SECTION 3 - RELATION TO EARLIER SURVEYS

Previous soil surveys in this area were conducted at reconnaissance level using small scale units. Only soil associations were mapped. Considering the substantial difference in the scale of mapping between those surveys and the present one, there is good general agreement in the description of the main soil components over most of the surveyed area.

To facilitate comparison, seven sketches of this area have been redrawn from earlier maps using an approximate scale of 1:650,000 (see Figures 5a to 5g).

Part of the Kalkee plains has been recently surveyed by Badawy (1977) using an aerial photograph at the scale of 1:31,680. The southern part of this survey overlaps the north western part of the presence survey. Both surveys used the same procedure. The Kalkee and Murra Warra associations mapped in the Kalkee survey correspond to the units H.1 and H.12, respectively, in the present report.

Examination of these earlier maps shows general agreement that the dominant soil association unit in this area is the grey and brown clays on the Wimmera undulating plains. Other main soils are the sandy duplex soils on the slopes and the plains in the southern part of the surveyed area and the rock outcrops and skeletal soils on the Grampians.

However, this survey (see soil association map) has illustrated the great complexity of soil associations in this area, e.g., at least six soil associations were mapped within the grey and brown clays.

This has clear implications for the planning of future research and extension work involving interpretation of soil maps at various scales.

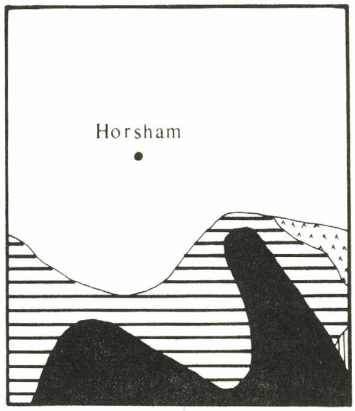


Figure 5a - Adapted from: "Soil Map of Victoria"
By J. K. M. Skene, 1956

KEY TO SOIL GROUPS AND MAPPING UNITS

Grey and Brown Soils of Heavy Texture
Alkaline clay loams and clays over clay subsoils. Derived from unconsolidated sediments.

Friable: Calcareous, self-mulching, grey soils, usually not saline. Includes red-brown earths.

Red Brown Earths
Slightly acid, brown loams over alkaline clay subsoils containing calcium carbonate; usually not saline. Derived from unconsolidated sediments, volcanic rocks and granite. Includes grey soils of heavy texture.

Podsolic Soils
Acid, grey soils with more or less bleached subsurface, over more clayey, acid subsoils. Derived from:

Sedimentary Rocks: Loams, silty loams and fine sandy loams over clay subsoils. Includes solodic and skeletal soils.

Unconsolidated Sediments: Sandy loams over clay subsoils and deep sands. Typically with surface organic matter accumulation and bleached sub-surface. Includes solodic and solonetzic soils, calcareous coastal sands, terra rossas and rendzinas.

Miscellaneous Soils
Podsolic, peaty and skeletal soils and red loams of the mountainous regions.

Note: The soil groups shown also include other soils. These are indicated, but are not defined on the soil map because they are either of small area or of uncertain extent.

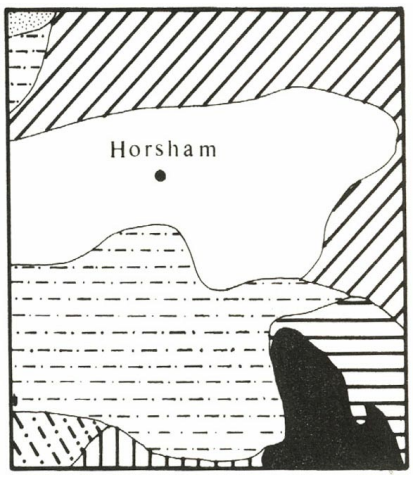


Figure 5b - Adapted from: Atlas of Australian Soils, Sheet 1
(Port Augusta – Adelaide – Hamilton Area)
by K. H. Northcote, 1960

