A LAND CAPABILITY STUDY OF THE CARDINIA SHIRE

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CENTRE FOR LAND PROTECTION RESEARCH

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Matthew J. Macmillan, Angela L. Smith and Nathalie M. Baxter

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Further Information

This report has been prepared to assist broad scale planning in the Cardinia Shire. The information in the report has been derived from air photo interpretation and a limited number of representative field sites. The scale of mapping adopted has necessitated some generalisations from the site information collected. While the ratings indicate the likely performance of the various types of land for a specific use, site specific information may be required for on-site planning. The precision of mapped boundaries is affected by the scale of the map. Any enlargement of the map will distort information and is unlikely to improve its accuracy.

The complete set of maps which accompany this report can be viewed at the Shire of Cardinia office, the NRE office at Dandenong or at CLPR, Bendigo.

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A Land Capability Study of the Cardinia Shire

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1. Land capability for agriculture - Victoria - Cardinia (Shire)
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PREFACE

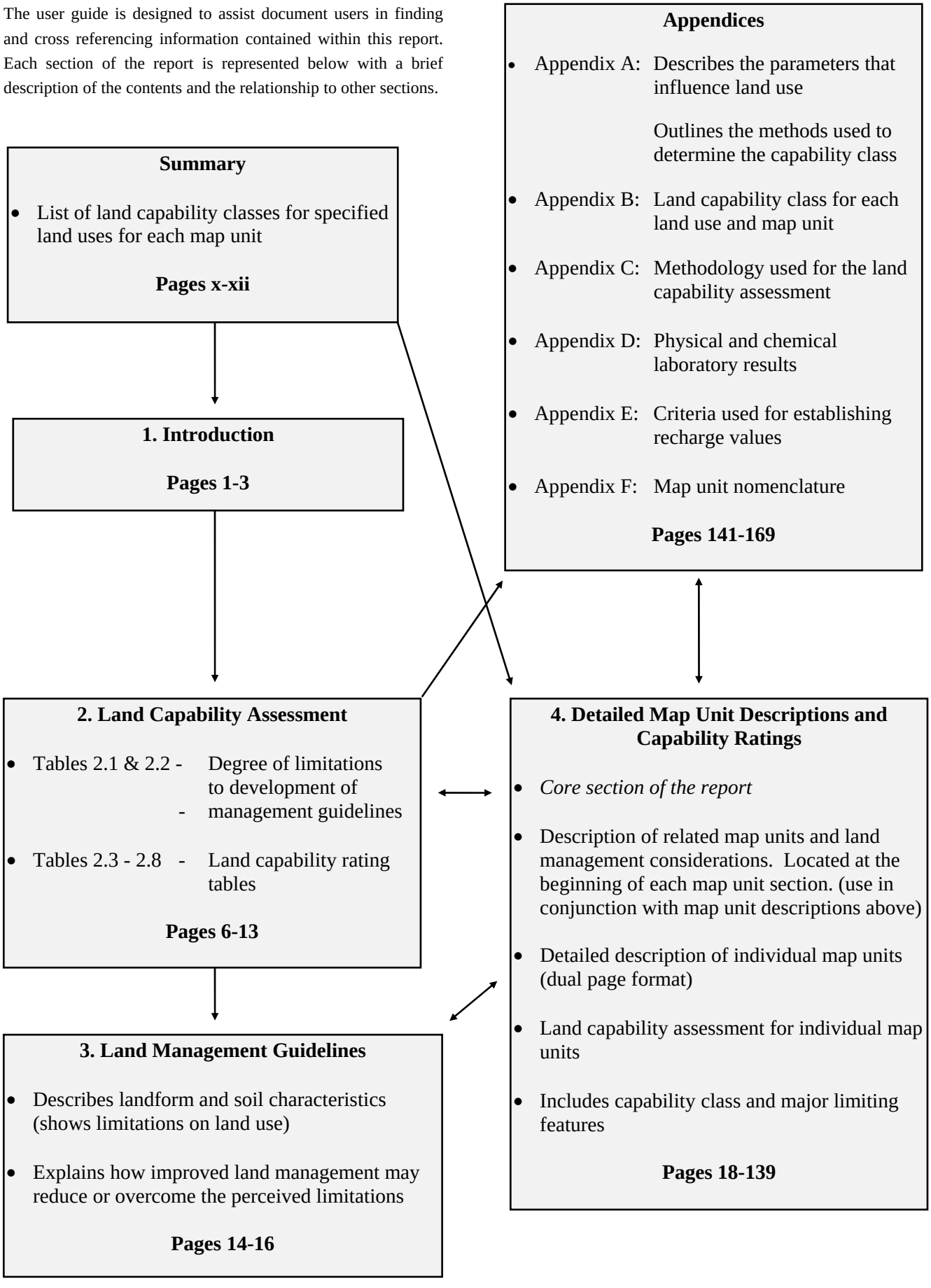
The Department of Natural Resources and Environment has been involved in formal land capability assessment studies since the early 1970s. The Land Capability Section of the (then) Soil Conservation Authority established the framework for the conduct of formal land capability studies upon which this more recent work is based. This framework included rating tables for some thirty activities. Ratings for various activities were presented as thematic maps, or combined into ratings for various land uses, depending upon the needs and abilities of the client.

It was proposed to undertake detailed Land Capability Studies in municipalities with significant pressures for change in land use to more intensive uses, where there was significant existing or potential land degradation issues, or where better quality agricultural land was under threat of development for residential purposes.

The primary objective has been to provide the municipality with detailed land resource information, consisting of base data on the nature of the land, and assessment of the likely performance of the land under various activities. This information can underpin many land use and management decisions by the municipal authority, both now and in the future. In doing so, many of the problems and unexpected costs incurred through inappropriate land use can be avoided.

USER GUIDE

The user guide is designed to assist document users in finding and cross referencing information contained within this report. Each section of the report is represented below with a brief description of the contents and the relationship to other sections.



EXAMPLE: This hypothetical example is designed to assist users to understand the interrelationship between the different sections in the report and the use of the accompanying maps.

Scenario: ***Determining the feasibility of further development north of Packenham Upper, (Map 1a) requiring secondary roads, septic tanks and building foundations.***

Step 1: Locate site on the Base Map and establish the map unit, for example, Dgd.

Step 2: Refer to Table i.i, in the Summary (p ix), for a general idea of the capability of this map unit to support the specified land uses AND / OR use the Land Capability Assessment for Secondary Roads, and Land Capability Assessment for Effluent Disposal maps. Locate the site and refer to the legend which will provide the rating and the limiting features.

Step 3: Inspect site. Refer to the core section of the report - Section 5. Detailed Map Unit Descriptions - and find the relevant map unit, Dgd (p 94). This will give a detailed description of the soil and landscape features of this map unit. Due to the broad scale of the maps, the first step is to determine whether the detailed soil and landscape features are similar to what is found on the site of interest. If not, the site may be similar to another map unit description or it may be an anomaly and therefore an individual study of the site may need to be carried out.

If the site is similar, the Land Capability Assessment table will give the rating for the land uses in question. For this example, the land capability ratings are:

Secondary Roads: Rating 4 - Limiting features: slope and drainage.

Effluent Disposal: Rating 4 - Limiting feature: drainage and permeability.

Building Foundations: Rating 4 - Limiting features: slope and drainage.

Step 4: To assist in understanding the definition of Class 4, refer to Table 2.2 (p 7) for the degree of limitations that Class 4 has for development, and the management guidelines needed to overcome the constraints.

Step 5: Section 3. Land Management Guidelines (chapter 3 p 14) will explain the limitations specified in step 3 (i.e. drainage for effluent disposal, and proportion of stones and boulders and linear shrinkage for secondary roads) and whether they can be reduced or overcome by an improved level of management.

Step 6: If the limitations can be overcome, referring to Appendix B will show if there are any other limitations which need to be overcome to allow the development to take place without causing degradation to land and water quality.

NOTE: Section 4.4 Devonian granitic map units (p 85). Understanding the whole study area is important in making planning decisions as development may be capable of occurring on the site of interest but the off-site effects may be considerable.

The process of how and when to use the various sections of the report is largely up to the user. There may be times when the user may need to refer to different sections of the report, particularly a new user, to ensure that they have a full understanding of the Land Capability Assessment process. For example, understanding the process of determining the Land Capability Assessment ratings is very important, therefore the user will need to refer to Section 2. Land Capability Assessment and Appendix A to establish how the ratings were determined.

SUMMARY

This study describes in detail the land present in the Cardinia Shire and provides information relevant to land use planning and assessment.

A land capability study provides a planning tool to assist the Shire in the development of a detailed planning scheme. It will facilitate the planning of future land use through a systematic and rational examination of the lands management requirements, and the consequences of undertaking a range of alternative land uses. Revision of the planning scheme, based on sound land resources information, is required to direct development away from areas not well suited to certain uses, and to maintain a balance between competing land uses and the better quality agricultural land, in the interest of the whole community.

The former Shire of Pakenham (area approximately 880 square kilometres) has now become incorporated into the Cardinia Shire. The new shire also includes a large area in the south, previously part of the City of Cranbourne, as well as an additional area close to the township of Emerald which was previously part of the former Shire of Sherbrooke. The Cardinia Shire has an area of approximately 1260 square kilometres.

The Shire has seen significant population growth over the last few decades due to its easy commuting distance to Melbourne and Dandenong by way of the Princes Highway and the Warragul Railway system. Growth has been concentrated around towns close to the highway, however there is increasing pressure for development away from the area set aside as the major growth corridor. The areas under pressure include Upper Beaconsfield, Gembrook, Cockatoo, Emerald and Maryknoll. It is well established that indiscriminate development of land for small lot rural and residential development may result in extensive land and water degradation, loss of good agricultural land and unnecessarily high development and maintenance costs.

The protection of good quality agricultural land is becoming increasingly important as rural residential development is encroaching upon and fragmenting the remaining highly productive areas. Identification of good quality agricultural land has, to a large extent, already been carried out in the alluvial area of the Koo-wee-rup swamp in the studies by Sargeant (1993, 1994). The Tertiary volcanic soils around Gembrook and Emerald are also valuable for horticultural production and will come under further pressure for rural residential development.

The agricultural ratings for this area show significant areas with ratings of class 3, while some areas have been categorised as class 4. Although the class 4 ratings occur on quite productive soils, the limitation for agriculture is commonly the steepness of the slope. The areas with a very poor rating (class 5) due to the very steep slopes, are generally too steep to be cultivated and are either not used for agricultural purposes or are used only for grazing.

The Shire has a diverse range of landforms including broard alluvial plains, gentle undulating rolling hills and steep hills. Steep slopes are associated with Silurian sediments and Devonian granite, and this land is often prone to sheet and gully erosion. Because of the favourable climate and long growing season, significant ground cover is present all year. This ground cover mitigates against significant erosion in many situations, however any practice that removes ground cover will greatly accelerate the rate of erosion. Increased erosion will occur around house sites, road batters, drains, eroded stream banks and bare cultivated paddocks. Westernport Bay is the ultimate destination for much of this eroded material.

An emerging problem in the shire is the increase in area of salt affected land. Salt discharge areas are becoming visible in the lower lying areas. Salt affected areas are particularly visible upslope of the Princes Highway and the railway line. Construction of the road and railway has created some compaction of the subsoil. This compaction restricts the flow of groundwater causing it to rise at certain points. As the level of groundwater approaches the rooting zone of trees, shrubs and grasses these plants die from the high levels of dissolved salts present in the groundwater. The rise in groundwater is primarily caused by the clearing of trees further up the catchment. Additionally, annual pastures that have replaced the trees use less water thereby compounding the salt problem. Many bores monitoring groundwater levels in the area show significant rises.

The high amount of ground cover in the summer months on the basalt soils aids in reducing the amount of erosion that may otherwise occur due to the steepness of the slopes. However when sheet erosion does occur, the topsoil is often washed into dams and streams leading to siltation and declining water quality. Improved cultivation practices, including the establishment of buffer zones around streams and drainage lines will reduce some of the siltation into the drainage lines.

Table i.i Summary of land capability classes.

Note: Please refer to Section 4 (Detailed Map Unit Descriptions and Capability Ratings) for further information.

MAP UNIT		LAND CAPABILITY RATING					
Symbol	**Description**	**Agriculture**	**Effluent Disposal**	**Farm Dams**	**Building foundations**	**Secondary Roads**	**Rural Residential**
Qa1	Quaternary alluvium, Koo-wee-rup peaty clay	2	5	3-4	5	5	5
Qa2	Quaternary alluvium, Koo-wee-rup peaty clay with sandy ridges	2	4	4	4	4	4
Qa3	Quaternary alluvium, Narre clay loam	3	4	3	3	3	4
Qa4	Quaternary alluvium, Narre clay loam with sandy ridges	2	3	3-4	3	3	3-4
Qa5	Quaternary alluvium, Tynong clay loam	3	3-4	3	3	3	3-4
Qa6	Quaternary alluvium, Dalmore clay (non-peaty)	3	4	5	3	5	5
Qa7	Quaternary alluvium, Dalmore clay (heavy -surface))	2	3	4	3	3	4
Qa8	Quaternary alluvium, Toomuc clay loam	3	4	3	3	3	4
Qa9	Quaternary alluvium, Monomeith clay loam	3	4	4	3	3	4
Qa10	Quaternary alluvium, Unclassified sandy ridges	3	3	3	3	3	3
Qa11	Quaternary alluvium, Monomeith clay loam with sandy ridges	3	4	3	3	3	4
Qa12	Quaternary alluvium, Dalmore clay	3	4	5	3	5	5
Tvb1	Tertiary volcanics, steep slope	5	5	5	5	5	5
Tvc1	Tertiary volcanics, moderately steep slope	4	4	5	4	4	5
Tvd1	Tertiary volcanics, moderate slope	3	3	4	4	4	4
Tve1	Tertiary volcanics, gentle crest	2	2	4	3	3	4
Tvf1	Tertiary volcanics, gentle slope	2-3	2	4	3	3	4
Tvh1	Tertiary volcanics, drainage depression	2-3	3	4	4	4	4
Tvb2	Tertiary volcanics, remnant capping, steep slope	5	5	5	5	5	5
Tvc2	Tertiary volcanics, remnant capping, moderately steep slope	4	4	5	4	4	5
Tvd2	Tertiary volcanics, remnant capping, moderate slope	3	3	4	4	4	4
Tve2	Tertiary volcanics, remnant capping, gentle crest	2	2	4	3	3	4
Tvf2	Tertiary volcanics, remnant capping, gentle slope	3-2	2	4	3	3	4
Tvh2	Tertiary volcanics, remnant capping, drainage depression	2-3	3	4	4	4	4
Tsd	Tertiary sediments, moderate slope	3	3	4	4	4	4
Tse	Tertiary sediments, gentle crest	3	2	4	3	3	4
Tsf	Tertiary sediments, gentle slope	3	4	3	4	4	4

Tablei.i Summary of land capability classes (continued).

MAP UNIT		LAND CAPABILITY RATING					
Symbol	**Description**	**Agriculture**	**Effluent Disposal**	**Farm Dams**	**Building Foundations**	**Secondary Roads**	**Rural Residential**
Tsg	Tertiary sediments, very gentle slope	3	4	3	4	4	4
Tsh	Tertiary sediments, drainage depression	3	4	3	4	4	4
Dga	Devonian granitic, steep crest.	4	4-3	5	4	4	5
Dgb	Devonian granitic, steep slope	5	5	5	5	5	5
Dgc	Devonian granitic, moderately steep slope	4	4	5	4	4	5
Dgd	Devonian granitic, moderate slope	3	4	4	4	4	4
Dge	Devonian granitic, gentle crest	4	5	5	5	5	5
Dgf	Devonian granitic, gentle slope	4	4	3	4	4	4
Dgg	Devonian granitic, very gentle slope	4	4	3	4	4	4
Dgh	Devonian granitic, drainage depression	5	5	5	4	4	5
Dgi	Devonian granitic, flat	5	5	5	4	4	5
Sma	Silurian metamorphic, steep crest	3-4	3-4	5	3	3	5
Smb	Silurian metamorphic, steep slope	5	5	5	5	5	5
Smc	Silurian metamorphic, moderately steep slope	4	4	5	4	4	5
Smd	Silurian metamorphic, moderate slope	5	3	4	5	5	5
Smf	Silurian metamorphic, gentle slope	5	3	4	5	5	5
Smh	Silurian metamorphic, drainage depression	3	4	5	4	4	5
Ssa	Silurian sediments, steep crest	3-4	3-4	4-5	3	3	4-5
Ssb	Silurian sediments, steep slope	5	5	5	5	5	5
Ssc	Silurian sediments, moderately steep slope	4	4	5	4	4	5
Ssd	Silurian sediments, moderate slope	3	3-4	4-5	4	4	4-5
Sse	Silurian sediments, gentle crest	3	3	4	2	3	4
Ssf	Silurian sediments, gentle slope	3	4	4	4	4	4
Ssg	Silurian sediments, very gentle slope	3	4	3	4	4	4
Ssh	Silurian sediments, drainage depression	3	4	3	4	4	4
Ssi	Silurian sediments, flats	3	4	3	4	4	4

1 INTRODUCTION

1.1 Overview

Land varies considerably in its basic characteristics and its response to the demands made upon it. Such demands include the production of food, fibre, water, and development for residential, industrial and recreational purposes.

Planners need to match the requirement of land use with the capability of the land to sustain that use and avoid land degradation. Prior knowledge of soil and land limitations can prevent unnecessary and costly mistakes. Information obtained through land capability assessments can provide the necessary data to assist local government with planning decisions and the preparation of planning strategies for the future.

Planning schemes developed and implemented by local government provide an effective means of managing changes in land use. A planning scheme may prohibit or place conditions on land use not well suited to a land type.

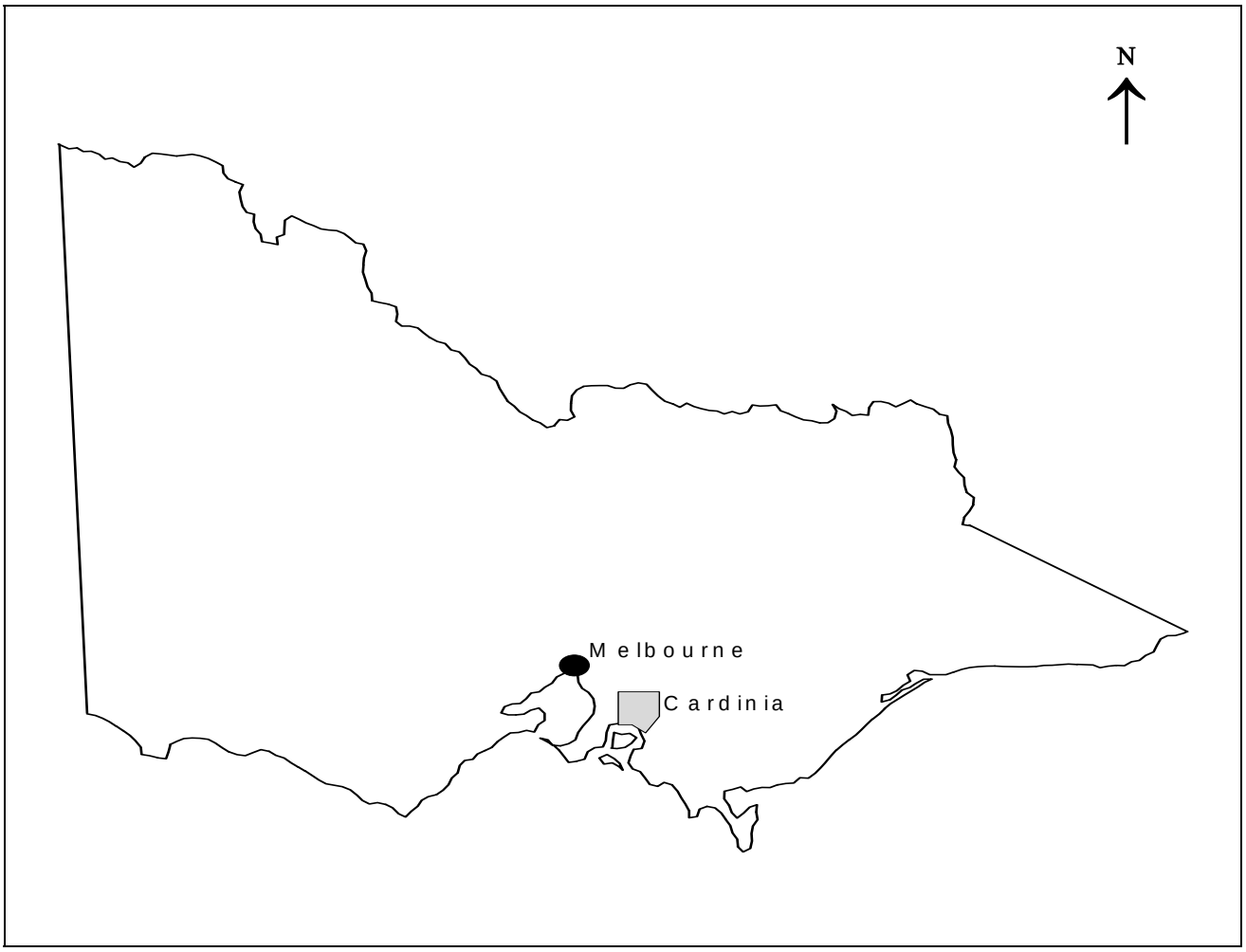
This report provides land resource information for broad-scale planning within the Cardinia Shire. It does not provide recommendations for land use and no allowance has been made for social or economic considerations which may influence planning proposals. It is primarily an examination of potential consequences and levels of management required for a range of land uses.

A previous study covering the former Shire of Pakenham, *Land Capability Study of the Westernport Catchment* by Goss, H.M., Reimers, T.. and van de Graff, R. H. M. (1987), has been used as a background to this study.

1.2 Location

The Cardinia Shire covers an area of around 1260 square kilometres and is located approximately 50 kilometres south east of Melbourne (Figure 1.1).

Figure 1.1 Location of Cardinia Shire.



1.3 Purpose of study

This study will provide land resource information and land capability analyses to the Cardinia Shire Council to assist the review and implementation of their planning scheme. The scheme aims to minimise land degradation, protect areas of conservation and agricultural importance and enable improved assessment of urban and rural residential development along the Berwick/Pakenham growth corridor.

The Cardinia Shire is situated on the fringe of Melbourne's south east growth corridor. The population has increased significantly in the last decade as urban and rural residential development has continued to extend along the Princes Highway and into the Dandenong Ranges in the north. The presence of a growth corridor along the Princes Highway is creating a demand for small rural land holdings, and such development requires careful planning if environmental degradation is to be minimised.

The Cardinia Shire has been predominantly rural, and valuable horticultural and agricultural enterprises still exist in the shire. In the northern ranges there are valuable red gradational soils especially in the Gembrook area. These soils are used for growing a wide range of vegetable and fruit crops, including carrots, potatoes, cabbages and apples. The relatively low cost of land, easy commuting distance to Melbourne and the rural environment makes the area attractive for residential development. Land that was once agricultural is being converted into rural residential lots, particularly on the fringes of the townships.

In planning for the future use of land in the shire, there is a need to preserve the qualities that make this area attractive, both economically and aesthetically, whilst also accommodating population growth. It is important to preserve better agricultural land and farming enterprises because of their significant input to the economy of the region.

To ensure a sound base for future planning strategies, the Cardinia Shire Council requested a land capability study by the Department of Natural Resources and Environment.

1.4 Objectives

Major Objective:

To provide land resource information to the Cardinia Shire Council that will facilitate the planning of future land use through a systematic and rational examination of management requirements, and consequences of a range of alternative land uses.

More specifically:

1. To map and describe the freehold land of the Cardinia Shire which is under increased pressure for conversion to rural residential development at a scale of 1:10 000. This will involve identifying dominant land types (including soil types and topography), climatic zones and other land characteristics relevant to the assessment of the capability of the land. These are areas that surround the existing townships of Emerald, Upper Beaconsfield, Gembrook, Maryknoll and Bunyip (see Figure 1.2).

2. To map and describe the freehold land of the former Cardinia Shire at a scale of 1:25 000 (excluding existing urban areas and public land) identifying dominant land types, climatic zones and other features relevant to the assessment of the capabilities of the land.

3. To prepare land capability analyses based on standardised rating tables of the 1:25000 study and the 1:10000 area.

    * agriculture,
    * effluent disposal (septic tanks),
    * farm (earthen) dams,
    * building foundations,
    * secondary roads
    * rural residential development allotment size of 0.5-2 ha.

4. To provide maps at 1:25 000 and 1:10 000 scale of :

    * topographic base map, including tree cover and map units, and
    * thematic land use maps with land capability classes.

5. To provide a satellite image of the shire displaying tree cover.

6. To provide the Shire with a digital copy of the land capability information gathered.

7. To assist the Cardinia Shire Council in the incorporation of this land resource information into its planning strategies.

2 LAND CAPABILITY ASSESSMENT

2.1 Philosophy and principles

Land capability assessment is a rational and systematic method of determining the ability of land to sustain a specific use and level of management, without causing significant long-term degradation.

The objectives of land capability assessments are:

i) to assist land managers and land use planners to identify areas of land with physical constraints for a range of nominated land uses;

ii) to identify management requirements that will ensure a particular land use can be sustained without causing significant on-site or off-site degradation to land or water quality.

To achieve these objectives, it is necessary to know the natural characteristics of the land, and understand the effects that a proposed land use may have on the land and the water derived from it.

Land capability assessments analyse basic landform and soil information to determine the ability of the land to sustain a desired land use. A strength of the methodology lies in its association with land systems since the results can be extrapolated, with care, to similar land components and land systems in other areas (Refer to 4.2)

The ratings provided by a land capability assessment are not intended to restrict development of land, but rather to identify the principal constraints of that land for a specified land use. It is a matter for the land manager or land use planner to decide if the cost of overcoming the constraints is justified. Where particularly severe physical constraints exist, the planning authority has the option of excluding that land from that use, or permitting the use only under strict conditions. The placement of conditions on development permits is quite a proper exercise of planning responsibility.

2.2 Land resource mapping - methodology and constraints

The main objective of land resource mapping is to identify areas of land that are uniform with respect to the characteristics that affect land use. These areas of land will have a similar land use capability for a nominated use and are likely to respond in a similar way to management. By identifying areas of land with a limited range of variability, the resultant map provides the basis for land capability assessment (for specific methodologies, refer Appendix C).

Mapping an area of land can be a complex task as many differences arise due to interactions between climate, geology and topography. While it is possible to measure and determine some of the land characteristics such as slope, rock outcrop, and soil type, other characteristics such as site drainage, and permeability are less easily determined.

The following procedure has been adopted for this study:

i) The geological boundaries are obtained from existing maps and verified in the field at the appropriate mapping scale.

ii) The broad landform pattern and the landform elements are identified from air-photos using a binocular stereoscope. The map units are derived from this information.

iii) Extensive field verification of map units ensure that map units are consistent with respect to parent material, slope, position in the landscape, soil type, drainage and native vegetation.

iv) A representative site for each map unit is selected, to record general landform and site information. The incidence of any land degradation in each map unit is also recorded.

v) A soil pit or large exposure of the soil profile is prepared at each selected site. Detailed soil profile information is recorded. Colour photographs are taken and soil samples collected for physical and chemical analyses (see Appendix D and the corresponding tables for each Land Unit in Section 4.2 for details).

vi) The permeability of the soil profile is measured when the soils are near field capacity (see Appendix C).

vii) The map unit boundaries are entered into a Geographic Information System where the data is combined with base-map information on roads, contours and streams to produce a final base map of the study area with appropriate headings and legend.

viii) Land capability ratings for those land uses relevant to the study are derived from the climatic, land and soil data available for each map unit based on standardised rating tables. Separate land capability assessment maps are prepared for the specified land uses.

ix) A report is prepared to provide accompanying land resource information and methodology for the land capability maps.

2.3 Assessment procedure

A land capability rating table lists key land characteristics such as slope, site drainage or soil depth, which may affect the ability of the land to support a specified land use. These land characteristics are quantified and graded into classes for the

land use being assessed. Each map unit within the study area is given a capability class according to the tables shown in Section 2.4.

It is the most limiting factor that determines the Capability Class for the map unit. This is related to the degree of limitation for that land use and the general level of management that will be required to minimise degradation.

A Capability Class of one represents essentially no physical limitations to the proposed land use whilst a Class of five indicates a very low capability to sustain the land use. Limitations in Class five generally exceed the current level of management skills and technology available. Severe deterioration of the environment is likely to occur if development is attempted. A Class of two, three or four will require increasing levels of management to sustain the particular land use, otherwise the environment will deteriorate.

Separate class descriptions are prepared for agriculture (Table 2.1) and other land uses (Table 2.2). Due to the scale of mapping adopted (1:25 000), the inherent variability within some landscapes may result in the presence of small unrepresentative areas within map units. In some cases, these areas will have a capability class exceeding that of the overall map unit. An opportunity may therefore exist to utilise land with less constraints for the chosen development.

2.4 Land capability rating tables

Each land capability rating table (refer Tables 2.3, 2.4, 2.5, 2.6, 2.7, 2.8) contains criteria which will strongly influence the ability of the land to sustain the desired land use. The limitations distinguishing each land capability class from one to five are also presented for comparison.

There has been no attempt to rank the criteria in order of importance. The objective of having classes is to identify the kind of limitation and its severity. It is recognised that criteria may interact, but an underlying objective of this study is to provide the information in a useable form, rather than have a convoluted series of alternative pathways that would be too complex for the intended user to follow.

Where there are known interactions between different criteria, it is the responsibility of the planner or land manager to assess the importance of the limiting factor(s) and to determine the need for management or additional financial input to overcome the limitation.

Theoretically a single diagnostic land quality could be found and used to rate land performance, but there is the risk of such a feature masking the true parameters that affect the land use, thus preventing a change to a more appropriate land use or level of management. Land use and land management practices will continue to change and if the community is concerned about long-term sustainability of specific land uses, then the limitations of the soil, the various processes of land degradation, and the possibility of off-site effects, must be recognised. Once a limitation to land use is identified, steps can be taken to overcome or minimise the long-term effect of land degradation that would result if the land use was continued

Table 2.1 Land capability classes for agriculture.

CLASS	CAPABILITY	DEGREE OF LIMITATION
Class 1	Very good	Can sustain a wide range of uses including an intensive cropping regime. Very high levels of production possible with standard management levels.
Class 2	Good	Moderate limitations to agricultural productivity, overcome by readily available management practices.
Class 3	Fair	Can sustain agricultural uses with low to moderate levels of land disturbance such as broadacre cultivation in rotation with improved pastures. Moderate to high levels of production possible with specialist management practices such as minimum tillage.
Class 4	Poor	Low capacity to resist land disturbance such as cultivation. Moderate production levels possible with specialist management such as improved pasture establishment with minimum tillage techniques. Recommended for low disturbance agriculture such as grazing or perennial horticulture.
Class 5	Very poor	Very low capability to resist disturbance. Areas of low productive capacity. Minimal grazing levels or non-agricultural uses recommended.

Note: Land is assessed for agricultural production on the basis of climate, topography, and the inherent characteristics of the soil. Climate differs from topography and soil features in that it is a regional parameter rather than site specific. The capability table identifies the versatility and potential productivity of an area for a range of agricultural uses, and highlights the necessary level of management required to sustain the land use.

These agricultural ratings are for comparative purposes only and should not be used as a basis for detailed property planning.

Table 2.2 Land capability classes for effluent disposal, farm dams, building foundations and secondary roads.

CLASS	CAPABILITY	DEGREE OF LIMITATION TO DEVELOPMENT	GENERAL DESCRIPTIONS AND MANAGEMENT GUIDELINES
Class 1	Very good	The limitation of long term instability, engineering difficulties or erosion hazards do not occur or they are very slight.	Areas with high capability for the proposed use. Standard designs and installation techniques, normal site preparation and management should be satisfactory to minimise the impact on the environment.
Class 2	Good	Slight limitations are present in the form of engineering difficulties and/or erosion hazard.	Areas capable of being used for the proposed use. Careful planning and the use of standard specifications for site preparation, construction and follow up management are necessary to minimise the impact of the development on the environment.
Class 3	Fair	Moderate engineering difficulties and/or moderately high erosion hazard exist during construction.	Areas with a fair capability for the proposed use. Specialised designs and techniques are required to minimise the impact of the development on the environment.
Class 4	Poor	Considerable engineering difficulties during development and/or a high erosion hazard exists during and after construction.	Areas with poor capability for the proposed use. Extensively modified design and installation techniques, exceptionally careful site preparation and management are necessary to minimise the impact of the development on the environment.
Class 5	Very poor	Long term severe instability, erosion hazards or engineering difficulties which cannot be practically overcome with current technology.	Performance of the land for the proposed use is likely to be unsatisfactory. Severe deterioration of the environment will occur if development is attempted in these areas.

Table 2.3 Land capability assessment for agriculture.

PARAMETERS INFLUENCING AGRICULTURAL PRODUCTION		LAND CAPABILITY RATINGS				
		Class 1	**Class 2**	**Class 3**	**Class 4**	**Class 5**
C: Climate	Length of growing season (months)	12 - 11	10 - 8	7 - 5	4 - 2	< 2
T: Topography	Slope (%)	1 - 3	4 - 10	11 - 20	21 - 32	> 32
S: Soil	Condition of topsoil *	25 - 21	20 - 16	15 - 11	10 - 6	5 - 1
	Depth of topsoil (mm)	> 300	300 - 160	150 - 110	100 - 50	< 50
	Depth to rock/hardpan (m)	> 2.0	2.0 - 1.5	1.5 - 1.0	1.0 - 0.5	< 0.5
	Depth to seasonal watertable (m)	> 5.0	5.0 - 2.0	2.0 - 1.5	1.5 - 1.0	< 1.0
	Total amount of water (mm) available to plants *	> 200	200 - 151	150 - 101	100 - 51	50 - 0
	Index of permeability/rainfall *	Very high	High	Moderate	Low	Very low
	Dispersibility of topsoil (Emerson) *	E6, E7, E8	E3(1), E3(2), E4, E5	E3(3), E3(4)	E2	E1
	Gravel/stone/boulder content (v/v %) *	0	1 - 10	11 - 25	26 - 50	> 50
	Electrical conductivity(μs/cm) *	< 300	300 - 600	600 - 1400	1400 - 3500	> 3500
	Susceptibility to sheet/rill erosion *+	Very low	Low	Moderate	High	Very high
	Susceptibility to gully erosion *+	Very low	Low	Moderate	High	Very high
	Susceptibility to wind erosion *+	Very low	Low	Moderate	High	Very high

Note: The potential agricultural productivity of land is generally classified by the CTS criteria (Climate, Topography and Soil), e.g. the 'ideal' prime agricultural areas would be denoted by C_1 T_1 S_1 compared with another area that had, for example, a 5 - 7 month growing season, slopes of 3% and a depth to rock/hardpan of only 0.7 m, denoted by C_3T_2 S_4. The overall Land Capability Class of this latter land would be 4; with soil factors being the major limiting features.

* See Appendix A

+ The susceptibility to erosion ratings for the Cardinia Shire have been improved by one rating due to the high growth rate and ground cover during the summer months.

Table 2.4 Land capability assessment for on-site effluent disposal.

PARAMETERS INFLUENCING EFFLUENT DISPOSAL	LAND CAPABILITY RATINGS				
	Class 1	**Class 2**	**Class 3**	**Class 4**	**Class 5**
Slope (%) *	< 3	3 - 10	11 - 20	21 - 32	> 32
Flooding risk *	Nil	Low	Moderate	High	Very high
Drainage *	Rapidly drained	Well drained	Moderately well drained	Imperfectly drained	Poorly drained
Depth to seasonal watertable (m)	> 2.0	2.0 - 1.5	1.5 - 1.0	1.0 - 0.5	< 0.5
Depth to hard rock/impermeable layer (m)	> 1.5	1.0 - 1.5	1.0 - 0.75	0.75 - 0.5	< 0.5
Number of months/year when average daily rainfall > K_{sat} *	0	1	2	3	> 3
Permeability (K_{sat} mm/day) *	> 500 **	500 - 100	100 - 50	50 - 10	< 10

Note: Areas capable of absorbing effluent from a standard anaerobic, all-waste, septic tank connected to a single family dwelling (approximate output of 1000 litres per day).

10 mm/day is equivalent to disposing of 1000 l/day along a 0.5 x 200 m trench

* See Appendix A

** Permeability > 1000 mm/day could pollute groundwater

Table 2.5 Land capability assessment for earthen dams.

PARAMETERS INFLUENCING THE CONSTRUCTION OF EARTHEN DAMS	LAND CAPABILITY RATINGS				
	Class 1	**Class 2**	**Class 3**	**Class 4**	**Class 5**
Slope (%) *	3 - 7	0 - 3	7 - 10	10 - 20	> 20
Linear shrinkage (%) *	0 - 5	6 - 12	13 - 17	18 - 22	> 22
Suitability of subsoil *	Very high	High	Moderate	Low	Very low
Depth to seasonal watertable (m)	> 5		5 - 2		< 2
Depth to hard rock (m)	> 5	5 - 3	3 - 2	2 - 1	< 1
Permeability (K_{sat} mm/day) *	< 1	1 - 10	11 - 100	101 - 1000	> 1000
Dispersibility of subsoil (Emerson)	E3(2), E3(3)	E3(1), E3(4)	E2(1), E2(2), E5(A), E5(B)	E2(3), E2(4), E5(C), E5(D)	E1, E6, E7, E8
Susceptibility to slope failure	Very low	Low	Moderate	High	Very high

Note: This table should only be considered for small farm dams to 1000 m^3 in capacity, that have a top water level less than 3 m above the original ground surface at the upstream side of the wall.

Rock outcrop, depth of topsoil and flooding risk were also considered but have not been included for reasons given in Appendix A.

* See Appendix A

Table 2.6 Land capability assessment for building foundations.

PARAMETERS INFLUENCING BUILDING FOUNDATIONS	LAND CAPABILITY RATINGS				
	Class 1	**Class 2**	**Class 3**	**Class 4**	**Class 5**
Slope (%)					
i) Slab	0 - 1	2 - 5	6 - 10	11 - 30	> 30
ii) Stumps/footings	0 - 5	6 - 10	11 - 30	30 - 45	> 45
Drainage *	Rapidly drained	Well drained	Moderately well drained	Imperfectly drained	Poorly drained
Depth to seasonal watertable (m)	> 5	5 - 2	2 - 1	1 - 0.5	< 0.5
Proportion of stones and boulders (v/v %)	0	1 - 10	11 - 20	21 - 50	> 50
Depth to hardrock (m)	> 1.5	1.5 - 0.75	0.75 - 0.51	0.5 - 0.25	< 0.25
Susceptibility to slope failure *	Very low	Low	Moderate	High	Very high
Linear shrinkage (%) *					
i) Slab	< 12	13 - 17	18 - 22	22 - 30	> 30
ii) Stumps/footings	< 6	7 - 12	13 - 17	18 - 22	> 22
Flood risk	Nil	Low	Moderate	Moderate/high	High

Note: Areas capable of being used for the construction of buildings of one or two stories. It is assumed that any excavation will be less than 1.5 m and can be completed by a tractor-backhoe or equipment of similar capacity. Two methods of construction are considered:

i) Concrete slab - 100 mm thick and reinforced

ii) Stumps or strip footings

* See Appendix A

Table 2.7 Land capability assessment for secondary roads.

