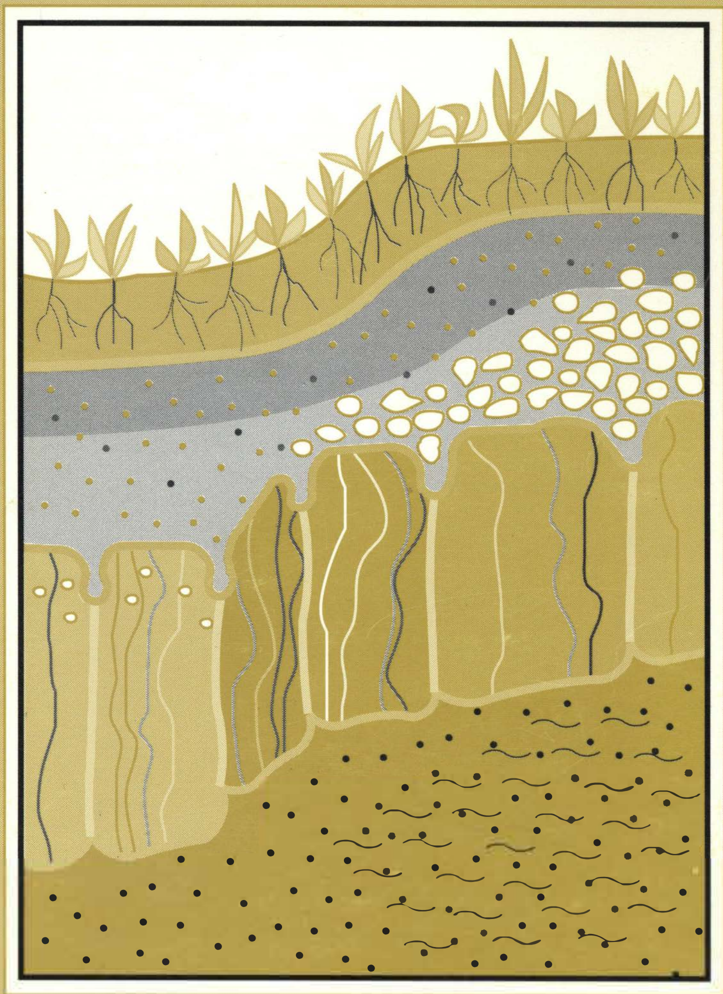

Department of
Primary Industry
and Fisheries
Tasmania

National
Soil
Conservation
Program

Soils of the South Esk Sheet Tasmania

(southern half)

and accompanying 1:100 000 scale

reconnaissance soil map

Soil Survey Series of Tasmania

No. 1

R B Doyle, M.Sc.

1993

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CONTENTS

List of Plates

List of Figures

Page

List of Tables

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2. SUMMARY

A reconnaissance soil survey (publication scale 1:100 000) has been conducted of the southern half of Sheet 8314, South Esk, Tasmania. The survey area is located approximately between latitudes 41° 45'S to 42° 00'S and longitudes 147° 00'E to 147° 30'E. This area of 120 000 hectares extends from just south of Cressy Agricultural Research Station to Campbell Town in the Midlands of Tasmania. The climate is dry temperate, mean annual rainfall ranging from 550 mm to 800 mm with a winter dominance in the north and a spring dominance in the south.

Eighteen soil profile classes and four miscellaneous soil units have been described in terms of field morphology and major chemical and physical properties. The soils have been grouped into associations, complexes, undifferentiated groups and miscellaneous soils for mapping purposes.

Physiographically, a major part of the area lies within the southern portion of the Launceston Tertiary Basin. To the south-west the country rises to the steep escarpment of the Great Western Tiers and Central Plateau. The geology is diverse with Triassic and Permian sandstones and mudstones, Jurassic dolerite, unconsolidated Tertiary sediments, Tertiary basalt, mixed Quaternary alluvium and aeolian sand and some minor occurrences of Cambrian and Precambrian phyllitic and volcanic rocks.

Vegetation includes dry and wet sclerophyll forest and grasslands with much of the area now cleared for agriculture and grazing.

The soils are diverse, reflecting the influence of parent material and topography while the nature and age of landforms is also seen to have exerted a strong influence on soil occurrence. They include Organosols (acid peats) and stony Ferrosols (red podzolics) above dolerite on the alpine Central Plateau; stony Ferrosols (red podzolics-krasnozems) above dolerite colluvium and bedrock on the Great Western Tiers escarpment (also marked by large areas of bare rock and scree); Dermosols and Chromosols (yellow and brown podzolics) above dolerite, phyllite, volcanic rocks, sandstones and mudstone on the lower slopes and foothills; Ferrosols (krasnozems) and Dermosols (non-calcic brown soils) above Tertiary basalt on low hills in the central basin; Kurosols and Sodosols (lateritic podzolics and soloths) on relict surfaces and high river terraces; Hydrosols and Sodosols (solodised solonetz) on lower river terraces; Vertosols and Hydrosols (black earths and humic gleys) on the modern flood plains and lagoons; Tenosols (siliceous sands) on valley sand dunes, sand sheets and on lunettes adjacent to lagoons.

Kurosols, Chromosols, Sodosols, Hydrosols, Tenosols and Vertosols provide some of the greatest challenges to management. The Vertosols are fertile but suffer surface flooding, stream bank erosion and have a narrow working window when moisture content is ideal for cultivation. The Tenosols (sandy soils) are rapidly draining and suffer from summer dryness and low moisture holding capacity. They are also prone to wind erosion when over-cultivated or where vegetative cover is reduced. The Kurosols, Chromosols, Sodosols and Hydrosols (all are texture contrast or duplex) have slow permeability and restricted drainage due to heavy clay subsoils. Their sandy surface horizons commonly dry out in summer resulting in plant moisture stress. Also these sandy topsoils are prone to wind erosion when over-cultivated or denuded and fluvial erosion when on rolling or steeper lands. The Dermosols and Ferrosols developed on basalt and dolerite colluvium have better physical structure and chemical properties than other soils of the survey but are often stony, shallow or are prone to erosion due to their occurrence on rolling to very steep slopes.

The higher nutrient status and better physical condition of the topsoils relative to lower surface horizons (A2's) and subsoils, for all of the soils in the study, is an important fact and highlights the large economic value in preventing topsoil erosion.

Note: The soil names used refer to the soil orders of the new Australian Soil Classification currently under development and readers are referred to Isbell (1993).

3. INTRODUCTION

3.1 Background

The primary aim of this reconnaissance soil survey was to provide descriptions of the key soil profile classes on the southern half of the South Esk Sheet (8314) and to map their distribution at a scale of 1:100 000 (see reconnaissance soil map, rear pocket). This work is part of a continuing program being undertaken to assist the Land Capability Survey of Tasmania, by providing soils information, particularly in areas where no soil survey work has been carried out previously. A knowledge of soil types, their distribution and limitations for agricultural use is fundamental to the assessment of land capability.

The survey area lies in the northern Midlands region of Tasmania between latitudes 41° 45'S and 42° 00'S and longitudes 147° 00'E and 147° 30'E. It is bounded approximately by Cressy Agricultural Research Station in the north-west, Epping Forest in the north-east, Millers Bluff in the south-west and Campbell Town in the south-east (Figure 3.1 and 4.1). The north-eastern half of the survey area is part of the Launceston Tertiary Basin described by Johnstone (1875) and Carey (1947) while the south-western section is comprised of the Macquarie Tier and further west at a higher elevation, the Great Western Tiers and Central Plateau (Figure 6.2).

This reconnaissance soil map completes an important unmapped section of the Launceston Tertiary Basin and environs lying to the south of the Longford sheet (Nicolls, 1958b) and to the north of the Interlaken sheet (Leamy, 1961). The soil map and legend data have been filed in the Department of Primary Industry and Fisheries Geographic Information System (GIS). All soil profile descriptions have been loaded into a computer database system which has been developed as part of this project.

3.2 Previous Work

Within the survey area two small but detailed soil surveys have been completed by the CSIRO Division of Soils. Hubble (1947) produced a soil map of 4 500 hectares of the Macquarie Estates area at a scale of 1:15 800. Dimmock and Loveday (1953) mapped 1000 hectares of basaltic soils along the Midland Highway between Campbell Town and Conara at scale of 1:18 200.

Directly to the north of the survey area the Longford reconnaissance soil map produced by Nicolls (1958b) is at a scale of 1:63 360. To the south, the eastern half of the 1:63 360 Interlaken reconnaissance soil map was produced by Leamy (1961).

There are several other areas within the Launceston Tertiary Basin which have been mapped. Those of most relevance to this survey are the Cressy-Longford area mapped by Stephens *et al.* (1942), and the Cressy Research Station mapped by Stephens (1940) and later Kershaw (1974 and 1975). Also to the north-west a reconnaissance soil map and report of the Quamby Sheet has been published (Nicolls, 1959). Noble (1991) has produced a land capability and revised soil map of the Cressy Research Station.

Soil chemical information has been published by Graley (1961) on the soils of the Longford soil map, and some chemical data is also contained in Stephens *et al.* (1942). Additional analytical data for 274 type soil profiles is stored in the CSIRO Division of Soils and Department of Primary Industry and Fisheries soils databases; much of this data remains unpublished.

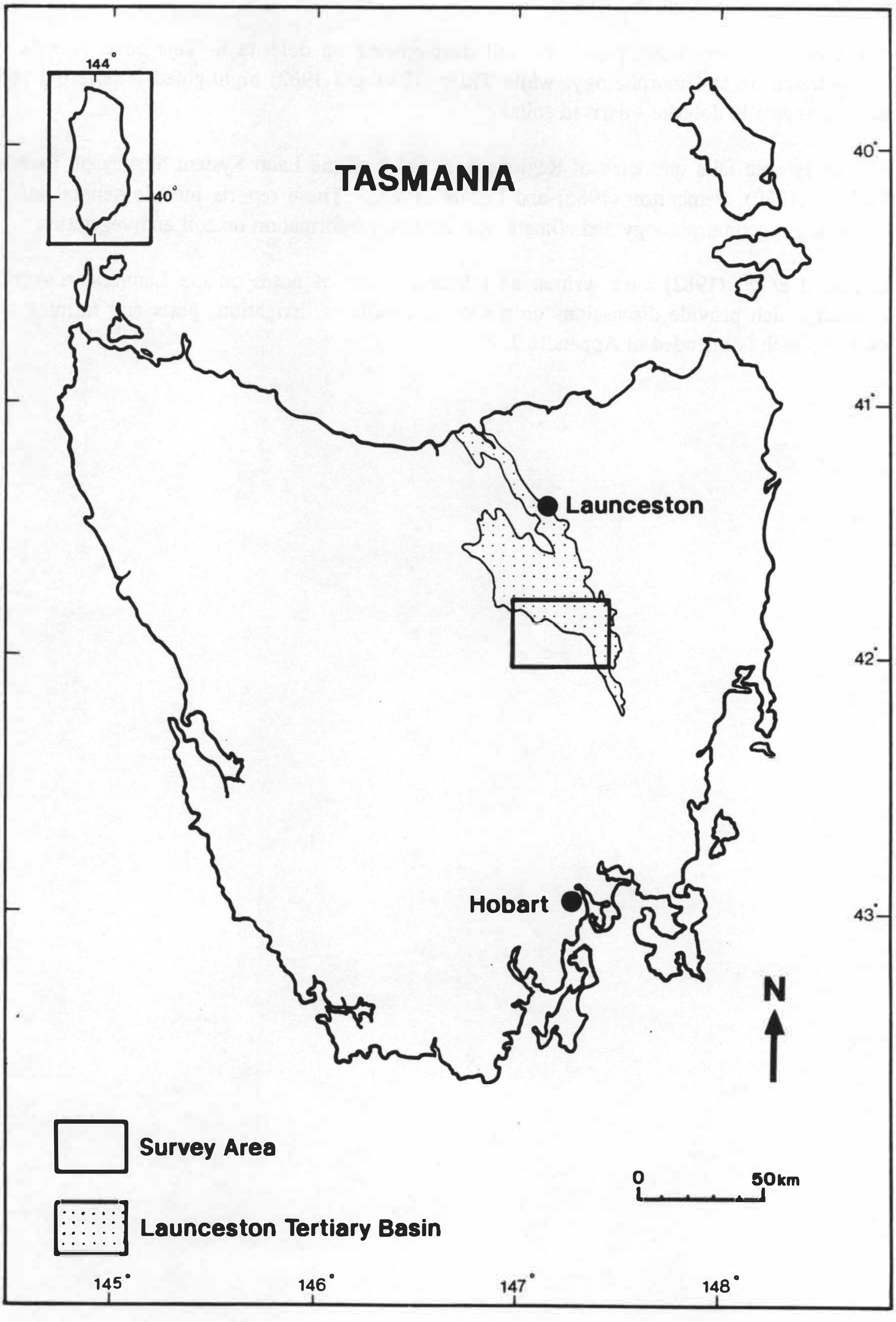


Figure 3.1 Location map showing the survey area and the Launceston Tertiary Basin.

Clay mineralogical data have been determined for the major soils occurring in the Launceston Tertiary Basin (Taylor and Pickering, 1963), and for a range of Tasmanian soils developed on dolerite and basalt (Pickering, 1958).

There are three important papers on soil development on dolerite in Tasmania: Nicolls (1957b) concentrated on soil morphology, while Tiller (1959 and 1962) highlighted weathering paths and trace elements in dolerite - derived soils.

The study area falls into each of Regions 4, 5 and 6 of the Land System Survey of Tasmania viz Pinkard (1980), Pemberton (1986) and Davies (1988). These reports include general information on geology, geomorphology and climate with auxiliary information on soil and vegetation.

Greenhill *et al.* (1982) have written an informative set of notes on the Launceston Agricultural District which provide discussions on the soils, fertilisers, irrigation, pests and farming systems, part of which is included in Appendix 2.

4. PHYSICAL ENVIRONMENT

4.1 Climate

The Midlands region lies in the rain shadow of the Great Western Tiers, with a district average rainfall of about 600 mm per annum on the lowland. Rainfall distribution is more variable than in other parts of the State (Foley, 1945). Meteorological stations are located at Cressy Research Station (150 m ASL.) and Palmerston (180 m) in the north and at Campbell Town (200 m) in the south (Figure 4.1). Data have been recorded at Ross (200 m) located 13 km south of Campbell Town.

Rainfall isohyets and the location of the climate stations are shown in Figure 4.1. Mean annual rainfall ranges from 544 mm at Campbell Town to 786 mm at Palmerston (Table 4.1). However, both these stations lie within the Launceston Tertiary Basin at low altitude and rainfall is likely to be higher and more effective on the Great Western Tiers due to both rapid increases in elevation and lower temperatures. Maximum rainfall in the area occurs in the period from mid-winter to mid-spring with the wettest months being July in the north of the survey area and October in the south. Rainfall is more reliable in winter and early spring (May to October) than in other seasons (Table 4.1 and Bureau of Meteorology, 1979). Summer is the driest season with a 31% probability of receiving 150 mm of rainfall, while winter has a 37% probability and spring a 47% probability (Bureau of Meteorology, 1979).

Climate Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	Rain Days
Cressy Research (1939-1989)	37	39	40	53	61	53	74	69	59	56	50	51	642	127
Palmerston (1962-1989)	44	42	61	58	78	60	93	90	81	66	55	58	786	130
Campbell Town (1915-1989)	38	36	36	44	47	43	48	47	48	56	47	54	544	91
Ross (1915-1989)	38	33	38	40	41	39	44	46	45	51	44	53	512	103

Table 4.1 Mean annual rainfall (mm) (Bureau of Meteorology, 1990).

Mean annual evaporation is 1130 mm/yr at Cressy and 1135 mm/yr at Campbell Town. Evaporation exceeds rainfall for eight months of the year, between September and April (Table 4.2).

Climate Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Cressy Research (1974-1986)	186	164	118	69	37	21	25	43	69	102	132	164	1130
Campbell Town (1973-1978)	189	155	109	66	34	21	31	47	69	105	126	177	1135

Table 4.2 Mean annual evaporation data (mm/yr) (Bureau of Meteorology, written communication).

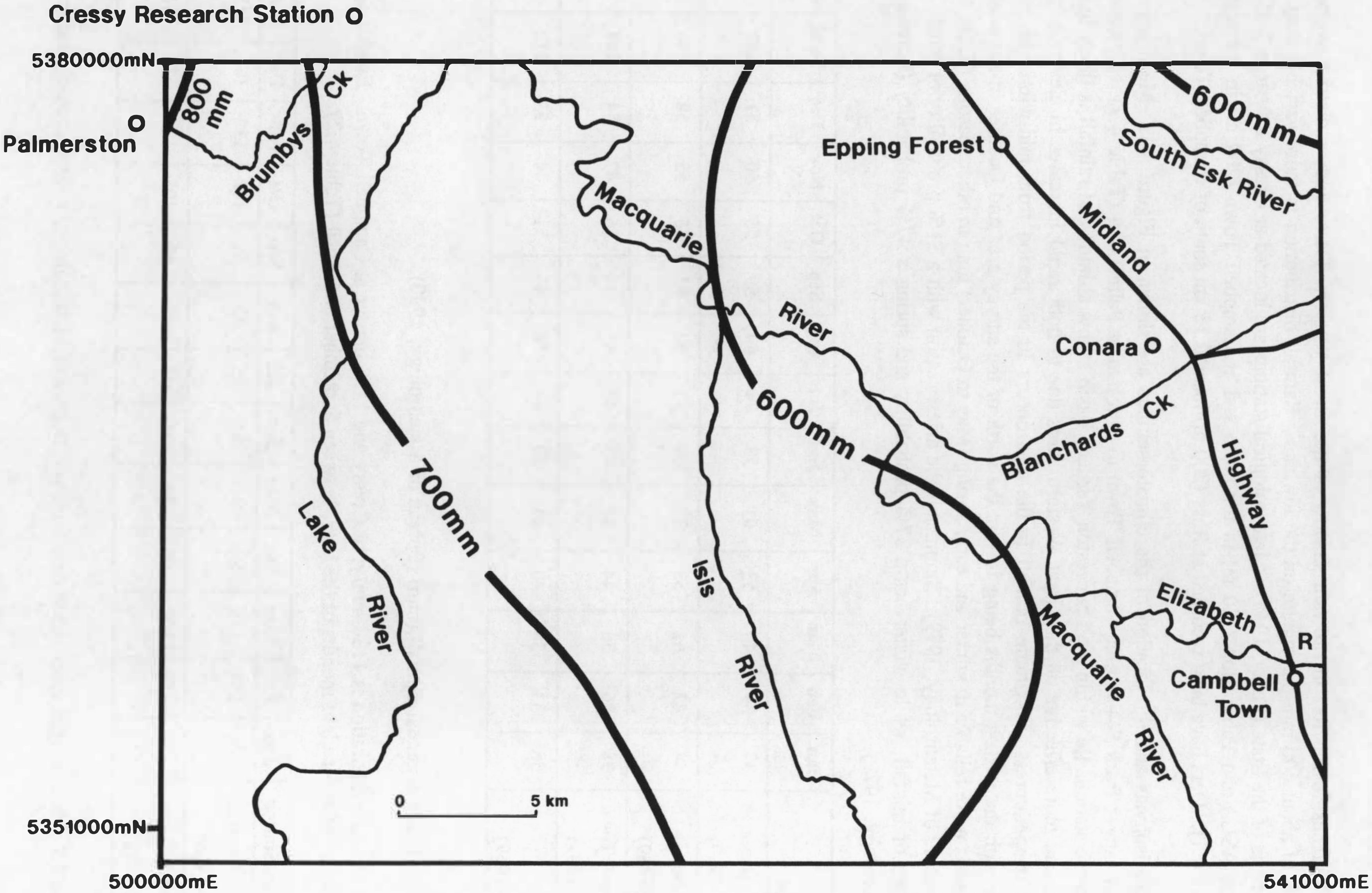


Figure 4.1 Rainfall isohyets, climate stations and major stream locations in the survey area.

Flooding is frequent throughout the South Esk River Basin. This is because of the large catchment area (9 000 km^2), the large area of flat land and the sinuous nature of the rivers. Serious floods involving loss of life, inundation of dwellings or bridge failure have occurred in 1828, 1852, 1863, 1872, 1893, 1929, 1931, 1946, 1956, 1960, 1969, 1970, 1974 and 1975 (Bureau of Meteorology, 1979). Early flood warnings have reduced the number of casualties and stock losses in the latter part of this century. Major floods are most common in autumn (35%) and winter (35%) but also occur in spring (21%) with a few experienced in early summer (9%), (Bureau of Meteorology, 1979).

Snowfalls occur on average one day every 3-4 years in Campbell Town and Cressy, generally in late winter or early spring. More frequent and heavier snowfalls occur on the upper slopes of the Great Western Tiers.

Mean annual maximum and minimum daily air temperatures range from 17.2 °C and 5.2 °C at Cressy Research Station to 17.6 °C and 4.8 °C at Campbell Town (Table 4.3) and more than 100 frosts per year occur at Cressy and Palmerston (Bureau of Meteorology, 1990). Mean temperatures will be lower and frosts more frequent on the Great Western Tiers.

Climate Station		Mean Annual Temperature	Mean Cold Month	Mean Warm Month
Campbell Town (1910-1987)	Mean Max	17.6	11.1	24.8
	Mean Min	4.8	0.3	8.9
	Mean Mean	11.2	5.7	16.9
Cressy Research (1940-1986)	Mean Max	17.2	10.9	23.6
	Mean Min	5.2	0.9	9.3
	Mean Mean	11.7	5.9	16.5
Oatlands (1884-1989)	Mean Max	15.5	9.4	22.0
	Mean Min	5.0	1.0	8.7
	Mean Mean	10.3	5.2	15.4
Palmerston (1965-1989)	Mean Max	17.5	11.1	24.6
	Mean Min	5.1	0.7	9.1
	Mean Mean	11.3	5.9	16.9

Table 4.3 Air temperatures (°C) for the Midlands Region (Bureau of Meteorology, 1990).

The prevailing airstream over Tasmania is westerly ('Roaring Forties'), however the orientation of the Launceston Tertiary Basin results in dominantly north and north-westerly winds. Winds are strongest and most persistent in late winter and early spring (Bureau of Meteorology, 1993). Drought is more common in the Midlands area than elsewhere in Tasmania, with large stock losses occurring on occasions (Bureau of Meteorology, 1979).

4.2 Geology

The survey area falls within that of the 1:50 000 geological map 'Lake River' of Mathews, 1974. Further information on the geology and groundwater resources of the Longford Basin, a sub-basin of the larger Launceston Tertiary Basin, is contained in Mathews, 1983. Johnstone (1875) first named and described the Launceston Tertiary Basin while Carey (1947) proposed a tectonic mode of origin.

As in Tasmania generally (Nicolls and Dimmock, 1965), the geology of the area largely determines the soil pattern because of the strong influence of geological structure on physiography, regional climate and soil parent materials.

Resistant Jurassic dolerite is extensive across the survey area and predominates in the south-west where it forms the cap (300 m thick) of the Central Plateau and the upper escarpment of the Great Western Tiers at elevations above 800 m. Dolerite scree mantles the mid-slopes of the Tiers escarpment (Figure 6.2). East of the Great Western Tiers a large area of dolerite occurs at lower elevations (200-500 m) on rugged hill country of the Macquarie Tier, Isis Hills and Jacobs Sugarloaf. A NW-SE trending ridge of dolerite of up to 350 m elevation, incorporating the southern Hummocky Hills and Dicks Banks, divides the South Esk River valley from the Macquarie and Lake River systems. Most of the western slopes of this ridge, particularly north-west of Campbell Town, are mantled with recent deep deposits of windblown sand.

Beneath the resistant dolerite cap which forms the Central Plateau and the cliffs of the upper Great Western Tiers escarpment, lie a suite of older and weaker rocks. Triassic shale and quartzose sandstone overlie Permian sedimentary rocks which are composed predominantly of mudstone and thin beds of sandstone and contain fossiliferous beds over basal gravelly tillite beds. Beneath these rocks are Cambrian and older volcanic and phyllitic rocks. A small area (3 ha) of dolomite has been mapped on the western edge of the survey area (Mathews, 1974).

Isolated areas of Triassic shale and quartzose sandstone are scattered within the lowland. An extensive area of Triassic sandstone occurs on the south-west slopes of Macquarie Tier and Isis Hills.

Low, rolling hills of Tertiary basalt occur in the Campbell Town - Conara area. Basalt also occurs in some valley floors, such as Blanchards Creek, where it was deposited as valley flow lavas.

Weakly consolidated Tertiary clays and sandy clays with sand beds and some quartz gravel layers have been deposited within the Launceston Tertiary Basin. Palynological dating indicates the bulk of the sedimentation occurred in the Eocene. Mathews (1974) interprets an intermittent lacustrine and fluviatile environment of deposition for the sediments based on the presence of lateral lensing of beds and the presence of rounded quartz gravel layers (fluvial) interbedded with thick clay beds (lacustrine). During the late Tertiary and Quaternary the basin sediments been incised by major rivers to produce a sequence of erosion surfaces and drop-off slopes (risers). Locally they are capped by unconsolidated Quaternary deposits of alluvium and aeolian sand.

4.3 Geomorphology

The topography of the area is dominated by the flat to undulating, broad valleys in the north-east, which form a small part of the Launceston Tertiary Basin, and the rugged Great Western Tiers escarpment and Central Plateau in the south-west (Figures 4.2, 6.1 and 6.2). A sequence of major faults and foothills forms the boundary between the two provinces. The Launceston Tertiary Basin, which extends well beyond the survey area (Figure 3.1), is a graben between the Central Plateau and the Ben Lomond Plateau. The basin formed by regional extension and block faulting in the Tertiary (Carey, 1947; Mathews, 1974 and 1983;). The floor of the basin is land of low relief, comprised of relict surfaces, terraces and flood plains. The general elevation of the basin is 150 - 250 metres above sea level.

In the south-west of the survey area the Macquarie Tier, Isis Hills and Jacobs Sugarloaf form rugged foothills below the steep escarpment of the Great Western Tiers and the Central Plateau. In the north-east a low ridge, up to 350 m, of resistant dolerite with a NW-SE trend (Hummocky Hills - Dicks Banks) divides the Launceston Tertiary Basin. Undulating to rolling low hills, with elevations up to 220 m, occur in the Campbell Town area.

The basin sediments which consist of Tertiary clays and sandy clays with beds of rounded quartz gravel, have been incised to form a sequence of river terraces and erosion surfaces.

The oldest and highest surface, Woodstock, lies at an elevation of 170 - 180 m near Hadspen and Prospect rising to 230 - 240 m near Campbell Town and Tunbridge. This surface correlates with Woodstock B described by Nicolls, 1960. Woodstock, named by Stephens *et al.* (1942), has been interpreted as a relict lake floor of Pliocene age overlying lake sediments. Nicolls (1960) raised doubt about the lake theory due to absence of a seaward barrier, but did not propose an origin for the Woodstock Surface. Nicolls (1960) indicated the Woodstock Surface was probably Pliocene age. Mathews (1974) mapped the Woodstock Surface as Quaternary. These ages suggest a 30 million year unconformity between the Woodstock Surface and the underlying sediments. Figure 4.3 shows the surface height for Woodstock plotted against distance up the basin from Hadspen to Tunbridge. Woodstock, as with Brickendon and Brumby is graded to a stream profile and thus probably represents an ancient river terrace (Figure 4.3).

Below Woodstock are the Brickendon Terraces, interpreted as a fluvial landforms with a quartz gravel lag concentrate. The terraces grade with distance up stream from 150 - 160 m at Hadspen to 200 m near 'Vaucluse'. The Brickendon Terraces have been cut across the Tertiary basin sediments and incorporate reworked materials, particularly water-worn quartz gravel which in places can be seen as thick stream channel deposits (4.5 km north of Epping Forest). Nicolls (1960) assigned a Pleistocene age to the Brickendon Terraces. Mathews (1983) suggested that the Brickendon Terraces may pre-date the Woodstock surface based on consideration of drill core evidence of quartz gravel similar to that of the Brickendon Terraces underlying the lateritic materials of the Woodstock Surface. Thus Mathews (1974) mapped the Brickendon Terraces as an exhumed Tertiary surface with quartz gravel deposit. This interpretation is not accepted in the present study as the Brickendon Terraces are clearly graded to the present stream channel (Figure 4.3) and lie beneath the general elevation of the Woodstock Surface which is also graded. Nicolls (1960) suggests the Brickendon soils were laterised during one or more of the interglacial phases of the Quaternary.

Lower river terraces, named Brumby (Nicolls, 1960), are graded to the modern stream and increase in elevation from 140 m at Hadspen to 180 m at 'Vaucluse'. The Brumby Terraces, which are fluvial terraces, are probably related to late Pleistocene climatic fluctuations (Nicolls, 1960). Mathews (1974) has mapped the deposits under the Brumby Terraces as Tertiary clays and sandy clays, but has given no age for the formation of the terraces per se.

The modern flood plain, named Canola (Nicolls, 1960), grades in elevation from 130 m near Hadspen to 180 m at 'Bloomfield'. The Canola flood plain varies from narrow strips on one side of a valley to extensive river flats broken by abandoned river channels. Canola is an active fluvial feature and is prone to annual flooding and stream bank erosion.

Narrow terraces, at 10-15 m above the present flood plain, occur along the Isis River and grade in elevation from 180 m at 'Bicton' to 240 m at 'Auburn'. These terraces correlate with the Brickendon Terraces in the main basin. However, the material comprising the terrace deposits is dominantly Permian boulders derived from the valleys extending up the Tiers escarpment.

Aeolian sands which occur over large areas have been correlated with arid cool conditions of the late glacial (Nicolls, 1958a), being derived from the river valley alluvium and Triassic sandstone exposed within the basin. Kershaw (written comm.) suggests they are less than 10,000 years old. This is confirmed by the weak profile development of the Panshanger soils and their presence on the modern flood plain.

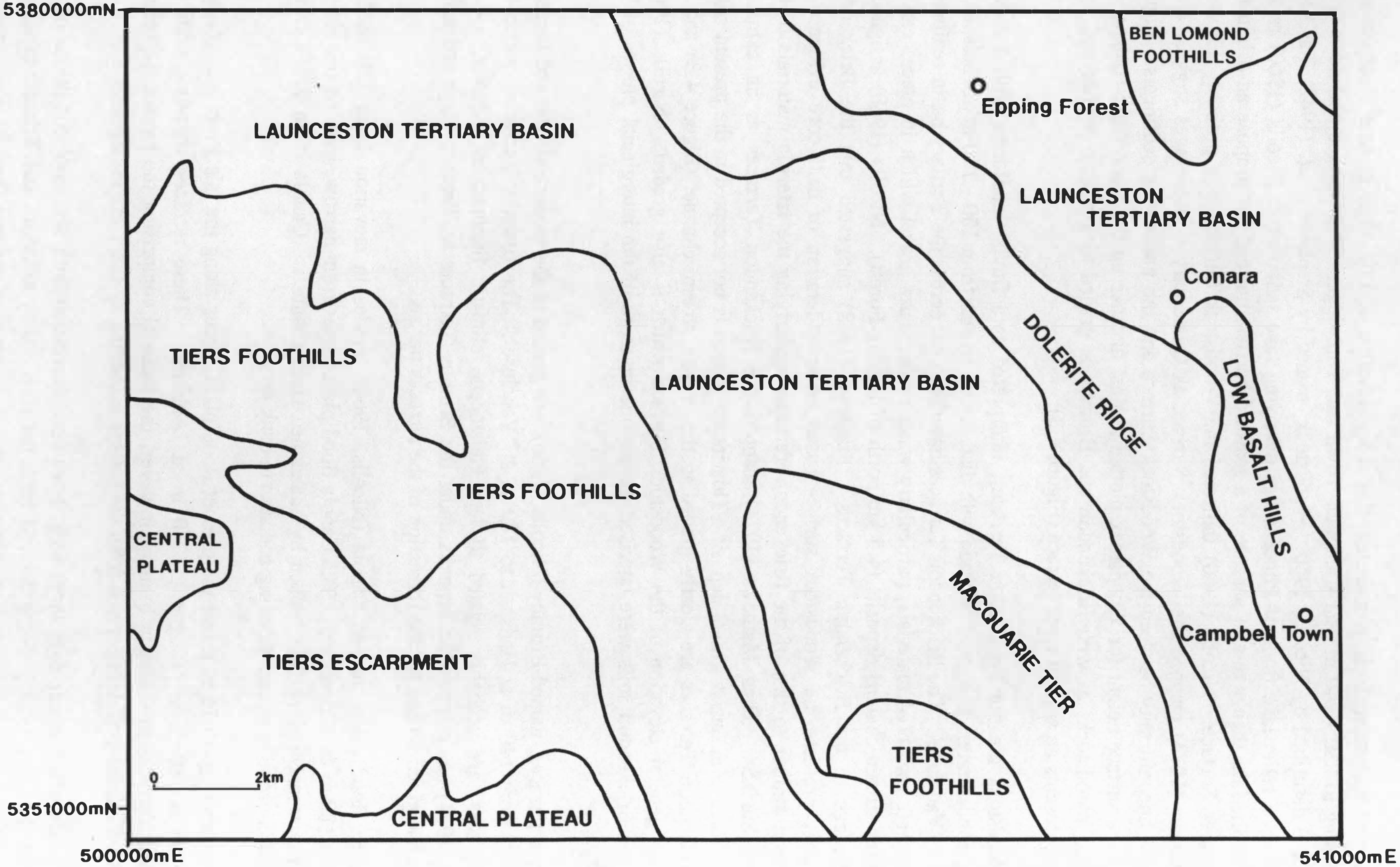


Figure 4.2 General geomorphology of the survey area.

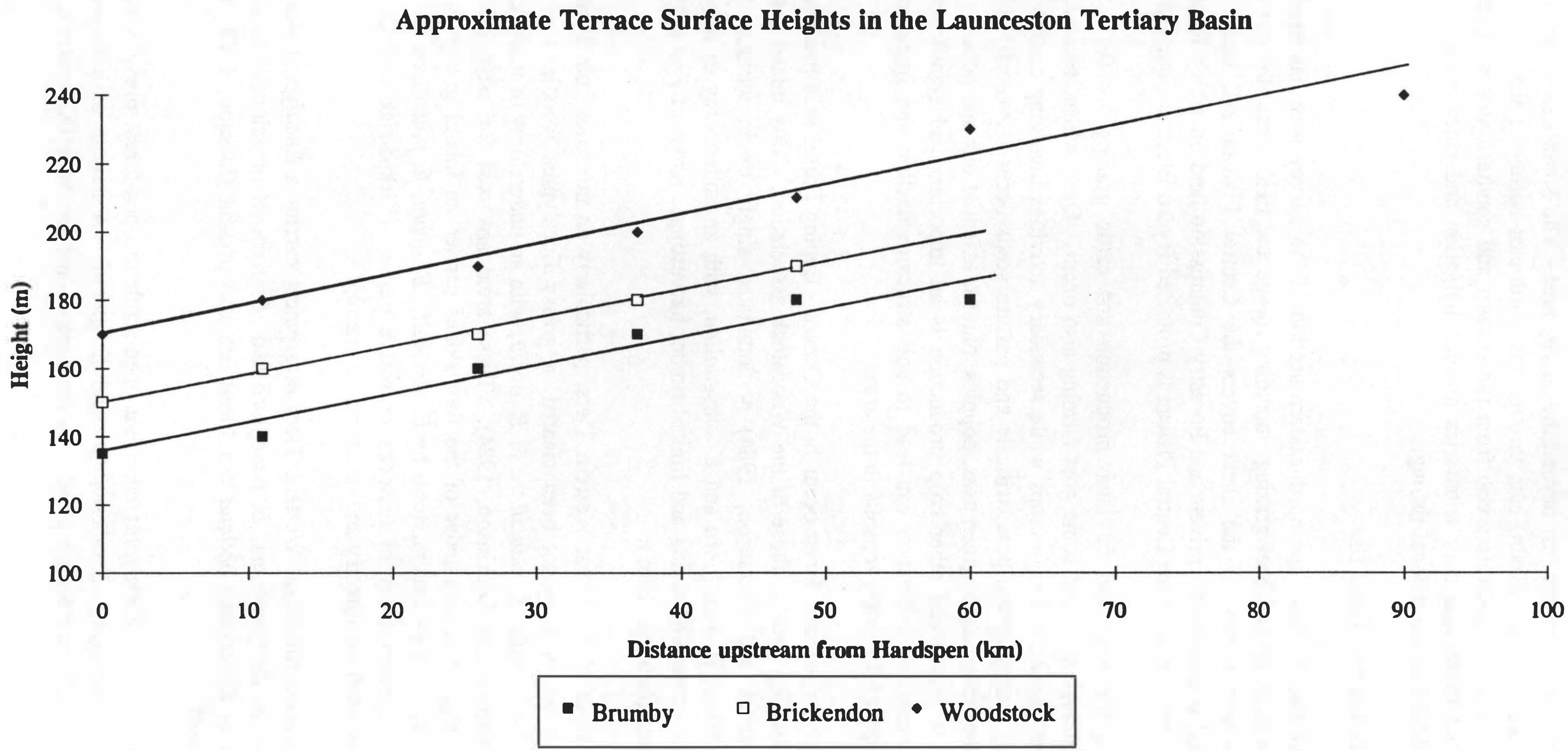


Figure 4.3. Graph showing the heights of surfaces in the Launceston Tertiary Basin plotted against distance upstream from Hadspen. Note all the surfaces including Woodstock are graded to a stream profile. This suggests they are fluvial terraces.

The main rivers draining the survey area are the Macquarie and Lake Rivers, with their headwaters rising from the southern and eastern slopes of the Great Western Tiers. Both rivers drain in a northerly direction and merge just beyond the survey area. The South Esk River, the largest river in the Launceston Tertiary Basin, cuts through the north-east corner of the survey area from the Fingal Valley, and its headwaters rise from the eastern and southern slopes of the Ben Lomond Plateau. These rivers and their tributaries provide irrigation and stock water and are used for power generation and recreational fishing.

4.4 Vegetation and Land Use

Approximately two-thirds of the north-eastern section of the survey area has been developed for agriculture, with sheep and beef grazing, including forage and field crops, the dominant activities. The south-western corner of the sheet covers the Central Plateau and Great Western Tiers escarpment and is dominantly private and Forestry Commission land on which forestry is the main enterprise. A small area of the Central Plateau is protected Hydro Electric Commission land.

Sheep grazing for wool and fat lamb production and cattle grazing are the main agricultural enterprises although deer and some goat farming also occur. Oats, wheat, turnips, field peas and brassicas form important forage crops while secondary activities involving cash cropping of oats, wheat, malting barley, green peas, triticale and pasture seeds occur. Presently and over the last decade increased cropping of green peas, poppies, onions, essential oils and potatoes has developed. The increase in potato and other crop production is an important and significant trend because untimely or excessive cultivation can lead to soil structure decline and increased rates of soil erosion on many of the sandy topsoils in the area.

Isolated pockets of lowland forest occur in the Conara - Epping Forest area predominantly on acid soils of low fertility such as those of the Woodstock association. This inland grassy Eucalyptus forest (Kirkpatrick and Dickinson, 1984) is dominated singly or in various mixtures by *E. viminalis*, *E. ovata*, *E. pauciflora* and *E. amygdalina*, with an understorey of tussocks or pasture and is used for extensive grazing and limited timber harvesting. Areas of *Poa* grassland occur on deep sandy soils (Jackson, 1965).

On the foot slopes of the Great Western Tiers, particularly on the soils from Permian mudstones and sandstones which have not been cleared, a grassy Eucalyptus woodland occurs dominated variously by *E. viminalis*, *E. pauciflora* or *E. ovata*, with an understorey of tussock grass or native pasture (Kirkpatrick and Dickinson, 1984). These areas are used for extensive grazing and/or timber harvesting. The remainder of the foot slopes carries an inland grassy Eucalyptus forest dominated singly or in various mixtures by *E. viminalis*, *E. ovata*, *E. pauciflora* and *E. amygdalina* species, with an understorey of tussocks or native pasture (Kirkpatrick and Dickinson, 1984). These areas are used for forestry and/or extensive grazing.

At higher elevation the Great Western Tiers escarpment carries a *Eucalyptus delegatensis* alpine woodland with *E. dalrympleana*, *E. pauciflora* and *E. rodwayi* occasionally dominating. Some isolated areas of *Eucalyptus obliqua* wet forest are also present (Jackson, 1965; Kirkpatrick and Dickinson, 1984).

On the Central Plateau *Eucalyptus coccifera* open-scrub to open-forest prevails with small areas dominated by *E. urnigera*, *E.subcrenulata* and *E. gunnii*. A mosaic of herbland communities, shrubs, mosses, ferns and sedges develop in depressions and wetlands (Kirkpatrick and Dickinson, 1984).

Much of the Tiers escarpment is utilised for forestry and recreational uses such as deer hunting, four wheel driving, wood collecting and bush walking. Many of the river and streams in the area are used for recreational fishing.

4.5 Land Capability

Land capability is a widely accepted form of land evaluation and classification based on a concept of sustainable land use. A seven class system is used in Tasmania (Noble, 1992).

Land capability assessment takes into account the physical nature of the land ie, topography, geology and soil, as well as factors such as climate, management practice and erosion hazard. All these factors help determine how an area of land may be used without damaging its long-term potential for sustainable agricultural production. The assessment also takes into account limitations that might affect agricultural use eg, stoniness, drainage, salinity or flooding.

Soil is a key factor in the assessment, but, may be overridden by other factors in determining the land capability class eg, climate or slope angle. Soil factors which are important are: depth, field texture, moisture holding capacity, structure, pH, salinity, nutrient status, internal drainage, presence of pans or abrupt changes in clay content and size and abundance of stones or boulders.

In the survey area a range of factors other than soil, are important in determining the agricultural potential of the land. These factors include climate (rainfall, frost, wind, drought), flooding (frequency, duration), slope angle, and erosion hazard.

The soil profile classes defined for the South Esk sheet (southern half), combined with other land factors mentioned have been rated as land capability Classes 4, 5, 6, and 7 (Plate 4.1). There is no Class 1, 2 or 3 land in the survey area.

In Chapter 6 a sub-section on *Land Use and Land Capability* is given for each individual soil profile class. This section outlines the major limiting factors for agricultural use, and indicates the land capability Classes for each soil.

Plate 4.1 View of Brickendon Terrace with Great Western Tiers and foothills in the background showing a range of land capability classes from 4 to 7 (520400E, 5365600N AMG).

5. METHODS

5.1 Field Methods

Soil profile descriptions were made primarily from soil cores extracted using a Proline drilling rig (Plate 5.1) but also from hand auger samples, roadside exposures and soil pits. Soil profile descriptions were made following the procedures defined in the Australian Soil and Land Survey Field Handbook (MacDonald *et al.*, 1990). Soil colours were recorded using the Munsell Soil Colour Charts (Kollmorgan Instruments, 1990). The soil attributes were written onto a soil description card (Appendix 4) in the field and later loaded into the Department of Primary Industry and Fisheries soil database both of which have been developed as part of the project.

Selection of soil description sites was by free survey method (Dent and Young, 1987) ie, soil profiles were described for all representative landforms and parent materials. Soil map units were mapped on stereo pairs of aerial photographs. The map unit boundaries have been based on both geomorphic relationships and geological material changes. Stereoscopic interpretation of 1:42 000 scale black and white photographs was used to delineate many soil boundaries. However, in areas where soil boundaries were related to changes in geology rather than landform, the geologic map boundaries were used.