KEY TO SOILS AND MAPPING UNITS

Soils with Uniform Texture Profiles (U)

Shallow Grey Brown Coherent Sandy Soils (Uc 6.11) - Hilly to mountainous: Rock outcrops and shallow grey-brown sandy soils (Uc 6.11) with leached sands (Uc 2.2 and Uc 2.3) on alluvial slopes, in basin plains and gullies; occasional basin plains of button-grass peats (O) surrounded by wet earths (Gn 2.81). In the wetter portions (e.g., Halls Gap-Mt. Victory), yellow leached earths (Gn 2.74 and Gn 2.34) occur on valley slopes, red earths (Gn 2.1) on upper hill slopes, and hard, acid or neutral, red soils (Dr 2.21 and Dr 2.22) in intermediate positions. There is considerable change in soil with altitude. Soils other than those recorded here probably occur also.

Cracking Grey Clay Soils (Ug 5.2) - Plains: Gilgai plains of cracking grey clays (Ug 5.2); dark cracking clays (Ug 5.16) and cracking clays with bleached horizons (Ug 3.2); also low rises of hard alkaline red soils (Dr 2.33); minor areas of other soils including hard alkaline yellow mottled soils (Dy 3.43); the area includes lakes and swamps with some lunettes (soils unclassified).

Gilgai plains with low rises and occasional dunes: Gilgai plains of cracking grey clays (Ug 5.2) with smaller areas of other cracking clays (Ug 3.2, Ug 5.16 and Ug 5.3) and broken by low rises, low elongated dunes of hard alkaline red soils (Dr 2.33) which are dominant in places; dunes of deep siliceous sand (Uc 1.2) occur close to some creek and river channels.

Gilgai plains with some swampy areas and lunettes: Gilgai plains of cracking grey clays (Ug 5.2) with smaller areas of other cracking clays (Ug 5.16 and Ug 5.2) in association with hard alkaline yellow mottled soils (Dy 3.43) and with low ridges of hard yellow mottled soils (Dy 3.8) and sandy yellow mottled soils (Dy 5.8); occasional dunes of deep siliceous sands (Uc 1.2) and small areas of many other soils, especially on lunettes.

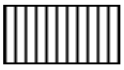
SOILS WITH CONTRASTING (DUPLEX) TEXTURE PROFILES (D)

Hard-setting Loamy Soils with Mottled Yellow Clayey Subsoils (Dy 3). Alkaline Reaction Trend Through Profile. Bleached A_2 Horizon

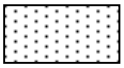
Valley plains and some lower hill slopes
Hard alkaline yellow mottled soils (Dy 3.43) associated with small areas of cracking grey clays (Ug 5.2) and localised areas of hard alkaline red soils (Dr 2.43).

Sandy Soils with Mottled Yellow Clayey Subsoils (Dy 5). Neutral Reaction Trend Through Profile. Bleached A_2 Horizon

Plains and valley plains with some swamps **-** Sandy neutral yellow mottled soils (Dy 5.42) with smaller areas of (Dy 5.41 and Dy 5.43) in association with leached sands (Uc 2.2 and Uc 2.3) which may be co-dominant locally. Other soils such as (Dy 3.6) containing ironstone gravel are present in minor areas, but may be prominent locally.



Plains with areas of dunes and ranges of sandhills - Sandy neutral and alkaline yellow mottled soils (Dy 5.42 and Dy 5.43) on the plains in association with leached sands (Uc 2.2) on the dunes and sandhills; soils of minor area include cracking grey clays (Ug 5.2) (Dd 1.23) Um 6.23) and shallow forms of (Dr 2.13) and (Dr 2.33) on the plains. Area has clay sub-strata.



Undulating: - dissected dunes and plains – swamps and lakes - Sandy neutral yellow mottled soils (Dy 5.42) with hard alkaline yellow mottled soils (Dy 3.4) and in association with leached sands (Uc 2.2 and Uc 2.3) which may be co-dominant locally; soils of minor area include cracking grey clays (Ug 5.2) and hard alkaline dark soils (Dd 1.23).