PARAMETERS INFLUENCING SECONDARY ROADS	LAND CAPABILITY RATINGS				
	Class 1	**Class 2**	**Class 3**	**Class 4**	**Class 5**
Slope (%)	0 - 1	2 - 5	6 - 10	11 - 30	> 30
Drainage *	Rapidly drained	Well drained	Moderately well drained	Imperfectly drained	Poorly drained
Depth to seasonal watertable (m)	> 5	5 - 2	2 - 1	1 - 0.5	< 0.5
Proportion of stones and boulders (v/v %) *	0	1 - 10	11 - 20	21 - 50	> 50
Depth to hard rock (m)	> 1.5	1.5 - 0.75	0.75 - 0.51	0.5 - 0.25	< 0.25
Susceptibility to slope failure *	Very low	Low	Moderate	High	Very high
Linear shrinkage (%) *	< 6	7 - 12	13 - 17	18 - 22	> 22
Bearing capacity (kPa) *	> 50	-	< 50	-	-
Flooding risk*	Nil	Low	Moderate	High	Very high
Dispersibility of subsoil Emerson (> 4% slope) *	E6, E7, E8	E4, E5, E3(1), E3(2)	E3(3), E3(4)	E2	E1
Unified Soil Group	GW, GC, SC	SM, SW, GM	SP, CL, CH, MH, GP	ML	Pt, OH, OL

Note: Areas capable of being used for the construction of earthen roads for light vehicles without sealed surfaces or concrete drainage and kerbing.

* See Appendix A

Table 2.8 Land capability assessment for rural residential and rural farmlet development

Rural residential development (0.4 ha - 2.0 ha)		Rural farmlet (> 5.0 ha)	
Building foundations	No change to capability class	Building foundations	No change to capability class
Secondary roads	No change to capability class	Secondary roads	No change to capability class
Effluent disposal	No change to capability class	Effluent disposal	**Improve rating by one class** if major limitation is due to permeability, drainage and depth to hardrock. No change to rating class if another criteria is the major limitation present
Earthen dams	No change to capability class	Earthen dams	**Improve rating by one class.** No change where slope, rapid permeability, risk of slope failure and dispersibility are the major limitations present

Rural residential development involves a range of land uses: building foundations, earthen dams, effluent disposal and secondary roads. There is a need to consider the capability of each individual land use in assessing the overall capability of a map unit to sustain rural residential development. More intensive use of the land will require an improved level of management to reduce the likelihood of land degradation.

The land and soil within certain map units can vary substantially in the Cardinia Shire. This variation within a map unit is more likely to occur with large size allotments. It is recognised that in areas greater than 5 ha, detailed site inspection can highlight areas with a higher capability to support a given land use. For example, dam construction may be restricted by shallow soil depth on a small allotment (less than 2 ha), however on a larger allotment a minor drainage line may be found to contain sufficient soil depth to enable a dam to be constructed. Larger allotments also allow for greater flexibility in management and design, while an allotment of 1/4 - 1 acre will place absolute limits on options for development.

In assessing the overall capability for rural residential development the capability of each individual land use has been combined to arrive at a final rating class.

For the purpose of this study, rural residential development has been defined as block sizes between 0.4 - 2.0 ha. The ratings for blocks greater than 5.0 ha are not depicted on the maps and in the report, although the table above gives an indication of the capability of the map units if they are larger than 5.0 ha, where there may be more variety in map units and therefore slope and soil types.

3. LAND MANAGEMENT GUIDELINES

3.1 Management of land characteristics that influence land use

The criterions used in land capability rating tables have been selected because of the limitations they impose on the use of the land. This section explains why these features are important and how an improved level of management can reduce or even overcome the limitation. Information has been extracted from Rowe *et. al.* (1980) and Charman and Murphy (1991).

3.1.1 Soil texture

Soil texture is largely determined by the proportions of different-sized soil particles which make up the soil. Topsoils with well-graded textures have a relatively even distribution of particle sizes from clay through to sand, and tend to be better able to support agricultural and pastoral activities than either very sandy or very clayey soils. They are better able to withstand cultivation and compaction and are more resistant to soil erosion.

Soil texture is closely related to available water-holding capacity. The fine sandy loam - silty clay loam soils have more available water than sands or clays, and so can maintain plant growth for longer periods after wetting.

Texture is also an important determinant in soil infiltration and internal drainage, with sandier soils tending to have greater infiltration rates and better internal drainage. Well-structured or self-mulching clays may be very difficult to cultivate in either the wet or dry states. On the other hand, soils with coarse or sandy texture are very unstable and easily eroded, and may need the protection of a vegetative cover over the dry season.

3.1.2 Boulders and rock outcrop

Boulders and rock outcrop provide physical obstacles to excavation, cultivation and plant growth, and so inhibit land uses involving these activities. It may be possible to remove isolated rock outcrops by blasting, but for extensive uses, such as cropping and grazing, boulders and rock outcrop are a permanent limitation. Additional costs may be involved with the increased management required to maintain pasture growth or reduce storm water run-off from rocky areas.

3.1.3 Depth to hard rock

The presence of shallow hard rock (<0.5 m) causes problems for engineering and agricultural land use. Shallow hard rock may need excavation for engineering activities such as road works, building foundations and other shallow excavation work. Shallow hard rock may be removed with heavy machinery and blasting. Agricultural land use including cropping and farm dams are permanently restricted where shallow hard rock is present.

Very shallow soils are inherently more susceptible to erosion and require the protection of a permanent undisturbed cover of vegetation.

3.1.4 Depth of topsoil

Topsoil is not favoured as a construction material because of its low bearing capacity. The greater the depth of topsoil, the greater the cost of removing and stockpiling it. Many excavation permits now require the topsoil to be re-spread on construction sites to facilitate revegetation and this can be done successfully provided the compacted surface is broken up prior to the top soil being returned.

3.1.5 Depth to seasonal, perched or permanent watertable

The presence of a watertable close to the surface causes problems for both agricultural and engineering land uses. Saturated soils have a low bearing capacity. Therefore high watertables are unsuitable for stable foundations (e.g. building foundations and roads).

High watertables restrict the percolation of additional water from rainfall, irrigation or the effluent from septic tanks through the soil profile, whereas a fluctuating watertable is likely to cause leaching of the more mobile plant nutrients, or the concentration of iron compounds which immobilise nutrients such as phosphorus. High watertables in the plant root zone will reduce aeration and restrict root growth. Trafficability can be adversely affected, and in the case of effluent disposal, public health aspects may be of concern. High watertables may also restrict the depth of excavation for farm dams and quarries, even shallow excavations for sand and gravel deposits.

Watertables can be lowered by pumping or constructing artificial drains, however if the water is saline, disposal options are limited.

3.1.6 Dispersible clays

Dispersion is the spontaneous deflocculation of the clay fraction of soil in water. Slaking is the breakdown of an aggregate into smaller aggregates and primary particles. Dispersion and slaking are important characteristics of a soil because of their influence on the stability of the soil structure. Soils with a high degree of slaking or dispersion have a high erosion potential and any activity that exposes the topsoil or subsoil to rainfall or running water increases the risk of erosion.

Dispersion is an indicator of sodic soils. It occurs when clay particles form a cloud around an aggregate placed in water.

Dispersive soils have a high Exchangeable Sodium Percentage (ESP). This is the insoluble sodium attached to clay particles. Excessive sodium forces the clay particles apart (dispersion) when in water. The fine clay particles that have dispersed, clog up the the small pores in the soil, degrading soil structure, and restricting root growth and water movement. The amount of sodium defines the sodicity level of the soil. Excessive exchangeable sodium causes the clay particles to disperse when in contact with water.

Dispersible topsoils usually have poor physical characteristics, such as surface crusting, cloddiness, poor aeration and low emergence of plant seedlings. Maintenance of an effective pasture cover or litter layer reduces raindrop splash, dispersion and the associated surface sealing of topsoils.

Dispersible subsoils predispose a site to tunnel or gully erosion. The risk may be minimised by careful pasture management such as ensuring that the slopes and drainage depressions are well vegetated with plant species that have deep root systems and high water requirements. Road batters may be subject to slumping and erosion, with subsequent turbidity of run-off water and sedimentation in nearby water storages. As the dispersibility of the subsoil increases, so does the need to reduce batter slopes and establish a protective vegetative cover on the exposed soil.

3.1.7 Flooding

Flooding can be a problem on land with very low gradients and within confined drainage ways. Precise data is difficult to obtain on the frequency of flood events and the classes have been determined by observations of land form, catchment geometry and soil types which reflect recent sediment deposition. A distinction should be made between fast flowing flood waters (flash floods) and flooding caused by a rise in water levels with little flow (inundation). The type and severity of impact caused by these two forms of flooding differ and therefore different types of management may be required to reduce the hazard.

Floods are a threat to human safety, causing damage to property and livestock. Thus, flood-prone land should not be used for intensive development, but should be retained for land use such as grazing, where stock can be moved to higher ground in times of increased hazard. In some areas the problem may be overcome by building levee banks or retarding basins, however there may be severe environmental problems caused by this form of management. Some modification of flooding characteristics may be possible by special management aimed at delaying surface run-off. When dealing with large catchments, the problem is a long-term hazard and a permanent limitation.

3.1.8 Organic matter

Where soil materials are to be used as road fill or for earthen dams, the presence of organic matter reduces soil quality for these purposes. Soils containing even moderate amounts of organic matter are more compressible and less stable than inorganic soils. The presence of organic material in sand for concrete is also undesirable.

When used as a medium for plant growth, a high level of organic matter is most desirable as it improves soil structure and chemical fertility. Soils high in organic matter are good for intensive cropping, however cultivation promotes rapid oxidation of organic matter and the condition of the topsoil will deteriorate if the organic matter is not replaced. Organic matter levels can be increased by sowing improved pastures, ploughing in green manure crops, and stubble retention.

3.1.9 Permeability

Soils of low permeability have poor drainage through the profile. On sloping land, lateral flow may occur above an impervious layer thereby draining the water away from the site, but on relatively flat areas such soils can become waterlogged and inhibit plant growth or become too boggy for the use of agricultural machinery. Low permeability in soils also reduces the efficiency of effluent disposal systems. This limitation can be overcome if sufficient area is available to increase the length of an absorption trench or utilise plants to transpire water from the effluent disposal area. For earthen dams, low permeability in the floor, the sides and the walls of the dam is most desirable. An extremely permeable soil may have excessive leaching of plant nutrients or an inability to retain moisture for plant growth. Such a soil may drain too rapidly to purify the effluent from septic tanks, thereby increasing the risk of polluting groundwaters or nearby streams.

3.1.10 Plasticity index

The plasticity index is a measure of the range of moisture content over which the soil is in the plastic state. A soil is most easily worked or is most readily deformed when in the plastic state. A low index indicates that the range is narrow, which is desirable where the stability of the material is important, such as in a road subgrade. However where the soil is to be cultivated, a higher plasticity index is desirable to enable working over a wider range of moisture contents.

3.1.11 Linear shrinkage (shrink-swell potential)

This relates to the capacity of clayey soil material to change in volume with changes in moisture content, and is dependant on the quantity and nature of the clay minerals present. The shrink-swell characteristics of a soil influence the capability of land for

uses such as roads or buildings which require a stable substrate. Buildings and roads shift or crack in soils which undergo large changes in volume during periodic wetting and drying. Construction on soils with a high shrink-swell potential requires special techniques such as laying deeper-than-usual foundations for roads or using a reinforced concrete slab rather than stumps or strip footings for buildings.

3.1.12 Site drainage

Site drainage is influenced by soil type, soil permeability, steepness of slope, slope shape, rainfall and position in the landscape. For most land uses it is important that water flows freely from the site, since poor site drainage can result in the land becoming waterlogged and boggy, inhibiting plant growth, damaging roads and buildings through subsidence, and reducing the capacity of the area to dispose of effluent. Special works or higher levels of management may be necessary to overcome poor site drainage and this will add to the cost of development and production.

3.1.13 Slope

As the angle and length of slope increases so too does the erosion hazard. The loss of adequate ground cover during the construction of dams, roads and buildings, or on land that is cultivated or overgrazed, increases the risk of erosion. Steeper slopes are more difficult and costly to use for agricultural, forestry or road-making activities, and impose limitations on the type of machinery which can be used. Certain soil types become unstable in wet conditions. As the slope increases, the risk of mass movement also increases, particularly if large quantities of water are contained in the soil profile. Instability can occur on natural slopes, under trees or pasture, road batters and earthen dam banks. Effluent from septic tanks contains high levels of nutrients and bacterial organisms. If the absorption beds are situated on sloping land, then during wet periods when the soil profile may be saturated (from excessive rainfall and/or run-off from upslope), there is an increased risk of effluent being washed into the streams and water storages further down the catchment. This may result in adverse consequences for water quality and aquatic ecosystems.

3.1.14 Soil reaction

The pH of the soil is a measure of its acidity or alkalinity. Most plants have a pH range in which optimum growth can be expected. Soil acidification occurs as nitrates that were fixed by pasture legumes are leached from the soil, and by the addition of acids in superphosphate. With the long-term use of superphosphate and nitrogen fixing legumes, and the constant removal of grain, hay and/or animal products from the land, the topsoils in many areas have become more acid (pH < 5.5 in H_20) and the potential for aluminium toxicity has increased. Acid soils and aluminium toxicity can result in a decline in plant vigour and growth.

3.1.15 Stones and gravel

The stone and gravel content in a soil can restrict land use and plant growth in the following ways:

I) reducing the available water content and nutrient supply in the profile;

ii) increasing the wear and tear on cultivating and excavating machinery;

iii) increasing the cost of harvesting root and tuber crops (e.g. potatoes).

Little can be done to overcome this limitation, other than the continual removal of stones from an area as they appear on the landsurface.

4. DETAILED MAP UNIT DESCRIPTIONS AND CAPABILITY RATINGS

Fifty-two map units have been identified in Cardinia Shire. Each of the following map units is described in a detailed two page format which provides relevant information to support land use planning and management. The information includes a general description of the map unit, detailed soil profile analysis, chemical and hydraulic properties of the soil, susceptibility and incidence of land degradation, and an assessment of the capability of the land to support various land uses.

The classes for the land capability ratings range from 1 to 5, with "1" being very good and "5" being very poor. (Refer to Tables 2.1 and 2.2 for more detailed explanations).

The potential agricultural productivity of land is generally classified by the CTS criteria (Climate, Topography and Soil). For example, the 'ideal' prime agricultural areas would be denoted by $C_1T_1S_1$ compared with another areas that had, for example, a five to seven month length of growing season, slopes of 3 per cent and a depth to rock/hardpan of only 0.7 m, denoted by $C_3T_2S_4$. (refer to Table 2.3). The overall Land Capability class of this land would be "4"; with soil factors (depth to hardrock) being the major limiting features.

Maps depicting the map units and the land capability assessments for the nominated land uses have been produced, these maps can be viewed at Cardinia Shire, Centre for Land Protection Research, or the Department of Natural Resources and Environment Office.

Note:

(i) Because soil observation depth did not exceed 1.5 metres, the depth to hard rock and depth to seasonal watertable have been generalised where they exceed 1.5 metres.

(ii) pH recorded in the soil profile descriptions are laboratory pH (water) results. The pH recorded in the interpretation of laboratory analysis are $CaCl_2$.

(iii) Minor drainage lines have not been mapped as separate map units. Soils of minor drainage lines often have similar soils of greater depth and reduced drainage capacity to those of the surrounding map unit. Minor drainage lines are often indicated as a minor watercourse on the land capability maps.

4.1 Quaternary alluvial map units (Qa)

There are 12 alluvial map units found in the Cardinia Shire. Considerable variation occurs within soils of the alluvial units, particularly in the area of the old Koo-wee-rup swamp.

A number of studies have been carried out in the alluvial area describing the different alluvial soils. The first study of this area was made by Goudie (1942). A study of these soils was also carried out by Sargeant (1975) and reported in *A Soil Survey of the Westernport Bay Catchment*. A further study of the swamp was carried out by Sargeant (1993), *A Soil Quality Assessment, Horticultural Preservation Zone Amendment L71*. The boundaries used in the alluvial area are taken mostly from Sargeant's study of the Horticultural Preservation Zone. Twelve different soil types were identified in this study. Eight of these represent significant areas within the Shire, the remaining four cover minor areas of the Horticultural Preservation Zone.

The alluvial soils can be differentiated into two major soil groups; swamp soils and the swamp fringe soils. The swamp soils have a 'peaty' top soil with an accumulation of organic matter up to 30 cm in depth. The swamp fringe soils are similar to the soils occurring higher in the catchment, including those that occur in association with Cardinia Creek and Bunyip River. These soils are lower in organic matter and generally have a higher sand content throughout the profile.

Those areas designated with sandy ridges indicate a landscape with greater than 20 per cent low sandy ridges. These ridges are remnants of the beds and levee banks of prior streams. Weathering granite and granodiorite are the major sources of quartz gravel and sand observed in the soil profiles within the sandy ridges. Gravel and coarse sandy fragments are common higher in the catchment, with finer clay sediments deposited lower in the catchment.

Land management considerations

The major land management considerations in these units include inundation, flooding and salinity.

Agriculture is the major land use within the alluvial areas, particularly horticulture, dairying and grazing. A Horticultural Preservation Zone has been established to protect the most productive alluvial soils used for intensive agriculture. In addition, an amendment to the planing scheme prohibits subdivision in this zone. These alluvial areas include map units Qa1, Qa2 and Qa6 (these are described by Sargeant (1993) as Koo-wee-rup peaty clay, Koo-wee-rup peaty clay with sandy ridges, and Dalmore clay (non-peaty)).

Minor residential development occurs outside the Horticultural Preservation Zone.

Some soils, particularly the Dalmore clays, are Vertosols (cracking clays); these alluvial soils have poor drainage and low permeability. This is mainly caused by the high sodicity in the subsoil. This also means that the internal drainage of these soils will be relatively poor.

The presence of an extensive drainage system mitigates against serious flooding events, however in exceptional circumstances floods may still occur. Localised ponding and minor inundation may occur during winter months. Localised ponding will cause problems with grazing lands such as soil compaction and pasture damage. Areas with sandy ridges are better drained and have higher soil water permeability than the clay soils. These sandy soils are preferred for grazing in the winter months.

Where site drainage and permeability are poor, a high risk of septic tank failure is present. An alternative form of effluent disposal should be investigated in these circumstances.

Significant areas of salt affected land have been recognised in the alluvial areas. Salting has the potential to significantly reduce agricultural production and may cause considerable damage to foundations, plumbing and gardens in residential areas. Where salting occurs in agricultural zones, it will require careful management to minimise loses in production and soil loss through sheet erosion. In residential areas, it may be necessary to consider rezoning options and prohibit further development on land known to be affected by salting. Salting is considered a very high hazard and may require long term remedial action at a catchment wide level, if control is to be achieved. Bare soils and the presence of spiny rush are good indicators of salinity.

SOILS OF QUATERNARY ALLUVIAL ORIGIN

Plate 1 **Map unit: Qa2**
Grey Kandosol

Plate 2 **Map unit: Qa3**
Grey Dermosol

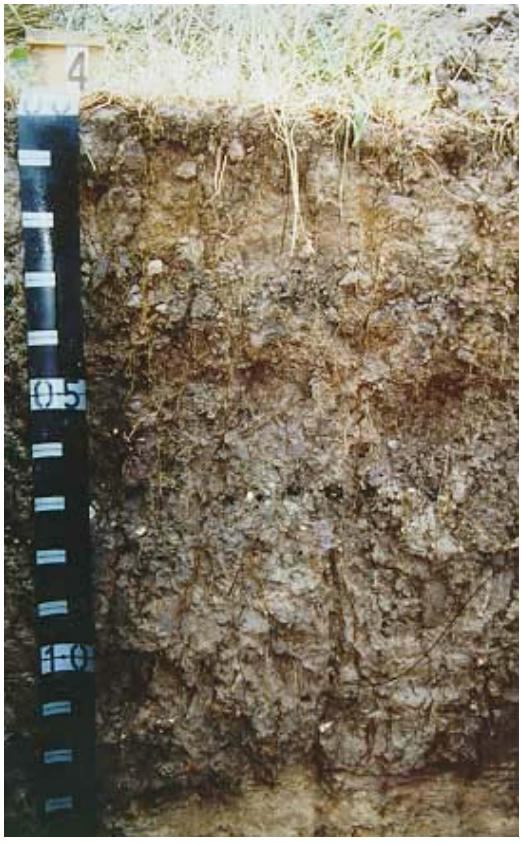
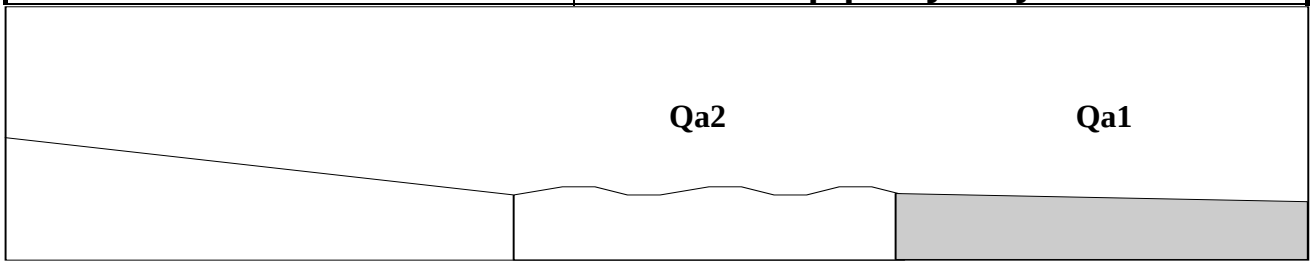


Plate 3 **Map unit: Qa4**
Grey Dermosol

Plate 4 **Map unit: Qa5**
Podosol/Kurosol

MAP UNIT SYMBOL: **Qa1** Area: 9625 ha	MAP UNIT: **Quaternary alluvium, Koo-wee-rup peaty clay**



A. GENERAL DESCRIPTION

This alluvial plain is situated in an area which was once part of an extensive Koo-wee-rup Swamp. The Koo-wee-rup peaty clay soil has organic peaty topsoils and peaty clay subsoils, and is highly valued for intensive agriculture. Three different phases of this soil were described by Goudie (1942). They include Normal Phase, Burnt Peat phase and Deep Peat phase. Each of these variations exist in the study area, however only the Normal Peat phase was studied in detail. The three types of Koo-wee-rup peat are similar, however due to scale restrictions all types have been mapped as Koo-wee-rup peaty clay. These soils generally have a clay loam to light peaty clay topsoil varying in depth from 25-40 cm; most topsoils are around 30 cm deep. In cultivated areas the AO horizon is often shallower or disappears completely. Since the swamp was drained, most of the peat has been lost due to shrinkage, burning of the peat and blowing of the topsoil. Grey medium to heavy clays are found in the subsoil with mottling increasing with depth. Varying amounts of coarse sand and grit may be found in the subsoil. The depth to seasonal watertable is variable; it may be shallower in some areas during winter and spring.

SITE CHARACTERISTICS

Parent Material Age:	Quaternary	**Depth to Seas. Watertable:**	> 1.5 m (variable)
Parent Material Lithology:	Alluvium	**Flooding Risk:**	Low
Landform Pattern:	Alluvial plain	**Drainage:**	Poorly Drained
Landform Element:	Swamp	**Rock Outcrop:**	Nil
Slope a) common:	< 1%	**Depth to Hard Rock:**	> 1.5 m
Slope b) range:	0-1%		
Potential Recharge to Groundwater:	Low		
Major Native Vegetation Species:	Melaleuca		
Present Land Use:	Horticulture, dairy, grazing		
Length of Growing Season:	April -November (8 months)		

LAND DEGRADATION

Degradation Processes	Water Erosion sheet/rill	Water Erosion gully	Wind Erosion	Mass Movement	Salting	Acidification
Susceptibility	Very low	Low	Very low	Low	Low	Moderate
Incidence	Very low	Very low	Low	Very low	Low	NA

B. SOIL PROFILE

PROFILE DESCRIPTION Site C5

A0 0-10 cm Organic matter

A1 10-30 cm Black (10YR2/1) peaty light clay, strong subangular blocky structure, peds <2 mm, rough fabric, firm consistence, pH 5.3. Clear transition to:

B1 30-50 cm Very dark grey (10YR3/1) heavy clay, very few fine faint yellow mottles, weak to moderate prismatic structure, peds 10-20 mm, smooth fabric, firm consistence. Gradual transition to:

B21 50-70 cm Very dark grey (10YR3/1) heavy clay, very few fine faint yellow mottles, weak prismatic structure, peds 10-20 mm, smooth, firm consistence, pH 5.3. Gradual transition to:

B22 70-90 cm Very dark grey (10YR3/1) heavy clay, very few fine faint yellow mottles, weak prismatic structure, peds 10-20 mm, smooth fabric, firm consistence, pH 5.5. Gradual transition to:

B23 90-120 cm Dark grey (10YR4/1) heavy clay, coarse distinct yellow mottles are common, moderate prismatic and subangular blocky structure, peds 10-20 mm, smooth fabric, firm consistence, pH 4.9. Diffuse transition to:

B24 120-150^{+}cm Grey (10YR5/1) heavy clay, many very coarse prominent yellow mottles, moderate prismatic structure, peds 20-50 mm, smooth, firm consistence.

CLASSIFICATION

Factual Key:	Uf6.22
Australian Soil Classification:	Humose-Mottled, Eutrophic, Black DERMOSOL; thick, slightly gravelly, peaty/clayey, very deep (confidence level 2)
Unified Soil Group:	CH

INTERPRETATION OF LABORATORY ANALYSIS

Horizon	pH ($CaCl_2$)	% Gravel	EC (salts)	Nutrient Status	P	K	Al	Organic Matter	Dispersibility
A1	4.5	5	VL	H	D	S	S	H	L
B21	4.3**	> 2	VL	M	D	S	T	M	M
B22	NA	> 2	NA	NA	NA	NA	NA	NA	M (est)
B23	4.1**	> 2	VL	M	D	S	T	VL	M

VL: Very Low L: Low M: Moderate H: High VH: Very High D: Deficient S: Satisfactory

T: Potentially Toxic NA: Not Available * see Appendix D for analytical results ** Strongly Acidic

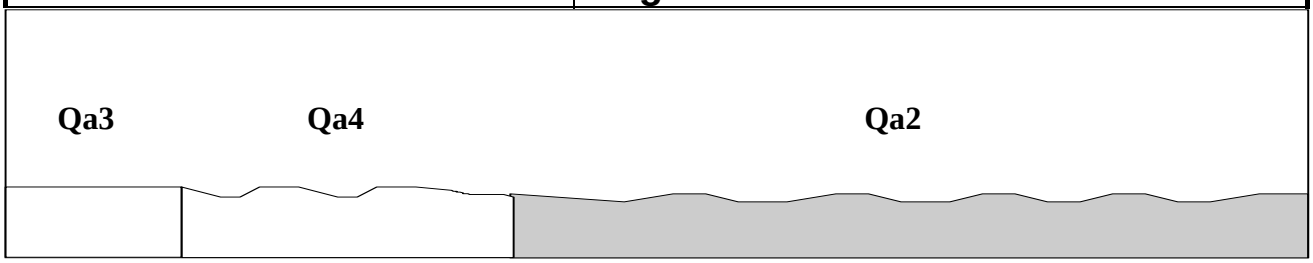
SOIL PROFILE CHARACTERISTICS:

Permeability:	Moderate (average 105 mm/day, range 95-220 mm/day)
Available Water Capacity:	Very high (260 mm H_2O)
Linear Shrinkage (B horizon):	Moderate (16%)

C. LAND CAPABILITY ASSESSMENT

Land Use	Class	Major Limiting Feature(s)/Land Use
Agriculture	$C_2T_1S_2$	Nil
Effluent Disposal (septic tanks)	5	Drainage
Farm Dams	3-4	Permeability
Building Foundations		
slab	5	Drainage
stumps/footings	5	Drainage
Secondary Roads	5	Drainage
Rural Residential development	5	Effluent disposal, building foundations, secondary roads

MAP UNIT SYMBOL: **Qa2** Area: 3544 ha	MAP UNIT: **Quaternary alluvium, Koo-wee-rup peaty clay with sandy ridges**



A. GENERAL DESCRIPTION

This alluvial plain also occurs in the Koo-wee-rup Swamp but has areas greater than 20 per cent composed of low sandy ridges. These ridges are remnants of prior streams. The sand found in the sandy ridges can vary from fine sand to coarse sand and gravel. Because of this distribution, the soils of this unit are highly variable. Compared with other swamp soils, the water holding capacity and fertility is lower, consequently productivity is lower. The texture of these soils ranges markedly from sands to clays due to the presence of intermittent sand lenses. There are no major limitations for agricultural production, although where the A11 is shallow, the poor conditions in the A12 horizon may limit productivity. The low nutrient content may have been caused by leaching of nutrients through the sandy soils, or production without replacement fertilisers. The depth to seasonal watertable is variable; it may be shallower in some areas during winter and spring, particularly in the depressions. When this is the case the land capability classes should be adjusted accordingly.

SITE CHARACTERISTICS

Parent Material Age:	Quaternary	**Depth to Seas. Watertable:**	> 1.5 m (variable)
Parent Material Lithology:	Alluvium	**Flooding Risk:**	Low
Landform Pattern:	Rises	**Drainage:**	Imperfectly drained
Landform Element:	Channel bench	**Rock Outcrop:**	Nil
Slope a) common:	1%	**Depth to Hard Rock:**	> 1.5 m
Slope b) range:	1-3%		

Potential Recharge to Groundwater:	Low
Major Native Vegetation Species:	Melaleuca
Present Land Use:	Grazing
Length of Growing Season:	8 months

LAND DEGRADATION

Degradation Processes	Water Erosion sheet/rill	Water Erosion gully	Wind Erosion	Mass Movement	Salting	Acidification
Susceptibility	Very low	Very low	Very low	Low	Low	Moderate
Incidence	Very low	Very low	Very low	Very low	Low	NA

B. SOIL PROFILE

PROFILE DESCRIPTION Site S2

A11 0-25 cm — Very dark brown (10YR3/1) organic fine sandy clay loam, moderate lenticular structure, rough fabric, peds 10-20 mm, firm consistence, pH 5.3. Clear transition to:

A12 25-80 cm — Dark grey (10YR4/1) fine sandy clay loam, sporadically bleached (10YR8/1) when dry, many fine distinct, light brownish grey mottles, weak lenticular structure, peds 20-50 mm, rough fabric, firm consistence, pH 5.2. Gradual transition to:

B1 80-105 cm Greyish brown (10YR5/2) sandy clay, weak lenticular structure, peds 20-50 mm, rough fabric, firm consistence, pH 5.2. Gradual transition to:

B2 105-150^{+} cm Light grey (7.5YR7/0) light clay with sand, medium distinct strong brown mottles and coarse distinct reddish yellow mottles are common, weak polyhedral structure, peds 20-50 mm, rough and smooth fabric, firm consistence, pH 5.4.

CLASSIFICATION

Factual Key:	Gn3.81 (major), Gn4.81, Uf6.22 (minor)
Australian Soil Classification:	Melanic-Mottled, Mesotrophic, Grey KANDOSOL; medium, non-gravelly, peaty/clayey, very deep (confidence level 2)
Unified Soil Group:	CL

INTERPRETATION OF LABORATORY ANALYSIS*

Horizon	pH ($CaCl_2$)	% Gravel	EC (salts)	Nutrient Status	P	K	Al	Organic Matter	Dispersibility
A11	4.7	< 1	VL	L	D	D	T	H	VL
A12	4.4**	0	VL	VL	D	D	T	VL	L
B1	4.3**	0	VL	VL	D	D	T	VL	M
B2	4.3**	0	VL	L	D	D	T	VL	L

VL: Very Low L: Low M: Moderate H: High VH: Very High D: Deficient S: Satisfactory

T: Potentially Toxic NA: Not Available * see Appendix D for analytical results ** Strongly Acidic

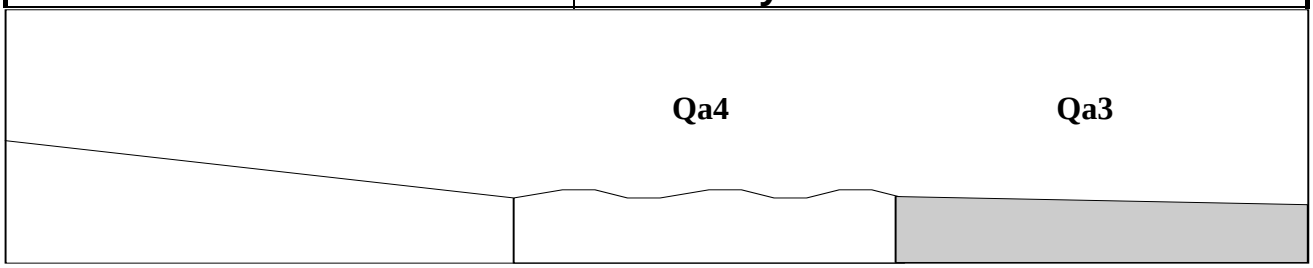
SOIL PROFILE CHARACTERISTICS:

Permeability:	Moderate (average 230 mm/day, range 110-355 mm/day)
Available Water Capacity:	Very high (283 mm H_2O)
Linear Shrinkage (B horizon):	Moderate (14%)

C. LAND CAPABILITY ASSESSMENT

Land Use	Class	Major Limiting Feature(s)/Land Use
Agriculture	$C_2T_1S_2$	Nil
Effluent Disposal (septic tanks)	4	Drainage
Farm Dams	4	Permeability
Building Foundations		
slab	4	Drainage
stumps/footings	4	Drainage
Secondary Roads	4	Drainage
Rural Residential Development	4	Secondary roads, farm dams, effluent disposal, building foundations

MAP UNIT SYMBOL: **Qa3** Area 13137 ha	MAP UNIT: **Quaternary alluvium, Narre clay loam**



A. GENERAL DESCRIPTION

This alluvial plain is present along the fringe of the former Koo-wee-rup Swamp. The soil is a grey Kandosol (Narre clay loam) similar to the swamp fringe soil identified by Goudie (1942). Narre clay loams were formed on the margins of the old swamp and were not waterlogged over a sufficient length of time to allow formation and accumulation of peat. The surface soils range from a sandy loam to light clay over medium to heavy clays. The A horizons of these soils often contain significant amounts of coarse sand. Drainage and permeability of these soils is often poor and water will often pond for long periods after rainfall. The depth to seasonal watertable is variable; it can be shallower in some areas during winter and spring. When this is the case, the land capability classes should be adjusted accordingly. These soils are often used for grazing rather than horticulture. Pugging of the top soil will occur if paddocks are overstocked in winter.

SITE CHARACTERISTICS

Parent Material Age:	Quaternary	**Depth to Seas. Watertable:**	> 1.5 m (variable)
Parent Material Lithology:	Alluvium	**Flooding Risk:**	Low
Landform Pattern:	Alluvial plain	**Drainage:**	Moderately well drained
Landform Element:	Plain	**Rock Outcrop:**	Nil
Slope a) common:	1%	**Depth to Hard Rock:**	> 1.5 m
Slope b) range:	0-3%		
Potential Recharge to Groundwater:	Low		
Major Native Vegetation Species:	Melaleuca		
Present Land Use:	Grazing (major), horticulture (minor)		
Length of Growing Season:	8 months		

LAND DEGRADATION

Degradation Processes	Water Erosion sheet/rill	Water Erosion gully	Wind Erosion	Mass Movement	Salting	Acidification
Susceptibility	Very low	Very low	Very low	Low	Moderate	Moderate
Incidence	Very low	Very low	Very low	Very low	Moderate	NA

B. SOIL PROFILE

PROFILE DESCRIPTION Site S3

A1 0-30 cm — Very dark grey brown (10YR3/2) light clay, strong subangular blocky structure, peds 5-10 mm, rough fabric, firm consistence, pH 5.3. Abrupt transition to:

A2 30-60 cm — Greyish brown (10YR5/2) coarse sandy clay, bleached (10YR8/2) when dry, weak polyhedral structure, peds 10-20 mm, rough fabric, very firm consistence, pH 5.0. Diffuse transition to:

B2 60-150^{+} cm — Grey (10YR6/1) medium clay, many coarse prominent yellowish brown mottles, moderate polyhedral structure, peds 10-20 mm, smooth fabric, firm consistence, pH 4.6.

CLASSIFICATION

Factual Key:	Gn3.91
Australian Soil Classification:	Melanic-Mottled, Eutrophic, Grey DERMOSOL; thick, non-gravelly, clayey/clayey, very deep (confidence level 2)
Unified Soil Group:	CL

INTERPRETATION OF LABORATORY ANALYSIS*

Horizon	pH ($CaCl_2$)	% Gravel	EC (salts)	Nutrient Status	P	K	Al	Organic Matter	Dispersibility
A1	4.6	< 1	VL	M	S	S	T	H	VL
A2	4.2**	< 1	VL	VL	D	D	T	L	M
B2	4.0**	< 1	L	L	D	D	T	VL	L

VL: Very Low L: Low M: Moderate H: High VH: Very High D: Deficient S: Satisfactory

T: Potentially Toxic NA: Not Available * see Appendix D for analytical results ** Strongly Acidic

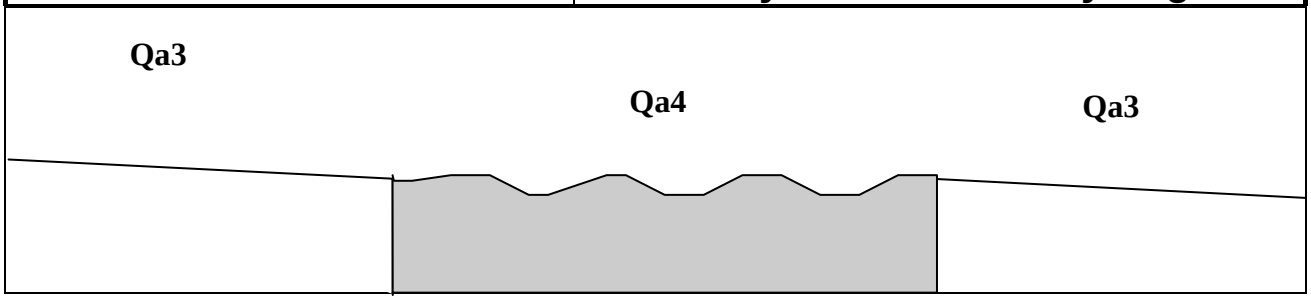
SOIL PROFILE CHARACTERISTICS:

Permeability:	Slow (average 20 mm/day, range 3-40 mm/day)
Available Water Capacity:	Very high (260 mm H_2O)
Linear Shrinkage (B horizon):	Low (12.5 %)

C. LAND CAPABILITY ASSESSMENT

Land Use	Class	Major Limiting Feature(s)/Land Use
Agriculture	$C_2T_1S_3$	Permeability-rainfall index
Effluent Disposal (septic tanks)	4	Permeability
Farm Dams	3	Depth to seasonal watertable, low dispersibility of subsoil, permeability
Building Foundations		
slab	3	Drainage, depth to watertable
stumps/footings	3	Drainage, depth to watertable, linear shrinkage
Secondary Roads	3	Drainage, linear shrinkage, USG subsoil
Rural Residential Development	4	Effluent disposal

MAP UNIT SYMBOL: **Qa4** Area: 2542 ha	MAP UNIT: **Quaternary alluvium, Narre clay loam with sandy ridges**



A. GENERAL DESCRIPTION

This alluvial plain also occurs along the fringe of the Koo-wee-rup Swamp, however the presence of sandy ridges distinguishes this unit from Qa3. The swamp fringe soil is similar to the Narre clay loam however the presence of fine, medium or coarse sands make the Narre clay loam with sandy ridges more suitable for grazing purposes. Soil fertility is not sufficient for horticulture. Drainage of these soils is more rapid than that of the Narre clay loam soils due to the high sand content. In the depressions the watertablemay be closer to the surface in the winter and spring months. When this is the case, the land capability classes should be adjusted accordingly.

