Soil Survey Report No. 31.
9th June, 1959.

REPORT ON SOILS OF THE HORSHAM SOLDIER SETTLEMENT PROJECT

by

J.K.M. Skene, Senior Soils Officer.

Soils Section,
Department of Agriculture.

An area of about 4,400 acres, several miles to the east of Horsham, in the parishes of Horsham and Bungalally was covered by soil survey in 1953 as a preliminary to its subdivision for soldier settlement and development under irrigation. The land had previously been given to wheat-growing for many years.

This report describes the soils and is accompanied by a soil map showing their distribution.

Climate.

Rainfall data for Horsham indicate a mean annual rainfall of about 17.8 in. for the area, with 11.3 in. falling in the period March to October. Wet days per annum average 102.

Mean annual maximum and minimum temperatures for Horsham are, respectively, 71.1^{o}F and 46.7^{o}F. The months May to October fall below the annual means.

Landscape.

The area has been largely cleared of the natural timber of grey-box and casuarina and is now a treeless plain. Differences in elevation between the brown soils on the higher parts and the lower-lying grey soils are small.

Description of Soil Types.

Three named and two unnamed soil types have been recorded. Horsham friable clay is considered a typical Wimmera "grey" soil. There have been variously described as chernozem-like, black earths, and grey soils of heavy texture. Bungalally clay and Type B also belong to this group.

Drung sandy loam is a red-brown earth, while Type A is a hydromorphic variant.

In addition to their normal phases, Horsham friable clay has a shallow phase and Bungalally clay, a friable deep subsoil phase.

Descriptions of the soil type profiles are given below.

Horsham friable clay ***(Hfc).*** In its natural state, gilgais may be present, but these have been obliterated following a long period of cultivation.

0- 3 in. Grey light clay, strong blocky, breaking down readily to fine granular aggregates; fine calcium carbonate concretion.

3-27 in. Dark grey medium clay, strong coarse blocky, breaking readily to fine blocky structure; slight soft calcium carbonate and fine concretions. Below 15 in. the aggregates are very angular and very friable.

27-39 in. Dark grey medium clay, strong medium blocky; friability decreasing; slight to light soft calcium carbonate and concretions.

39-72 in. Yellowish grey, passing to yellow-grey, medium clay with light to heavy calcium carbonate; a few soft ferruginous concretions and slight brown mottling.

Horsham friable clay, shallow phase. This is similar to the normal phase except that the yellowish grey, calcareous clay in the deep subsoil occurs at less than 3 ft from the surface.

Bungalally clay ***(Bc).*** This soil type occurs in shallow, broad depressions at slightly lower levels than Horsham friable clay.

0- 2 in. Grey clay; strong small blocky, hard aggregates.

2-18 in. Dark grey heavy clay with rusty brown staining on cleavage planes; strong coarse blocky structure and deep vertical cracking.

18-30 in. Yellowish grey heavy clay with slight gypsum.

30-72 in. Yellow-grey medium clay with slight rusty brown mottling; slight soft calcium carbonate and concretions.

Bungalally clay, friable subsoil phase. This is confined to a low flat situation in the south-west of the area.

The yellowish grey gypseous clay commencing at 18 in. is more friable and extensive than in the normal phase and continues to about 54 in. Below this yellow-grey medium clay occurs as in the normal phase.

Strata of fine sandy clay and sand were found under the Bungalally clay, friable subsoil phase at about 12 ft., but the extent of these sediments elsewhere is not known

Drung sandy loam ***(Dsl)***

0- 4 in. Brown sandy loam, hard and cemented when dry; coarse platy structure.

4- 7 in. Brown, with light brown sand penetrating cracks in the underlying clay. Sometimes this horizon is not apparent and clay occurs at 4 in.

7-12 in. Brown, diffusely mottled with dark yellow-grey, heavy clay; moderate medium columnar structure ?

12-24 in. Brown medium clay; strong medium prismatic passing to blocky structure.

24-60 in. Yellowish brown, weakly mottled with yellow-grey, medium clay or light clay; light soft calcium carbonate and concretions.

60-84 in. Mottled brown and yellow grey clay with variable calcium carbonate.

Type A. This type is situated in the lower parts of the rises of Drung sandy loam.

0- 2 in. Brownish grey or grey-brown fine sandy loam, slightly cemented when dry.

2- 4 in. Light grey brown sandy clay loam, moderately cemented when dry.

4- 9 in. Diffusely mottled dark grey-brown and yellow-grey heavy clay.