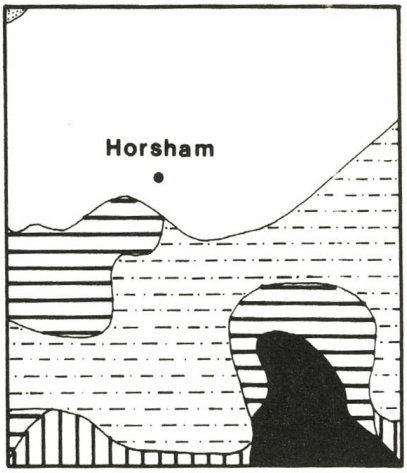


Figure 5c - Adapted from: "Resources Survey, Wimmera Region" The soil map in the Soils Section By J. K. M. Skene, 1961

KEY TO SOILS AND MAPPING UNITS

Deep Sands
Infertile, deep, sandy soils occur on the dunes associated with sandy solonetzic soils on the plains and interdune flats.

Grey Soils of Heavy Texture
Locally known as Wimmera black soils. Gilgai formations are common. There are two sub-groups, viz:

1. Friable Heavy Grey Soils
   Intermingled with brown soils of heavy texture, and associated with red-brown earths and some non-friable heavy grey soils.

2. Non-friable Heavy Grey Soils
   Associated with red-brown earths, brown soils of heavy texture, solonetzic soils and some friable heavy grey soils.

Solonetzic Soils
Associated with deep sands and grey soils of heavy texture.

Podsolic Soils
This unit includes small areas of skeletal soils.

Skeletal Soils
Skeletal soils occur mainly on the higher parts of the Grampians associated with podsolic soils especially on lower slopes and in valleys.

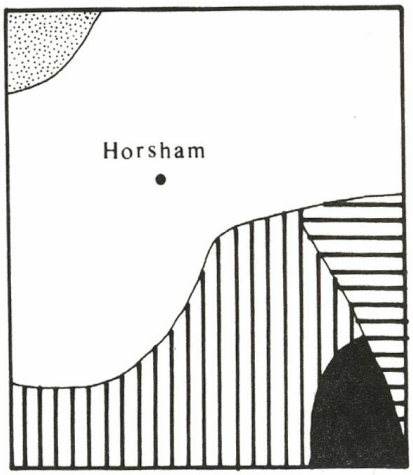


Figure 5d - Adapted from: "Atlas of Australian Resources, Second series, Soils Second Edition" By the Department of National Development, Canberra, 1963

KEY TO DOMINANT GREAT SOIL GROUPS AND MAPPING UNITS

Solodised solonetz and solonetz soils

Grey and brown soils of heavy texture

Solodic soils

Grey-brown, brown, red, yellow and meadow (= gley) podzolic soils

Skeletal soils

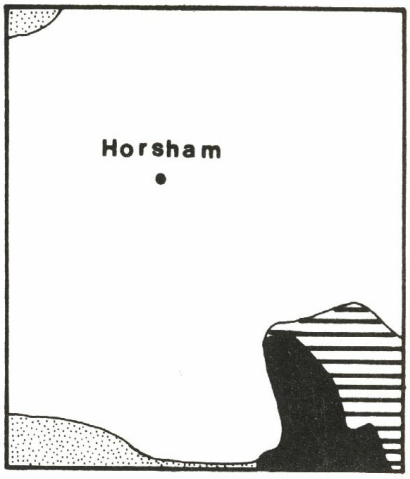


Figure 5e - Adapted from: "Soil Map of Victoria"
By K. H. Northcote, 1964

KEY TO SOILS AND MAPPING UNITS

Sandy plains and dune ranges, ***Sandy Neutral Duplex Soils*** (Dy 5.42) – yellow clay subsoils