SITE CHARACTERISTICS

Parent Material Age:	Quaternary	**Depth to Seas. Watertable:**	> 1.5 m (variable)
Parent Material Lithology:	Alluvium	**Flooding Risk:**	Low
Landform Pattern:	Alluvial plain	**Drainage:**	Moderately well drained
Landform Element:	Plain	**Rock Outcrop:**	Nil
Slope a) common:	1%	**Depth to Hard Rock:**	> 1.5 m
Slope b) range:	0-3%		
Potential Recharge to Groundwater:	Low		
Major Native Vegetation Species:	Melaleuca		
Present Land Use:	Grazing		
Length of Growing Season:	8 months		

LAND DEGRADATION

Degradation Processes	Water Erosion sheet/rill	Water Erosion gully	Wind Erosion	Mass Movement	Salting	Acidification
Susceptibility	Very low	Very low	Very low	Low	Low	Low
Incidence	Very low	Very low	Very low	Very low	Low	NA

B. SOIL PROFILE

PROFILE DESCRIPTION Site S4

A1 0-30 cm Dark greyish brown (10YR4/2) light clay, weak angular blocky structure, peds 10-20 mm, rough fabric, strong consistence, pH 5.1. Clear transition to:

B21 30-80 cm Dark greyish brown (10YR4/2) medium clay, strong angular blocky structure, peds 10-20 mm and 20-50 mm, smooth fabric, strong consistence, pH 4.8. Gradual transition to:

B22 80-150 cm Dark greyish brown (10YR4/2) gritty light clay, strong angular blocky and columnar structure, peds 20-50 mm and 200-500 mm smooth fabric, very firm consistence, pH 4.8. Clear transition to:

2Cb 150^{+} cm Brown (10YR5/3) sand, apedal single grain, sandy (grains prominent), very weak consistence, pH 4.6.

CLASSIFICATION

Factual Key:	Uf6.23
Australian Soil Classification:	Acidic, Mesotophic, Grey DERMOSOL; medium, non-gravelly, clayey/clayey, very deep (Confidence level 2)
Unified Soil Group:	MH

INTERPRETATION OF LABORATORY ANALYSIS*

Horizon	pH ($CaCl_2$)	% Gravel	EC (salts)	Nutrient Status	P	K	Al	Organic Matter	Dispersibility
A1	4.3**	0	VL	M	S	S	T	H	VL
B21	4.0**	0	VL	L	S	S	T	H	VL
B22	4.0**	0	VL	L	S	S	T	L	M
B3	3.9**	0	VL	VL	S	D	T	VL	L

VL: Very Low L: Low M: Moderate H: High VH: Very High D: Deficient S: Satisfactory

T: Potentially Toxic NA: Not Available * see Appendix D for analytical results ** Strongly Acidic

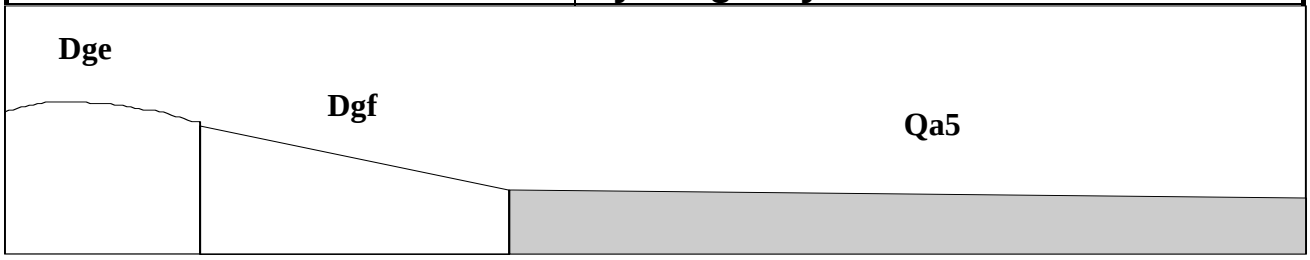
SOIL PROFILE CHARACTERISTICS:

Permeability:	Moderate (average 165 mm/day, range 50-260 mm/day)
Available Water Capacity:	Very high (233 mm H_20)
Linear Shrinkage (B horizon):	Moderate (13%)

C. LAND CAPABILITY ASSESSMENT

Land Use	Class	Major Limiting Feature(s)/Land Use
Agriculture	$C_2T_1S_2$	Nil
Effluent Disposal (septic tanks)	3	Moderately well drained
Farm Dams	3-4	Permeability
Building Foundations		
slab	3	Drainage, depth to watertable
stumps/footings	3	Drainage, depth to watertable
Secondary Roads	3	Drainage, depth to watertable, linear shrinkage
Rural Residential Development	3-4	Farm Dams

MAP UNIT SYMBOL: **Qa5** Area 3821 ha	MAP UNIT: **Quaternary alluvium, Tynong clay loam**



A. GENERAL DESCRIPTION

This alluvial plain occurs on the swamp fringe, adjacent to gently undulating granitic terrain. Subsequently, the Tynong clay loam soils have a high gravel and sand concentration throughout the profile. These soils are generally a clay loam over medium to heavy clay. Horizons of coffee rock, that forms a dense cemented pan, were observed where there is leaching of organic matter and iron oxides through the profile. Permeability is generally low and ponding often occurs after significant rain. These soil types are commonly used for grazing.

SITE CHARACTERISTICS

Parent Material Age:	Quaternary	**Depth to Seas. Watertable:**	> 1.5 m
Parent Material Lithology:	Alluvium	**Flooding Risk:**	Low
Landform Pattern:	Alluvial plain	**Drainage:**	Moderately well drained
Landform Element:	Plain	**Rock Outcrop:**	Nil
Slope a) common:	1%	**Depth to Hard Rock:**	> 1.5 m
Slope b) range:	0-3%		
Potential Recharge to Groundwater:	Low		
Major Native Vegetation Species:	Melaleuca, Messmate, Narrow-leaved Peppermint		
Present Land Use:	Grazing		
Length of Growing Season:	8 months		

LAND DEGRADATION

Degradation Processes	Water Erosion sheet/rill	gully	Wind Erosion	Mass Movement	Salting	Acidification
Susceptibility	Low	Very low	Very low	Low	Moderate	Moderate
Incidence	Very low	Very low	Very low	Very low	Low	NA

B. SOIL PROFILE

PROFILE DESCRIPTION Site S5

A11 0-10 cm Very dark grey (5YR3/1) clay loam, moderate polyhedral structure, peds 10-20 mm, rough fabric, weak consistence, pH 4.5. Abrupt transition to:

A12 10-25 cm Dark grey (5YR4/1) sandy clay loam (coarse sand), moderate polyhedral structure, peds 5-10 mm, rough fabric, very weak consistence, pH 4.7. Clear transition to:

Bhs 25-35 cm Dark brown (7.5YR3/2) organic pan (Coffee rock), massive structure, sandy fabric, strong consistence, pH 4.9. Gradual transition to:

D1 35-70 cm Pinkish grey (7.5YR7/2) coarse sandy clay, coarse distinct red mottles and coarse prominent reddish yellow mottles are common, moderate subangular blocky structure, peds 5-10 mm, rough fabric, firm consistence, pH 5.3. Clear transition:

D2 70-150^{+} cm Grey (7.5YR6/0) medium clay, many very coarse prominent reddish yellow mottles, moderate polyhedral structure, peds 10-20 mm, rough fabric, very firm consistence, pH 6.0.

CLASSIFICATION

Factual Key:	Uc5/Dy
Australian Soil Classification:	Parapanic, Humic, Semiaquic PODOSOL (over KUROSOL); medium, non-gravelly, clay loamy/clayey, very deep (confidence level 2)
Unified Soil Group:	CH

INTERPRETATION OF LABORATORY ANALYSIS*

Horizon	pH ($CaCl_2$)	% Gravel	EC (salts)	Nutrient Status	P	K	Al	Organic Matter	Dispersibility
A11	3.7**	0	VL	VL	D	D	T	H	VL
A12	3.7**	0	VL	VL	D	D	T	M	VL
Bhs	4.0**	0	VL	VL	D	D	T	H	L
D1	4.2**	0	VL	VL	D	D	T	VL	M
D2	5.6	0	M	L	D	D	S	VL	L

VL: Very Low L: Low M: Moderate H: High VH: Very High D: Deficient S: Satisfactory

T: Potentially Toxic NA: Not Available * see Appendix D for analytical results ** Strongly Acidic

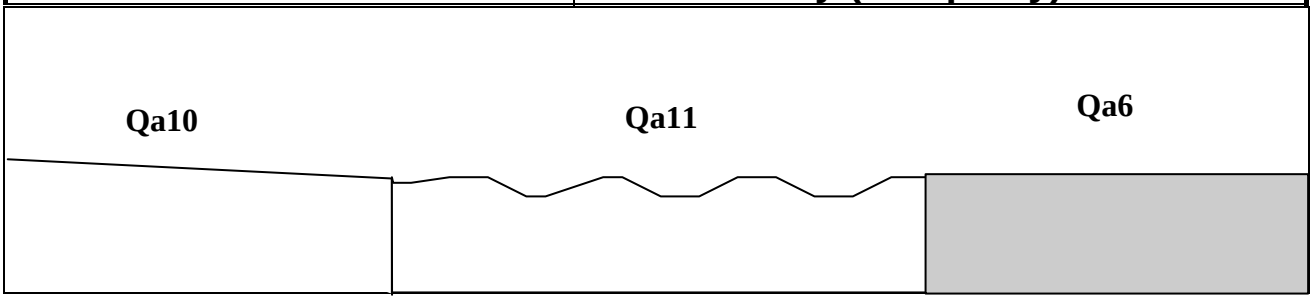
SOIL PROFILE CHARACTERISTICS:

Permeability:	Slow (average 65 mm/day, range 35-85 mm/day)
Available Water Capacity:	High (200 mm H_2O)
Linear Shrinkage (B horizon):	Moderate (17.5%)

C. LAND CAPABILITY ASSESSMENT

Land Use	Class	Major Limiting Feature(s)/Land Use
Agriculture	$C_2T_1S_3$	Permeability-rainfall index
Effluent Disposal (septic tanks)	3-4	Permeability, drainage
Farm Dams	3	Linear shrinkage, depth to seasonal watertable, permeability
Building Foundations		
slab	3	Drainage, depth to seasonal watertable
stumps/footings	3	Linear shrinkage, drainage, depth to seasonal watertable
Secondary Roads	3	Linear shrinkage, drainage, USG subsoil
Rural Residential Development	3	Effluent disposal, farm dams, secondary roads, building foundations

MAP UNIT SYMBOL: **Qa6** Area: 1441 ha	MAP UNIT: **Quaternary alluvium, 6, Dalmore clay (non peaty)**



A. GENERAL DESCRIPTION

This alluvial plain is part of the former Koo-wee-rup Swamp. The Dalmore clay (non peaty) is similar to the Dalmore clay (Qa12), however it has a less peaty friable surface. The topsoil is dark grey to black medium to heavy clay. The subsoil is a dark grey heavy clay. Mottling of the subsoil increases as the soil depth increases. This soil is not considered as fertile as the Dalmore clay as there is less organic matter in the topsoil and subsoil. This soil type has not been commonly used for horticulture, however recently more of this soil type is being used for horticultural production. The high clay content of the topsoil makes management difficult; when dry it forms hard clods, and when wet becomes very sticky which is related to the sodicity of the soil. If the soil is worked when wet, smearing and compaction of the soil surface will occur. Pugging of the soil in winter by stock will have a similar effect. The high clay content of this soil means that the soil has a high shrink swell capacity and will crack when dry. This property has implications for engineering as fences, roads and foundations require a stable substrate. Acid topsoils and subsoils were noted in preliminary sites. Aluminium toxicity may be a problem in these soils.

SITE CHARACTERISTICS

Parent Material Age:	Quaternary	**Depth to Seas. Watertable:**	> 1.5 m
Parent Material Lithology:	Alluvium	**Flooding Risk:**	Low
Landform Pattern:	Alluvial plain	**Drainage:**	Moderately well drained
Landform Element:	Plain	**Rock Outcrop:**	Nil
Slope a) common:	1%	**Depth to Hard Rock:**	> 1.5 m
Slope b) range:	0-3%		
Potential Recharge to Groundwater:	Low		
Major Native Vegetation Species:	Melaleuca		
Present Land Use:	Horticulture, some grazing		
Length of Growing Season:	8 months		

LAND DEGRADATION

Degradation Processes	Water Erosion sheet/rill	Water Erosion gully	Wind Erosion	Mass Movement	Salting	Acidification
Susceptibility	Very low	Low	Very low	Low	Low	Moderate
Incidence	Very low	Very low	Very low	Very low	Low	NA

B. SOIL PROFILE

PROFILE DESCRIPTION Site C9

A1 0-40 cm Black (10YR5/1) peaty light medium clay, strong subangular blocky structure (self-mulching), peds 2-5 mm, rough fabric, strong consistence, pH 5.9. Clear transition to:

B21 40-90 cm Black (2.5Y2.5/0) heavy clay, strong lenticular structure, slickensides, peds 20-50 mm, smooth fabric, very strong consistence, pH 5.7. Gradual transition to:

B22 90-150^{+} cm Black (5Y2.5/1) heavy clay, a few medium faint yellow and orange mottles, moderate lenticular and prismatic structure, slickensides, peds 10-20 mm, smooth fabric, very strong consistence, pH 5.4.

CLASSIFICATION

Factual Key:	Ug5.1
Australian Soil Classification:	Epihypersodic, Self-mulching, Black VERTOSOL; non-gravelly, medium, fine/very fine, very deep (confidence level 2)
Unified Soil Group:	OH

INTERPRETATION OF LABORATORY ANALYSIS*

Horizon	pH ($CaCl_2$)	% Gravel	EC (salts)	Nutrient Status	P	K	Al	Organic Matter	Dispersibility
A1	4.9	< 2	VL	VH	S	S	T	H	VL
B21	4.8	< 2	VL	VH	S	S	T	H	M-H
B22	4.7	< 2	VL	H	S	S	T	M	M-H

VL: Very Low L: Low M: Moderate H: High VH: Very High D: Deficient S: Satisfactory

T: Potentially Toxic NA: Not Available * see Appendix D for analytical results ** Strongly Acidic

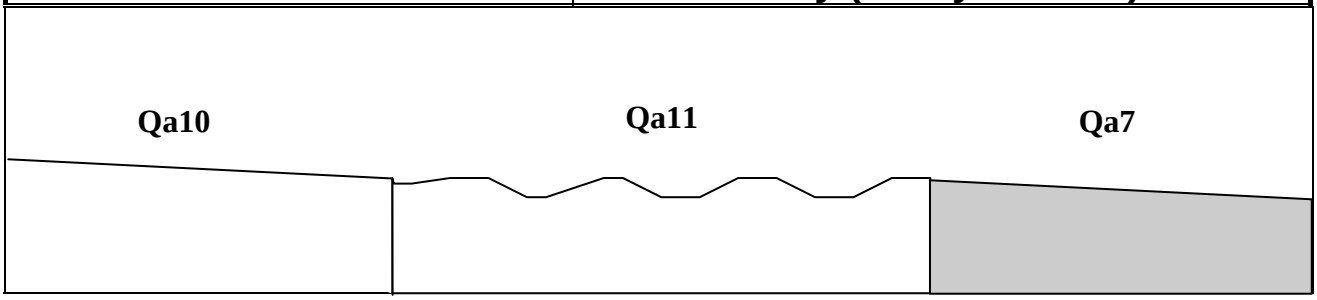
SOIL PROFILE CHARACTERISTICS:

Permeability:	Slow (average 23 mm/day, range 3-40 mm/day)
Available Water Capacity:	Very high (> 200 mm H_2O)
Linear Shrinkage (B horizon):	Moderate (17%)

C. LAND CAPABILITY ASSESSMENT

Land Use	Class	Major Limiting Feature(s)/Land Use
Agriculture	$C_2T_1S_3$	Permeability-rainfall index
Effluent Disposal (septic tanks)	4	Permeability
Farm Dams	5	Suitability of subsoil
Building Foundations		
slab	3	Drainage
stumps/footings	3	Drainage
Secondary Roads	5	USG
Rural Residential Development	5	Farm dams, secondary roads

MAP UNIT SYMBOL: **Qa7** Area: 7027 ha	MAP UNIT: **Quaternary alluvium, Dalmore clay (heavy surface)**



A. GENERAL DESCRIPTION

This map unit is similar to the former swampy plains of Qa6 and Qa12. The Dalmore clay (heavy surface) is similar to Dalmore clay (Qa12), however it lacks the peaty friable surface. The topsoil is dark grey to black medium to heavy clay and the subsoil is a dark grey heavy clay. As soil depth increases there is an increase in mottling of the subsoil. The high clay content of the topsoil makes it difficult to manage. When the soil is dry hard clods form and when wet the soil becomes very sticky, which is related to the sodicity of the soil. If the soil is worked when wet, smearing and compaction of the soil surface will occur. Pugging of the soil in winter by stock will have a similar effect. The high clay content of this soil means that the soil has a high shrink swell capacity and will crack when dry. This property has implications for engineering as fences, roads and foundations need a stable substrate. The profile is commonly sodic and the subsoil acidic. Even though the flood risk for this unit is considered low, in wet years these soils will be inundated for long periods over winter and the watertable may be at or near the surface. When this is the case the land capability classes should be adjusted accordingly.

SITE CHARACTERISTICS

Parent Material Age:	Quaternary	**Depth to Seas. Watertable:**	> 1.5 m
Parent Material Lithology:	Alluvium	**Flooding Risk:**	Low
Landform Pattern:	Alluvial plain	**Drainage:**	Moderately well drained
Landform Element:	Plain	**Rock Outcrop:**	Nil
Slope a) common:	1%	**Depth to Hard Rock:**	> 1.5 m
Slope b) range:	0-3%		
Potential Recharge to Groundwater:	Low		
Major Native Vegetation Species:	Melaleuca		
Present Land Use:	Grazing		
Length of Growing Season:	8 months		

LAND DEGRADATION

Degradation Processes	Water Erosion sheet/rill	gully	Wind Erosion	Mass Movement	Salting	Acidification
Susceptibility	Very low	Low	Very low	Low	Low	Low
Incidence	Very low	Very low	Very low	Very low	Low	NA

B. SOIL PROFILE

PROFILE DESCRIPTION Site C8

A1 0-30 cm Very dark grey (10YR3/1) medium clay, weak subangular blocky structure, peds 5-10 mm, rough fabric, firm consistence, pH 5.5. Clear transition to:

B21 30-60 cm Dark grey (10YR4/1) heavy clay, moderate lenticular structure, slickensides, peds 10-20 mm, smooth fabric, firm consistence, pH 5.6. Gradual transition to:

B22 60-90 cm Dark grey (10YR4/1) heavy clay, moderate lenticular structure, slickensides, peds 10-20 mm smooth fabric, firm consistence, pH 5.1. Gradual transition to:

B3 90-110^{+} cm Dark, greyish brown (10YR4/2) sandy clay, weak prismatic and subangular blocky structure, peds 10-20 mm, smooth fabric, firm consistence.

CLASSIFICATION

Factual Key:	Ug5.16
Australian Soil Classification:	Epihypersodic-Endoacidic, Epipedal, Black VERTOSOL; slightly gravelly, medium fine/ medium fine, very deep (confidence level 2)
Unified Soil Group:	CH

INTERPRETATION OF LABORATORY ANALYSIS*

Horizon	pH ($CaCl_2$)	% Gravel	EC (salts)	Nutrient Status	P	K	Al	Organic Matter	Dispersibility
A1	4.8	< 10	VL	M	D	S	S	H	L-M
B21	4.5	< 10	VL	M	D	S	T	M	M-H
B22	4.3**	< 10	L	M	D	S	T	L	M-H

VL: Very Low L: Low M: Moderate H: High VH: Very High D: Deficient S: Satisfactory

T: Potentially Toxic NA: Not Available * see Appendix D for analytical results ** Strongly Acidic

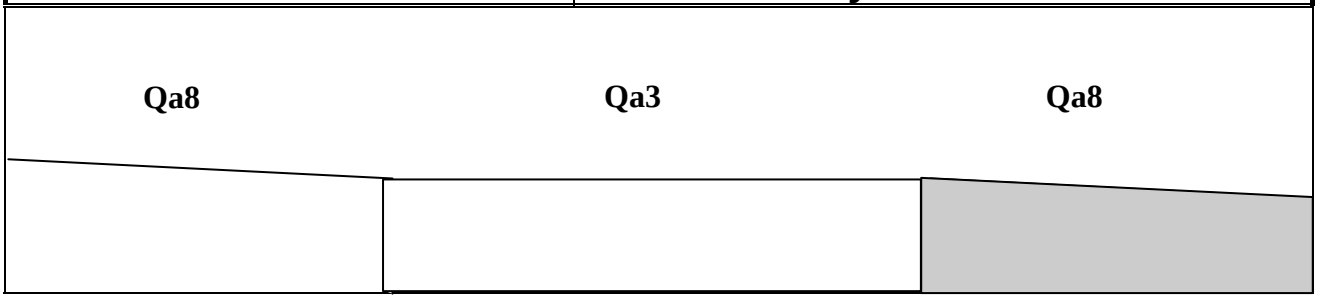
SOIL PROFILE CHARACTERISTICS:

Permeability:	Moderate (average 165 mm/day, range 50-260 mm/day)
Available Water Capacity:	Very high (> 200 mm H_2O)
Linear Shrinkage (B horizon):	Moderate (16 %)

C. LAND CAPABILITY ASSESSMENT

Land Use	Class	Major Limiting Feature(s)/Land Use
Agriculture	$C_2T_1S_2$	Nil
Effluent Disposal (septic tanks)	3	Drainage
Farm Dams	4	Permeability
Building Foundations		
slab	3	Drainage
stumps/footings	3	Drainage, linear shrinkage
Secondary Roads	3	Drainage, linear shrinkage, USG subsoil
Rural Residential Development	4	Farm dams

MAP UNIT SYMBOL: **Qa8** Area: 99.4ha	MAP UNIT: **Quaternary alluvium, Toomuc sandy loam**



A. GENERAL DESCRIPTION

This alluvial plain is part of the former Koo-wee-rup Swamp, and is often found in association with Qa3. The soil contains large amounts of sand to a depth of about 60 cm. Much of this material would have been deposited by the nearby Cardinia Creek. The topsoil is a sand to sandy loam over a lighter textured bleached A2 horizon. The subsoil is generally sodic and highly dispersive. Iron oxide nodules may be found in the A2 horizon and the clay subsoil is generally mottled clay which indicates periodic waterlogging. The topsoil tends to have a low fertility and for this reason the soil is more commonly used for grazing rather than horticulture.

SITE CHARACTERISTICS

Parent Material Age:	Quaternary	**Depth to Seas. Watertable:**	> 1.5 m
Parent Material Lithology:	Alluvium	**Flooding Risk:**	Low
Landform Pattern:	Alluvial plain	**Drainage:**	Moderately well drained
Landform Element:	Plain	**Rock Outcrop:**	Nil
Slope a) common:	1%	**Depth to Hard Rock:**	> 1.5 m
Slope b) range:	0-3%		
Potential Recharge to Groundwater:	Low		
Major Native Vegetation Species:	Melaleuca		
Present Land Use:	Grazing, horticulture		
Length of Growing Season:	8 months		

LAND DEGRADATION

Degradation Processes	Water Erosion sheet/rill	Water Erosion gully	Wind Erosion	Mass Movement	Salting	Acidification
Susceptibility	Low	Low	Very low	Low	Moderate	Moderate
Incidence	Very low	Very low	Very low	Very low	Low	NA

B. SOIL PROFILE

PROFILE DESCRIPTION Site GP21

A1 0-25 cm Dark grey brown (10YR4/2) sandy loam, weak subangular blocky structure, peds 5-10 mm, rough fabric, very weak consistence, pH 5.6. Abrupt transition to:

A2 25-45 cm Greyish brown (10YR5/2) loamy sand, bleached (10YR8/2) when dry, weak subangular structure, peds 10-20 mm, rough fabric, very weak consistence, pH 5.7. Clear transition to:

B2 44-120^{+} cm Dark grey brown (10YR4/2) medium clay, many coarse prominent yellowish brown mottles, moderate polyhedral structure, peds 10-20 mm, rough fabric, firm consistence, pH 6.1.

CLASSIFICATION

Factual Key:	Dy3.41
Australian Soil Classification:	Magnesic, Mottled-Subnatric, Grey SODOSOL; thick, non-gravelly, loamy/clayey, very deep (confidence level 2)
Unified Soil Group:	CL

INTERPRETATION OF LABORATORY ANALYSIS*

Horizon	pH ($CaCl_2$)	% Gravel	EC (salts)	Nutrient Status	P	K	Al	Organic Matter	Dispersibility
A1	4.8	< 1	VL	L	NA	NA	NA	H	NA
A2	4.6	< 1	VL	VL	NA	NA	NA	NA	NA
B2	4.8	< 1	VL	L	NA	NA	NA	NA	H (est)

VL: Very Low L: Low M: Moderate H: High VH: Very High D: Deficient S: Satisfactory

T: Potentially Toxic NA: Not Available * see Appendix D for analytical results ** Strongly Acidic

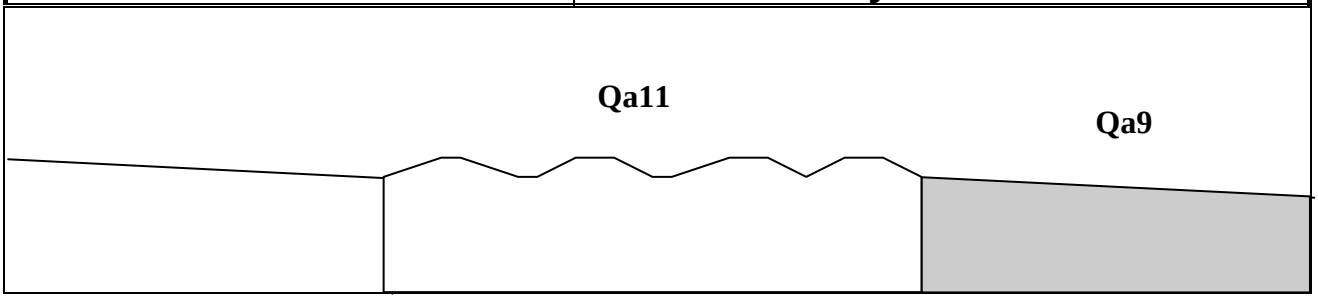
SOIL PROFILE CHARACTERISTICS:

Permeability:	Slow (average 20 mm/day, range 3-40 mm/day)
Available Water Capacity:	Very high (260 mm H_2O)
Linear Shrinkage (B horizon):	Low (12.5 %)

C. LAND CAPABILITY ASSESSMENT

Land Use	Class	Major Limiting Feature(s)/Land Use
Agriculture	$C_2T_1S_3$	Permeability-rainfall index
Effluent Disposal (septic tanks)	4	Permeability
Farm Dams	3	Depth to seasonal watertable, permeability, low dispersibility of subsoil
Building Foundations		
slab	3	Depth to seasonal watertable, drainage
stumps/footings	3	Depth to seasonal watertable, drainage
Secondary Roads	3	Depth to seasonal watertable, drainage, USG subsoil
Rural Residential Development	4	Effluent disposal

MAP UNIT SYMBOL: **Qa9** Area: 10530 ha	MAP UNIT: **Quaternary alluvium, Monomeith clay loam**



A. GENERAL DESCRIPTION

This alluvial plain occurs on the fringe of the former Koo-wee-rup Swamp to the south east of the Shire, south of Catani and Bayles. The soils of this unit are derived from deposition by the Lang Lang River, Gum Scrub, Yanathan and other creeks. This unit has occassional sandy ridges which are the remnants of prior stream banks and levees. The topsoils are generally grey or grey brown clay loams to light clay to a depth of 20-30 cm. The subsoils are generally sodic, with deep, mottled, medium to heavy clays. These soils are often used for grazing and dairying rather than horticulture.

SITE CHARACTERISTICS

Parent Material Age:	Quaternary	**Depth to Seas. Watertable:**	> 1.5 m
Parent Material Lithology:	Alluvium	**Flooding Risk:**	Low
Landform Pattern:	Alluvial plain	**Drainage:**	Moderately well drained
Landform Element:	Plain	**Rock Outcrop:**	Nil
Slope a) common:	1%	**Depth to Hard Rock:**	> 1.5 m
Slope b) range:	0-3%		
Potential Recharge to Groundwater:	Low		
Major Native Vegetation Species:	Melaleuca, Messmate, Narrow-leaved Peppermint		
Present Land Use:	Grazing		
Length of Growing Season:	8 months		

LAND DEGRADATION

Degradation Processes	Water Erosion sheet/rill	Water Erosion gully	Wind Erosion	Mass Movement	Salting	Acidification
Susceptibility	Low	Low	Very low	Low	Low	Low
Incidence	Very low	Very low	Very low	Very low	Low	NA

B. SOIL PROFILE

PROFILE DESCRIPTION Site C7

A1 0-30 cm — Very dark grey (10YR3/1) fine sandy clay loam, moderate subangular blocky structure, peds 10-20 mm, rough fabric, firm consistence, pH 5.4. Clear transition to:

B1 30-80 cm — Dark grey (10YR4/1) light medium clay with silt, bleached (10YR7/2) when dry, coarse faint yellow and pale mottles are common, moderate prismatic structure, peds 20-50 mm, smooth fabric, strong consistence. Gradual transition to:

B2 80-150^{+} cm — Grey (10YR6/2) heavy clay, many medium distinct yellow and pale mottles, moderate subangular blocky structure, peds 5-10 mm, smooth fabric, strong consistence, pH 6.8.

CLASSIFICATION

Factual Key:	Gn3.92 (major), Dy3.12 (minor)
Australian Soil Classification:	Melanic-Sodic, Eutrophic, Grey DERMOSOL; medium, non-gravelly, clay loamy/clayey, very deep (confidence level 2)
Unified Soil Group:	CH

INTERPRETATION OF LABORATORY ANALYSIS*

Horizon	pH ($CaCl_2$)	% Gravel	EC (salts)	Nutrient Status	P	K	Al	Organic Matter	Dispersibility
A1	4.6	0	L	L	D	S	T	H	L
B1	NA	20	NA	NA	NA	NA	NA	NA	H
B2	6.3	20	M	M	D	D	S	VL	H

VL: Very Low L: Low M: Moderate H: High VH: Very High D: Deficient S: Satisfactory

T: Potentially Toxic NA: Not Available * see Appendix D for analytical results ** Strongly Acidic

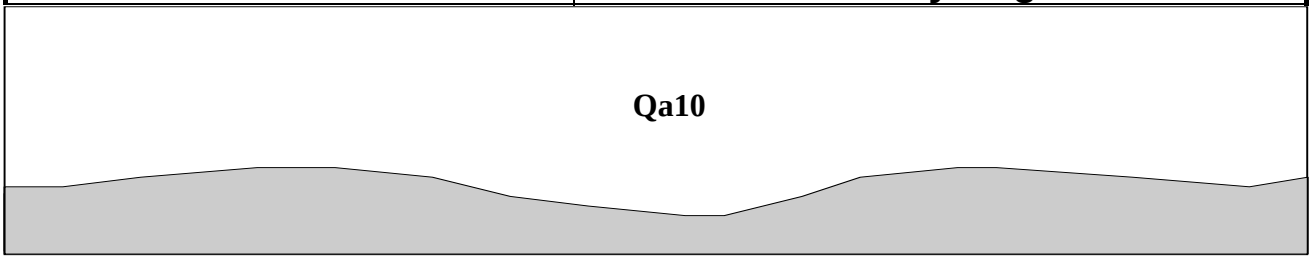
SOIL PROFILE CHARACTERISTICS:

Permeability:	Slow (average 20 mm/day, range 3-40 mm/day)
Available Water Capacity:	Very high (> 200 mm H_2O)
Linear Shrinkage (B horizon):	Moderate (15%)

C. LAND CAPABILITY ASSESSMENT

Land Use	Class	Major Limiting Feature(s)/Land Use
Agriculture	$C_2T_1S_3$	Permeability-rainfall index
Effluent Disposal (septic tanks)	4	Permeability
Farm Dams	4	Dispersive subsoil
Building Foundations		
slab	3	Drainage
stumps/footings	3	Drainage, linear shrinkage
Secondary Roads	3	Drainage, linear shrinkage
Rural Residential Development	4	Effluent disposal, farm dams

MAP UNIT SYMBOL: **Qa10** Area: 3011 ha	MAP UNIT: **Quaternary alluvium, Unclassified sandy ridge**



A. GENERAL DESCRIPTION

This unit represents a number of areas in the Shire where sand ridges occur. The sand may have been deposited by rivers and streams or may have been wind blown. The sand has been deposited on top of various materials and often varies in depth. The sand ridges consist mostly of pure sand apart from an accumulation of organic matter in the topsoil. Quite often the leaching of organic matter and iron oxides down the profile causes the build up of an organic pan or coffee rock. This pan will often form on top of a more impervious layer. The coffee rock occurs from between 30-100 cm. The high sand content means that nutrients leach out of the soil rapidly making them relatively infertile. Leaching of nutrients will also cause an increase in the acidity of the soil. These unclassified sand ridges occur close to the township of Cardinia, and south and east of Lang Lang. Land use is usually restricted to grazing and dairying, however soils with a shallow sandy soil over clay are increasingly being used for horticultural purposes. Plant available water capacity may be reduced due to the presence of the hardpan which restricts root penetration.

SITE CHARACTERISTICS

Parent Material Age:	Quaternary	**Depth to Seas. Watertable:**	> 2.0 m
Parent Material Lithology:	Alluvium	**Flooding Risk:**	Low
Landform Pattern:	Sand plain, dune field	**Drainage:**	Moderately well drained
Landform Element:	Dune, lunette	**Rock Outcrop:**	Nil
Slope a) common:	1%	**Depth to Hard Rock:**	> 2.0 m
Slope b) range:	0-3%		
Potential Recharge to Groundwater:	Low		
Major Native Vegetation Species:	Melaleuca		
Present Land Use:	Grazing		
Length of Growing Season:	8 months		

LAND DEGRADATION

Degradation Processes	Water Erosion sheet/rill	Water Erosion gully	Wind Erosion	Mass Movement	Salting	Acidification
Susceptibility	Very low	Very low	Moderate	Low	Low	Moderate
Incidence	Very low	Very low	Very low	Very low	Low	NA

B. SOIL PROFILE

PROFILE DESCRIPTION Site C1

A1 0-30 cm Black (10YR2/1) loamy sand, weak subangular blocky structure, peds 10-20 mm, rough fabric, loose consistence, pH 5.2. Clear transition to:

A2 30-90 cm Dark grey (10YR5/2) sand, bleached (10YR7/1) when dry, weak subangular blocky structure, peds 5-10 mm rough fabric, very weak consistence, pH 6.0. Gradual transition to:

Bhs 90-105 cm Dark brown (7.5YR4/3) organic pan (Coffee rock), apedal massive (structureless), strong consistence, pH 5.5. Gradual transition to:

B2 105^{+} cm Grey (10YR5/6) sandy clay, many coarse prominent pale brown mottles, weak subangular blocky structure, peds 5-10 mm, rough fabric, firm consistence, pH 4.8.

CLASSIFICATION

Factual Key:	Uc2
Australian Soil Classification:	Humose, Humic, Semiaquic PODOSOL; thick, non-gravelly, sandy/clayey (confidence level 2)
Unified Soil Group:	CL

INTERPRETATION OF LABORATORY ANALYSIS*

Horizon	pH ($CaCl_2$)	% Gravel	EC (salts)	Nutrient Status	P	K	Al	Organic Matter	Dispersibility
A1	4.7	0	L	VL	S	S	S	H	VL
A2	4.2**	0	VL	VL	S	D	T	VL	VL
Bhs	NA	0	NA	NA	NA	NA	NA	NA	VL
B2	4.0**	< 10	L	L	D	D	S	VL	L

VL: Very Low L: Low M: Moderate H: High VH: Very High D: Deficient S: Satisfactory

T: Potentially Toxic NA: Not Available * see Appendix D for analytical results ** Strongly Acidic

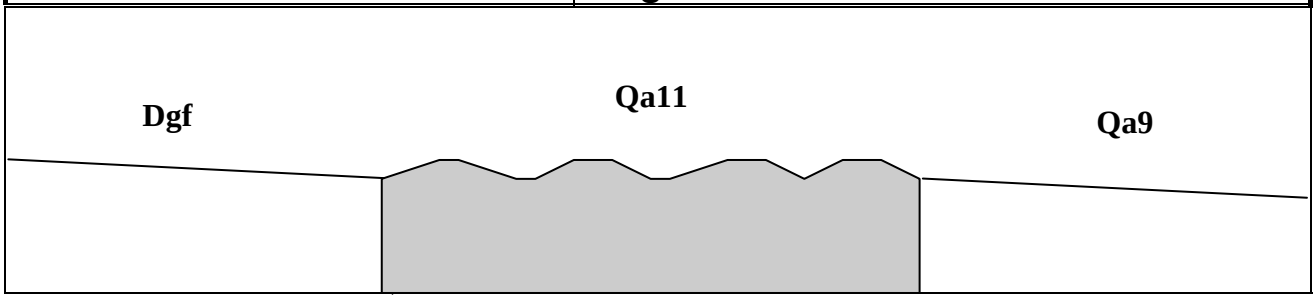
SOIL PROFILE CHARACTERISTICS:

Permeability:	Slow (average 65 mm/day, range 35-85 mm/day)
Available Water Capacity:	High (150-200 mm H_2O)
Linear Shrinkage (B horizon):	Very low (6%)

C. LAND CAPABILITY ASSESSMENT

Land Use	Class	Major Limiting Feature(s)/Land Use
Agriculture	$C_2T_1S_3$	Susceptibility to wind erosion, permeability-rainfall index
Effluent Disposal (septic tanks)	3	Drainage, permeability
Farm Dams	3	Permeability
Building Foundations		
slab	3	Drainage
stumps/footings	3	Drainage
Secondary Roads	3	Drainage, USG
Rural Residential Development	3	Effluent disposal, farm dams, building foundations, secondary roads

MAP UNIT SYMBOL: **Qa11** Area: 5295	MAP UNIT: **Quaternary alluvium, Monomeith clay loam with sandy ridges**



A. GENERAL DESCRIPTION

This alluvial plain has developed on the margins of the Koo-wee-rup swamp and was not waterlogged long enough for the formation and accumulation of peat. The sandy ridges of this unit indicate that more than 20 per cent of the area is made up of low rises with soils comprising sandy or gravelly material. The surface soils range in texture from a loamy sand to sandy loam to gravelly or sandy clay. Below the B22 horizon there is generally a layer of loamy or gravelly sand of varying depths, mostly less than 1.5 metres in depth. Below this, the texture increases to sandy clays. These soil profiles are common on the sandy ridges that make up around 20 per cent of the area. Where there are no sandy ridges the soils are similar to the Monomeith clay loam (Qa9). However these soils may have discrete sand lenses or layers coming in at different depths. Due to the variation in the soil the drainage and permeability varies. On the sandier ridges drainage is less restricted. These soils are often used for grazing and dairying rather than horticulture, as the sodic subsoil can reduce the available water capacity for plants.