9-21 in. Mottled dark brown and brownish yellow heavy clay.

21-48 in. Mottled brownish yellow and yellow-grey medium clay; light soft calcium carbonate and concretions.

48-72 in. Moderately mottled yellow-grey, yellow-brown and grey medium clay; slight calcium carbonate.

Type B. Occurs in the faint depressions in the lowest parts of the area.

0- 4 in. Grey, with slight rusty brown mottling, light clay.

4-15 in. Mottled grey and yellow grey, with rusty brown flecking, heavy clay.

15-30 in. Yellow-grey heavy clay; light soft calcium carbonate and concretions.

30-45 in. Greyish yellow medium clay; slight soft calcium carbonate and concretions.

45-60 in. Yellow-grey with some rusty brown mottling, medium clay; slight calcium carbonate.

Lunette Soils. These are unclassified grey and brown soils on the relatively high land near Dock Lake.

Area of Soil Types.

	Acres
Horsham friable clay	745
“ “ “ shallow phase	1,034
Bungalally clay	534
“ “ friable subsoil phase	394
Drung sandy loam	804
Type A	200
Type B	391

Complexes (Hfc – A, Hfc – Dsl, A – B)		115
Lunette Soils		155
	TOTAL	4,372

Chemical and Physical Properties of the Soils.

Particle size distribution, pH, soluble salts and other data for five representative profiles are given in an appendix.

Particle Size Distribution. The data illustrate the similarity of the textural profiles of the Horsham friable clay and the Bungalally clay. Both are high in clay, have weakly developed textural A horizons, while the particle size distribution is similar in each and does not altar much down the profile from 3 in. to 6 ft. State of aggregation of the particles rather than particle size itself apparently is responsible for the different physical nature of these two soil types.

The contrast in texture between the A and B horizons in the Drung sandy loam is well illustrated by a pronounced rise in clay content. In the B horizon, clay contents are nearly as high and the particle size distribution is not very different from those in the Horsham and Bungalally soil types, although their physical characteristics are very different.

Exchangeable Cations. Data for representative profiles of Horsham friable clay, shallow phase and Drung sandy loam are given in Table 1.

TABLE 1. **Exchangeable Cations**

Soil No.	Depth in.	pH	Clay %	Total metal m.e.	Ex. ions %	% of total metal ions as				Ca
						Ca	Mg	K	Na	Na
Horsham friable clay, shallow phase										
5666	0- 3	7.7	43.2	26.7		59	31	9	1	87
5667	3-12	8.7	56.8	36.3		52	40	6	2	33
5668	12-20	9.0	60.5	35.3		40	52	6	2	19
5669	20-39	9.4	54.4	30.4		30	58	7	5	6.7
5670	39-54	9.4	54.1	30.4		24	61	7	8	2.9
Drung Sandy loam										
5680	0- 4	6.3	9.2	4.4		63	22	13	2	39
5681	4- 7	6.7	9.0	4.4		60	27	9	4	14
5682	7-12	8.3	47.9	22.9		25	54	9	12	2.1
5683	12-26	9.0	57.5	30.0		17	60	9	14	1.3
5684	26-40	9.4	53.3	25.1		17	60	10	13	1.3

In the Horsham friable clay profile, the exchange complex of all horizons is fully saturated with metal ions. The total exchangeable metal ion level is closely related to clay content and all horizons show values approximating to 60 milli-equivalents per 100 g. of clay. This is a fairly high level associated with clays predominantly of the illite type.

Except in the surface horizon, the Drung sandy loam profile is also fully saturated, while the average exchangeable metal ion value per 100 g. of clay is only slightly lower at approximately 50 milliequivalents. This points to a similar clay constitution in both soil types.

Both soils show a similar trend down the profile of decreasing calcium and replacement of the calcium by magnesium and sodium. However, the relative increase in sodium with depth is of more significance in the Drung sandy loam, since by 7 in. the proportion of sodium is such that it can be expected to adversely affect the physical properties, and in particular the permeability, of the subsoil of that type. A similar condition does not occur in the Horsham friable clay profile although it is likely to occur below 5 ft.

From the chemical fertility aspect, the exchangeable potassium level is important. This is moderate in the surface of the Drung sandy loam, but is very high in the subsoil horizons and in all horizons of the Horsham friable clay.

Reaction. The surface soils vary from slightly acid in the Drung sandy loam to moderately alkaline in the Horsham friable clay and Bungalally clay. All the subsoils are moderately or strongly alkaline.