Undulating clay plains, ***Grey Cracking Clays*** (Ug 5.2)

Grampians "rugged ranges", ***Rock Outcrops*** and ***Various Sand Soils***
(Uc 6, Uc 4, Uc 1)

Alluvial – Colluvial plains, ***Hard Alkaline Duplex Soils*** (Dy 3.43) – yellow clay subsoils

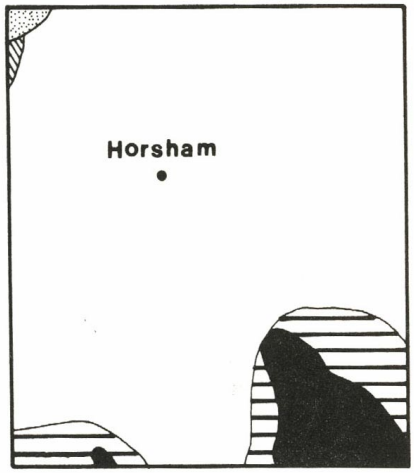


Figure 5f - Adapted from: The map of "Soils of Western Victoria"
By G. Blackburn, 1974

KEY TO SOILS AND MAPPING UNITS

Soils of Free Drainage

Deep, quartz sands (podzols)

Brown sands and calcareous loams (brown solonised soils)

Shallow, stoney and sandy (skeletal)

Soils of Impeded Drainage

Grey or brown deep clay; occasional crabholes (grey and brown clays)

Grey and brown sands and loams, with distinct clay subsoils
(solonetzic, solodic, podsolic, duplex soils)

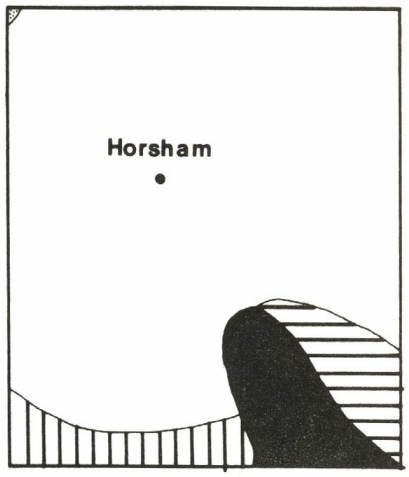


Figure 5g - Adapted from: "A Soil Map of Australia"
By K. H. Northcote* et al., *1975

KEY TO SOILS AND MAPPING UNITS

Neutral, sandy, pedal, mottled yellow duplex soils with bleached A_2 horizons (Dy 5.42) on aeolian (dunes) plains.

Deep grey, self-mulching cracking clays (Ug 5.24) on depositional plains.

Neutral, sandy pedal, mottled yellow duplex soils with bleached A_2 horizons (Dy 5.42) on undulating topography.

Shallow, grey-brown, weakly structured sandy soils (Uc 6.11) on hills

Alkaline, hard, pedal, mottled yellow duplex soils with bleached A_2 horizons (Dy 3.43) on depositional plains

REFERENCES

Badawy, N.S. (1977) – Soils of part of the Kalkee Plains, Dept. Agric. Vic. Soils Survey Rep. No. 53.

Blackburn, G. (1974) – The soils of the Western Victoria, *In* "The Natural History of Western Victoria", Eds. Douglas, M. H and O'Brien, L. Aust. Inst. Agric. Sc. (Kalprint Graphics, Hamilton).

Northcote, K. H. (1960a) – Atlas of Australian Soils. Map and Legend No. 1 – Dominant Soils for Sheet 1, Port Augusta-Adelaide-Hamilton Area (C.S.I.R.O. Aust. and Melb. Univ. Press, Melbourne).

Northcote, K. H. (1960b) – Atlas of Australian Soils. Explanatory Data for Sheet 1, Port Augusta-Adelaide-Hamilton Area (C.S.I.R.O. Aust. and Melb. Univ. Press, Melbourne).