SITE CHARACTERISTICS

Parent Material Age:	Quaternary	**Depth to Seas. Watertable:**	> 1.5 m
Parent Material Lithology:	Alluvium	**Flooding Risk:**	Low
Landform Pattern:	Alluvial plain	**Drainage:**	Moderately well drained
Landform Element:	Plain	**Rock Outcrop:**	Nil
Slope a) common:	1%	**Depth to Hard Rock:**	> 1.5 m
Slope b) range:	0-3%		
Potential Recharge to Groundwater:	Low		
Major Native Vegetation Species:	Melaleuca		
Present Land Use:	Grazing, dairying		
Length of Growing Season:	8 months		

LAND DEGRADATION

Degradation Processes	Water Erosion sheet/rill	gully	Wind Erosion	Mass Movement	Salting	Acidification
Susceptibility	Very low	Low	Very low	Low	Low	Moderate
Incidence	Very low	Very low	Very low	Very low	Low	NA

B. SOIL PROFILE

PROFILE DESCRIPTION Site C6

A1 0-10 cm Very dark grey brown (10YR3/2) fine sandy clay loam, moderate subangular blocky structure, peds 2-5 mm, rough fabric, firm consistence, pH 5.3. Clear transition to:

B21 10-55 cm Dark grey (10YR4/1) heavy clay, fine distinct yellowish mottles are common, strong prismatic structure, peds 20-50 mm, smooth fabric, very firm consistence. Diffuse transition to:

B22 55-105 cm Grey (10YR5/1) heavy clay, many very coarse prominent yellow mottles, moderate prismatic structure, peds 20-50 mm, smooth fabric, very firm consistence, pH 5.5. Gradual transition to:

SAND 105-120 cm Grey (10YR6/1) loamy or clayey sand, apedal single grained, sandy fabric, very weak consistence, pH 6.75. Abrupt transition to:

2B2 120^{+} cm Grey (10YR5/1) heavy clay, many very coarse prominent yellow mottles, moderate prismatic structure, peds 20-50 mm, smooth fabric, very firm consistence, pH 7.0.

CLASSIFICATION

Factual Key:	Dy3.41
Australian Soil Classification:	Eutrophic, Mottled-Hypernatric, Grey SODOSOL; thick, slightly gravelly, clay loamy/clayey, very deep (confidence level 2)
Unified Soil Group:	CL

INTERPRETATION OF LABORATORY ANALYSIS*

Horizon	pH ($CaCl_2$)	% Gravel	EC (salts)	Nutrient Status	P	K	Al	Organic Matter	Dispersibility
A1	4.4**	< 10	VL	VL	D	S	T	H	VL
B2	4.3**	< 10	VL	L	D	D	T	L	M

VL: Very Low L: Low M: Moderate H: High VH: Very High D: Deficient S: Satisfactory

T: Potentially Toxic NA: Not Available * see Appendix D for analytical results ** Strongly Acidic

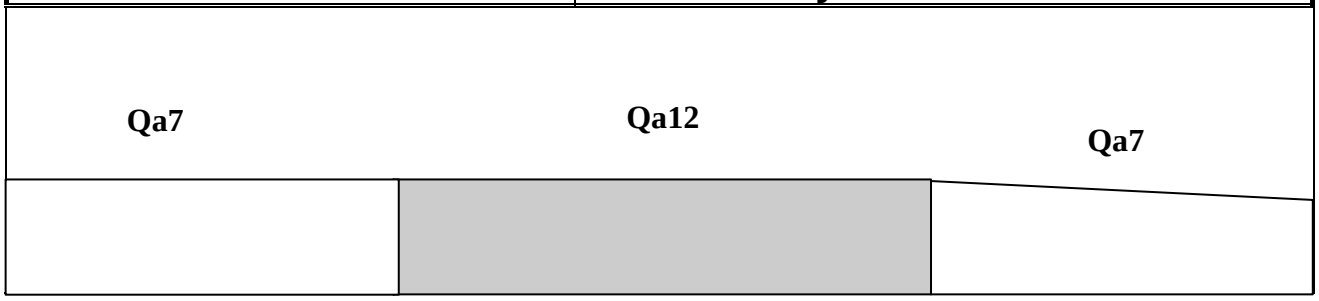
SOIL PROFILE CHARACTERISTICS:

Permeability:	Slow (average 20 mm/day, range 3-40 mm/day)
Available Water Capacity:	Very high (> 200 mm H_2O)
Linear Shrinkage (B horizon):	Low (11%)

C. LAND CAPABILITY ASSESSMENT

Land Use	Class	Major Limiting Feature(s)/Land Use
Agriculture	$C_2T_1S_3$	Permeability-rainfall index
Effluent Disposal (septic tanks)	4	Permeability
Farm Dams	3	Suitability of subsoil, depth to seasonal watertable, permeability
Building Foundations		
slab	3	Drainage
stumps/footings	3	Drainage
Secondary Roads	3	Drainage, USG subsoil
Rural Residential Development	4	Effluent disposal

MAP UNIT SYMBOL: **Qa12** Area: 2022 ha	MAP UNIT: **Quaternary alluvium, Dalmore clay**



A. GENERAL DESCRIPTION

This map unit is part of the alluvial plains of the Koo-wee-rup Swamp. Dalmore clay has a peaty friable surface soil 20-30 cm in depth. This layer passes into a heavy black clay. As depth increases orange and pale grey mottles become evident. The organic self mulching nature of the topsoil allows for an easily worked friable seed bed. These soils are very valuable for horticultural purposes because of the friable top soil, inherent fertility and improved drainage provided by the organic topsoil and subsoil. If the soil is worked when wet smearing and compaction of the soil surface will occur, which is a result of the sodicity of the soil. The subsoil has a high shrink swell capacity and cracks when dry. This movement affects fences and structural foundations as they require a stable substrate.

SITE CHARACTERISTICS

Parent Material Age:	Quaternary	**Depth to Seas. Watertable:**	> 1.5 m
Parent Material Lithology:	Alluvium	**Flooding Risk:**	Low
Landform Pattern:	Alluvial plain	**Drainage:**	Moderately well drained
Landform Element:	Plain	**Rock Outcrop:**	Nil
Slope a) common:	1%	**Depth to Hard Rock:**	> 1.5 m
Slope b) range:	0-3%		
Potential Recharge to Groundwater:	Low		
Major Native Vegetation Species:	Melaleuca		
Present Land Use:	Horticulture		
Length of Growing Season:	8 months		

LAND DEGRADATION

Degradation Processes	Water Erosion sheet/rill	Water Erosion gully	Wind Erosion	Mass Movement	Salting	Acidification
Susceptibility	Very low	Low	Very low	Low	Moderate	Low
Incidence	Very low	Very low	Very low	Very low	Low	NA

B. SOIL PROFILE

PROFILE DESCRIPTION Site C9

A1 0-35 cm — Black (10YR5/1) peaty light clay, strong subangular blocky structure (self-mulching), peds 2-5 mm, rough fabric, strong consistence, pH 5.9. Clear transition to:

B21 35-95 cm — Black (2.5Y2.5/0) heavy clay, strong lenticular structure, slickensides, peds 20-50 mm, smooth fabric, very strong consistence, pH 5.7. Gradual transition to:

B22 95-150^{+} cm — Black (5Y2.5/1) heavy clay, moderate lenticular and prismatic structure, slickensides, peds 10-20 mm, smooth fabric, very strong consistence, pH 5.4.

CLASSIFICATION

Factual Key:	Ug5.1
Australian Soil Classification:	Epihypersodic, Self-mulching, Black VERTOSOL; non-gravelly, medium fine/very fine, very deep (confidence level 2)
Unified Soil Group:	OH

INTERPRETATION OF LABORATORY ANALYSIS*

Horizon	pH ($CaCl_2$)	% Gravel	EC (salts)	Nutrient Status	P	K	Al	Organic Matter	Dispersibility
A1	4.9	< 2	VL	VH	S	S	T	H	VL
B21	4.8	< 2	VL	VH	S	S	T	H	M-H
B22	4.7	< 2	VL	H	S	S	T	M	M-H

VL: Very Low L: Low M: Moderate H: High VH: Very High D: Deficient S: Satisfactory

T: Potentially Toxic NA: Not Available * see Appendix D for analytical results ** Strongly Acidic

SOIL PROFILE CHARACTERISTICS:

Permeability:	Slow (average 23 mm/day, range 3-40 mm/day)
Available Water Capacity:	Very high (> 200 mm H_2O)
Linear Shrinkage (B horizon):	Moderate (17%)

C. LAND CAPABILITY ASSESSMENT

Land Use	Class	Major Limiting Feature(s)/Land Use
Agriculture	$C_2T_1S_3$	Permeability-rainfall index
Effluent Disposal (septic tanks)	4	Permeability
Farm Dams	5	Suitability of subsoil
Building Foundations		
slab	3	Drainage
stumps/footings	3	Drainage, linear shrinkage
Secondary Roads	5	USG
Rural Residential Development	5	Farm dams, secondary roads

4.2 Tertiary volcanic map units (Tv)

Twelve Tertiary volcanic map units have been identified in the study area. The eruption point of the volcanic flow is located north of Gembrook. Most of the volcanic material from this flow occurs in and around Gembrook, with some occurring around Emerald and Mt Paradise. The volcanic parent material is basalt.

The landscape generally consists of broad flat to gently sloping crests with simple slopes leading into the drainage depressions. In some cases, slopes increase in steepness close to the drainage line. There is some dissection of this landscape with minor drainage lines experiencing some sheet and gully erosion.

Soil development is generally uniform across the landscape, with minor soil variation related to position in the landscape, and often the history of land management in the area. The major soil type that occurs is a well structured, deep red Ferrosol. This soil has high fertility, rapid drainage, and high water holding capacity.

The original vegetation on this unit was dense forest with the most common upper story species being Mountain Ash, Messmate and Narrow-leaved Peppermint.

The shallow volcanic cap of Mt Paradise is south of the major volcanic flow (Tvb2 to Tvh2). This shallow cap sits over less permeable granitic material. The unit represents a relatively small area, along a ridge line adjacent to the Toomuc valley. The hilltop (Mt. Paradise) has a broad flat crest leading to steep side slopes. Erosion of these slopes has lead to a build up of colluvial material further down the slope. This colluvial material sits over an impermeable granitic bedrock.

The volcanic soils at Mt Paradise are well structured and free draining, while the underlying basalt rock is deeply fractured. The combination of these characteristics ensures rapid movement of water through the soil profile, however when the groundwater reaches the less permeable granitic material, groundwater movement is restricted. Saturation of the profile occurs above the impermeable granite material, leading to lateral movement of groundwater. This lateral movement appears as intermittent springs at the surface, close to where the two geologies meet (see diagram below). The extra water in the soil profile near the contact zone increases the weight of the soil and reduces its stability. Mass movement (land slip) will occur where the weight of the soil exceeds the shear strength of the soil.

Areas that show evidence of slip activity or have similar characteristics to land with evidence of prior movement are generally considered to be at risk of further mass movement.

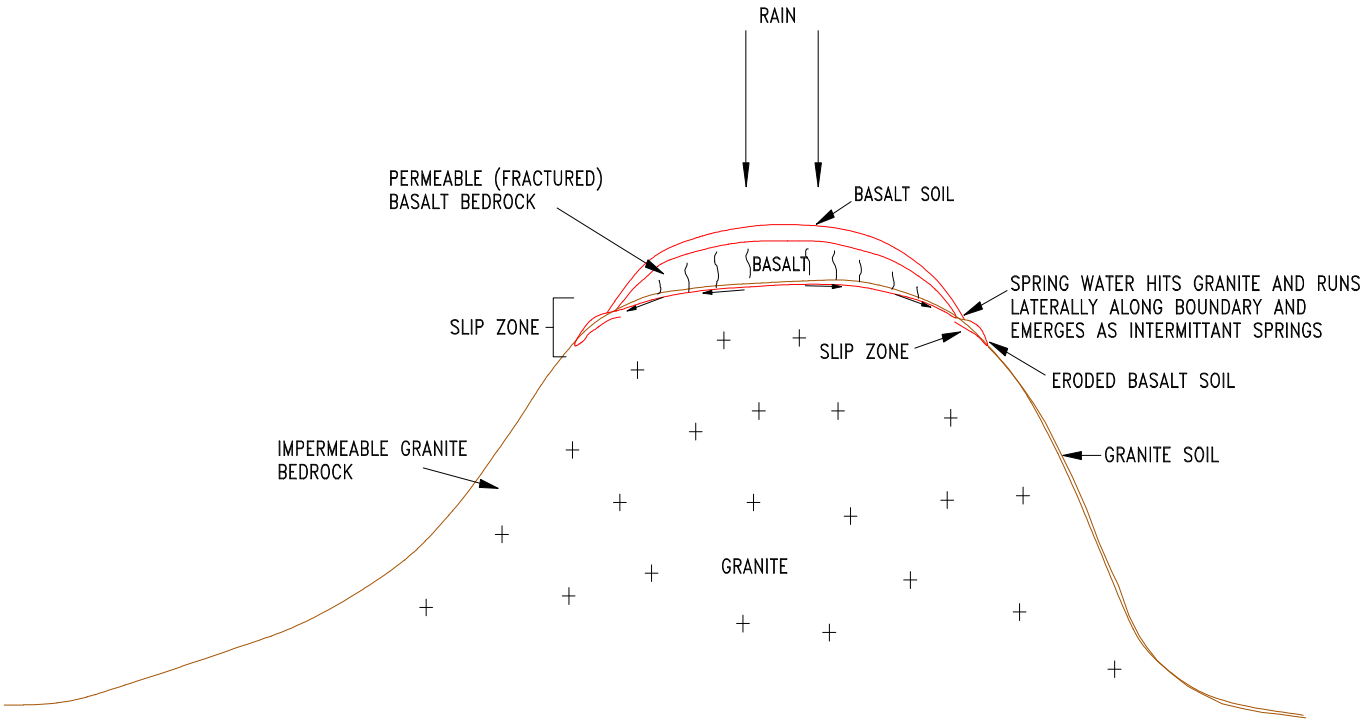
Observations at the south western edge of the identified contact zone showed a number of clear slips in drainage lines, and an extensive area which has clearly sunk several metres, probably since clearing for agricultural purposes.

The area designated as nominally slip prone is shown on Map 1a. The units on the slip prone area are designated Tertiary volcanic, remnant capping (Tvb2-Tvf2). From observations, the areas most affected by land slip are gullies where water is concentrated from run-on further up-slope or where water percolates out of springs. The critical areas appear to be basalt capping over granite or sedimentary lithology. The likelihood of a slip occurring is strongly influenced by the steepness of a slope. Most land slips observed were seen on slopes greater than 20 per cent, i.e. Tvc2 and Tvb2 units, with the majority of these slips occurring on slopes over 30 per cent.

Land management considerations

Land degradation is common and widespread on these units. Significant sheet, rill and minor gully erosion occurs on a number of slope classes in this volcanic unit. In an undisturbed situation these soils are not highly susceptible to erosion. However, if the vegetation has been removed and the soil structure broken down through intensive cultivation, erosion will occur. Evidence of current erosion was observed, as well as old erosional events. The effects of this erosion may not always be obvious due to the number of cultivations carried out during the year. That is, after an erosive event, paddocks are cultivated and the gullies are covered over.

An added problem is the presence of chemical contaminants in the soil on a number of properties in this area. On these properties there are some quarantine restrictions against grazing stock. A number of landholders can no longer graze stock. Without the need for pasture to feed stock, fallowed paddocks are more common, thereby increasing areas susceptible to erosion.



The soils derived from the volcanic parent material have a range of favourable attributes that make them suitable for horticultural production, and therefore higher returns for land placed under production. These favourable attributes include soil depth, structure, drainage and nutrient status.

The continual loss of this valuable soil resource through erosion is somewhat ignored in horticultural zones. Much of the erosion occurs on steep slopes and drainage lines. Proven land management practices such as the introduction of grassed waterways, buffer strips and shortened cultivated rows, will minimise soil erosion and enable the effective utilisation of gentle to moderate slopes.

It would also be wise to protect this resource from urban encroachment through some form of agricultural preservation zone, this will ensure that the resource will be available for utilization in the future.

The off-site impacts of soil erosion are also significant. Local waterways carry very heavy sediment loads, which lead to the deterioration of water supplies and stream habitat, including the rapid siltation of farm dams.

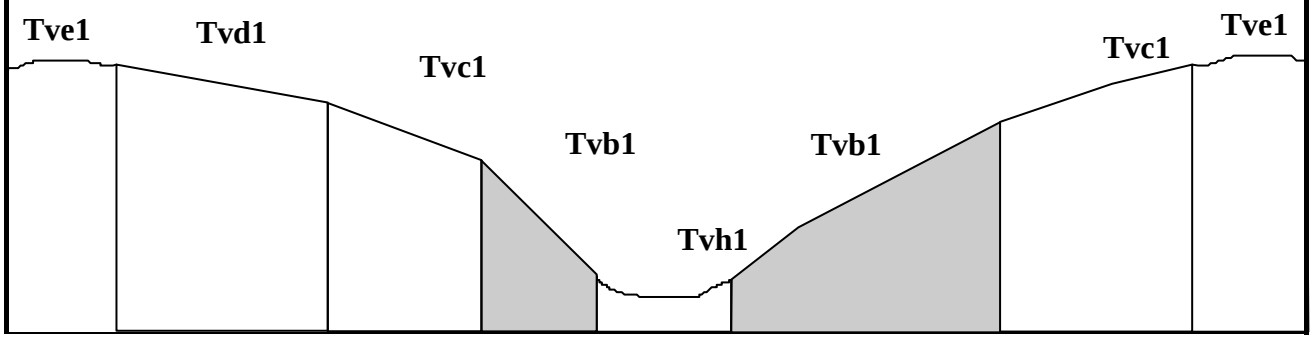
While the mass movement of soil in some units is not a major limitation to current grazing practices, it has serious implications for activities that include construction and residential development. Should a change in land use be proposed, such as construction activities involving residential development, it would be prudent for the Cardinia Shire Council to seek expert geotechnical advice. It is also advisable that the south eastern side of Mt Paradise be given due consideration.

SOILS OF VOLCANIC ORIGIN

Plate 5 **Map Units: Tvb, Tvc, Tvd**
Red Ferrosol

Plate 6 **Map Units: Tve, Tvf**
Red Ferrosol

MAP UNIT SYMBOL: **Tvb1** Area: 211 ha	MAP UNIT: **Tertiary volcanics, steep slope**



A. GENERAL DESCRIPTION

This map unit has steep basalt slopes which generally occur closer to a major drainage line than the crest. Red Ferrosols are common on this unit with a lighter topsoil grading into a clayey subsoil. These soils are deep, well structured, free draining and high in free iron in the subsoil. Due to the steepness of these slopes, the soil is subject to serious sheet erosion, particularly where cultivation is attempted.

SITE CHARACTERISTICS

Parent Material Age:	Quaternary	**Depth to Seas. Watertable:**	> 1.5 m
Parent Material Lithology:	Basalt	**Flooding Risk:**	Nil
Landform Pattern:	Steep hills	**Drainage:**	Well drained
Landform Element:	Hillslope	**Rock Outcrop:**	< 10%
Slope a) common:	35%	**Depth to Hard Rock:**	> 1.5 m
Slope b) range:	> 32%		
Potential Recharge to Groundwater:	High		
Major Native Vegetation Species:	Mountain Ash, Narrow-leaved Peppermint, Messmate, Blackwood		
Present Land Use:	Grazing (major), horticulture (minor)		
Length of Growing Season:	10 months		

LAND DEGRADATION

Degradation Processes	Water Erosion sheet/rill	Water Erosion gully	Wind Erosion	Mass Movement	Salting	Acidification
Susceptibility	Moderate	Low	Very low	Very high	Low	Moderate
Incidence	High	Moderate	Low	High	Low	NA

B. SOIL PROFILE

PROFILE DESCRIPTION Site S14

A1 0-20 cm Dark brown (7.5YR3/2) light clay, weak subangular blocky structure, peds 20-50 mm, rough fabric, very firm consistence, pH 5.0. Abrupt transition to:

B1 20-50 cm Dark reddish brown (5YR3/2) light clay, moderate subangular blocky structure, peds 5-10 mm, rough fabric, firm consistence, pH 5.2. Gradual transition to:

B21 50-100 cm Reddish brown (2.5YR4/4) light medium clay, moderate polyhedral structure, peds 10-20 mm, rough fabric, firm consistence, pH 5.4. Diffuse transition to:

B22 100-150^{+} cm Reddish brown (2.5YR4/4) light medium clay, coarse distinct red mottles are common, strong subangular blocky structure, peds 5-10 mm, smooth fabric, weak consistence, pH 5.5.

CLASSIFICATION

Factual Key:	Uf5.12
Australian Soil Classification:	Melacic, Mesotrophic, Red FERROSOL; medium, non-gravelly, clayey/clayey, very deep, (confidence level 2)
Unified Soil Group:	CH

INTERPRETATION OF LABORATORY ANALYSIS*

Horizon	pH ($CaCl_2$)	% Gravel	EC (salts)	Nutrient Status	P	K	Al	Organic Matter	Dispersibility
A1	4.2**	0	VL	L	S	S	T	H	L
B1	4.4**	0	VL	L	D	S	T	L	L
B21	4.8	0	VL	VL	D	D	T	VL	L

VL: Very Low L: Low M: Moderate H: High VH: Very High D: Deficient S: Satisfactory

T: Potentially Toxic NA: Not Available * see Appendix D for analytical results ** Strongly Acidic

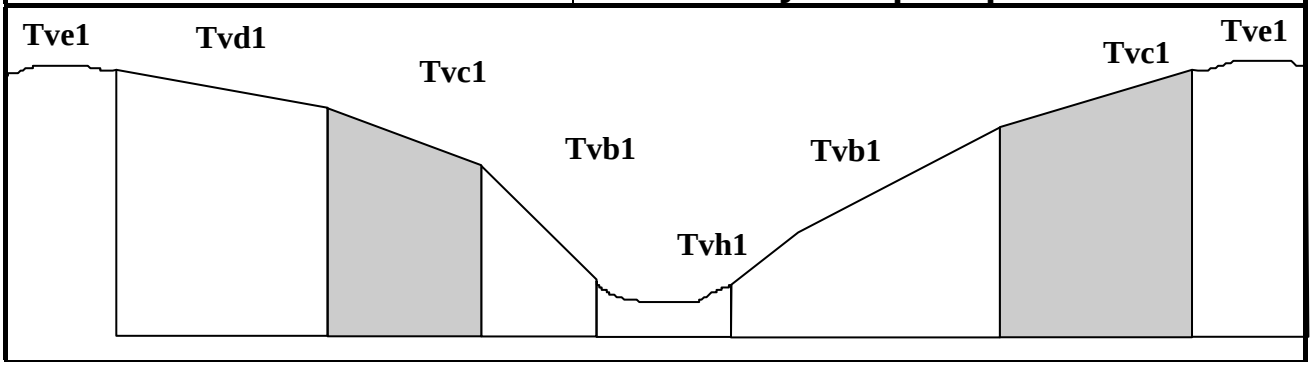
SOIL PROFILE CHARACTERISTICS:

Permeability:	Rapid (average 730 mm/day, range 190-975 mm/day)
Available Water Capacity:	Very high (> 200 mm/H_2O)
Linear Shrinkage (B horizon):	Moderate (17%)

C. LAND CAPABILITY ASSESSMENT

Land Use	Class	Major Limiting Feature(s)/Land Use
Agriculture	$C_2T_5S_3$	Slope
Effluent Disposal (septic tanks)	5	Slope
Farm Dams	5	Slope, susceptibility to slope failure
Building Foundations		
slab	5	Slope, susceptibility to slope failure
stumps/footings	5	Susceptibility to slope failure
Secondary Roads	5	Slope, susceptibility to slope failure
Rural Residential Development	5	Secondary roads, farm dams, building foundations, secondary roads

MAP UNIT SYMBOL: **Tvc1** Area: 588.6ha	MAP UNIT: **Tertiary volcanics, moderately steep slope**



A. GENERAL DESCRIPTION

This map unit is quite common in the Gembrook area. Even though the slopes of this unit are steep, intensive cropping is still common. These units occur closer to the drainage line than the crest, and often run directly to the drainage line. Soil erosion is common; water concentrated in drainage lines moves large amounts of soil, especially if it has been recently cultivated. The common soil type on this unit is a deep red Ferrosol with a clay loam topsoil grading to a clayey subsoil. These soils are well structured, free draining, fertile, and high in free iron in the subsoil.

SITE CHARACTERISTICS

Parent Material Age:	Tertiary	**Depth to Seas. Watertable:**	> 1.5 m
Parent Material Lithology:	Basalt	**Flooding Risk:**	Nil
Landform Pattern:	Rolling Hills	**Drainage:**	Well drained
Landform Element:	Hillslope	**Rock Outcrop:**	< 1%
Slope a) common:	26%	**Depth to Hard Rock:**	> 1.5m
Slope b) range:	21-32 %		

Potential Recharge to Groundwater:	High
Major Native Vegetation Species:	Mountain Ash, Blackwood, Narrow-leaved Peppermint
Present Land Use:	Horticulture
Length of Growing Season:	10 months

LAND DEGRADATION

Degradation Processes	Water Erosion sheet/rill	Water Erosion gully	Wind Erosion	Mass Movement	Salting	Acidification
Susceptibility	Low-mod	Low-mod	Very low	High	Low	Moderate
Incidence	Moderate	Low	Very low	Moderate	Low	NA

B. SOIL PROFILE

PROFILE DESCRIPTION Site S14

A1 0-20 cm Dark brown (7.5YR3/2) light clay, weak subangular blocky structure, peds 20-50 mm, rough fabric, very firm consistence, pH 5.0. Abrupt transition to:

B1 20-55 cm Reddish brown (5YR4/3) light clay, moderate polyhedral structure, peds 10-20 mm, rough fabric, firm consistence, pH 5.2. Gradual transition to:

B21 55-105 cm Reddish brown (2.5YR4/4) light medium clay, moderate polyhedral structure, peds 10-20 mm, rough fabric, firm consistence, pH 5.4. Diffuse transition to:

B22 105-150^{+}cm Reddish brown (2.5YR4/4) light medium clay, coarse distinct red mottles are common, strong subangular blocky structure, peds 5-10 mm, smooth fabric, weak consistence, pH 5.5.

CLASSIFICATION

Factual Key:	Uf5.12
Australian Soil Classification:	Melacic, Mesotrophic, Red FERROSOL; medium, non-gravelly, clayey/clayey, very deep (confidence level 2)
Unified Soil Group:	CH

INTERPRETATION OF LABORATORY ANALYSIS*

Horizon	pH ($CaCl_2$)	% Gravel	EC (salts)	Nutrient Status	P	K	Al	Organic Matter	Dispersibility
A1	4.2**	0	VL	L	S	S	T	H	L
B1	4.4**	0	VL	L	D	S	T	L	L
B21	4.8	0	VL	VL	D	D	T	VL	L

VL: Very Low L: Low M: Moderate H: High VH: Very High D: Deficient S: Satisfactory

T: Potentially Toxic NA: Not Available * see Appendix D for analytical results ** Strongly Acidic

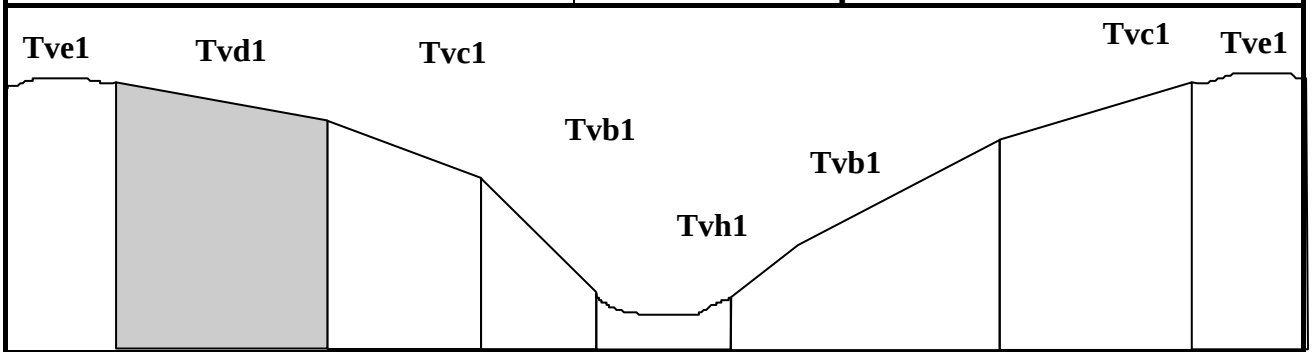
SOIL PROFILE CHARACTERISTICS:

Permeability:	Rapid (average 730 mm/day, range 190-975 mm/day)
Available Water Capacity:	Very high (> 200 mm H_2O)
Linear Shrinkage (B horizon):	Moderate (17%)

C. LAND CAPABILITY ASSESSMENT

Land Use	Class	Major Limiting Feature(s)/Land Use
Agriculture	$C_2T_4S_{2-3}$	Slope
Effluent Disposal (septic tanks)	4	Slope
Farm Dams	5	Slope
Building Foundations		
slab	4	Slope, susceptibility to slope failure
stumps/footings	4	Susceptibility to slope failure
Secondary Roads	4	Slope, susceptibility to slope failure
Rural Residential Development	5	Farm dams

MAP UNIT SYMBOL: **Tvd1** Area: 1983 ha	MAP UNIT: **Tertiary volcanics, moderate slope**



A. GENERAL DESCRIPTION

The moderate basalt slopes of this map unit are common in the Gembrook area. The soils are similar to those of other volcanic units in the area. These soils are deep, well structured, freely drained red Ferrosols, however, they are very susceptible to erosion if there is little vegetative cover, or if they have been recently cultivated. These fertile soils are commonly used for horticultural purposes.

SITE CHARACTERISTICS

Parent Material Age:	Tertiary	**Depth to Seas. Watertable:**	> 1.5 m
Parent Material Lithology:	Basalt	**Flooding Risk:**	Nil
Landform Pattern:	Rolling hills	**Drainage:**	Well drained
Landform Element:	Hillslope	**Rock Outcrop:**	< 10%
Slope a) common:	16%	**Depth to Hard Rock:**	> 1.5m
Slope b) range:	11-20%		
Potential Recharge to Groundwater:	Moderate		
Major Native Vegetation Species:	Mountain Ash, Blackwood, Narrow-leaved Peppermint		
Present Land Use:	Horticulture, grazing		
Length of Growing Season:	10 months		

LAND DEGRADATION

Degradation Processes	Water Erosion sheet/rill	gully	Wind Erosion	Mass Movement	Salting	Acidification
Susceptibility	Low-mod	Low	Very low	High	Low	Moderate
Incidence	Moderate	Low	Very low	Moderate	Low	NA

B. SOIL PROFILE

PROFILE DESCRIPTION Site S14

A1 0-20 cm Dark brown (7.5YR3/2) light clay, weak subangular blocky structure, peds 20-50 mm, rough fabric, very firm consistence, pH 5.0. Abrupt transition to:

B1 20-60 cm Reddish brown (5YR4/3) light clay, moderate polyhedral structure, peds 10-20 mm, rough fabric, firm consistence, pH 5.2. Gradual transition to:

B21 60-110 cm Reddish brown (2.5YR4/4) medium clay, moderate polyhedral structure, peds 10-20 mm, rough fabric, firm consistence, pH 5.4. Gradual transition to:

B3 110-150^{+} cm Reddish brown (2.5YR4/4) medium clay, strong subangular blocky structure, peds 5-10 mm, smooth fabric, weak consistence, pH 5.5.

CLASSIFICATION

Factual Key:	Uf5.12
Australian Soil Classification:	Melacic, Mesotrophic, Red FERROSOL; medium, non-gravelly, clayey/clayey, very deep (confidence level 2)
Unified Soil Group:	CH

INTERPRETATION OF LABORATORY ANALYSIS*

Horizon	pH ($CaCl_2$)	% Gravel	EC (salts)	Nutrient Status	P	K	Al	Organic Matter	Dispersibility
A1	4.2**	0	VL	L	S	S	T	H	L
B1	4.4**	0	VL	L	D	S	T	L	L
B21	4.8.	0	VL	VL	D	D	T	VL	L

VL: Very Low L: Low M: Moderate H: High VH: Very High D: Deficient S: Satisfactory

T: Potentially Toxic NA: Not Available * see Appendix D for analytical results ** Strongly Acidic

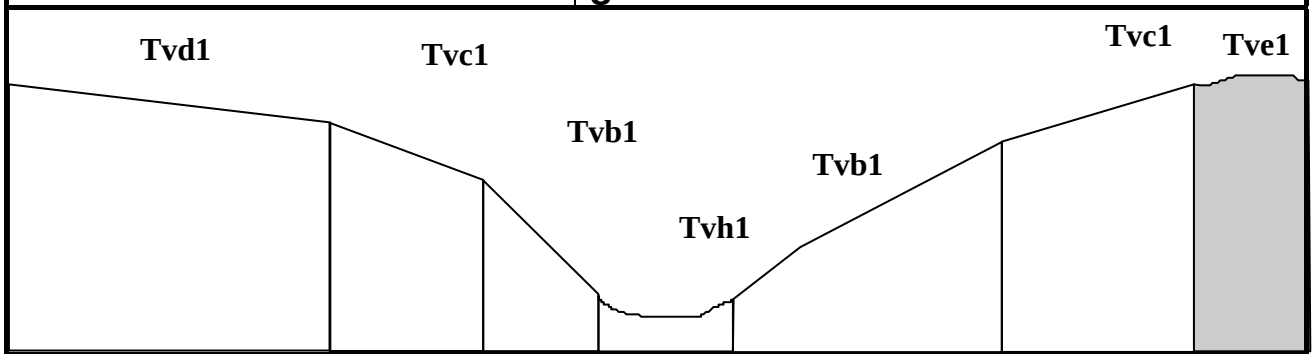
SOIL PROFILE CHARACTERISTICS:

Permeability:	Rapid (average 730 mm/day, range 190-975 mm/day)
Available Water Capacity:	Very high (> 200 mm H_2O)
Linear Shrinkage (B horizon):	Moderate (17%)

C. LAND CAPABILITY ASSESSMENT

Land Use	Class	Major Limiting Feature(s)/Land Use
Agriculture	$C_2T_3S_{2-3}$	Slope
Effluent Disposal (septic tanks)	3	Slope
Farm Dams	4	Slope, permeability, susceptibility to slope failure
Building Foundations		
slab	4	Slope, susceptibility to slope failure
stumps/footings	4	Susceptibility to slope failure
Secondary Roads	4	Slope, susceptibility to slope failure
Rural Residential Development	4	Secondary roads, farm dams, building foundations

MAP UNIT SYMBOL: **Tve1** Area: 1983 ha	MAP UNIT: **Tertiary volcanics, gentle crest**



A. GENERAL DESCRIPTION

Gentle crests and ridges are common in and around Gembrook. The hill crests may be gently sloping to flat, however, the side slope leading up to these crests are steeper. The shape of the crest is not a discreet, well defined hilltop and could be better described as a long undulating ridge line. Soils on the crests are similar to those on the ridges that are slightly lower in the landscape. Red Ferrosols are common; these soils are deep, well structured and free draining. Because these soils occur on gentle slopes, erosion is less of a problem. These fertile soils are commonly utilised for horticultural production.

SITE CHARACTERISTICS

Parent Material Age:	Quaternary	**Depth to Seas. Watertable:**	> 1.5 m
Parent Material Lithology:	Basalt	**Flooding Risk:**	Nil
Landform Pattern:	Undulating Hills	**Drainage:**	Well drained
Landform Element:	Hillcrest	**Rock Outcrop:**	< 5%
Slope a) common:	2%	**Depth to Hard Rock:**	> 1.5 m
Slope b) range:	1-4%		
Potential Recharge to Groundwater:	Moderate		
Major Native Vegetation Species:	Mountain Ash, Blackwood, Narrow-leaved Peppermint		
Present Land Use:	Horticulture		
Length of Growing Season:	10 months		

LAND DEGRADATION

Degradation Processes	Water Erosion sheet/rill	gully	Wind Erosion	Mass Movement	Salting	Acidification
Susceptibility	Low	Very low	Very low	Low	Low	Moderate
Incidence	Low	Low	Very low	Low	Low	NA

B. SOIL PROFILE

PROFILE DESCRIPTION Site S15

A1 0-30 cm Reddish brown (5YR4/4) light medium clay, strong polyhedral structure, peds 5-10 mm, rough fabric, very firm consistence, pH 4.7. Gradual transition to:

B2 30-100 cm Dark reddish brown (5YR3/3) medium clay, strong polyhedral structure, peds 10-20 mm, smooth fabric, firm consistence, pH 5.4. Diffuse transition to:

B3 100-150^{+} cm Reddish brown (5YR4/4) light medium clay, strong polyhedral structure, peds 20-50 mm, smooth fabric, firm consistence, pH 5.3.

