined in terms both of horizons and of layers. They include six units not

recorded by Churchward (1960). Several of the phases and variants are of minor extent and are not shown on the soil map.

(ii) Ground Water – at each site, texture and moisture profiles were used to assess the probable relative permeability to water of each horizon. From these, the probability of water tables developing, and the lateral movement of water have been assessed.

## II. THE SOILS

A fuller discussion of the layers and soils is given by Churchwood (1960).

### *1. The Layers*

For convenience, the layers of material from which the soils of the district have been formed have been given local names by Churchward.

***Kyalite*** is the youngest or uppermost layer. It is discontinuous, occupying chiefly the dunes (other than the eroded north-western and western slopes), the swales and the nearby plain surfaces. It is markedly porous and unorganised.

***Speewa*** is the next older layer. It lies below Kyalite, or forms the present land surface where Kyalite is absent, as in may of the grey plain soils, and on the more eroded surfaces of dunes.

***Bymue*** is below (older than) Speewa. It is rather more strongly leached and organised at corresponding textural grades.

***Tooleybuc*** is below and older than Bymue. It is continuous and, like the younger layers, follows in a general way the contours of the present land surface, but with crests of dunes rather to the west and north of the present crests. It is strongly organised into dense blocky units with glossy clay surfaces. When moist it is very impermeable to water.

***Recent*** - is distinct from any of the above are small areas of contemporary wind blown material (mainly sand) deposited on one or other of the above surfaces. Also, near the river are small areas of contemporary or recent river deposits.

### *2. The Soil Units*

The following are intended only for identification within the limits of the present survey.

They are in accord with Churchward's descriptions except where the contrary in noted, but do not always allow for the same range of variation within a unit.

#### (i) Units recorded at Woorinen (Churchwood 1960)

***Unit A. - Slopes of large dune masses.***

There is typically at least 4 ft. of dull brown, lime-free, loamy sand. Thence a fairly sharp change in colour, with or without a gradual texture increase to a sandy clay loam. Textured no heavier than this persists to at least 7 feet.

***Unit B. - Crests and slopes of smaller east-west dunes, and slopes of large dune masses.***

There is less than 4 ft. (typically) 1 to 2 ft.) of brown, lime free sandy loam, changing sharply to a red-brown clay to sandy clay loam, with moderate amounts of fine and visible lime. There is a more plastic, denser clay at about 5 ft.

**Light deep subsoil phase.**

This has lighter textures (sandy clay loam to sandy loam) below the first clay maximum, and often a downward shift of the lime maximum into this zone at 3 to 4 ft.

***Unit C. - Lower slopes of the dunes***

A brownish grey loamy sand, crumbly and lime-free, rests at about 1½ ft. on grey sandy clay loam (sandy clay – Churchward) with dense clay at about 6 ft. Grey colours predominate throughout.

***Unit D. - Crest and slopes of large dune masses.***

A dull brown sandy loam to sandy clay loam, very brittle and powdery, with heavy amounts of lime in the fine earth from the surface downwards. A gradual texture increase to sandy clay begins before 2 ft., with moderate amounts of concretionary and soft lime. This texture continues to the dense clay at about 5 ft.

***Unit E. - Slope of the large dune mass.***

This unit is similar to D, but with slight limestone rubble at or near the surface, and with heavy concentrations at about 10 in.

***Unit H. - Lower slopes of the dunes, and extending into the plain.***

The surface is a grey or brownish grey sandy loam to sandy clay loam, containing moderate fine-earth lime, with light hard lime below 6 in. This rests at 12 in. on a mottled grey sandy clay loam having a strong lime maximum at 18 in. Bright, mottled, medium clay with heavy concentrations of rubble occurs at about 4 ft. (Churchward 4-7 ft.). On the soil map, it is shown only as a component of a complex with Unit K.

***Unit K. - Brown clay plain and lower slopes of the dunes.***

A porous, brown or grey-brown, sandy clay or clay surfaces passes gradually to a brown or reddish brown light or medium clay at about 6 in. Moderate hard and soft lime occur below 12 in. A less permeable clay occurs at about 6 ft. (Churchward 2 ½ ft.).

**Light deep subsoil phase**

The texture is sandy clay loam instead of clay at about 2 to 3 ft., and the surface may contain fine earth lime.

**Rubbly phase.**

Moderate amounts of coarse hard lime occur at about 9 in.

Grey surface variant

A grey or brownish grey surface soil is underlain before 15 in. by a dull brown mottled (or brighter) clay.

***Unit L. - Grey clay plain***

A brittle, dark grey sandy clay, with or without slight lime, grades from 9 in. into grey or yellowish brownish grey medium clay. A distinct sandiness persists into the clay to a depth of up to 3 ft. Dense plastic clay occurs at 4 to 7 ft.

***Unit N. - Grey clay plain***

Unit N grades into unit L but lacks the sandy influence. The surface is a dark grey, light or medium clay, resting at 18 to 24 in. on a more plastic, dense, yellowish brownish grey clay. Slight to light soft and hard lime occurs at 8 to 12 in.