Northcote, K. H. (1964) – "Soil Map of Victoria" *In* Victorian Year Book No. 78 (Commonwealth Bureau of Census and Statistics, Victorian Office).

Northcote, K. H., Hubble, G. D., Isbell, R. F., Thomson, C. H. and Bettenay, E. (1975) – "A Description of Australian Soils" (C.S.I.R.O. Aust).

Plumb, T. W. (1963) – Ed. Soils, 2nd Edition, *In* "Atlas of Australian Resources", 2nd Series (Dept. Nat. Dev., Canberra).

Skene, J. K. M. (1956) – "Soil Map of Victoria" (Soils Sec. Dept. Agric. Vic).

Skene, J. K. M. (1961) – Physical Resources, Soils, *In* "Resources Survey, Wimmera Region", p. 77 (Central Planning Authority, Government of Victoria).

Stace, H. C. T, Hubble, G. D., Brewer, R., Northcote, K. H., Sleeman, J. R., Mulcahy, M. J. and Hallsworth, E. G. (1968) – "A Handbook of Australian Soils". (Rellim Technical Publications : Glenside, S.A.)

APPENDIX I - APPROXIMATE AREAS OF THE LANDSCAPE UNITS AND THEIR COMPONENT SOIL ASSOCIATIONS

Landscape unit			Component soil associations		
Name	**Area (ha)**	**% of survey area**	**Code**	**Area (ha)**	**% of landscape unit area**
Dissected plains	6,160	2.4	H. 8	6,160	100.0
Dissected slopes	9,120	3.6	H. 2	6,520	71.4
			H. 1	1,790	19.6
			H. 8	320	3.6
			H. 4	280	3.1
			H. 3	210	2.3
Elongated sand dunes	9,930	3.9	H. 4	9,930	100.0
Flood plains	46,070	18.2	H. 5	17,600	38.2
			H. 7	7,340	15.9
			H. 4	5,330	11.6
			H. 2	4,820	10.5
			H.14	4,190	9.1
			H. 1	2,350	5.1
			H. 3	2,250	4.9
			H. 6	2,190	4.7
Lakes and lunettes	11,690	4.6	H. 2	5,490	47.0
			H.13	4,550	38.9
			H.12	700	6.0
			H. 5	520	4.4
			H. 1	430	3.7
Lower outwash slopes	8,690	3.4	H. 9	8,690	100.0
Mountains	6,750	2.7	H.11	6,750	100.0
Prior streams	7,020	2.8	H. 4	5,350	76.2
			H. 7	1,670	23.8
Ridges and low rises	13,680	5.4	H. 2	8,960	65.5
			H.12	1,650	12.0
			H. 8	1,540	11.3
			H. 1	1,530	11.2
River frontages*			Various		
Sand sheets and sand rises	3,100	1.2	H. 4	3,100	100.0
Gently undulating plains	120,010	47.4	H. 1	72,620	60.5
			H. 3	24,750	20.6
			H. 6	14,780	12.3
			H.12	2,930	2.5
			H. 2	2,480	2.1
			H. 8	990	0.8
			H. 4	770	0.6
			H. 5	440	0.4
			H. 7	250	0.2
Undulating sand plain	3,160	1.3	H.15	3,160	100.0
Upper outwash slopes	7,820	3.1	H.10	7,820	100.0
Total	253,200	100		253,200	

* Areas of this unit and its component soil associations are included in the *flood plains* landscape unit due to the scale of mapping used in Figure 2.

APPENDIX II - DEFINITION OF SOIL TERMS

***Amounts**:* As used here, with reference to soil inclusions, the different terms and their percentages are as follows:

Occasional (< 1) – trace (1-3) – slight (3-10) –
light (10-30) – moderate (30-70) – heavy (> 70)

***Bleached**:* Describes a soil horizon which has become pale in colour owing to leaching.

***Boundary**:* When used in describing soil profiles, it defines the nature of the change from one soil horizon to the one below. The width (or thickness) of the boundary may be described as sharp, clear, gradual or diffuse, while the shape may be wavy or irregular. Boundaries also separate mapping units.