CLASSIFICATION

Factual Key:	Uf5.21
Australian Soil Classification:	Haplic, Mesotrophic, Red FERROSOL; thick, non-gravelly, clayey/clayey, very deep (confidence level 2)
Unified Soil Group:	MH

INTERPRETATION OF LABORATORY ANALYSIS*

Horizon	pH ($CaCl_2$)	% Gravel	EC (salts)	Nutrient Status	P	K	Al	Organic Matter	Dispersibility
A1	4.3**	< 1	VL	L	S	S	T	H	L
B2	5.1	< 1	VL	L	D	S	S	L	L
B3	5.7	15	VL	VL	D	D	S	VL	L

VL: Very Low L: Low M: Moderate H: High VH: Very High D: Deficient S: Satisfactory

T: Potentially Toxic NA: Not Available * see Appendix D for analytical results ** Strongly Acidic

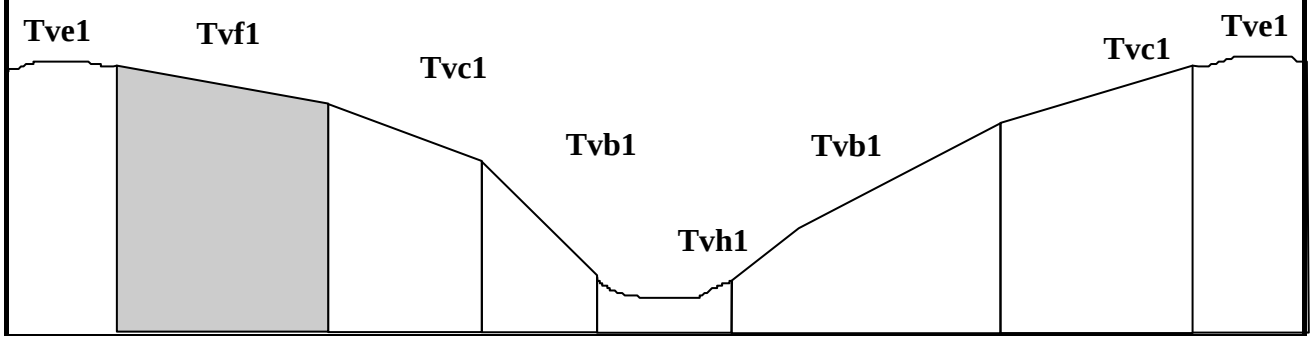
SOIL PROFILE CHARACTERISTICS:

Permeability:	Rapid (average 730 mm/day, range 190-975 mm/day)
Available Water Capacity:	Very high (260 mm H_2O)
Linear Shrinkage (B horizon):	Moderate (13.5%)

C. LAND CAPABILITY ASSESSMENT

Land Use	Class	Major Limiting Feature(s)/Land Use
Agriculture	$C_2T_1S_2$	Nil
Effluent Disposal (septic tanks)	2	Nil
Farm Dams	4	Permeability
Building Foundations		
slab	2	Nil
stumps/footings	3	Linear Shrinkage
Secondary Roads	3	Linear Shrinkage, USG
RuralResidential Development	4	Farm Dams

MAP UNIT SYMBOL: **Tvf1** Area: 449 ha	MAP UNIT: **Tertiary volcanics, gentle slope**



A. GENERAL DESCRIPTION

This map unit is commonly found closer to the crest than to the drainage line. The major soil type is a deep, well structured red Ferrosol. This unit is less prone to erosion because of the lower slope gradients. Some erosion may occur where long slopes are cultivated. This unit isparticularly valuable for horticultural production.

SITE CHARACTERISTICS

Parent Material Age:	Tertiary	**Depth to Seas. Watertable:**	> 1.5 m
Parent Material Lithology:	Basalt	**Flooding Risk:**	Nil
Landform Pattern:	Undulating Hills	**Drainage:**	Well drained
Landform Element:	Hillslope	**Rock Outcrop:**	0%
Slope a) common:	7%	**Depth to Hard Rock:**	> 1.5m
Slope b) range:	4-10 %		
Potential Recharge to Groundwater:	Low		
Major Native Vegetation Species:	Mountain Ash, Blackwood, Narrow-leaved Peppermint, Messmate		
Present Land Use:	Horticulture		
Length of Growing Season:	10 months		

LAND DEGRADATION

Degradation Processes	Water Erosion sheet/rill	gully	Wind Erosion	Mass Movement	Salting	Acidification
Susceptibility	Low-mod	Low	Very low	Low	Low	Moderate
Incidence	Moderate	Low	Very low	Low	Low	NA

B. SOIL PROFILE

PROFILE DESCRIPTION Site S15

A1 0-30 cm Reddish brown (5YR4/4) light medium clay, strong polyhedral structure, peds 5-10 mm, rough fabric, very firm consistence, pH 4.7. Gradual transition to:

B2 30-110 cm Dark reddish brown (5YR3/3) medium clay, moderate polyhedral structure, peds 10-20 mm, smooth fabric, firm consistence, pH 5.4. Gradual transition to:

B3 110-150^{+} cm Greyish brown (10YR5/2) light medium clay, strong polyhedral structure, peds 20-50 mm, smooth fabric, rigid firm consistence, pH 5.3.

CLASSIFICATION

Factual Key:	Uf5.12
Australian Soil Classification:	Haplic, Mesotrophic, Red FERROSOL; thick, non-gravelly, clayey/clayey, very deep (confidence level 2)
Unified Soil Group:	MH

INTERPRETATION OF LABORATORY ANALYSIS*

Horizon	pH ($CaCl_2$)	% Gravel	EC (salts)	Nutrient Status	P	K	Al	Organic Matter	Dispersibility
A1	4.3**	< 1	VL	L	S	S	T	H	L
B2	5.1	< 1	VL	L	D	S	S	L	L
B3	5.7	15	VL	VL	D	D	S	VL	L

VL: Very Low L: Low M: Moderate H: High VH: Very High D: Deficient S: Satisfactory

T: Potentially Toxic NA: Not Available * see Appendix D for analytical results ** Strongly Acidic

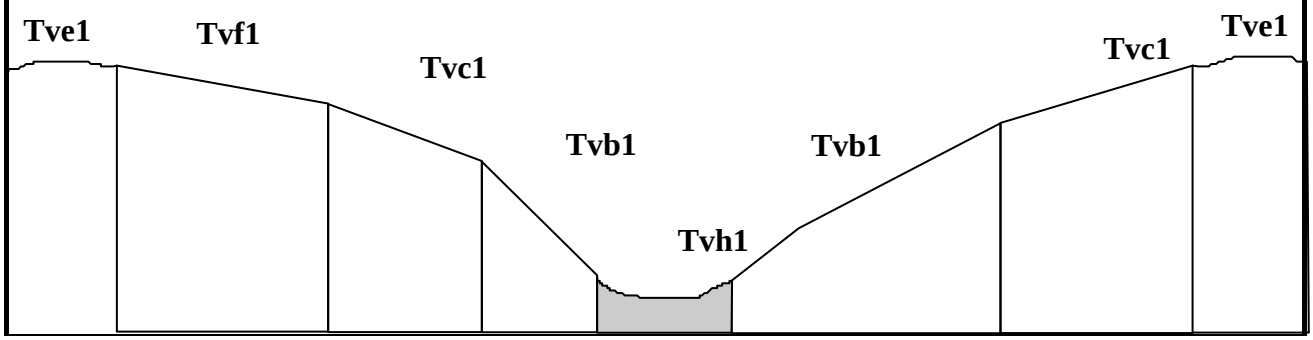
SOIL PROFILE CHARACTERISTICS:

Permeability:	Rapid (average 730 mm/day, range 190-975 mm/day)
Available Water Capacity:	Very high (> 200 mm H_2O)
Linear Shrinkage (B horizon):	Moderate (13.5 %)

C. LAND CAPABILITY ASSESSMENT

Land Use	Class	Major Limiting Feature(s)/Land Use
Agriculture	$C_2T_2S_{2-3}$	Susceptibility to sheet erosion
Effluent Disposal (septic tanks)	2	Nil
Farm Dams	4	Permeability
Building Foundations		
slab	3	Slope
stumps/footings	3	Linear shrinkage
Secondary Roads	3	Linear shrinkage, USG
Rural Residential Development	4	Farm dams

MAP UNIT SYMBOL: **Tvh1** Area: 238 ha	MAP UNIT: **Tertiary volcanics, drainage depression**



A. GENERAL DESCRIPTION

Drainage depressions occur throughout the volcanic terrain. Due to the position in the landscape, drainage depressions are highly variable and frequently suffer from significant sheet and gully erosion. The soils are generally fertile, well structured and free draining red ferrosols. In general, steep upper drainage lines will most likely have sufferred significant erosion over time, while the soils of lower drainage lines are likely to have been built up from soil deposition. In Gembrook, dams are commonly built in major drainage lines to support horticultural practices.

SITE CHARACTERISTIC

Parent Material Age:	Tertiary	**Depth to Seas. Watertable:**	> 1.5 m
Parent Material Lithology:	Basalt	**Flooding Risk:**	Nil
Landform Pattern:	Undulating Hills	**Drainage:**	Moderately well drained
Landform Element:	Hillslope	**Rock Outcrop:**	0%
Slope a) common:	8%	**Depth to Hard Rock:**	> 2.0m
Slope b) range:	5-20 %		

Potential Recharge to Groundwater:	Low
Major Native Vegetation Species:	Blackwood, Narrow-leaved Peppermint, Messmate
Present Land Use:	Horticulture, dams
Length of Growing Season:	10 months

LAND DEGRADATION

Degradation Processes	Water Erosion sheet/rill	Water Erosion gully	Wind Erosion	Mass Movement	Salting	Acidification
Susceptibility	Low-mod	Low-mod	Very low	High	Moderate	Moderate
Incidence	Moderate	Moderate	Very low	Moderate	Low	NA

B. SOIL PROFILE

PROFILE DESCRIPTION Site S14

A1 0-35 cm Dark brown (7.5YR3/2) light clay, moderate subangular blocky structure, peds 20-50 mm, rough fabric, very firm consistence, pH 5.0. Clear transition to:

B1 35-60 cm Reddish brown (5YR4/3) light clay, moderate polyhedral structure, peds 10-20 mm, rough and smooth fabric, firm consistence, pH 5.2. Gradual transition to:

B21 60-110 cm Dark reddish brown (2.5YR4/4) medium clay, moderate polyhedral structure, peds 10-20 mm, rough and smooth fabric, firm consistence, pH 5.4. Diffuse transition to:

B22 110-150^{+} cm Reddish brown (2.5YR4/4) light medium clay, coarse distinct red mottles are common, strong subangular blocky structure, peds 5-10 mm, smooth fabric, weak consistence, pH 5.5.

CLASSIFICATION

Factual Key:	Uf5.12
Australian Soil Classification:	Melacic, Mesotrophic, Red FERROSOL; thick, non-gravelly, clayey/clayey, very deep (confidence level 2)
Unified Soil Group:	CH

INTERPRETATION OF LABORATORY ANALYSIS*

Horizon	pH ($CaCl_2$)	% Gravel	EC (salts)	Nutrient Status	P	K	Al	Organic Matter	Dispersibility
A1	4.2**	0	VL	L	S	S	T	H	L
B1	4.4**	0	VL	L	D	S	T	L	L
B21	4.8	0	VL	VL	D	D	T	VL	L

VL: Very Low L: Low M: Moderate H: High VH: Very High D: Deficient S: Satisfactory

T: Potentially Toxic NA: Not Available * see Appendix D for analytical results ** Strongly Acidic

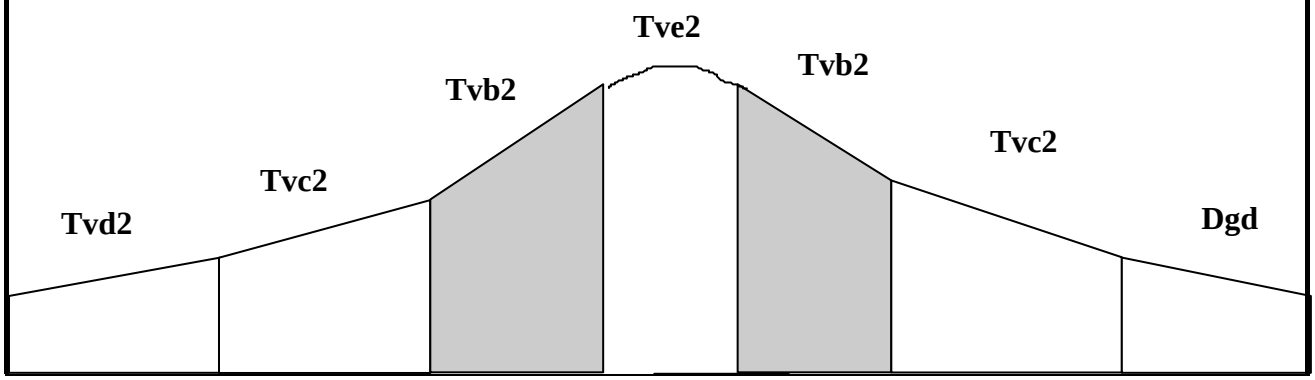
SOIL PROFILE CHARACTERISTICS:

Permeability:	Moderate (average 350 mm/day, range 100-480 mm/day)
Available Water Capacity:	Very high (> 200 mm H_2O)
Linear Shrinkage (B horizon):	Moderate (17%)

C. LAND CAPABILITY ASSESSMENT

Land Use	Class	Major Limiting Feature(s)/Land Use
Agriculture	$C_2T_{2-3}S_{2-3}$	Susceptibility to sheet and gully erosion, slope
Effluent Disposal (septic tanks)	3	Drainage
Farm Dams	4	Permeability, susceptibility to slope failure
Building Foundations		
slab	4	Slope, susceptibility to slope failure
stumps/footings	4	Susceptibility to slope failure
Secondary Roads	4	Susceptibility to slope failure
Rural Residential Development	4	Secondary roads, farm dams, building foundations

MAP UNIT SYMBOL: **Tvb2** Area: 111 ha	MAP UNIT: **Tertiary volcanics, remnant capping, steep slope**



A. GENERAL DESCRIPTION

Steep slopes are associated with the crests of the Mt Paradise area. A deep, well structured, free draining red Ferrosol soil is present. Due to the steepness of slopes, serious soil erosion and land slippage can occur. Land slips are readily observed in this map unit. Natural springs may occur on these units. Because of this, soils profiles may be wet for many months of the year. This unit is mostly used for grazing.

SITE CHARACTERISTICS

Parent Material Age:	Quaternary	**Depth to Seas. Watertable:**	> 1.5 m
Parent Material Lithology:	Basalt	**Flooding Risk:**	Nil
Landform Pattern:	Steep Hills	**Drainage:**	Well drained
Landform Element:	Hillslope	**Rock Outcrop:**	< 5%
Slope a) common:	35%	**Depth to Hard Rock:**	> 1.5 m
Slope b) range:	> 32%		
Potential Recharge to Groundwater:	High		
Major Native Vegetation Species:	Mountain Ash, Blackwood, Narrow-leaved Peppermint, Messmate		
Present Land Use:	Grazing		
Length of Growing Season:	10 months		

LAND DEGRADATION

Degradation Processes	Water Erosion sheet/rill	Water Erosion gully	Wind Erosion	Mass Movement	Salting	Acidification
Susceptibility	Mod-high	Low-mod	Very low	Very high	Low	Moderate
Incidence	High	Moderate	Low	Very high	Low	NA

B. SOIL PROFILE

PROFILE DESCRIPTION Site S14

A1 0-20 cm Dark brown (7.5YR3/2) light clay, weak subangular blocky structure, peds 20-50 mm, rough fabric, very firm consistence, pH 5.0. Abrupt transition to:

B1 20-50 cm Dark reddish brown (5YR3/2) light clay, moderate subangular blocky structure, peds 5-10 mm, rough fabric, firm consistence, pH 5.2. Gradual transition to:

B21 50-100 cm Reddish brown (2.5YR4/4) light medium clay, moderate polyhedral structure, peds 10-20 mm, rough fabric, firm consistence, pH 5.4. Diffuse transition to:

B22 100-150^{+} cm Reddish brown (2.5YR4/4) light medium clay, coarse distinct red mottles are common, strong subangular blocky structure, peds 5-10 mm, smooth fabric, weak consistence, pH 5.5.

CLASSIFICATION

Factual Key:	Uf5.12
Australian Soil Classification:	Melacic, Mesotrophic, Red FERROSOL; medium, non-gravelly, clayey/clayey, very deep (confidence level 2)
Unified Soil Group:	CH

INTERPRETATION OF LABORATORY ANALYSIS*

Horizon	pH ($CaCl_2$)	% Gravel	EC (salts)	Nutrient Status	P	K	Al	Organic Matter	Dispersibility
A1	4.2**	0	VL	L	S	S	T	H	L
B1	4.4**	0	VL	L	D	S	T	L	L
B21	4.8	0	VL	VL	D	D	T	VL	L

VL: Very Low L: Low M: Moderate H: High VH: Very High D: Deficient S: Satisfactory

T: Potentially Toxic NA: Not Available * see Appendix D for analytical results ** Strongly Acidic

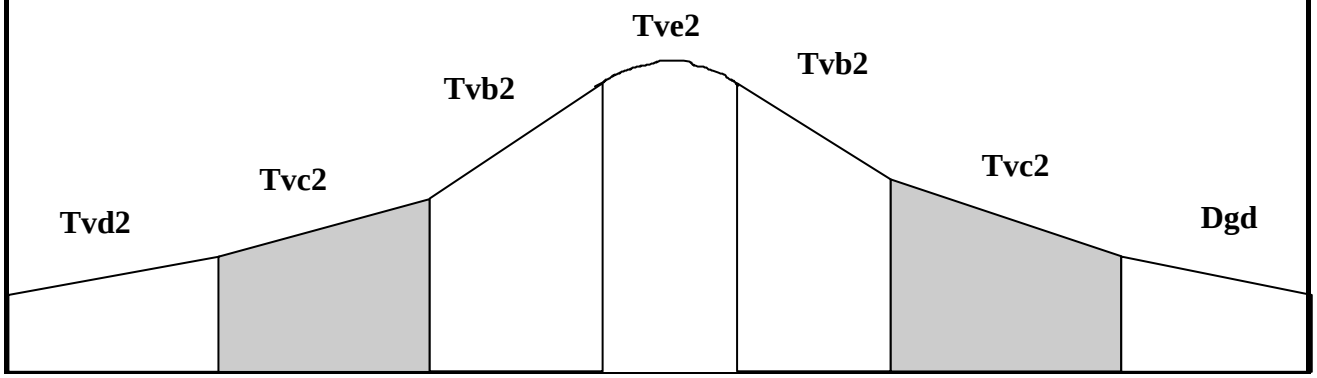
SOIL PROFILE CHARACTERISTICS:

Permeability:	Rapid (average 730 mm/day, range 190-975 mm/day)
Available Water Capacity:	Very high (> 200 mm H_2O)
Linear Shrinkage (B horizon):	Moderate (17%)

C. LAND CAPABILITY ASSESSMENT

Land Use	Class	Major Limiting Feature(s)/Land Use
Agriculture	$C_2T_5S_{3-4}$	Slope
Effluent Disposal (septic tanks)	5	Slope
Farm Dams	5	Slope, susceptibility to slope failure
Building Foundations		
slab	5	Slope, susceptibility to slope failure
stumps/footings	5	Susceptibility to slope failure
Secondary Roads	5	Slope, susceptibility to slope failure
Rural Residential Development	5	Secondary roads, farm dams, building foundations, secondary roads

MAP UNIT SYMBOL: **Tvc2** Area:1 45.5 ha	MAPUNIT: **Tertiary volcanics, remnant capping, moderately steep slope**



A. GENERAL DESCRIPTION

These moderately steep slopes occur closer to the crest than to the drainage line. The common soil type is a red Ferrosol with clay loam topsoils grading to clayey subsoils. In wetter areas, brown Dermosol soils can be found. This unit is generally used for grazing. Evidence of prior landslips are visible on this unit. The moderately steep slopes in this area should be treated as slip prone. Closer investigation should be carried out before any development of these areas occur. This unit is often dissected by minor drainage lines which are susceptible to sheet and gully erosion, especially where cultivation has taken place. Water concentrated in drainage lines will also increase the risk of landslips.

SITE CHARACTERISTICS

Parent Material Age:	Tertiary	**Depth to Seas. Watertable:**	> 1.5 m
Parent Material Lithology:	Basalt	**Flooding Risk:**	Nil
Landform Pattern:	Rolling Hills	**Drainage:**	Well drained
Landform Element:	Hillslope	**Rock Outcrop:**	< 1%
Slope a) common:	26%	**Depth to Hard Rock:**	> 1.5m
Slope b) range:	21-32 %		
Potential Recharge to Groundwater:	High		
Major Native Vegetation Species:	Mountain Ash, Blackwood, Narrow-leaved Peppermint, Messmate		
Present Land Use:	Grazing		
Length of Growing Season:	10 months		

LAND DEGRADATION

Degradation Processes	Water Erosion sheet/rill	Water Erosion gully	Wind Erosion	Mass Movement	Salting	Acidification
Susceptibility	Low-mod	Low-mod	Very low	High	Low	Moderate
Incidence	Moderate	Low	Very low	Very high	Low	NA

B. SOIL PROFILE

PROFILE DESCRIPTION Site S14

A1 0-20 cm Dark brown (7.5YR3/2) light clay, weak subangular blocky structure, peds 20-50 mm, rough fabric, very firm consistence, pH 5.0. Abrupt transition to:

B1 20-55 cm Reddish brown (5YR4/3) light clay, moderate polyhedral structure, peds 10-20 mm, rough fabric, firm consistence, pH 5.2. Gradual transition to:

B21 55-105 cm Reddish brown (2.5YR4/4) light medium clay, moderate polyhedral structure, peds 10-20, rough fabric, firm consistence, pH 5.4. Diffuse transition to:

B22 105-150^{+} cm Reddish brown (2.5YR4/4) light medium clay, coarse distinct red mottles are common, strong subangular blocky structure, peds 5-10 mm, smooth fabric, weak consistence, pH 5.5.

CLASSIFICATION

Factual Key:	Uf5.12
Australian Soil Classification:	Melacic, Mesotrophic, Red FERROSOL; medium, non-gravelly, clayey/clayey, very deep (confidence level 2)
Unified Soil Group:	CH

INTERPRETATION OF LABORATORY ANALYSIS*

Horizon	pH ($CaCl_2$)	% Gravel	EC (salts)	Nutrient Status	P	K	Al	Organic Matter	Dispersibility
A1	4.2**	0	VL	L	S	S	T	H	L
B1	4.4**	0	VL	L	D	S	T	L	L
B21	4.8	0	VL	VL	D	D	T	VL	L

VL: Very Low L: Low M: Moderate H: High VH: Very High D: Deficient S: Satisfactory

T: Potentially Toxic NA: Not Available * see Appendix D for analytical results ** Strongly Acidic

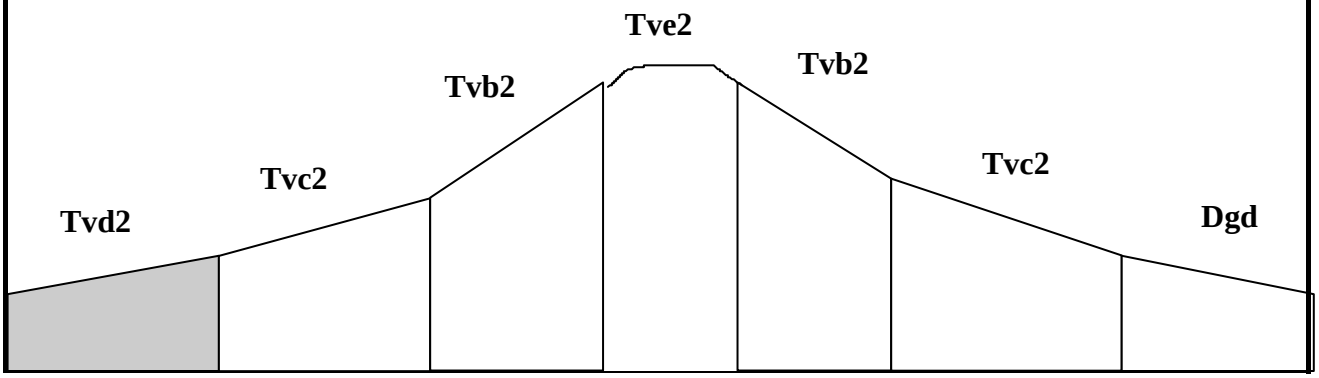
SOIL PROFILE CHARACTERISTICS:

Permeability:	Rapid (average 730 mm/day, range 190-975 mm/day)
Available Water Capacity:	Very high (> 200 mm H_2O)
Linear Shrinkage (B horizon):	Moderate (17%)

C. LAND CAPABILITY ASSESSMENT

Land Use	Class	Major Limiting Feature(s)/Land Use
Agriculture	$C_2T_4S_{2-3}$	Slope
Effluent Disposal (septic tanks)	4	Slope
Farm Dams	5	Slope
Building Foundations		
slab	4	Slope, susceptibility to slope failure
stumps/footings	4	Susceptibility to slope failure
Secondary Roads	4	Slope, susceptibility to slope failure
Rural Residential Development	5	Farm dams

MAP UNIT SYMBOL: **Tvd2** Area: 142ha	MAP UNIT: **Tertiary volcanics, remnant capping, moderate slope**



A. GENERAL DESCRIPTION

This unit contains moderate slopes which may have a considerable accumulation of colluvial material when they appear lower in the landscape or adjoin drainage lines. The common soil type is a well structured, free draining, red Ferrosol, while minor variants include brown Dermosols. The soils of this unit are less susceptible to land slip and erosion than steeper map units, however some slips were observed in this unit. If any development is to occur, these areas should be subject to further investigation. This unit is generally used for grazing purposes.

SITE CHARACTERISTICS

Parent Material Age:	Tertiary	**Depth to Seas. Watertable:**	> 1.5 m
Parent Material Lithology:	Basalt	**Flooding Risk:**	Nil
Landform Pattern:	Rolling Hills	**Drainage:**	Well drained
Landform Element:	Hillslope	**Rock Outcrop:**	< 10%
Slope a) common:	16%	**Depth to Hard Rock:**	> 1.5m
Slope b) range:	11-20%		
Potential Recharge to Groundwater:	Moderate		
Major Native Vegetation Species:	Mountain Ash, Blackwood, Narrow-leaved Peppermint, Messmate		
Present Land Use:	Grazing		
Length of Growing Season:	10 months		

LAND DEGRADATION

Degradation Processes	Water Erosion sheet/rill	Water Erosion gully	Wind Erosion	Mass Movement	Salting	Acidification
Susceptibility	Low-mod	Low	Very low	High	Low	Moderate
Incidence	Moderate	Low	Very low	High	Low	NA

B. SOIL PROFILE

PROFILE DESCRIPTION Site S14

A1 0-20 cm Dark brown (7.5YR3/2) light clay, weak subangular blocky structure, peds 20-50 mm, rough fabric, very firm consistence, pH 5.0. Abrupt transition to:

B1 20-60 cm Reddish brown (5YR4/3) light clay, moderate polyhedral structure, peds 10-20 mm, rough fabric, firm consistence, pH 5.2. Gradual transition to:

B21 60-110 cm Reddish brown (2.5YR4/4) medium clay, moderate polyhedral structure, peds 10-20 mm, rough fabric, firm consistence, pH 5.4. Gradual transition to:

B22 110-150^{+} cm Reddish brown (2.5YR4/4) medium clay, strong subangular blocky structure, peds 5-10 mm, smooth fabric, weak consistence, pH 5.5.

CLASSIFICATION

Factual Key:	Uf5.12
Australian Soil Classification:	Melacic, Mesotrophic, Red FERROSOL; medium, non-gravelly, clayey/clayey, very deep (confidence level 2)
Unified Soil Group:	CH

INTERPRETATION OF LABORATORY ANALYSIS*

Horizon	pH ($CaCl_2$)	% Gravel	EC (salts)	Nutrient Status	P	K	Al	Organic Matter	Dispersibility
A1	4.2**	0	VL	L	S	S	T	H	L
B1	4.4**	0	VL	L	D	S	T	L	L
B21	4.8	0	VL	VL	D	D	T	VL	L

VL: Very Low L: Low M: Moderate H: High VH: Very High D: Deficient S: Satisfactory

T: Potentially Toxic NA: Not Available * see Appendix D for analytical results ** Strongly Acidic

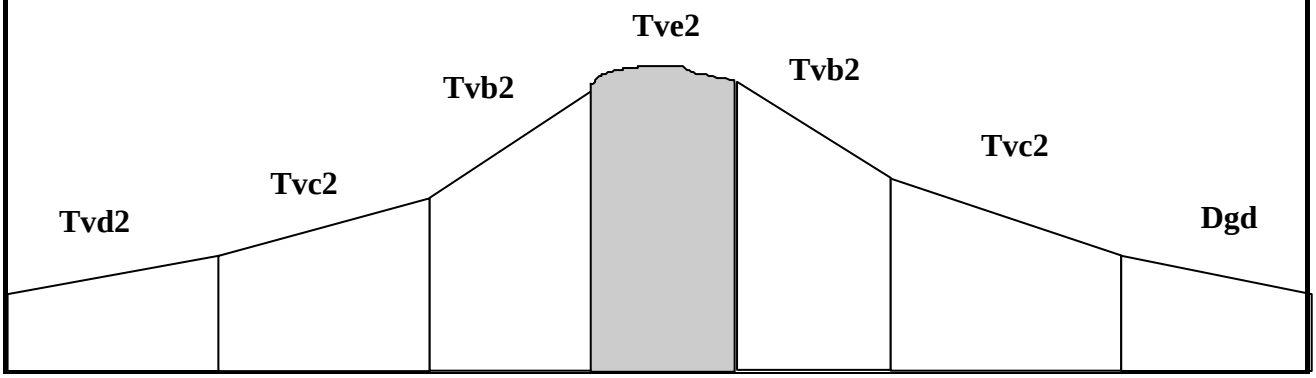
SOIL PROFILE CHARACTERISTICS:

Permeability:	Rapid (average 730 mm/day, range 190-975 mm/day)
Available Water Capacity:	Very high (> 200 mm H_2O)
Linear Shrinkage (B horizon):	Moderate (17%)

C. LAND CAPABILITY ASSESSMENT

Land Use	Class	Major Limiting Feature(s)/Land Use
Agriculture	$C_2T_3S_{2-3}$	Slope
Effluent Disposal (septic tanks)	3	Slope
Farm Dams	4	Slope, permeability, susceptibility to slope failure
Building Foundations		
slab	4	Slope, susceptibility to slope failure
stumps/footings	4	Susceptibility to slope failure
Secondary Roads	4	Slope, susceptibility to slope failure
Rural Residential Development	4	Secondary roads, farm dams, building foundations

MAP UNIT SYMBOL: **Tve2** Area: 32 ha	MAP UNIT: **Tertiary volcanics, remnant capping, crest**



A. GENERAL DESCRIPTION

Few gentle crests and ridges are present in the Shire. The hill crests may be gently sloping to flat, however the side slopes leading up to these crests can be very steep. The shape of the crest can be described as long undulating ridge line. The soils on the crests are red Ferrosols. These soils are all deep, well structured, free draining and high in free iron. Because these soils occur on gentle slopes, erosion is less of a problem, however crests adjacent to steep side slopes may be subject to land slip.

SITE CHARACTERISTICS

Parent Material Age:	Quaternary	**Depth to Seas. Watertable:**	> 1.5 m
Parent Material Lithology:	Basalt	**Flooding Risk:**	Nil
Landform Pattern:	Rolling Hills	**Drainage:**	Well drained
Landform Element:	Hillcrest	**Rock Outcrop:**	< 5%
Slope a) common:	2%	**Depth to Hard Rock:**	> 1.5 m
Slope b) range:	1-4%		
Potential Recharge to Groundwater:	High		
Major Native Vegetation Species:	Mountain Ash, Blackwood, Narrow-leaved Peppermint, Messmate		
Present Land Use:	Grazing		
Length of Growing Season:	10 months		

LAND DEGRADATION

Degradation Processes	Water Erosion sheet/rill	Water Erosion gully	Wind Erosion	Mass Movement	Salting	Acidification
Susceptibility	Low	Very low	Very low	Low	Low	Moderate
Incidence	Low	Low	Very low	Moderate	Low	NA

B. SOIL PROFILE

PROFILE DESCRIPTION Site S15

A1 0-30 cm Reddish brown (5YR4/4) light medium clay, strong polyhedral structure, peds 5-10 mm, rough fabric, very firm consistence, pH 4.7. Gradual transition to:

B2 30-100 cm Dark reddish brown (5YR3/3) medium clay, strong polyhedral structure, peds 10-20 mm, smooth fabric, firm consistence, pH 5.4. Diffuse transition to:

B3 100-150 cm^{+} Reddish brown (5YR4/4) light medium clay, strong polyhedral structure, peds 20-50 mm, smooth fabric, firm consistence, pH 5.3.

CLASSIFICATION

Factual Key:	Uf5.21
Australian Soil Classification:	Haplic, Mesotrophic, Red FERROSOL; thick, non-gravelly, clayey/clayey, very deep (confidence level 2)
Unified Soil Group:	MH

INTERPRETATION OF LABORATORY ANALYSIS*

Horizon	pH ($CaCl_2$)	% Gravel	EC (salts)	Nutrient Status	P	K	Al	Organic Matter	Dispersibility
A1	4.3**	< 1	VL	L	S	S	T	H	L
B2	5.1	< 1	VL	L	D	S	T	L	L
B3	5.7	15	VL	VL	D	D	S	VL	L

VL: Very Low L: Low M: Moderate H: High VH: Very High D: Deficient S: Satisfactory

T: Potentially Toxic NA: Not Available * see Appendix D for analytical results ** Strongly Acidic

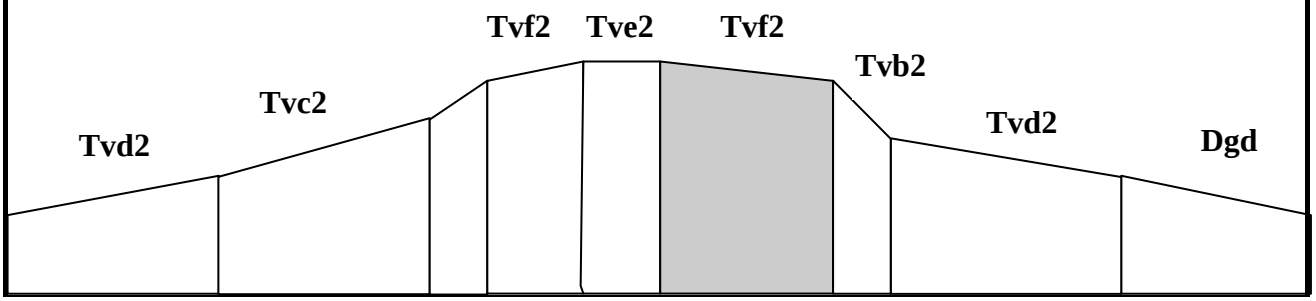
SOIL PROFILE CHARACTERISTICS:

Permeability:	Rapid (average 730 mm/day, range 190-975 mm/day)
Available Water Capacity:	Very high (260 mm H_2O)
Linear Shrinkage (B horizon):	Moderate (13.5%)

C. LAND CAPABILITY ASSESSMENT

Land Use	Class	Major Limiting Feature(s)/Land Use
Agriculture	$C_2T_1S_2$	Nil
Effluent Disposal (septic tanks)	2	Nil
Farm Dams	4	Permeability
Building Foundations		
slab	2	Nil
stumps/footings	3	Linear Shrinkage
Secondary Roads	3	Linear Shrinkage, USG
Rural Residential Development	4	Farm Dams

MAP UNIT SYMBOL: **Tvf2** Area: 343 ha	MAP UNIT: **Tertiary volcanics, remnant capping, gentle slope**



A. GENERAL DESCRIPTION

The gentle slopes are generally found close to crests and broad flat ridges. The soils of this unit are deep, well structured red Ferrosols. This unit is less prone to erosion and land slips because of the gentle slope, however these slopes may slip due to the proximity of steep side slopes. This unit is used mostly for grazing.

SITE CHARACTERISTICS

Parent Material Age:	Tertiary	**Depth to Seas. Watertable:**	> 1.5 m
Parent Material Lithology:	Basalt	**Flooding Risk:**	Nil
Landform Pattern:	Undulating Hills	**Drainage:**	Well drained
Landform Element:	Hillslope	**Rock Outcrop:**	0%
Slope a) common:	7%	**Depth to Hard Rock:**	> 1.5m
Slope b) range:	4-10 %		
Potential Recharge to Groundwater:	High		
Major Native Vegetation Species:	Blackwood, Narrow-leaved Peppermint, Messmate		
Present Land Use:	Grazing		
Length of Growing Season:	10 months		

LAND DEGRADATION

Degradation Processes	Water Erosion sheet/rill	Water Erosion gully	Wind Erosion	Mass Movement	Salting	Acidification
Susceptibility	Mod-low	Low	Very low	Low	Low	Moderate
Incidence	Moderate	Low	Very low	Moderate	Low	NA

B. SOIL PROFILE

PROFILE DESCRIPTION Site S15

A1 0-30 cm Reddish brown (5YR4/4) light medium clay, strong polyhedral structure, peds 5-10 mm, rough fabric, very firm consistence, pH 4.7. Gradual transition to:

B2 30-110 cm Dark reddish brown (5YR3/3) medium clay, moderate polyhedral structure, peds 10-20 mm, smooth fabric, firm consistence, pH 5.4. Gradual transition to:

B3 110-150 cm Greyish brown (10YR5/2) light medium clay, strong polyhedral structure, peds 20-50 mm, smooth fabric, rigid firm consistence, pH 5.3.

CLASSIFICATION

Factual Key:	Uf5.12
Australian Soil Classification:	Haplic, Mesotrophic, Red FERROSOL; thick, non-gravelly, clayey/clayey, very deep (confidence level 2)
Unified Soil Group:	MH

INTERPRETATION OF LABORATORY ANALYSIS*

Horizon	pH ($CaCl_2$)	% Gravel	EC (salts)	Nutrient Status	P	K	Al	Organic Matter	Dispersibility
A1	4.3**	< 1	VL	L	S	S	T	H	L
B2	5.1	< 1	VL	L	D	S	T	L	L
B3	5.7	15	VL	VL	D	D	S	VL	L

VL: Very Low L: Low M: Moderate H: High VH: Very High D: Deficient S: Satisfactory

T: Potentially Toxic NA: Not Available * see Appendix D for analytical results ** Strongly Acidic

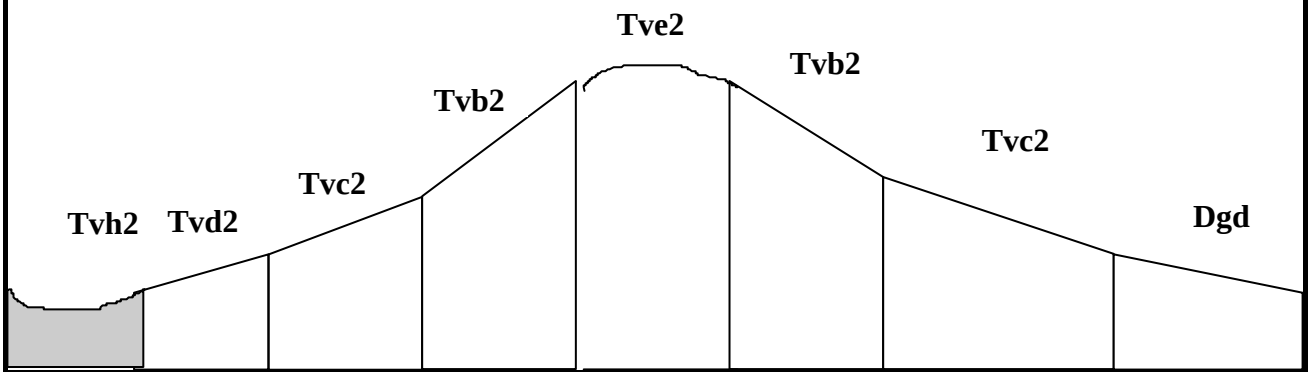
SOIL PROFILE CHARACTERISTICS:

Permeability:	Rapid (average 730 mm/day, range 190-975 mm/day)
Available Water Capacity:	Very high (> 200 mm H_2O)
Linear Shrinkage (B horizon):	Moderate (13.5 %)

C. LAND CAPABILITY ASSESSMENT

Land Use	Class	Major Limiting Feature(s)/Land Use
Agriculture	$C_2T_2S_{3-2}$	Susceptibility to sheet erosion
Effluent Disposal (septic tanks)	2	Nil
Farm Dams	4	Permeability
Building Foundations		
slab	3	Slope
stumps/footings	3	Linear shrinkage
Secondary Roads	3	Linear shrinkage, USG
Rural Residential Development	4	Farm dams

MAP UNIT SYMBOL: **Tvh2** Area: 9 ha	MAP UNIT: **Tertiary volcanics, remnant capping, drainage depression**



A. GENERAL DESCRIPTION

The drainage depressions vary greatly depending on where they are located in the landscape. Steep drainage lines which occurr upslope are likely to have been eroded, while soils in areas at the break of slope are likely to have been built up by soil deposition. In Gembrook, dams are common in drainage lines at the bottom of the hillslopes. The red Ferrosol soils present are generally fertile, well-structured, free draining and high in free iron. Steep drainage depressions are often subject to significant erosion.