Nitrogen. The few analyses given for nitrogen and organic carbon are useful only to illustrate broadly the levels of organic matter likely to be found in the upper parts of soil profiles in the area.

Soluble Salts. In the two Horsham friable clay profiles, total soluble salts are low throughout, although contents are slightly higher below 3 ft. In the Bungalally clay profile, which has poorer internal drainage, high levels occur from 17 in. to 132 in. depth, whilst moderate levels occur within this zone in both of the Drung sandy loam profiles. All surface soils are low in total soluble salts.

Sodium chloride follows the same general trend as total salts. The nature of the salts other than chloride has not been determined, but gypsum is indicated in the subsoils where the sodium chloride content is appreciably lower than the total soluble salts.

The salinity hazard under irrigation has been assessed from the salt contents at 3-4 ft. depth of soil samples taken during the course of the field survey. These data are summarised in Table 2. Salt content range from low to moderate in all the soil types, but there is a higher proportion of soils with low levels in the Horsham friable clay than in either the Bungalally clay or the Drung sandy loam.

TABLE 2. **Percentage of Soils with Salt Contents in the Ranges Shown.**

Soil Type	No. of samples	% Sodium chloride at 3-4 ft.			
		0-.100	.101-.200	.201-.300	Above .300
		%	%	%	%
Horsham friable clay	44	61	24	15	-
Bungalally clay	25	46	20	20	14
Drung sandy loam	25	16	40	36	8
Type A	10	-	20	80	-
Type B	10	50	40	10	-

Soil Types and Irrigation.

Heavy textured grey soils successfully support irrigated pastures in northern Victoria where the soil profile is sufficiently well-structured, and consequently permeable, to allow satisfactory moisture relationships for plant growth. Both phases of Horsham friable clay are in this category and are regarded as very suitable for irrigated pastures. The soils are mostly low in salt and the salt hazard is considered to be slight.

Bungalally clay is not so well-structured, although the friable subsoil phase has good characteristics below 30 in. The salt content is moderately high in the deeper subsoil and the type occurs in low situations. For these reasons, Bungalally clay appears less attractive for irrigation than Horsham friable clay, but given adequate surface drainage it supports satisfactory pastures.

Type B is inferior because of its poorer structure and low situation in the topography.

Drung sandy loam and Type A were regarded unfavourably for irrigation and it was recommended that these soils should be avoided if possible. Red-brown earths are irrigated extensively in northern Victoria, but in the case the surface soils are shallow and the subsoils are dense, heavy clays of low permeability. Subsequent experience has shown that it is difficult to avoid moisture stress during mid-summer on pastures grown on Drung sandy loam. Salt concentrations are moderate in the subsoils, but there is some salt risk in view of the poor internal drainage of these soils.

APPENDIX

Particle size distribution and other data for the principal soil types.

NOTE: Gravel is material greater than 2 mm and is expressed as percentage of the field sample; all other estimations relate to the oven dry fine earth and are percentages except reaction and C.N. ratio.

SOIL TYPE	HORSHAM FRIABLE CLAY											
	Normal Phase						Shallow Phase					
Soil No.	5660	5661	5662	5663	5664	5665	5666	5667	5668	5669	5670	5671
Depth (in.)	0-3	3-14	14-29	29-37	37-54	54-72	0-3	3-12	12-20	20-39	39-54	54-72
Texture	MC	MC	MC	MC	MC	MC	MC	MC	MC	MC	MC	MC
Gravel ($CaCO_3$)	0.9	Tr.	Tr.	1.1	4.7	1.9	Tr.	Tr.	Tr.	4.1	3.2	9.1
Coarse sand	8	7	9	6	4	4	11	8	7	5	4	5
Fine sand	20	18	20	16	12	10	31	21	19	15	14	17
Silt	7	6	6	7	7	6	9	7	6	6	6	7
Clay	61	66	62	68	66	57	45	61	65	58	58	61
Loss on acid treatment	3.8	3.4	3.0	3.6	11.7	23.0	2.3	3.0	3.7	15.4	17.5	10.5
Loss on ignition	6.8	6.5	6.0	6.5	9.8	14.0	6.2	5.9	6.2	10.8	12.6	8.8
Calcium carbonate	0.5	0.3	0.1	0.5	9.7	23.0	-	-	-	13.2	17.5	9.4
Total soluble salts	.046	.046	.036	.066	.112	.125	.040	.046	.053	.086	.115	.112
Sodium chloride	.013	.009	.013	.017	.017	.022	.012	.013	.013	.014	.022	.026
Nitrogen	.083	.056	.044	.042			.133	.090	.039			
Organic carbon	0.79	0.47	0.42	0.38			1.27	0.52	0.29			
C-N ratio	10	8	10	9			10	6	8	6		
Reaction (pH)	8.3	8.7	9.0	9.2	9.4	9.5	7.7	8.7	9.0	9.4	9.4	9.5