***Colour**:* In this report the soil colours are described in common terms such as brown, red-brown, etc. These terms refer to the air-dry soils.

***Consistence**:* Comprises the attributes of soil material that are expressed by the degree and king of cohesion and adhesion or by the resistance to deformation or rupture. It is markedly affected by the moisture state of the soil. Consistence has been recorded in this report at three moisture contents: dry, moist and wet. Terms used for consistence when dry are: soft and hard; when moist: friable; and when wet: plastic and sticky. The description has been further qualified by the use of the words 'none', 'slightly', 'moderately', 'very' and 'extremely'.

***Cracking soils**:* The term refers to the seasonal or periodic characteristic of those clay soils which develop and exhibit, during a dry season or period, cracks as wide as, or wider than, 6 mm and at least 30 cm deep. The frequency of cracking should be at least one crack per square metre. All such cracks may not be evident at the soil surface where this is massive.

***Ferruginous concretions**:* More or less rounded nodules of variable size and composed mainly of iron oxide.

***Gilgai**:* An uneven surface manifestation or puffs and depressions often referred to as crabholes.

***Gravel**:* Particles between 80 and 2 mm in equivalent diameter.

***Great soil group**:* Refers to the soil classification system as described in "A Handbook of Australian Soils" by Stace *et al*., 1968. Each soil group in this survey has been classified using this system.

***Hard-setting**:* A surface soil is considered to be hard-setting when it becomes hard and apparently apedal on periodic drying out.

***Lime**:* Calcium carbonate either finely divided or in concretions (hard nodules).

***Mottled, mottling**:* These terms refer to soil horizons in which two or more colours are present. The soil may differ in colour either within peds or aggregates, or between them. They do not refer to stains or coloured deposits on ped faces or to the linings of cavities.

Diffusely mottled implies that neighbouring colours are only slightly different.

Moderately mottled means that the colours are evidently different, but not strongly contrasting.

Strongly mottled indicates the presence of markedly contrasting colours.

***Ped**:* An individual natural soil aggregate.

***Rough-faced peds**:* Peds are characterised by the porous and general floc condition of ped faces. Individual peds may not be very easy to identify. The peds themselves are relatively porous (see also soil fabric).

***Self-mulching**:* Self-mulching is that condition of the surface soil, notably of clays, in which a high degree of pedality is exhibited with the peds falling apart, naturally, as the soil dries to form a loose surface mulch. In cultivated soils, ploughing when wet may appear to destroy the surface mulch which, however, will reform upon drying.

***Smooth-faced peds**:* Peds are characterised by the smooth textured or lac condition of the ped faces, which have variable lustre or shininess. Individual peds are easily identified. These peds are dense in comparison with rough-faced peds (see also soil fabric).

***Soil fabric**:* Describes the appearance of the soil material (under 10X hand lens). Differences in fabric are associated with the presence or absence of peds and the lustre of the ped surfaces and the presence, size and arrangement of pores (voids) in the soil mass. Terms used in this report are: rough and smooth.

Soil horizon: A layer of soil, more or less parallel to the land surface, similar throughout and recognisably different from the material above and below. The horizon may be distinguished by differences in one or more of the following characteristics: colour, texture, structure, consistence, mottling, organic matter content and the presence of visible products of weathering and leaching such as calcium carbonate, gypsum, iron oxide and ferruginous concretions. The following horizons in the soil profile may be recognised:

> ***Surface or A Horizon**:* The surface layer of the soil in which organic matter has accumulated and which may be partly leached of clay and soluble material. It may be divided into two or more sub-horizons as follows :
>
> > ***A_1 horizon:*** The surface soil more or less darkened by organic matter – a zone of maximum biological activity.
> >
> > ***A_2 horizon:*** A sub-surface layer lower in organic matter than the A_1 and, in consequence, usually lighter in colour. It is the zone of maximum leaching.
>
> ***Subsoil or B Horizon**:* Situated below the surface or A horizon and is usually heavier in texture than that horizon. The B horizon represents the zone of accumulation of clay and other materials, including calcium carbonate and iron oxides.