SITE CHARACTERISTIC

Parent Material Age:	Tertiary	**Depth to Seas. Watertable:**	> 1.5 m
Parent Material Lithology:	Basalt	**Flooding Risk:**	Nil
Landform Pattern:	Undulating Hills	**Drainage:**	Moderately well drained
Landform Element:	Hillslope	**Rock Outcrop:**	0%
Slope a) common:	8%	**Depth to Hard Rock:**	> 2.0m
Slope b) range:	5-20%		
Potential Recharge to Groundwater:	Low		
Major Native Vegetation Species:	Blackwood, Narrow-leaved Peppermint, Messmate		
Present Land Use:	Horticulture		
Length of Growing Season:	10 months		

LAND DEGRADATION

Degradation Processes	Water Erosion sheet/rill	Water Erosion gully	Wind Erosion	Mass Movement	Salting	Acidification
Susceptibility	Low-mod	Low-mod	Very low	High	Moderate	Moderate
Incidence	Moderate	Moderate	Very low	Moderate	Low	NA

B. SOIL PROFILE

PROFILE DESCRIPTION Site S14

A1 0-35 cm Dark brown (7.5YR3/2) light clay, moderate subangular blocky structure, peds 20-50 mm, rough fabric, very firm consistence, pH 5.0. Clear transition to:

B1 35-60 cm Reddish brown (5YR4/3) light clay, moderate polyhedral structure, peds 10-20 mm structure, rough and smooth fabric, firm consistence, pH 5.2. Gradual transition to:

B2 60-110 cm Dark reddish brown (2.5YR4/4) medium clay, moderate polyhedral structure, peds 10-20 mm, rough and smooth fabric, firm consistence, pH 5.4. Diffuse transition to:

B3 110-150^{+} cm Reddish brown (2.5YR4/4) light medium clay, coarse, distinct red mottles are common, strong subangular blocky structure, peds 5-10 mm, smooth fabric, weak consistence, pH 5.5.

CLASSIFICATION

Factual Key:	Uf5.12
Australian Soil Classification:	Melacic, Mesotrophic, Red FERROSOL; thick, non-gravelly, clayey/clayey, very deep (confidence level 2)
Unified Soil Group:	CH

INTERPRETATION OF LABORATORY ANALYSIS*

Horizon	pH ($CaCl_2$)	% Gravel	EC (salts)	Nutrient Status	P	K	Al	Organic Matter	Dispersibility
A1	4.2**	0	VL	L	S	S	T	H	L
B1	4.4**	0	VL	L	D	S	T	L	L
B2	4.8	0	VL	VL	D	D	T	VL	L

VL: Very Low L: Low M: Moderate H: High VH: Very High D: Deficient S: Satisfactory

T: Potentially Toxic NA: Not Available * see Appendix D for analytical results ** Strongly Acidic

SOIL PROFILE CHARACTERISTICS:

Permeability:	Moderate (average 350 mm/day, range 100-480 mm/day)
Available Water Capacity:	Very high (> 200 mm H_2O)
Linear Shrinkage (B horizon):	Moderate (17%)

C. LAND CAPABILITY ASSESSMENT

Land Use	Class	Major Limiting Feature(s)/Land Use
Agriculture	$C_2T_{2-3}S_{2-3}$	Susceptibility to sheet and gully erosion, slope
Effluent Disposal (septic tanks)	3	Drainage
Farm Dams	4	Permeability, susceptibility to slope failure
Building Foundations		
slab	4	Slope, susceptibility to slope failure
stumps/footings	4	Susceptibility to slope failure
Secondary Roads	4	Susceptibility to slope failure
Rural Residential Development	4	Secondary roads, farm dams, building foundations

4.5 Tertiary sedimentary map units (Ts)

In the south west of the Shire, close to the areas of Lang Lang, Heath Hill and Nyora, a small area of tertiary sedimentary terrain exits. This area is part of the widespread sheet of Upper Miocene sandy fluviatile beds (floodplain), and was termed Baxter Sandstone (Keble, Jenkins and Thompson 1950, as cited by Rosengren, 1984, and Jenkins 1962, 1974). It was noted by Thompson (1974), that this material also contained large amounts of silts and clays as well as sands, and therefore proposed the term Baxter Formation in preference to the term Baxter Sandstone (Rosengren 1984). These sediments have been subject to warping rather than strong faulting and folding.

These Tertiary sediments contain ferruginous gravel and weakly cemented sandy clays and clays. At depth there may be iron cemented sandstone and some build up of ironstone nodules between the A and B horizons. These clays are mottled, and may show distinctive red mottling at depth. Much of the Tertiary deposits have been covered by more recent Quaternary clays and sands.

The terrain in this area is best described as low rolling hills or undulating low hills.

Grazing has taken place since early European settlement. Loss of vegetation cover through clearing, combined with periods of cultivation and over grazing, have modified the soils present. In many cases, erosion has removed much of the original topsoil, while cultivation has resulted in mixing of topsoil and subsoil. Many soil types present are considered to be modified soils and are likely to differ from undisturbed soils in their natural state.

Soils vary due to changes in land use, topography and climate. Gentle crests show greater soil depth than steep crests and slopes. The latter being subjected to continuous soil erosion. Lower slopes are subject to less erosion as well as a build up of colluvial material leading to deeper soils. Flatter areas and drainage depressions are subject to alluvial deposition. The topsoils in these alluvial areas often have high concentrations of sand. Soil depth in drainage lines regularly exceeds 2.0 metres in depth. Soils present on gentle crests are mostly Sodosols. Mottled yellow Dermosols with bleached A2 horizons and sodic subsoils dominate the gentle slopes and broad drainage depressions of the low, undulating hills.

Bleached A2 horizons are common. These bleached A2 horizons have high percentages of silt and fine sand. Because of this, the A2 horizons have a low liquid limit. When excess water is added these soils, the A2 horizons become sloppy and have little cohesive strength. The A2 horizon is susceptible to sheet erosion if exposed by the removal of vegetation and topsoil.

In some areas, excluding the flats and drainage depressions, a layer of stone and gravel may exist in the A2 horizon, or at the top of the B horizon. These sedimentary stones appear as discreet layers and are generally subangular to angular ranging in size from 20-200 mm in diameter. These stones can account for up to 40 per cent of the volume of the horizon. Rocks do not commonly occur on the surface or within the B horizons.

Various land degradation problems exist within the Tertiary landscape. In the steeper terrain, some sheet and gully erosion occur where vegetation cover is sparse. The sodic subsoils present in the low undulating terrain have contributed to gully and stream bank erosion.

Waterlogging is common along drainage lines and below leaking dams. In these situations, spiny rush is a good indicator of waterlogging and possible salinity.

Land management considerations

The major land management concerns include low subsoil permeability and moderate to high dispersibility of the subsoil, particularly on the lower slopes and depressions. Shallow depth to hard rock may be a problem on crests. With rural residential development increasing in these areas, careful design of effluent disposal fields, farm dams and secondary roading is required. Consideration must also be given to dam construction and the impact upon environmental streamflows.

In some areas within this unit, there may be an accumulation of sandy material in the topsoil. Where free draining topsoil overlies a sandy to medium clay, it creates favourable growing conditions for horticultural crops. These areas are limited in size as the build up of sand is not common. The sand build-up may be from aeolian sources or recent alluvium.

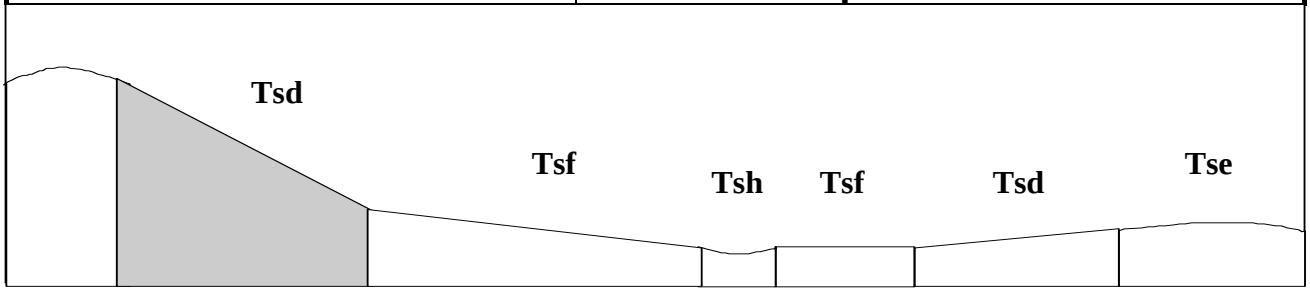
Grazing is more common in this area with few limitations except for pugging of the soil which may occur with overstocking in winter months.

SOILS OF TERTIARY SEDIMENTARY ORIGIN

Plate 7 **Map Units: Tsd, Tsf**
Brown Dermosol

Plate 8 **Map Unit: Tse**
Brown Sodosol

MAP UNIT SYMBOL: **Tsd** Area: 3008 ha	MAP UNIT: **Tertiary sediments, moderate slope**



A. GENERAL DESCRIPTION

These moderate slopes are found throughout this sedimentary area. Soils have increased depth where material accumulates close to the drainage line or break of slope. The dominant soil type is a mottled yellow Dermosol with a bleached A2 horizon and a sodic subsoil. A rock layer is common in the A2 horizon or on top of the B1 horizon. The sandy or silty A2 horizon has a very weak structure that breaks down readily when excess water is added.

SITE CHARACTERISTICS

Parent Material Age:	Tertiary	**Depth to Seas. Watertable:**	> 1.5 m
Parent Material Lithology:	Sediments	**Flooding Risk:**	Nil
Landform Pattern:	Rolling hills	**Drainage:**	Well drained
Landform Element:	Hillslope	**Rock Outcrop:**	< 10%
Slope a) common:	16%	**Depth to Hard Rock:**	> 1.5 m
Slope b) range:	11-20%		

Potential Recharge to Groundwater:	Low
Major Native Vegetation Species:	Narrow-leaved Peppermint , Messmate, Melaleuca
Present Land Use:	Grazing
Length of Growing Season:	8 months

LAND DEGRADATION

Degradation Processes	Water Erosion sheet/rill	Water Erosion gully	Wind Erosion	Mass Movement	Salting	Acidification
Susceptibility	Low	Low	Very low	Moderate	Low	Moderate
Incidence	Low	Low	Very low	Low	Low	NA

B. SOIL PROFILE

PROFILE DESCRIPTION Site C2

A1 0-15 cm Very dark greyish brown (10YR3/2) clay loam (fine sandy), moderate subangular blocky structure, peds 10-20 mm, rough fabric, weak consistence, pH 5.9. Clear transition to:

A21 15-30 cm Brown (10YR5/3) fine sandy clay loam, bleached (10YR7/2) when dry, weak subangular blocky structure, rough fabric, peds 10-20 mm, weak consistence, pH 5.8. Clear transition to:

A22 30-45 cm Yellowish brown (2.5Y6/3) fine sandy clay, massive structure, earthy fabric, firm consistence, a few medium subrounded sedimentary pebbles. Clear transition to:

B1 45-55 cm Brownish yellow (10YR6/6) light clay, medium distinct yellowish orange mottles are common, weak subangular blocky structure, peds 20-50 mm, rough fabric, firm consistence. Clear transition to:

B21 55-90 cm Yellowish brown (10YR5/6) heavy clay (with coarse sand), many coarse prominent yellowish orange mottles, strong subangular blocky structure, smooth fabric, peds 10-20 mm, weak consistence, pH 5.5. Clear transition to:

B22 90-150 cm Yellowish brown (10YR5/6) heavy clay, many very coarse prominent yellowish orange mottles, strong subangular blocky structure, smooth fabric, peds 20-50 mm, weak consistence, pH 5.4.

CLASSIFICATION

Factual Key:	Gn3.84
Australian Soil Classification:	Bleached-Sodic, Eutrophic, Brown DERMOSOL; medium, slightly gravelly, clay loamy/clayey, very deep (confidence level 2)
Unified Soil Group:	CH

INTERPRETATION OF LABORATORY ANALYSIS*

Horizon	pH ($CaCl_2$)	% Gravel	EC (salts)	Nutrient Status	P	K	Al	Organic Matter	Dispersibility
A1	4.8	7	VL	VL	D	D	S	H	VL
A21	4.6	10	VL	L	D	D	T	L	VL
A22	NA	15	NA	NA	NA	NA	NA	NA	M
B1	NA	20	NA	NA	NA	NA	NA	NA	M
B21	4.5	25	VL	L	D	D	S	VL	L
B22	4.7	25	VL	M	D	S	S	VL	L

VL: Very low L: Low M: Moderate H: High VH: Very high D: Deficient S: Satisfactory

T: Potentially Toxic NA: Not Available * see Appendix D for analytical results ** Strongly Acidic

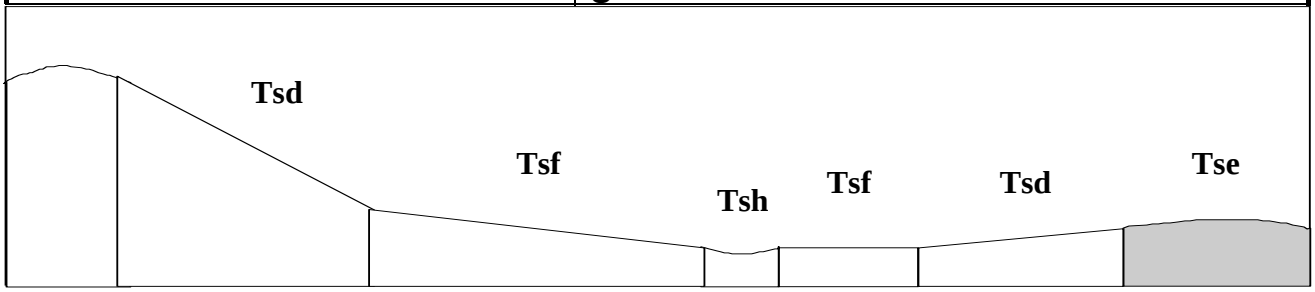
SOIL PROFILE CHARACTERISTICS:

Permeability:	Moderate (average 155 mm/day, range 90-300 mm/day)
Available Water Capacity:	Very high (220 mm H_2O)
Linear Shrinkage (B horizon):	Moderate (17%)

C. LAND CAPABILITY ASSESSMENT

Land Use	Class	Major Limiting Feature(s)/Land Use
Agriculture	$C_2T_3S_3$	Slope, gravel and stone content
Effluent Disposal (septic tanks)	3	Slope
Farm Dams	4	Slope, permeability
Building Foundations		
slab	4	Slope
stumps/footings	3	Slope, proportion of stones, susceptibility to slope failure, linear shrinkage
Secondary Roads	4	Slope
Rural Residential Development	4	Farm dams, building foundations (slab), secondary roads

MAP UNIT SYMBOL: **Tse** Area: 3008 ha	MAP UNIT: **Tertiary sediments, gentle crest**



A. GENERAL DESCRIPTION

Gentle crests are common in this area. Soil depth varies between 1.0 to 1.5 metres with few surface rocks. Mottled brown Sododol soils are dominant and may contain a distinct bleached A2 horizon. Soils may have a stone layer in the A2 horizon at about 25-30 cm in depth. The bleached A2 horizons have poor structure and are prone to erosion if exposed, but in general, erosion risk is low because of the gentle slope.

SITE CHARACTERISTICS

Parent Material Age:	Tertiary	**Depth to Seas. Watertable:**	> 1.5 m
Parent Material Lithology:	Sediments	**Flooding Risk:**	Nil
Landform Pattern:	Low hills	**Drainage:**	Well drained
Landform Element:	Crest	**Rock Outcrop:**	< 10%
Slope a) common:	4%	**Depth to Hard Rock:**	1.5m (variable)
Slope b) range:	2-7%		

Potential Recharge to Groundwater:	Low
Major Native Vegetation Species:	Messmate, Narrow-leaved Peppermint
Present Land Use:	Grazing
Length of Growing Season:	8 months

LAND DEGRADATION

Degradation Processes	Water Erosion sheet/rill	Water Erosion gully	Wind Erosion	Mass Movement	Salting	Acidification
Susceptibility	Low	Low	Very low	Low	Very low	Moderate
Incidence	Low	Low	Very low	Very low	Very low	NA

B. SOIL PROFILE

PROFILE DESCRIPTION Site C4

A1 0-15 cm — Very dark greyish brown (10YR3/2) sandy clay loam, moderate prismatic structure, peds 10-20 mm, rough fabric, firm consistence, pH 6.1. Clear transition to:

A2 15-55 cm — Brown (7.5YR5/4) fine sandy loam, bleached (7.5YR7/2) when dry, weak subangular blocky structure, peds 5-10 mm, rough fabric, weak consistence, pH 5.2. Clear transition to:

B1 55-70 cm — Yellowish brown (10YR5/4) light clay (with fine sand), weak subangular blocky structure, peds 20-50 mm, rough fabric, firm consistence, small subrounded sedimentary pebbles are common, pH 6.0. Clear transition to:

B21 70-85 cm — Dark yellowish brown (10YR4/6) medium heavy clay, coarse faint red mottles are common, moderate subangular blocky to prismatic structure, peds 5-10 mm, rough fabric, a few small subrounded sedimentary (ironstone) pebbles, pH 6.0. Clear transition to:

B22 85-100^{+} cm Dark yellowish brown (10YR4/6) medium heavy clay, coarse faint red mottles are common, strong prismatic structure, peds 5-10 mm, smooth fabric, firm consistence, pH 6.0.

CLASSIFICATION

Factual Key:	Dy3.41
Australian Soil Classification:	Eutrophic, Mottled-Hypernatric, Brown SODOSOL; thick slightly gravelly, clay loamy/clayey, very deep (confidence level 2)
Unified Soil Group:	CL

INTERPRETATION OF LABORATORY ANALYSIS*

Horizon	pH ($CaCl_2$)	% Gravel	EC (salts)	Nutrient Status	P	K	Al	Organic Matter	Dispersibility
A1	5.1	5	VL	M	D	S	S	H	L
A2	4.6	0	VL	VL	D	S	T	VL	L
B1	NA	40	NA	NA	NA	NA	NA	NA	M-H
B21	4.9	35	VL	VL	D	D	S	VL	M-H
B22	NA	20	NA	NA	NA	NA	NA	NA	L

VL: Very low L: Low M: Moderate H: High VH: Very high D: Deficient S: Satisfactory

T: Potentially Toxic NA: Not Available * see Appendix D for analytical results ** Strongly Acidic

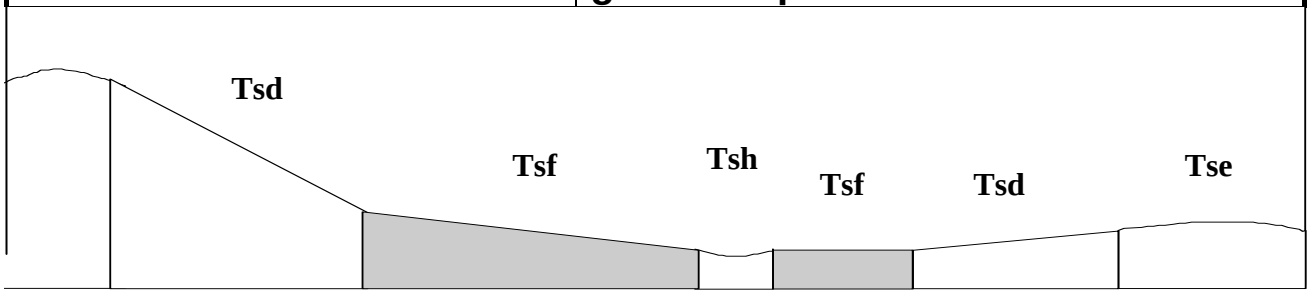
SOIL PROFILE CHARACTERISTICS:

Permeability:	Moderate (average 130 mm/day, range 15-260 mm/day)
Available Water Capacity:	High (180 mm H_20)
Linear Shrinkage (B horizon):	Low (9%)

C. LAND CAPABILITY ASSESSMENT

Land Use	Class	Major Limiting Feature(s)/Land Use
Agriculture	$C_2T_2S_3$	Gravel and stone content
Effluent Disposal (septic tanks)	2	Nil
Farm Dams	4	Permeability, depth to hardrock (variable)
Building Foundations		
slab	3	Proportion of stone and gravel
stumps/footings	3	Proportion of stone and gravel
Secondary Roads	3	Proportion of stone and gravel, dispersibility of subsoil, USG subsoil
Rural Residential Development	4	Farm dams

MAP UNIT SYMBOL: **Tsf** Area: 3008 ha	MAP UNIT: **Tertiary sediments, gentle slope**



A. GENERAL DESCRIPTION

Gentle slopes are common throughout this sedimentary terrain. The dominant soil type is a mottled, yellow Dermosol with a bleached A2 horizon and sodic subsoil. The A horizons range from sandy loams to fine sandy clay loams. A2 horizons may contain more sand and silt making them sloppy when saturated. This horizon may erode if exposed. Some horizons may contain high concentrations of quartz sand. The B horizons range from light medium to heavy clays and are strongly mottled and sodic. The sodic nature of the subsoil makes this unit susceptible to water erosion. Grazing is the most common land use on this unit.

SITE CHARACTERISTICS

Parent Material Age:	Tertiary	**Depth to Seas. Watertable:**	> 1.5 m
Parent Material Lithology:	Sediments	**Flooding Risk:**	Very low
Landform Pattern:	Low hills	**Drainage:**	Imperfectly drained
Landform Element:	Gentle slope	**Rock Outcrop:**	< 2%
Slope a) common:	7%	**Depth to Hard Rock:**	> 1.5 m
Slope b) range:	4-10%		

Potential Recharge to Groundwater:	Low
Major Native Vegetation Species:	Messmate, Melaleuca
Present Land Use:	Grazing (major), Horticulture (minor)
Length of Growing Season:	8 months

LAND DEGRADATION

Degradation Processes	Water Erosion sheet/rill	Water Erosion gully	Wind Erosion	Mass Movement	Salting	Acidification
Susceptibility	Low	Low	Very low	Low	Low	Low
Incidence	Low	Low	Low	Very low	Low	NA

B. SOIL PROFILE

PROFILE DESCRIPTION Site C2

A1 0-15 cm — Very dark greyish brown (10YR3/2) clay loam (fine sandy), moderate subangular blocky structure, peds 10-20 mm, rough fabric, weak consistence, pH 5.9. Clear transition to:

A21 15-30 cm — Brown (10YR5/3) fine sandy clay loam, bleached (10YR7/2) when dry, weak subangular blocky structure, rough fabric, peds 10-20 mm, weak consistence, pH 5.8. Clear transition to:

A22 30-50 cm — Yellowish brown (2.5Y6/3) fine sandy clay, bleached (10YR8/2) when dry, massive structure, earthy fabric, firm consistence, a few medium subrounded sedimentary pebbles. Clear transition to:

B1 50-65 cm Brownish yellow (10YR6/6) light clay, medium distinct yellowish orange mottles are common, weak subangular blocky structure, peds 20-50 mm, rough fabric, firm consistence. Clear transition to:

B21 65-90 cm Yellowish brown (10YR5/6) heavy clay (with coarse sand) many coarse prominent yellowish orange mottles, strong subangular blocky structure, smooth fabric, peds 10-20 mm, weak consistence, pH 5.5. Clear transition to:

B22 90-150^{+} cm Yellowish brown (10YR5/6) heavy clay, many very coarse prominent yellowish orange mottles, strong subangular blocky structure, smooth fabric, peds 20-50 mm, weak consistence pH 5.4.

CLASSIFICATION

Factual Key:	Gn3.84
Australian Soil Classification:	Bleached-Sodic, Eutrophic, Brown DERMOSOL; medium, slightly gravelly, clay loamy/clayey, very deep (confidence level 2)
Unified Soil Group:	CH

INTERPRETATION OF LABORATORY ANALYSIS*

Horizon	pH ($CaCl_2$)	% Gravel	EC (salts)	Nutrient Status	P	K	Al	Organic Matter	Dispersibility
A1	4.8	7	VL	VL	D	D	S	H	VL
A21	4.6	10	VL	L	D	D	T	L	VL
A22	NA	15	NA	NA	NA	NA	NA	NA	M
B1	NA	20	NA	NA	NA	NA	NA	NA	M
B21	4.5	25	VL	L	D	D	S	VL	L
B22	4.7	25	VL	M	D	S	S	VL	L

VL: Very low L: Low M: Moderate H: High VH: Very high D: Deficient S: Satisfactory

T: Potentially Toxic NA: Not Available * see Appendix D for analytical results ** Strongly Acidic

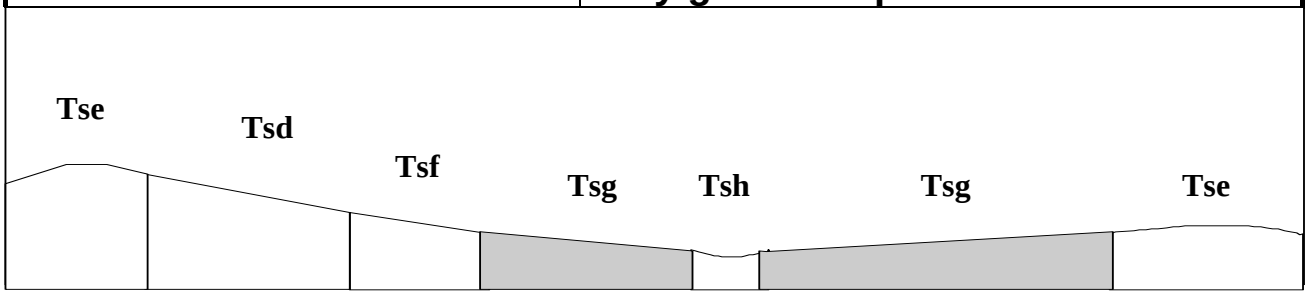
SOIL PROFILE CHARACTERISTICS:

Permeability:	Slow (average 15 mm/day, range 10-25 mm/day)
Available Water Capacity:	Very high (220 mm H_2O)
Linear Shrinkage (B horizon):	Moderate (17%)

C. LAND CAPABILITY ASSESSMENT

Land Use	Class	Major Limiting Feature(s)/Land Use
Agriculture	$C_2T_2S_3$	Permeability-rainfall index, gravel and stone content
Effluent Disposal (septic tanks)	4	Permeability, drainage
Farm Dams	3	Permeability, linear shrinkage, low dispersibility of subsoil
Building Foundations		
slab	4	Drainage
stumps/footings	4	Drainage
Secondary Roads	4	Drainage
Rural Residential Development	4	Effluent disposal, building foundations, secondary roads

MAP UNIT SYMBOL: **Tsg** Area: 2380 ha	MAP UNIT: **Tertiary sediments, very gentle slope**



A. GENERAL DESCRIPTION

The very gentle sedimentary slopes contain similar soils to those found on the gentle slopes (Tsf). Bleached and mottled Dermosols with a sodic subsoil are common. Drainage of these soils is slow and waterlogging is common in winter and spring. Soil depth is greater on these slopes and may reach two metres. Sheet and rill erosion are uncommon because of the gentle slope, however sodic subsoils have contributed to gully erosion on this unit. Land use on this unit is primarily grazing, however areas with recently deposited sands may be used for horticultural purposes.

SITE CHARACTERISTICS

Parent Material Age:	Tertiary	**Depth to Seas. Watertable:**	> 1.0 m
Parent Material Lithology:	Sediments	**Flooding Risk:**	Low
Landform Pattern:	Low hills	**Drainage:**	Imperfectly drained
Landform Element:	Very gentle slope	**Rock Outcrop:**	< 2%
Slope a) common:	2%	**Depth to Hard Rock:**	> 1.5 m
Slope b) range:	1-3%		
Potential Recharge to Groundwater:	Low		
Major Native Vegetation Species:	Melaleuca		
Present Land Use:	Grazing (major), Horticulture (minor)		
Length of Growing Season:	8 months		

LAND DEGRADATION

Degradation Processes	Water Erosion sheet/rill	gully	Wind Erosion	Mass Movement	Salting	Acidification
Susceptibility	Very low	Low	Very low	Low	Moderate	Moderate
Incidence	Low	Low	Low	Very low	Low	

B. SOIL PROFILE

PROFILE DESCRIPTION

A1 0-20 cm — Very dark grey (10YR3/1) fine sandy clay loam, moderate to strong subangular blocky to prismatic structure, peds 10-20 mm rough fabric, weak consistence (moist), pH 5.9. Abrupt transition to:

A2 20-45 cm — Pale brown (10YR6/3) fine sandy clay loam, bleached (10YR7/2) when dry, weak subangular blocky structure, peds 10-20 mm, rough fabric, weak consistence (moist), pH 5.8. Gradual transition to:

B1 45-70 cm — Greyish brown (10YR5/2) light medium clay, many faint medium yellow and orange mottles, weak prismatic structure, peds 10-20 mm, smooth fabric, firm consistence (moderately moist). Gradual transition to:

B21 70-150^{+} cm Light brownish grey (10YR6/2) heavy clay, many coarse distinct orange and yellow mottles, strong subangular blocky structure, peds 5-10 mm, smooth fabric, firm consistence (moderately moist), pH 5.5.

CLASSIFICATION

Factual Key:	Gn3.84
Australian Soil Classification:	Bleached-Sodic Eutrophic, Brown DERMOSOL; medium, slightly gravelly, clay loamy/clayey, very deep (confidence level 2)
Unified Soil Group:	CH

INTERPRETATION OF LABORATORY ANALYSIS*

Horizon	pH ($CaCl_2$)	% Gravel	EC (salts)	Nutrient Status	P	K	Al	Organic Matter	Dispersibility
A1	4.8	7	VL	VL	D	D	S	H	VL
A2	4.6	10	VL	L	D	D	T	L	VL
B1	NA	20	NA	NA	NA	NA	NA	NA	M
B21	4.5	25	VL	L	D	D	S	VL	L

VL: Very low L: Low M: Moderate H: High VH: Very high D: Deficient S: Satisfactory

T: Potentially Toxic NA: Not Available * see Appendix D for analytical results ** Strongly Acidic

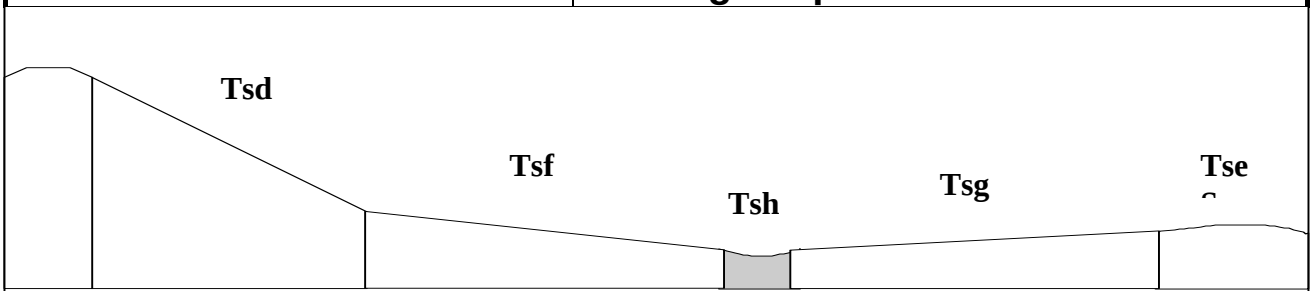
SOIL PROFILE CHARACTERISTICS:

Permeability:	Slow (average 15 mm/day, range 10-25 mm/day)
Available Water Capacity:	Very high (220 mm H_2O)
Linear Shrinkage (B horizon):	Moderate (17%)

C. LAND CAPABILITY ASSESSMENT

Land Use	Class	Major Limiting Feature(s)/Land Use
Agriculture	$C_2T_1S_3$	Permeability-rainfall index, gravel and stone content
Effluent Disposal (septic tanks)	4	Drainage, permeability
Farm Dams	3	Permeability, linear shrinkage, low dispersibility of subsoil
Building Foundations		
slab	4	Drainage
stumps/footings	4	Drainage
Secondary Roads	4	Drainage
Rural Residential Development	4	Effluent disposal, building foundations, secondary roads

MAP UNIT SYMBOL: **Tsh** Area: 1982 ha	MAP UNIT: **Tertiary sediments, drainage depression**



A. GENERAL DESCRIPTION

Drainage lines which run through the sedimentary terrain are generally wide with soil profiles reaching two metres in depth. In many situations, minor drainage lines may not have been mapped due to restrictions of scale, especially in steeper units. Bleached and mottled grey Dermosols and Sodosols are common. Gully erosion occurs in this unit due to the dispersive nature of the subsoil and salting also occurs. Seasonal flooding is common, and waterlogging is a problem in winter and spring months. The leaching of soil nutrients has resulted in the formation of acidic topsoils.

SITE CHARACTERISTICS

Parent Material Age:	Tertiary	**Depth to Seas. Watertable:**	> 1.0 m
Parent Material Lithology:	Sediments	**Flooding Risk:**	Moderate
Landform Pattern:	Low hills	**Drainage:**	Imperfectly drained
Landform Element:	Drainage depression	**Rock Outcrop:**	Nil
Slope a) common:	3%	**Depth to Hard Rock:**	> 1.5 m
Slope b) range:	0-7%		
Potential Recharge to Groundwater:	Low		
Major Native Vegetation Species:	Melaleuca, Messmate		
Present Land Use:	Grazing		
Length of Growing Season:	8 months		

LAND DEGRADATION

Degradation Processes	Water Erosion sheet/rill	gully	Wind Erosion	Mass Movement	Salting	Acidification
Susceptibility	Low	Low	Very low	Low	Moderate	Moderate
Incidence	Low	low	Low	Very low	Low	NA

B. SOIL PROFILE

PROFILE DESCRIPTION Site C3

A1 0-25 cm Very dark greyish brown (10YR3/2) fine sandy clay loam, weak subangular blocky structure, peds 10-20 mm, rough fabric, very weak consistence, pH 4.9. Clear transition to:

A2 25-60 cm Greyish brown (10YR5/2) fine sandy clay loam, bleached (10YR8/2) when dry, weak subangular blocky structure, peds 10-20 mm, rough fabric, weak consistence, pH 4.6. Gradual transition to:

B1 60-100 cm Greyish brown (10YR5/2) fine sandy clay loam, medium yellow and orange mottles are common, moderate prismatic structure, peds 10-20 mm, rough fabric, firm consistence. Gradual transition to:

B2 100-135 cm Light brownwish grey (10YR6/2) medium clay, many coarse distinct yellow and orange mottles, moderate subangular blocky structure, peds 5-10 mm, smooth fabric, firm consistence, pH 5.0. Gradual transition to:

B3 135-150+ cm Light yellowish brown (10YR6/4) sandy clay loam, many coarse distinct yellow and orange mottles, weak subangular blocky structure, peds 5-10 mm, rough fabric, firm consistence.

CLASSIFICATION

Factual Key:	Dy3.41, Gn3.04
Australian Soil Classification:	Acidic-Sodic, Eutrophic, Grey DERMOSOL (SODOSOL); medium, slightly gravelly, clay loamy/clayey, very deep (confidence level 2)
Unified Soil Group:	CL

INTERPRETATION OF LABORATORY ANALYSIS*

Horizon	pH ($CaCl_2$)	% Gravel	EC (salts)	Nutrient Status	P	K	Al	Organic Matter	Dispersibility
A1	4.1**	10	VL	L	S	S	T	H	VL
A2	4.1**	15	VL	VL	D	D	T	L	L
B1	NA	10	NA	NA	NA	NA	NA	NA	M
B2	4.2**	25	L	M	D	D	T	VL	H

VL: Very low L: Low M: Moderate H: High VH: Very high D: Deficient S: Satisfactory

T: Potentially Toxic NA: Not Available * see Appendix D for analytical results ** Strongly Acidic

SOIL PROFILE CHARACTERISTICS:

Permeability:	Slow (average 15 mm/day, range 10-25 mm/day)
Available Water Capacity:	Very high (> 200 mm H_2O)
Linear Shrinkage (B horizon):	Low (11%)

C. LAND CAPABILITY ASSESSMENT

Land Use	Class	Major Limiting Feature(s)/Land Use
Agriculture	$C_2T_1S_3$	Permeability-rainfall index
Effluent Disposal (septic tanks)	4	Drainage, permeability
Farm Dams	3	Permeability, depth to seasonal watertable
Building Foundations		
slab	4	Drainage
stumps/footings	4	Drainage
Secondary Roads	4	Drainage, dispersibility of subsoil
Rural Residential Development	4	Effluent disposal, building foundations, secondary roads

4.4 Devonian granitic map units (Dg)

There are two distinct granitic geological formations, the Lysterfield granodiorite in the north east of the Shire, and the Tynong granite in the west of the Shire.

These two formations have different mineral compositions, however there is little difference in the types of soil formed on both parent materials. They have therefore been combined for the purpose of this study.

The granitic terrain is very diverse, with elevated undulating plateaus, steep highly dissected slopes, gentle slopes and broad drainage lines.

Granitic soils vary when changes in aspect, topography and climate occur. There are two major soil types present in the granitic terrain, both of which can be related to their positions in the landscape. They are brown Chromosols and grey Kurosols.

The most widespread soil type is a grey Kurosol which occurs on map units with gentle to very gentle slopes. In general, this soil has a dark brownish grey to grey sandy loam topsoil overlying a mottled yellow brown to brownish grey, sandy clay. The soil contains coarse angular sands and small gravel. Soil depth on lower slopes or in drainage lines may be greater than two metres deep and contain a higher percentages of sand and gravel.

A characteristic feature of this soil is the presence of a bleached A2 horizon overlying a mottled clay subsoil. This characteristic is indicative of a poorly drained subsoil which is subject to waterlogging. The lighter textured topsoils drain freely, while the clay subsoils drain slowly. This causes water to pond above the clay horizon. On sloping land, the downslope movement of groundwater results in the emergence of springs and soaks. This problem is exacerbated where land has been extensively cleared.