5.2 Soil Taxonomic Units and Mapping Units

The taxonomic unit used in this survey is the soil profile class which replaces the soil series unit used in earlier Australian and Tasmanian surveys (Gunn *et al.*, 1988). A soil profile class is a group of soils having similar profiles ie, similar horizon sequence, development from similar parent materials and having many similar chemical properties (Gunn *et al.*, 1988). Each soil profile class has been defined on both field descriptions made during field survey, and by correlation with soil series and map unit descriptions recorded in previous work in the region, mainly by CSIRO workers. Many of the soil series names introduced in earlier work have been found relevant in the present work and have been adopted as names of correlated soil profile classes.

Eleven of eighteen soil profile classes were correlated with soil series established in previous soil surveys. Correlation has allowed the retention of the original soil names, although those characteristics more common to this survey are highlighted in the soil profile class descriptions.

The map units in this survey include soil associations, soil complexes, undifferentiated groups and miscellaneous soils (Gunn *et al.*, 1988). Soil associations comprise two or more taxonomic units (soil profile classes or un-named soils) each of which is related to a distinct recognisable landscape feature but which are mapped together due to limitation imposed by map scale. Each component profile class can be recognised in the field and may be separated at a larger scale of mapping. The soil association is named after the dominant soil profile class and is displayed on the map by a two-character symbol eg, Brumby association is represented as Br.

A soil complex consists of two or more soil profile classes which occur in an intricate pattern, or possibly with no apparent pattern associated with their occurrence, and thus cannot be separated without unwarranted effort at conventional scales of mapping. A soil complex is named according to the dominant component soil profile classes eg, Canola-Panshanger, and is displayed on the map by two hyphenated symbols eg, Ca-Ps.

Undifferentiated groups consist of two or more different soil profile classes which have been combined because use and management are the same or similar. For example some feature such as stoniness, steepness or frequency of flooding determines use and management eg, Macquarie+Brickendon, which would be shown on the map as Mq+Bk.

Miscellaneous soils are mapping units which may be readily delineated but for which it has not been possible to define component soil profile classes due to lack of both time and access. They are usually very rocky and/or occur on steep slopes. The miscellaneous units are delineated by use of the letter and number eg, M1 or, if related to a defined soil profile class, three letters eg, MEa (Miscellaneous soils related to Eastfield).

5.3 Analytical Methods

Laboratory analyses have been carried out on 35 selected soil profiles. Previous soil analytical data from CSIRO Division of Soils work in this region have been interpreted, and some results are included in this report. The analysis of soil profiles has been undertaken to determine and characterise soil processes and broadly indicate fertility. Generally only one or two profiles from each soil profile class have been analysed. As a result the discussion and inferences drawn from the data are tentative. It is recommended that land managers undertake regular topsoil analysis to confirm fertiliser or soil conditioner requirements. A rating table of chemical values is provided in Appendix 1 and an extract from 'The Launceston Agricultural District' (Greenhill *et al.*, 1982), which discusses fertilisers needs in the area, is provided in Appendix 2.

Available potassium and phosphorus were measured by the Colwell method (1965), with total phosphorus measured on an ICP following digestion in perchloric nitric acid.

Soil pH and electrical conductivity were measured in a 1:5 soil:water ratio.

Organic carbon was measured using the Walkley and Black method described in Rayment and Higginson (1992). Total nitrogen was measured using an auto analyser following method 7A2 in Rayment and Higginson (1992).

Cation exchange capacity and exchangeable cations (Ca, K, Mg, Na) were measured by ammonium chloride extraction at pH 7.0, (method 15B3 in Rayment and Higginson, 1992).

Clay mineralogy was determined by the Tasmanian Department of Mines using X-ray diffraction, and grain size analysis was carried out by plummet-balance and sieve methods.

Plate 5.1 Soil proline rig used to extract soil cores in operation in the field.

6. SOIL PROFILE CLASSES AND SOIL MAPPING UNITS

6.1 Introduction

In this section the soils are described in terms of the dominant taxonomic units (soil profile classes) and mapping units differentiated during the soil survey.

Each dominant soil profile class is referenced and the diagnostic features are listed. The soils are also described in relation to environmental features ie, drainage class, geology and landform, major morphological features (refer to Appendix 4), chemical properties, and classification. A summary figure shows the soil horizon sequences and thickness range of each horizon. The soil mapping units are described in terms of geographical distribution dominant soil profile classes and inclusions of other soils ie, variants and unrelated soils.

Table 6.1 lists the soil profile classes in relation to geology and landform. The order in which the soil profile classes are described in the text corresponds to Table 6.1. Colour plates of the predominant soil profiles are given in Appendix 5.

Eighteen soil profile classes and four miscellaneous soil units have been defined in the following section. Two idealised cross-sections show the relationship of the soils to landforms and geology (see Figures 6.1 and 6.2).

The main horizon designations such as A1, A2, B2g, etc are described in Appendix 3, and are in accordance with the definitions of MacDonald *et al.* (1990). Soil colour codes used in the text eg, 10YR 5/6, relate to the Munsell Soil Color Charts (Kollmorgan Instruments, 1990), however an English language description of the soil colour code is usually given (Plate 6.1).

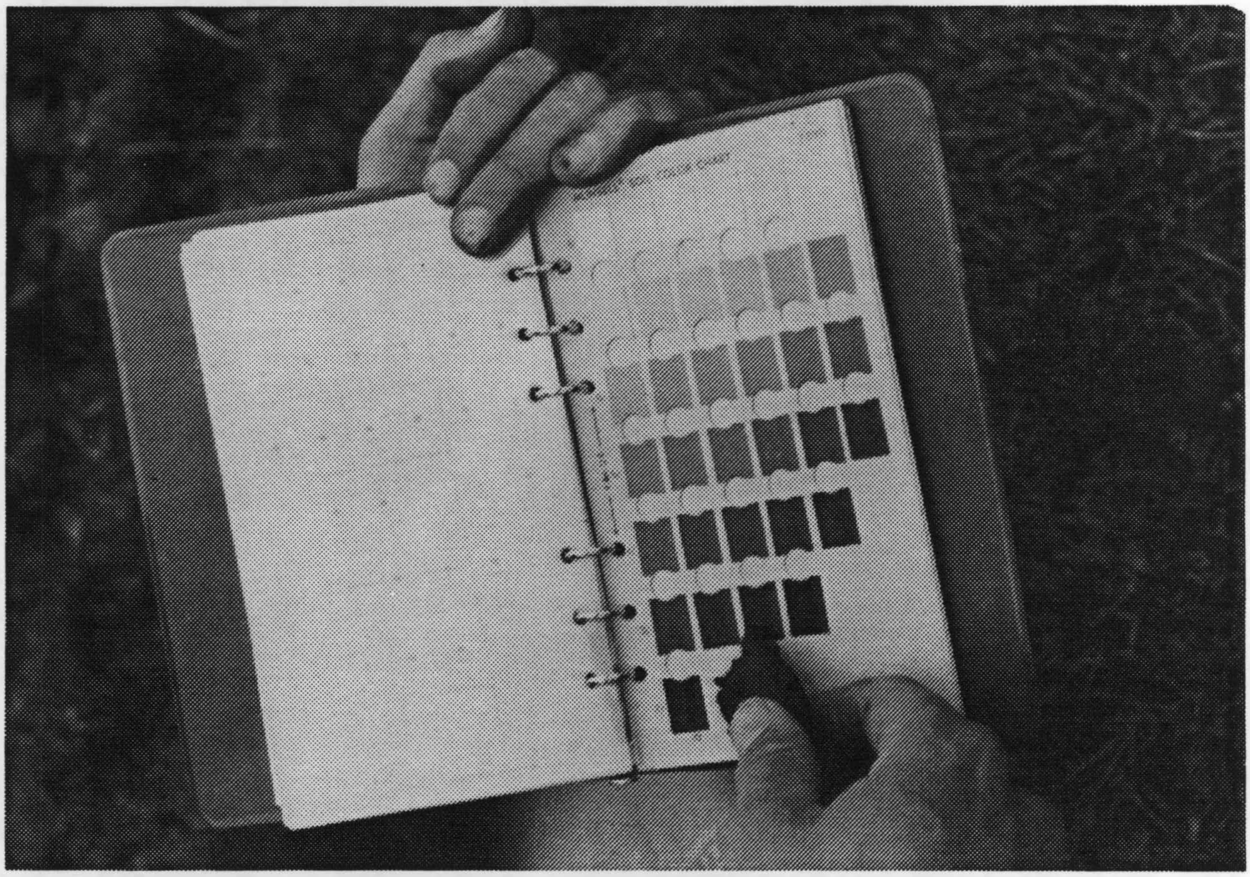
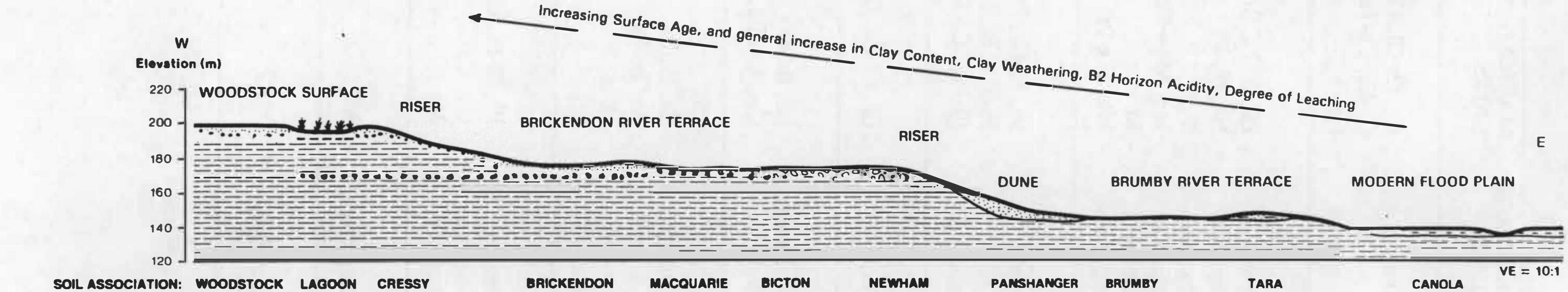


Plate 6.1 Describing soil colour in the field using the Munsell Soil Color Charts.

PROFILE CLASS	LANDFORM TYPE	DRAINAGE CLASS	MAPPING UNITS
Soils on Modern Alluvium			
Canola	Modern flood plain	Poor	Ca, Ca-Gl, Ca-Ps, Ca-Ea, Ca-Ta
Lagoon	Lagoons, mainly on Woodstock surface	Very poor	Lg
Soils on Launceston Tertiary Basin Sediments			
Brumby	Brumby, lower river terraces	Poor	Br, Br-Ps, Br-Ta
Newham	Risers or drop-off slopes	Imperfect	Ne, Ne-Ps
Brickendon	Brickendon river terraces	Imperfect	Bk,
Macquarie	Brickendon river terraces	Imperfect	Mq, Mq+Bk, Mq-Ps
Bicton	Terraces from Permian & older rocks	Imperfect	Bi
Woodstock	Woodstock surface	Imperfect	Wk, Wk-Ps
Soils on Aeolian Deposits			
Panshanger	Sand dunes, lunettes and sand sheets	Rapid	Ps, Ps-Ca, Ps-Mq, Ps-Wk, Ps-Bo, Ps-Ea,
Tara	Small eroded dune remnants	Moderate	(Br-Ta, Ca-Ta)
Soils on Alluvial Fan Deposits			
Glen	Alluvial fans, undulating to rolling	Poor	Gl, Gl-Ca, Gl-Ps
Soils on Basalt			
Breadalbane	Low hills, undulating to rolling	Moderate	Bd, Bd-Ps
Campbell Town	Low hills, undulating crests and shoulders	Well	Cm, Cm-Bd, Cm-Ps
Soils on Dolerite			
Eastfield	Hill slopes, rolling to steep	Imperfect	Ea, Ea-Ps,
Bloomfield	Hill slopes, rolling to steep	Moderate	Bo, Bo-Ps
Un-named Soils	Steep to very steep slopes	Imperfect	MEa
Un-named Soils	Talus slopes, rolling to very steep	Well	M1
Soils on Sandstones, Mudstones and Tillite			
Blessington	Sandstone hills, rolling to steep slopes	Imperfect	Bl, Bl-Ps, Bl-Ca
Quamby	Mudstone hills, rolling to steep slopes	Imperfect	Qu, Qu-Bl
Miller	Tillite hills, rolling to steep slopes	Imperfect	Mi
Soils on Cambrian and Precambrian Volcanics and Phyllites			
Un-named Soils	Tiers foothills, rolling to very steep	Imperfect	M2
Soils on Organic Deposits			
Un-named Soils	Alpine depressions and swamps	Very poor	M3

Table 6.1 Soil profile classes in listed relation to geology and landform.



SOIL ASSOCIATION:	WOODSTOCK	LAGOON	CRESSY	BRICKENDON	MACQUARIE	BICTON	NEWHAM	PANSHANGER	BRUMBY	TARA	CANOLA
CLASSIFICATION:	Ferric Natric Brown Kurosol (Dy,Dr)	Stratic Redoxic Hydrosol (Uf, Gn)	Ferric Mesotrophic Red Chromosol (Dr, Db)	Bleached-Sodic Mesotrophic Brown Chromosol (Db,Dy)	Ferric Subnatric Brown Sodosol (Dy, Db)	Bleached-Mottled Mesotrophic Brown Kurosol (Dy, Db)	Bleached-Sodic Mesotrophic Brown Chromosol (Dy,Db)	Basic Regolithic Orthic Tenosol (Uc)	Bleached-Vertic Solosodic Redoxic Hydrosol (Db,Dy)	Haplic Eutrophic Red Kandosol & Chromosol (Gn,Dr)	Haplic Pedal Black Vertosol (Ug,Gn)
DRAINAGE CLASS:	Imperfect	Very Poor	Moderately Well	Imperfect	Imperfect	Imperfect	Imperfect	Rapid	Poor	Moderately Well	Poor
CLAY CONTENT OF B2:	>80%	>30%	>80%	>75%	>80%	>90%	>75%	<20%	40-60%	25-45%	40-60%
CLAY MINERALS OF B2:	Kaolinite + minor goethite	–	Kaolinite + minor smectite	Kaolinite + minor goethite	–	Kaolinite + minor smectite	Kaolinite + minor goethite	Smectite + kaolinite	Smectite + Kaolinite	Kaolinite + Smectite	Smectite + minor Kaolinite
CEC OF B2:	25-45	10-25	25-30	25-30	35-50	35-45	25-45	<15	25-40	10-30	20-40
BASE SATURATION OF B2:	45-55%	55-80%	5-20%	25-55%	50-70%	25-40%	30-50%	>50%	>70%	>70%	>60%
REACTION TREND:	Acid	Neutral	Acid	Acid	Neutral	Acid	Acid-Neutral	Neutral	Alkaline	Neutral	Alkaline-Neutral
CHROMA OF B2:	10YR - 7.5YR	10YR	10YR - 5YR (not mapped)	7.5YR - 10YR	10YR	10YR	10YR - 2.5Y	7.5YR - 10YR	2.5YR - 10YR	7.5YR	BLACK

GEOLOGICAL KEY

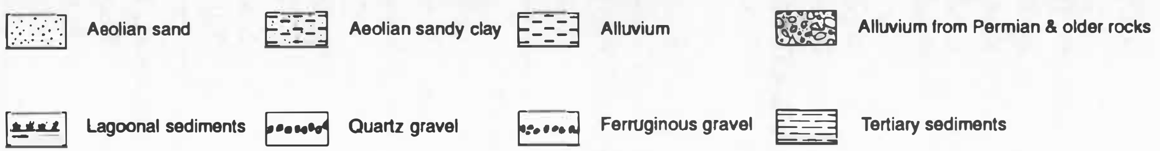


Figure 6.1 Idealised cross-section of the soil occurrence in the Launceston Tertiary Basin.

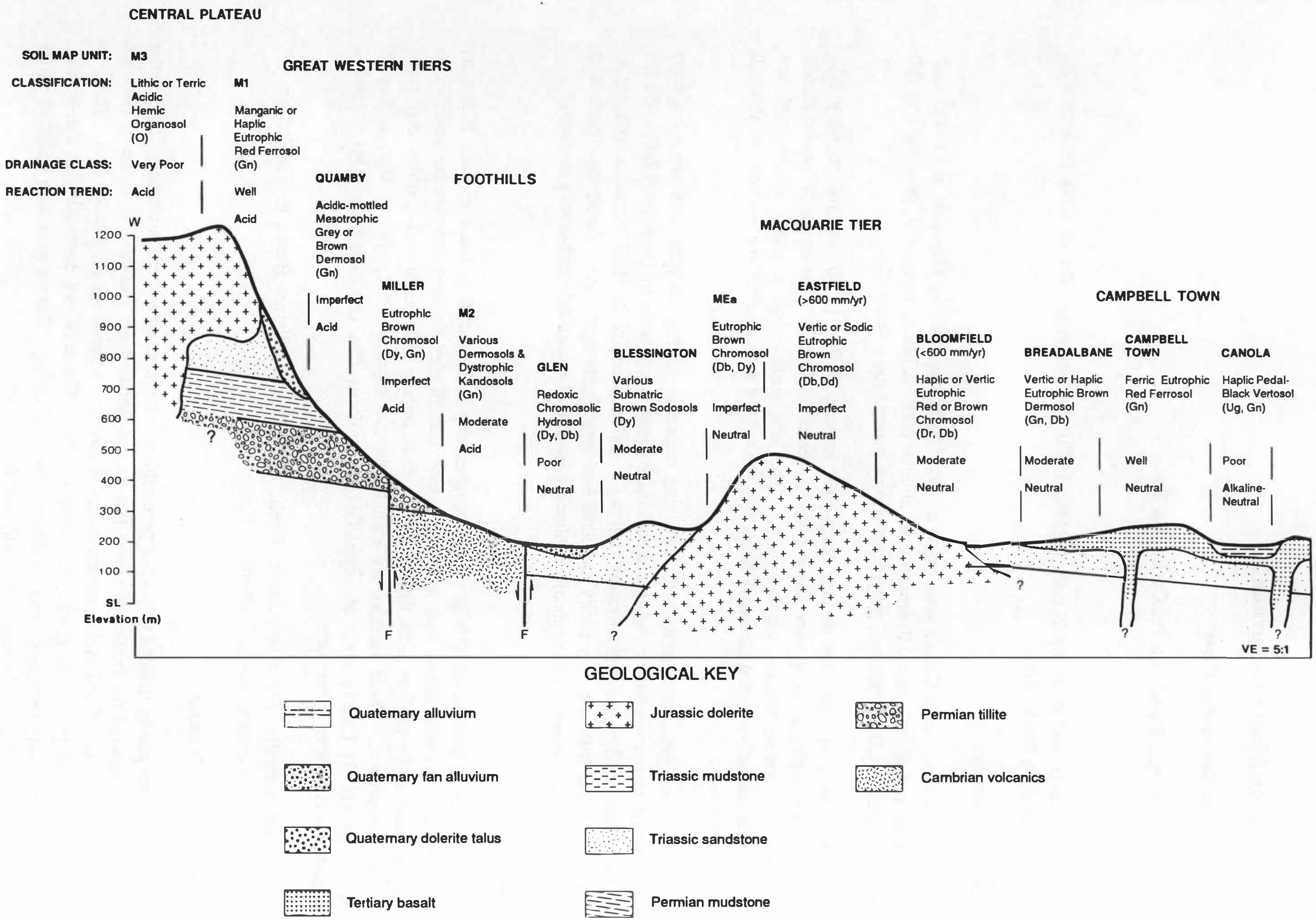


Figure 6.2 Idealised cross-section of soil occurrence between the Great Western Tiers and Campbell Town.

6.2 Soils on Modern Alluvium

6.2.1 Canola Soil Profile Class

Mapping Units Ca, Ca-Gl, Ca-Ps, Ca-Ea, Ca-Ta

Reference

The name Canola was given by Nicolls (1958b, 1959) to a series of alluvial soils of high clay content on modern flood plains.

Diagnostic Features

In the present survey area Canola soils occur as uniform, black, cracking clay soils associated with flood plains, stream valleys and depressions on alluvial fans. A black, structured, swelling clay (60 cm) commonly overlies a mottled, greyish browm or strong brown sandy clay.

The surface soil, of light clay or clay loam field texture, is thin (<10 cm) and strongly self-mulching, developing a strong very fine granular structure on drying. This grades to a more cloddy or medium - coarse blocky, medium clay. The soil surface has a gilgai micro-relief and slickensides (smooth grooved surfaces) develop in the subsoil as a result of the marked shrink-swell nature of the clay.

The topsoils are generally slightly acid, becoming neutral to slightly alkaline with depth and have high organic matter contents. Pedogenic carbonate (lime) is common in the subsoil below 60 cm depth. Many profiles are slightly saline, and the electrical conductivity (EC) increases with depth. When wet these soils are very sticky and have low bearing strength. As a result machinery may become bogged. When dry the subsoils commonly have hard consistence and cracks develop.

Classification

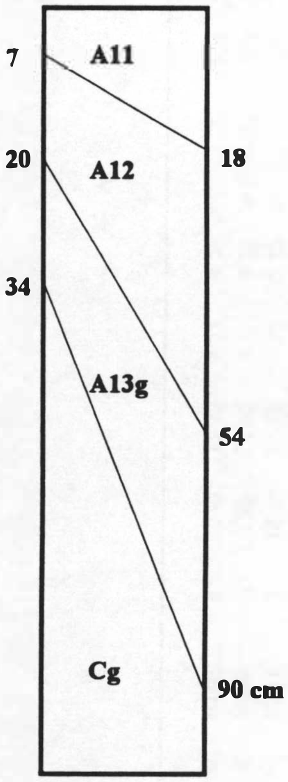
In the system of Stace *et al.* (1968) Canola profiles may be classified as black earths. However, other profiles in wetter areas, such as oxbows, have subsoil gley features and may be classified as wiesenboden while profiles with lighter surface field texture and gradational profiles may trend toward chernozem. These variants are included in the mapping units. In the Factual Key of Northcote (1979) Canola soils are classified as uniform fine cracking soils (Ug), although gradational (Gn) forms also occur.

In the new Australian soil classification (Isbell, 1993) Canola soils are Haplic or Endocalcareous, Pedal or Self-Mulching, Black, Vertosols.

Environmental Features

Canola soils are poorly drained with slow permeability after wetting and crack closure. They occur in the lowest parts of the landscape where run-on and flooding are common in winter. They are associated with river flood plains, stream valley floors and depressions on alluvial fans. The sites are generally flat (<1%) to gently undulating (1-3%). The soils are developing in fine-grained alluvium, commonly receiving yearly additions due to flooding. Canola soils also occur in valley floor positions at higher elevations on gently undulating sites.

Modal Profile - Canola Soil Profile Class



A11; Black (10YR 2/1 ranging to 10YR 3/2); light clay or clay loam; generally no mottles; moderate very fine granular structure plus moderate fine subangular or angular blocky structure; rough ped fabric; firm (moist); generally no stones; field pH 6.0; salinity 0.1 dSm-1; clear or abrupt smooth boundary;

A12; Black to very dark grey (10YR 2/0 - 10YR 3/1); light to heavy clay; may have few grey and strong brown mottles; moderate medium-coarse angular blocky structure with some fine granular peds; smooth ped fabric; very firm (moist); generally on stones, some profiles may have few dolerite stones; field pH 6.5; salinity 0.2 dSm-1; clear to gradual smooth boundary;

A13g; Black to very dark grey (10YR 2/0 - 3/1); medium clay; few-common strong brown (7.5YR 5/6) or dark yellowish brown (10YR 4/6) mottles; moderate medium angular blocky structure or moderate medium lenticular structure; smooth ped fabric; very firm (moist); few manganiferous and/or calcareous nodules; generally no stones, some profiles may have few dolerite stones; field pH 7.2; salinity 0.5 dSm-1; clear boundary;

Cg, C or B2g; Strong brown (7.5YR 4/6 - 10YR 4/4) or greyish brown (2.5Y 4/2); sandy clay or medium clay (variable); common yellowish-brown mottles (10YR 5/8); massive or medium lenticular structure; firm (moist); common slickensides; few calcareous or manganiferous soft segregations; generally no stones, some profiles may have few to common dolerite stones; field pH 7.4; salinity 1.0 dSm-1.

Profile Variation

Profiles may vary due to recent flooding, with deposition of fine sand and silt on the surface of some profiles.

The depth of the black upper profile is generally greater than 50 cm but may range from 30 - 100 cm thickness. In narrow valleys bordered by steep slopes cut in dolerite, stone content generally increases and soil depth decreases.

General Chemical, Physical and Mineralogical Properties

Analytical data for selected profiles are given in Table 6.2. Organic carbon contents are medium to high in all surface horizons and decrease rapidly with depth.

Total nitrogen is variable but medium to high levels occur in the surface horizons decreasing to low, then very low, levels with depth.

Surface pH is slightly acid (5.9 or greater) and increases gradually with depth reaching 8.5 or greater at 75 cm in three of the five analysed profiles.

Available potassium levels are variable and may reflect applied fertiliser, values are generally low to medium in the surface horizons and low to very low beneath.

Soil Profile Class "Property" Grid Reference (AMG)	Profile Number	Horizon	Sample Depth (cm)	pH water (1:5)	EC (d/sm)	Total P (mg/kg)	Avail. P (mg/kg)	Avail. K (mg/kg)	Org. Carb. (%)	Total N (%)	C/N Ratio	Ca	Mg	Na	K	Total Bases	CEC	BASE SAT (%)	ESP (%)	Ca/Mg Ratio
												(milli-equivalents / 100 grams of soil)								
Canola	SP 11	A11	0 - 14	7.4	0.39	524	17	179	8.80	0.725	12	18.59	28.13	4.69	0.52	52.1	52	99	9.0	0.66
"Kelvin Grove"	SP 11	A12(a)	14 - 40	8.7	0.81	230	1	203	2.50	0.207	12	14.27	32.43	9.09	0.55	57.1	63	90	14.3	0.44
540400E	SP 11	A12(b)	40 - 65	9.0	0.87	152	0	168	1.80	0.118	15	16.64	31.98	9.39	0.49	59.4	55	108	17.1	0.52
5377700N	SP 11	A13k	65 - 80	8.9	0.78	123	0	156	0.80	0.066	12	18.46	31.16	6.29	0.51	56.9	47	120	13.3	0.59
	SP 11	A14g	80 - 120	8.7	0.42	164	0	162	0.60	0.048	13	14.14	26.46	3.56	0.59	45.1	42	106	8.4	0.53
	SP 11	C	120 - 130	8.9	0.10	146	0	132	0.20	0.025	8	5.71	10.38	1.31	0.34	17.7	19	93	6.9	0.55
Canola	SP 103	A11	0 - 26	6.3	0.05	175	7	37	2.40	0.174	14	7.82	3.40	0.44	0.16	11.8	18	66	2.5	2.30
"St Johnstone"	SP 103	A12	26 - 36	6.8	0.04	185	2	24	0.40	0.037	11	4.75	3.33	0.47	0.13	8.7	13	68	3.7	1.43
529800E	SP 103	A13g	36 - 53	7.5	0.06	96	2	70	0.50	0.077	6	10.26	11.36	0.89	0.31	22.8	33	70	2.7	0.90
5361300N	SP 103	Cw	53 - 95	8.5	0.08	52	2	50	0.20	0.002	100	5.67	6.07	0.72	0.20	12.7	17	76	4.3	0.93
Canola	SP 104	A11	0 - 13	6.0	0.06	314	17	50	3.40	0.281	12	9.04	4.69	0.47	0.19	14.4	24	61	2.0	1.93
"St Johnstone"	SP 104	A12	13 - 35	6.5	0.05	224	4	34	0.90	0.095	9	6.27	4.15	0.53	0.16	11.1	18	60	2.9	1.51
529400E	SP 104	A31	35 - 50	7.0	0.05	146	2	72	0.50	0.073	7	10.40	9.65	0.70	0.26	21.0	31	68	2.3	1.08
5361500N	SP 104	A32	50 - 55	7.5	0.06	132	0	66	0.20	0.040	5	10.29	10.28	0.97	0.29	21.8	30	73	3.2	1.00
Canola	SP 112	A11	0 - 6	5.9	0.18	265	26	257	7.30	0.569	13	15.00	7.22	0.32	0.53	23.1	32	73	1.0	2.08
"Fosterville"	SP 112	A12	6 - 28	6.4	0.11	102	5	130	2.80	0.242	12	16.09	11.01	0.43	0.33	27.9	37	76	1.2	1.46
535400E	SP 112	A13	28 - 45	6.9	0.09	72	0	88	1.40	0.147	10	18.21	15.05	0.65	0.31	34.2	39	88	1.7	1.21
5354600N	SP 112	A3	45 - 65	7.8	0.08	62	0	74	1.30	0.106	12	22.47	19.27	0.97	0.30	43.0	46	93	2.1	1.17
Canola	SP 115	A11	0 - 10	6.1	0.15	282	23	98	4.30	0.349	12	10.38	7.01	0.93	0.29	18.6	26	73	3.6	1.48
"Fosterville"	SP 115	A12	10 - 27	6.6	0.07	181	8	34	1.90	0.195	10	7.67	6.09	0.88	0.18	14.8	21	70	4.2	1.26
536500E	SP 115	A13g	27 - 46	7.6	0.23	79	2	60	0.90	0.118	8	10.08	16.12	3.39	0.30	30.1	37	82	9.2	0.63
5355200N	SP 115	B2g	46 - 75	7.9	1.12	53	0	53	0.46	0.030	15	7.67	14.12	4.75	0.25	28.1	27	103	17.4	0.54
	SP 115	Cwg	75 - 95	8.7	1.13	52	0	47	0.06	0.007	9	10.62	11.38	4.53	0.20	27.9	22	128	20.8	0.93

Table 6.2 Analytical data for Canola soil profile class.

Soil Profile Class "Property" Grid Reference (AMG)	Profile Number	Horizon	Sample Depth (cm)	Gravel (of total) >2000 (μm) (%)	Sand Coarse >250 (μm) (%)	Sand Fine <250 (μm) (%)	Silt (%)	Clay (%)	Clay Mineralogy Smectite (Approximate weight %)	Clay Mineralogy Kaolinite (Approximate weight %)
Canola	SP 11	A11	0 - 14	0	6	27	21	46	70	30
"Kelvin Grove"	SP 11	A12(a)	14 - 40	0	5	9	11	75	80	20
540400E	SP 11	A12(b)	40 - 65	0	6	10	10	74		
5377700N	SP 11	A13k	65 - 80	11	5	17	13	64	80	20
	SP 11	A14g	80 - 120	0	3	26	15	55	85	15
	SP 11	C	120 - 130	0	10	51	15	24		
Canola	SP 103	A11	0 - 26	0	16	47	14	23		
"St Johnstone"	SP 103	A12	26 - 36	20	35	36	9	21		
529800E	SP 103	A13g	36 - 53	0	19	27	3	52		
5361300N	SP 103	Cw	53 - 95	0	15	55	0	29		
Canola	SP 104	A11	0 - 13	0	29	30	11	30		
"St Johnstone"	SP 104	A12	13 - 35	12	48	25	8	20		
529400E	SP 104	A31	35 - 50	2	34	22	5	39		
5361500N	SP 104	A32	50 - 55	19	30	24	7	39		
Canola	SP 112	A11	0 - 6	2	10	38	21	30		
"Fosterville"	SP 112	A12	6 - 28	11	11	23	17	48	65	35
535400E	SP 112	A13	28 - 45	2	10	19	11	60	70	30
5354600N	SP 112	A3	45 - 65	4	9	15	11	64	70	30
Canola	SP 115	A11	0 - 10	0	4	56	21	19		
"Fosterville"	SP 115	A12	10 - 27	0	5	55	20	20		
536500E	SP 115	A13g	27 - 46	0	2	35	12	51		
5355200N	SP 115	B2g	46 - 75	0	2	45	12	41		
	SP 115	Cwg	75 - 95	2	2	58	13	27		

Table 6.2 Continued.

Total phosphorus values are moderate at the surface and low beneath. Available phosphorus is low in the topsoils and very low beneath, as with most Tasmanian soils.

The cation exchange capacity (CEC) is high throughout the profile, due to high organic matter contents in the surface horizons and increasing clay contents in the subsoil. The level of leaching is low as indicated by base saturation being >60% in all horizons. The exchangeable sodium percentage (ESP = Na/CEC X 100) is variable but is generally less than 6% in the upper profile. In two profiles the ESP is greater than 6 in the subsoil and this suggests that sodicity and dispersion may be a problem in some subsoils.

The mean field salinity values (dSm-1) indicate a possible subsoil salinity problem in many of these soils, however the laboratory data from the five analysed profiles suggest wide variation.

Grain size analyses indicate these soils have a clay bulge at 30-80 cm. Topsoils have a clay loam to light clay field texture with 20-30% clay, but beneath the topsoil clay content increases to medium or heavy clay (30-50% clay). The clay content then decreases in the lower horizons.

Smectite, a swelling clay, is dominant throughout the profile (70%-85%) with minor kaolin (15-30%). Generally smectite abundance increases, and kaolin decreases with depth. This tentatively suggests smectite is stable in these soils and that kaolin clays may be derived from more recent flood events.

Soil Mapping Units

Canola association soils occur mainly on the modern flood plains of the Lake, Isis, Macquarie, South Esk and Elizabeth Rivers. However, they also occur in depressions on fan surfaces and valley floor deposits within stepper terrain. Areas mapped as Canola association (Ca) are strongly dominated by Canola soils but may contain small areas of other soils such as Panshanger on sand dunes, or Glen on alluvial fans, or Brumby on areas on lower river terraces.

Also it is not always possible to map areas dominated by Canola seperately from other dominant soils. For example very complex areas which include Canola with Panshanger on sand dunes (Ca-Ps) or Tara soils on low rises (Ca-Ta) have been mapped as complexes and both soils are co-dominant. Other complexes include Canola soils with Eastfield (Ca-Ea) and Glen soils (Ca-Gl).

Land Use and Capability Class

The Canola soils have self-mulching topsoils of high natural productivity, although low in available phosphorus and potassium. They would be suitable for direct drill techniques. However, the relatively coarse granular nature of the soil may inhibit the germination of small-seeded crops such as poppies. The nature of the clay type and its high content in these soils can result in low bearing strength and poor trafficability when wet and make deeper cultivation slow and difficult when very dry. Crops such as peas, oats and onions produce good yields on Canola soils, while pastures have greater drought tolerance due to higher moisture retention than many of the sandier surface soils in the region.

Canola soils commonly suffer surface flooding in winter and are of slow permeability once wetted. Some of these soils also suffer surface salinity and many have moderate subsoil salinity. This is mainly due to their low elevation in the landscape ie, saline run-on or through-flow may be occurring, but subsoil salinity may also be related to saline ground water at shallow depth.

The majority of the land on which Canola soils are dominant is Class 4, but, closer to streams or rivers, or in depressions or oxbows where the frequency of flooding is higher Canola soils may be mapped as Classes 5 or 6. The major limitations affecting their potential for agricultural use are flood risk, slow internal drainage and the short available working window between the soils being too dry and too wet for cultivation. In areas adjacent to stream and rivers, stream bank erosion may be problem.

6.2.2 Lagoon Soil Profile Class

Mapping Unit Lg

Reference

Lagoon soils are defined provisionally in this survey. They are Hydrosols which form on lagoonal deposits occurring on the Woodstock surface.

Diagnostic Features

Lagoon soils have a black, humic clay loam topsoil over stratified, strongly mottled clay to clay loam subsoils. Permeability is very slow and profiles commonly lie wet for much of the winter and early spring. A deep core was taken from Smiths Lagoon near Cleveland and other brief soil descriptions were made from auger borings. Due to this fact a profile description rather than a modal profile has been included below.

Classification

The Lagoon soils are classified as humic gley in the system of Stace *et al.* (1968) and as non calcareous gradational soils (Gn) or uniform fine soils (Uf) in the system of Northcote (1979).

In the new Australian soil classification system (Isbell, 1993) these soils are Eutrophic or Humose, Stratic, Redoxic Hydrosols.

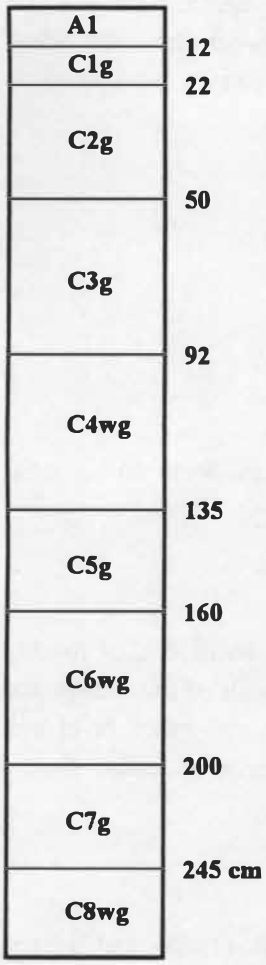
Environmental Features

Several large (1-2 km diameter) lagoons have formed on the Woodstock surface near Cleveland, Conara and in the Isis River valley. These landforms are interpreted as blow out structures, the lagoons being a result of deflation of former Woodstock soils (Mathews, in prep). Down wind from the lagoons Panshanger soils are associated with lunettes and sand banks. The soils are very poorly drained and subject to winter flooding. Rushes and sedges are the dominant vegetation.

Profile Description

Soil profile 27	Smiths Lagoon, Cleveland, Midland Highway
Drainage:	Very poorly drained
Grid Reference:	535000 E 5371000 N AMG
Classification:	Eutrophic, Stratic, Redoxic Hydrosol
Landform:	Lagoon on Woodstock Surface
Vegetation:	Rushes and sedges

Soil Profile Description - SP27



A1; Black (10YR 2/1); humic heavy clay loam; weak fine-medium subangular blocky structure; earthy fabric; few live roots; field pH 6.2; 0.1 dSm-1; abrupt irregular boundary;

C1g; Grey (10YR 6/1 moist); light clay; massive; earthy fabric; firm (moist); few live roots; field pH 6.5; 0.1 dSm-1; clear irregular boundary;

C2g; Strong brown (7.5YR 5/8); many medium prominent grey (7.5YR 5/0) and dark grey (7.5YR 4/0) mottles; medium clay; weak medium angular blocky to massive structure; earthy fabric; firm (moist); common clay skins; few live roots; field pH 7.3; 0.05 dSm-1; clear smooth boundary;

C3g; Light grey (10YR 7/1); few strong brown (7.5YR 5/6) mottles; sandy clay loam; massive; sandy fabric; weak (moist); no live roots; field pH 7.6; 0 dSm-1; diffuse boundary;

C4wg Olive yellow (2.5Y 6/8); many very coarse prominent light grey (10YR 7/1) mottles; sandy light clay; massive; sandy fabric; weak (moist); no live roots; field pH 7.6; 0 dSm-1; gradual smooth boundary;

C5g; Light grey (10YR 7/1); few medium distinct yellowish brown (10YR 5/8) and very dark greyish brown (10YR 3/2) mottles; heavy sandy loam; massive; sandy fabric; weak (moist); no live roots; field pH 7.7; 0 dSm-1; gradual smooth boundary;

C6wg; Brownish yellow (10YR 6/8); common coarse prominent light grey (10YR 7/1) mottles; heavy silty clay loam; massive; earthy fabric; no live roots; field pH 7.7; 0 dSm-1;

C7g; Very pale brown (10YR 7/4); common medium distinct yellowish brown (10YR 5/8) mottles; fine sandy clay loam; massive; sandy fabric; no live roots; field pH 7.8; 0 dSm-1;

C8wg; Brownish yellow (10YR 6/8 moist); common medium distinct light grey (10YR 7/1) mottles; light clay; massive; field pH 7.8; 0.1 dSm-1.

Profile Variation

Topsoils may vary in thickness from 10 to 20 cm and range from peaty clay loams to humic loams. The grey coloured subsoils may have common orange mottling along root channels and textures include medium and heavy clays.

General Chemical, Physical and Mineralogical Properties

Laboratory measured soil pH increases gradually with depth from 6.2 in the humic surface horizon to 8.2 at 245 cm (see Table 6.3). The lower surface pH is probably due to the accumulation of organic matter which is in medium amounts (3.2% organic carbon).

The total nitrogen values are medium in the surface and low to very low in the subsoil. They are probably a reflection of the levels of organic matter.

Total phosphorus is low in the upper profile and very low below 50 cm depth. Measurable values of available phosphorus were not detected in the profile.

Soil Profile Class "Property" Grid Reference (AMG)	Profile Number	Horizon	Sample Depth (cm)	pH water (1:5)	EC (d/sm)	Total P (mg/kg)	Avail. P (mg/kg)	Avail. K (mg/kg)	Org. Carb. (%)	Total N (%)	C/N Ratio	Ca (milli-equivalents / 100 grams of soil)	Mg	Na	K	Total Bases	CEC	BASE SAT (%)	ESP (%)	Ca/Mg Ratio
Lagoon	SP 27	A1	0 - 12	6.2	0.14	80	0	794	3.20	0.343	9	8.49	5.12	1.20	2.55	17.3	24	71	4.9	1.66
"Vaucluse "	SP 27	C1g	12 - 22	6.6	0.10	55	0	658	1.40	0.147	10	6.72	5.32	1.06	2.13	15.2	20	75	5.2	1.26
535000E	SP 27	C2g	22 - 50	7.5	0.08	55	0	806	0.20	0.045	4	7.84	7.84	1.24	2.74	19.7	24	81	5.1	1.00
5371000N	SP 27	C3g	50 - 92	7.8	0.04	22	0	200	0.00	0.017	0	2.46	2.62	0.41	0.46	5.9	10	60	4.2	0.94
	SP 27	C4g	92 - 135	8.1	0.04	22	0	219	0.00	0.015	0	3.43	3.77	0.56	0.44	8.2	15	56	3.8	0.91
	SP 27	C5g	135 - 160	8.0	0.04	22	0	219	0.00	0.013	0	2.74	3.03	0.53	0.51	6.8	11	62	4.9	0.90
	SP 27	C6wg	160 - 200	8.1	0.04	28	0	238	0.00	0.015	0	4.57	5.02	0.84	0.48	10.9	18	62	4.8	0.91
	SP 27	C7g	200 - 225	8.2	0.03	23	0	238	0.00	0.015	0	4.38	4.82	0.86	0.55	10.6	17	64	5.2	0.91
	SP 27	C8wg	225 - 245	8.2	0.04	29	0	226	0.00	0.015	0	3.69	3.91	0.81	0.41	8.8	19	46	4.2	0.94

Soil Profile Class "Property" Grid Reference (AMG)	Profile Number	Horizon	Sample Depth (cm)	Gravel (of total) >2000 (μm) (%)	Sand Coarse >250 (μm) (%)	Sand Fine <250 (μm) (%)	Silt (%)	Clay (%)
Lagoon	SP 27	A1	0 - 12	0	1	21	20	58
"Vaucluse "	SP 27	C1g	12 - 22	0	1	23	16	60
535000E	SP 27	C2g	22 - 50	0	0	8	5	87
5371000N	SP 27	C3g	50 - 92	0	8	55	8	30
	SP 27	C4g	92 - 135	0	1	49	12	38
	SP 27	C5g	135 - 160	0	0	59	10	31
	SP 27	C6wg	160 - 200	0	0	38	20	42
	SP 27	C7g	200 - 225	0	0	48	17	35
	SP 27	C8wg	225 - 245	0	0	36	19	45

Table 6.3 Analytical data for Lagoon soil profile class.