Soil profile: This is the vertical section of a soil exposing the sequence of horizons from the surface to an arbitrary depth. A depth of at least 1.2 m was used in this survey.

***Soil reaction trend**:* Indicates the general direction of pH changes down the solum, e.g., alkaline trend – the surface soil has a pH value higher than 5.0 and the deep subsoil has a value higher than 8.0.

***Soil type**:* a group of soils with the same general profile characteristics, including the texture of the surface soil. Individually and grouped in complexes, it is the basic unit of soil mapping in this survey.

***Structure**:* Describes the way in which the primary soil particles are arranged into soil aggregates (peds). The descriptive terms used here are: crumb, angular blocky, sub-angular blocky and prismatic. The size or class of the aggregates may be fine, medium or coarse, while the grade (pedality) may be weak, moderate or strong.

***Texture**:* Soil texture is a measure of the behaviour of a small handful of soil when moistened to sticky point (approximately to field moisture capacity), kneaded into a ball and then pressed out between thumb and forefinger. It is strongly influenced by clay content and is affected by other properties including clay mineral type, organic matter, oxides, carbonates and exchangeable cations. Texture is described in terms of texture grades, examples of which are sand, sandy loam, sandy clay loam, clay loam, light clay, medium clay and heavy clay.

Unaggregated massive = structureless, i.e., 'apedal'

APPENDIX III - SOIL SURVEY METHODS

Scale

The area has been mapped in the field using aerial photographs at two different scales, 1:31,680 and 1:50,000. Soil boundaries and landscape features were examined and marked on the corresponding photograph.

The maps in this report were compiled at a scale of 1:100,000 and reduced to the scale of 1:250,000.

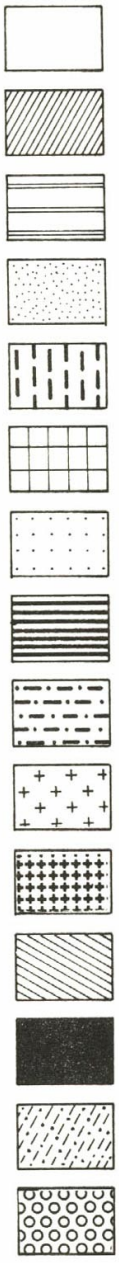
Procedure

Soil descriptions were obtained from about 2,000 sites scattered throughout the surveyed area. Sampling density varied according to the complexity of the soil pattern. Surface features such as topography, vegetation and land use were noted at each site. A 10 cm diameter Jarrett soil auger was used. The soil profile was exposed, usually to a depth of 120 cm but sometimes to 210 cm or deeper, and the soil classified into its soil type or soil group. During classification, each horizon in the soil profile was examined and its thickness, colour, texture, structure, fabric, consistence and the presence of lime, gypsum and any other inclusions were noted. Each site which was examined, and its relevant classification, were marked on the aerial photograph. Boundaries were drawn to demarcate soil mapping units.

The smallest area that can be shown on the soil type map at the scale used is about 20 hectares. This means that any area shown on the map as a single soil association unit may have small areas of one or more different soil associations within it, but not to a greater extent than about 5% of the occurrence.

Within the context of this survey the term soil association is used to refer to a soil group specific to its natural mapping unit. Sequential or recurring pattern relationships of soils within any particular mapping unit are not implied.