The nutrient status of the grey Kurosol is relatively poor. The sandy topsoils drain rapidly and nutrients are easily leached from the soil. In addition, lower slopes and flats are likely to be acidic and may need lime application for optimum production.

The brown Chromosols are found on map units with steep to moderate slopes and crests, particularly in the north of the Shire. Large areas of this type of granitic terrain remains forested. The soil is a poorly developed, shallow sand, generally less than one metre deep. At the surface, these soils are dark grey to brown sandy loams, below this, a layer of coarse sand and gravel overlies granite rock. The soil depth is variable, hard rock is frequently close to the surface or is exposed as granite boulders or tors.

The topsoil contains large amounts of coarse sand and gravel. In addition, much of the available nutrients are held in the organic sandy topsoil. Once this has been removed, the remaining soil is very infertile, leading to poor pasture cover. Severe erosion may then occur when vegetative cover is lost, resulting in difficulties in establishing pastures.

A red Dermosol also occurs in the north of the Shire around Gembrook and Emerald. A detailed assessment of this soil was not undertaken. This soil has formed in elevated, high rainfall areas, from the increased weathering of the parent rock. This soil is easily distinguished by the colour of the B horizon. Instead of the brownish grey of the grey Kurosol, and the yellowish brown of the brown Chromosol, the B horizon is a distinct red to red brown. These soils are deep, well structured and free draining, they also have a higher nutrient status than other granitic soils. Evidence of minor landslips is found along exposed cuttings for roads, while sheet and gully erosion occur where soils are cultivated, or vegetative cover is sparse.

The distribution of this soil can be variable. Site inspection will be required to confirm its presence in the granitic map units surrounding Gembrook and Emerald. In some areas, the red Dermosols may be found in close association with other granitic soil types. Where this is the case, red Dermosols are more likely to be found on hill slopes with southerly and easterly aspects.

Some intensive agriculture is carried out on these soils around Gembrook.

Land management considerations

The management of land in the granitic landscape is influenced primarily by the steepness of slope, depth to hard rock and drainage characteristics of the soil.

Where steep slopes and crests occur, shallow soils, outcropping bedrock and slope provide the major limitations to development and/or use for agriculture. The siting of building envelopes, primary roading, farm dams and effluent disposal systems are often restricted by the shallow bedrock and steep terrain. However, improved technology can overcome some development limitations at considerable cost. Any development of these areas would need to be subject to careful planning, to ensure that severe soil erosion is minimised. Development of secondary roads and farm dams is not recommended in this steep terrain.

Agriculture in this steep terrain is restricted to grazing enterprises which use improved land management techniques to minimise soil erosion.

The gently undulating granitic terrain contains deeper soils and less rock outcrop, however it is the very poor drainage and very high dispersibility of the subsoil which place the major constraints on development. Poor drainage has a major impact upon the effectiveness of standard septic tanks, it also undermines road and building foundations. Where perched

watertables exist, the foundations of farm dams are placed at risk. In addition, the highly dispersive subsoils are extremely prone to gully erosion once the topsoil is removed. All types of construction which involve the exposure of the subsoil, particularly secondary roads and farm dams, will require strict development controls to minimise the development of eroding gullies.

The gently undulating terrain favours grazing enterprises. The low nutrient status of the topsoil combined with poor drainage and waterlogging do not favour intensive or broadacre cropping.

In elevated, high rainfall areas, site inspection may identify the presence of deep, well structured red Dermosols. Due to the drainage characteristics of this soil, there is little problem with waterlogging or perched watertables. However, steep land is at risk from minor landslip.

The red Dermosols appear capable of supporting grazing, forestry and intensive horticulture, particularly on gentle and moderate slopes.

SOILS OF GRANITIC ORIGIN

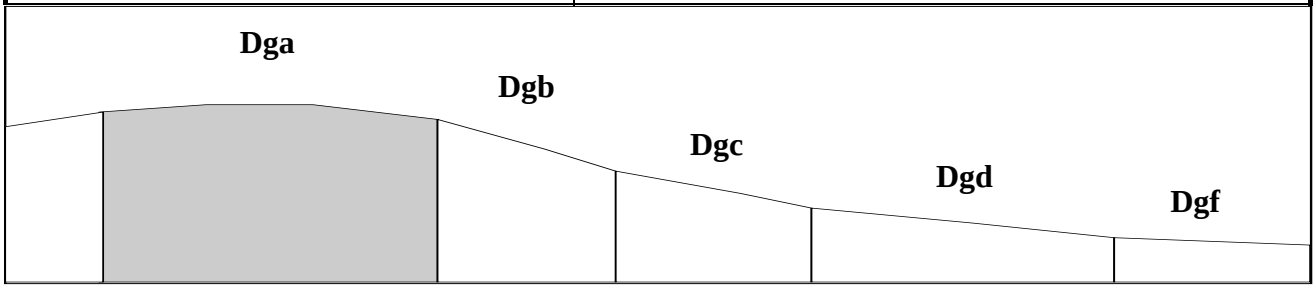
Plate 9 **Map Units: Dgb, Dgc, Dgd,**
Brown Chromosol

Plate 10 **Map Units: Dga, Dge**
Brown Chromosol

Plate 11 **Map Units: Dgf, Dgg**
Grey Kurosol

Plate 12 **Map Units: Dgh, Dgi**
Grey Kurosol

MAP UNIT SYMBOL: **Dga** Area: 72.6 ha	MAP UNIT: **Devonian granitic, steep crest**



A. GENERAL DESCRIPTION

The soils of this unit are generally brown Chromosols and in some areas grey Tenosols. Outcropping granite tors are common and depth to hardrock is variable. Grey Tenosols are common where very shallow soils are present due to rock outcrop. These soils are generally dark brown sandy loams, or coarse sand and gravel, over sands. The brown Chromosol soils are more common with sandy loam topsoils over sandy to medium clay subsoils. These soils generally have bleached A2 horizons and mottled subsoils. Both soils sit on a weathered granitic rock that overlies hard rock. Nutrients are readily leached from these soils, leaving them generally infertile. If vegetation is removed these soils will erode.

SITE CHARACTERISTICS

Parent Material Age:	Devonian	**Depth to Seas. Watertable:**	> 1.5 m
Parent Material Lithology:	Granite/granodiorite	**Flooding Risk:**	Nil
Landform Pattern:	Plateau/low hills	**Drainage:**	Moderately well drained
Landform Element:	Hillcrest	**Rock Outcrop:**	20-50% (Variable)
Slope a) common:	10%	**Depth to Hard Rock:**	> 1.5m
Slope b) range:	4-35%		
Potential Recharge to Groundwater:	Low		
Major Native Vegetation Species:	Messmate, Melaleuca		
Present Land Use:	Recreational		
Length of Growing Season:	8 months		

LAND DEGRADATION

Degradation Processes	Water Erosion sheet/rill	Water Erosion gully	Wind Erosion	Mass Movement	Salting	Acidification
Susceptibility	Moderate	Moderate	Moderate	Moderate	Low	Moderate
Incidence	Low	Low	Low	Low	Low	NA

B. SOIL PROFILE

PROFILE DESCRIPTION Site S27

A1 0-10 cm Very dark greyish brown (10YR3/2) coarse sandy loam, weak subangular blocky structure, peds 10-20 mm, rough fabric, weak consistence, pH 5.5. Clear transition to:

A2 10-25 cm Light yellowish brown (10YR6/4) sandy clay loam, bleached (10YR8/3) when dry, massive structure, sandy fabric, very weak consistence, pH 5.3. Clear transition to:

B2 25-60 cm Yellowish brown (10YR5/6) light medium clay, coarse prominent orange and coarse faint red mottles are common, weak polyhedral structure, peds 50-100 mm, smooth fabric, firm consistence, pH 5.5. Diffuse transition to:

C 60-150^{+} cm Weathered granite rock.

CLASSIFICATION

Factual Key:	Dy3.81 (major), Dy3.41 (minor)
Australian Soil Classification:	Bleached-Mottled, Magnesic, Brown Chromosol; medium, slightly gravelly, loamy/clayey, moderate (confidence level 2)
Unified Soil Group:	CH

INTERPRETATION OF LABORATORY ANALYSIS*

Horizon	pH ($CaCl_2$)	% Gravel	EC (salts)	Nutrient Status	P	K	Al	Organic Matter	Dispersibility
A1	4.4**	2%	VL	VL	D	S	T	H	VL
A2	4.3**	2%	VL	VL	D	D	S	VL	L
B2	4.6	< 1%	VL	L	D	D	S	VL	L

VL: Very low L: Low M: Moderate H: High VH: Very high D: Deficient S: Satisfactory

T: Potentially Toxic NA: Not Available * see Appendix D for analytical results ** Strongly Acidic

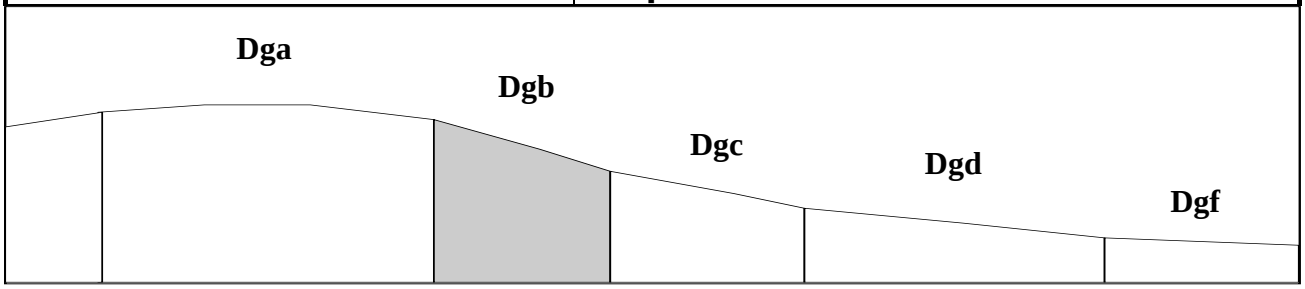
SOIL PROFILE CHARACTERISTICS:

Permeability:	Slow (estimate)
Available Water Capacity:	Low (80 mm H_2O)
Linear Shrinkage (B horizon):	Moderate (15%)

C. LAND CAPABILITY ASSESSMENT

Land Use	Class	Major Limiting Feature(s)/Land Use
Agriculture	$C_2T_2S_4$	Boulder content
Effluent Disposal (septic tanks)	4-3	Permeability
Farm Dams	5	Suitability of subsoil
Building Foundations		
slab	4	Proportion of boulders
stumps/footings	4	Proportion of boulders
Secondary Roads	4	Proportion of boulders
Rural Residential Development	5	Farm dams

MAP UNIT SYMBOL: **Dgb** Area: 1183 ha	MAP UNIT: **Devonian granitic, steep slope**



A. GENERAL DESCRIPTION

These steep slopes are generally found in association with steep crests (Dga). They are frequently dissected by minor drainage lines. These slopes often lead directly to drainage lines or moderately steep slopes. The major soil type is a brown Chromosol, with an occasional grey Tenosol present. The brown Chromosols have sandy loam topsoils over a sandy to medium clay. A bleached A2 horizon and mottled subsoils is common. Outcropping granite tors and rock restrict soil depth in many locations, the grey Tenosol is usually present under these circumstances. These soils are generally dark brown sandy loams, often coarse sand and gravel, over sands. Both soils sit on a decomposing sandy granite rock that overlies hard rock. Nutrients are readily leached from these soils making the soil relatively infertile. If vegetation is removed these soils are highly erodible and subject to sheet, rill and gully erosion. This unit is also subject to landslip.

SITE CHARACTERISTICS

Parent Material Age:	Devonian	**Depth to Seas. Watertable:**	> 1.5 m
Parent Material Lithology:	Granite/granodiorite	**Flooding Risk:**	Nil
Landform Pattern:	Mountains/low hills	**Drainage:**	Well drained
Landform Element:	Hillslope	**Rock Outcrop:**	< 50%
Slope a) common:	35	**Depth to Hard Rock:**	0.5-1.0m
Slope b) range:	> 32%		
Potential Recharge to Groundwater:	High		
Major Native Vegetation Species:	Messmate, Narrow-leaved Peppermint, Hakea, Melaleuca		
Present Land Use:	Recreational		
Length of Growing Season:	8 months		

LAND DEGRADATION

Degradation Processes	Water Erosion sheet/rill	Water Erosion gully	Wind Erosion	Mass Movement	Salting	Acidification
Susceptibility	High	Moderate	Moderate	High	Low	Moderate
Incidence	Moderate	Low	Low	Moderate	Low	NA

B. SOIL PROFILE

PROFILE DESCRIPTION SITE S26

A1 0-10 cm Dark greyish brown (10YR4/2) clayey coarse sand, weak subangular blocky structure, peds 10-20 mm, rough fabric, very weak consistence, pH 5.4. Clear transition to:

A2 10-40 cm Pale brown (10YR6/3) clayey coarse sand, bleached (10YR8/2) when dry, a few medium faint dark grey mottles, massive structure, weak consistence, a few small rounded granodiorite pebbles, pH 5.3. Clear transition to:

B2 40-90 cm Yellowish brown (10YR5/6) medium clay, very coarse prominent light brownish grey mottles are common, weak polyhedral structure, peds 50-100 mm, smooth fabric, very firm consistence, pH 6.0. Clear transition to:

C 90-150 cm Weathered granodiorite.

CLASSIFICATION

Factual Key:	Dy3.81 (major), Dy3.41 (minor)
Australian Soil Classification:	Bleached-Mottled, Magnesic, Brown Chromosol; thick, non-gravelly, sandy/clayey, moderate (confidence level 2)
Unified Soil Group:	CH

INTERPRETATION OF LABORATORY ANALYSIS*

Horizon	pH ($CaCl_2$)	% Gravel	EC (salts)	Nutrient Status	P	K	Al	Organic Matter	Dispersibility
A1	4.3**	< 1	VL	VL	D	D	T	H	VL
A2	4.4**	< 1	VL	VL	D	D	S	VL	L
B2	5.0	< 1	VL	L	D	D	S	VL	L

VL: Very low L: Low M: Moderate H: High VH: Very high D: Deficient S: Satisfactory

T: Potentially Toxic NA: Not Available * see Appendix D for analytical results ** Strongly Acidic

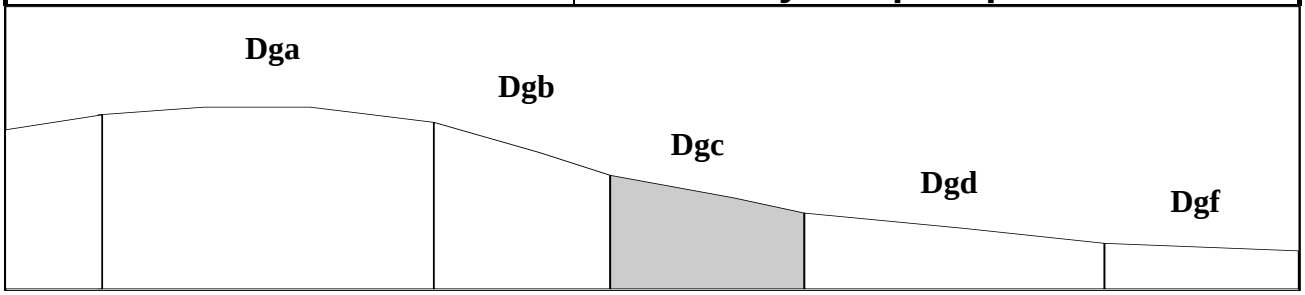
SOIL PROFILE CHARACTERISTICS:

Permeability:	Slow (average 35 mm/day, range 2-110 mm/day)
Available Water Capacity:	Moderate (130 mm H_2O)
Linear Shrinkage (B horizon):	Moderate (15%)

C. LAND CAPABILITY ASSESSMENT

Land Use	Class	Major Limiting Feature(s)/Land Use
Agriculture	$C_2T_5S_4$	Slope
Effluent Disposal (septic tanks)	5	Slope
Farm Dams	5	Slope
Building Foundations		
slab	5	Slope
stumps/footings	4	Slope, proportion of stone and boulders, susceptibility to slope failure
Secondary Roads	5	Slope
Rural Residential Development	5	Secondary roads, farm dams, effluent disposal, building foundations (Slab)

MAP UNIT SYMBOL: **Dgc** Area: 90 ha	MAP UNIT: **Devonian granitic, moderately steep slope**



A. GENERAL DESCRIPTION

These moderately steep slopes are often seen in association with steep slopes (Dgb) and steep crests (Dga). They are highly dissected with minor drainage lines. These slopes often lead directly to drainage lines or moderate slopes. Outcropping granite rocks occur and depth to hardrock is variable. Where rock comes close to the surface, water from upslope may appear on the surface as a spring or minor depression. The implications for development where springs occur is that these areas are often waterlogged and drainage is impeded. Building upslope from these areas may cause problems with effluent disposal. Brown Chromosol soils with sandy loams over sandy to medium clays, commonly bleached A2 horizons and mottled subsoils are common. Minor grey Tenosols with dark brown sandy loams over sands may be present. These soils sit on decomposing granitic rock that overlies hard rock. Nutrients are readily leached from these soils making them relatively infertile. If vegetation is removed, these soils are highly erodible and subject to sheet, rill and gully erosion.

SITE CHARACTERISTICS

Parent Material Age:	Devonian	**Depth to Seas. Watertable:**	> 1.5 m
Parent Material Lithology:	Granite/granodiorite	**Flooding Risk:**	Nil
Landform Pattern:	Low hills	**Drainage:**	Moderately well drained
Landform Element:	Hillslope	**Rock Outcrop:**	< 10%
Slope a) common:	26%	**Depth to Hard Rock:**	0.5-1.0 m
Slope b) range:	21-32%		
Potential Recharge to Groundwater:	Moderate		
Major Native Vegetation Species:	Messmate, Narrow-leaved Peppermint, Hakea, Melaleuca		
Present Land Use:	Recreational		
Length of Growing Season:	8 months		

LAND DEGRADATION

Degradation Processes	Water Erosion sheet/rill	Water Erosion gully	Wind Erosion	Mass Movement	Salting	Acidification
Susceptibility	Moderate	Moderate	Moderate	Moderate	Low	Moderate
Incidence	Low	Low	Low	Low	Low	NA

B. SOIL PROFILE

PROFILE DESCRIPTION Site S26

A1 0-10 cm Dark greyish brown (10YR4/2) clayey coarse sand, weak subangular blocky structure, peds 10-20 mm, rough fabric, very weak consistence, pH 5.4. Clear transition to:

A2 10-50 cm Pale brown (10YR6/3) clayey coarse sand, bleached (10YR8/2) when dry, a few medium faint dark grey mottles, massive structure, weak consistence, a few small rounded granodiorite pebbles, pH 5.3. Clear transition to:

B2 50-90 cm Yellowish brown (10YR5/6) medium clay, very coarse prominent light brownish grey mottles are common, weak polyhedral structure, peds 50-100 mm, smooth fabric, very firm consistence, pH 6.0. Clear transition to:

C 90-150 cm Weathered granodiorite.

CLASSIFICATION

Factual Key:	Dy3.41 (major), Dy3.81, Uc1.12 (minor)
Australian Soil Classification:	Bleached-Mottled, Magnesic, Brown Chromosol; thick, non-gravelly, sandy/clayey, moderate (confidence level 2)
Unified Soil Group:	CH

INTERPRETATION OF LABORATORY ANALYSIS*

Horizon	pH ($CaCl_2$)	% Gravel	EC (salts)	Nutrient Status	P	K	Al	Organic Matter	Dispersibility
A1	4.3**	< 1	VL	VL	D	D	S	M	VL
A2	4.4**	< 1	VL	VL	D	D	T	VL	L
B2	5.0	< 1	VL	L	D	D	S	VL	L

VL: Very low L: Low M: Moderate H: High VH: Very high D: Deficient S: Satisfactory

T: Potentially Toxic NA: Not Available * see Appendix D for analytical results ** Strongly Acidic

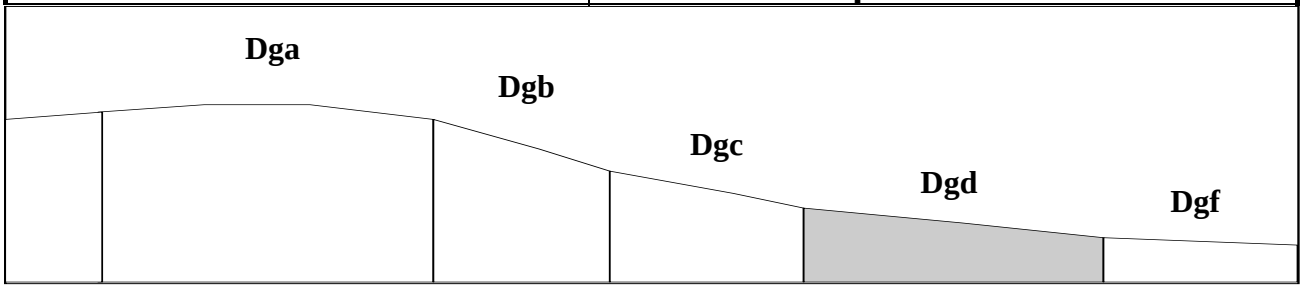
SOIL PROFILE CHARACTERISTICS:

Permeability:	Slow (average 35 mm/day, range 2-110 mm/day)
Available Water Capacity:	Moderate (130 mm H_2O)
Linear Shrinkage (B horizon):	Moderate (15%)

C. LAND CAPABILITY ASSESSMENT

Land Use	Class	Major Limiting Feature(s)/Land Use
Agriculture	$C_2T_4S_3$	Slope
Effluent Disposal (septic tanks)	4	Slope, slow permeability
Farm Dams	5	Slope
Building Foundations		
slab	4	Slope
stumps/footings	3	Slope, drainage, proportion of boulders, susceptibility to slope failure, linear shrinkage
Secondary Roads	4	Slope
Rural Residential Development	5	Farm dams

MAP UNIT SYMBOL: **Dgd** Area: 8974 ha	MAP UNIT: **Devonian granitic, moderate slope**



A. GENERAL DESCRIPTION

These moderate slopes are generally found in association with gentle slopes and gentle crests and may be dissected by minor drainage lines. Outcropping granite rocks are rare and depth to hardrock is variable. Where the rock comes close to the surface, water from upslope may appear on the surface as a spring and this has implications for development. These areas are often waterlogged and drainage is impeded. Building upslope from these areas may cause standard effluent disposal systems to fail. These soils are generally brown Chromosols with sandy loams over sandy to medium clays with bleached A2 horizons and mottled subsoils. In addition a grey Kurosol may occur. The grey Kurosol is a similar soil which is differentiated by the grey colour and increased depth. The soils sit on a decomposing sandy granitic rock that overlies hard rock. Nutrients are readily leached from these soils making them relatively infertile. If vegetation is removed these soils are subject to sheet, rill and gully erosion.

SITE CHARACTERISTICS

Parent Material Age:	Devonian	**Depth to Seas. Watertable:**	> 1.5 m
Parent Material Lithology:	Granite/granodiorite	**Flooding Risk:**	Nil
Landform Pattern:	Low hills	**Drainage:**	Imperfectly drained
Landform Element:	Hillslope	**Rock Outcrop:**	< 20%
Slope a) common:	15%	**Depth to Hard Rock:**	> 1.0 m
Slope b) range:	11-20%		
Potential Recharge to Groundwater:	Moderate		
Major Native Vegetation Species:	Messmate, Narrow-leaved Peppermint, Hakea, Melaleuca		
Present Land Use:	Grazing		
Length of Growing Season:	8 months		

LAND DEGRADATION

Degradation Processes	Water Erosion sheet/rill	Water Erosion gully	Wind Erosion	Mass Movement	Salting	Acidification
Susceptibility	Moderate	Moderate	Moderate	Moderate	Low	Moderate
Incidence	Low	Low	Low	Low	Low	NA

B. SOIL PROFILE

PROFILE DESCRIPTION Site S26

A1 0-10 cm Dark greyish brown (10YR4/2) clayey coarse sand, weak subangular blocky structure, peds 10-20 mm, rough fabric, very weak consistence, pH 5.4. Clear transition to:

A2 10-40 cm Pale brown (10YR6/3) clayey coarse sand, bleached (10YR8/2) when dry, a few medium faint dark grey mottles, massive structure, weak consistence, a few small rounded granodiorite pebbles, pH 5.3. Clear transition to:

B2 40-90 cm Yellowish brown (10YR5/6) medium clay, very coarse prominent light brownish grey (10YR6/2) mottles are common, weak polyhedral structure, peds 50-100 mm, smooth fabric, very firm consistence, pH 6.0. Clear transition to:

C 90-150 cm Weathered granodiorite

CLASSIFICATION

Factual Key:	Dy3.41(major), Dy3.81 (minor)
Australian Soil Classification:	Bleached-Mottled, Magnesic, Brown Chromosol; thick, non-gravelly, sandy/clayey, moderate (confidence level 2)
Unified Soil Group:	CH

INTERPRETATION OF LABORATORY ANALYSIS*

Horizon	pH ($CaCl_2$)	% Gravel	EC (salts)	Nutrient Status	P	K	Al	Organic Matter	Dispersibility
A1	4.3**	< 1	VL	VL	D	D	S	M	VL
A2	4.4**	< 1	VL	VL	D	D	T	VL	L
B2	5.0	< 1	VL	L	D	D	S	VL	L

VL: Very low L: Low M: Moderate H: High VH: Very high D: Deficient S: Satisfactory

T: Potentially Toxic NA: Not Available * see Appendix D for analytical results ** Strongly Acidic

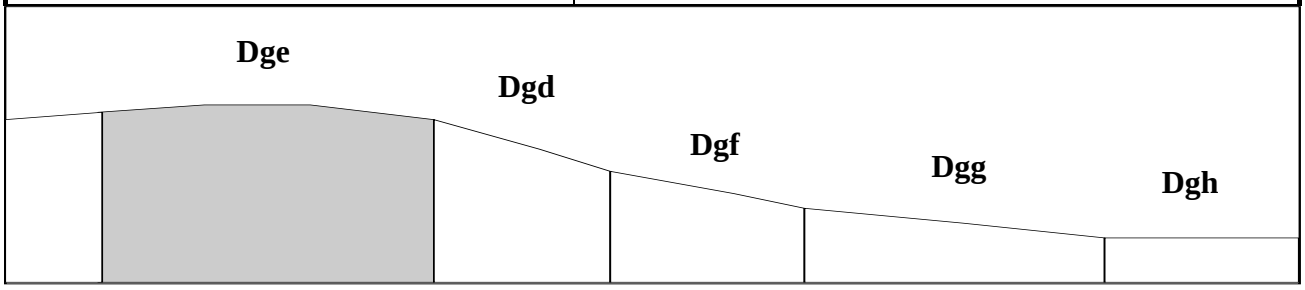
SOIL PROFILE CHARACTERISTICS:

Permeability:	Slow (average 35 mm/day, range 2-108 mm/day)
Available Water Capacity:	Moderate (130 mm/day)
Linear Shrinkage (B horizon):	Moderate (15%)

C. LAND CAPABILITY ASSESSMENT

Land Use	Class	Major Limiting Feature(s)/Land Use
Agriculture	$C_2T_3S_3$	Slope, topsoil condition, available water capacity, permeability-rainfall index, gravel stone and boulder content, susceptibility to sheet ,gully and wind erosion
Effluent Disposal (septic tanks)	4	Drainage, permeability
Farm Dams	4	Slope
Building Foundations		
slab	4	Slope, drainage
stumps/footings	4	Drainage
Secondary Roads	4	Slope, drainage
Rural Residential Development	4	Secondary roads, farm dams, effluent disposal, building foundations

MAP UNIT SYMBOL: **Dge** Area: 440 ha	MAP UNIT: **Devonian granitic, gentle crest**



A. GENERAL DESCRIPTION

Outcropping granite tors may occur and depth to hardrock is variable on the gentle granitic crests. The soils are variable, however brown Chromosols are most common with the occassional Grey Kurosol on gentle side slopes. The brown Chromosols have sandy loams topsoils over sandy to medium clays with bleached A2 horizons and mottled sub soils. Nutrients are readily leached from these soils making them relatively infertile. Removal of vegetation may cause these soils to erode.

SITE CHARACTERISTICS

Parent Material Age:	Devonian	**Depth to Seas. Watertable:**	> 1.5 m
Parent Material Lithology:	Granite/granodiorite	**Flooding Risk:**	Nil
Landform Pattern:	Plateau/low hills	**Drainage:**	Poorly drained
Landform Element:	Hillcrest	**Rock Outcrop:**	2-20 % (variable)
Slope a) common:	5%	**Depth to Hard Rock:**	1.5m
Slope b) range:	0-10%		
Potential Recharge to Groundwater:	Low		
Major Native Vegetation Species:	Messmate, Narrow-leaved Peppermint, Hakea, Melaleuca		
Present Land Use:	Grazing		
Length of Growing Season:	8 months		

LAND DEGRADATION

Degradation Processes	Water Erosion sheet/rill	Water Erosion gully	Wind Erosion	Mass Movement	Salting	Acidification
Susceptibility	Low	Low	Moderate	Very low	Low	Moderate
Incidence	Low	Low	Low	Very low	Low	NA

B. SOIL PROFILE

PROFILE DESCRIPTION Site S27

A1 0-10 cm Very dark grey brown (10YR3/2) coarse sandy loam, weak subangular blocky structure, peds 10-20 mm, rough fabric, weak consistence, pH 5.5. Clear transition to:

A2 10-25 cm Light yellowish brown (10YR6/4) sandy clay loam, bleached (10YR8/3) when dry, massive structure, sandy fabric, very weak consistence, pH 5.3. Clear transition to:

B2 25-60 cm Yellowish brown (10YR5/6) light medium clay, coarse prominent orange and coarse faint red mottles are common, weak polyhedral structure, peds 50-100 mm, smooth fabric, firm consistence, pH 5.5. Diffuse transition to:

BC 60-150^{+} cm Partially weathered granodiorite rock.

CLASSIFICATION

Factual Key:	Dy3.81 (major), Dy3.41 (minor)
Australian Soil Classification:	Bleached-Mottled, Magnesic, Brown Chromosol; medium, slightly gravelly, loamy/clayey, moderate (confidence level 2)
Unified Soil Group:	CH

INTERPRETATION OF LABORATORY ANALYSIS*

Horizon	pH ($CaCl_2$)	% Gravel	EC (salts)	Nutrient Status	P	K	Al	Organic Matter	Dispersibility
A1	4.4**	2%	VL	VL	D	S	T	H	VL
A2	4.3**	2%	VL	VL	D	D	S	VL	L
B2	4.6	< 1%	VL	L	D	D	S	VL	L

VL: Very low L: Low M: Moderate H: High VH: Very high D: Deficient S: Satisfactory

T: Potentially Toxic NA: Not Available * see Appendix D for analytical results ** Strongly Acidic

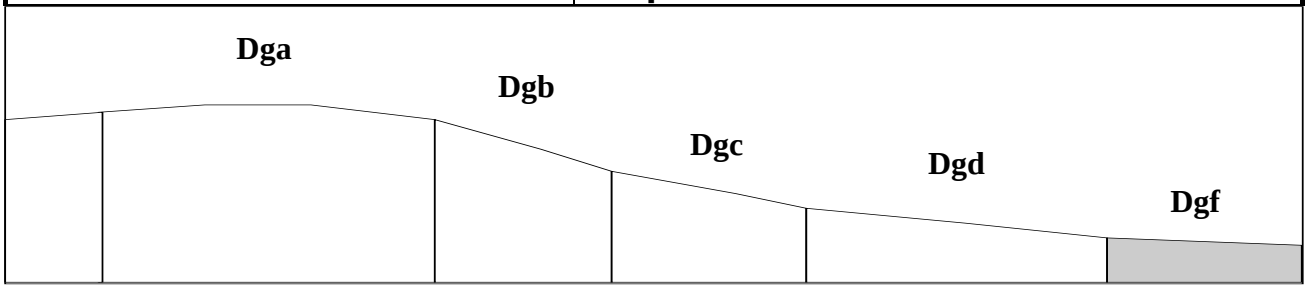
SOIL PROFILE CHARACTERISTICS:

Permeability:	Very slow (average 2 mm/day, range 0-5 mm/day)
Available Water Capacity:	Low (80 mm H_2O)
Linear Shrinkage (B horizon):	Moderate (15%)

C. LAND CAPABILITY ASSESSMENT

Land Use	Class	Major Limiting Feature(s)/Land Use
Agriculture	$C_2S_2T_4$	Permeability-rainfall index
Effluent Disposal (septic tanks)	5	Drainage, no. of months/year av. rainfall >Ksat, very slow permeability
Farm Dams	5	Suitability of subsoil
Building Foundations		
slab	5	Drainage
stumps/footings	5	Drainage
Secondary Roads	5	Drainage
Rural Residential Development	5	Secondary roads, farm dams, effluent disposal, building foundations

MAP UNIT SYMBOL: **Dgf** Area: 5810 ha	MAP UNIT: **Devonian granitic, gentle slope**



A. GENERAL DESCRIPTION

This map unit is generally found on the elevated plateaux and undulating low foothills of the Tynong granite formation. This unit is often found in association with gentle crests (Dge) and drainage lines. The acidic grey Kurosol soils have sandy loam topsoils overlying sandy to medium clay subsoils. Bleached A2 horizons and mottled and sodic subsoils are common. Because of the lower position on the landscape, these soils are subject to waterlogging. These slopes may contain colluvial material where they adjoin steep slopes. These leached colluvial soils are also acidic.

SITE CHARACTERISTICS

Parent Material Age:	Devonian	**Depth to Seas. Watertable:**	> 1.0m
Parent Material Lithology:	Granite/granodiorite	**Flooding Risk:**	Nil
Landform Pattern:	Low hills	**Drainage:**	Imperfectly drained
Landform Element:	Footslope	**Rock Outcrop:**	< 5%
Slope a) common:	8%	**Depth to Hard Rock:**	> 1.5 m
Slope b) range:	4-10%		
Potential Recharge to Groundwater:	Low		
Major Native Vegetation Species:	Messmate, Narrow-leaved Peppermint, Hakea, Melaleuca		
Present Land Use:	Grazing		
Length of Growing Season:	8 months		

LAND DEGRADATION

Degradation Processes	Water Erosion sheet/rill	Water Erosion gully	Wind Erosion	Mass Movement	Salting	Acidification
Susceptibility	Low	Low	Low	Very low	Low	Moderate
Incidence	Low	Low	Low	Very low	Low	NA

B. SOIL PROFILE

PROFILE DESCRIPTION Site S28

A11 0-5 cm — Dark grey (10YR4/1) humic coarse sandy loam, weak subangular blocky structure, peds 2-5 mm, smooth fabric, very weak consistence, pH 4.8. Abrupt transition to:

A12 5-20 cm — Greyish brown (10YR5/2) light coarse sandy loam, massive structure, sandy fabric, very weak consistence, pH 5.1. Clear transition to:

A2 20-40 cm — Pale brown (10YR6/3) heavy coarse sandy loam, bleached (10YR7/3) when dry, a few medium faint yellowish brown mottles, massive structure, sandy fabric, weak consistence, pH 5.6. Gradual transition to:

B1 40-60 cm Light brownish grey (10YR6/2) coarse sandy clay, many coarse distinct yellowish brown mottles, weak subangular blocky structure, peds 20-50 mm, rough fabric, weak consistence. Clear transition to:

B2 60-85 cm Light grey (10YR6/1) medium clay, many very coarse prominent yellowish brown (10YR5/8) mottles, weak subangular blocky structure, peds 20-50 mm, smooth fabric, very firm consistence, pH 5.5. Diffuse transition to:

C 85-150^{+} cm Weathered granodiorite rock.

CLASSIFICATION

Factual Key:	Dy3.41 (major), Dy3.81 (minor)
Australian Soil Classification:	Bleached-Sodic, Magnesic-Natric, Grey KUROSOL; thick, non-gravelly, loamy/clayey, moderate (confidence level 2)
Unified Soil Group:	CH

INTERPRETATION OF LABORATORY ANALYSIS*

Horizon	pH ($CaCl_2$)	% Gravel	EC (salts)	Nutrient Status	P	K	Al	Organic Matter	Dispersibility
A11	3.9**	< 1	VL	VL	D	D	T	H	VL
A12	4.2**	< 1	VL	VL	D	D	S	VL	L
A2	4.2**	< 1	VL	VL	D	D	T	VL	L
B2	4.2**	0	VL	L	D	D	T	VL	L

VL: Very low L: Low M: Moderate H: High VH: Very high D: Deficient S: Satisfactory

T: Potentially Toxic NA: Not Available * see Appendix D for analytical results ** Strongly Acidic

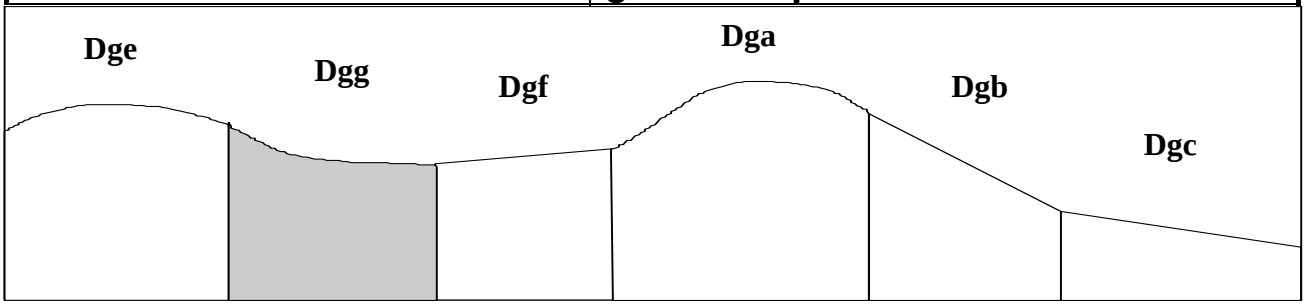
SOIL PROFILE CHARACTERISTICS:

Permeability:	Slow (average 35 mm/day, range 0-80 mm/day)
Available Water Capacity:	Low-Moderate (100 mm H_2O)
Linear Shrinkage (B horizon):	Moderate (13.5%)

C. LAND CAPABILITY ASSESSMENT

Land Use	Class	Major Limiting Feature(s)/Land Use
Agriculture	$C_2T_2S_4$	Topsoil conditions (A12)
Effluent Disposal (septic tanks)	4	Drainage, slow permeability
Farm Dams	3	Slope, linear shrinkage, suitability of subsoil, depth to seasonal watertable, depth to hardrock, permeability, low dispersibility of subsoil
Building Foundations		
slab	4	Drainage
stumps/footings	4	Drainage
Secondary Roads	4	Drainage
Rural Residential Development	4	Secondary roads, effluent disposal, building foundations

MAP UNIT SYMBOL: **Dgg** Area: 1790 ha	MAP UNIT: **Devonian granitic, very gentle slope**



A. GENERAL DESCRIPTION

This map unit is generally found on the elevated plateaux and low undulating foothills. This unit often occurs in association with gentle crests (Dge), gentle slopes (Dgf) and drainage lines (Dgh). The soils are commonly grey Kurosols with sandy loams over sandy to medium clays. These slopes may contain colluvial material where they adjoin steep slopes. The colluvial wash over these soils is highly leached and the topsoils on this unit are generally acidic. These soils have bleached A2 horizons, with mottled and sodic subsoils. Because of the gentle slopes this unit is subject to waterlogging. Many springs occur and may be associated with minor salting. The presence of tussock grass and swamp paperbark are good indicators of the presence of waterlogging or a spring.