Available potassium levels are very high in the upper 50 cm and medium in the subsoil. This is difficult to explain but may relate to fire history.

CEC is medium to high in the upper 50 cm and low in the lower profile. The high CEC values in the upper profile reflect higher clay and organic carbon contents.

The profile is non saline with electrical conductivity values being only 0.14 dSm-1 at the surface and decreases with depth to 0.04 dSm-1 at 2 m.

The grain size data fluctuate with depth, but generally the upper 50 cm of the profile has a higher clay content (between 60-90%) than the lower profile (30-45%). The lower profile has a higher fine sand content (36-55%).

Soil Mapping Units

Lagoon soils have been mapped as the Lagoon soil association (Lg). Other minor soils which occur in the mapping unit are Canola soils in drainage lines (Plate 6.2).

Land Use and Capability Class

The lagoons are used for grazing when dry. In wet periods they commonly fill with water due to the internal site drainage pattern and slow permeability of the soils. The lagoons form important bird and wildlife habitats.

The land with which Lagoon soils are associated is placed in capability Class 6. They are unsuitable for cropping because they fill regularly with water during wet periods and are very poorly drained.

Plate 6.2 View of Smiths Lagoon near Cleveland.

6.3 Soils on Launceston Tertiary Basin Sediments

6.3.1 Brumby Soil Profile Class

Mapping Units Br, Br-Ps, Br-Ta

Reference

The name Brumby was given by Nicolls (1958b) to a series of soils on river terraces adjacent to Brumbys Creek in the Cressy-Longford area.

Diagnostic Features

Brumby soils are duplex profiles which develop on low river terraces. They have fine sandy surface horizons, to about 30 cm depth, which abruptly overlie tough, medium-heavy clay subsoils.

Commonly the A2 and upper B2 horizons are mottled. This indicates that water tables are perched for periods during winter above the clay B2 horizons. The subsoils appear massive when wet but exhibit coarse prismatic or blocky structure when dry (Plate 6.3).

The profiles have an alkaline reaction trend, ie, slightly acid topsoils overlie neutral upper B2 horizons which grade to alkaline lower subsoils.

Many Brumby profiles have slight subsoil salinity. A few have surface salinity problems. Pedogenic carbonate (lime) occurs in the subsoils of some profiles.

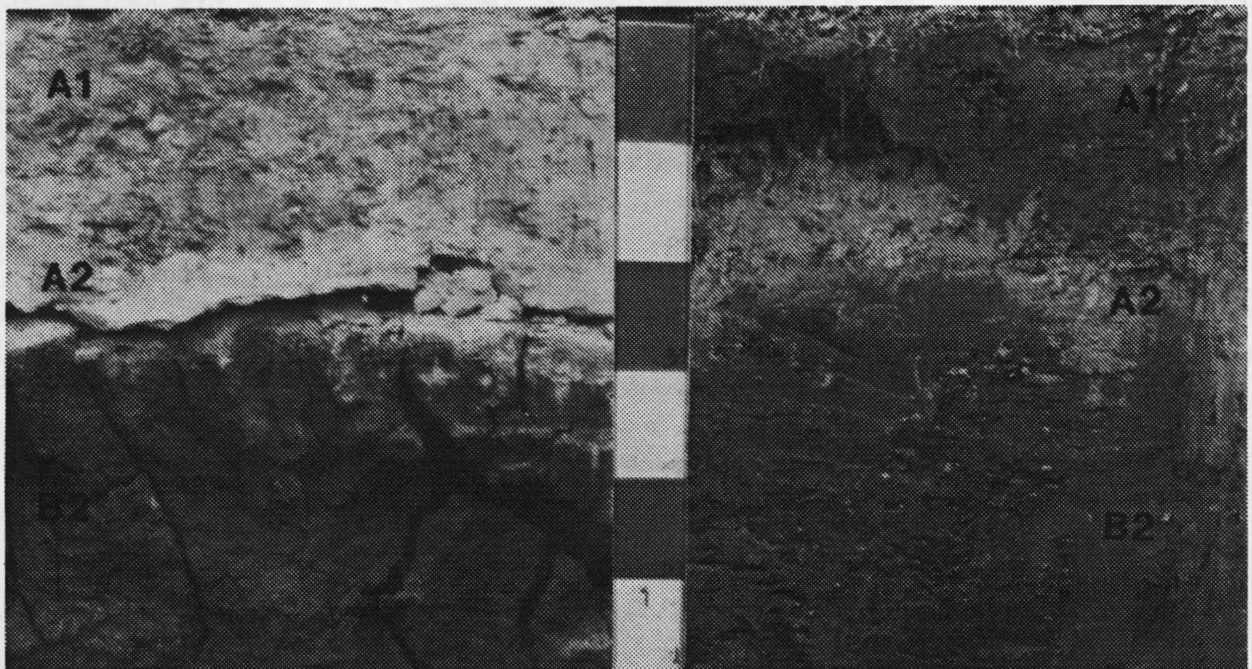


Plate 6.3 Brumby soil structure dry (left) and wet (right); note the prismatic structure when dry and essentially massive structure moist. The bleached A2 horizon is hard setting when dry and becomes a structureless slurry when wet.

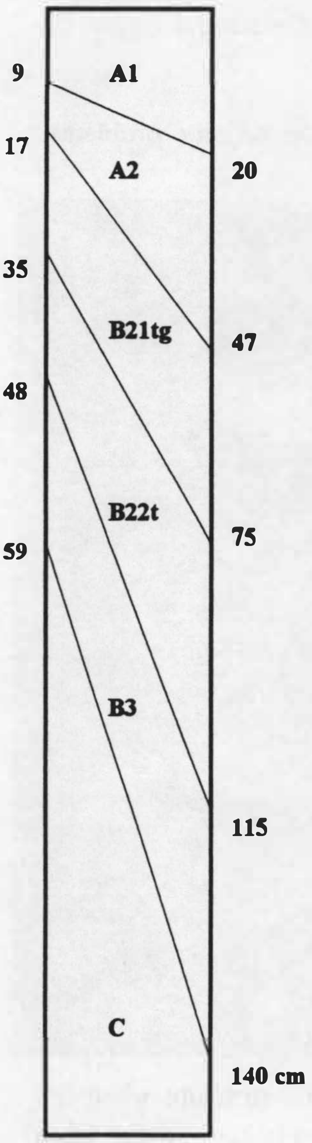
Classification

Brumby soils classify as solodized solonetz in the system of Stace *et al.* (1968) and as yellow and brown duplex soils (Dy, Db) in the Northcote system (1979). In the new Australian classification (Isbell, 1993) they are Bleached-Vertic, Sodosolic or Chromosolic, Redoxic Hydrosols, however, profiles benefiting form lateral drainage classify as Vertic, Mottled-Subnatric, Brown Sodosols.

Environmental Features

Brumby soils are poorly drained and form on flat to gently undulating (0-3%) alluvial river terraces 3-6 m above the present flood plain. The elevation of the Brumby terraces increases from 140 to 180 m with distance upstrean (Figure 4.3). Problems of slow run-off and slow permeability result in surface flooding in winter at many sites. Brumby soils have formed in fine textured Quaternary alluvium above Tertiary clay deposits at depth. Topsoils may contain an aeolian sand component. In some profiles scattered rounded dolerite stones are present both at the surface and in the soil profile. The annual rainfall is between 500 and 700 mm.

Modal Profile - Brumby Soil Profile Class



A1; Very dark greyish brown (10YR 3/2 - 10YR 4/2); few yellowish brown (10YR 5/6) mottles; loam or sandy loam; weak fine to medium subangular blocky structure; sandy to earthy fabric; very weak (dry); pH 5.5 ; salinity 0.1 dSm-1; clear smooth boundary;

A2; Greyish brown to light brownish grey (10YR 5/2 - 10YR 6/2); few to common yellowish brown or strong brown primary mottles (10YR 4/6 - 5/8); fine sandy loam or loamy fine sand; single grained or weak medium angular blocky structure; sandy fabric; weak (dry); some with few ferruginous nodules; a few fine profiles contain a few sub-rounded quartz gravel; field pH 6.0; salinity 0.0 dSm-1; abrupt wavy boundary;

B21tg; Light olive brown to brown (2.5Y 4/3 - 2.5Y 5/3 - 10YR 4/3); common yellowish brown to yellowish red or red medium mottles (10YR 5/6 - 5/8 to 7.5YR 4/6) and common very dark brown mottles (10YR 3/2); medium clay; massive (moist), moderately coarse prismatic structure (dry); rough to smooth ped fabric; very firm to strong (dry) in few profiles very few fine manganiferous segregations; some with very few fine sub-rounded quartz gravel; field pH 7.0; salinity 0.1 dSm-1; gradual smooth boundary;

B22t; Olive brown (2.5Y 4/3 - 2.5Y 5/3); common yellowish brown to red mottles (10YR 5/6 to 5YR 4/6); heavy clay to medium clay; massive (moist) with moderately very coarse blocky structure (dry); earthy or rough ped fabric; strong (dry); in some profiles few fine manganiferous soft segregations; field pH 7.5; salinity 0.2 dSm-1; gradual smooth boundary;

B3 or **B23t**; Light olive brown (2.5Y 5/4 - 5Y 5/3) common yellowish brown and grey mottles (10YR 5/6 and 10YR 7/1); heavy clay; massive may part to weak coarse blocky structure; earthy fabric; field pH 8.0; 0.5 dSm-1;

C; Massive; clay to sandy clay; field pH 8.0; salinity 0.2 dSm-1;

Soil Profile Class "Property" Grid Reference (AMG)	Profile Number	Horizon	Sample Depth (cm)	pH water (1:5)	EC (d/sm)	Total P (mg/kg)	Avail. P (mg/kg)	Avail. K (mg/kg)	Org. Carb. (%)	Total N (%)	C/N Ratio	Ca	Mg	Na	K	Total Bases	CEC	BASE SAT (%)	ESP (%)	Ca/Mg Ratio
												(milli-equivalents / 100 grams of soil)								
Brumby	SP 39	A1	0 - 20	5.1	0.19	223	20	60	3.30	0.296	11	4.86	2.64	0.39	0.29	8.2	12	70	3.3	1.84
"Leverington"	SP 39	A2	20 - 26	5.9	0.05	83	8	33	0.70	0.069	10	1.95	2.80	0.46	0.20	5.4	8	69	5.9	0.70
521400E	SP 39	B21tg	26 - 32	6.3	0.13	68	1	95	1.10	0.117	9	5.72	14.90	1.76	0.46	22.8	26	88	6.7	0.38
5374100N	SP 39	B22tg	32 - 53	7.3	0.18	71	0	123	1.00	0.111	9	8.49	24.34	3.10	0.60	36.5	36	102	8.7	0.35
	SP 39	B23tg	53 - 82	8.6	0.54	62	0	130	0.30	0.045	7	8.45	31.02	6.13	0.66	46.7	37	127	16.6	0.27
	SP 39	B24t	82 - 165	8.9	0.66	38	0	74	0.20	0.016	13	6.53	21.74	6.19	0.43	35.5	30	119	20.8	0.30
Brumby	SP 63	A1	0 - 18	5.7	0.04	239	9	44	1.80	0.161	11	3.60	1.27	0.27	0.27	5.4	7	78	3.8	2.82
"Formosa"	SP 63	A2	18 - 25	6.5	0.02	71	0	21	0.40	0.036	11	1.45	0.71	0.19	0.21	2.6	4	73	5.4	2.04
507700E	SP 63	B21t	25 - 60	7.3	0.08	125	0	91	0.80	0.079	10	8.72	11.85	1.34	0.41	22.5	35	65	3.9	0.74
5376700N	SP 63	B22t	60 - 70	8.1	0.30	95	0	85	0.60	0.036	17	10.76	16.51	3.43	0.46	27.7	36	77	9.5	0.65
Brumby	SP 66	A1	0 - 20	5.0	0.17	328	35	104	2.30	0.140	16	1.73	0.44	0.11	0.34	2.6	6	44	1.9	3.88
"Cressy Station"	SP 66	A2	20 - 32	6.0	0.07	152	9	55	0.60	0.060	10	1.10	0.28	0.07	0.16	1.6	3	63	2.7	3.89
506300E	SP 66	B21tg	32 - 50	6.2	0.07	270	4	109	0.60	0.090	7	9.83	11.53	1.23	0.61	23.2	20	119	6.3	0.85
5379200N	SP 66	B22tg	50 - 80	6.5	0.06	196	2	88	1.50	0.070	21	6.38	11.26	1.58	0.42	19.6	19	105	8.5	0.57
	SP 66	Cg	90 - 95	7.9	0.12	92	0	98	0.80	0.050	16	7.21	14.96	3.88	0.41	26.5	19	142	20.9	0.48
Brumby	SP 89	A1	0 - 10	5.3	0.13	179	8	107	1.50	0.161	9	2.69	0.81	0.28	0.29	4.1	8	51	3.5	3.33
"Connorville"	SP 89	A2	10 - 36	6.8	0.03	139	3	43	0.12	0.031	4	2.96	1.63	0.39	0.20	5.2	8	61	4.6	1.82
507700E	SP 89	B21tg	36 - 50	8.2	0.09	86	3	64	0.12	0.049	2	4.25	13.54	3.17	0.26	21.2	30	72	10.7	0.31
5371400N	SP 89	B22t	50 - 70	8.9	0.16	64	2	71	0.00	0.028	0	5.69	20.25	6.03	0.37	32.4	36	91	16.9	0.28
	SP 89	B3g	70 - 90	9.6	0.40	52	6	71	0.00	0.014	0	5.23	18.22	7.35	0.34	31.2	24	128	30.1	0.29
Brumby	SP 113	A1	0 - 15	5.6	0.06	302	90	143	2.75	0.228	12	6.04	4.15	0.39	0.24	10.8	13	83	3.0	1.45
"Fosterville"	SP 113	A2	15 - 31	6.3	0.06	156	46	64	1.00	0.077	13	4.77	7.82	0.87	0.24	13.7	15	89	5.7	0.61
536100E	SP 113	B21tg	31 - 45	7.2	0.13	114	12	179	0.75	0.085	9	7.96	25.93	3.04	0.58	37.7	37	102	8.2	0.31
5354800N	SP 113	B22t	45 - 75	8.2	0.27	90	6	179	0.25	0.028	9	5.98	28.06	4.36	0.55	39.4	36	110	12.2	0.21
	SP 113	B3k	75 - 95	9.4	0.66	48	3	164	0.00	0.013	0	13.71	30.20	7.62	0.46	52.0	37	141	20.7	0.45

Table 6.4 Analytical data for Brumby soil profile class.

Soil Profile Class "Property" Grid Reference (AMG)	Profile Number	Horizon	Sample Depth (cm)	Gravel (of total) >2000 (µm) (%)	Sand Coarse >250 (µm) (%)	Sand Fine <250 (µm) (%)	Silt (%)	Clay (%)	Clay Mineralogy (Approximate weight %) Smectite	Kaolinite	Illite	Goethite
Brumby	SP 39	A1	0 - 20	14	5	60	18	17				
"Leverington"	SP 39	A2	20 - 26	13	9	55	18	18				
521400E	SP 39	B21tg	26 - 32	11	4	27	12	58				
5374100N	SP 39	B22tg	32 - 53	11	3	20	9	67				
	SP 39	B23tg	53 - 82	7	2	17	8	73				
	SP 39	B24t	82 - 165	8	6	44	8	42				
Brumby	SP 63	A1	0 - 18	2	6	55	22	17	15	85		
"Formosa"	SP 63	A2	18 - 25	2	8	53	26	12	5	90	5	
507700E	SP 63	B21t	25 - 60	0	3	21	9	67	20	75		5
5376700N	SP 63	B22t	60 - 70	0	2	19	13	66	35	55		10
Brumby	SP 66	A1	0 - 20	2	6	72	6	17				
"Cressy Station"	SP 66	A2	20 - 32	10	13	64	15	8				
506300E	SP 66	B21tg	32 - 50	2	6	34	6	55				
5379200N	SP 66	B22tg	50 - 80	0	5	40	5	49				
	SP 66	Cg	80 - 95	0	5	46	9	41				
Brumby	SP 89	A1	0 - 10	50	6	41	39	14				
"Connorville"	SP 89	A2	10 - 36	27	21	32	33	14				
507700E	SP 89	B21tg	36 - 50	2	5	16	22	57				
5371400N	SP 89	B22t	50 - 70	1	1	14	41	44				
	SP 89	B3g	70 - 90	0	1	28	11	59				
Brumby	SP 113	A1	0 - 15	0	3	52	23	23				
"Fosterville"	SP 113	A2	15 - 31	0	3	46	23	28	75	25		
536100E	SP 113	B21tg	31 - 45	0	1	24	14	61	75	25		
5354800N	SP 113	B22t	45 - 75	0	2	29	12	57	70	30		
	SP 113	B3k	75 - 95	0	1	28	14	56	80	20		

Table 6.4 Continued.

Profile Variation

About 30% of profiles have few or very few calcareous nodules in the lower B2 and B3 horizons. Topsoil and A2 field textures range from sandy loam to silt loam. Topsoil thickness varies depending on the depth of windblown sand which has accumulated on the soil surface. Variant Brumby soils with thicker sandy surface horizons (50-60 cm) are not uncommon, and are transitional to Panshanger soils.

Some profiles may contain small amounts of ferruginous gravel and/or quartz gravel derived by erosion of soil materials higher in the landscape.

General chemical, physical and mineralogical properties

Analytical data for five profiles are given in Table 6.4. Low to medium organic carbon contents in the A1 drop sharply to very low levels in the A2 and extremely low levels in the clay subsoils.

Topsoils are generally moderately acid, but not uncommonly are strongly acid. Soil pH increases with depth becoming alkaline in the lower profile (1 m depth) and usually exceeding pH 8.0.

Topsoils have low total nitrogen contents (0.1-0.2%) which decrease rapidly to very low contents in the subsoils. Total phosphorus is medium to low in the topsoil and low to very low in the subsoil. Available phosphorus follows a similar trend. Available potassium is generally low throughout the profile.

Commonly the upper B2 horizons are slightly to moderately sodic having an exchangeable sodium percentage (ESP)of 6-12%. This sodicity increases with depth with subsoil ESP values of 12-24. This may be associated with clay dispersion and slow permeability.

The cation exchange capacity (CEC) is 4-15 meq/100g with high base saturation >70% in the fine sandy surface horizons. In the subsoils CEC is 25-40 meq/100g with base saturation commonly 80-100%. This reflects the high clay content and low degree of leaching in these profiles. Calcium is the dominant cation in the upper profile but magnesium, and in some profiles sodium, is dominant in the lower profile.

Data of Taylor and Pickering (1963) indicate mixed kaolin and illite clay mineralogy in Brumby subsoils. Results of clay mineralogy analysis in the present study suggest a mixed kaolin and smectite mineralogy with a clear trend of smectite increasing with depth. This goes some way to explaining the very slow permeability of these soils when moist ie, due to the presence of expanding clays and increasing exchangeable sodium percentage with depth.

Clay content in the upper A1 and A2 horizons is typically 7-15%, silt contents range from 20-30% and in all profiles the A2 is slightly sandier than the A1 horizon. The B2 horizons typically have 50-70% clay with 20-30% sand and 10-20% silt.

Electrical conductivity values generally increase with depth with many subsoils having slightly saline subsoils (at >50 cm depth).

Soil Mapping Units

The soil mapping units include the Brumby association (Br) in which Brumby soils are dominant with small inclusions of Canola, Panshanger, Tara or Newham soils, and soil complexes where two or more soils are co-dominant eg, Br-Ps, Br-Ta. The most extensive areas of both Brumby association and Brumby complexes are in the north-east of the survey area along the margins of the Lake River, Brumbys Creek and Woodside Rivulet, in the north-west along the South Esk River and scattered along the length of the Macquarie River, where they are mostly associated with Panshanger soils.

Two other soils, the Nile series and the Nuka series, which were described and mapped by Nicolls (1958b) and Hubble (1947) are very similar to the Brumby soils but for two main differences. In the Nuka series sandy surface horizons are thinner (<20 cm) and carbonate is prominent in the lower B2 horizons. In the Nile series variable amounts of dolerite gravel and stone occur throughout the profile. In order to delineate these soils more detailed mapping would be required. These soils, Nuka and Nile, are therefore included in the Brumby association (Br) in this survey.

Land Use and Capability Class

Brumby soils have a fine sandy loam upper profile (A1 and A2) with an average depth of 30 cm. This weakly structured topsoil, with low organic matter content, can suffer rapid structural decline with untimely or excessive cultivation. Brumby soils would greatly benefit from minimum tillage practices as this will aid the build up of organic matter and aggregate stability.

In winter the slow rate of run-off and slow permeability result in surface flooding of flat sites. Also A2 horizons often become a wet structureless slurry whilst in summer many A2 are hardsetting. Similar soils on mainland Australia have shown variable response to gypsum and lime applications in respect to hardsetting, however reduced tillage and traffic, particularly when soils are wet, can significantly reduce sodium sensitivity (Aylmore and Sills, 1982).

The soil pH, available phosphorus and potassium data suggest these soils should respond to lime, potash and phosphorus fertilisers.

The majority of land in which Brumby soils are dominant is classified as land capability Class 4. However, at the land capability unit level, several units may be identified: land where Brumby soils on side slopes have better lateral drainage; land where the soils have thicker sandy topsoils (transitional to Panshanger) and better surface drainage; and land with Brumby soils on flat terraces prone to surface flooding with poor internal drainage. Land in low lying drainage lines where surface flooding and waterlogging are frequent, and concentrations of salt occur, would is classified as Class 5.

6.3.2 Newham Soil Profile Class

Mapping Units Ne, Ne-Ps

Reference

The name Newham was given by Nicolls (1958b) to a series of soils on drop-off slopes between the Brickendon and Brumby terraces.

Diagnostic Features

Newham soils are gravelly, yellow duplex soils occurring on undulating (3-10%) to rolling (10-32%) slopes which allows for moderately rapid surface run-off and lateral profile drainage despite the presence of slowly permeable clayey subsoils.

Newham soils have loamy topsoils above a thin or discontinuous A2 horizon containing variable amounts of quartz gravel. The A2 horizons pass abruptly to friable, brightly mottled, yellowish brown or brown, medium to heavy clay subsoils. The subsoil horizons generally have a coarse blocky structure and coarse red and grey mottles occur at depth.

Classification

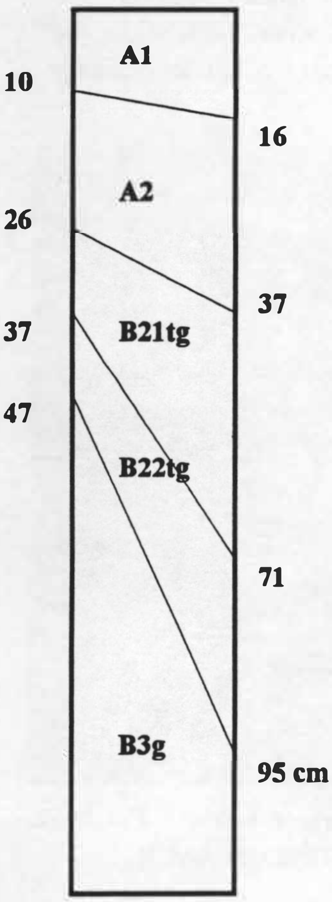
These soils are classified as yellow podzolic, although some are transitional to soloth, in the system of Stace *et al.* (1968). In the Northcote system (1979) Newham soils are yellow and brown duplex soils (Dy, Db).

In the new Australian classification (Isbell, 1993) they key out as Bleached-Sodic or Mottled, Mesotrophic to Eutrophic, Brown Chromosols.

Environmental Features

Newham soils occur on drop-off slopes descending from the Brickendon surface. Topography ranges from undulating (3-10%) to rolling (10-32%). The upper profile has formed in colluvium (slope deposits) composed of eroded quartz gravel in a sandy matrix. Surface deposits of aeolian sand also occur, particularly at the base of west to north facing slopes. The subsoils have developed in Tertiary clays which became exposed to weathering during stream incision (post Brickendon). The soils are imperfectly drained and have slowly permeable subsoils. However, moderate rates of run-off reduce the internal drainage problems associated with similar duplex soils on flatter terrain eg, Brickendon and Brumby soil profile classes.

Modal Profile - Newham Soil Profile Class



A1; Very dark greyish brown to dark brown (10YR 3/2 - 7.5YR 3/2); loam to fine sandy loam; weak fine subangular plus subangular blocky structure; earthy fabric; very weak (dry); few sub-rounded fine to medium quartz gravels; field pH 5.5; salinity 0.1 dSm-1; clear smooth boundary;

A2 or A3; Brown (10YR 5/3); sandy loam to loam; weak fine angular blocky structure; sandy fabric; weak to firm (dry); few profiles may have common ferruginous nodules; few to many sub-rounded fine to medium quartz gravels; field pH 5.3; salinity 0.0 dSm-1; abrupt or clear wavy boundary;

B21tg; Yellowish brown (10YR 5/5 - 5/6); medium-heavy clay; dark grey staining on ped faces; common red or dark red mottles (10 R 4/8 - 2.5YR 4/8); moderate medium angular blocky breaking to fine angular blocky structure; earthy or rough ped fabric; very firm (dry); very few fine to medium quartz gravels; field pH 6.1; salinity 0.0 dSm-1; gradual smooth boundary;

B22tg; Brown to olive brown (2.5Y 4/3 - 10YR 4/3); medium-heavy clay; common red or dark yellowish brown mottles (2.5YR 4/6 or 10YR 4/4); massive breaking to coarse angular blocky structure; earthy fabric; very few quartz gravels as above; field pH 6.3; salinity 0.0 dSm-1; diffuse boundary;

B23tg or B3; Light olive brown (2.5Y 5/3 - 5/4); heavy clay; many coarse red and grey mottles (2.5YR 4/6 and 10YR 6/1); massive; earthy fabric; field pH 6.5; salinity 0.2 dSm-1;

Profile Variation

The lighter coloured A2 horizons are variable in thickness and are often indistinct. Also the A1 horizon may pass abruptly to a very hard, gravelly A2 and upper B2 horizon, which can become impenetrable in dry periods. Quartz gravel in these soils ranges from few to abundant in amount.

General Chemical, Physical and Mineralogical Properties

Analytical data for two Newham profiles are given in Table 6.5. Moderate to low levels of organic carbon occur in the topsoils and these decrease sharply to very low levels in the lower surface (A2) and subsoil horizons (B2's). Total nitrogen contents follow a similar trend.

Topsoils and A2 horizons are moderately to strongly acid, but pH increases to slightly acid and neutral with depth in the clayey subsoils.

Both topsoils and subsoils are low in available potassium, while available phosphorus is moderate to low in topsoils and very low in all other horizons.

Cation exchange capacity (CEC) is generally low (< 10 meq/100g) in the sandy loam topsoils and very low (< 4 meq/100g) in the bleached A2 horizons. Subsoils have high CEC (> 25 meq/100g) as would be expected in clayey materials. However, leaching is moderate as indicated by base saturation values which are medium (40-60%) in sandy surface horizons and variably low to medium (30-60%) in clay subsoils.

Soil Mapping Units

The soil mapping units are the Newham association (Ne) in which the Newham soil profile class is dominant and the Newham-Panshanger complex (Ne-Ps) in which the two named soils are co-dominant. Small areas of Panshanger and Canola soils occur within the Newham association; the former occur in footslope positions on westerly facing slopes, while the latter occur in drainage lines which are too small to be mapped separately.

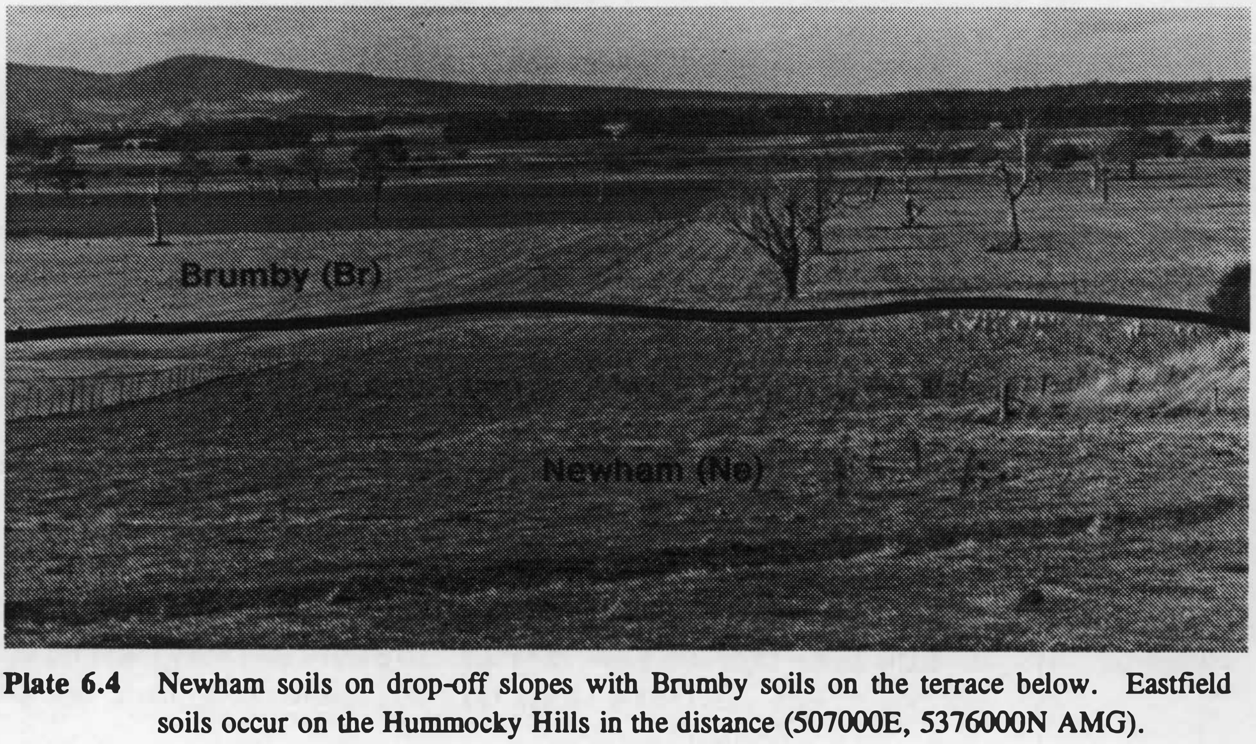


Plate 6.4 Newham soils on drop-off slopes with Brumby soils on the terrace below. Eastfield soils occur on the Hummocky Hills in the distance (507000E, 5376000N AMG).

Soil Profile Class "Property" Grid Reference (AMG)	Profile Number	Horizon	Sample Depth (cm)	pH water (1:5)	EC (d/sm)	Total P (mg/kg)	Avail. P (mg/kg)	Avail. K (mg/kg)	Org. Carb. (%)	Total N (%)	C/N Ratio	Ca	Mg	Na	K	Total Bases	CEC	BASE SAT (%)	ESP (%)	Ca/Mg Ratio
												(milli-equivalents / 100 grams of soil)								
Newham	SP 81	A1	0 - 12	5.1	0.08	206	15	88	3.30	0.233	14	2.66	1.10	0.34	0.24	4.3	9	50	3.9	2.42
"Woodrising"	SP 81	A21	12 - 24	5.5	0.05	123	2	47	0.30	0.044	7	1.46	0.77	0.34	0.17	2.7	6	50	6.2	1.89
513500E	SP 81	A22	24 - 32	5.5	0.05	91	0	40	0.40	0.026	15	1.28	1.59	0.39	0.14	3.4	6	56	6.4	0.80
5377100N	SP 81	B21tg	32 - 45	5.9	0.08	64	0	47	0.60	0.080	8	3.13	8.80	1.32	0.22	13.5	28	48	4.7	0.36
	SP 81	B22tg	45 - 57	6.0	0.11	66	0	60	0.60	0.080	8	3.09	10.35	1.92	0.25	15.6	23	67	8.2	0.30
	SP 81	Cg	57 - 65	5.6	0.35	45	0	67	0.30	0.030	10	2.52	9.88	3.19	0.25	16.1	32	51	10.0	0.25
Newham	SP 82	A1	0 - 14	5.3	0.07	237	23	60	2.30	0.162	14	2.89	0.90	0.44	0.19	4.4	7	60	6.0	3.20
"Woodrising"	SP 82	A21	14 - 25	5.6	0.04	152	7	27	0.30	0.044	7	1.57	0.66	0.38	0.12	2.7	5	53	7.4	2.36
513600E	SP 82	A22	25 - 35	5.9	0.04	175	2	27	0.00	0.000		0.98	0.68	0.40	0.11	2.2	3	68	12.5	1.46
5376700N	SP 82	B21tg	35 - 55	6.6	0.07	90	0	40	0.20	0.037	5	2.81	9.80	1.42	0.21	14.2	45	31	3.1	0.29
	SP 82	B22tg	55 - 80	6.7	0.09	76	0	40	0.20	0.030	7	2.87	10.72	1.85	0.21	15.7	41	38	4.5	0.27
	SP 82	Cg	80 - 95	6.9	0.10	51	0	40	0.10	0.006	17	2.27	8.82	1.73	0.17	13.0	32	41	5.4	0.26

Soil Profile Class "Property" Grid Reference (AMG)	Profile Number	Horizon	Sample Depth (cm)	Gravel (of total) > 2000 (µm) (%)	Sand Coarse > 250 (µm) (%)	Sand Fine < 250 (µm) (%)	Silt (%)	Clay (%)
Newham	SP 81	A1	0 - 12	10	18	43	20	19
"Woodrising"	SP 81	A21	12 - 24	25	36	35	13	16
513500E	SP 81	A22	24 - 32	22	32	30	13	25
5377100N	SP 81	B21tg	32 - 45	8	11	10	4	75
	SP 81	B22tg	45 - 57	9	9	8	3	81
	SP 81	Cg	57 - 65	0	7	10	11	72
Newham	SP 82	A1	0 - 14	4	30	37	15	19
"Woodrising"	SP 82	A21	14 - 25	8	34	35	15	16
513600E	SP 82	A22	25 - 35	22	64	18	8	11
5376700N	SP 82	B21tg	35 - 55	0	0	0	1	99
	SP 82	B22tg	55 - 80	0	1	1	0	98
	SP 82	Cg	80 - 95	0	16	5	2	77

Table 6.5 Analytical data for Newham soil profile class.

Newham soil association and complex occur mainly in the north-west of the survey area between Brumbys Creek and the southern end of the Hummocky Hills.

Land Use and Capability Class

These soils have been cultivated in places but are generally used for improved pastures. Newham soils contain variable amounts of quartz gravel in the surface horizons (A2) which is abrasive on tillage equipment.

The sloping terrain and sandy topsoils assist lateral drainage. However internal drainage may not be sufficient to allow reliable winter access for working or harvesting of crops. Also, the sandy surface horizons are generally shallower than those of Brickendon or Brumby soils. As with many of the sandy surface horizons in the survey area they are prone to fluvial and wind erosion if the vegetative cover is removed.

Land where Newham soils are dominant is Class 4. Although they have generally shallower topsoils than the Brumby soils, the improved lateral drainage makes them easier to work, especially in wetter periods. However, care must be taken in diverting excess surface run-off down slope which may result in rill and sheet erosion.

6.3.3 Brickendon Soil Profile Class

Mapping Unit Bk

Reference

The name Brickendon was given by Stephens *et al.* (1942) to the soils found to be characteristic of the Brickendon terraces (Nicolls, 1960) in the Longford and Cressy areas.

Diagnostic Features

A key feature of Brickendon soils is the presence of variable, but often large, amounts of water-worn quartz gravel in the upper profile, particularly the A2 horizon. Profiles are duplex with greyish brown sandy and gravelly surface horizons which abruptly overlie strong brown to yellowish brown, medium to heavy clay subsoils.

Brickendon soils have an acid reaction profile. The upper B2 develops a distinctive coarse blocky structure. These soils are imperfectly drained with generally slow rates of run-off and slow to moderate permeability.

Classification

Nicolls (1958b) classified Brickendon soils as lateritic podzolics. Although these soils do not have cemented ferruginous gravel they do have a dominantly kaolin mineralogy and distinctive coarse red and grey mottling in the subsoils typical of lateritic weathering. In the Northcote system (1979) all profiles are yellow and brown duplex (Dy, Db) with an abrupt boundary between sandy surface horizons and heavy clay subsoils.

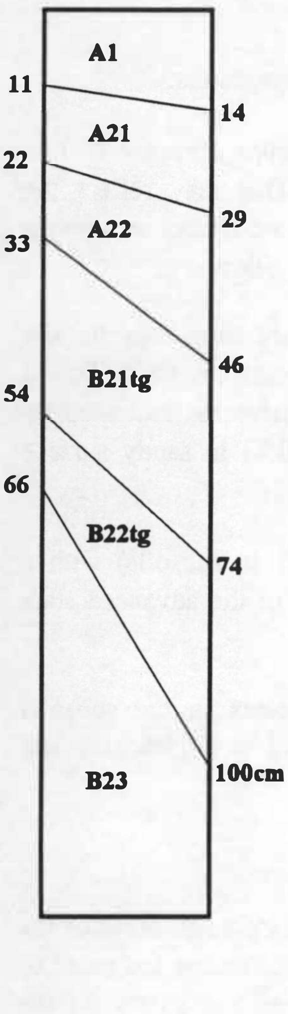
In the new Australian classification (Isbell, 1993) these soils are Bleached-Sodic, Mesotrophic Brown Chromosols or where subsoil pH is below 5.5 Bleached-Mottled, Mesotrophic, Brown Kurosols.

Environmental Features

Brickendon soils are imperfectly drained and occur on flat to gently undulating (0-3%) high terrace surfaces named the Brickendon Terraces by Nicolls (1958b, 1960). These terraces are incised into Tertiary clay deposits and increase in elevation upstream from 150-160 m at Hadspen to 200 m at 'Vaucluse' and 'Bloomfield' in survey area. They occur adjacent to the Lake, Macquarie and South Esk Rivers.

The parent materials for these soils are sandy surface deposits, which may have an aeolian origin, over subrounded fine to medium quartz gravel which appears to be water-worn suggesting the material is alluvial being derived from reworking of the Tertiary sediments. The subsoils are developed on Tertiary clay.

Modal Profile - Brickendon Soil Profile Class



A1; Very dark greyish brown (10YR 3/2 - 10YR 4/2); loam to loamy sand; weak subangular blocky structure breaking to single grained; sandy fabric; weak (dry); few to common rounded to subrounded fine quartz gravel; pH 5.3; salinity 0.2 dSm-1; clear smooth boundary;

A21; Greyish brown to light brownish grey (10YR 5/2 - 10YR 6/2); few yellowish brown mottles (10YR 5/6); sandy loam to loamy sand; weak fine angular blocky structure breaking to single grained; sandy fabric; weak (moist); few-common ferruginous nodules in some profiles; common to abundant subrounded fine to medium quartz gravel; field pH 5.7; salinity 0.0 dSm-1; clear smooth boundary;

A22; Light brownish grey to pale brown (10YR 6/3 - 6/2); few yellowish brown mottles (10YR 5/6); sandy loam to loamy sand; single grained; sandy fabric; very weak (moist) ; few to abundant fine to medium subrounded quartz gravel; common ferruginous nodules in some profiles; field pH 6.2; salinity 0.0 dSm-1; abrupt wavy boundary;

B21tg or **B21t**; Strong brown to yellowish brown (7.5YR 5/6 - 10YR 5/6); few to common red (10 R 4/8) and few light olive brown mottles (2.5Y 5/4); heavy clay; moderate coarse to very coarse angular blocky or prismatic structure breaking to medium angular blocky structure; rough ped fabric; very firm (dry); few ferruginous nodules in some profiles; very few fine to medium subrounded quartz gravels; field pH 6.3; salinity 0.1 dSm-1; gradual smooth boundary;

B22tg or **B22t**; Yellowish brown to light olive brown (10YR 5/6 - 2.5Y 5/6); common red mottles (10 R 4/8); heavy clay; massive breaking to coarse prismatic or angular blocky structure; earthy fabric; very firm (dry); few ferruginous nodules in some profiles; field pH 6.5; salinity 0.1 dSm-1; gradual smooth boundary;

B23 or **B3** or C; Yellowish brown (10YR 5/6); common coarse red (10 R 4/8) and white mottles (10YR 8/2); heavy clay; massive; earthy fabric; very few ferruginous nodules in some profiles; field pH 6.5; salinity 0.1 dSm-1;

Profile Variation

The key area of variability is the amount of quartz gravel in the A2 horizons. This may range from few to abundant, fine to medium, subrounded quartz gravel. The thickness of the sandy A1 horizon is variable due to irregular surface accumulation of aeolian sand.

The structure of the clay subsoils may vary from medium to very coarse and from angular blocky to prismatic. The hue of the upper B2 horizon is predominantly 10YR but range in hue between 7.5YR and 2.5Y. A2 horizons commonly hardset when dry.

General Chemical, Physical and Mineralogical Properties

Analytical data for two Brickendon profiles are given in Table 6.6. Organic matter contents are medium to high in topsoils but decrease sharply to low levels in the lower surface (A2) and very low levels in the clay subsoil. Total nitrogen contents are medium in the topsoils but drop sharply to very low levels in the lower surface horizons and clay subsoils.

Soil pH is moderately acid in the topsoils and slightly to moderately acid in the subsoils.

Available phosphorus is high in the topsoils of the analysed profiles but drops abruptly to low levels in the lower surface horizons and to zero in the clay subsoils. This may reflect the application of phosphatic fertilisers. The available potassium contents follow a different trend with a gradual decrease with depth from low levels in the topsoil to very low levels below.

Cation exchange capacity (CEC) is generally low (7-9 meq/100g) in the sandy loam topsoils and very low (<4 meq/100g) in the bleached A2 horizons. Subsoils have moderate CEC (25-30 meq/100g) as would be expected in clay materials. Leaching has been moderate as indicated by percentage base saturation. Values were medium to high (approximately 60%) in sandy surface horizons and variable but generally low to medium (20-60%) in the clay subsoils.

The clay mineralogy of Brickendon soils is dominated by kaolinite (75-90% in subsoils) with a trace of smectite (<5%) and minor goethite (10-15%). This is an indication of the advanced state of weathering of these materials. Kaolinite percentage increases with depth.

The particle size analysis supports the field textures, with high clay contents in the subsoils (>75%) and low clay contents in the sandy and gravelly surface horizons (A1 = 8-15% clay and A2 = 7-10% clay).

Soil Mapping Units

Brickendon association (Bk) although dominated by Brickendon soils may include small areas of the Newham or Panshanger soil profile classes. The Newham soils occur on terrace scarps too small to be mapped separately while Panshanger soils are associated with sand dunes and sheets on the Brickendon terraces.

Land Use and Capability Class

Brickendon soils have quartz gravelly A2 horizons which are strongly abrasive to tillage equipment and hardset when dry. Deep subsoils may be sodic (ESP>6) and have slow permeability. Wetness may make winter working or harvesting difficult. This is due to shallow surface horizons overlying slowly permeable subsoils which hold up water in winter (perched water table).