KEY TO SOIL ASSOCIATION UNITS



H. 1
H. 2
H. 3
H. 4
H. 5
H. 6
H. 7
H. 8
H. 9
H.10
H.11
H.12
H.13
H.14
H.15

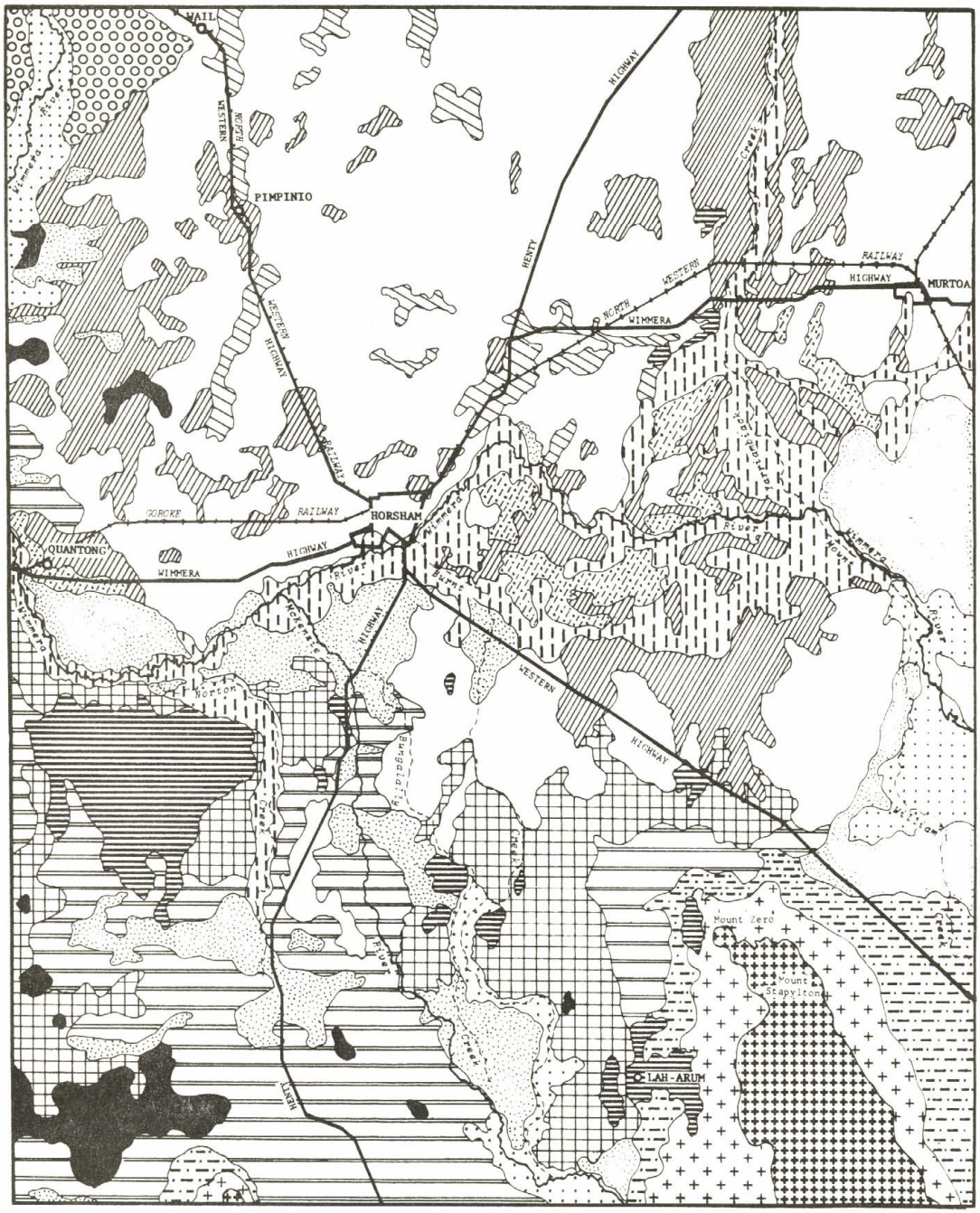
CONVENTIONAL SYMBOLS

State Highway ----------

Railway ----------

River ----------

Creek ----------



SOIL ASSOCIATION MAP OF HORSHAM MAP SHEET NO. 7324