APPENDIX

SOIL TYPE	BANGALALLY CLAY							
Soil No.	5672	5673	5674	5675	5676	5677	5678	5679
Depth (in.)	0-2	2-17	17-29	29-39	39-54	54-72	72-108	108-132
Texture	LC	HC	HC	MC	MC	MC	MC	LC
Gravel ($CaCO_3$)				0.6	0.9	3.9		
Coarse sand	12	7	5	4	4	3	5	9
Fine sand	30	20	16	13	13	10	15	28
Silt	12	9	9	9	10	8	10	13
Clay	44	61	67	70	69	68	68	49
Loss on acid treatment	1.7	2.5	3.0	4.0	4.1	11.3	2.6	1.5
Loss on ignition	5.0	5.8	5.4	5.8	6.0	8.7	5.2	3.7
Calcium carbonate	0.0	0.0	0.1	1.0	1.5	7.8	0.4	0.0
Total soluble salts	.043	.139	.759	.657	.653	.667	.568	.373
Sodium chloride	.016	.081	.251	.347	.378	.409	.357	.249
Nitrogen	.111	.081	.042					
Organic carbon	1.12	0.63	0.28					
C-N ratio	10	8	7					
Reaction (pH)	7.4	8.3	8.1	8.6	8.6	8.7	8.8	8.5

APPENDIX

SOIL TYPE	DRUNG SANDY LOAM								
Soil No.	5651	5652	5653	5654	5655	5656	5657	5658	5659
Depth (in.)	0-2	2-4	4-9	9-15	15-21	22-30	30-41	41-56	56-72
Texture	SL	SCL	HC	HC	HC	MC	MC	LC	LC
Gravel ($CaCO_3$)						19.4	3.4	4.8	11.8
Coarse sand	23	23	12	9	9	10	10	11	13
Fine sand	46	41	25	20	22	24	26	26	27
Silt	10	9	5	5	5	7	7	7	6
Clay	16	24	55	63	62	51	49	47	46
Loss on acid treatment	1.2	1.6	2.3	2.6	3.0	8.4	8.0	9.0	8.4
Loss on ignition	4.8	4.8	6.6	6.4	5.8	7.0	5.6	6.9	6.9
Calcium carbonate					0.1	6.7	3.6	7.1	6.9
Total soluble salts	.026	.030	.112	.284	.393	.393	.403	.406	.389
Sodium chloride	.011	.013	.061	.175	.196	.207	.217	.225	.225
Nitrogen	.131		.102						
Organic carbon	1.59		0.87						
C-N ratio	12		9						
Reaction (pH)	6.3	6.5	8.3	8.8	8.9	9.1	9.2	9.2	9.2

APPENDIX

SOIL TYPE	DRUNG SANDY LOAM									
Soil No.	5680	5681	5682	5683	5684	5685	5686	5687	5688	5689
Depth (in.)	0-4	4-7	7-12	12-26	26-40	40-60	60-75	75-86	86-120	120-138
Texture	SL	SL	HC	HC	HC	MC	MC	LC	MC	
Gravel ($CaCO_3$)					14.6	13.9	7.9	5.1	4.2	0.3
Coarse sand	32	31	16	12	13	12	15	17	7	3
Fine sand	49	48	25	19	20	19	22	26	21	15
Silt	7	9	6	5	4	4	4	4	10	20
Clay	9	9	51	62	57	55	52	46	57	58
Loss on acid treatment	0.7	0.5	1.9	2.3	5.5	10.2	7.6	6.1	5.6	4.2
Loss on ignition	2.4	1.9	5.6	6.0	8.3	8.2	7.0	6.1	6.6	6.7
Calcium carbonate					3.6	8.3	5.8	4.4	4.3	3.1
Total soluble salts	.010	.010	.046	.096	.257	.246	.340	.307	.370	.370
Sodium chloride	.007	.005	.016	.046	.119	.191	.186	.169	.210	.245
Nitrogen	.053		.063	.059						
Organic carbon	0.75		0.38	0.24						
C-N ratio	14		6	4						
Reaction (pH)	6.3	6.7	8.3	9.0	9.4	9.3	9.3	9.3	9.2	9.0