Soil Profile Class "Property" Grid Reference (AMG)	Profile Number	Horizon	Sample Depth (cm)	pH water (1:5)	EC (d/sm)	Total P (mg/kg)	Avail. P (mg/kg)	Avail. K (mg/kg)	Org. Carb. (%)	Total N (%)	C/N Ratio	Ca	Mg	Na	K	Total Bases	CEC	BASE SAT (%)	ESP (%)	Ca/Mg Ratio
												(milli-equivalents / 100 grams of soil)								
Brickendon	SP 59	A1	0 - 13	5.7	0.06	478	58	85	4.50	0.287	16	4.01	1.23	0.20	0.27	5.7	9	65	2.3	3.27
"Formosa"	SP 59	A2	13 - 30	5.9	0.03	148	13	79	1.40	0.098	14	1.83	0.64	0.15	0.22	2.8	4	63	3.4	2.85
507200E	SP 59	B21tg	30 - 52	6.1	0.05	163	0	68	1.20	0.085	14	5.01	8.26	0.72	0.25	14.3	30	48	2.4	0.61
5377600N	SP 59	B22t	52 - 78	6.0	0.06	161	0	56	1.20	0.085	14	3.38	10.15	1.06	0.22	14.8	27	55	3.9	0.33
	SP 59	B23t	78 - 93	5.7	0.08	98	0	32	0.60	0.042	14	1.70	8.08	3.43	0.22	13.4	30	45	11.4	0.21
Brickendon	SP 62	A1	0 - 13	5.1	0.06	362	58	103	4.30	0.278	15	2.84	0.73	0.17	0.35	4.1	7	59	2.5	3.88
"Formosa"	SP 62	A21	13 - 30	5.6	0.02	418	4	32	0.60	0.036	17	0.50	0.24	0.17	0.16	1.1	2	45	7.2	2.09
507000E	SP 62	A22	30 - 42	6.2	0.03	109	0	38	0.60	0.031	19	1.69	1.09	0.79	0.19	3.8	6	68	14.3	1.54
5376650N	SP 62	B21t	42 - 85	5.3	0.08	150	0	21	0.80	0.031	26	1.45	4.82	0.74	0.20	7.2	29	25	2.6	0.30
	SP 62	B22t	85 - 95	5.0	0.09	154	0	21	0.40	0.025	16	0.42	3.82	0.72	0.22	5.2	24	22	3.0	0.11

Soil Profile Class "Property" Grid Reference (AMG)	Profile Number	Horizon	Sample Depth (cm)	Gravel (of total) >2000 (μm) (%)	Sand Coarse >250 (μm) (%)	Sand Fine <250 (μm) (%)	Silt (%)	Clay (%)	Clay Mineralogy: Kaolinite	Illite	Goethite	Lepidocrocite
									(Approximate weight %)			
Brickendon	SP 59	A1	0 - 13	19	23	49	13	15				
"Formosa"	SP 59	A2	13 - 30	78	57	26	10	8	85		5	
507200E	SP 59	B21tg	30 - 52	0	2	6	1	91	75		15	5
5377600N	SP 59	B22t	52 - 78	0	1	3	0	97	85		10	2
	SP 59	B23t	78 - 93	0	2	12	3	84	90		5	
Brickendon	SP 62	A1	0 - 13	27	27	50	12	11				
"Formosa"	SP 62	A21	13 - 30	52	35	42	13	10				
507000E	SP 62	A22	30 - 42	0	26	30	17	27	65	5	20	5
5376650N	SP 62	B21t	42 - 85	0	9	6	10	75	85		10	2
	SP 62	B22t	85 - 95	0	14	11	13	62	80		15	

Table 6.6 Analytical data for Brickendon soil profile class.

The weak structure of the topsoils and their sandy and gravelly nature make them susceptible to structural decline if excessively cultivated, with consequent wind and water erosion potential. Currently these soils are used for pasture production with rotations to cereals and brassicas.

The soil pH and available potassium data suggest these soils will benefit particularly from lime and potash fertiliser applications.

Land where Brickendon soils are dominant is Class 4. The amount of quartz gravel present in the profile combined with the imperfect internal drainage, weakly structured sandy topsoils and acid reaction trend make these soils marginal for intensive cropping use.

6.3.4 Macquarie Soil Profile Class

Map units Mq, Mq+Bk, Mq-Ps

Reference

The Macquarie soil profile class is defined in this survey and is named after the Macquarie River which flows through the central survey area where Macquarie soils were first described.

Diagnostic Features

Macquarie soils are duplex soils which form on the Brickendon terraces. They differ from the Brickendon soil profile class by the presence of abundant ferruginous gravel in the A2 horizon and contain little or no quartz gravel. The surface horizons are sandy and overlie a medium to heavy clay subsoil with a coarse columnar or prismatic structure. The subsoils are commonly sodic with ESP > 6.

Macquarie soils are imperfectly drained with slow to moderate rates of run-off and slowly permeable subsoils.

Classification

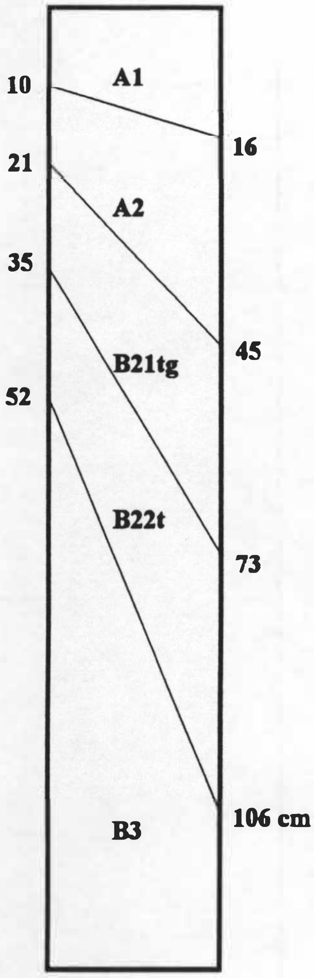
The Macquarie soils are solodised solonetz in the system of Stace *et al.* (1968). In the system of Northcote (1979) these soils are yellow and brown duplex (Dy, Db) with neutral to alkaline reaction trend.

In the new Australian soil classification system (Isbell, 1993) they are classed as Ferric or Vertic, Subnatric, Brown Sodosols.

Environmental Features

Macquarie soils form on flat to gently undulating (0-3%) Brickendon River Terraces occurring in the lowland area along the lower Isis, Lake and Macquarie Rivers. The terraces are cut into Tertiary clayey sediments. The sandy surface horizons may have an aeolian component. Rainfall is under 700 mm/yr.

Modal Profile - Macquarie Soil Profile Class



A1; Very dark greyish brown to very dark grey (10YR 3/2 - 3/1); sandy loam or loam; weak fine subangular blocky structure breaking to single grained; sandy fabric; very weak (dry); very few medium ferruginous nodules; field pH 5.3; salinity 0.2 dSm-1; clear smooth boundary;

A2 or **A21**; Greyish brown (10YR 5/2); few strong brown mottles in some profiles; sandy loam or loamy sand; single grained plus weak fine to medium blocky structure; sandy fabric; weak (dry); many medium ferruginous nodules; very few 2-20 mm quartz gravels in some profiles; field pH 6.1; salinity 0.1 dSm-1; A2 has abrupt wavy, A21 clear boundary;

Some profiles; **A22** Greyish brown (10YR 5/2); loamy sand or sandy loam; single grained or massive; sandy fabric; many ferruginous nodules; field pH 6.3; salinity 0.1 dSm-1; abrupt boundary;

B21tg; Yellowish brown (10YR 5/5 - 4/4); few to common red (10R 4/8) or strong brown mottles (7.5YR 4/6); heavy to medium clay; moderate coarse or very coarse columnar structure; rough or smooth ped fabric; firm to very firm (dry); few to common ferruginous nodules; field pH 6.9; salinity 0.0 dSm-1; gradual boundary;

B22t; Yellowish brown (10YR 5/4 - 5/6); common red (10R 4/8) primary mottles plus few grey (10YR 6/1) secondary mottles; heavy to medium clay; moderate coarse angular blocky or lenticular structure; smooth or rough ped fabric; very firm (dry); common distinct clay skins and in some profiles common distinct slickensides; very few to few ferruginous nodules; field pH 7.3; salinity 0.2 dSm-1; gradual smooth boundary;

B3 or **B23t**; Olive brown to light olive brown (2.5Y 3/3 - 5/4); few red or grey mottles in some profiles; heavy to medium clay; massive; earthy fabric; strong (dry); common distinct clay skins and many distinct slickensides; few ferruginous nodules; field pH 7.6; 0.3 dSm-1;

Profile Variation

Ferruginous gravel in the A1 and A2 horizons ranges from common to abundant. Subsoil colours range from 10YR to 2.5Y and mottle abundance is variable.

General Chemical, Physical and Mineralogical Properties

Analytical data are given in Table 6.7. Organic carbon contents are low (<1.0%) in topsoils and decrease sharply to very low levels in the lower surface (A2) and clay subsoil horizons. Total nitrogen contents are low in all horizons.

Soil pH is slightly acid in topsoils becoming neutral in the lower surface horizons and alkaline in subsoils.

Available phosphorus is low in all horizons and not detectable in the clay subsoils. The available potassium levels follow a similar trend being low in all horizons.

Soil Profile Class "Property" Grid Reference (AMG)	Profile Number	Horizon	Sample Depth (cm)	pH water (1:5)	EC (d/sm)	Total P (mg/kg)	Avail. P (mg/kg)	Avail. K (mg/kg)	Org. Carb. (%)	Total N (%)	C/N Ratio	Ca	Mg	Na	K	Total Bases	CEC	BASE SAT (%)	ESP (%)	Ca/Mg Ratio
												(milli-equivalents / 100 grams of soil)								
Macquarie	SP 28	A1	0 - 15	5.1	0.04	70	0	40	0.70	0.087	8	1.49	0.29	0.18	0.11	2.1	5	44	3.7	5.08
"Vaucluse"	SP 28	A2	15 - 35	6.0	0.02	27	4	12	0.00	0.021	0	0.71	0.35	0.15	0.10	1.3	2	54	6.3	2.01
537200E	SP 28	B21tg	35 - 60	7.6	0.13	60	0	95	0.60	0.084	7	7.72	13.63	2.71	0.40	24.5	36	68	7.5	0.57
5373800N	SP 28	B22t	60 - 75	8.3	0.23	31	0	67	0.30	0.047	6	6.65	13.55	3.74	0.30	24.4	35	69	10.6	0.49
	SP 28	B23t	75 - 90	8.3	0.52	45	0	33	0.10	0.034	3	5.96	12.08	4.84	0.23	23.6	49	48	9.9	0.49

Soil Profile Class "Property" Grid Reference (AMG)	Profile Number	Horizon	Sample Depth (cm)	Gravel (of total) >2000 (µm) (%)	Sand Coarse >250 (µm) (%)	Sand Fine <250 (µm) (%)	Silt (%)	Clay (%)
Macquarie	SP 28	A1	0 - 15	1	13	67	9	11
"Vaucluse"	SP 28	A2	15 - 35	21	16	67	9	7
537200E	SP 28	B21tg	35 - 60	0	3	11	3	83
5373800N	SP 28	B22t	60 - 75	2	1	9	5	84
	SP 28	B23t	75 - 90	0	1	7	17	75

Table 6.7 Analytical data for Macquarie soil profile class.

Cation exchange capacity (CEC) is generally very low (<4 meq/100g) in the sandy loam surface horizons. Subsoils have high CEC (25-50 meq/100g) as would be expected in clay materials. Leaching has been moderate as indicated by base saturation percent; values were medium (40-60%) in sandy surface horizons and medium to high (>60%) in clay subsoils but decreasing with depth.

The grain size analysis supports the field textures with high clay contents in the subsoils (>75%) and low clay contents in the sandy and gravelly surface horizons (A1 = 11%, A2 = 7% clay).

Soil Mapping Units

The mapping units include the Macquarie association (Mq) in which Macquarie soil profile class is dominant, an undifferentiated group in which Macquarie and Brickendon soils (Mq+Bk) are co-dominant and a soil complex in which Macquarie and Panshanger soils (Mq-Ps) are co-dominant. The undifferentiated group comprises two soils with similar limitations to cultivation ie, the presence of quartz gravel in Brickendon soils and ferruginous gravel in the Macquarie soils, both are strongly duplex. In the soil complex (Mq-Ps) two differing soils, Macquarie and Panshanger, occur in an intricate pattern requiring they be mapped together (Mq-Ps). The Macquarie soils occur on river terraces equivalent to Brickendon adjacent to the Lake, Macquarie and lower Isis Rivers.

Land Use and Capability Class

The ferruginous gravelly A2 horizons of Macquarie soils is abrasive of tillage equipment. The heavy clay subsoils are sodic and have slow permeability. These factors combined with shallow topsoils may make winter working or harvesting difficult.

As with Brickendon soils the sandy and gravelly topsoils are subject to rapid structural decline under cultivation. Reduced tillage and trafficing, particularly when soils are wet, will help to reduce this problem. Currently these soils are used mainly for pasture production with rotations to cereals and brassicas.

The low topsoil pH and the presence of sodic subsoils indicate that the use of lime and gypsum as soil conditioners will reduce acidity and improve soil structure. Available phosphorus and potassium data suggest these soils will benefit from potassium and phosphate fertiliser applications.

The Macquarie soils have similar features to the Brickendon soils, and are considered marginal for intensive cropping use. Land dominated by these soils is land capability Class 4.

6.3.5 Bicton Soil Profile Class

Mapping Units Bi

Reference

Bicton is a name introduced in this survey for soils forming on mixed alluvium in the Isis River valley. The soils are named after the property 'Bicton' where they were first described.

Diagnostic Features

Bicton soils are imperfectly drained, acid, duplex soils. Very dark greyish brown, sandy loam topsoils grade to light brownish grey, loamy sand A2 horizons abruptly overlying slowly permeable, yellowish brown, weakly structured or massive, heavy clay subsoils. Scattered water worn gravel and stone derived mainly from Permian and older rocks occur on the soil surface and throughout the profile.

Classification

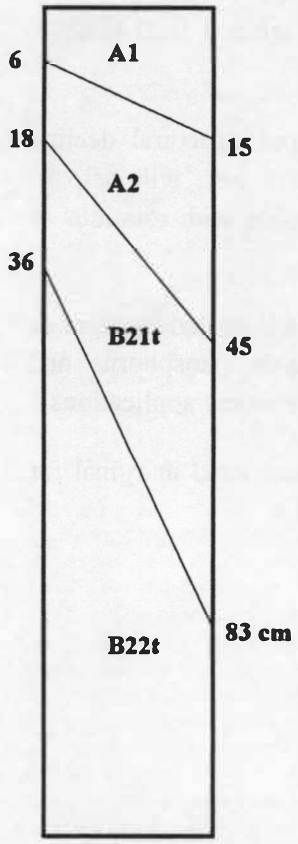
Bicton soils classify as yellow podzolic in the system of Stace *et al.* (1968) and acid, yellow and brown duplex soils in the system of Northcote (1979).

In the new Australian soil classification system (Isbell, 1993) these soils are Bleached-Mottled, Mesotrophic, Brown Kurosols, however some profiles with subsoil pH greater than 5.5, which are otherwise similar, classify in the order Chromosol.

Environmental Features

Bicton soils form on flat river terraces composed of mixed alluvium derived from Permian and older rocks. The terraces occur at a general elevation of 180 - 200 m and probably correlate with the Brickendon terraces of the Lake, Macquarie and South Esk valleys. They lie 10-15 m above the present flood plain and occur in the upper Isis River valley. Run-off is slow and rainfall is 700-800 mm/yr.

Modal Profile - Bicton Soil Profile Class



A1; Very dark grey to very dark greyish brown (10YR 3/1 - 3/2); loam to sandy loam; weak extremely fine subangular blocky structure or single grained; sandy fabric; very weak (moist); common medium ferruginous nodules in some profiles; few or very few subrounded 6-60 mm gravels of sandstone and quartzite; many very fine roots; field pH 5.1; clear smooth boundary;

A2; Light brownish grey (10YR 6/2); loamy sand to sandy loam; single grained or very weak extremely fine subangular blocky structure; sandy fabric; very weak (moist); few to many medium ferruginous nodules few or very few subrounded 6-60 mm gravels of sandstone and quartzite; few to common very fine roots; field pH 5.9; abrupt wavy boundary;

B21t; Dark yellowish brown (10YR 4/6 - 4/4); few red or yellowish red (2.5YR 4/8 - 5YR 5/8) mottles in some profiles; heavy clay; weak medium angular blocky structure; rough ped fabric; very firm (moist); common distinct clay skins; very few subrounded 6-60 mm gravels of sandstone and quartzite; very few very fine roots; field pH 5.7; gradual irregular boundary;

B22t; Light olive brown to dark yellowish brown (2.5Y 5/4 - 5/6 to 10YR 4/4); few mottles as above; massive parting to coarse angular blocky structure; very firm (moist); common distinct clay skins; very few subrounded 6-60 mm gravels of sandstone and quartzite; no roots; field pH 6.1;

Profile Variation

Surface stoniness and both the abundance of mottles and the matrix hue of the B2 horizons are the main variables in these soils.

General Chemical, Physical and Mineralogical Properties

Analytical data for a single profile are given in Table 6.8. Bicton soils have strongly acid topsoils and a moderately acid reaction in the lower profile. They would respond well to lime applications.

Total nitrogen content is medium in the topsoil dropping sharply to very low levels in the lower topsoil and subsoil. Organic carbon content follows a similar trend being medium to high at the surface but dropping to very low levels in the lower topsoil and subsoil.

Available phosphorus contents are very high in the surface horizons of the analysed profile and this is probably a reflection of applied fertilisers, as available potassium levels are also high. Both available phosphorus and potassium drop sharply to low or very low values in the subsoil.

The cation exchange capacity is medium-low in the topsoil and very low in the lower topsoil (A2) but increases to high levels in the clay subsoil. Base saturation is generally low except for the topsoil indicating these soils are moderately to strongly leached. The moderate CEC and high base status of the topsoil probably reflect the medium to high organic matter content.

Lower subsoils are magnesic, ie, a very high ratio of exchangeable magnesium to calcium. These soils are non sodic.

The clay mineralogy data indicate the dominant clay mineral is kaolinite with minor smectite which increases with depth in the subsoil.

Soil Mapping Units

Bicton soils are mapped as the Bicton association (Bi). Related soils include Canola which occur in drainage depressions and Glen which occur on alluvial fans backing onto the terraces on which Bicton soils are forming. Bicton soils occur only in the mid and upper Isis river valley.

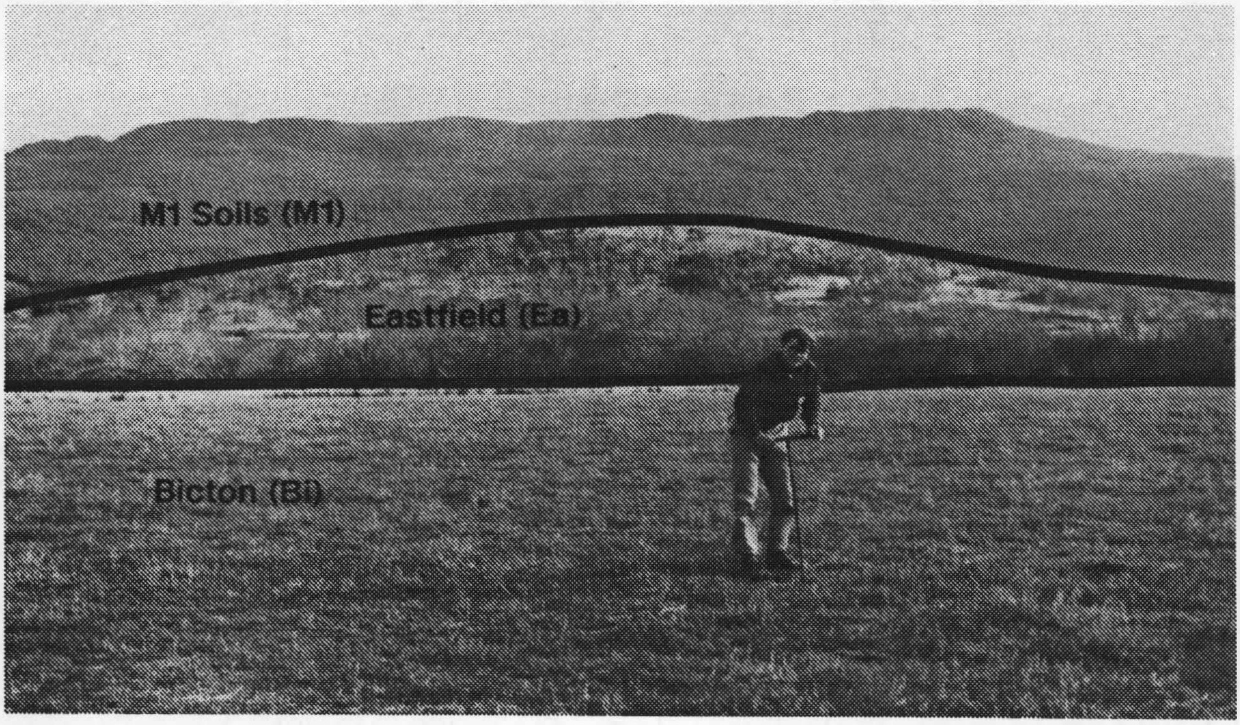


Plate 6.5 Bicton soils developed on a higher level river terrace in the Isis River valley with Eastfield soils on Single Hill (middle ground) and M1 soils on the Great Western Tiers behind (520600E, 5360000N, AMG).

Soil Profile Class "Property" Grid Reference (AMG)	Profile Number	Horizon	Sample Depth (cm)	pH water (1:5)	EC (d/sm)	Total P (mg/kg)	Avail. P (mg/kg)	Avail. K (mg/kg)	Org. Carb. (%)	Total N (%)	C/N Ratio	Ca	Mg	Na	K	Total Bases	CEC	BASE SAT (%)	ESP (%)	Ca/Mg Ratio
												(milli-equivalents / 100 grams of soil)								
Bicton	SP 133	A1	0 - 18	5.5	0.08	278	100	269	4.60	0.381	12	4.77	1.35	0.17	0.60	6.9	12	60	1.5	3.53
"Bicton"	SP 133	A2	18 - 40	5.4	0.04	52	22	81	0.80	0.056	14	0.63	0.46	0.12	0.20	1.4	5	27	2.2	1.36
519700E	SP 133	B21t	40 - 76	5.3	0.09	46	0	109	0.80	0.050	16	2.01	7.33	0.94	0.33	10.6	42	25	2.2	0.27
5361300N	SP 133	B22tg	76 - 95	5.2	0.15	36	0	60	0.30	0.018	17	0.84	10.76	1.75	0.24	13.6	36	38	4.9	0.08

Soil Profile Class "Property" Grid Reference (AMG)	Profile Number	Horizon	Sample Depth (cm)	Gravel (of total) >2000 (μm) (%)	Sand Coarse >250 (μm) (%)	Sand Fine <250 (μm) (%)	Silt (%)	Clay (%)	Clay Mineralogy (Approximate weight %) Smectite	Kaolinite	Goethite
Bicton	SP 133	A1	0 - 18	48	17	38	19	26	5	95	
"Bicton"	SP 133	A2	18 - 40	46	23	25	21	31	5	95	
519700E	SP 133	B21t	40 - 76	0	1	2	4	94	15	80	5
5361300N	SP 133	B22tg	76 - 95	0	1	1	8	90	20	75	5

Table 6.8 Analytical data for Bicton soil profile class.

Land Use and Capability Class

Bicton soils are currently devoted to pastoral uses. These soils have acid reaction trend and are moderately leached of exchangeable nutrients. They have a slight stoniness limitation. Bicton soils are best suited to pastoral and forestry uses unless fertilisers, particularly lime, are applied.

Land on which Bicton soils are dominant is land capability Class 4. This is because the profiles have strongly acid topsoil, moderately acid subsoil and, although avaliable nutrient status is high in the topsoil of the analysed profile, this drops sharply beneath the surface layer. Also the presence of gravel and larger stones may hinder cultivation.

6.3.6 Woodstock Soil Profile Class

Mapping Units Wk, Wk-Ps

Reference

The name Woodstock was given by Stephens *et al.* (1942) to the series of soils developed on the Woodstock surface (Nicolls, 1960) in the Cressy and Longford areas.

Diagnostic Features

Woodstock soils are imperfectly drained, acid, duplex soils with low natural fertility. They occur on flat to undulating relict erosion surfaces. The A1 horizons are loose loamy sands and overlie loose, sandy A2 horizons with abundant, nodular, ferruginous gravel. This may become a massive cemented layer in some areas. The subsoils are typically strong brown to reddish brown, friable clays with a few dispersed ferruginous gravels. These subsoils grade below to more massive, kaolinitic, coarsely mottled, red and white clay.

The soil pH is acid in the topsoil, acid in the A2, slightly acid in the B2 and slightly acid to acid in the lower subsoil.

Classification

Woodstock soils have been classified as lateritic podzolics in the system of Stace *et al.* (1968) by previous authors, however field dispersion tests and ESP data suggest many of these soils are soloth. In the Factual Key of Northcote (1979) Woodstock soils are generally yellow or red, acid, duplex soils (Dy, Dr).

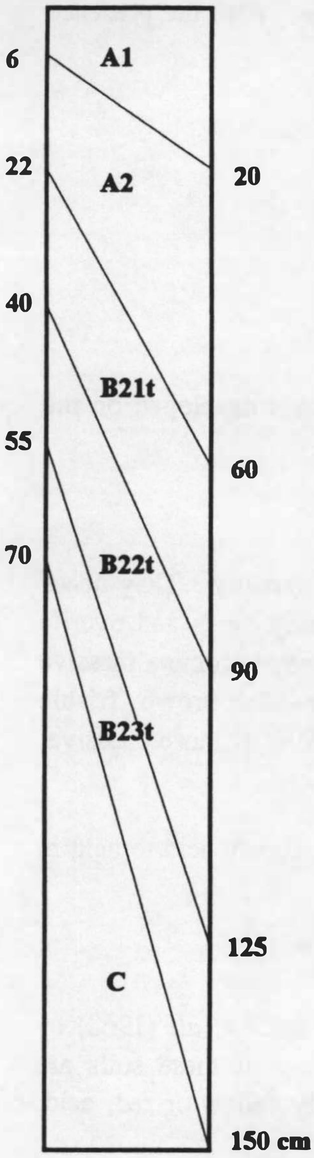
In the new Australian soil classification (Isbell, 1993) they are Ferric, Magnesic or Natric, Brown Kurosols, however a small number of profiles having a pH greater 5.5 in the B2 horizon are classified as Ferric, Subnatric, Brown Sodosols.

Environmental Features

Woodstock soils occur on a high, flat to gently undulating erosion surface, probably of fluvial origin (Mathews, in prep) which lies 30-50 m above the modern flood plain. This surface increases in elevation from 170-180 m near Hadspen, in the north of the Launceston Tertiary Basin, to 230-240 m at Tunbridge in the south (Figure 4.3). The Midland Highway crosses the largest remnant of this surface between Epping Forest and Conara. Large lagoons, greater than 1 km in diameter, are a prominent feature, particularly north of Conara (Nicolls, 1958b).

The topsoils are sands, probably with aeolian input, which cap a ferruginous gravel in a sandy matrix. The ferruginous gravel, which in places is massive and cemented, overlies highly weathered Tertiary clays. These clays appear to have been lateritised having a pattern of red and white coarse mottling and kaolinitic mineralogy, cf 'plinthite' (USDA, 1975).

Modal Profile - Woodstock Soil Profile Class



A1; Very dark grey to very dark greyish brown (10YR 3/1 to 3/2); loamy sand or sandy loam; single grained or weak fine to very fine subangular blocky structure; sandy fabric; loose (moist); few to common 2-6 mm ferruginous nodules; field pH 5.2; salinity 0.1 dSm-1; clear smooth boundary;

A2; Light brownish grey to brown (10YR 6/2 - 10YR 5/3); loamy sand; single grained, sandy fabric; loose (moist); some profiles have weak very fine subangular blocky structure; many to abundant 2-20 mm ferruginous nodules; few profiles have a fine quartz gravels; field pH 5.9; salinity 0.0 dSm-1; abrupt wavy boundary;

B21t; Yellowish brown to dark yellowish brown (10YR 5/4 - 10YR 4/6) some profiles are yellowish red or red (5YR 4/6 - 2.5YR 4/6); few to common red mottles (10R 4/6 - 2.5YR 4/8); heavy clay; moderate medium angular blocky breaking to fine angular blocky structure; rough-smooth ped; very firm (moist); common distinct clay skins; few 2-6 mm ferruginous nodules; field pH 6.0; salinity 0.0 dSm-1; gradual boundary;

B22t; Light olive brown to yellowish brown and strong brown (2.5Y 5/6 - 10YR 4/6 - 7.5YR 4/6); common red mottles (10R 4/6 - 2.5YR 4/8); weak fine to medium angular blocky structure; heavy to medium clay; smooth or rough ped fabric; firm to very firm (moist); common distinct clay skins; few 2-6 mm ferruginous nodules; field pH 5.9; salinity 0.0 dSm-1; gradual smooth boundary;

B23t or **B3**; Yellowish brown to strong brown (10YR 5/6 - 7.5YR 5/8); common red or light grey mottles; medium to heavy clay; massive; rough ped fabric; firm (moist); common distinct clay skins; few 2-6 mm ferruginous nodules; field pH 5.7; salinity 0.1 dSm-1; gradual boundary;

C; Light grey or grey (10YR 7/2 or 7.5YR 5/1) heavy clay; common white or red coarse mottles; massive; very firm (moist); kaolin dominant;

Profile Variation

The thickness of the sandy topsoils varies widely and topsoil field textures range from sand to sandy loam. Duller coloured subsoil clays occur in some profiles.

Massive, cemented, ferruginous gravel horizons at shallow depth below the sandy A1 are present in some areas.

General Chemical, Physical and Mineralogical Properties

Analytical data for two Woodstock soil profiles are given in Table 6.9, one of which is from earlier work by CSIRO Division of Soils (H19). Woodstock soils have low to medium levels of organic carbon in the surface horizons and these drop sharply to very low levels in the lower topsoil and trace levels in the clay subsoils.

Total nitrogen contents are generally low to very low in the topsoils and extremely low in all lower horizons. Available potassium and phosphorus is low to very low in all horizons of virgin profiles. Total phosphorus values are also low.

Soil reaction is moderately acid in the topsoil becoming slightly acid in the upper B2 horizons and then moderately acid below. Lime applications on these soils should be beneficial.

The sandy A1 horizons have low CEC (<12 meq/100g) with the A2 horizons having very low CEC (<6 meq/100g). Base saturation is variable, but generally medium to high in these upper sandy layers.

The subsoils, which are clayey, have medium to high CEC (>20 meq/100g) and low-medium base saturation (20-60%) which reflects the high degree of leaching in these soils. The exchange complex is dominated by magnesium and sodium. The clay subsoils are magnesic (Isbell, 1993), having a calcium to magnesium ratio <0.1.

The clay mineralogy is dominated by kaolinite (>80%) with minor smectite (5-20%) and minor goethite (5-15%). The high kaolinite content reflects a high degree of weathering of the materials in these soils. The data from this survey in agreement with clay mineralogy results for Woodstock soils in the Longford - Cressy area published by Taylor and Pickering (1963).

Soil Mapping Units

The mapping units include the Woodstock association (Wk) and a Woodstock-Panshanger complex (Wk-Ps). Woodstock soils dominate the association (Wk) but other soils such as Panshanger occur on sand dunes and Canola and Kinburn (refer to Nicolls 1958b) occur in some drainage depressions. In the soil complexes two or more soils are co-dominant and cannot be mapped separately (Wk-Ps). In all Woodstock mapping units variants with duller-coloured clay subsoils and lesser amounts of ferruginous gravel occur.

Woodstock soils occur over an extensive area of the north-eastern half of the map sheet. They are particularly extensive between Epping Forest and Conara along the Midlands Highway.

Land Use and Capability Class

Woodstock soils have deep sandy surface horizons commonly with many to abundant ferruginous gravels in the A2 horizons. They are acid, and low in soil nutrients. Thus they should benefit from lime, potash and phosphatic fertilisers. The weakly coherent sandy surface horizons are prone to wind and water erosion. The B2 horizons are friable but acid. The sodic nature of some B2 horizons could result in dispersion problems. Some of the subsoils were tested and found to be dispersive by the Emerson (1967) test.

Much of the land on which Woodstock soils are dominant carries sclerophyll forest dominated by *Eucalyptus amygdalina* with an understorey of native grasses.

Soil Profile Class "Property" Grid Reference (AMG)	Profile Number	Horizon	Sample Depth (cm)	pH water (1:5)	EC (d/sm)	Total P (mg/kg)	Avail. P (mg/kg)	Avail. K (mg/kg)	Org. Carb. (%)	Total N (%)	C/N Ratio	Ca	Mg	Na	K	Total Bases	CEC	BASE SAT (%)	ESP (%)	Ca/Mg Ratio
												(milli-equivalents / 100 grams of soil)								
Woodstock	SP 166	A1	0 - 20	5.5	0.04	57	2	14	1.50	0.094	16	2.24	1.22	0.40	0.25	4.1	5	87	8.5	1.84
"Cleveland Hwy"	SP 166	A21	20 - 33	6.8	0.02	16	2	14	0.12	0.014	9	0.17	0.50	0.29	0.29	1.2	2	56	13.0	0.33
572000E	SP 166	A22	33 - 51	6.8	0.02	23	1	14	0.00	0.013	0	0.13	0.60	0.33	0.28	1.3	2	64	15.8	0.22
5333200N	SP 166	B21t	51 - 95	6.1	0.15	65	1	64	0.00	0.031	0	0.83	19.38	3.75	0.53	24.5	45	55	8.4	0.04
	SP 166	B22t	95 - 110	6.8	0.19	63	1	79	0.00	0.020	0	0.75	17.33	4.23	0.57	23.0	39	59	10.8	0.04
Woodstock	H 19	A1	0 - 4	6.4		70			2.10	0.176	12	2.70	1.00	0.10	0.22	4.0	16	25	0.6	2.70
CSIRO	H 19	A21	4 - 10	5.6		40			0.90	0.075	12	1.60	0.21	0.10	0.15	2.1	8	26	1.3	7.62
Somerset	H 19	A22	10 - 28	5.7		10			0.30	0.032	9									
530456E	H 19	A23	28 - 36	6.2																
5370494N	H 19	B21	36 - 56	6.3								0.74	7.20	1.70	0.22	9.9	22	45	7.8	0.10
	H 19	B22	56 - 86	6.4																
	H 19	B23	114 - 127	5.4								1.10	7.80	2.90	0.09	11.9	23	51	12.6	0.14

Soil Profile Class "Property" Grid Reference (AMG)	Profile Number	Horizon	Sample Depth (cm)	Gravel (of total) >2000 (μm) (%)	Sand Coarse >250 (μm) (%)	Sand Fine <250 (μm) (%)	Silt (%)	Clay (%)	Clay Mineralogy Smectite	Kaolinite	Illite	Goethite
									(Approximate weight %)			
Woodstock	SP 166	A1	0 - 20	0	7	83	6	4		100		
CSIRO	SP 166	A21	20 - 33	3	6	83	7	4		85	15	
Somerset	SP 166	A22	33 - 20	16	7	82	6	4		90	5	5
530456E	SP 166	B21t	51 - 33	0	1	10	3	86	5	80		15
5370494N	SP 166	B22t	95 - 110	0	2	13	3	81	5	80		15
Woodstock	H 19	A1	0 - 4	22	11	60	17	9				
"Cleveland Hwy"	H 19	A21	4 - 10	38	9	65	16	8				
572000E	H 19	A22	10 - 28									
5333200N	H 19	A23	28 - 36									
	H 19	B21	36 - 56		1	9	1	86		65-80		20-30
	H 19	B22	56 - 86									
	H 19	B23	114 - 127	22	6	15	8	72				

Table 6.9 Analytical data for Woodstock soil profile class.

Land on which Woodstock soils are dominant are either Class 4 or 5, depending on the depth of the topsoil, and the amount of cemented ferruginous gravel present. Although some cropping could be carried out on areas of Class 4 land, the sandy topsoils are subject to wind and water erosion. Soil management and conservation techniques such as minimum tillage, development of windbreaks, and stubble retention should reduce the wind erosion hazard. On areas of Class 5 land, very large amounts of ferruginous gravels, which may be cemented, severely limit tillage, making these areas generally unsuitable for cultivation.

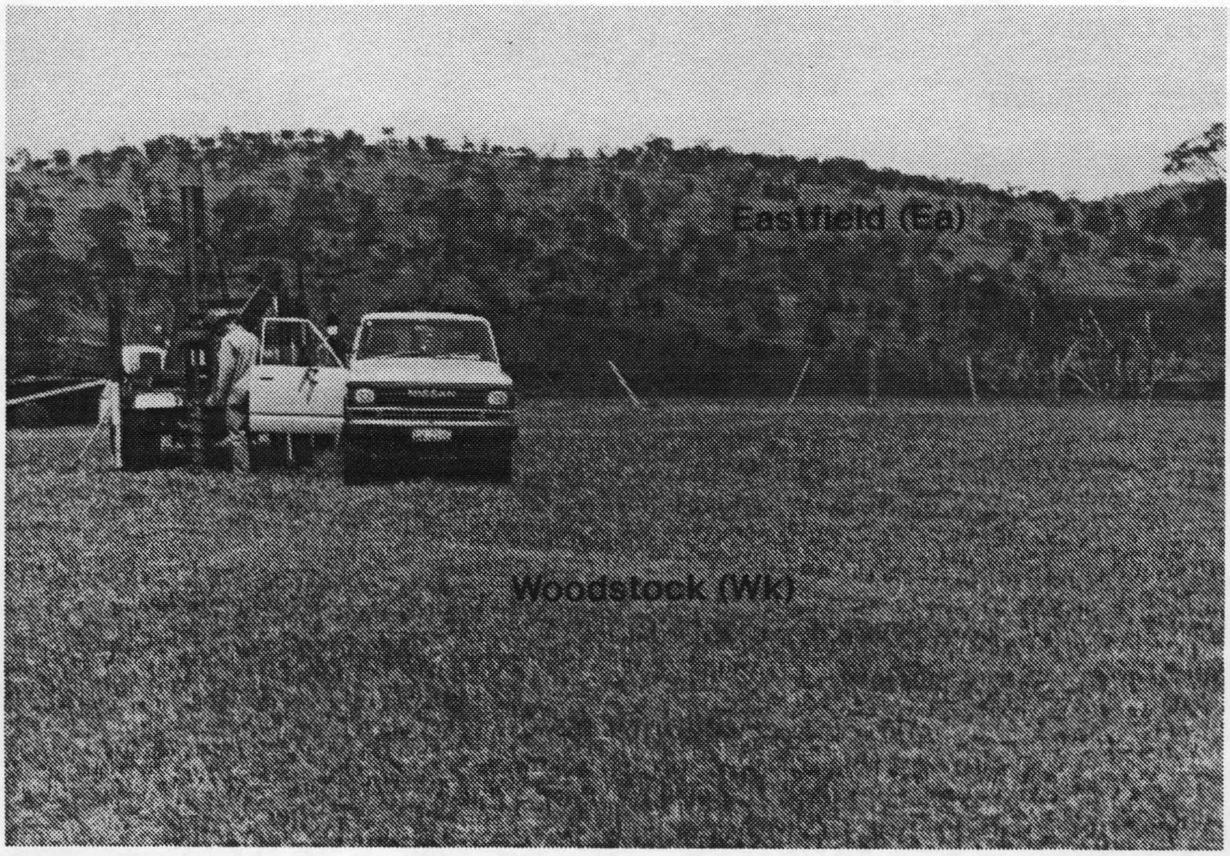


Plate 6.6 Woodstock soils developed on the Woodstock surface in the Macquarie River valley, 12 km west of Campbell Town, with Eastfield soils on the dolerite slope behind (528150E, 5360850N AMG).

6.4 Soils on Aeolian Deposits

6.4.1 Panshanger Soil Profile Class

Mapping units Ps, Ps-Bo, Ps-Ea, Ps-Ca, Ps-Mq, Ps-Wk

Reference

The name Panshanger was given by Nicolls (1958b) to a group of soils formed on windblown sands in the Longford area.

Diagnostic Features

Panshanger soils include a range of deep (>75 cm) uniform sandy profiles ranging from reddish brown to greyish brown in colour. The soils are characterised by topsoils with a slight accumulation of organic matter and weak soil structure overlying structureless, brown, sandy lower profiles. The deep sandy profiles may overlie bedrock or cap other soils at depth eg,. Brumby or Woodstock soils. Panshanger soils are rapidly drained and highly permeable and have low moisture holding capacity

Classification

Nicolls first mapped Panshanger soils in the Longford (1958b) and Quamby (1959) reconnaissance soil maps. Nicolls describes them as variable yellowish brown, brown or reddish brown siliceous sands. In the soil map sheet to the south, Interlaken, Leamy (1961) subdivided these sandy soils into grey and brown soils on windblown sands.

These soils are classified as siliceous sands in the system of Stace *et al.* (1968), and as uniform sands (Uc) in the system of Northcote (1979). In the new Australian classification (Isbell, 1993) these sandy soils are Basic, Regolithic, Orthic Tenosols.

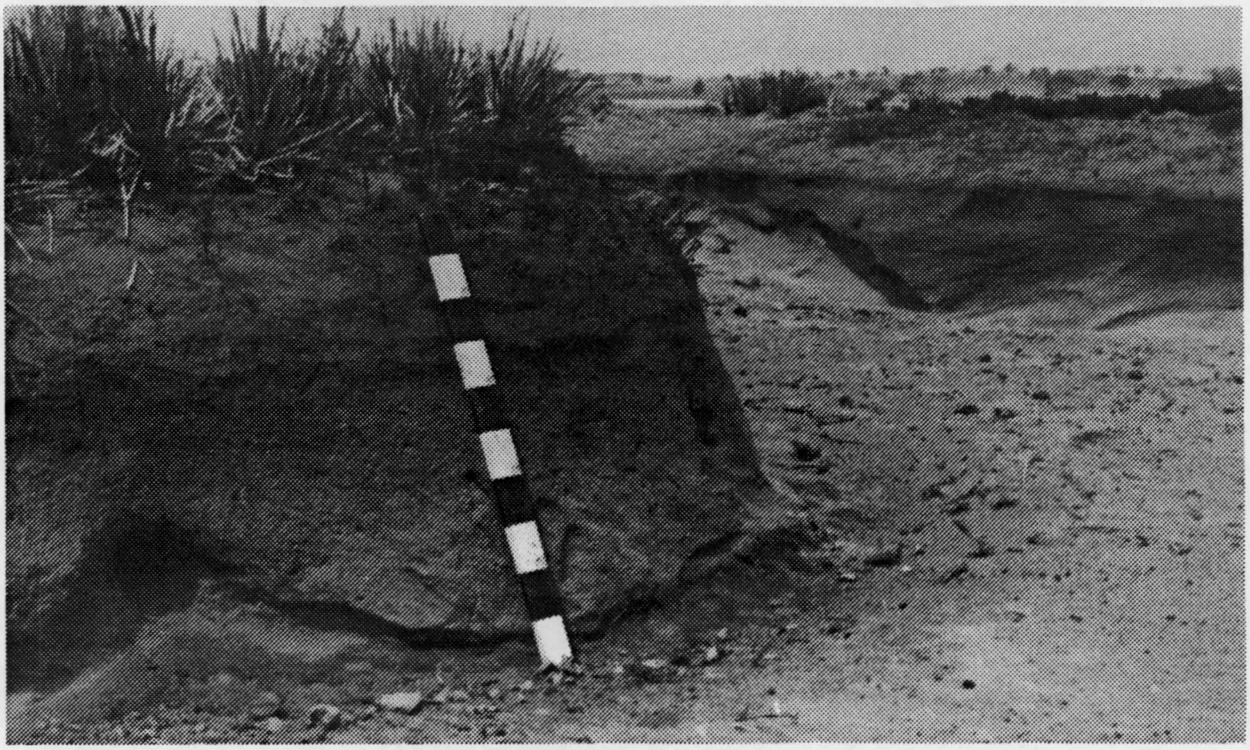
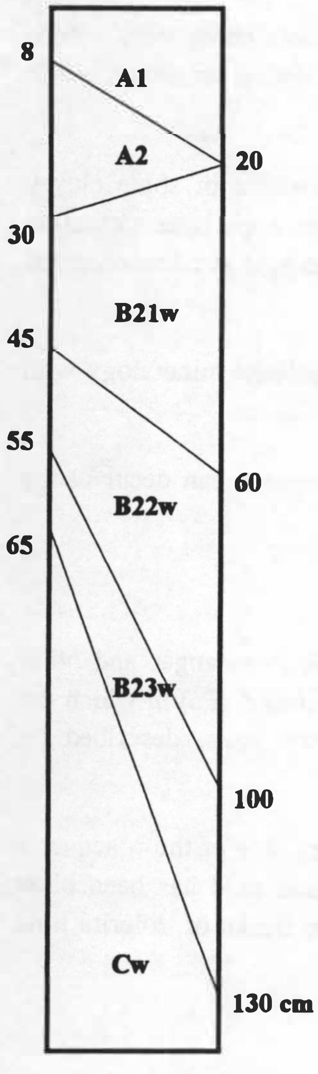


Plate 6.7 Panshanger soil profile in the Macquarie River valley. Note the burial of a previous topsoil (at 30-40 cm) by younger windblown sand deposits. These soils require careful management to prevent wind erosion (527800E, 5368600N AMG).