**(ii) Units not previously recorded at Woorinen**

These units delineate areas which do not appear to fit into any of the units described by Churchward at Woorinen. At this stage they are not regarded as new major categories, and are given numbers instead of letters.

***Unit 1. - Grey clay plain***

This unit has a brittle dark grey surface, lime free or nearly so, ranging from sandy clay to light sandy clay loam. There may or may not be a weak clay maximum between 12 and 24 in., and there is a sharp texture increase to a clay causing marked water impedance between 4 ft. and 6 ft. Slight amounts of lime may occur as shallow at 6 in., and there is a strong lime maximum (light to heavy amounts) between 20 and 40 in. There are heavy concentrations of rubble at 3 ft. and 5 ft. just above and extending into the clay. The colours brighten gradually from about 18 in. to dominantly reddish or red-brown in the rubble zone and clay layer. (This unit differs from unit H in the deeper, lime free surface, and in the deeper occurrence of the first lime maximum).

***Unit 2. - Grey clay plain***
The surface is a dark grey clay, compact and poorly structured, with heavy amounts of fine-earth lime. Moderate to heavy amounts of hard lime form a thick layer from about 10 in. A dense plastic red-brown or mottled clay occurs at about 24 to 30 in.

***Unit 3. - Lower slope of large dune mass***
A dark grey or dark brownish grey loam, lime-free, lies at 6 in. on brownish grey, passing quickly to brown, medium clay.

***Unit 4. - Grey clay plain***
Dark grey-brown, crumbly, sandy clay loam, overlies a thin layer of grey sand on black heavy or medium clay. This passes to a yellowish brownish grey clay which persists to at least 6 ft. The profile is almost lime-free.

***Unit 5. - Shallow depressions, on the lower grey clay plain***
This is a relatively dark grey, light clay with dark dull brown staining and fine mottling. It rests at about 3 ft. on dark grey, dense, medium clay. The profile is lime free, and there is a striking increase in structural development at the point of texture increase.

***Unit 6. - Grey clay plain near the river***
A dark grey or dark brownish grey medium clay, with or without dark dull brown staining, passes at various depths to a dominantly grey, medium or heavy clay which continues to at least 6 ft. Lime is absent, or occasionally present in traces below 24 in. Unlike unit N, which is alkaline, unit 6 is acid to neutral through the profile.

**(iii) Complexes**

Three complexes have not been mapped. One is a small area where units H and K have not been separated. The other two occur in the area to the south which has not been surveyed in detail. One is a low-lying area of very saline, heavy grey soils, and the other a dune and slope formation consisting of units B and D with small areas of units E. F and K. (See Churchward 1960 for unit F).

***3. Relation of Soil Units to the Earlier Survey of Woorinen***
Taylor and Penman (1930) consider certain of the soils, viz., Type 9 at Woorinen and Type 10 at Speewa to be mainly of alluvial origin whereas Churchward regards all the Woorinen soils to be of aeolian materials. He has not examined the Speewa soils.

In the present Beverford Extension, the river frontage soils (Units 5 and 5) appear to have affinities with Type 10 such as absence of calcium carbonate and acid pH values throughout the soil profile. However, the profiles appear to be less strongly differentiated texturally and generally have clay below 3 or 4 ft. in contrast to silty of fine sandy textures in Type 10. It seems likely that Unit 6 is predominantly aeolian material variously eroded and modified by river action and that Unit 5 consists a recent, but not contemporary, alluvial deposit in a river-incised depression.

Churchward has made a much finer subdivision of the higher soils than Penman and Taylor. Thus, at Woorinen, Type 1 includes seven and Type 8 includes six of the new units. On the other hand, Types 9 and 91 are much less variable and, in the main, these Woorinen occurrences are covered by three units (Units L, N and P). In the Beverford Extension area, only Units L and N have been used, but Churchward's map of Woorinen was not available when this field work was done and it now seems probable that the present Unit N corresponds more closely to Unit P.

The relationships between the new soil units and the Woorinen soil types are summarised in Table 1.

***TABLE 1 - Relation of Soil Units at Woorinen and Beverford to the Soil Types of the Earlier Soil Survey.***

| Taylor and Penman (1930) | Churchward (1960) | Beverford Extension |
|---|---|---|
| Type 1 (Tyntynder sand And Tatchera sand). | Units A, B, C, D, E, F, G | Units A, B, C, D, E |
| Type 7 (Woorinen loam) | Unit K with lesser occurrence Of Units J, H and L | Units H, K and L |
| Type 8 (Tatchera sand and Sandy loam) | Units J and L with lesser occurrences of Units G, H, K N. | Units H, K and L |
| Type 9a (Beverford loam) | Units L and N | Units L and N |
| Type 9 (Beverford clay loam) | Unit P with lesser occurrence Of Units L and N | Units L and N |
| Type 10 (Swan Hill Clay) | Not recorded | Not recorded |
| | Not recorded | Units 1 and 2 – related to Unit H |
| | Not recorded | Unit 3 – related to Unit B |
| | Not recorded | Unit 4 – related to Unit L |
| | Not recorded | Units 5 and 6 - affinities with Type 10 |

### *4. Salinity*

It was not the purpose of the survey to investigate the salt status of the soils in detail. However, salt contents in the surface 6 in. and in the 3-4 ft. depth were determined at about 90 situations and the following generalisations are drawn from these results.