Environmental Features

Panshanger soils develop on windblown sand deposited as dunes, sand sheets and lunettes. These sand deposits are distributed on the modern flood plains, on the margins of lagoons, on river terraces and at the base of hill slopes. Due to the prevailing north-westerly wind patterns sand deposits accumulate on southern and eastern terrace surfaces of the main river valleys and bank up against west facing hillslopes. Extensive sand deposits exist on the lower western slopes of dolerite ridges in the upper Macquarie River valley north-west of Campbell Town.

Modal Profile - Panshanger Soil Profile Class



A1; 15 Very dark greyish brown (10YR 3/2 - 3/1); sand to loamy sand; no mottles; single grained or weak fine subangular blocky structure; sandy fabric; loose or very weak (moist and dry); common fine roots; field pH 5.8; salinity 0.0 dSm-1; clear smooth boundary;

Occasionally present, A2; grey to greyish brown (10YR 5/2 - 5/1); sand to loamy sand; single grained structure; loose (dry); field pH 6.5;

B21tw; Strong brown to dark yellowish brown (7.5YR 4/6 - 10YR 4/6); no mottles, some profiles may have few grey or brown mottles; sand to loamy sand; single grained or massive; sandy fabric; loose to very weak (dry); few fine roots; field pH 6.7; salinity 0.1 dSm-1; gradual smooth boundary;

B22w; Strong brown to yellowish brown (7.5YR 4/6 - 10YR 4/4 - 5/6); loamy sand; single grained or massive; sandy fabric; very weak (dry); few clay coatings and a few manganiferous soft segregations in some profiles; very few fine roots; field pH 7.0; salinity 0.1 dSm-1; gradual smooth boundary;

B23w or B3; Yellowish brown (10YR 5/6); sandy loam to loamy sand; single grained or massive; sandy fabric; very weak (dry); field pH 6.7; salinity 0.0 dSm-1;

Cw or Cgt; Variable yellowish brown colours, may be mottled; sand to loamy sand but some clay horizons; single grained or massive; loose (dry), some clay horizons firm; field pH 6.5; salinity 0.0 dSm-1;

Profile Variation

Soil pH is variable, some topsoils have pH as low as 4.7. Topsoil colours include 7.5YR 3/2, and soil textures range between sand and sandy loams. The topsoil structure may also be quite variable proportionate to the amount of organic matter and fines in the sandy matrix.

Regionally the depth of sand deposits is highly variable and the Panshanger profile class is defined only when depth of sandy material is greater than 75 cm.

In certain profiles, particularly those on the Woodstock Surface, soft lumps of iron-humus cemented coffee rock occur at 80-100 cm deep. In other areas, where siliceous sands have blown over dolerite, outcrops and floaters of bedrock may be common in the profile. Some profiles overlie heavy clay materials at variable depth (clay base).

General Chemical, Physical and Mineralogical Properties

Analytical data for five Panshanger profiles are given in Table 6.10. These deep sandy soils generally have < 15% clay throughout the upper 75 cm of the profile. Soil pH is generally slightly to moderately acid in the topsoil becoming neutral to slightly acid in the subsoil.

Organic carbon contents are generally low in the surface and drop sharply to very low levels below the topsoil. Total nitrogen is low to very low in most topsoils and very low in all subsoil horizons.

Total phosphorus contents are very low throughout the profile, while available phosphorus values range from low to medium in topsoils and decrease rapidly with depth. Available potassium levels are naturally low in these soils.

Cation exchange capacity is low or very low in all horizons with the exception of some clayey subsoils. However, the soils are not strongly leached having moderate to high base saturation (>40%). An exception being where A2 horizons are present, stronger leaching has often occurred with base saturation of less than 30%.

The clay mineral analysis of a single profile shows a mixed smectite and kaolinite mineralogy with minor goethite. Smectite, a swelling clay, increases with depth.

Panshanger soils do not generally suffer salinity problems although salt seepages can occur at the edge of some dunes where they overlie a clayey substrate.

Soil Mapping Units

Panshanger soils have been mapped in a range of soil complexes in which Panshanger and other soils are co-dominant (Ps-Bo, Ps-Ea, Ps-Ca, Ps-Mq, Ps-Wk) and as an association (Ps) in which the Panshanger soil profile class is dominant. The heavier textured Wilmore soils, described by Stephens *et al.* (1942), may occur on sand lunettes.

Panshanger soils are most extensive in the central map area along the eastern side of the Macquarie River valley, The valley faces into the prevailing north-westerly winds and sand has been blow downwind and been deposited on the eastern river terraces and against the flanks of dolerite hills which form the boundary of the river valley.

Land Use and Capability Class

Panshanger soils have traditionally been used for pasture and field crop production. These sandy free draining soils respond rapidly to early spring moisture and warmth. Presently they are increasingly being utilised for cropping for cereals, poppies and potatoes. Management problems include the control of both wind and water erosion. These soils are prone to erosion due their sandy field texture, weak soil structure and loose consistence. Panshanger soils are prone to drought due to a low water holding capacity and will require frequent applications of irrigation water under cropping systems.

Soil Profile Class "Property" Grid Reference (AMG)	Profile Number	Horizon	Sample Depth (cm)	pH water (1:5)	EC (d/sm)	Total P (mg/kg)	Avail. P (mg/kg)	Avail. K (mg/kg)	Org. Carb. (%)	Total N (%)	C/N Ratio	Ca	Mg	Na	K	Total Bases	CEC	BASE SAT (%)	ESP (%)	Ca/Mg Ratio
												(milli-equivalents / 100 grams of soil)								
Panshanger	SP 42	A1	0 - 8	5.2	0.05	125	13	115	2.40	0.180	13	2.44	0.75	0.06	0.14	3.4	5	71	1.2	3.26
"Leverington"	SP 42	A21	8 - 40	5.2	0.02	31	3	24	0.00	0.020	0	0.22	0.06	0.02	0.04	0.3	2	16	1.1	3.91
521700E	SP 42	A22	40 - 66	6.0	0.02	29	1	11	0.00	0.000		0.31	0.16	0.03	0.05	0.6	2	28	1.6	1.93
5375900N	SP 42	B21sm	66 - 80	6.1	0.08	39	0	76	0.10	0.010	10	0.87	4.25	0.62	0.18	5.9	8	75	7.8	0.21
	SP 42	B22t	80 - 115	5.7	0.19	50	0	57	0.10	0.010	10	1.44	13.06	2.04	0.18	16.7	22	77	9.4	0.11
	SP 42	BC	115 - 135	6.0	0.05	23	0	26	0.00	0.000		0.43	4.26	0.75	0.08	5.5	7	76	10.3	0.10
	SP 42	C	135 - 150	6.4	0.06	27	0	13	0.00	0.000		0.30	2.89	0.56	0.06	3.8	5	82	12.1	0.10
Panshanger	SP 54	A1	0 - 22	6.4	0.04	184	0	297	1.30	0.130	10	2.66	0.68	0.08	0.74	4.2	6	64	1.2	3.93
"Mt Joy"	SP 54	A3	22 - 48	6.6	0.04	107	0	216	0.30	0.060	5	6.11	4.53	0.19	0.47	11.3	16	71	1.2	1.35
515800E	SP 54	B21w	48 - 78	8.0	0.04	75	0	87	0.10	0.010	10	4.70	5.29	0.31	0.23	10.5	13	78	2.3	0.89
5377300N	SP 54	B22w	78 - 125	8.1	0.06	59	0	80	0.10	0.020	5	5.43	6.50	0.83	0.25	13.0	17	77	4.9	0.84
	SP 54	B23w	125 - 145																	
Panshanger	SP 88	A1	0 - 12	5.8	0.03	60	17	87	0.60	0.047	13	1.08	0.36	0.26	0.19	1.9	3	69	9.3	2.99
"Connorville"	SP 88	C1	12 - 55	5.7	0.02	30	15	73	0.20	0.000		0.58	0.20	0.27	0.17	1.2	1	85	18.7	2.89
511900E	SP 88	C2	55 - 75	5.5	0.02	15	6	40	0.10	0.000		0.35	0.18	0.28	0.11	0.9	1	76	23.1	1.97
5369400N	SP 88	C3wg	75 - 95	4.9	0.05	28	0	37	0.10	0.000		0.65	1.52	0.32	0.14	2.6	20	13	1.6	0.43
Panshanger	SP 102	A1	0 - 14	5.5	0.06	204	7	489	1.40	0.134	10	3.66	1.51	0.14	1.55	6.9	14	43	3.0	2.42
"St Johnstone"	SP 102	A3	14 - 30	6.5	0.06	211	6	472	0.60	0.055	11	5.01	2.10	0.42	0.75	8.3	14	61	3.1	2.39
530000E	SP 102	B21w	30 - 75	7.3	0.07	171	6	274	0.40	0.033	12	6.27	3.60	0.39	0.49	10.8	15	71	2.6	1.74
5361400N	SP 102	B22wg	75 - 95	8.4	0.06	96	2	102	0.10	0.000		5.28	4.12	0.51	0.24	10.2	13	78	3.9	1.28
Panshanger	H 18	A11	0 - 5	6.0		60			0.80	0.07	11	2.00	0.39	0.05	0.08	2.5	5	48	1.0	5.13
CSIRO	H 18	A12	5 - 13	5.4					0.30	0.04	8	0.70	0.20	0.05	0.05	1.0	2	48	2.5	3.50
"Valley Field"	H 18	B21w	13 - 43	5.5					0.10	0.01	8									
526303E	H 18	B22w	43 - 71	5.7																
5370511N	H 18	B23w	71 - 109	6.0																
	H 18	B3	119 - 140	6.1																
	H 18	C1	173 - 185	5.6		20						0.42	8.40	2.30	0.17	9.0	22	41	10.5	0.05
	H 18	C2	292 - 305	5.6								5.27	2.40	0.44	0.89	8.6				

Table 6.10 Analytical data for Panshanger soil profile class.

Soil Profile Class "Property" Grid Reference (AMG)	Profile Number	Horizon	Sample Depth (cm)	Gravel (of total) >2000 (µm) (%)	Sand Coarse >250 (µm) (%)	Sand Fine <250 (µm) (%)	Silt (%)	Clay (%)	Clay Mineralogy (Approximate weight %) Smectite	Kaolinite	Illite	Goethite
Panshanger	SP 42	A1	0 - 8	0	9	85	6	1				
"Leverington"	SP 42	A21	8 - 40	0	11	87	2	1				
521700E	SP 42	A22	40 - 66	0	8	77	14	1				
5375900N	SP 42	B21sm	66 - 80	0	9	72	5	14				
	SP 42	B22t	80 - 115	0	8	46	4	43				
	SP 42	BC	115 - 135	0	11	75	1	13				
	SP 42	C	135 - 150	0	14	73	12	1				
Panshanger	SP 54	A1	0 - 22	0	14	75	4	7	15	80	5	
"Mt Joy"	SP 54	A3	22 - 48	0	11	62	3	25	45	50		5
515800E	SP 54	B21w	48 - 78	0	12	68	3	17	65	30		5
5377300N	SP 54	B22w	78 - 125	0	19	55	3	22	60	35		5
	SP 54	B23w	125 - 145									
Panshanger	SP 88	A1	0 - 12	1	36	50	7	7				
"Connorville"	SP 88	C1	12 - 55	0	33	55	6	6				
511900E	SP 88	C2	55 - 75	0	34	47	9	10				
5369400N	SP 88	C3wg	75 - 95	3	17	24	6	53				
Panshanger	SP 102	A1	0 - 0	0	20	69	4	7				
"St Johnstone"	SP 102	A3	14 - 14	0	22	58	3	17				
530000E	SP 102	B21w	30 - 30	0	17	58	3	22				
5361400N	SP 102	B22wg	75 - 95	0	23	55	4	18				
Panshanger	H 18	A11	0 - 5	0	32	63	4	5				
CSIRO	H 18	A12	5 - 13	0	24	73	1	2				
"Valley Field"	H 18	B21w	13 - 43									
526303E	H 18	B22w	43 - 71									
5370511N	H 18	B23w	71 - 109									
	H 18	B3	119 - 140	0	17	77	3	2				
	H 18	C1	173 - 185	0	14	44	3	39				
	H 18	C2	292 - 305									

Table 6.10 Continued.

Panshanger soils occurring on undulating (3-10%) to moderately rolling (10-15%) land are Class 4. Although they have the potential for some cropping they are unsuitable for intensive cropping use because of the high wind and water erosion hazard, and due to the potential for rapid structural decline following loss of organic mater. Techniques such as no-till or minimum tillage, shelter belting, stubble retention and use of cover crops would be recommended when cropping these soils. Areas of steeper rolling land (15-32%) and/or where outcrops of dolerite are commonly occurring is classified as Class 5. These steeper areas would be unsuitable for cultivation because of slope angle and associated increased erosion hazard. In these areas shelter belts, agro-forestry, maintenance of pasture cover or block planting of deep rooted vegetation would be recommended.

6.4.2 Tara Soil Profile Class

Mapping Units Br-Ta, Ca-Ta (Note:- Tara soils are mapped as complexes only)

Reference

These soils were first described by Hubble (1947) and mapped on the Macquarie Estates soil map. Later Nicolls (1958b) described Tara series on the Longford reconnaissance soil map as part of the Brumby soil association.

Diagnostic Features

Tara soils are moderately well drained, reddish brown, gradational to duplex soils. Dark brown, very weak, sandy loam topsoils overlie dark reddish brown, sandy clay loam B1 horizons. The lighter textured upper profile overlies strong brown, sandy light clay or sandy clay loam B2 horizons which grade to similarly coloured, sandy light clay lower subsoils. Manganiferous soft segregations are scattered throughout the B horizons in most profiles.

Classification

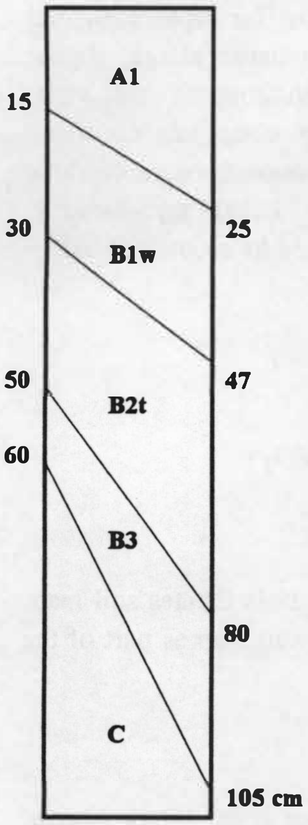
In the Factual Key of Northcote (1979) Tara soils classify as non-calcic gradational (Gn) or neutral red duplex soils (Dr) while in the system of Stace *et al.* (1968) they fit best into the non-calcic brown soils grouping.

In the new Australian soil classification system (Isbell, 1993) Tara soils are Haplic, Eutrophic, Red and Brown Kandosols or Chromosols.

Environmental Features

Tara soils form on gently undulating (1-3%) small rises on river terraces and flood plains. The soil field texture and the subdued nature of the dune landforms on which Tara soils develop indicate aeolian sands and clays are the parent materials. The small sandy rises on which the soils occur appear to represent the eroded remnants of older, once larger, sand dunes. Tara soils have thus developed on the truncated remnants of sand dunes explaining the smaller flatter nature of the landform and the somewhat heavier field textured of the Tara soils with respect to the Panshanger soils (Figure 6.1).

Modal Profile - Tara Soil Profile Class



A1; Dark brown (7.5YR 3/2); loam to sandy loam; weak fine subangular blocky structure breaking to single grained; sandy fabric; very weak (moist); field pH 5.4; 0.2 dSm-1; clear irregular boundary;

B1w; Dark reddish brown to yellowish red (5YR 3/3 - 4/6); sandy clay loam to sandy light clay; weak medium angular blocky structure or massive; sandy fabric; weak to firm (moist); few manganiferous soft segregations; field pH 5.9; 0.1 dSm-1; gradual or clear smooth boundary;

B2t; Strong brown (7.5YR 4/6); sandy clay loam to sandy light clay; massive breaking to weak medium angular blocky structure; earthy fabric; weak to firm (moist); few manganiferous soft segregations; field pH 6.8; 0.1 dSm-1; gradual smooth boundary;

B3; Strong brown to dark yellowish brown (7.5YR 4/6 - 10YR 3/4); sandy clay loam to sandy light clay; massive breaking to coarse angular blocky structure; earthy fabric; firm (moist); few manganiferous soft segregations; field pH 7.0; 0.1 dSm-1; gradual clear boundary;

C; Strong brown to dark yellowish brown (7.5YR 4/6 - 10YR 5/6); variable texture, loamy sandy to sandy clay; single grained; sandy fabric; few manganiferous soft segregations in some profiles; field pH 7.2; 0.0 dSm-1;

Profile Variation

Field textures in the B1 and B2 horizons are dominantly sandy clay loam, but range from sandy loam in the B1 to sandy clay in the B2. Profiles range from dominantly gradational to red duplex.

Soil pH may be as low as 4.2 in the topsoil in some profiles.

General Chemical, Physical and Mineralogical Properties

Analytical data are given for two profiles in Table 6.11. Profile SP 80 is a typical example of the gradational form and profile SP 79 of the duplex form.

Low to very low amounts of organic matter occur in the surface horizons and these decrease sharply with depth.

Available phosphorus and potassium values are medium in the topsoil. Available phosphorus values drop sharply to very low levels in the subsoil while available potassium values decrease irregularly with depth to generally low levels in the subsoils. Total phosphorus is medium to low in the topsoils and low to very low in the subsoils.

Cation exchange capacities are low in sandier horizons (<12 meq/100g) but moderate (12-25 meq/100g) in clayey horizons. The soils are only weakly leached having high base saturation (>60%).

Soil Profile Class "Property" Grid Reference (AMG)	Profile Number	Horizon	Sample Depth (cm)	pH water (1:5)	EC (d/sm)	Total P (mg/kg)	Avail. P (mg/kg)	Avail. K (mg/kg)	Org. Carb. (%)	Total N (%)	C/N Ratio	Ca (milli-equivalents / 100 grams of soil)	Mg	Na	K	Total Bases	CEC	BASE SAT (%)	ESP (%)	Ca/Mg Ratio
Tara	SP 79	A1	0 - 19	4.7	0.09	201	22	135	2.30	0.173	13	1.82	0.65	1.71	0.26	4.4	7	68	26.2	2.80
"Staunton"	SP 79	A31	19 - 38	5.8	0.04	56	2	40	0.30	0.012	25	1.93	0.66	0.64	0.09	3.3	4	80	15.4	2.91
510100E	SP 79	A32	38 - 50	6.4	0.04	42	0	13	0.10	0.000		1.53	0.69	0.41	0.07	2.7	3	89	13.6	2.21
5375800N	SP 79	B21tg	50 - 70	7.6	0.08	58	0	88	0.10	0.016	6	4.04	9.59	1.44	0.28	15.3	22	70	6.5	0.42
	SP 79	B22t	70 - 95	7.9	0.14	57	0	94	0.10	0.019	5	5.40	14.11	2.31	0.31	22.1	32	69	7.2	0.38
Tara	SP 80	A1	0 - 20	5.8	0.07	223	29	235	0.50	0.080	6	3.78	1.27	0.23	0.64	5.9	7	81	3.2	2.96
"Woodrising"	SP 80	B1w	20 - 35	5.4	0.04	144	14	100	0.12	0.040	3	2.45	0.90	0.29	0.35	4.0	6	68	5.0	2.70
513700E	SP 80	B2t	35 - 40	6.1	0.03	110	2	86	0.00	0.034	0	6.91	3.83	0.28	0.37	11.4	11	100	2.4	1.80
5377600N	SP 80	B3	40 - 60	6.8	0.03	72	2	86	0.00	0.020	0	3.79	2.59	0.32	0.36	7.1	8	87	4.0	1.46
	SP 80	C	60 - 90	7.0	0.03	46	2	57	0.00	0.012	0	2.54	1.92	0.26	0.27	5.0	5	101	5.2	1.33
	SP 80	2Ct	90 - 95	7.1	0.06	57	2	71	0.00	0.014	0	4.66	4.54	0.49	0.38	10.1	11	88	4.3	1.03

Soil Profile Class "Property" Grid Reference (AMG)	Profile Number	Horizon	Sample Depth (cm)	Gravel (of total) >2000 (μm) (%)	Sand Coarse >250 (μm) (%)	Sand Fine <250 (μm) (%)	Silt (%)	Clay (%)	Clay Mineralogy (Approximate weight %) Smectite	Kaolinite	Illite	Goethite
Tara	SP 79	A1	0 - 19	0	4	71	14	11				
"Staunton"	SP 79	A31	19 - 38	0	3	78	12	7				
510100E	SP 79	A32	38 - 50	0	3	80	12	5				
5375800N	SP 79	B21tg	50 - 70	0	2	37	16	45				
	SP 79	B22t	70 - 95	0	0	16	20	64				
Tara	SP 80	A1	0 - 20	0	4	71	9	16				
"Woodrising"	SP 80	B1w	20 - 35	0	3	75	8	13	30	65	5	
513700E	SP 80	B2t	35 - 40	0	4	65	6	25	30	60	5	5
5377600N	SP 80	B3	40 - 60	0	4	67	9	19	35	55	5	5
	SP 80	C	60 - 90	0	5	76	8	11				

Table 6.11 Analytical data for Tara soil profile class.

Soil Mapping Units

Tara soils are not mapped separately but occur in a complex pattern with both the Brumby soils (Br-Ta) and the Canola soils (Ca-Ta). In each map unit the Tara soils form on gentle sandy rises while the associated soils form on flatter sites. The main areas of occurrence are in the north-west of the survey area on terraces and flood plains adjacent to the Macquarie and Lake Rivers.

Land Use and Capability Class

Tara soils are most commonly used for pasture and field crops for sheep and cattle grazing. However, they have good potential for poppies, potatoes and other vegetable crops although they are of small area and mixed with poorer soils. Potential management problems are wind erosion and water erosion. The land on which these soils are dominant would be mapped as land capability Class 4.

6.5 Soils on Alluvial Fan Deposits

6.5.1 Glen Soil Profile Class

Map units Gl, Gl-Ca

Reference

Glen is a name introduced in this survey for soils forming on stony alluvial fans on the foot slopes of the Great Western Tiers. The name is taken from 'The Glen' a small basin in the upper Lake River area. Glen soils are correlated with the A4 soils of the Quamby reconnaissance soil map of Nicolls (1959). They resemble the Brumby soils but contain much dolerite stone.

Diagnostic Features

Glen soils and poorly drained and form on sloping alluvial fans at the edge of the Great Western Tiers. Very dark grey loam topsoils grade to light brownish grey, gravelly A2 horizons abruptly overlying mottled, yellowish brown, coarsely structured or massive heavy clay subsoils. The subsoils are only slowly permeable and this fact combined with the high amounts of through-flow induce overland flow during winter and spring.

Dolerite gravel and stones are distributed throughout the profile and also litter the soil surface.

Classification

Glen soils are yellow or gleyed podzolic soils in the system of Stace *et al.* (1968), and key out as yellow and brown duplex soils (Dy, Db) in the system of Northcote (1979).

They are tentatively classified as Bleached-Vertic, Chromosolic or Sodosolic, Redoxic Hydrosols in the new Australian soil classification system (Isbell, 1993).

Environmental Features

These soils form on gently undulating to rolling fan surfaces (3-32%) on the foot slopes of the Great Western Tiers. They form on dolerite gravel and detritus deposited by alluvial fan processes. Due to poor drainage characteristics and the considerable amount of through-flow of moisture from the adjacent Tiers escarpment, these soils remain moist most of the year. Rainfall is estimated at 700-900 mm/yr.

Profile Variation

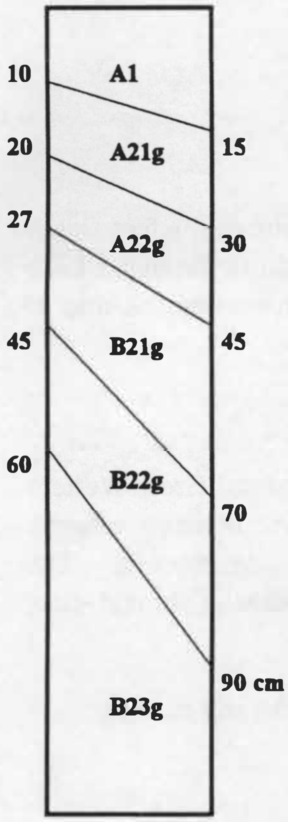
Stone content in the profiles is highly variable, and some profiles may incorporate ferruginous gravels in the A2 horizon. Paler coloured and more strongly mottled subsoils with humic to peaty topsoils occur in wetter areas. Less stony profiles grade toward Brumby soils.

General Chemical, Physical and Mineralogical Properties

No profiles from this soil class have been analysed.

These soils are related to the Brumby soil profile class with similar profile forms. The key differences are the gravelly profile, stony soil surface and that they develop on sloping fans.

Modal Profile - Glen Soil Profile Class



A1; Very dark grey (10YR 3/2); loam; moderate fine subangular blocky breaking to very fine subangular blocky structure; earthy fabric; weak (moist); some ferruginous gravel may occur; common subrounded dolerite coarse gravel; common fine roots; field pH 5.5; 0.0 dSm-1; clear boundary;

A21g; Light brownish grey (2.5Y 6/2); common olive brown mottles; heavy fine sandy loam; massive; sandy fabric; weak (moist); common subrounded dolerite gravel and cobbles; common fine roots; field pH 5.7; 0.0 dSm-1; clear boundary;

A22g; Light brownish grey (2.5Y 6/2); common olive brown mottles; sandy clay loam; massive; sandy fabric (weak moist); some ferruginous gravel may occur; common subrounded dolerite gravel and cobbles; few fine roots; field pH 5.8; 0.0 dSm-1; abrupt wavy boundary;

B21g; Yellowish brown to dark yellowish brown (10YR 5/6- 10YR 4/5); common greyish brown mottles; heavy clay; moderate very coarse angular blocky breaking to medium-coarse angular blocky structure; very firm (moist); rough ped fabric; common distinct clay coatings; few to common dolerite cobble and stones; few fine roots; field pH 5.9; 0.0 dSm-1; gradual boundary;

B22g; Yellowish brown (10YR 5/6); common greyish brown mottles; heavy clay; massive breaking to weak medium angular blocky structure; very firm (moist); earthy fabric; common distinct clay coatings; few dolerite stones; no roots; field pH 6.0; 0.0 dSm-1; gradual smooth boundary;

B23g, B3g; Yellowish brown (10YR 5/5); medium clay; massive; earthy fabric; very firm (moist); common distinct clay coatings; few manganiferous soft segregations; few to common dolerite stones; field pH 6.2; 0.0 dSm-1;

Soil Mapping Units

Glen soils are mapped as both soil associations and soil complexes. In the Glen association (Gl) the Glen soil profile class dominates with other soils such as Brumby forming on low river terraces or Eastfield soils forming on dolerite outcrops. In the soil complexes (Gl-Ca and Gl-Ps), Glen soils are co-dominant with Canola, occurring on flood plains, and Panshanger occurring on sand dunes. The Glen soils occur mainly in the west of the map sheet on fans which form on the foot slopes of the Great Western Tiers.

Land Use and Capability Class

These soils are currently utilised for pasture production with sheep and cattle grazing being the main enterprises. Minor areas are still under forest and timber clearance is presently being undertaken.

The stony nature of the soils will limit cultivation, and surface flooding is common in winter. The moderate rainfall (>700 mm/yr) and abundant through-flow of soil moisture off the slopes of the Great Western Tiers make these excellent summer pasture soils.

Land in which Glen soils are dominant would mostly be mapped as land capability Class 5 with some areas of Class 4 (Plate 6.8). Areas which are very stony or are waterlogged for long periods would be mapped as Class 5 land while areas of Class 4 land, which can sustain limited cropping enterprises, occur where stoniness and drainage limitations are less pronounced.

Plate 6.8 Glen soils forming on an alluvial fan at the foot of the Great Western Tiers with Canola soils on the flood plain below. Note the stony surface and recent forest clearance (506400E, 5361500N AMG).

6.6 Soils on Basalt

6.6.1 Breadalbane Soil Profile Class

Mapping Units Bd, Bd-Ps

Reference

The name Breadalbane was given by Loveday and Dimmock (1952) and Dimmock and Loveday (1953) to a series of soils forming on low basalt hills in the Conara-Campbell Town and Relbia-Western Junction areas.

Diagnostic Features

Breadalbane soils are shallow, gradational to weakly duplex, brown soils which develop on low Tertiary basalt hills. Scattered stones or gravels of basalt are common at the surface with occasional rock outcrops, particularly on hilltops.

Well structured, dark brown to black, friable, clay loam topsoils grade to brown or reddish brown, more coarsely structured, medium clay subsoils. A clear break to weakly weathered basalt occurs at about 50-70 cm. Breadalbane profiles are moderately well drained.

Classification

Breadalbane soils have been classified by various authors (Dimmock and Loveday, 1953; Nicolls, 1958; Leamy, 1961) as brown earths and euchrozems but most commonly as non-calcic brown soils in the system of Stace *et al.* (1968). In the Northcote (1979) system these are generally non-calcic gradational soils (Gn) trending to weak duplex brown soils (Db).

In the new Australian soil classification system (Isbell, 1993) these soils are dominantly Haplic or Vertic, Eutrophic, Brown Dermosols. Profiles with a stronger texture contrast classify as Haplic or Vertic, Eutrophic, Brown Chromosols.

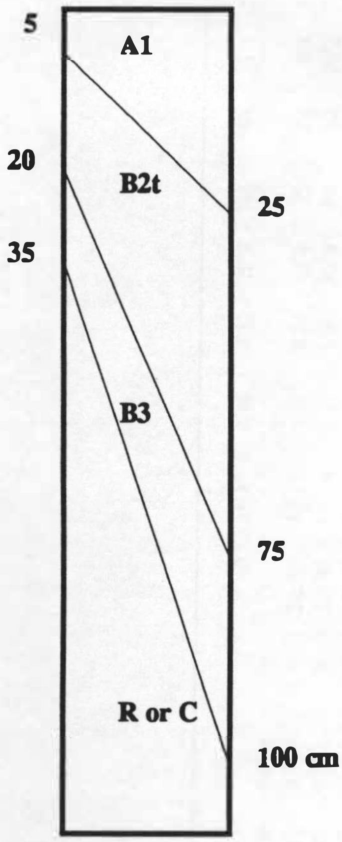
Environmental Features

Breadalbane soils form on Tertiary basalt lavas on gently undulating (3-10%) to rolling (10-32%) low hills in the eastern part of the survey area, particularly around Conara and Campbell Town. Annual rainfall is between 500 and 700 mm, runoff is moderately rapid and profiles are moderately permeable. A report on the basaltic soils of Campbell Town by Dimmock and Loveday (1953) provides a detailed soil map covering 1000 hectares adjacent to the Midland highway between Campbell Town and 'Wanstead'.

Profile Variation

Profiles range from gradational to weakly duplex. Soil depth and stone content can be quite variable. Profiles in bedrock hollows and depressions, where drainage is restricted, become darker in colour and exhibit more pronounced vertic features. These profiles correlate with the Wanstead soil series described by Dimmock and Loveday (1953). Wanstead soils have not been mapped seperately at the present scale of mapping but are included within the Breadalbane association and Breadalbane - Panshanger complex.

Modal Profile - Breadalbane Soil Profile Class



A1; Dark brown to black (7.5YR 3/3 - 10YR 2/1); clay loam or heavy loam; moderate to strong fine subangular blocky breaking to very fine subangular blocky structure; rough ped fabric; very weak (moist); few coarse gravels of basalt; common fine roots; field pH 5.9; salinity 0.1 dSm-1; clear to abrupt smooth boundary;

Some profiles A12 or A3; Dark brown to black (7.5YR 3/4 - 10YR 2/1); light or medium clay; structure as above; field pH 6.5; salinity 0.1 dSm-1;

B2t; Dark reddish brown to brown or yellowish brown (5YR 3/2 - 10YR 5/4); few yellowish brown mottles in some profiles; medium or heavy clay; moderate to strong medium or coarse angular blocky breaking to fine angular blocky structure; rough ped fabric; firm (moist); common distinct clay skins, slickensides in some profiles; few to common coarse gravels of basalt; few fine roots; field pH 7.0; salinity 0.1 dSm-1; gradual smooth boundary;

B3, BC; Yellowish brown to dark reddish brown also light olive brown (10YR 5/8 - 5YR 3/4); medium or heavy clay; moderate medium to coarse angular blocky structure with coarse to medium structure in some profiles; rough ped fabric; firm (moist) slickensides in some profiles; few to common coarse gravels of basalt; very few fine roots; field pH 7.3; salinity 0.1 dSm-1; sharp boundary;

R or C; Weathered basalt bedrock.

General Chemical, Physical and Mineralogical Properties

Chemical analysis were undertaken on three profiles SP15, SP111, and SP29. Additional chemical data come from the CSIRO soil profiles H52 and H87 (Table 6.12).

Soil pH is slightly acid in the surface horizons becoming neutral to slightly alkaline in the B2 horizons.

Available potassium contents are moderate but variable in the topsoil and decrease slowly with depth. Available phosphorus is low to very low in the topsoil and very low in the subsoils. Phosphatic fertilisers will be required if cropping these soils.

Soil organic matter contents are low to medium in the topsoil and decrease rapidly with depth to low contents in the subsoil. Soil nitrogen is medium to low in the topsoil and decreases sharply with depth to low or very low levels in the subsoil.

Cation exchange capacity (CEC) is moderate (20%) in the topsoil and increases to high levels in the subsoil (35-50%). These soils are only weakly leached as base saturation is high in all horizons (>60%) and is dominated by even amounts of calcium and magnesium.

The clay mineralogy of these soils is variable. Some profiles are dominated by smectite clays (50-60%) while others are dominated by kaolinite (20-60%) or interlayered kaolin-smectite (20-100%). Goethite is also present in small amounts (5-10%).

Soil Profile Class "Property" Grid Reference (AMG)	Profile Number	Horizon	Sample Depth (cm)	pH water (1:5)	EC (d/sm)	Total P (mg/kg)	Avail. P (mg/kg)	Avail. K (mg/kg)	Org. Carb. (%)	Total N (%)	C/N Ratio	Ca	Mg	Na	K	Total Bases	CEC	BASE SAT (%)	ESP (%)	Ca/Mg Ratio
												(milli-equivalents / 100 grams of soil)								
Breadalbane	SP 15	A1	0 - 16	5.8	0.10	208	7	225	3.40	0.296	11	8.78	3.22	0.30	0.70	13.0	19	68	1.6	2.73
"Woorak"	SP 15	B2t	16 - 28	6.7	0.06	137	0	178	1.80	0.168	11	19.72	11.88	0.59	0.59	32.8	43	76	1.4	1.66
531400E																				
5375900N																				
Breadalbane	SP 29	A1	0 - 25	6.1	0.09	115	1	116	1.30	0.154	8	8.42	5.48	0.62	0.42	14.9	18	84	3.5	1.54
"Vaucluse"	SP 29	B21t	25 - 55	7.2	0.10	88	0	123	0.70	0.096	7	16.77	14.06	2.00	0.55	33.4	39	85	5.1	1.19
537300E	SP 29	B22t	55 - 75	8.2	0.46	110	0	95	0.50	0.069	7	19.07	17.87	4.17	0.49	42.0	37	114	11.3	1.07
5373900N	SP 29	BC	75 - 90	8.6	0.89	57	0	102	0.30	0.037	8	23.66	19.86	5.92	0.51	50.7	41	123	14.3	1.19
Breadalbane	SP 111	A1	0 - 11	5.8	0.06	212	15	739	3.37	0.302	11	8.14	3.99	0.36	1.73	14.2	19	73	1.9	2.04
"Stockwell"	SP 111	A3	11 - 20	6.6	0.08	156	4	817	2.00	0.165	12	20.22	14.06	0.62	2.33	37.2	44	85	1.4	1.44
528850E	SP 111	B2t	20 - 45	7.7	0.08	131	3	540	1.37	0.100	14	22.69	16.97	0.75	1.50	41.9	49	86	1.5	1.34
5368750N																				
Breadalbane	H 52	A1	0 - 5	6.1		150			3.27	0.318	10	12.70	14.90	1.66	1.25	28.9	44	66	3.8	0.85
CSIRO	H 52	B21	6 - 23	6.7					1.75	0.203	9	18.00	23.50	3.20	1.03	42.5	58	74	5.6	0.77
Campbell Town	H 52	B22	23 - 38	7.9		100			1.58	0.183	9	18.40	32.20	5.00	1.00	51.6	62	83	8.1	0.57
537355E	H 52	B3	41 - 58	9.3					0.70	0.065	11	2.00								
5366764N																				
Breadalbane	H 87	A1	0 - 5	6.3		700			4.90	0.495	10	22.40	10.50	0.03	0.75	33.7	49	69	0.1	2.13
CSIRO	H 87	A3	5 - 10	6.6		640			3.00	0.327	9	25.00	11.10	0.25	1.20	37.3	49	76	0.5	2.25
Campbell Town	H 87	B2	11 - 27	7.0		690			1.50	0.165	9	25.80	16.70	0.13	0.29	42.8	50	85	0.3	1.54
537346E	H 87	B3	27 - 39	7.2					0.90	0.084	11									
5364910N	H 87	C	39 - 55	7.3								24.40	11.70	0.46	0.15	36.3	41	89	1.1	2.09

Table 6.12 Analytical data for Breadalbane soil profile class

Soil Profile Class Grid Reference (AMG)	Profile	Horizon	Sample (cm)	Gravel >2000 (μm) (%)	Sand >250 (μm) (%)	Sand <250 (μm) (%)	Silt (%)	Clay (%)	Clay Mineralogy (Approximate weight %) Smectite	Kaouinite	Goethite	Kaolin-Smectite	Haematite	Inter-Stratified
Breadalbane	SP 15	A1	0 - 16	1	5	48	26	21		80		20		
"Woorak"	SP 15	B2t	16 - 28	1	1	15	8	77				100		
531400E														
5375900N														
Breadalbane	SP 29	A1	0 - 25	3	9	44	14	33	40	55	5			
"Vaucluse"	SP 29	B21t	25 - 55	0	3	16	13	68	45	55				
537300E	SP 29	B22t	55 - 75	0	2	14	21	63	40	60				
5373900N	SP 29	BC	75 - 90	0	1	9	23	68						
Breadalbane	SP 111	A1	0 - 0	0	2	52	12	34						
"Stockwell"	SP 111	A3	11 - 20	0	1	13	7	79						
528850E	SP 111	B2t	20 - 45	1	1	11	4	85						
5368750N														
Breadalbane	H 52	A1	0 - 5	3	5	27	22	40						
CSIRO	H 52	B21	6 - 23	0	2	15	13	67						
Campbell Town	H 52	B22	23 - 38	15	2	13	14	68	50-65	10-20			10-20	10-20
537355E	H 52	B3	41 - 58	0										
5366764N														
Breadalbane	H 87	A1	0 - 5	21	3	31	32	22						
CSIRO	H 87	A3	5 - 10	66	7	33	19	35						
Somerset	H 87	B2	11 - 27	55	14	27	8	45	50-65	10-20			5-10	10-20
537346E	H 87	B3	27 - 39											
5364910N	H 87	C	39 - 55											

Table 6.12 Continued.

Soil Mapping Units

Breadalbane soils are mapped as both a soil association and as a soil complex. In the soil association the Breadalbane soils are dominant with other soils such as Panshanger occurring on dunes, Campbell Town soils on better drained sites and Wanstead series soils (Dimmock and Loveday, 1953) in bedrock hollows and depressions. In the soil complex Breadalbane and Panshanger soils are co-dominant and have been mapped together.

Breadalbane soils have been mapped in the lower Fingal Valley and between Conara and Campbell Town in the south-west of the survey area.

Land Use and Capability Class

Breadalbane soils are mostly utilised for pasture with limited areas of cereal crops. Although they are shallow and slightly stony they have good topsoil structure and are moderately well drained.

Breadalbane soils have moderate natural fertility, although the chemical data suggest they would respond well to applications of phosphorous and nitrogen fertilisers. Cereal and poppy crops should do well on these finely structured soils although irrigation would be required.

Land on which Breadalbane soils are dominant would be mapped mostly as Class 4 land with some areas of Class 5 land. These soils have well developed topsoil structure and in relatively stone free areas they could be regularly cropped and are Class 4 land. However, the climatic limitations of low rainfall (<700 mm) and the risk of out of season frosts restrict the range of crops that can be grown. In areas of excessive stoniness or where rock outcrops occur eg, around knolls or crests of small hills, Class 5 land would be mapped.

6.6.2 Campbell Town Soil Profile Class

Mapping Units Cm, Cm-Bd, Cm-Ps

Reference

The original name Campbelton was used by Dimmock and Loveday (1953) for a series of soils developed on basalt near Campbell Town. This unusual spelling has been altered to Campbell Town soil profile class in this survey to remove confusion.

Diagnostic Features

Campbell Town soils are moderately deep, well drained, friable, red or reddish brown gradational soils which form on gently undulating (3-10%) to rolling (10-32%) basalt hills. Topsoils are moderately well structured, dark reddish brown, clay loams of about 5-10 cm thickness. They overlie reddish brown, light clay subsoils with moderate soil structure. Profiles grade to either mottled grey and red clays on the lateritic residual surfaces or decomposing basalt in other areas. Commonly, stones and some ferruginous gravel are present on the surface.

Classification

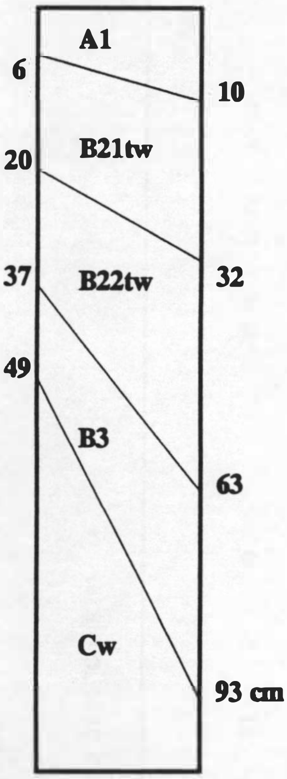
Campbell Town soils have been classified as both red earths and krasnozems (CSIRO soil data base). In the system of Northcote (1979) Campbell Town soils are pedal non-calcic gradational soils (Gn).

In the new Australian soil classification system (Isbell, 1993) these soils are Ferric or Haplic, Eutrophic, Red Ferrosols.

Environmental Features

Campbell Town soils form on the gently undulating (3-10%) to rolling (10-32%) crests, shoulders and side slopes of low basalt hills at elevations of approximately 180 to 220 m in the areas near Campbell Town. Rainfall is less than 600 mm/yr. Profiles are freely drained and runoff is moderately rapid.

Modal Profile - Campbell Town Soil Profile Class



A1; Dark reddish brown to very dark greyish brown (5YR 3/2 - 10YR 3/2); loam or clay loam; moderate fine granular or subangular blocky structure; very weak (moist); few to common coarse gravels and cobbles of basalt and ferricrete; field pH 5.8; salinity 0.0 dSm-1; clear smooth boundary;

B21tw; Dark reddish brown to reddish brown (2.5YR 3/4 to 5YR 4/4); light clay; moderate fine to medium angular blocky structure; weak (moist); few to common coarses gravels and cobbles of basalt and ferricrete; field pH 6.2; salinity 0.1 dSm-1; gradual smooth boundary;

B22tw; Dark reddish brown to brown (2.5YR 3/4 to 7.5YR 4/4); common grey mottles in some profiles; light or medium clay; moderate medium angular blocky structure breaking to finer (< 10 mm) blocky; weak (moist); few to common stones of basalt and ferricrete; field pH 6.9; salinity 0.1 dSm-1; gradual smooth boundary;

B3 or **B23**; Yellowish brown to olive brown (10YR 4/4 to 2.5Y 3/5); common red or brown mottles in some profiles; light or medium clay; weak fine to medium angular blocky structure; weak (moist); few to common stones of basalt and ferricrete; field pH 7.2; salinity 0.3 dSm-1; gradual boundary;

Cw or **R**; Bluish/greenish grey or dark red (5BG 7/1 - 5B 6/1 or 10R 3/6); common bright yellow or strong brown coarse mottles, or if matrix red then grey mottles; kaolinsed clay or weathered basalt bedrock; if clayey field pH 7.7 and salinity 0.8 dSm-1.

Profile Variation

Profile depth and stone content are the main variable features. Topsoil structure ranges from blockly to granular and may be only weakly developed in some profiles. Common medium ferrigenous nodules in the upper horizons of many profiles.

General Chemical, Physical and Mineralogical Properties

The analytical data given in Table 6.13 come from CSIRO soil profile H30. Topsoils are slightly acid with neutral to slightly alkaline subsoils.

Both total nitrogen and organic carbon contents are medium to low in the topsoil and very low in the subsoil.

Soil Profile Class "Property" Grid Reference (AMG)	Profile Number	Horizon	Sample Depth (cm)	pH water (1:5)	EC (d/sm)	Total P (mg/kg)	Avail. P (mg/kg)	Avail. K (mg/kg)	Org. Carb. (%)	Total N (%)	C/N Ratio	Ca	Mg	Na	K	Total Bases	CEC	BASE SAT (%)	ESP (%)	Ca/Mg Ratio
												(milli-equivalents / 100 grams of soil)								
Campbell	H 30	A11	0 - 5	6.4		1040			2.30	0.260	9	9.30	3.80	0.27	1.40	14.5	29	49	0.9	2.45
Town	H 30	A12	5 - 13	6.4		1040			2.10	0.240	9									
CSIRO	H 30	B1	14 - 30	7.1					0.90	0.100	9	5.50	3.90	0.28	0.34	9.7	17	58	1.7	1.41
Campbell Town	H 30	B21	30 - 51	7.5		910			0.43	0.041	10									
540089E	H 30	B22	56 - 76	7.5					0.30	0.035	9									
5361198N	H 30	B23	81 - 94	7.8		270			0.20	0.031	6	3.50	5.30	1.30	0.23	9.0	15	61	8.7	0.66
	H 30	B24	102 - 119	8.3					0.10	0.017	6									
	H 30	B31	122 - 145	8.2		110						5.40	11.40	4.00	0.24	17.0	21	80	18.9	0.47
	H 30	B32	152 - 203	7.9																
	H 30	Cw	259 - 269	7.7																

Soil Profile Class "Property" Grid Reference (AMG)	Profile Number	Horizon	Sample Depth (cm)	Gravel (of total) >2000 (μm) (%)	Sand Coarse >250 (μm) (%)	Sand Fine <250 (μm) (%)	Silt (%)	Clay (%)	Clay Mineralogy Kaolinite	Haematite	Goethite
									(Approximate weight %)		
Campbell	H 30	A11	0 - 5	0	11	35	25	27			
Town	H 30	A12	5 - 13	0	11	34	24	27			
CSIRO	H 30	B1	14 - 30	0	3	33	17	44	65-80	20-30	
Campbell Town	H 30	B21	30 - 51								
540089E	H 30	B22	56 - 76								
5361198N	H 30	B23	81 - 94	45	24	31	9	36			
	H 30	B24	102 - 119								
	H 30	B31	122 - 145	0	8	13	5	70	65-80	10-20	10-20
	H 30	B32	152 - 203								
	H 30	Cw	259 - 269								

Table 6.13 Analytical data for Campbell Town soil profile class.

The cation exchange capacity (CEC) is high (>25 meq/100g) in the topsoil and medium (12-25 meq/100g) in the subsoil. Base saturation percentage is medium (40-60%) in the topsoil due to clay and organic matter and high (>60%) in the subsoil due to high clay content.

The clay mineralogy of these soils is dominated by kaolinite (65-80%), haematite (10-30%) and goethite (10-20%).

Soil Mapping Units

Campbell Town soils have been mapped both as a soil association (Cm) and as a soil complex (Cm-Bd). In the soil association Campbell Town soils are the dominant profile with other soils such as Panshanger occurring on sand dunes and Breadalbane on poorer drained slopes. In the soil complex, Cm-Bd, Campbell Town and Breadalbane soils are co-dominant and have been mapped together.

Campbell Town soils occur in the south-west of the survey area on low hills in the immediate vicinity of Campbell Town.

Land Use and Capability Class

Campbell Town soils are suitable for cropping but their versatility is restricted due to limitations of stoniness, rock outcrops, slope angle and climate. They occur in one of the driest regions of Tasmania and are thus prone to drought. Irrigation water is scarce and farm dam storage is continually increasing in the area to address this problem.

The land on which these soils are dominant are either Class 4 or Class 5 land. The climatic limitations of low rainfall and the risk of out of season frosts, together with the amount of stones and rock outcrops, restrict the versatility of this land for agricultural use. Areas which are excessively stony, with many rock outcrops or on steeper slopes are Class 5 land.

6.7 Soils on Dolerite

6.7.1 Eastfield Soil Profile Class

Mapping Units Ea, Ea-Ps

Reference

The name Eastfield was given by Stephens *et al.* (1942) to a series of podzolic soils forming on dolerite hill slopes in the Cressy-Longford area.

Diagnostic Features

Eastfield soils have a greyish brown loam or fine sandy loam surface with weak structure, on a light grey fine sand to sandy loam A2 horizon often with many rounded medium ferruginous nodules. At the base of the A2 at about 30 cm a sharp change to a brown or yellowish brown, slightly mottled, tough clay (B2) occurs. The B2 horizons are very coarsely structured and hard when dry and plastic when wet. Partially weathered dolerite fragments and loose stones are common throughout the profile.

Outcrops of dolerite are common within the map unit area and the Eastfield profiles are generally intermediate or shallow (<80 cm) and form on dolerite bedrock. Eastfield soils are imperfectly drained and have slowly permeable subsoils. Runoff is usually moderately rapid to rapid.

Classification

In the system of Stephens (1962) and Stace *et al.* (1968) Eastfield soils have been classified as grey-brown podzolics by Dimmock (1964 unpublished); Nicolls (1958) and Leamy (1961). They are brown or dark duplex soils (Db or Dd) in the Factual Key of Northcote (1979).

In the new Australian soil classification system (Isbell, 1993) these soils are Vertic or Ferric, Eutrophic, Brown Chromosols and Sodosols.

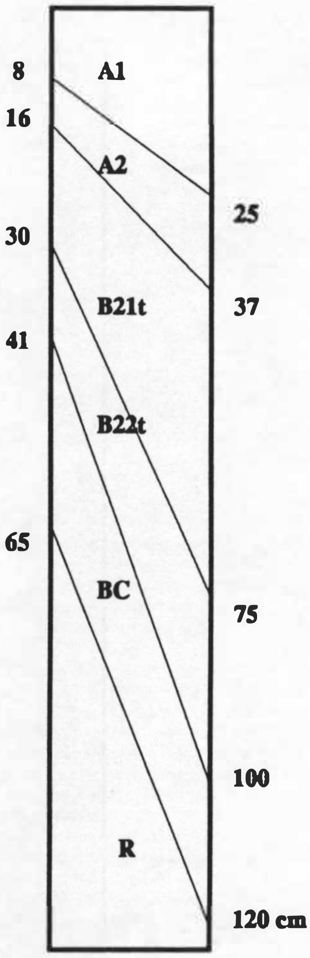
Environmental Features

Eastfield soils are imperfectly drained soils and form on dolerite hill country on rolling (10%-32%) to steep slopes (32-56%), while the Miscellaneous soils related to Eastfield (MEa) occur on steep (32%-56%) to very steep slopes (>56%). Eastfield soils are typically slightly stony and rest on bedrock at about 60-80 cm depth. Eastfield soils occur on dolerite hillslopes in the central basin, the Macquarie Tier and the footslopes of both the Ben Lomond Plateau and the Great Western Tiers. The Eastfield soils form under a higher and more effective rainfall, (>600 mm/yr), than the related Bloomfield soils which tend to form in the drier regions of the survey area (<600 mm/yr).

Profile Variation

The clay subsoil may rest sharply on weakly weathered dolerite boulders at variable depth, or there maybe a gradual change to decomposing dolerite at about 60-80 cm. The abundance of stones and boulders in the profiles is variable ranging from a few stones to abundant boulders. Subsoil colours are variable ranging from yellowish grey with red mottling to brown and yellowish brown with dark grey mottling.

Modal Profile - Eastfield Soil Profile Class



A1; Very dark grey to very dark greyish brown (10YR 3/1 - 10YR 3/2); loam to sandy loam; weak fine to medium subangular blocky structure; sandy or earthy fabric; very weak (moist); variable amounts of dolerite stones and boulders; common fine roots; field pH 5.5; salinity 0.1 dS-m; clear smooth boundary;

A2; Dark greyish brown to greyish brown (10YR 4/2 - 5/2); sandy loam to loamy sand; single grained structure or very weak medium angular blocky structure; sandy fabric; very weak (moist); common ferruginous nodules in some profiles; variable amounts of dolerite stones and boulders; common fine roots; field pH 5.7; salinity 0.0 dS-m; abrupt smooth boundary;

B21t; Thick; brown to yellowish brown (10YR 4/3 - 10YR 5/4); medium to heavy clay; common dark red or reddish brown mottles in some profiles; moderate coarse or very coarse angular blocky structure; very firm (moist); rough ped fabric; few slickensides and common distinct clay skins; very few ferruginous nodules in some profiles; variable amounts of dolerite stones and boulders; few fine roots; field pH 6.8; salinity 0.0 dS-m; clear boundary;

B22t; Dark reddish brown to olive brown (5YR 3/3 - 2.5Y 4/4); heavy clay; common red to reddish brown mottles in some profiles; moderate coarse angular blocky structure; strong (moist); rough or smooth ped fabric; common distinct slickensides and common distinct clay skins; very few ferruginous nodules in some profiles; variable amounts of dolerite stones and boulders; very few fine roots; field pH 7.4; salinity 0.1 dS-m; clear boundary;

BC, B3, Cw; Thick; light olive brown to greyish brown (2.5Y5/4 - 2.5Y 4/3); light clay to medium clay; few strong brown mottles in some profiles; massive; earthy fabric; strong (moist); common distinct slickensides; common calcareous soft segregations in some profiles; variable amounts of dolerite stones and boulders; field pH 7.0; salinity 0.0 dS-m;

R; Dolerite bedrock; clayey matrix may penetrate down cracks.

General Chemical, Physical and Mineralogical Properties

Analytical data for two Eastfield soil profiles are listed in Table 6.14. Soil pH is generally moderately acid at the surface increasing to neutral or slightly alkaline in the subsoil but may become moderately alkaline in profiles with carbonate occurring in the BC or C horizon.

Organic carbon content is medium (2-4%) in the topsoil but drops sharply to low or very low contents in the A2 horizon and in the subsoil horizons.

Total nitrogen content is low to medium in the topsoil and decreases sharply to very low contents in the A2 horizon and subsoil.

Available potassium contents are medium to high in the topsoil but low to medium in the A2 horizon. In the subsoil available potassium contents are medium to high.

Soil Profile Class "Property" Grid Reference (AMG)	Profile Number	Horizon	Sample Depth (cm)	pH water (1:5)	EC (d/sm)	Total P (mg/kg)	Avail. P (mg/kg)	Avail. K (mg/kg)	Org. Carb. (%)	Total N (%)	C/N Ratio	Ca	Mg	Na	K	Total Bases	CEC	BASE SAT (%)	ESP (%)	Ca/Mg Ratio
												(milli-equivalents / 100 grams of soil)								
Eastfield	SP 12	A1	0 - 8	5.4	0.14	166	15	348	2.00	0.194	10	3.19	1.53	0.33	0.88	5.9	10	61	3.4	2.08
"Kelvin Grove"	SP 12	A2	8 - 18	6.4	0.04	115	2	193	0.80	0.096	8	2.69	1.78	0.48	0.40	5.4	9	57	5.1	1.51
540600E	SP 12	B21tg	18 - 60	8.1	0.11	70	0	491	0.70	0.093	8	9.64	18.65	4.57	1.38	34.2	42	82	11.0	0.52
5376300N	SP 12	B22t	60 - 70	8.9	0.15	122	0	441	0.70	0.075	9	10.09	20.63	5.91	1.25	37.9	44	86	13.4	0.49
	SP 12	Ctk	70 - 80	9.3	0.45	132	0	324	0.40	0.039	10	17.15	17.25	5.36	0.85	40.7	34	119	15.7	0.99
Eastfield	SP 43	A1	0 - 16	5.8	0.08	386	7	62	4.10	0.310	13	11.21	4.08	0.21	0.18	15.7	20	77	1.0	2.75
"Leverington"	SP 43	A2	16 - 23	6.3	0.03	143	0	44	1.30	0.123	11	7.15	3.90	0.16	0.14	11.4	16	71	1.0	1.83
520800E	SP 43	B21t	23 - 47	6.8	0.04	124	0	123	0.70	0.100	7	15.04	15.16	0.53	0.40	31.1	38	81	1.4	0.99
5375300N	SP 43	B22t	47 - 65	7.4	0.04	109	0	123	0.60	0.070	9	14.17	15.53	0.78	0.38	30.9	41	76	1.9	0.91
	SP 43	B3	65 - 80	8.2	0.05	79	0	142	0.10	0.020	5	15.37	16.69	1.23	0.36	33.7	42	81	2.9	0.92

Soil Profile Class "Property" Grid Reference (AMG)	Profile Number	Horizon	Sample Depth (cm)	Gravel (of total) >2000 (µm) (%)	Sand Coarse >250 (µm) (%)	Sand Fine <250 (µm) (%)	Silt (%)	Clay (%)	Clay Mineralogy (Approximate weight %) Smectite	Kaolinite	Illite
Eastfield	SP 12	A1	0 - 8	0	14	50	18	18		80	20
"Kelvin Grove"	SP 12	A2	8 - 18	0	18	48	16	18	25	65	10
540600E	SP 12	B21t	18 - 60	0	4	17	11	68	80	20	
5376300N	SP 12	B22t	60 - 70	6	13	17	12	59	85	15	
	SP 12	B3	70 - 80	4	28	16	9	47			
Eastfield	SP 43	A1	0 - 16	0	4	54	29	14			
"Leverington"	SP 43	A2	16 - 23	0	6	52	26	17			
520800E	SP 43	B21t	23 - 47	0	2	30	13	56			
5375300N	SP 43	B22t	47 - 65	1	2	27	15	56			
	SP 43	B3	65 - 80	1	2	41	10	47			

Table 6.14 Analytical data for Eastfield soil profile class.

Available phosphorus contents are medium to low in topsoils and low to very low in the A2 horizon. In the clayey subsoils available phosphorus is extremely low. Eastfield soils would greatly benefit from phosphatic fertilisers.

The cation exchange capacity (CEC) is low (<12%) in the surface horizons (A1 + A2) and base saturation is generally high (>60%) with calcium the dominant cation. In the clay subsoils the CEC is high (>25%), due to high clay content, and base saturation is high with magnesium and calcium the dominant cations.

Soil Mapping Units

Eastfield soils are mapped as soil associations and soil complexes. In the soil association (Ea) Eastfield soil profile class dominates with associated soils such as Panshanger occurring on sand banks flanking footslopes and Canola in small drainage lines. Eastfield soils may grade toward stony brown soils of the Bloomfield soil profile class on drier, sunnier slopes (northerly aspects). In the soil complex (Ea-Ps) the Eastfield and Panshanger soil profile classes are both dominant and occur in an intricate pattern.

Land Use and Capability Class

Eastfield soils are most commonly used for grazing and forestry. They are generally unsuitable for cultivation due to stoniness.

The presence of acid topsoils and low phosphorus contents suggest lime and phosphatic fertilisers would prove beneficial to pasture production.

Land on which Eastfield soils are dominant is either Class 5 or Class 6 land depending on the amount of stone and rock outcrop present. Class 5 land areas could be cultivated for pasture renewal, whereas Class 6 land has such an abundance of boulders and rock that only native pasture or forest is supported (see Plate 6.11).

6.7.2 Bloomfield Soil Profile Class

Mapping Units Bo, Bo-Ps

Reference

The Bloomfield soil profile class is defined for the first time in this survey. Bloomfield soils correlate with 'Brown Soils on Dolerite' which were briefly described by Nicolls (1958b) under the Eastfield soil association in his report on the soils of the Longford sheet and the 'Brown Soils on Dolerite' were later mapped and described by Leamy (1961) on the adjoining Interlaken sheet.

Diagnostic Features

Bloomfield soils are similar to the podzolic soils developed on dolerite, ie, Eastfield soils, but lack the distinctive A2 horizon. Instead they have a loam to clay loam topsoil with a sharp change to brown, reddish brown or yellowis

h brown clay subsoils at about 20 cm. Topsoils are dark brown to black with moderate soil structure while B2 horizons are clayey with moderately developed blocky structure. The subsoils become extremely firm when dry. Bloomfield soils are moderately well drained.

Classification

Bloomfield soils are classified as non-calcic brown soils in the system of Stace *et al.* (1968) and as duplex brown soils (Db) in the system of Northcote (1979).

In the new Australian soil classification system (Isbell, 1993) these soils are Haplic or Vertic, Eutrophic, Brown Chromosols.

Environmental Features

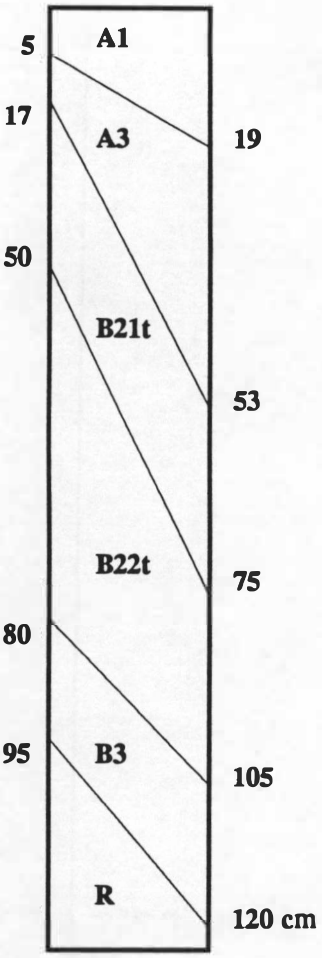
Bloomfield soils form on dolerite on rolling (10-32%) to steep (32-56%) land in the drier parts of the survey area, generally under 600 mm rainfall, and at elevations below 400 m. Bloomfield soils occur mainly in the south-eastern corner of the survey area on dolerite hills between Ross and Conara. Profile drainage is moderate and runoff is rapid, however subsoils are only slowly permeable due to heavy textures and coarse structure.

Plate 6.9 Bloomfield and Panshanger soils on rolling to steep slopes in the Macquarie River valley with the Macquarie Tier in the background (531400E, 5362600N, AMG).

Profile Variation

The thickness of the topsoils is highly variable, particularly in areas where windblown sands cap the profile or where Bloomfield soils occur in association with Panshanger soils. Generally on footslopes the topsoils are sandier and thicker, while on steeper, upper slopes sandy topsoils become thinner. Abundance of coarse fragments and total soil profile depth are also quite variable factors.

Modal Profile - Bloomfield Soil Profile Class



A1; Dark brown to black (7.5YR 3/2 - 10YR 2/0); sandy loam or clay loam; moderate fine subangular blocky or granular structure; sandy or rough ped fabric; very weak to weak (dry); few medium gravels of dolerite; field pH 5.9; salinity 0.2 dSm-1; clear smooth boundary;

A3 or AB; Dark brown (7.5YR 3/2 - 3/4); variable clay (medium); moderate fine to medium angular blocky structure; rough ped fabric; weak to firm (dry); few to common medium to coarse gravels of dolerite; field pH 6.2; salinity 0.1 dSm-1; abrupt smooth boundary;

B21t; Dark reddish brown to dark yellowish brown (5YR 3/3 - 10YR 4/4); few very dark grey mottles in some profiles (10YR 3/1); medium clay; moderate medium to coarse angular blocky structure; smooth ped fabric; strong (dry); few dolerite stones; field pH 6.8; salinity 0.0 dSm-1; gradual boundary;

B22t; Yellowish brown to brown (10YR 5/6 - 7.5YR 4/4); few olive mottles in some profiles (5Y 4/3); medium clay (sandy); moderate medium angular blocky structure; smooth ped fabric; strong (dry); few slickensides in some profiles; few dolerite stones; field pH 7.5; salinity 0.0 dSm-1; gradual boundary;

B3 or B/C; Light olive brown or brown (2.5Y 5/4 or 7.5YR 4/4); few red or yellowish brown mottles in some profiles (2.5YR 3/6 - 10YR 5/6); medium to light clay; variable blocky structures; earthy fabric; few dolerite stones; field pH 7.5; salinity 0.0 dSm-1; sharp boundary;

R; dolerite bedrock with clayey matrix penetrating down cracks.

General Chemical, Physical and Mineralogical Properties

A single profile from the Bloomfield soil profile class was analysed and this soil had a component of windblown sand at the surface (Table 6.15). However, an additional profile was sampled by Leamy (1961) from the 'Brown Soils on Dolerite' mapping unit, on the adjoining Interlaken sheet. Data from this profile (H213) are extrapolated to this survey.

The soil pH is generally slightly to moderately acid at the surface increasing to neutral or slightly alkaline in the subsoil.

Organic carbon content is medium in the topsoil but drops sharply to low contents in the A3 horizon and in the subsoils.

Total nitrogen content is medium in the topsoil and decreases sharply to low or very low contents in the A3 horizon and subsoil.

Available potassium contents are medium throughout the profile. Available phosphorus contents are medium to low in topsoils and low to very low in the A3 horizon. In the clayey subsoils available phosphorus is extremely low.

Soil Profile Class "Property" Grid Reference (AMG)	Profile Number	Horizon	Sample Depth (cm)	pH water (1:5)	EC (d/sm)	Total P (mg/kg)	Avail. P (mg/kg)	Avail. K (mg/kg)	Org. Carb. (%)	Total N (%)	C/N Ratio	Ca	Mg	Na	K	Total Bases	CEC	BASE SAT (%)	ESP (%)	Ca/Mg Ratio
												(milli-equivalents / 100 grams of soil)								
Bloomfield	SP 123	A1	0 - 12	5.6	0.08	259	19	130	2.79	0.239	12	6.12	1.55	0.49	0.36	8.5	14	60	3.5	3.96
"Merton Vale"	SP 123	A3	12 - 49	6.6	0.03	79	2	34	0.27	0.035	8	3.26	1.96	0.53	0.17	5.9	9	68	6.0	1.67
535400E	SP 123	B2t	49 - 59	6.8	0.06	86	0	113	0.88	0.066	13	6.85	8.68	1.68	0.39	17.6	27	64	6.2	0.79
5356800N	SP 123	B3tg	59 - 75	7.7	0.15	82	0	188	0.99	0.091	11	11.49	15.90	3.47	0.57	31.4	42	75	8.3	0.72
Bloomfield	H 213	A1	0 - 2	5.5	0.25	380			11.20	0.811	14	15.30	4.50	0.18		20.0	38	53	0.5	3.40
"Annandale"	H 213	A3	2 - 15	5.1	0.10	180			4.12	0.340	12	10.40	2.80	0.06		13.3	30	44	0.2	3.71
526180E	H 213	B21	25 - 41	6.7	0.05	100			1.54	0.148	10									
5337202N	H 213	B22	41 - 53	7.3	0.54							29.80	15.30	0.14		45.2	46	98	0.3	1.95
	H 213	BC	53 - 63	7.7	0.57							27.50	15.40	0.20		43.1	43	100	0.5	1.79
	H 213	C	63 - 81	7.3	0.54															

Soil Profile Class "Property" Grid Reference (AMG)	Profile Number	Horizon	Sample Depth (cm)	Gravel (of total) >2000 (µm) (%)	Sand Coarse >250 (µm) (%)	Sand Fine <250 (µm) (%)	Silt (%)	Clay (%)
Bloomfield	SP 123	A1	0 - 12	1	20	53	9	18
"Merton Vale"	SP 123	A3	12 - 49	3	18	63	5	14
535400E	SP 123	B2t	49 - 59	18	11	34	4	50
5356800N	SP 123	B3tg	59 - 75	3	6	21	2	70
Bloomfield	H 213	A1	0 - 2	0	5	34	21	21
"Annandale"	H 213	A3	2 - 15	1	7	43	22	22
526180E	H 213	B21	25 - 41					
5337202N	H 213	B22	41 - 53	2	2	12	3	78
	H 213	BC	53 - 63	16	13	17	7	60
	H 213	C	63 - 81					

Table 6.15 Analytical data for Bloomfield soil profile class.

The cation exchange capacity (CEC) is medium (12-25%) in the surface horizons (A1 + A3) and base saturation is medium to high with calcium the dominant cation. In the clay subsoils the CEC is high, due to high clay content, and base saturation is high with calcium and magnesium the dominant cations.

Soil Mapping Units

Bloomfield soils are mapped as both a soil association and as a soil complex. In the soil association Bloomfield is dominant with Canola in drainage lines and Panshanger on sand dunes. Eastfield soils may also occur. In the soil complex both Bloomfield and Panshanger soils are co-dominant.

Bloomfield soils occur mainly in the south-eastern corner of the survey area on dolerite hills between the towns of Ross and Conara.

Land Use and Capability Class

Leamy (1961) states that "these soils have responded well to aerial top-dressing and oversowing with, on some properties, as much as an eight times increase in carrying capacity." Low available phosphorus contents indicate phosphatic fertilisers would be most beneficial.

The majority of the land in which Bloomfield soils are dominant is Class 5 land, although some areas of Class 6 land occur on steeper and/or rockier slopes. Some cropping on these soils is practised on lower slopes where profiles are often thicker due to the deposition of windblow sand and grade toward the Panshanger soils. However, stoniness, the prevalence of rock outcrops and steep slopes generally makes them unsuitable for implement work. Seasonal dryness is another factor limiting the development of these soils.

6.7.3 Un-named Miscellaneous Soils Related to Eastfield Soil Profile Class

Mapping Unit MEa

Reference

The MEa map unit comprises a number of un-named soils relating to the Eastfield soil profile class which occur on steep (32-56%) to very steep (>56%) dolerite slopes. Soils on these parent materials and slopes have been previously mapped as Deddington soil association by Nicolls (1958b).

Diagnostic Features

Variable soils commonly having thin, stony, dark brown, sandy loam or loam topsoils commonly over greyish brown, sandy loam A2 horizons sharply over brown, reddish brown or yellowish brown stony medium to heavy clay subsoils. Stoniness, and outcrop is very common. These factors together with high slope angles severely limit the usefulness of these soils.

Classification

These soils are classified as grey-brown podzolics in the system of Stace *et al.* (1968). In the Factual Key of Northcote (1979) these soils are classed as yellow and brown duplex soils (Dy, Db).

In the new Australian soil classification (Isbell, 1993) these soils will most commonly are moderately gravelly, shallow, Eutrophic or Mesotrophic, Brown, Chromosols.

Environmental Features

The soils form on dolerite bedrock on steep (32-56%) and very steep (>56%) land. The soil surface is stony and rock outcrops are common. MEa has been mapped on Dicks Banks, Macquarie Tier, Isis Hills, O'Connors Peak and the lower slopes of the Great Western Tiers.

Modal Profile

Profiles are variable but generally similar to Eastfield soils although shallower and stonier and occur on steeper slopes.

General Chemical, Physical and Mineralogical Properties

No soils samples were taken in this mapping unit, chemical properties are likely to be similar with Eastfield soils.

Soil Mapping Units

The soil mapping unit (MEa) is a miscellaneous soil group of profiles related or similar to Eastfield soils but occurring on steep to very steep (>32%) terrain. Areas of rock outcrop and very bouldery profiles are common.

Land Use and Capability Class

Because of steep terrain, surface stoniness and frequent rock outcrop the agricultural potential of the MEa soils is low. They are mostly confined to rough grazing in open woodland and forestry. The key land use of these soils is for gradual forest clearance leading to improved pasture following fertiliser applications on private land with forestry, recreational and conservation uses on public lands.

Land where MEa soils are dominant is Class 6, however areas that are extremely steep and rocky are Class 7.

6.7.4 Un-named Soils of Miscellaneous Soils Mapping Unit M1

Mapping Unit M1

Reference

The M1 map unit comprises a range of un-named soils previously mapped on adjoining sheets as 'Yellow Brown Soils on Solifluction Deposits' by Nicolls (1959) and Leamy (1961). The M1 map unit contains dominant soil types which broadly correlate with the Holloway and Excalibur soil profile classes defined by Laffan and Grant (in prep).

Diagnostic Features

The dominant soils in the M1 map unit are stony and/or bouldery (dolerite), particularly in the surface soil, with strong brown to yellowish red, friable, clay loam to light clay subsoils. Typically black, stony, sandy loams overlie stony clay loams at about 50 cm depth which grade to light clays and weathered dolerite or dolerite colluvium at about 120 cm depth. The soils have a gradational profile and are well drained.

Classification

Previously mapped by Leamy (1961) and Nicolls (1958b) as 'Yellow Brown Soils on Solifluction Deposits', the dominant soils have been classified as red podzolics and krasnozems in the system of Stace *et al.* (1968). M1 soils are generally gradational pedal soils (Gn) in the system of Northcote (1979).

In the new Australian soil classification (Isbell, 1993) these soils are Haplic or Manganic, Eutrophic, Red Ferrosols.

Environmental Features

The M1 map unit soils form on both *in situ* dolerite and on solifluction debris which consists of cobbles and boulders of dolerite imbedded in an earthy matrix.

The M1 soils generally occur at elevations above about 500 m that constitute the upper slopes of the Tiers escarpment where rainfall is both higher (>700 mm) and more effective. They occur on rolling (10-32%), steep (32-56%) and very steep slopes (>56%) which are heavily timbered with wet sclerophyll forest in which *Eucalyptus delegatensis* is common. Large areas of dolerite rock scree may cover the soil surface in places. Steep bluffs, escarpments and scree slopes are common in the M1 unit (Plate 6.10).

Profile Variation

The abundance of surface cobbles and boulders covers the range from few to profuse. Some profiles contain many manganiferous soft segregations in the B2 horizons. Large areas of bare rock or scree are common, having little or no agricultual or forestry potential.

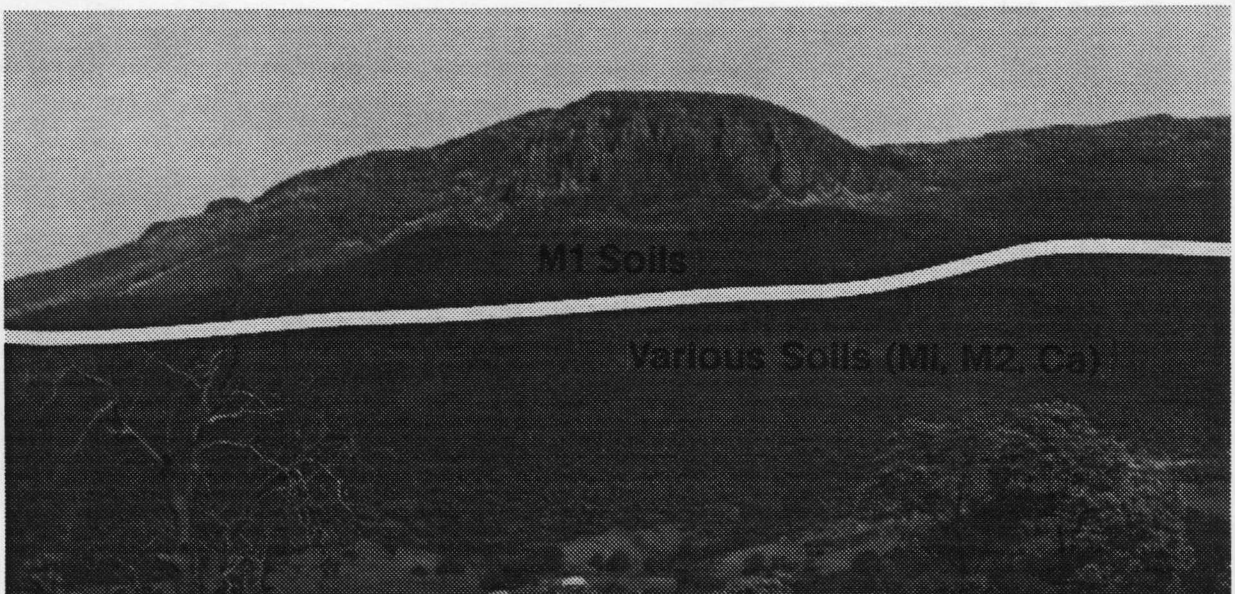
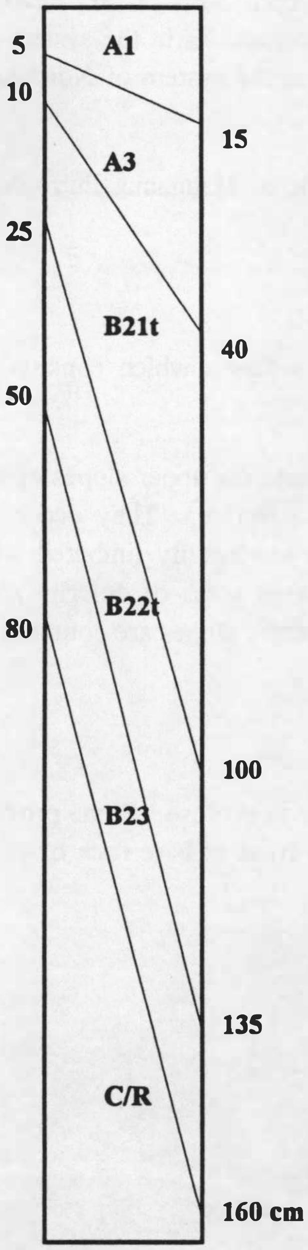


Plate 6.10 M1 soils and exposures of bedrock on the scarp of the Great Western Tiers with Miller (Mi), M2 soils and small areas of Canola (Ca) soils in middle ground and Eastfield (Ea) soils on dolerite slopes in the foreground (505600E, 5366300N, AMG).

M1 modal

Modal Profile - M1 Soils



A1; Black (5YR 2/1); loam or sandy loam; moderate very fine to extremely fine granular structure; rough ped fabric; very weak (moist); common to many fine live roots; many gravels and cobbles of dolerite; field pH 5.9; salinity 0.1 dSm-1; clear smooth boundary;

A3/A2; Dark reddish brown (5YR 3.2 - 3/3); variable loamy sand to clay loam; weak to moderate very fine granular parting to extremely fine granular structure; earthy ped fabric; very weak (moist); common to many fine and medium live roots; many to abundant gravels of dolerite; field pH 5.8; salinity 0.0 dSm-1; clear wavy boundary;

B21t or B1 Strong brown to dark red (7.5YR 4/6 - 2.5YR 3/6); fine sandy clay loam to clay loam; moderate very fine granular structure plus fine subangular blocky; rough ped fabric; weak (moist); few to common clay skins; common fine and medium live roots; abundant gravels and cobbles of dolerite; field pH 6.0; salinity 0.0 dSm-1; gradual smooth boundary;

B22t; Yellowish red to strong brown (5YR 4/6 - 7.5YR 4/6) sandy clay loam; ; moderate fine-medium angular blocky structure; weak (moist); rough ped fabric; few to common manganiferous soft segregations; common to many clay skins; few to common fine live roots; abundant gravels and cobbles of dolerite; field pH 5.8; salinity 0.0 dSm-1; gradual smooth boundary;

B23; Yellowish red to strong brown (5YR 4/6 - 7.5YR 4/6); light clay; moderate medium angular blocky structure parting to finer sizes; rough ped fabric; weak (moist); common to many clay skins; no roots; variable amounts of 20-200 mm gravels and cobbles of dolerite; field pH 5.7; salinity 0.0 dSm-1; diffuse boundary;

C/R; either abundant dolerite gravels in light clay matrix or bedrock;

General Chemical, Physical and Mineralogical Properties

Chemical data from two soil profiles of the M1 map unit are listed in Table 6.16. Soil pH is slightly acid in the topsoils and remains uniform down the profile.

Total phosphorus contents are medium to high in the upper profile and medium to low in the subsoils. The available phosphorus is variable from high to low amounts in the topsoils, to low available amounts in the subsoils.

Available potassium contents are very high in the topsoils and high to medium in the subsoil.

Carbon contents are particularly high in the surface horizons and decrease progressively with depth to low levels in the subsoil. Total nitrogen contents are medium to high in the topsoils but decrease to low and very low levels with depth. The C/N ratios are much higher in the M1 soils indicating a slower rate of organic matter breakdown in the wetter cooler climate relative to the lowland soils.

Soil Profile Class "Property" Grid Reference (AMG)	Profile Number	Horizon	Sample Depth (cm)	pH water (1:5)	EC (d/sm)	Total P (mg/kg)	Avail. P (mg/kg)	Avail. K (mg/kg)	Org. Carb. (%)	Total N (%)	C/N Ratio	Ca	Mg	Na	K	Total Bases	CEC	BASE SAT (%)	ESP (%)	Ca/Mg Ratio
												(milli-equivalents / 100 grams of soil)								
Miscellaneous	SP 183	A1	0 - 13	6.3	0.06	2054	70	599	13.20	0.600	22	24.85	8.22	0.20	1.79	35.06	43	82	0.5	3.02
Soils 1	SP 183	A3	13 - 20	6.1	0.04	1307	22	330	7.20	0.330	22	13.25	3.67	0.20	1.72	18.84	28	68	0.7	3.61
"The Big Den"	SP 183	B21t	20 - 50	6.5	0.02	467	1	168	1.70	0.090	19	7.36	3.71	0.21	0.71	11.99	17	71	1.2	1.98
504400E	SP 183	B22	50 - 75	6.7	0.02	338	0	114	1.00	0.070	14	7.87	4.61	0.20	0.47	13.15	15	87	1.3	1.71
5356100N	SP 183	B23	75 - 105	6.8	0.02	344	0	109	0.80	0.060	13	7.78	4.84	0.20	0.44	13.26	16	83	1.3	1.61
	SP 183	Cg	105 - 106	6.5	0.02	181	0	163	1.00	0.050	20	11.74	11.99	0.33	0.56	24.62	28	89	1.2	0.98
Miscellaneous	SP 184	A1	0 - 5	6.0	0.06	452	8	309	9.60	0.370	26	24.02	5.64	0.16	1.31	31.13	30	104	0.5	4.26
Soils 1	SP 184	A3	5 - 25	5.9	0.03	303	0	268	3.20	0.120	27	4.24	1.30	0.28	1.05	6.87	10	67	2.7	3.26
"The Big Den"	SP 184	B1	25 - 55	6.1	0.02	169	0	286	1.50	0.070	21	3.50	1.23	0.12	0.90	5.75	9	65	1.4	2.85
501100E	SP 184	B21	55 - 120	6.1	0.02	248	0	241	1.30	0.060	22	5.14	1.99	0.15	0.77	8.05	11	73	1.4	2.58
5353000N	SP 184	B22	120 - 121	6.1	0.02	320	0	77	1.30	0.050	26	6.65	3.16	0.31	0.36	10.48	15	69	2.1	2.10

Soil Profile Class "Property" Grid Reference (AMG)	Profile Number	Horizon	Sample Depth (cm)	Gravel (of total) >2000 (µm) (%)	Sand Coarse >250 (µm) (%)	Sand Fine <250 (µm) (%)	Silt (%)	Clay (%)
Miscellaneous	SP 183	A1	0 - 13	77	20	53	13	14
Soils 1	SP 183	A3	13 - 20	42	23	36	20	21
"The Big Den"	SP 183	B21t	20 - 50	76	16	29	24	30
504400E	SP 183	B22	50 - 75	45	17	28	23	32
5356100N	SP 183	B23	75 - 105	55	14	27	22	37
	SP 183	Cg	105 - 106	0	0	4	27	69
Miscellaneous	SP 184	A1	0 - 5	76	60	18	16	6
Soils 1	SP 184	A3	5 - 25	66	56	24	14	6
"The Big Den"	SP 184	B1	25 - 55	32	54	22	17	7
501100E	SP 184	B21	55 - 120	67	46	23	17	14
5353000N	SP 184	B22	120 - 150	45	29	26	26	19

Table 6.16 Analytical data for un-named soil profile class on dolerite colluvium, M1 map unit.

The CEC and total exchangeable base content seem to correspond closely with the clay content and the organic matter content of the horizons ie, high organic matter and/or high clay content equates to high CEC and/or high base status.

Soil Mapping Units

The soil map unit is a miscellaneous soil group, M1, and a modal description of the dominant soil profile has been described in a previous section. However, considerable variability from this modal profile can be expected with profiles having thicker peaty topsoils and yellower subsoils in areas of restricted drainage and areas of bare rock and boulders occurring on bluffs, very steep slopes or bare bouldery scree slopes.

Land Use and Capability Class

Although quite fertile, the steep topography and stony profiles make these soils unsuitable for agricultural development. They would be prone to high rates of fluvial erosion and mass movement in many areas if cleared of the native forest cover. The most suitable uses for these areas are for forestry and conservation.