The soils of the dunes are generally low in sodium chloride. Levels, with two exceptions were found to be below 0.03% in the surface and below 0.08% in the subsoil at 3-4 ft. The two exceptions of 0.21% and 0.25%. One of these situations is not irrigated and other occurs at the break of slope. Soils at the break of slope tend to be incipiently saline, but relatively few such situations have been examined here. However, a number of sites at intermediate levels in Units 1 and K show moderate sodium chloride contents (up to 0.24%) in the subsoil, although surface contents are fairly low at less than 0.10.

The soils of the grey plains in the northern part of the area are variably saline, although no bad salting was encountered. In general, salt levels in the surface soils are not harmful, although a few situations in Unit N show evidence of some surface concentration of salt (0.11 – 0.14%). Concentrations in the subsoils (at 304 ft.) cover a wide range from low to moderate (0.30%) but suggest that there is a potential salinity hazard over the northern grey plain should water tables rise in this area.

Salinity in the complex of heavy grey soils in the southern basin is high. Surface values mostly exceeding 1.0%. In its present state, this area is quite useless for irrigated agriculture. An adjoining small area of Unit L is less saline and still carried moderate pasture, although surface salt levels are tending to be high (up to 0.55%).

### 5. *Reaction*

The pH value has been determined on a number of surface (0-6 in.) and subsoil (3-4 ft.) samples from the river frontage and adjoining grey plain (Units 6 and N respectively).

Values of about pH 8.5 in the surface and pH 9.5 in the subsoil were found in the soils from Unit N. This is consistent with the reaction of the Woorinen soils. Published and unpublished data show these to be alkaline (pH 7 – 8.5) in the surface and strongly alkaline (above pH 9.0) in the subsoils.

On the other hand in Unit 6, the surface values ranged from pH 5.5 to 7.1 and the subsoil values from pH 6.0 to 7.5. These values are consistent with the acid values (below pH 7.0) generally found in the profiles of Type 10 at Speewa.

## III. PERMEABILITY AND DRAINAGE CHARACTERISTICS OF THE SOILS

Churchward's investigations into the characteristics of the layers point to the presence throughout the Woorinen area of an underlying layer (the Tooleybuc layer) offering major impedance to the movement of water through the soils.

The prevalence of water tables under intensive irrigation in the Beverford Extension area points to the same conclusion.

Permeability assessments of the upper layers and the drainage potential of the soil units are set out Table 2.

***TABLE 2 - Drainage Characteristics of the Soil Units.***

| Soil Unit | Depth to clay of low permeability | Permeability of materials above clay | Drainage potential |
|---|---|---|---|
| A | more than 7 ft. | Very high | Good |
| B | 5 ft. | Moderate to high | Fair to good |
| B light deep subsoil phase | 5 ft. | High | Good |
| C | 6 ft. | High | Good |
| D | 5 ft. | Moderate | Good |
| E | 3 ½ - 5 ft. | High | Fair |
| H | 4 ft. | High | Fair |
| K | 6 ft. | Moderate to low | Fair to poor |
| K light deep subsoil phase | 6 ft. | High | Good |
| L | 2 – 4 ft. | Moderate | Poor |
| N | 1 ½ - 2 ft. | Moderate | Poor |
| 1 | 4 – 6 ft. | Moderate ` | Fair |
| 2 | 2 ft. | Moderate | Poor |
| 3 | ? | Moderate | Poor ? |
| 4 | ? | Moderate | Fair ? |
| 5 | 3 ft. | Moderate | Poor |
| 6 | 1 –2 ft. | Low | Poor |

Column 2 refers to the depth to a clay of low permeability and considered to be unresponsive to drainage. This is not necessarily the major impending layer referred to above. The permeability ratings given in Column 3 refer to the least permeable layer within the overflying materials. However, minor impedances found in the "light deep subsoil" phases and in Unit 1 have not been considered in the rating of these soils. The permeability ratings – that is the relative rate at which they are likely to conduct water – have been assessed from observations on ground water and soil moisture status and from soil textures. The following ratings have been given.

| | | |
|---|---|---|
| Sandy and sandy loams | . . . . | very high permeability |
| Sandy clay loams | . . . . | high permeability |
| Sandy clays and some | . . . . | moderate permeability porous (?) clays |
| Dense clays | . . . . | low permeability |

The drainage potential of the soil depends on : -

(a) the depth to the layer of major impedance to water
(b) the permeability of the materials above this layer. These materials range from highly permeable to only slightly more permeable than the underlying layer of major impedance.

The drainage potentials given in Column 4 of Table 2 have been assessed from the Permeability ratings and the depth to a clay layer or low permeability in conjunction with irrigation and drainage experience on corresponding soils at Woorinen. Where a poorly permeable clay layer occurs within 4 ft. from the surface, the drainage potential is never likely to be better than fair and more often is poor.

## IV. REFERENCES


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