Much of the land on which these soils are dominant is Class 6 and 7, depending on slope angles and rockiness combined with climatic limitations associated with higher elevations (lower temperatures and higher more effective rainfalls).

6.8 Soils on Sandstones, Mudstones and Tillite

6.8.1 Blessington Soil Profile Class

Mapping Units Bl, Bl-Ps, Bl-Ca

Reference

The name Blessington was given by Nicolls (1958b) to a series of soils forming on Permian and Triassic sandstones on the eastern part of the Longford reconnaissance soil map.

Diagnostic Features

Blessington soils form on Triassic and Permian siliceous sandstones. Typically a dark greyish brown sandy loam to loamy sand topsoil with weak structure caps a light grey to light brown, loamy sand, A2 horizon. These surface horizons are underlain, at about 35-45 cm by plastic sandy clays or sandy clay loams grading into decomposing sandstone. Prominent dark brown clay coatings are common in the B2 horizons. Accumulations of loose, grey sand on the surface is a common feature of these soils. Profiles are imperfectly drained.

Classification

Blessington soils have been classified by previous authors (Nicolls, 1958b) as yellow podzolic in the systems of Stephens (1962) and Stace *et al.* (1968), however it is likely that many are solodic soils. They key out as yellow duplex (Dy) soils in the Factual Key of Northcote (1979).

In the new Australian soil classification (Isbell, 1993) these soils are Vertic or Mesotrophic, Subnatric, Brown Sodosols.

Environmental Features

Soils of the Blessington profile class form on siliceous sandstones of both Triassic and Permian age. Profiles develop on rolling (10-32%) land with areas of steep (32-56%) land on the footslopes of the Great Western Tiers. The main area in which these soils occur is on the south western edge of the Macquarie Tier, on the lower slopes of the Great Western Tiers and in small isolated areas of the central survey area.

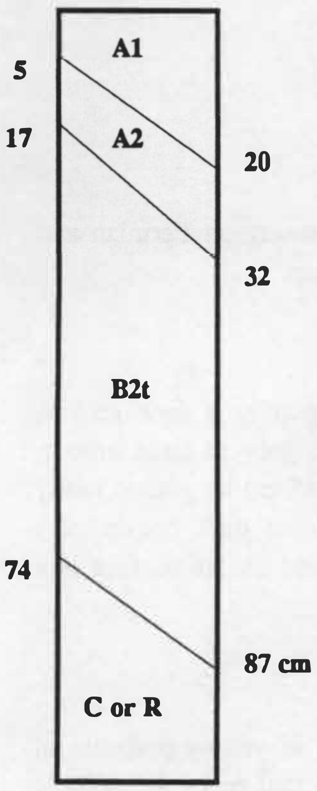
Profile Variation

Few profiles have ferruginous nodules in the A2 horizon. The depth of the sandy surface horizons is highly variable.

General Chemical, Physical and Mineralogical Properties

No analytical data are available for this soil profile class. However the field pH data indicate the topsoils and A2 horizons are moderately acid and that pH increases in the B2 horizons to neutral levels. Field salinity values indicate the topsoils and A2 horizons are non saline, the B2 horizons are slightly saline and the C horizons may be highly saline.

Modal Profile - Blessington Soil Profile Class



A1; Loamy sand to sandy loam; very dark greyish brown (10YR 3/2); weak fine-medium (10-20 mm) angular or subangular blocky structure breaking to single grained; sandy fabric; loose to very weak (moist and dry); few sandstone or quartz gravels; common fine live roots; field pH 5.5; salinity 0.1 dSm-1; clear to gradual smooth boundary;

A2; Sand to sandy loam; dark grey to dark greyish brown (7.5YR 4/1 - 10YR 4/2); massive or single grained; sandy fabric; very weak (moist and dry); few sandstone or quartz gravels; few fine live roots; field pH 5.5; salinity 0.2 dSm-1; abrupt wavy boundary;

B2t; Strong brown to yellowish brown (7.5YR 5/8 - 10YR 5/6); common red (10R - 2.5YR 4/6) mottles; sandy light clay to sandy heavy clay; coarse (50-100 mm) prismatic or columnar structure; smooth ped fabric; very firm (moist and dry); many dark brown clay coating on peds; few fine live roots; salinity 0.4 dSm-1; field pH 6.7; clear boundary;

C or R; Very pale brown to light olive grey (10YR 8/3 - 2.5Y 5/3) loamy sand or sandy loam; massive or single grained; sandy fabric; variable loose to firm (moist and dry); no roots; salinity 1.3 dSm-1; field pH 6.4;

Soil Mapping Units

The Blessington soils are mapped both as a soil association (Bl) and as soil complexes (Bl-Ps and Bl-Ca). In the soil association the Blessington soils are dominant, with other soils such as Quamby occurring on mudstone beds, Canola in isolated drainage lines and Panshanger on sandy banks or dunes. In the soil complexes the Blessington occur as co-dominant with the other named soils eg, Blessington-Panshanger (Bl-Ps) in which both Blessington and Panshanger soils occur in an intricate pattern and are unable to be mapped separately.

The main areas of occurrence of Blessington soils are on undulating slopes south of Jacobs Sugarloaf, on scattered low hills west of Campbell Town and in a complex with Quamby soils on the footslopes of the Great Western Tiers.

Land Use and Capability Class

Blessington soils are used mostly for pasture production. They are also used for occasional fodder crops. The sandy nature of the surface horizons of these soils makes them prone to wind and water erosion. Summer moisture stress may also be a limiting factor. Leamy (1961) states "...these soils are used mainly for extensive grazing. They are shallow, coarse textured and infertile but should respond to oversowing and top-dressing."

Land where Blessington soils are dominant is Class 4, with some areas of Class 5 land on steeper slopes. Under cultivation appropriate conservation measures would be needed to reduce the risk of wind and water erosion.

6.8.2 Quamby Soil Profile Class

Mapping Units Qu, Qu-Bl

Reference

The Quamby soil profile class is defined for the first time in this survey and the name is taken from the Quamby mudstone on which many of the soils develop. Quamby soils correlate with some profiles described under the name 'Yellow Podzolics on Mudstone' (YPm) and mapped by Nicolls (1959).

Diagnostic Features

Quamby soils are shallow, strongly acid, gradational profiles developed on Permian mudstones and siltstones. Thin (10 cm), moderately structured, dark greyish brown, silty loam topsoils grade to blocky or prismatic structured silty clay loam B2 horizons, grading to silty clay lower subsoils.

Profiles have imperfect internal drainage and moderately rapid runoff. The subsoils are commonly dispersive by the Emerson aggregate test (1967).

Classification

These soils are classified as grey earths in the system of Stace *et al*. (1968) and are non-calcic gradational (Gn) soils in the Factual Key of Northcote (1979).

In the new Australian soil classification system (Isbell, 1993) these soils are Acidic, Dystrophic, Grey or Brown Dermosols, although those profiles with a stronger texture contrast may qualify as Sodic Chromosols.

Environmental Features

Quamby soils form on rolling (10-32%) to steep (32-56%) land on the slopes of the Great Western Tiers. The profiles develop on mudstone and siltstone bedrock and occur under rainfalls of 600 - 800 mm/yr.

General Chemical, Mineralogical and Physical Properties

Analytical data for Quamby soil profile class are presented in Table 6.17. Both the topsoils and the subsoils range from moderate to strongly acid. No salinity problems occur in these soils.

The organic carbon content is high in the topsoil, medium in the upper subsoil and low in the lower subsoil. Total nitrogen contents are medium in the topsoil but drop sharply to very low contents in all other horizons. The C/N ratio is high in these soils suggesting the rate of organic matter breakdown is slow. This may be due to climatic reasons (lower temperature and higher rainfall) or low levels of microbial activity.

Available phosphorus contents are very low throughout the profile. Available potassium contents are high in the topsoil and low to medium in the subsoil.

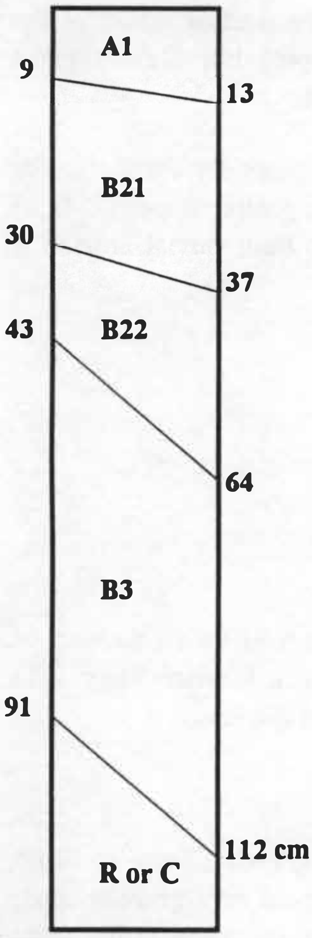
The sum of the basic cations is medium in the topsoil but very low in the subsoil suggesting a high level of leaching. This is supported by the acid reaction profile.

Soil Profile Class "Property" Grid Reference (AMG)	Profile Number	Horizon	Sample Depth (cm)	pH water (1:5)	EC (d/sm)	Total P (mg/kg)	Avail. P (mg/kg)	Avail. K (mg/kg)	Org. Carb. (%)	Total N (%)	C/N Ratio	Ca	Mg	Na	K	Total Bases	CEC	BASE SAT (%)	ESP (%)	Ca/Mg Ratio
												(milli-equivalents / 100 grams of soil)								
Quamby	SP 186	A1	0 - 8	5.5	0.06	165	5	418	6.50	0.260	25	5.68	2.71	0.20	0.72	9.31	20	45	1.0	2.10
"Connorville"	SP 186	B21	8 - 30	5.1	0.02	109	3	135	2.10	0.090	23	0.77	1.15	0.25	0.48	2.65	10	26	2.4	0.67
506575E	SP 186	B22	30 - 45	5.1	0.03	140	3	115	1.00	0.070	14	0.26	0.80	0.18	0.39	1.63	7	22	2.5	0.33
5360575N	SP 186	B/C	45 - 68	5.1	0.03	168	3	135	1.00	0.080	13	0.30	1.52	0.28	0.38	2.48	8	31	3.5	0.20

Soil Profile Class "Property" Grid Reference (AMG)	Profile Number	Horizon	Sample Depth (cm)	Gravel (of total) >2000 (μm) (%)	Sand Coarse >250 (μm) (%)	Sand Fine <250 (μm) (%)	Silt (%)	Clay (%)
Quamby	SP 186	A1	0 - 8	51	5	45	33	17
"Connorville"	SP 186	B21	8 - 30	26	5	27	40	28
506575E	SP 186	B22	30 - 45	37	9	27	37	28
5360575N	SP 186	B/C	45 - 68	0	11	27	33	29

Table 6.17 Analytical data for Quamby soil profile class.

Modal Profile - Quamby Soil Profile Class



A1; Dark brown to very dark greyish brown (7.5YR 3/2 - 10YR 3/2); loam to silt loam; moderate fine to medium subangular blocky structure parting to finer sizes; earthy fabric; very weak (moist); few mudstone gravels; many fine and very fine roots; field pH 5.1; salinity 0.2 dSm-1; clear or abrupt smooth boundary;

B21; Brown to light brownish grey (7.5 YR 5/4 - 10YR 6/2); few dark reddish brown or yellowish brown mottles (2.5YR 3/4 - 10YR 6/6); silty clay loam; moderate medium prismatic or angular blocky structure parting to finer sizes in some profiles; rough ped fabric; weak (moist); common clay skins; few mudstone gravels (6-60 mm); few to common fine roots; dispersion 3(2) to 2(1); field pH 5.4; salinity 0.0 dSm-1; gradual smooth boundary;

B22; Brown to greyish brown (7.5YR 5/4 - 10YR 5/2); few to common dark reddish brown or yellowish brown mottles (2.5YR 3/4 - 10YR 6/6); silty clay loam to silty light clay; moderate fine to medium angular blocky structure parting to finer sizes; rough-ped fabric; weak (moist); common clay skins; few to common mudstone gravels (6-60 mm); few to common fine roots; dispersion 3(2) to 2(2); field pH 5.2; salinity 0.0 dSm-1; clear to abrupt boundary;

B3; Brown to light brownish grey (10YR 4/3 - 2.5Y 6/2); silty clay loam; massive; many mudstone gravels (2-20 mm); field pH 5.5; salinity 0.0 dSm-1; clear or gradual boundary;

R or C; Pale yellow or light grey weathered to fresh bedrock; field pH 5.0; salinity 0 dSm-1;

Profile Variation

Subsoil colour ranges from brown to light grey. The B3 horizon may contain clay coatings; and may be dispersive. The degree of mottling in the subsoil is variable.

The analysed profile was quite silty with 33-40% silt down the profile. The topsoil had more fine sand and less clay than the subsoil horizons suggesting some clay translocation has occurred.

Soil Mapping Units

Quamby soils have been mapped in both a soil association (Qu) and as a soil complex (Qu-Bl). In the soil association Quamby soils are dominant with small areas of other miscellaneous soils occurring in drainage lines. In the soil complex (Qu-Bl) both Quamby and Blessington are co-dominant.

Quamby soils occur on rolling (10-32%) to steep (32-56%) slopes in the south-west of the map sheet on the slopes of the Great Western Tiers and in the Big Den.

Land Use and Capability Class

Quamby soils are currently utilised for grazing and timber production. The shallow nature of the soils, silty textures, dispersion potential and location in moderately sloping hill country make Quamby soils prone to fluvial erosion, typically rill and tunnel gully erosion.

The risk of erosion combined with the high slope angle make these soils generally unsuitable for cultivation. They are Classes 5 and 6, dependent on slope. Some areas on gentler slopes (<18%) with deeper soils may be mapped as Class 4. Care would be needed to limit fluvial erosion if cultivation was undertaken.

6.8.3 Miller Soil Profile Class

Mapping Unit Mi,

Reference

The Miller soil profile class, defined for the first time in this survey, are soils which develop on Permian tillite in the south west of the survey area along the edge of the Great Western Tiers. The name is taken from Millers Bluff, which is a prominent topographic point in this area.

Diagnostic Features

The Miller soil profile class are gradational to duplex soils developed on gravelly, Permian tillite. Typical profiles have a friable, very dark grey, slightly gravelly loamy topsoil over gravelly sandy clay loam A2 horizons, grading to gravelly, yellowish brown, light or medium clay subsoils which change with depth to fresh *in situ* tillite. Profiles are imperfect to moderately well drained.

Classification

These soils are classified as yellow podzolic in the system of Stace *et al.* (1968) and acid gradational or duplex yellow (Gn, Dy) soils in the Factual Key of Northcote (1979).

In the new Australian soil classification (Isbell, 1993) these soils are Bleached or Acidic, Mesotrophic to Eutrophic, Brown Dermosols and Chromosols.

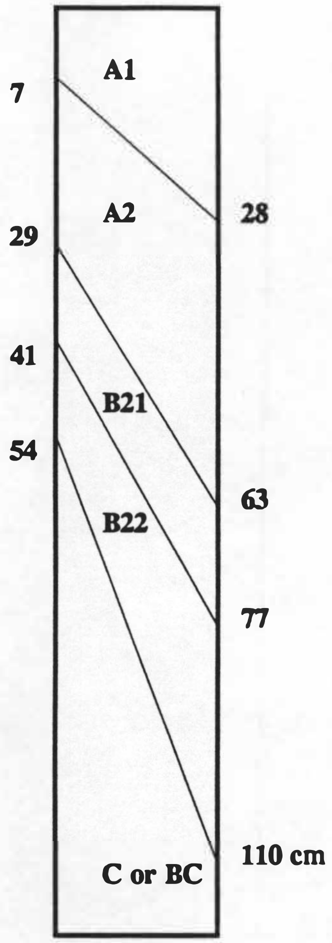
Environmental Features

These soils form on rolling (10-32%) to steep (32-56%) land on the foothills of the Great Western Tiers. The parent material is *in situ* and colluvial Permian tillite which is composed mainly of rounded and subrounded, gravel and cobble sized clasts (20-200 mm) of quartzite but with some slate, sandstone and granite. Rainfall is between 600 - 800 mm/yr.

Profile Variation

Some of these soils grade toward duplex profiles. Yellowish brown mottling occurs in some topsoils. The gravel content of the soils is quite variable.

Modal Profile - Miller Soil Profile Class



A1; Very dark grey (10YR 3/1); loam; weak fine to medium angular blocky structure breaking to extremely fine angular blocky structure; very weak (moist and dry); earthy or sandy fabric; few to common quartzite and sandstone gravels; common very fine and fine roots; field pH 5.8; salinity 0.2 dSm-1; clear smooth boundary;

A2; Dark greyish brown to grey (10YR 4/2 - 10YR 5/1); sandy clay loam to sandy loam; single grained plus extremely fine weak blocky structure; loose to very weak (moist and dry); sandy or earthy fabric; few to common sandstone and quartzite gravels; few to common very fine roots; field pH 5.2; salinity 0.0 dSm-1; clear or abrupt smooth boundary;

B21; Yellowish brown to dark yellowish brown (10YR 5/6 - 4/6); light to medium clay; moderately to weak medium angular blocky structure parting to finer sizes; weak to firm (moist); weak to very strong (dry); rough ped fabric; few - common clay-organic coatings; few quartzite and sandstone gravels; few very fine roots; field pH 5.7; salinity 0.1 dSm-1; clear to gradual boundary;

B22; Light to heavy clay; yellowish brown (10YR 5/6); moderately to weak medium to coarse angular blocky structure; weak to firm (moist); weak to very strong (dry); rough ped fabric; few to common clay and/or organic coatings; few quartzite and sandstone gravels; few very fine roots; field pH 6.0; salinity 0.2 dSm-1; gradual boundary;

C or BC; Light olive or brownish grey (5Y 6/2 - 2.5Y 6/3); sandy clay to fine sandy loam; massive; abundant to profuse gravels or *in situ* bedrock; field pH 5.5; salinity 0.0 dSm-1;

General Chemical, Physical and Mineralogical Properties

Analytical data for the Miller soil profile class are listed in Table 6.18. Soil pH trend is moderately acid throughout the profile. However the field pH data suggest the A2 horizons are strongly acid.

Available potassium and phosphorus contents are low to medium in the topsoils and low in the A2 horizons and subsoils. These data suggest Miller soils will respond to applied potash and phosphatic fertilisers.

Organic carbon content is medium in the topsoil but decreases to very low contents in the subsoils. Total nitrogen contents follow a similar trend.

The cation exchange capacity is low in the sandy topsoils and high in the clayey subsoils. The base saturation levels are medium in the topsoils, low in the lower topsoil and low to very low in the subsoil, indicating a high degree of leaching. Leaching increases with depth in the profile.

ESP values are <3 indicating these soils are not sodic.

Soil Profile Class "Property" Grid Reference (AMG)	Profile Number	Horizon	Sample Depth (cm)	pH water (1:5)	EC (d/sm)	Total P (mg/kg)	Avail. P (mg/kg)	Avail. K (mg/kg)	Org. Carb. (%)	Total N (%)	C/N Ratio	Ca	Mg	Na	K	Total Bases	CEC	BASE SAT (%)	ESP (%)	Ca/Mg Ratio
												(milli-equivalents / 100 grams of soil)								
Miller	SP 138	A1	0 - 9	5.4	0.07	190	10	125	4.60	0.297	15	3.48	0.93	0.16	0.45	5.0	10	52	1.6	3.74
"The Glen"	SP 138	A21	9 - 25	5.3	0.04	71	3	84	2.70	0.110	25	1.79	0.45	0.14	0.37	2.8	7	42	2.2	3.94
502300E	SP 138	A22	25 - 45	5.5	0.03	38	0	50	1.10	0.047	23	1.10	1.12	0.21	0.28	2.7	7	36	2.9	0.99
5365400N	SP 138	B2tg	45 - 75	5.5	0.03	57	0	105	0.70	0.050	14	1.19	4.24	0.26	0.43	6.1	31	20	0.8	0.28
	SP 138	BC	75 - 85	5.6	0.03	43	0	152	0.40	0.018	22	0.59	5.60	0.37	0.54	7.1	23	31	1.6	0.11
	SP 138	R	85 - 95	6.1	0.02	58	0	180	0.30	0.009	33	0.20	7.71	0.51	0.61	9.0	20	46	2.6	0.03

Soil Profile Class "Property" Grid Reference (AMG)	Profile Number	Horizon	Sample Depth (cm)	Gravel (of total) >2000 (µm) (%)	Sand Coarse >250 (µm) (%)	Sand Fine <250 (µm) (%)	Silt (%)	Clay (%)	Clay Mineralogy (Approximate weight %) Smectite	Kaolinite	Illite	Goethite
Miller	SP 138	A1	0 - 0	1	20	51	20	9				
"The Glen"	SP 138	A21	9 - 25	1	13	54	19	13				
502300E	SP 138	A22	25 - 45	0	13	46	23	18	15	75	5	5
5365400N	SP 138	B2tg	45 - 25	1	9	30	24	37	15	75	5	5
	SP 138	BC	75 - 45	4	20	27	30	24	35	60		5
	SP 138	R	85 - 95	4	29	24	25	21				

Table 6.18 Analytical data for Miller soil profile class.

Soil Mapping Units

Miller soils are mapped as a soil association (Mi) in which the Miller soil profile class is dominant. However other miscellaneous soils may occur in drainage lines and shallower profiles may occur on ridge crests and steep slopes.

Miller soils are mainly mapped in the western part of the survey area below Parknook Hill (Plate 6.11), on the footslopes of the Great Western Tiers and below the Mitford Hills and Millers Bluff.

Land Use and Capability Class

Stoniness, acidity and low fertility are the primary limitations to agricultural use of these soils. Presently Miller soils are utilised for extensive pasture and forestry. They would probably respond well to phosphatic and potash fertiliser applications. The moderately acid topsoils and strongly acid A2 horizons suggest lime applications would be beneficial.

Land where Miller soils are dominant is Class 4 and 5 because of slope, stone content and low fertility of the soils which are unsuitable for intensive cultivation. Areas of rolling land with slopes up to 18% are Class 4, but careful management to prevent rill and sheet erosion would be required if cultivated. Steeper areas are Class 5 land (Plate 6.11).

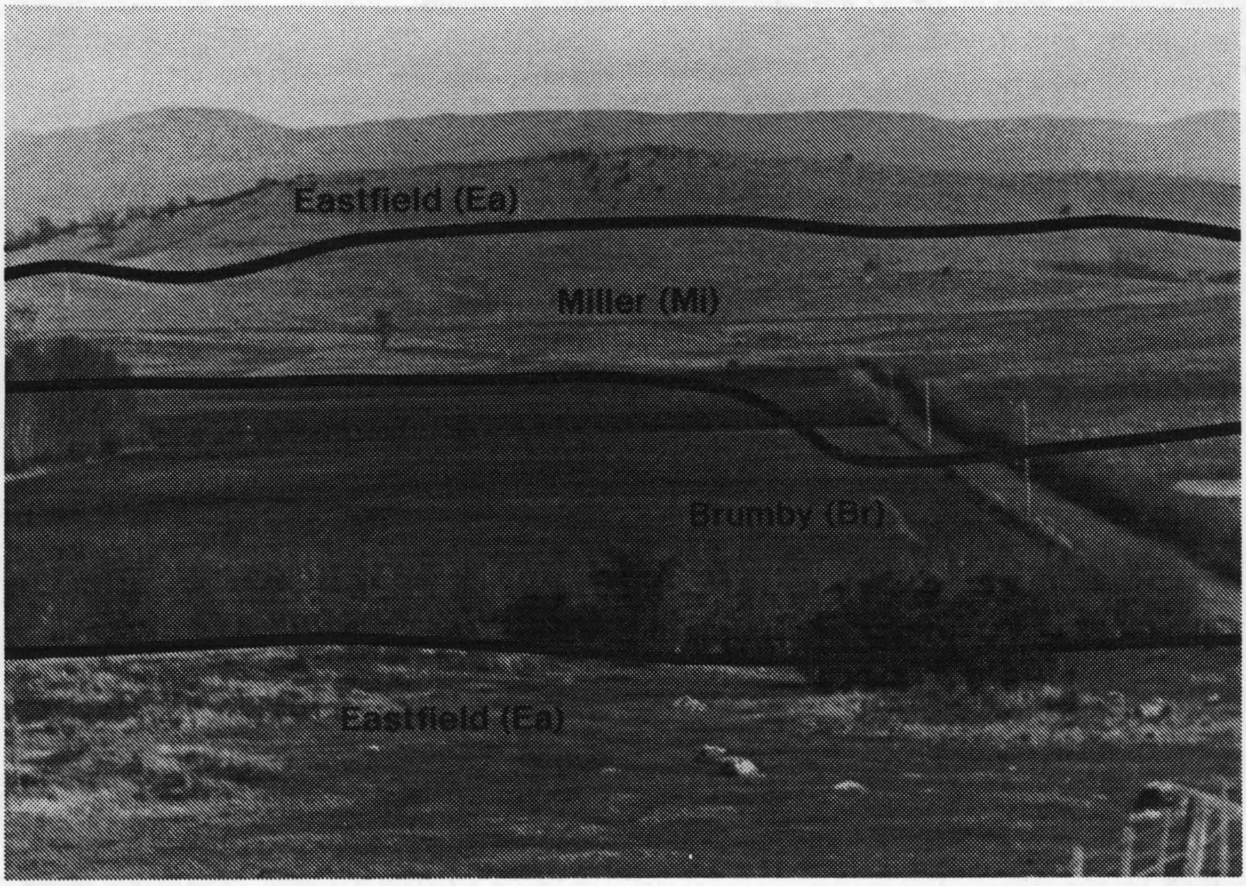


Plate 6.11 Miller soils forming on rolling to steep slopes near 'Parknook' with Eastfield soils on rolling to steep dolerite slopes and Brumby soils on low river terraces (506300E, 5372100N, AMG).

6.9 Soils on Cambrian and Precambrian Volcanics and Phyllites

6.9.1 Un-named Soils of Miscellaneous Soils Mapping Unit M2

Mapping Unit M2

Reference

M2 is a miscellaneous soil mapping unit described for the first time in this survey. The dominant soils broadly correlate with the red and yellow podzolic soils of the RYP unit mapped and described by Nicolls (1959).

Diagnostic Features

A range of un-named soils mapped as M2 form on Cambrian and Precambrian volcanic and phyllitic rocks on the foothills of the Great Western Tiers. The soils are generally podzolic, having a lighter coloured A2, and they may have duplex or gradational texture profiles. Those on the volcanic rocks tend to have redder subsoils and better soil structure than those on phyllite. The profiles are acid throughout and commonly contain rock fragments.

Classification

The un-named soils of the M2 map unit are acid, pedal, gradational soils (Gn), and acid, yellow and red, duplex soils (Dy) in the Factual Key of Northcote (1979). They are generally classified as yellow and red podzolic soils or non-calcic brown soils in the system of Stace *et al.* (1968).

In the new Australian soil classification system (Isbell, 1993) these soils are Red and Brown Dermosols, Kandosols and Chromosols.

Environmental Features

The un-named soils of the M2 mapping unit form on rolling (10-32%), steep (32-56%) and very steep (>56%) slopes on Cambrian and older rocks. These dominant rock types are volcanic breccia or tuff, and phyllite. Two profiles, one from each of these materials, are described below. They occur on the foothills of the Great Western Tiers, in the south-western part of the map sheet where rainfall is between 600 and 800 mm/yr (Plate 6.10).

General Chemical, Physical and Mineralogical Properties

Analytical data for profile SP137 which is developed on phyllite is listed in Table 6.19. The soil has an acid reaction profile.

Organic carbon is very high in the topsoil, medium in the A2 horizon and low to very low in the subsoil.

Available phosphorus values are medium in the topsoil and very low in all other horizons. Available potassium values are high in the topsoil and low in all other horizons. The higher values in the topsoil are probably due to high organic matter levels.

Cation exchange capacity (CEC) is low except in the surface where they are moderate due to high organic carbon values. The base saturation values follow a similar trend.

Soil Profile Class "Property" Grid Reference (AMG)	Profile Number	Horizon	Sample Depth (cm)	pH water (1:5)	EC (d/sm)	Total P (mg/kg)	Avail. P (mg/kg)	Avail. K (mg/kg)	Org. Carb. (%)	Total N (%)	C/N Ratio	Ca	Mg	Na	K	Total Bases	CEC	BASE SAT (%)	ESP (%)	Ca/Mg Ratio
												(milli-equivalents / 100 grams of soil)								
Miscellanous	SP 137	A1	0 - 5	5.3	0.07	236	15	314	13.20	0.606	22	11.72	4.56	0.32	0.82	17.4	19	94	1.7	2.57
Soils 2	SP 137	A2	5 - 15	5.2	0.03	79	0	98	2.20	0.141	16	1.92	0.90	0.14	0.24	3.2	6	54	2.4	2.14
"The Glen"	SP 137	AB	15 - 30	5.1	0.04	60	0	77	0.70	0.044	16	0.75	0.56	0.17	0.17	1.6	4	43	4.4	1.34
504900E	SP 137	B2w	30 - 70	5.2	0.04	86	0	36	0.80	0.032	25	0.15	0.41	0.24	0.21	1.0	4	24	5.6	0.36
5365100N	SP 137	B3	70 - 95	5.9	0.03	41	0	23	0.20	0.001	200	0.03	0.51	0.18	0.19	0.9	3	34	6.6	0.05

Soil Profile Class "Property" Grid Reference (AMG)	Profile Number	Horizon	Sample Depth (cm)	Gravel (of total) >2000 (μm) (%)	Sand Coarse >250 (μm) (%)	Sand Fine <250 (μm) (%)	Silt (%)	Clay (%)	Clay Mineralogy (Approximate weight %) Kaolinite	Illite	Goethite	Illite-Smectite	Gibbsite
Miscellanous	SP 137	A1	0 - 5	24	13	64	18	5					
Soils 2	SP 137	A2	5 - 15	55	16	55	24	5	65	10		25	
"The Glen"	SP 137	AB	15 - 30	55	22	49	24	6	75	5	5	15	
504900E	SP 137	B2w	30 - 70	63	17	42	29	11	65	5	10	20	
5365100N	SP 137	B3	70 - 95	30	7	60	27	6	70	5	10	10	5

Table 6.19 Analytical data for un-named soil profile class on phyllitic rocks, M2 mapping unit.

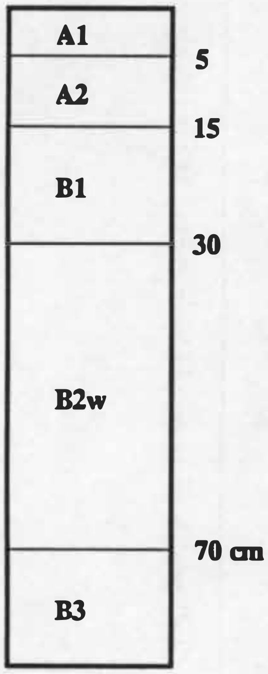
There are no salinity problems in these soils. ESP values reach 6.6 in the lower profile suggesting slight sodicity at depth (below 50 cm).

There is no analytical data for profiles developed on the volcanic rocks but field pH data indicate the soils are moderately acid and no salinity problem occurs. The clay loam textures are likely to result in moderate CEC values.

Typical Profile on Phyllitic rocks

Soil profile 137

Drainage:	Moderately rapid run-off, moderately well drained
Grid Reference:	504900 E 5365100 N AMG
Classification:	Gn2.18, Yellow Podzolic Bleached-Acidic, Dystrophic, Brown Kandosol
Landform:	Rolling (10-32%) land, slope 20%
Vegetation:	Eucalyptus amygdalina, extensively cleared



A1; Very dark grey (10YR 3/1 moist); dark greyish brown (10YR 4/2 dry); gritty loam; single grained plus weak extremely fine subangular blocky structure; very weak (moist); sandy fabric; loose (dry); common coarse gravels of phyllite; common very fine roots; 4.8 field pH; 0.1 dSm-1; clear smooth boundary;

A2; Greyish brown (10YR 5/2 moist); light grey (10YR 7/2 dry); gravelly loam; single grained; sandy fabric; loose (moist); loose (dry); many angular coarse gravels of phyllite; few very fine roots; 5.1 field pH; 0 dSm-1; clear smooth boundary;

B1; Strong brown (7.5YR 4/6 moist); light yellowish brown (10YR 6/4 dry); gravelly fine sandy loam; single grained; sandy fabric; loose (moist); loose (dry); many angular coarse gravels of phyllite; few very fine roots; 5.1 field pH; 0 dSm-1; clear boundary;

B2w; Strong brown (7.5YR 5/8 moist); brownish yellow (10YR 6/6 dry); gravelly silty loam; single grained; earthy fabric; loose (moist); loose (dry); abundant angular coarse gravels of phyllite; few very fine roots; 4.4 field pH; 0 dSm-1; gradual smooth boundary;

B3; Light olive brown (2.5Y 5/6 moist); light red (2.5YR 7/6 dry); silty loam; massive parting to single grained; earthy fabric; loose (moist); loose (dry); many angular coarse gravels of phyllite; few very fine roots; 5.7 field pH; 0 dSm-1;

Soil Mapping Units

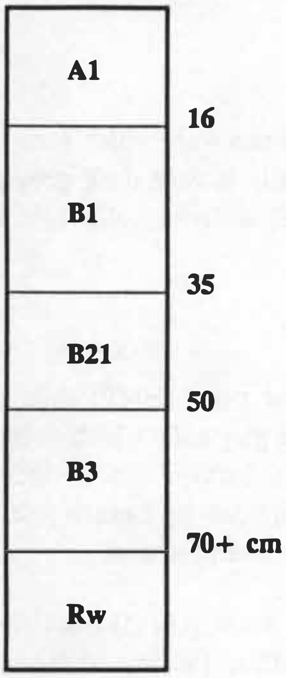
The soil map unit is a miscellaneous grouping with several un-named soils occurring. Two of these un-named soils are described above.

M2 soils occur in the west of the map sheet on the slopes of O'Connors Peak and the lower slopes of the Great Western Tiers near 'Caseyville' and 'Parknook'.

Typical Profile on Volcanic rocks

Soil Profile 193

Drainage:	Moderately rapid run-off, moderately well drained
Grid Reference:	506300 E and 5368900 N AMG
Classification:	Gn4.81, Non-calcic brown soil, Bleached-Acidic, Brown Dermosol
Landform:	Moderately inclined hill slope, slope 16%



A1; **Very dark grey (5YR 3/1 moist); light clay loam; moderate fine subangular blocky parting to extremely fine subangular blocky structure; rough ped fabric; weak (moist); common fine macropores; few moderately strong subangular gravels of volcanic breccia; many very fine roots; 5.6 field pH; 0 dSm-1; clear irregular boundary;**

B1; **Brown (7.5YR 4/4 moist); common medium faint very dark greyish brown (10YR 3/2) mottles; sandy clay loam; moderate medium angular blocky parting to fine angular blocky structure; rough ped fabric; weak (moist); few moderately strong subangular gravels of volcanic breccia; common very fine roots; 5.7 field pH; 0 dSm-1; clear wavy boundary;**

B21; **Brown (7.5YR 4/3 moist); gravelly sandy clay loam; moderate fine angular blocky structure; earthy fabric; very weak (moist); common very fine macropores; common subangular gravels of volcanic breccia; common very fine live roots; 5.7 field pH; 0 dSm-1; clear wavy boundary;**

B3; **Dark yellowish brown (10YR 4/5 moist); common coarse faint brown (10YR 5/3) mottles; light clay; moderate medium angular blocky parting to fine angular blocky structure; rough ped fabric; weak (moist); few moderately strong subangular gravels of volcanic breccia; few very fine roots; 5.9 field pH; 0 dSm-1; clear wavy boundary;**

Rw; **6.2 field pH; strongly weathered volcanic breccia**

Land Use and Capability Class

Those soils on phyllite have low natural fertility and poor physical structure. They can also be quite shallow in places and occur on rolling to very steep (>10%) land. As such their main potential is for forestry and extensive grazing. The poor soil structure and fine sandy to silt textures make these soils prone to fluvial erosion. Those soils from volcanic rocks have better physical properties but may also be quite shallow and occur on rolling to very steep land.

Land on which these soils occur is Class 5 with Class 6 on steeper slopes. Some areas of gently sloping land with deeper soils is Class 4, particularly where soils develop on volcanic rocks.

6.10 Soils from Organic Deposits

6.10.1 Un-named Soils of Miscellaneous Soils Mapping Unit M3

Mapping Unit M3

Reference

The M3 mapping unit is defined for the first time in this survey and it broadly correlates with the high moor peats (HMP) mapping unit of Nicolls (1959).

Diagnostic Features

The un-named soils of the M3 map unit are various acid peat and alpine humus soils which form in depressions, hollows and swamps on the alpine Central Plateau. Typically a very dark grey to black peat, commonly of 40-50 cm thickness, overlies clayey alluvium, dolerite colluvium or bedrock substrate. Thin iron pans may occur beneath the peat.

Classification

The soils of the M3 map unit have previously been mapped as high moor peats (HMP) soils by Nicolls (1959) and Leamy (1961). Leamy (1961) describes them as organic gley soils which overlie mottled clayey alluvium. These soils have not been described in this survey due to access difficulties and occurrence on non-agricultural land. Soil-landform descriptions by Leamy (1961) and Nicolls (1959) have been used to allow mapping by aerial photographic interpretation.

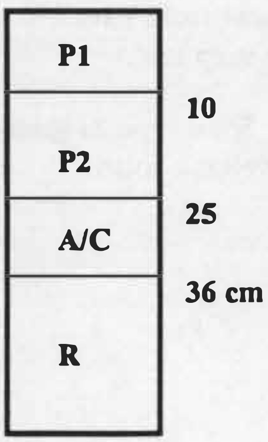
In the system of Northcote (1979) these soils are classified as organic soils (O). In the new Australian soils classification of Isbell (1993) these soils are various Acidic, Fibric and Hemic, Organosols.

Environmental Features

These soils form from accumulations of organic matter in depressions and hollows and overlie clayey alluvium, bouldery dolerite colluvium or dolerite bedrock.

The soils of the M3 map unit are confined to depressions and alluvial basins on the Central Plateau at altitudes over 700 m in the south-west corner of the survey area. Annual rainfall is generally greater than 800 mm/yr.

Soil Description from CSIRO H110



P1; Very dark brown (10YR 2/2); fibric peat; massive; abundant roots; pH 4.5; diffuse boundary;

P2; Black (10YR 2/1); peat; massive; pH 4.7;

A/C; Black (10YR 2/1); fibric loam; massive; pH 5.0;

R; Dolerite boulders or bedrock.

Soil Profile Class "Property" Grid Reference (AMG)	Profile Number	Horizon	Sample Depth (cm)	pH water (1:5)	EC (d/sm)	Total P (mg/kg)	Avail. P (mg/kg)	Avail. K (mg/kg)	Org. Carb. (%)	Total N (%)	C/N Ratio	Ca	Mg	Na	K	Total Bases	CEC	BASE SAT (%)	ESP (%)	Ca/Mg Ratio
												(milli-equivalents / 100 grams of soil)								
Miscellanous	SP 137	A1	0 - 5	5.3	0.07	236	15	314	13.20	0.606	22	11.72	4.56	0.32	0.82	17.4	19	94	1.7	2.57
Soils 2	SP 137	A2	5 - 15	5.2	0.03	79	0	98	2.20	0.141	16	1.92	0.90	0.14	0.24	3.2	6	54	2.4	2.14
"The Glen"	SP 137	B1	15 - 30	5.1	0.04	60	0	77	0.70	0.044	16	0.75	0.56	0.17	0.17	1.6	4	43	4.4	1.34
504900E	SP 137	B2w	30 - 70	5.2	0.04	86	0	36	0.80	0.032	25	0.15	0.41	0.24	0.21	1.0	4	24	5.6	0.36
5365100N	SP 137	B3	70 - 95	5.9	0.03	41	0	23	0.20	0.001	200	0.03	0.51	0.18	0.19	0.9	3	34	6.6	0.05

Soil Profile Class "Property" Grid Reference (AMG)	Profile Number	Horizon	Sample Depth (cm)	Gravel (of total) >2000 (µm) (%)	Sand Coarse >250 (µm) (%)	Sand Fine <250 (µm) (%)	Silt (%)	Clay (%)	Clay Mineralogy (Approximate weight %) Kaolinite	Illite	Goethite	Illite-Smectite	Gibbsite
Miscellanous	SP 137	A1	0 - 5	24	13	64	18	5					
Soils 2	SP 137	A2	5 - 15	55	16	55	24	5	65	10		25	
"The Glen"	SP 137	B1	15 - 30	55	22	49	24	6	75	5	5	15	
504900E	SP 137	B2w	30 - 70	63	17	42	29	11	65	5	10	20	
5365100N	SP 137	B3	70 - 95	30	7	60	27	6	70	5	10	10	5

Table 6.19 Analytical data for un-named soil profile class on phyllitic rocks, M2 mapping unit.

General Chemical, Physical and Mineralogical Properties

Data from a CSIRO soil profile (H110) from the Quamby reconnaissance soil survey (Nicolls, 1959) to the north-west is presented in Table 6.20.

Soils are acid with pH $\geq$5.0 throughout. Organic carbon content is very high in upper peat profile (>29%) and both total nitrogen and total phosphorus contents are very high in the P2 horizon.

Soil Mapping Units

These soils are mapped as a miscellaneous grouping M3. They occur a small area on the plateau top occurring in swampy depressions such as Priests Marshes, Christmas Marshes, Flash Charlies Marsh and Poachers Creek, in the south-west corner of the survey area.

Land Use and Capability Class

These soils are wet most of the year and support a vegetation of grasses, rushes and sedges. They occur mostly in State Forest areas.

These areas are Classes 6 and 7 land. Because of the fragile nature of these alpine organic soils, extreme care must be taken in their management due to the high risk of erosion if the soil surface is broken or disturbed. Severe climatic conditions on the Great Western Tiers Plateau further restrict the use of this land.

7. DISCUSSION

This survey provides information on soil occurrence in an important agricultural and forestry area of Tasmania. The study covers part of the Midlands region of Tasmania where increased cropping is occurring in a traditionally pastoral area. The soil map is at a small scale and further field investigation of the soils will be required to support detailed farm-scale management decisions. The majority of the field sample sites and soil descriptions are located in the agricultural areas in the north-eastern half of the area. Many of the soils in the higher country on the Great Western Tiers escarpment and plateau are mapped as miscellaneous soil groups and further detailed mapping will be required to define and map soils in these areas for specific forestry or other purposes.

In this study eighteen soil profile classes and four miscellaneous soil units have been mapped and described. The soil pattern in the survey area is extremely complex and this survey provides a simplified regional framework of soil occurrence. Windblown sand, dolerite and terrace deposits are the dominant soil parent materials. Other materials including mudstones, sandstones, phyllite and volcanic rocks have also provided soil parent materials.

Duplex, gradational, uniform and organic soils occur (Northcote, 1979). Duplex and uniform soils provide some of the greatest challenges to management. The uniform clays of the Canola soil profile class are fertile but suffer surface flooding, stream bank erosion and have a narrow working window when moisture content is ideal for cultivation. The management of these soils can be made easier with surface drainage and flood protection systems. Other uniform soils, the Panshanger soil profile class are rapidly draining, deep, sandy soils. Panshanger soils suffer from summer dryness due their sandiness and low organic matter contents which result in low moisture holding capacity. They are also prone to wind erosion when over-cultivated or where vegetative cover is reduced. The key to management of these soils lies in protection from wind erosion, improvement in organic matter contents and possibly in topdressing with suitable clay to improve water holding capacity.

A range of duplex soils (Brumby, Brickendon, Macquarie, Bicton and Woodstock) occur on flat to gently undulating terrace lands and provide a range of challenges to land managers. Problems of salinity are being met increasingly on the Brumby soils. Problems of high gravel content in the Macquarie, Bicton, Brickendon and Woodstock soils can inhibit cultivation. However the key problem with these soils is the duplex nature of the profile. That is, a profile where lighter textured topsoils and A2 horizons abruptly overlie heavy or medium clay subsoils. The subsoils often have coarse structure and are very clay-rich. These factors result in slow permeability and restricted drainage. Also the sandy or light topsoils quickly dry out in summer and pastures and crops can suffer moisture stress. Many A2 horizons are hardsetting. One of the reasons for the presence of many duplex soils may be the rapid rate at which clay is translocated in these soils due to clay dispersion and sodicity. This process is known as solonisation and is due to the presence of sodium on the exchange sites of soil clays which enhances dispersion and downward translocation of clay. Evidence of this process is shown by the presence of clay coatings in the B2 horizons of many duplex soils and the presence of lag gravels (ferruginous) in A2 horizons resting abruptly on the clayey B2 horizon (Plate 6.12). The lag gravel with a sandy matrix being the remainder following downward translocation of clay. The key to successful management of these duplex soils is the improvement of topsoil structure and, where costs permit, the use of deep tillage and gypsum or lime applications to improve the subsoil structure and drainage. Other options are to install surface drains, or where subsoils are not dispersive, subsoil drainage such as moles, tiles, PVC piping or surface slope interception drains to reduce run-on.

Duplex soils also occur on sloping terrain and include the Newham, Eastfield, Bloomfield and Blessington soil profile classes. These soils in addition to some of the problems discussed above may be susceptible to fluvial erosion. However their occurrence on sloping land assists lateral profile drainage.

Plate 6.12 View of the subsoil of soil profile 132, Woodstock soil profile class, showing thick clay coatings suggesting clay translocation in duplex soils in the Launceston Tertiary Basin (note 'Y' shaped cracks coated with clay, indicated with letter 'C', 524600E, 5363750N, AMG).

Gradational soils on basalt occur in the Conara to Campbell Town area and are some of the more fertile and physically better soils in the survey area. These soils are suitable for cultivation if limitations of water storage, stoniness and topsoil erosion can be managed. Fertile gradational soils also occur on the upper slopes of the Great Western Tiers (M1 soils); however these soils occur on rolling, steep and very steep slopes (>10%). They are also stony and there is much rock outcrop. These soils are best suited to forestry and conservation uses.

The general physical fertility of the soils of the region is low with the exception of the shallow krasnozems around Campbell Town and M1 soils on the Great Western Tiers. However, in duplex soils where the sandy A1 and A2 horizons are thick enough (>40 cm) they can provide a rooting depth adequate for good plant growth even on strongly duplex sodic soils, particularly where the slope of the land is sufficient to prevent waterlogging. The duplex soils on flat terrain tend to suffer waterlogging in winter and spring due to impermeable subsoils, whilst in summer the light sandy surface horizons rapidly dry-out resulting in poor moisture conditions for plant growth throughout much of the year. Artificial drainage and irrigation will increase the productive capability of such soils.

The general chemical fertility (pH, degree of leaching, available phosphorus and potassium, organic matter, total nitrogen) of the soils in the region deteriorates with age and degree of weathering. In all soils the higher nutrient status of the topsoil relative to the lower topsoil or subsoil is an important factor and highlights the economic value in preventing topsoil erosion. In all soils the cation exchange capacity and pH of the subsoils generally decreased with age. This indicates leaching and acidification are age-related processes. In the terrace soils kaolin is the most common clay mineral group on the older, higher surfaces eg, Woodstock and Brickendon soils; illite and smectite increase in soils on lower terrace surfaces eg, Brumby soils, and smectite is dominant in the modern flood plain soils ie, Canola soils.

A common feature of all the soils of the region is that topsoils have better structure, higher organic matter contents, higher nutrient status and higher biological activity than the underlying soil horizons. The topsoil layer is the part of the soil profile, above all, that needs to be protected and enhanced. Good soil management can achieve this in a range of ways such as direct drilling, stubble retention, reduced or minimum tillage, use of green manure crops and prevention of topsoil erosion with trees, wind breaks, timely and careful soil tillage and soil testing to identify nutrient deficiencies. By increasing the organic matter content of the soils a manager can improve water holding capacity, improve soil structure and enhance the soil fauna such as earthworms, soil bacteria, and other microfauna (earthworm numbers are low in this region, Garnsey pers. comm., DPIF Tasmania). Topsoils with high organic matter content tend to have higher CEC, base status and better soil structure. The bulk of the available plant nutrients, for all of the soils of the survey area, is in the topsoils, commonly the upper 10-15 cm of the soil profile. The total nitrogen and available potassium and phosphorus contents all peak in the topsoils. However, the topsoils of many of the lowland soils have low organic matter contents with fine sandy field textures which make them prone to rapid structural decline if over cultivated. Soil management techniques which improve structure and profile drainage, increase biological activity and rectify nutrient deficiencies are important for continued sustainable use of the soils in this important agricultural and forestry region of Tasmania.

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9. APPENDICES

Appendix 1

Rating table for chemical properties

General chemical properties

	Very low	Low	Medium	High	Very High
Organic Carbon (%)	<1	1-2	2-4	4-8	>8
Total Nitrogen (%)	<0.1	0.1-0.2	0.2-0.4	>0.4	
Total Phosphorus (mg/kg)	<100	100-200	200-500	500-1000	>1000
CEC (meq/100g soil)	<6	6-12	12-25	25-50	>50
Base Saturation (%)	<20	20-40	40-60	>60	

Note: Organic matter content can be estimated by multiplying organic carbon contents by 1.724.

Colwell Extractable Phosphorus and Potassium

Light soils (sandy loams)	Low	Medium	High
P (mg/kg)	<10	10-35	>35
K (mg/kg)	<100	100-200	>200
Heavy soils (clays)	Low	Medium	High
P (mg/kg)	<30	30-80	>80
K(mg/kg)	<150	150-300	>300

Salinity

	None	Slight	Moderate	High	Very High
(dSm-1)	<0.2	0.2-0.7	0.7-1.2	1.2-3.0	>3.0

Soil Acidity

	Slightly	Moderately	Strongly	Extremely
pH range	6.5-6.0	5.9-5.3	5.2-4.5	<4.5

Modified from Blackemore *et al.* (1987) and following discussions with McMahon (pers. comm. DPIF Tasmania) and Sparrow (pers. comm. DPIF Tasmania).

Appendix 2

Extract from 'The Launceston Agricultural District'

Greenhill, W.M., Hart M.A. and Pinkard G.J. 1982 (unpublished): The Launceston Agricultural District, Department of Agriculture Tasmania, 16p.

FERTILISER REQUIREMENTS

Phosphorus

Practically all district soils in their natural state are deficient in phosphorus. However, because of the length of time since clearing and the first use of superphosphate, as well as the different rates which have been applied in past years, it is difficult to generalise on crop and pasture requirements. For those soils of moderate fertility which have received regular topdressing in the past, a rate normally considered satisfactory for cereal crops and pastures is 100-150 kilograms of superphosphate (9.6%P) per hectare.

Experimental work with soils in the Cressy/Longford area which have had a extensive history of cropping (hay, cereals etc) has indicated that when soil potassium levels are low it is often not possible to obtain a response to applied phosphorus.

When levels of soil phosphorus are low (say, below 35 mg/kg bicarbonate - extractable P) and the topdressing of improved pastures is being considered, it is probably an advantage to increase the rate of superphosphate to 200 kilograms per hectare. For cereals and field peas, the rate can be economically increased to 250 kilograms per hectare.

Potassium

Potassium usually sold as muriate of potash, is required on many local soils and, in particular, those with a past history of cropping and hay making. Levels vary from extremely low (below 50 mg/kg bicarbonate - extractable K) to satisfactory (270 mg/kg and above). The quantity of potash used to overcome a potassium deficiency will, in most instances, range from a 'corrective' application of 120 kilograms per hectare to a smaller regular maintenance dressing of 30 kilograms per hectare. When heavy cuts are made it is normally a sound practice to replace the potassium removed with an application of up to 120 kilograms of potash per hectare. Lucerne crops may require more than this. Potassium is usually applied in a superphosphate and potash mixture.

Lime

Lime is important in the early development of pastures where the soil pH is below 5.2. Below 4.8 a pre-sowing application of 2.5 tonnes of ground limestone per hectare is often indicated. Above pH 4.8 the drilling of pasture seed with ground limestone or 50:50 lime-superphosphate, at rates of 400 kilograms per hectare is usually found to be adequate. Traditionally, soil pH results have been carried out in a 5:1 water-soil solution, pH(W). An improved test which is now applied to virgin soils involves the use of a calcium chloride solution, to give a value of pH (Ca), that is considered a more reliable guide to the need for lime on such soils. Some farmers in the district believe the use of lime on established pastures with a pH (W) below 5.5 to be beneficial to stock health, pasture production and soil physical condition.

Molybdenum

Molybdenum is a trace element required in very small quantities for plant health and development. The early identification of a molybdenum deficiency in soils about Cressy and Longford resulted in a changed farming pattern from predominantly cereals to pastures. Most district soils are naturally deficient in molybdenum and corrective measures, usually through the application of 150-200 kilograms per hectare of molybdate superphosphates as a topdressing each 5-7 years, is considered a sound practice. The indiscriminate use of molybdenum can significantly reduce the availability of soil copper.

Nitrogen

Nitrogen, usually most economically available as sulphate of ammonia, is not required by healthy clovered pastures. On occasions, additional late autumn or early spring growth in strong ryegrass pastures will be encouraged by the use of nitrogen at rates of up to 200 kilograms of sulphate of ammonia per hectare.

Sulphur and Zinc

These elements are present in Tasmanian manufactured superphosphate and are normally provided to the soil in sufficient quantity through the regular use of that fertiliser.

Copper and Cobalt

It is unlikely that natural levels of either copper or cobalt will be so low in district soils that they affect either plant or livestock health and growth.

Selenium

The regular use of superphosphate, through the action of its sulphur content, may result in a reduction in the amount of selenium available to pastures. Selenium deficiency has appeared in sheep and cattle in the district in the form of white muscle disease and ill-thrift problems. On several properties selenium drenches are administered to young stock as a regular managerial practice.

Iodine

Although iodine is not required for plant growth, deficiencies have been recorded in livestock, particularly when depastured on land in close proximity to the Macquarie River system. If advised, iodine is normally administered to stock by way of injection.

Boron

Boron deficiency has been noted in several indicator crops eg, turnips and poppies, on different soil types in the district. When indicated by sensitive crops, the simplest method of correction is by the use of boron superphosphate at 150-200 kilograms per hectare when sowing.

Appendix 3

List of Key Soil Horizon Designations Used in Text

Master Horizons (all of which may be subdivided eg, A11 and A12)

A1	Topsoil, zone of maximum biological activity, dark in colour.
A2	Grey, generally sandy, sometimes bleached, eluvial horizon (less clay, organic matter and sesquioxides than horizons above and below).
A3	Transitional between an A and a B horizon but more similar to A than a B.
B1	Upper B horizon, transitional to overlying A horizon (more similar to a B than an A).
B2	Main subsoil horizon, either:- 1) illuvial clay, humus or sesquioxide accumulations or 2) maximum pedological development ie, structure or colour.
B3	Transitional horizon between B2 and C horizon.
BC	As above.
C	Partially weathered parent material.
R	Bedrock.
P1	Primarily undecomposed organic matter (peat).
P2	Primarily decomposed organic matter (peat).

Main Subscripts Used

g	strong gleying is indicated by prominent mottling or greyish colours.
h	accumulation of humified, well decomposed organic matter.
k	accumulation of carbonate.
t	accumulation of silicate clay (illuviation).
w	weakly developed B, ie, colour or structure B, little or no illuviation.

For full horizon definitions refer to MacDonald *et al.* (1990).

Appendix 4

SOIL PROFILE DESCRIPTION CARD DPIF, TASMANIA

SITE DESCRIPTION

DB Profile No:

Project Name:
Proj Profile No:
Map Scale:
Sheet No:
Map Name:
AMG Easting:
AMG Northing:
Film No:
Run No:
Frame No:

State Code:
Property Name:
Property Owner:
Nearest Town:
Describer:
Date:
Rainfall (MA.mm):
Air Temp (3pm MA):
Type of Site:
Type of Desc:
Soil Samples:
Soil Photos:

Run off (0-5):
Permeability (1-4):
Drainage (1-6):
Elevation (m):
Soil Class:
Isbell Class:
Northcote PPF:
Great Soil Group:
Soil Taxonomy:
Land System:
Land Cap Class:
Geol Map Unit:

LANDFORM ELEMENT (20 m radius)

Element Slope Class (p 12)

LE	Level	(<1%)
VG	Very gentle	(1-3%)
GE	Gentle	(3-10%)
MO	Moderate	(10-32%)
ST	Steep	(32-56%)
VS	Very steep	(56-100%)
PR	Precipitous	(100-300%)
CL	Cliffed	(>300%)

Element Morphological Type

C	Crest
H	Hillock
R	Ridge
S	Simple slope
U	Upper slope
M	Mid slope
L	Lower slope
F	Flat
V	Open depression
D	Closed depression

Element Slope Inclination

X	Waxing
N	Waning
A	Maximal
I	Minimal (page 18)

Mode of Geomorphic Activity

ER	Eroded
EA	Eroded or aggraded
AG	Aggraded
	Or code (page 21)

Geomorphic Agent

GR	Gravity
SO	Solution
SM	Soil creep
SH	Sheet wash
WM	Mass movement
OV	Over-bank stream
CH	Channelled stream
WI	Wind
FR	Freeze thaw
GL	Glacial
TI	Tides
EU	Eustasy
VO	Volcanic
HU	Human
	Or code (page 23)

Element Type

BKP	Backplain
BAR	Bar
BRI	Beach ridge
BEN	Bench
BOU	Blow-out
DDE	Drainage depression
DUN	Dune
EST	Estuary
FAN	Fan
FOO	Footslope
FOR	Foredune
GUL	Gully
HCR	Hillcrest
HSL	Hillslope
LAG	Lagoon
LDS	Landslide
LEV	Levee
LUN	Lunette
MOU	Mound
PLA	Plain
SCA	Scarp
STB	Streambed
STC	Stream channel
SWP	Swamp
TEP	Terrace plain
TEF	Terrace flat
TDF	Tidal flat
VLF	Valley flat
	Or code (page 24)

LANDFORM PATTERN (300 m radius)

Pattern Slope Class (p 37)

LE	Level	(<1%)
VG	Very gentle	(1-3%)
GE	Gentle	(3-10%)
MO	Moderate	(10-32%)
ST	Steep	(32-56%)
VS	Very steep	(56-100%)
PR	Precipitous	(>100%)

Pattern Relief Class

M	Very high	>300 m
H	High	90 - 300 m
L	Low	30 - 90 m
R	Very low	9 - 30 m
P	Extremely low	<9 m

Pattern Type

ALF	Alluvial fan
ALP	Alluvial plain
BEA	Beach ridge plain
COL	Covered plain
DEL	Delta
DUN	Dunefield
FLO	Flood plain
HIL	Hills
LAC	Lacustrine plain
LOW	Low hills
MEA	Meander plain
PNP	Peneplain
PLT	Plateau
PLA	Plain
SAN	Sand plain
TEL	Terraced land
	Or code (page 48)

LAND SURFACE (p 87)

Slope angle (eg 10%)

Aspect (eg 010°)

Land Surface Disturbance

0	No disturbance (ND)
1	ND except grazed
2	Limited clearing
3	Extensive clearing
4	Complete cleared
5	Complete cleared/cult
6	Cultivation rainfed
7	Cultivation irrigated
8	Highly disturbed

Condition of Surface Soil

G G	Cracking
M M	Self-mulching
L L	Loose
S S	Soft
F F	Firm
H H	Hard setting
C C	Surface crust
Z Z	Saline
	Or code (page 141)

Microrelief Type

Z	No microrelief
C	Crabbole gilgai
N	Normal gilgai
L	Linear gilgai
A	Lattice gilgai
M	Melonhole gilgai
G	Contour gilgai
D	Debil-debil
W	Swamp hummocky
U	Mound/depression
S	Mass movement
R	Terrace
	Or code (page 91)

Land Surface Erosion

Degree of Erosion

0 0	None
1 1	Minor
2 2	Moderate
3 3	Severe
4 4	Very severe

State of Erosion

AA	Active
S S	Stabilized
P P	Partly stabilized

Type of Erosion

WW	Wind
S S	Sheet
RR	Rill
GG	Gully
CC	Scald
TT	Tunnel
BB	Streambank
VV	Wave
MM	Mass movement

Erosion Depth

Enter depth (cm) Col 1
Enter depth (cm) Col 2

Erosion Width

Enter width (m) Col 1
Enter width (m) Col 2

Inundation Frequency (p 96)

0	No inundation
1	< once per 100 years
2	Once in 50 - 100 years
3	Once in 10 - 50 years
4	Once in 1 - 10 years
5	> once per year

Duration of Inundation

1	< 1 day
2	1 - 20 days
3	20 - 120 days
4	> 120 days

Depth of Inundation

1	< 50 mm
2	50 - 100 mm
3	100 - 300 mm
4	300 mm - 1 m
5	> 1 m

Coarse Fragments

Abundance Coarse Fragments

0	None	(0%)
1	Very few	(<2%)
2	Few	(2-10%)
3	Common	(10-20%)
4	Many	(20-50%)
5	Abundant	(50-90%)
6	Very abundant	(>90%)

Size of Coarse Fragments

1	Fine gravel	(2-6mm)
2	Med. gravel	(6-20mm)
3	Coa. gravel	(20-60mm)
4	Cobbles	(60-200mm)
5	Stones	(200-600mm)
6	Boulders	(600mm-2m)
7	Large boulders	(>2 m)

Rock Outcrops

0	No rock outcrop	
1	V slightly rocky	(<2%)
2	Slightly rocky	(2-10%)
3	Rocky	(10-20%)
4	V Rocky	(20-50%)
5	Rockland	(>50%)
	Lithology code (p 160)	

Water table depth (m±)

VEGETATION (p 58)

Type of Forest

1	Non rain forest
2	Rain forest
3	Mixture
4	Plantation
5	No vegetation

Emergence species present

Top Stratum (Species Code)

1st
2nd
3rd

Mid Stratum (Species Code)

1st
2nd
3rd

Lower Stratum (Species Code)

1st
2nd
3rd

Growth Form of Stratum

Top
Mid
Low

Height of Stratum

Top
Mid
Low

Cover Class of Stratum

Top
Mid
Low

Rain Forest Complexity

S	Simple
X	Simple-complex
C	Complex

Floristic Composition of tallest

Enter code (page 83)

Leaf size code (page 83)

Indicator Growth Form

Enter code (page 84)

SUBSTRATE (p 153)

Depth to Substrate (m)

Confidence Substrate = PM?

N	Not parent material
D	Dubious, doubtful
P	Probable
A	Almost certain, certain

Grain Size of Substrate

1	Silt/clay size	<0.06mm
2	Sand size	0.06-2mm
3	Gravel size	>2mm

Texture of Substrate

F	Fragmental
X	Crystalline
P	Porphyritic
A	Amorphous

Structure of Substrate

V	Massive
S	Vesicular
C	Concretionary
P	Platy
R	Vermicular
B	Bedded
F	Fissile
L	Foliated

Mineral Composition Substrate

Enter code (page 155)

Strength of Substrate

VW	Very weak
W	Weak
M	Moderate
S	Strong
VS	Very strong

Substrate Rock Code

BA	Basalt
BR	Breccia
KM	Calcareous mudstone
KS	Calcareous sand
C	Clay
CG	Conglomerate
DR	Dolerite
DM	Dolomite
FC	Ferricrete
GS	Gneiss
GN	Granite
GV	Gravel
GW	Greywacke
IG	Igneous rock
IS	Ironstone
LI	Limestone
PH	Phyllite
QU	Quartzite
QS	Quartz sandstone
S	Sand
SA	Sandstone
ST	Schist
SH	Shale
SS	Shells
Z	Silt
ZS	Siltstone
SL	Slate
	or code (page 160)

Alteration of Substrate

F	Ferruginised
L	Kaolinised
S	Silicified
K	Calcified
O	Other

Genetic Type Substrate Mass

Enter code (page 166)

Page numbers refer to Yellow Handbook (MacDonald et al. 1990).

SOIL HORIZON DESIGNATION (page 104)

	Master horizon								

[illegible]NESS

	Upper (cm)								
	Lower (cm)								

HORIZON BOUNDARY (page 149)

DISTINCTNESS	Sharp	<5 mm	S	S	S	S	S	S	S	S
	Abrupt	5-20 mm	A	A	A	A	A	A	A	A
	Clear	20-50 mm	C	C	C	C	C	C	C	C
	Gradual	50-100 mm	G	G	G	G	G	G	G	G
	Diffuse	>100 mm	D	D	D	D	D	D	D	D
SHAPE	Smooth		S	S	S	S	S	S	S	S
	Wavy		W	W	W	W	W	W	W	W
	Irregular		I	I	I	I	I	I	I	I
	Tongued		T	T	T	T	T	T	T	T
	Broken		B	B	B	B	B	B	B	B

SOIL WATER STATUS (page 138)

MOISTURE	Dry	D	D	D	D	D	D	D	D
	Slightly moist	T	T	T	T	T	T	T	T
	Moist	M	M	M	M	M	M	M	M
	Wet	W	W	W	W	W	W	W	W

MATRIX COLOUR (page 113)

MOIST	Hue								
	Value								
	Chroma								
DRY	Hue								
	Value								
	Chroma								

PRIMARY MOTTLES (page 114)

ABUNDANCE	Type (enter code)									
	None	0	0	0	0	0	0	0	0	0
	Very few	0-2%	1	1	1	1	1	1	1	1
	Few	2-10%	2	2	2	2	2	2	2	2
	Common	10-20%	3	3	3	3	3	3	3	3
	Many	20-50%	4	4	4	4	4	4	4	4
SIZE	Fine	<5 mm	1	1	1	1	1	1	1	1
	Medium	5-15 mm	2	2	2	2	2	2	2	2
	Coarse	>15 mm	3	3	3	3	3	3	3	3
	Very coarse	>30 mm	4	4	4	4	4	4	4	4
CONTRAST	Faint		F	F	F	F	F	F	F	F
	Distinct		D	D	D	D	D	D	D	D
	Prominent		P	P	P	P	P	P	P	P
COLOUR	Hue									
	Value									
	Chroma									

SECONDARY MOTTLES (page 114)

ABUNDANCE	Type (enter code)									
	None	0	0	0	0	0	0	0	0	0
	Very few	0-2%	1	1	1	1	1	1	1	1
	Few	2-10%	2	2	2	2	2	2	2	2
	Common	10-20%	3	3	3	3	3	3	3	3
	Many	20-50%	4	4	4	4	4	4	4	4
SIZE	Fine	<5 mm	1	1	1	1	1	1	1	1
	Medium	5-15 mm	2	2	2	2	2	2	2	2
	Coarse	15-30 mm	3	3	3	3	3	3	3	3
	Very coarse	>30 mm	4	4	4	4	4	4	4	4
CONTRAST	Faint		F	F	F	F	F	F	F	F
	Distinct		D	D	D	D	D	D	D	D
	Prominent		P	P	P	P	P	P	P	P
COLOUR	Hue									
	Value									
	Chroma									

FIELD TEXTURE (page 115)

QUALIFIER	Light		-	-	-	-	-	-	-	-
	Heavy		+	+	+	+	+	+	+	+
	Gritty	2 - 6 mm	GT	GT	GT	GT	GT	GT	GT	GT
	Gravelly	6 - 60 mm	GV	GV	GV	GV	GV	GV	GV	GV
	Stony	60 - 200 mm	SN	SN	SN	SN	SN	SN	SN	SN
	Bouldery	>200 mm	BO	BO	BO	BO	BO	BO	BO	BO
	Humic		HU	HU	HU	HU	HU	HU	HU	HU
	Peaty		PE	PE	PE	PE	PE	PE	PE	PE
	Sapric		A	A	A	A	A	A	A	A
	Fibric		I	I	I	I	I	I	I	I
	Texture code (page 115)									

PRIMARY STRUCTURE (page 124)

GRADE	Massive		V	V	V	V	V	V	V	V
	Single grain		G	G	G	G	G	G	G	G
	Weakly developed		W	W	W	W	W	W	W	W
	Moderately developed		M	M	M	M	M	M	M	M
	Strongly developed		S	S	S	S	S	S	S	S
SIZE	Extremely fine	<2 mm	1	1	1	1	1	1	1	1
	Very fine	2-5 mm	2	2	2	2	2	2	2	2
	Fine	5-10 mm	3	3	3	3	3	3	3	3
	Medium	10-20 mm	4	4	4	4	4	4	4	4
	Medium-Coarse	20-50 mm	5	5	5	5	5	5	5	5
	Coarse	50-100 mm	6	6	6	6	6	6	6	6
	Coarse-VC	100-200 mm	7	7	7	7	7	7	7	7
	Very coarse	200-500 mm	8	8	8	8	8	8	8	8
	Extremely coarse	>500 mm	9	9	9	9	9	9	9	9
TYPE	Platy		PL	PL	PL	PL	PL	PL	PL	PL
	Prismatic		PR	PR	PR	PR	PR	PR	PR	PR
	Columnar		CO	CO	CO	CO	CO	CO	CO	CO
	Angluar blocky		AB	AB	AB	AB	AB	AB	AB	AB
	Subangular blocky		SB	SB	SB	SB	SB	SB	SB	SB
	Polyhedral		PO	PO	PO	PO	PO	PO	PO	PO
	Lenticular		LE	LE	LE	LE	LE	LE	LE	LE
	Granular		GR	GR	GR	GR	GR	GR	GR	GR
	Cast		CA	CA	CA	CA	CA	CA	CA	CA
LINK	Plus		1	1	1	1	1	1	1	1
	Parting to		2	2	2	2	2	2	2	2

SECONDARY STRUCTURE (page 124)

GRADE	Massive		V	V	V	V	V	V	V	V
	Single grain		G	G	G	G	G	G	G	G
	Weakly developed		W	W	W	W	W	W	W	W
	Moderately developed		M	M	M	M	M	M	M	M
	Strongly developed		S	S	S	S	S	S	S	S
SIZE	Extremely fine	<2 mm	1	1	1	1	1	1	1	1
	Very fine	2-5 mm	2	2	2	2	2	2	2	2
	Fine	5-10 mm	3	3	3	3	3	3	3	3
	Medium	10-20 mm	4	4	4	4	4	4	4	4
	Medium-coarse	20-50 mm	5	5	5	5	5	5	5	5
	Coarse	50-100 mm	6	6	6	6	6	6	6	6
	Coarse-VC	100-200 mm	7	7	7	7	7	7	7	7
	Very coarse	200-500 mm	8	8	8	8	8	8	8	8
	Extremely coarse	>500 mm	9	9	9	9	9	9	9	9
TYPE	Platy		PL	PL	PL	PL	PL	PL	PL	PL
	Prismatic		PR	PR	PR	PR	PR	PR	PR	PR
	Columnar		CO	CO	CO	CO	CO	CO	CO	CO
	Angular blocky		AB	AB	AB	AB	AB	AB	AB	AB
	Subangular blocky		SB	SB	SB	SB	SB	SB	SB	SB
	Polyhedral		PO	PO	PO	PO	PO	PO	PO	PO
	Lenticular		LE	LE	LE	LE	LE	LE	LE	LE
	Granular		GR	GR	GR	GR	GR	GR	GR	GR
	Cast		CA	CA	CA	CA	CA	CA	CA	CA

STICKINESS (page 139)

DEGREE	Non-sticky	0	0	0	0	0	0	0	0
	Slightly sticky	1	1	1	1	1	1	1	1
	Moderately sticky	2	2	2	2	2	2	2	2
	Very sticky	3	3	3	3	3	3	3	3

PLASTICITY DEGREE (page 140)

DEGREE	Non-plastic	0	0	0	0	0	0	0	0
	Slightly plastic	1	1	1	1	1	1	1	1
	Moderately plastic	2	2	2	2	2	2	2	
	Very plastic	3	3	3	3	3	3	3	3

PLASTICITY TYPE (page 140)

TYPE	Superplastic	S	S	S	S	S	S	S	S
	Normal plasticity	N	N	N	N	N	N	N	N
	Subplastic	U	U	U	U	U	U	U	U
	Strongly subplastic	T	T	T	T	T	T	T	T

MOIST SOIL STRENGTH (page 139)

MOIST CONSISTENCE	Loose	0	0	0	0	0	0	0	0
	Very weak	1	1	1	1	1	1	1	1
	Weak	2	2	2	2	2	2	2	2
	Firm	3	3	3	3	3	3	3	3
	Very firm	4	4	4	4	4	4	4	4
	Strong	5	5	5	5	5	5	5	5
	Very strong	6	6	6	6	6	6	6	6
	Rigid	7	7	7	7	7	7	7	7

DRY SOIL STRENGTH (page 139)

DRY CONSISTENCE	Loose	0	0	0	0	0	0	0	0
	Very weak	1	1	1	1	1	1	1	1
	Weak	2	2	2	2	2	2	2	2
	Firm	3	3	3	3	3	3	3	3
	Very firm	4	4	4	4	4	4	4	4
	Strong	5	5	5	5	5	5	5	5
	Very strong	6	6	6	6	6	6	6	6
	Rigid	7	7	7	7	7	7	7	7

PENETRATION RESISTANCE

MOIST SOIL	Soft	1	1	1	1	1	1	1	1
	Firm	2	2	2	2	2	2	2	2
	Stiff	3	3	3	3	3	3	3	3
	Very stiff	4	4	4	4	4	4	4	4
	Hard	5	5	5	5	5	5	5	5

FABRIC (page 134)

FABRIC	Earthy	E	E	E	E	E	E	E	E
	Sandy	G	G	G	G	G	G	G	G
	Rough-ped	R	R	R	R	R	R	R	R
	Smooth-ped	S	S	S	S	S	S	S	S

CRACKS (page 136)

CRACKS	Fine	<5 mm	1	1	1	1	1	1	1	1
	Medium	5 - 10 mm	2	2	2	2	2	2	2	2
	Coarse	10 - 20 mm	3	3	3	3	3	3	3	3
	Very coarse	20 - 50 mm	4	4	4	4	4	4	4	4
	Extremely coarse	>50 mm	5	5	5	5	5	5	5	5

MACROPORES (page 136)

ABUNDANCE	No macropores		0	0	0	0	0	0	0	0
	Few	(<1/100 mm^2)	1	1	1	1	1	1	1	1
	Common	(1 - 5/100 mm^2)	2	2	2	2	2	2	2	2
	Many	(>5/100 mm^2)	3	3	3	3	3	3	3	3
DIAMETER	Very fine	(.075 - 1 mm)	1	1	1	1	1	1	1	1
	Fine	(1 - 2 mm)	2	2	2	2	2	2	2	2
	Medium	(2 - 5 mm)	3	3	3	3	3	3	3	3
	Coarse	(>5 mm)	4	4	4	4	4	4	4	4

CUTANS (page 135)

ABUNDANCE	No cutans		0	0	0	0	0	0	0	0
	Few	<10%	1	1	1	1	1	1	1	1
	Common	10-50%	2	2	2	2	2	2	2	3
	Many	>50%	3	3	3	3	3	3	3	3
DISTINCT-NESS	Faint		F	F	F	F	F	F	F	F
	Distinct		D	D	D	D	D	D	D	D
	Prominent		P	P	P	P	P	P	P	P
TYPE	Unspecified		U	U	U	U	U	U	U	U
	Clay skins		C	C	C	C	C	C	C	C
	Organic - humus		H	H	H	H	H	H	H	H
	Mangan		M	M	M	M	M	M	M	M
	Carbonate		B	B	B	B	B	B	B	B
	Slicken sides		K	K	K	K	K	K	K	K
	Stress cutans		S	S	S	S	S	S	S	S
	Other cutans		O	O	O	O	O	O	O	O
COLOUR	Hue									
	Value									
	Chroma									
LOC.	Coating ped faces		1	1	1	1	1	1	1	1
	Lining pores/cracks		2	2	2	2	2	2	2	2

PEDOGENIC SEGREGATIONS (page 146)

ABUNDANCE	None		0	0	0	0	0	0	0	0
	Very few	<2%	1	1	1	1	1	1	1	1
	Few	2-10%	2	2	2	2	2	2	2	2
	Common	10-20%	3	3	3	3	3	3	3	3
	Many	20-50%	4	4	4	4	4	4	4	4
	Abundant	>50%	5	5	5	5	5	5	5	5
SIZE	Fine	<2 mm	1	1	1	1	1	1	1	1
	Medium	2-6 mm	2	2	2	2	2	2	2	2
	Coarse	6-20 mm	3	3	3	3	3	3	3	3
	Very coarse	20-60 mm	4	4	4	4	4	4	4	4
	Extremely coarse	>60 mm	5	5	5	5	5	5	5	5
NATURE OF SEGREGATION	Unidentified		U	U	U	U	U	U	U	U
	Carbonate		K	K	K	K	K	K	K	K
	Gypsum		Y	Y	Y	Y	Y	Y	Y	Y
	Manganiferous		M	M	M	M	M	M	M	M
	Fe/Mn		N	N	N	N	N	N	N	N
	Ferruginous		F	F	F	F	F	F	F	F
	Aluminous		A	A	A	A	A	A	A	A
	Saline		Z	Z	Z	Z	Z	Z	Z	Z
	Organic		H	H	H	H	H	H	H	H
	Fe - Organic		G	G	G	G	G	G	G	G
	Argillaceous		L	L	L	L	L	L	L	L
	Earthy		E	E	E	E	E	E	E	E
	Other		O	O	O	O	O	O	O	O
FORM	Crystals		X	X	X	X	X	X	X	X
	Concretions		C	C	C	C	C	C	C	C
	Nodules		N	N	N	N	N	N	N	N
	Soft segregations		S	S	S	S	S	S	S	S
	Veins		V	V	V	V	V	V	V	V
	Laminae		L	L	L	L	L	L	L	L

COARSE FRAGMENTS (page 123)

ABUNDANCE	None		0	0	0	0	0	0	0	0
	Very few	<2%	1	1	1	1	1	1	1	1
	Few	2-10%	2	2	2	2	2	2	2	2
	Common	10-20%	3	3	3	3	3	3	3	3
	Many	20-50%	4	4	4	4	4	4	4	4
	Abundant	50-90%	5	5	5	5	5	5	5	5
	Profuse	>90%	6	6	6	6	6	6	6	6

STRENGTH	Very weak	VW	VW	VW	VW	VW	VW	VW	VW
	Weak rock	W	W	W	W	W	W	W	W
	Moderately weak rock	M	M	M	M	M	M	M	M
	Strong rock	S	S	S	S	S	S	S	S
	Very strong rock	VS	VS	VS	VS	VS	VS	VS	VS

SHAPE	Rounded	R	R	R	R	R	R	R	R
	Subrounded	U	U	U	U	U	U	U	U
	Subangular	S	S	S	S	S	S	S	S
	Angular	A	A	A	A	A	A	A	A
	(or code p 99)								

DISTRIBUTION	Undisturbed	U	U	U	U	U	U	U	U
	Reorientated	R	R	R	R	R	R	R	R
	Stratified	S	S	S	S	S	S	S	S
	Dispersed	D	D	D	D	D	D	D	D

SIZE	Fine gravel	2 - 6 mm	1	1	1	1	1	1	1	1
	Medium gravel	6 - 20 mm	2	2	2	2	2	2	2	2
	Coarse gravel	20 - 60 mm	3	3	3	3	3	3	3	3
	Cobbles	60 - 200 mm	4	4	4	4	4	4	4	4
	Stones	200 - 600 mm	5	5	5	5	5	5	5	5
	Boulders	600 mm - 2 m	6	6	6	6	6	6	6	6
	Large boulders	>2 m	7	7	7	7	7	7	7	7

	Lithology code (page 160)								

PANS (page 143)

CEMENTATION	Uncemented	0	0	0	0	0	0	0	0
	Weakly cemented	1	1	1	1	1	1	1	1
	Moderately cemented	2	2	2	2	2	2	2	2
	Strongly cemented	3	3	3	3	3	3	3	3
	Very strong cemented	4	4	4	4	4	4	4	4

STRUCTURE	Massive	V	V	V	V	V	V	V	V
	Vesicular	S	S	S	S	S	S	S	S
	Concretionary	C	C	C	C	C	C	C	C
	Nodular	N	N	N	N	N	N	N	N
	Platy	L	L	L	L	L	L	L	L
	Vermicular	R	R	R	R	R	R	R	R

CONTIN-UITY	Continuous	C	C	C	C	C	C	C	C
	Discontinuous	D	D	D	D	D	D	D	D
	Broken	B	B	B	B	B	B	B	B

TYPE OF PAN	Calcrete	K	K	K	K	K	K	K	K
	Silcrete	L	L	L	L	L	L	L	
	Red-brown hardpan	R	R	R	R	R	R	R	R
	Duripan	D	D	D	D	D	D	D	D
	Fragipan	F	F	F	F	F	F	F	F
	Densipan	N	N	N	N	N	N	N	N
	Thin iron pan	I	I	I	I	I	I	I	I
	Ferricrete	E	E	E	E	E	E	E	E
	Alcrete (bauxite)	A	A	A	A	A	A	A	A
	Manganiferous	M	M	M	M	M	M	M	M
	Ortstein	T	T	T	T	T	T	T	T
	Organic pan	C	C	C	C	C	C	C	C
	Cultivation pan	V	V	V	V	V	V	V	V
	Other pan	O	O	O	O	O	O	O	O

LIVE ROOTS (page 148)

ABUNDANCE	None	(0)	0	0	0	0	0	0	0	0
	Few	(1-10 or 1-2)	1	1	1	1	1	1	1	1
	Common	(10-25 or 2-5)	2	2	2	2	2	2	2	2
	Many	(25-200 or >5)	3	3	3	3	3	3	3	3
	Abundant	(>200 or >5)	4	4	4	4	4	4	4	4

SIZE	Very fine	<1 mm	1	1	1	1	1	1	1	1
	Fine	1-2 mm	2	2	2	2	2	2	2	2
	Medium	2-5 mm	3	3	3	3	3	3	3	3
	Coarse	>5 mm	4	4	4	4	4	4	4	4

Root abundance given in brackets: 1st value is for very fine & fine: 2nd value is for medium & coarse.

FIELD pH& SALINITY

EC/pH	pH (field)								
	Salinity (dSm^{-1})								

DISPERSION (Emerson Test)

	Enter code (Classes 1 - 8 & subclasses)								

EFFERVESCENCE (page 147)

EFFERVESCENCE	Non-calcareous	N	N	N	N	N	N	N	N
	Slightly calcareous	S	S	S	S	S	S	S	S
	Moderately calcareous	M	M	M	M	M	M	M	M
	Highly calcareous	H	H	H	H	H	H	H	H
	Very highly calcareous	V	V	V	V	V	V	V	V

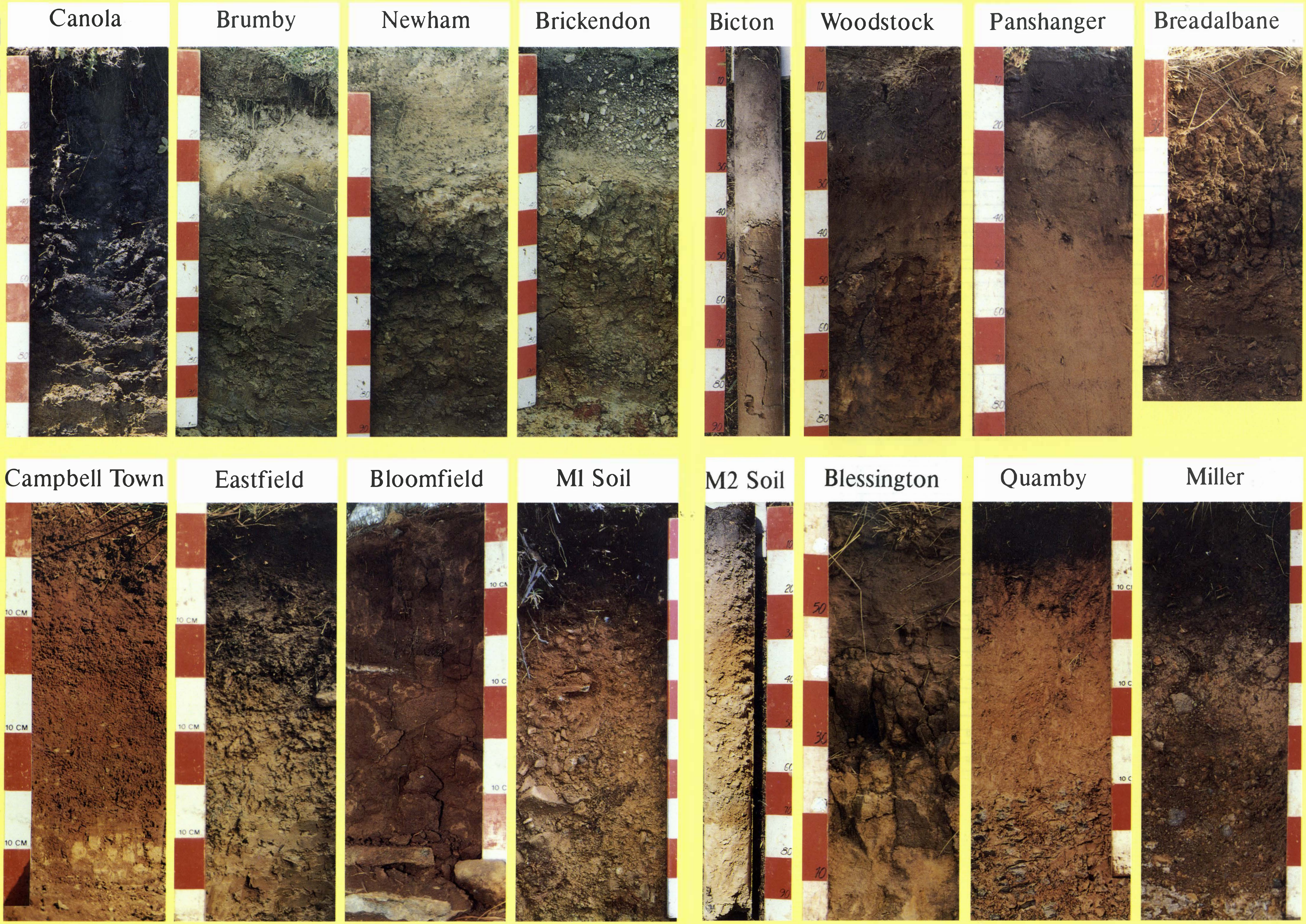
WATER REPELLENCE (page 142)

REPELL.	Non water repellent	N	N	N	N	N	N	N	N
	Water repellent	R	R	R	R	R	R	R	R
	Strongly water repellent	S	S	S	S	S	S	S	S

SUBSTRATE NOTES:

PROFILE NOTES:

LOCATION NOTES:



Appendix 5 Predominant soil profile classes of the South Esk 1:100 000 map sheet, Tasmania (interval on scale bar is 10cm).