SITE CHARACTERISTICS

Parent Material Age:	Devonian	**Depth to Seas. Watertable:**	1.0 m
Parent Material Lithology:	Granite/granodiorite	**Flooding Risk:**	Nil
Landform Pattern:	Low hills	**Drainage:**	Imperfectly drained
Landform Element:	Footslope	**Rock Outcrop:**	< 5%
Slope a) common:	2%	**Depth to Hard Rock:**	> 1.5 m
Slope b) range:	1-3%		
Potential Recharge to Groundwater:			
Major Native Vegetation Species:	Messmate, Narrow-leaved Peppermint, Hakea, Melaleuca		
Present Land Use:	Grazing		
Length of Growing Season:	8 months		

LAND DEGRADATION

Degradation Processes	Water Erosion sheet/rill	Water Erosion gully	Wind Erosion	Mass Movement	Salting	Acidification
Susceptibility	Very low	Very low	Low	Very low	Moderate	Moderate
Incidence	Low	Low	Low	Very low	Low	NA

B. SOIL PROFILE

PROFILE DESCRIPTION Site S28

A11 0-5 cm — Dark grey (10YR4/1) humic coarse sandy loam, weak subangular blocky structure, peds 2-5 mm, smooth fabric, very weak consistence, pH 4.8. Abrupt transition to:

A12 5-20 cm — Greyish brown (10YR5/2) light coarse sandy loam, massive structure, sandy fabric, very weak consistence, pH 5.1. Clear transition to:

A2 20-40 cm — Pale brown (10YR6/3) coarse sandy loam, bleached (10YR7/3) when dry, a few medium faint yellowish brown (10YR5/8) mottles, massive structure, sandy fabric, weak consistence, pH 5.6. Gradual transition to:

B1 40-60 cm Light brownish grey (10YR6/2), coarse sandy clay, many coarse distinct yellowish brown mottles, weak subangular blocky structure, peds 20-50 mm, rough fabric, weak consistence. Clear transition to:

B2 60-85 cm Light grey (10YR6/1) medium clay, many very coarse prominent yellowish brown mottles, weak subangular blocky structure, peds 20-50 mm, smooth fabric, very firm consistence, pH 5.5. Diffuse transition to:

C 85-150 cm Weathered granodiorite rock.

CLASSIFICATION

Factual Key:	Dy3.41
Australian Soil Classification:	Bleached-Sodic, Magnesic-Natric, Grey KUROSOL; thick, non-gravelly, loamy/clayey, moderate (confidence level 2)
Unified Soil Group:	CH

INTERPRETATION OF LABORATORY ANALYSIS*

Horizon	pH ($CaCl_2$)	% Gravel	EC (salts)	Nutrient Status	P	K	Al	Organic Matter	Dispersibility
A11	3.9**	< 1	VL	VL	D	D	T	H	VL
A12	4.2**	< 1	VL	VL	D	D	T	VL	L
A2	4.2**	< 1	VL	VL	D	D	T	VL	L
B2	4.2**	0	VL	L	D	D	T	VL	L

VL: Very low L: Low M: Moderate H: High VH: Very high D: Deficient S: Satisfactory

T: Potentially Toxic NA: Not Available * see Appendix D for analytical results ** Strongly Acidic

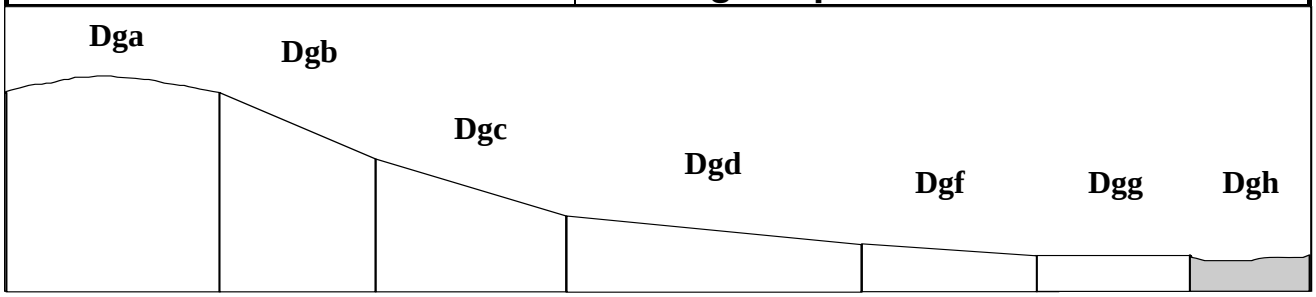
SOIL PROFILE CHARACTERISTICS:

Permeability:	Slow (average 35 mm/day, range 0-80 mm/day)
Available Water Capacity:	Low-Moderate (100 mm H_2O)
Linear Shrinkage (B horizon):	Moderate (13.5%)

C. LAND CAPABILITY ASSESSMENT

Land Use	Class	Major Limiting Feature(s)/Land Use
Agriculture	$C_2T_1S_4$	Conditions of topsoil (A12)
Effluent Disposal (septic tanks)	4	Drainage, slow permeability
Farm Dams	3	Linear shrinkage, suitability of subsoil, depth to seasonal watertable, depth to hardrock, permeability, low dispersibility of subsoil
Building Foundations		
slab	4	Drainage
stumps/footings	4	Drainage
Secondary Roads	4	Drainage
Rural Residential Development	4	Secondary roads, effluent disposal, building foundations

MAP UNIT SYMBOL: **Dgh** Area: 1260 ha	MAP UNIT: **Devonian granitic, drainage depression**



A. GENERAL DESCRIPTION

Drainage depressions vary from broad open drainage depressions in the valleys, to narrow drainage corridors that connect major drainage lines and incipient floodplains at low elevations. Grey Kurosols with clay subsoils are common in the lower and more defined drainage lines. A buried, uniform coarse sandy soil is often found at depth. The leached topsoils are acidic and contain high amounts of coarse sand and gravel. These soils are prone to waterlogging in winter and spring, especially where drainage depressions occur in broad flat valleys. The occurrence of tussock grass and swamp paperbark may indicate the presence of waterlogging. In winter months, drainage depressions at low elevation, may have high seasonal watertables and surface ponding.

SITE CHARACTERISTICS

Parent Material Age:	Devonian	**Depth to Seas. Watertable:**	0.5-1.0 m
Parent Material Lithology:	granite/granodiorite	**Flooding Risk:**	Moderate
Landform Pattern:	Undulating Hills	**Drainage:**	Imperfectly drained
Landform Element:	Drainage depression	**Rock Outcrop:**	Nil
Slope a) common:	3%	**Depth to Hard Rock:**	> 1.7 m
Slope b) range:	1-15%		
Potential Recharge to Groundwater:	Low		
Major Native Vegetation Species:	Messmate, Narrow-leaved Peppermint, Hakea, Melaleuca		
Present Land Use:	Grazing		
Length of Growing Season:	8 months		

LAND DEGRADATION

Degradation Processes	Water Erosion sheet/rill	Water Erosion gully	Wind Erosion	Mass Movement	Salting	Acidification
Susceptibility	Low	Low	Low	Very low	Low	Moderate
Incidence	Low	Moderate	Low	Very low	Low	NA

B. SOIL PROFILE

PROFILE DESCRIPTION Site S30

A1 0-15 cm Dark grey (10YR4/1) loam, moderate subangular blocky structure, peds 20-50 mm, rough fabric, weak consistence, pH 4.9. Abrupt transition to:

A21 15-30 cm Greyish brown (10YR5/2) silty loam, bleached (10YR8/1) when dry, massive structure, earthy fabric, weak consistence, pH 5.0. Gradual transition to:

A22 30-50 cm Dark yellowish brown (10YR6/3) coarse sandy loam, bleached (10YR8/1) when dry, many coarse distinct orange mottles and coarse faint brown mottles, massive structure, earthy fabric, very weak consistence, pH 5.0. Clear transition to:

B2 50-85 cm Grey (7.5YR6/0) medium clay, many coarse distinct orange mottles and coarse faint brown mottles, moderate polyhedral and angular blocky structure, peds 5-10 mm, smooth fabric, plastic consistence, few small subrounded pebbles, pH 5.0. Gradual transition to:

C 85-150 cm Partially weathered granodiorite.

CLASSIFICATION

Factual Key:	Dy3.41 (major), Dy3.81 (minor)
Australian Soil Classification:	Bleached-Mottled, Mesotrophic, Grey KUROSOL; thick, non-gravelly, loamy/clayey, moderate (confidence level 2)
Unified Soil Group:	CH

INTERPRETATION OF LABORATORY ANALYSIS*

Horizon	pH ($CaCl_2$)	% Gravel	EC (salts)	Nutrient Status	P	K	Al	Organic Matter	Dispersibility
A1	4.0**	0	VL	VL	S	D	T	H	L
A21	4.1**	0	VL	VL	S	D	S	M	M
A22	4.1**	0	VL	VL	D	D	T	VL	M
B2	4.0**	0	VL	VL	D	D	T	L	VL

VL: Very low L: Low M: Moderate H: High VH: Very high D: Deficient S: Satisfactory

T: Potentially Toxic NA: Not Available * see Appendix D for analytical results ** Strongly Acidic

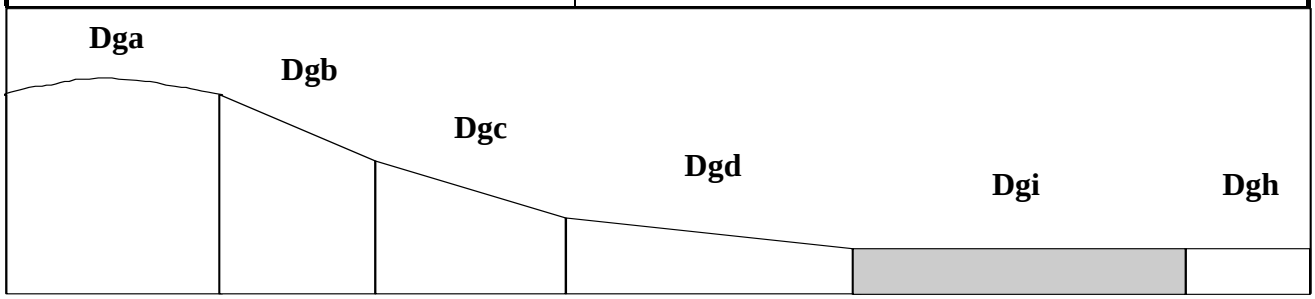
SOIL PROFILE CHARACTERISTICS:

Permeability:	Very slow (0-10 mm/day (estimate))
Available Water Capacity:	Moderate (120 mm H_2O)
Linear Shrinkage (B horizon):	Moderate (15%)

C. LAND CAPABILITY ASSESSMENT

Land Use	Class	Major Limiting Feature(s)/Land Use
Agriculture	$C_2T_2S_5$	Depth to seasonal watertable
Effluent Disposal (septic tanks)	5	No. of months/year av. rainfall >Ksat, very slow permeability
Farm Dams	5	Depth to seasonal watertable, dispersibility of subsoil
Building Foundations		
slab	4	Drainage, depth to seasonal watertable
stumps/footings	4	Drainage, depth to seasonal watertable
Secondary Roads	4	Drainage, depth to seasonal watertable
Rural Residential Development	5	Farm dams, effluent disposal

MAP UNIT SYMBOL: **Dgi** Area: 41 ha	MAP UNIT: **Devonian granitic, flat**



A. GENERAL DESCRIPTION

The flats are associated with the lower slopes and drainage lines of the granitic terrain. Acidic, grey Kurosols are common with light topsoils and clay subsoils. These soils generally have bleached A2 horizons and strongly mottled subsoils. Buried, uniform coarse sandy soil may be found at depth. Colluvial material from adjoining slopes and alluvial wash from past flooding events has contributed to the formation of this soil. Topsoils influenced by alluvial deposition contain higher amounts of coarse sand and gravel. These soils are prone to waterlogging in winter and spring months, especially close to the drainage depressions where the occurrence of tussock grass and swamp paperbark indicates the presence of waterlogging.

SITE CHARACTERISTICS

Parent Material Age:	Devonian	**Depth to Seas. Watertable:**	0.5-1 m
Parent Material Lithology:	Granite/granodiorite	**Flooding Risk:**	Moderate
Landform Pattern:	Plateau/low hills	**Drainage:**	Imperfectly drained
Landform Element:	Valley flat	**Rock Outcrop:**	Nil
Slope a) common:	1%	**Depth to Hard Rock:**	> 1.7 m
Slope b) range:	0-2		
Potential Recharge to Groundwater:	Low		
Major Native Vegetation Species:	Melaleuca, Messmate		
Present Land Use:	Grazing		
Length of Growing Season:	8 months		

LAND DEGRADATION

Degradation Processes	Water Erosion sheet/rill	Water Erosion gully	Wind Erosion	Mass Movement	Salting	Acidification
Susceptibility	Low	Low	Low	Very low	Moderate	Moderate
Incidence	Low	Low	Low	Very low	Low	NA

B. SOIL PROFILE

PROFILE DESCRIPTION Site S30

A1 0-15 cm Dark grey (10YR4/1) loam, moderate subangular blocky structure, peds 20-50 mm, rough fabric, weak consistence, pH 4.9. Abrupt transition to:

A21 15-30 cm Greyish brown (10YR5/2) silty loam, bleached (10YR8/1) when dry, massive structure, earthy fabric, weak consistence, pH 5.0. Gradual transition to:

A22 30-50 cm Dark yellowish brown (10YR6/3) coarse sandy loam, bleached (10YR8/1) when dry, many coarse distinct orange mottles and coarse faint brown mottles, massive structure, earthy fabric, very weak consistence, pH 5.0. Clear transition to:

B2 50-85 cm Grey (7.5YR6/0) medium clay, many coarse distinct orange mottles and coarse faint brown mottles, moderate polyhedral and angular blocky structure, peds 5-10 mm, smooth fabric, plastic consistence, few small subrounded pebbles, pH 5.0. Gradual transition to:

BC 85-150 cm Partially weathered granodiorite.

CLASSIFICATION

Factual Key:	Dy3.41 (major), Dy3.81 (minor)
Australian Soil Classification:	Bleached-Mottled, Mesotrophic, Grey KUROSOL; thick, non-gravelly, loamy/clayey, moderate (confidence level 2)
Unified Soil Group:	CH

INTERPRETATION OF LABORATORY ANALYSIS*

Horizon	pH ($CaCl_2$)	% Gravel	EC (salts)	Nutrient Status	P	K	Al	Organic Matter	Dispersibility
A1	4.0**	0	VL	VL	S	D	T	H	L
A21	4.1**	0	VL	VL	S	D	T	M	M
A22	4.1**	0	VL	VL	D	D	T	VL	M
B2	4.0**	0	VL	VL	D	D	T	L	VL

VL: Very low L: Low M: Moderate H: High VH: Very high D: Deficient S: Satisfactory

T: Potentially Toxic NA: Not Available * see Appendix D for analytical results ** Strongly Acidic

SOIL PROFILE CHARACTERISTICS:

Permeability:	Very slow (0-10 mm/day (estimate))
Available Water Capacity:	Moderate (120 mm H_2O)
Linear Shrinkage (B horizon):	Moderate (15%)

C. LAND CAPABILITY ASSESSMENT

Land Use	Class	Major Limiting Feature(s)/Land Use
Agriculture	$C_2T_1S_5$	Depth to seasonal watertable
Effluent Disposal (septic tanks)	5	No. of months/year av. rainfall > Ksat, permeability
Farm Dams	5	Depth to seasonal watertable, very low dispersibility of subsoil
Building Foundations		
slab	4	Drainage, depth to seasonal watertable
stumps/footings	4	Drainage, depth to seasonal watertable
Secondary Roads	4	Drainage, depth to seasonal watertable
Rural Residential Development	5	Farm dams, effluent disposal

4.5 Silurian metamorphic map units (Sm)

The Silurian metamorphic sediments are found in the vicinity of Upper Beaconsfield and Mt Burnett, adjacent to the granitic terrain. This can be seen as a narrow band of rocky steep crests, and highly dissected steep slopes. The metamorphosed areas often have higher relief than the surrounding areas. Moving away from the zone of contact, lower hills with less steep slopes and drainage lines are prominent. This metamorphic area is also known as a metamorphic aureole.

Metamorphosed sediments may display various levels of metamorphism. The intrusion of granitic material into the sedimentary rock has caused pressure, heating and folding of the sedimentary material. These processes bring about changes in the mineral composition, causing the rocks to become harder and more dense. Close to the granitic intrusion, strongly heated material such as hornfels may be found. This is an extremely hard and dense rock, and is generally found on steep crests and steep slopes. In addition, there is little evidence of the layering present in normal sedimentary material, however when moving away from the contact zone, layering of the sedimentary material becomes more obvious. The boundary between slightly heated sedimentary material and unheated sediments is difficult to delineate. The increase in hardness of metamorphic rocks makes them more resistant to weathering than the sedimentary material.

Soils formed on the metamorphic aureole are generally shallow and stony. Brown Sodosols are common where rocky crests and steep rocky slopes occur. Weakly structured, stony red Dermosols are present on shallow, steep slopes, and grey Chromosols appear where soil depth increases, especially when moderate slopes are encountered. Deeper yellow Chromosol soils occur around the break of slope and other gentle slopes. Surface stone is common on all crests and steep to moderate slopes.

All the above soils have bleached A2 horizons. These horizons have high percentages of silt and fine sand with low liquid limits. When excess water is added to these horizons they become sloppy and have little cohesive strength. If this horizon is exposed through removal of vegetation and topsoil, severe erosion can occur.

On many of the steep metamorphic units, excluding drainage depressions, a layer of stone is present in the A2 horizon, or the top of the B1 horizon. These sedimentary stones appear as discreet layers in these horizons and are generally angular in shape ranging in size from 20-600 mm in diameter and may be up to 60 per cent of the volume of the horizon. Stones that appear in the B2 layer are generally well distributed throughout the horizon, however there are occurrences where there may be an accumulation of stone, 20-600 mm in diameter, on top of the C-Horizon. Even though stones occur on the surface and in the B-horizons, the greatest concentration of stones are generally found in a layer in the A2 horizon.

Land management considerations

The metamorphic aureole has obvious hazards for a range of land uses. The major limitations are steep slopes, depth to hard rock and shallow soil depth. The steep terrain is susceptible to sheet and gully erosion, especially where vegetation cover is poor.

The siting of access tracks, building foundations, septic tanks and dams is made difficult by steep slopes, depth to rock and shallow soils. Soil conservation measures will be required to minimise erosion during house construction.

With rural residential development rapidly increasing in these areas, careful design of effluent disposal fields, farm dams and secondary roading is required. The major problem with secondary roading is the fine sandy A2 horizon. The A horizon, if left exposed, is prone to erosion. Road cuttings that are exposed are subject to undercutting by water and small slips may occur as a result.

The soils of this unit are often infertile and acidic, both in the A and B horizons. For this reason and the steepness of the terrain, metamorphic units are best suited for grazing, or conservation purposes.

SOILS OF SILURIAN METAMORPHIC ORIGIN

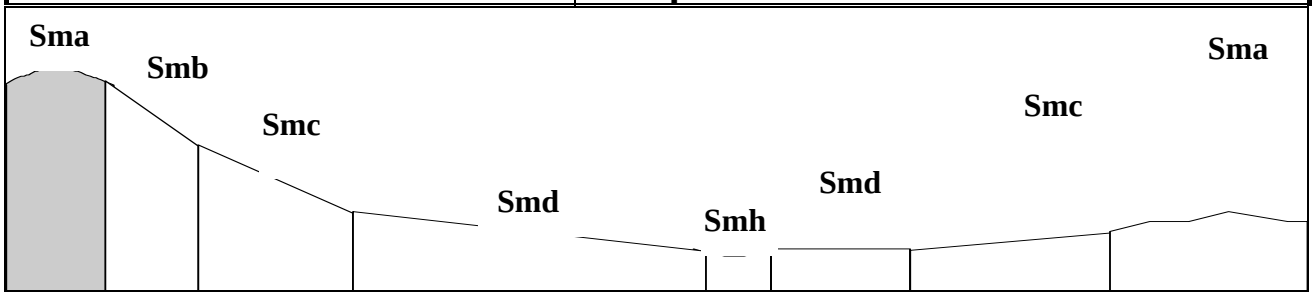
Plate 13 **Map Unit: Sma**
Brown Sodosol

Plate 14 **Map Unit: Smb**
Red Dermosol

Plate 15 **Map Unit: Smc, Smh**
Grey Chromosol

Plate 16 **Map Units: Smd**
Yellow Chromosol

MAP UNIT SYMBOL: **Sma** Area: 60 ha	MAP UNIT: **Silurian metamorphics, steep crest**



A. GENERAL DESCRIPTION

Steep metamorphic crests occur in the north of the Shire adjacent to the granitic terrain. A shallow stony brown Sodosol soil is common. Tenosols may also be found in very shallow soils where rock outcrop is significant. Soil depth varies from 30-80 cm in this unit. Surface stone is common, and may be up to 20 per cent in uncleared areas. A layer of stone is present between a depth of 10-30 cm in the A2 horizons. The bleached A2 horizons are poorly structured and have high contents of fine sand and silt. Surface stone can cause problems in agricultural situations, however in a construction situation it is easily removed. Topsoil should be retained and replaced after construction and the site revegetated to avoid sheet and gully erosion.

SITE CHARACTERISTICS

Parent Material Age:	Silurian	**Depth to Seas. Watertable:**	> 1.5 m
Parent Material Lithology:	Metamorphosed sediments	**Flooding Risk:**	Nil
Landform Pattern:	Rolling hills	**Drainage:**	Well drained
Landform Element:	Crest	**Rock Outcrop:**	< 20%
Slope a) common:	7%	**Depth to Hard Rock:**	0.3-0.8 m (variable)
Slope b) range:	3-15%		
Potential Recharge to Groundwater:	High		
Major Native Vegetation Species:	Messmate, Narrow-leaved Peppermint, Silver Wattle		
Present Land Use:	Grazing, native forest		
Length of Growing Season:	8 months		

LAND DEGRADATION

Degradation Processes	Water Erosion sheet/rill	Water Erosion gully	Wind Erosion	Mass Movement	Salting	Acidification
Susceptibility	Low	Low	Low	Very low	Low	Low
Incidence	Moderate	Low	Low	Low	Low	NA

B. SOIL PROFILE

PROFILE DESCRIPTION Site S39

A1 0-5 cm Very dark grey (10YR3/1) fine sandy loam, weak subangular blocky structure, peds 10-20 mm, rough fabric, very weak consistence, pH 5.4. Abrupt transition to:

A2 5-30 cm Light brown (10YR6/3) loam fine sandy, bleached (10YR7/3) when dry, strong subangular structure, peds 20-50 mm rough fabric, weak consistence, a few large subangular metamorphic pebbles, pH 5.5. Clear transition to:

B2 30-80 cm Brown (10YR5/4) medium clay, coarse distinct brown and orange mottles are common, strong polyhedral structure, peds 5-10 mm, smooth fabric, very firm consistence, a few subrounded metamorphic cobbles (60-200 mm), pH 5.9. Diffuse transition to:

C 80^{+} cm Weathered metamorphic rock.

CLASSIFICATION

Factual Key:	Dy3.41(major), Uc, Gn3.04 (minor)
Australian Soil Classification:	Magnesic, Mottled-Subnatric, Brown SODOSOL; medium, non-gravelly, loamy/clayey, moderate (confidence level 2)
Unified Soil Group:	CH

INTERPRETATION OF LABORATORY ANALYSIS*

Horizon	pH ($CaCl_2$)	% Gravel	EC (salts)	Nutrient Status	P	K	Al	Organic Matter	Dispersibility
A1	4.5	1	VL	L	D	D	T	H	VL
A2	4.4**	12	VL	VL	D	D	T	L	VL
B2	4.8	3	VL	L	D	D	S	VL	VL

VL: Very low L: Low M: Moderate H: High VH: Very high D: Deficient S: Satisfactory

T: Potentially Toxic NA: Not Available * see Appendix D for analytical results ** Strongly Acidic

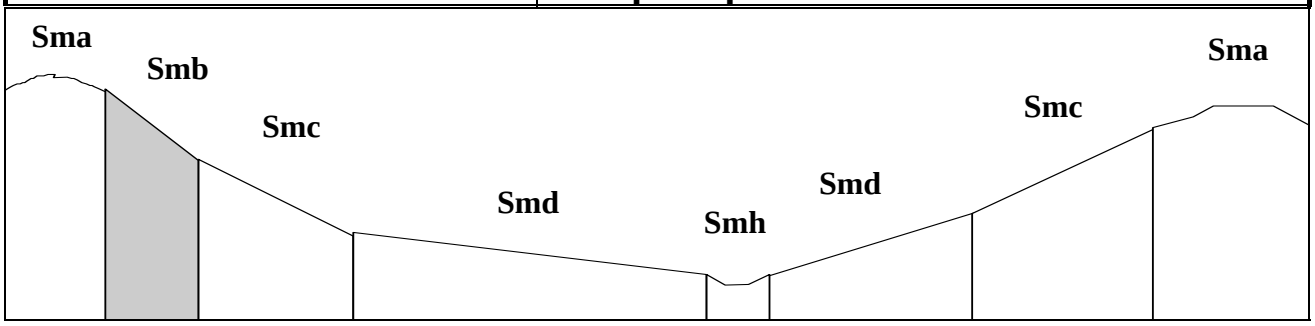
SOIL PROFILE CHARACTERISTICS:

Permeability:	Moderate (average 100 mm/day, range 0-330 mm/day)
Available Water Capacity:	Moderate (125 mm H_2O)
Linear Shrinkage (B horizon):	Moderate (17%)

C. LAND CAPABILITY ASSESSMENT

Land Use	Class	Major Limiting Feature(s)/Land Use
Agriculture	$C_2T_2S_{3-4}$	Depth to hardrock (variable)
Effluent Disposal (septic tanks)	3-4	Depth to impermeable layer (variable)
Farm Dams	5	Very low dispersibility of subsoil, shallow depth to hardrock (variable)
Building Foundations		
slab	3	Slope, proportion of stone and boulders
stumps/footings	3	Proportion of stone and boulders, linear shrinkage
Secondary Roads	3	Slope, proportion of stone and boulders, linear shrinkage, USG
Rural Residential Development	5	Farm dams

MAP UNIT SYMBOL: **Smb** Area: 195 ha	MAP UNIT: **Silurian metamorphics, steep slope**



A. GENERAL DESCRIPTION

Steep sedimentary slopes are present adjacent to the granitic terrain in the north of the Shire. Soils are similar to those found on the crests (Sma) with predominantly shallow, stony red Dermosols and occassional brown Sodosols and Tenosols. Soil depth may vary from 50-110 cm. The A2 horizons have high percentages of silt and sand, and are prone to erosion if the topsoil is removed.

SITE CHARACTERISTICS

Parent Material Age:	Silurian	**Depth to Seas. Watertable:**	> 1.3 m
Parent Material Lithology:	Metamorphosed sediments	**Flooding Risk:**	Nil
Landform Pattern:	Rolling hills	**Drainage:**	Well drained
Landform Element:	Crest	**Rock Outcrop:**	< 20%
Slope a) common:	35%	**Depth to Hard Rock:**	0.5-1.1 m
Slope b) range:	> 33%		
Potential Recharge to Groundwater:	High		
Major Native Vegetation Species:	Narrow-leaved Peppermint, Messmate, Casuarina		
Present Land Use:	Grazing, native forest		
Length of Growing Season:	8 months		

LAND DEGRADATION

Degradation Processes	Water Erosion sheet/rill	Water Erosion gully	Wind Erosion	Mass Movement	Salting	Acidification
Susceptibility	Moderate	Low	Moderate	High	Low	Low
Incidence	Moderate	Moderate	Low	Moderate	Low	NA

B. SOIL PROFILE

PROFILE DESCRIPTION Site S40

A1 0-10 cm Dark greyish brown (10YR4/2) humic fine sandy loam, weak subangular blocky structure, peds 10-20 mm, rough fabric, very weak consistence, pH 5.4. Clear transition to:

A21 10-30 cm Brown (10YR5/3) fine sandy loam, weak polyhedral structure, peds 20-50 mm, rough fabric, weak consistence, very few small subrounded metamorphic pebbles, pH 5.7. Gradual transition to:

A22 30-60 cm Yellowish brown (10YR5/4) sandy clay loam fine sandy, weak subangular blocky structure, peds 20-50 mm, rough fabric, weak consistence, many large (20-60 mm) subrounded metamorphic pebbles, pH 6.1. Gradual transition to:

B1	60-70 cm	Brown (7.5YR5/4) fine sandy clay, many medium distinct brownish yellowish mottles, moderate polyhedral structure, peds 20-50 mm, smooth fabric, firm consistence, pH 6.1. Clear transition to:
B2	70-110 cm	Reddish brown (5YR4/4) medium clay, strong polyhedral structure, peds 20-50 mm, smooth fabric, angular metamorphic cobbles (60-200 mm) are common, firm consistence, pH 5.8. Diffuse transition to:
B/C	110^{+} cm	Reddish brown (5YR4/4) light medium clay, moderate polyhedral structure, peds 20-50 mm, smooth structure, many angular metamorphic cobbles (60-200 mm), firm consistence.

CLASSIFICATION

Factual Key:	Gn3.04 (major), Dy3.41, Uc (minor)
Australian Soil Classification:	Eutrophic, Red DERMOSOL; medium, non-gravelly, loamy, clayey, very deep. (confidence level 2)
Unified Soil Group:	CL

INTERPRETATION OF LABORATORY ANALYSIS*

Horizon	pH ($CaCl_2$)	% Gravel	EC (salts)	Nutrient Status	P	K	Al	Organic Matter	Dispersibility
A1	4.5	1	VL	VL	D	S	T	H	VL
A21	4.7	5	VL	VL	D	D	S	VL	VL
A22	4.9	28	VL	VL	D	D	S	VL	L
B1	4.8	4	VL	VL	D	D	S	VL	VL
B2	4.8	0	VL	L	D	D	S	VL	L

VL: Very low L: Low M: Moderate H: High VH: Very high D: Deficient S: Satisfactory

T: Potentially Toxic NA: Not Available * see Appendix D for analytical results ** Strongly Acidic

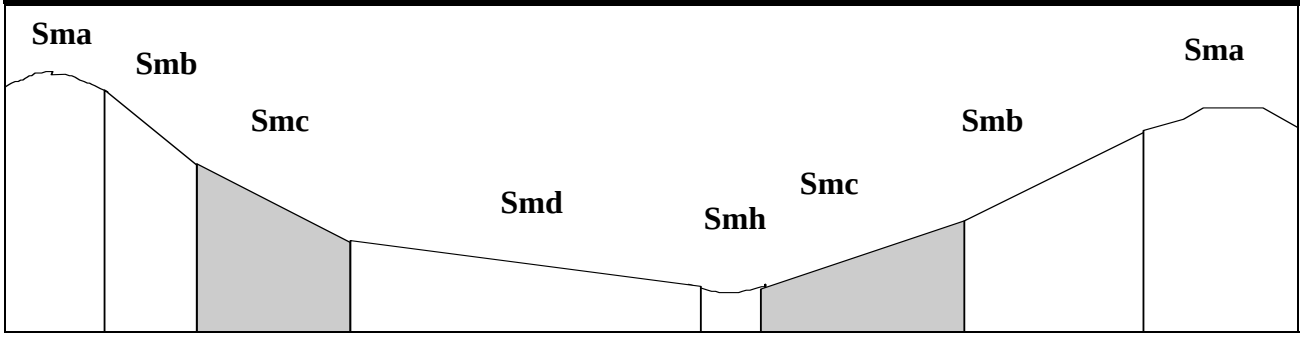
SOIL PROFILE CHARACTERISTICS:

Permeability:	Slow (average 50 mm/day, range 0-80 mm/day)
Available Water Capacity:	Moderate (148 mm H_2O)
Linear Shrinkage (B horizon):	Moderate (13.5%)

C. LAND CAPABILITY ASSESSMENT

Land Use	Class	Major Limiting Feature(s)/Land Use
Agriculture	$C_2T_5S_4$	Slope
Effluent Disposal (septic tanks)	5	Slope
Farm Dams	5	Slope
Building Foundations		
slab	5	Slope
stumps/footings	4	Slope, proportion of stone and boulders, susceptibility to slope failure
Secondary Roads	5	Slope
Rural Residential Development	5	Secondary roads, farm dams, effluent disposal, building foundations

MAP UNIT SYMBOL: **Smc** Area: 736 ha	MAP UNIT: **Silurian metamorphics, moderately steep slope**



A. GENERAL DESCRIPTION

Moderately steep slopes are found mostly in the north of the district near the metamorphic aureole. Stony, grey Chromosol soils with bleached A2 horizons are common, with variants including red and yellow Dermosols. Soil depth is between 75-130 cm. A stone layer is common in the A2 horizon, or at the top of the B1 horizon. The fine sandy or silty A2 horizon has very weak structure which breaks down readily when excess water is added. These slopes are prone to sheet and rill erosion, particularly if the A2 horizon is exposed.

SITE CHARACTERISTICS

Parent Material Age:	Silurian	**Depth to Seas. Watertable:**	> 1.3 m
Parent Material Lithology:	Metamorphosed sediments	**Flooding Risk:**	Nil
Landform Pattern:	Rolling hills	**Drainage:**	Well drained
Landform Element:	Hillslope	**Rock Outcrop:**	< 20%
Slope a) common:	25%	**Depth to Hard Rock:**	0.5-1.3 m
Slope b) range:	21-32%		
Potential Recharge to Groundwater:	High		
Major Native Vegetation Species:	Messmate, Narrow-leaved Peppermint		
Present Land Use:	Improved pasture grazing, native forest, state forest		
Length of Growing Season:	8 months		

LAND DEGRADATION

Degradation Processes	Water Erosion sheet/rill	Water Erosion gully	Wind Erosion	Mass Movement	Salting	Acidification
Susceptibility	Moderate	Low	Low	Moderate	Low	Moderate
Incidence	Moderate	Low	Low	Moderate	Low	NA

B. SOIL PROFILE

PROFILE DESCRIPTION Site S42

A1 0-5 cm Dark greyish brown (10YR4/2) loam fine sandy, moderate subangular blocky structure, peds 2-5 mm, rough fabric, weak consistence, pH 5.3. Clear transition to:

A2 5-45 cm Pale brown (10YR6/3) sandy clay loam fine sandy, bleached (10YR7/3) when dry, weak polyhedral structure, peds 10-20 mm, rough fabric, weak consistence, many subrounded metamorphic cobbles (60-200 mm), pH 5.3. Clear transition to:

B2 45-80 cm Pale brown (10YR6/3) light clay, coarse prominent red mottles and coarse distinct orange mottles are common, strong polyhedral structure, peds 2-5 mm, smooth fabric, firm consistence, many subrounded metamorphic cobbles (60-200 mm), pH 5.5. Gradual transition to:

C 80^{+} cm Weathered metamorphic rock.

CLASSIFICATION

Factual Key:	Dy3.41(major), Gn3.04 (minor)
Australian Soil Classification:	Bleached-Mottled, Magnesic, Grey CHROMOSOL; thick, slightly gravelly, loamy/clayey, moderate (confidence level 2)
Unified Soil Group:	CL

INTERPRETATION OF LABORATORY ANALYSIS*

Horizon	pH ($CaCl_2$)	% Gravel	EC (salts)	Nutrient Status	P	K	Al	Organic Matter	Dispersibility
A1	4.2**	3	VL	VL	D	S	T	H	VL
A2	4.3**	26	VL	VL	D	D	T	VL	VL
B2	4.6	30	VL	L	D	D	S	VL	VL

VL: Very low L: Low M: Moderate H: High VH: Very high D: Deficient S: Satisfactory

T: Potentially Toxic NA: Not Available * see Appendix D for analytical results ** Strongly Acidic

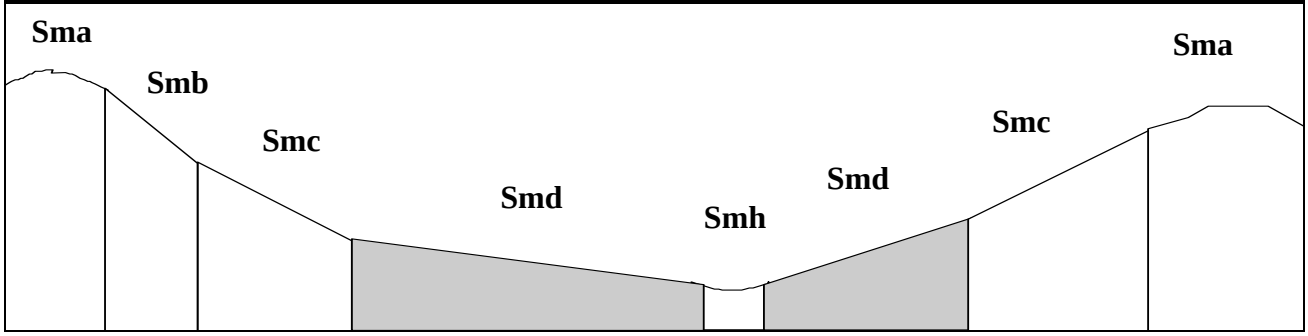
SOIL PROFILE CHARACTERISTICS:

Permeability:	Moderate (average 130 mm/day, range 40-230 mm/day)
Available Water Capacity:	Moderate (125 mm H_2O)
Linear Shrinkage (B horizon):	Low (12%)

C. LAND CAPABILITY ASSESSMENT

Land Use	Class	Major Limiting Feature(s)/Land Use
Agriculture	$C_2T_4S_4$	Slope, gravel stone and boulder content
Effluent Disposal (septic tanks)	4	Slope
Farm Dams	5	Slope, suitability of subsoil, very low dispersibility of subsoil
Building Foundations		
slab	4	Slope
stumps/footings	3	Slope, depth to seasonal watertable, proportion of stones and boulders, susceptibility to slope failure
Secondary Roads	4	Slope, proportion of stones and boulders
Rural Residential Development	5	Farm dams

MAP UNIT SYMBOL: **Smd** Area: 914 ha	MAP UNIT: **Silurian metamorphic, moderate slope**



A. GENERAL DESCRIPTION

Moderate slopes occur along a noticeable break between steep and gentle slopes. Soils occurring on this unit are related to position in the landscape. The accumulation of colluvial material downslope influences soil formation and depth. The dominant soil type is a mottled yellow Chromosol with a bleached A2 horizon. A stone layer is common in the A2 horizon, or on the top of the B1 horizon. The fine sandy or silty A2 horizon has very weak structure which breaks down readily when excess water is added, making these slopes prone to sheet and rill erosion if the A2 horizon is exposed. Minor drainage lines may suffer from gully erosion.

SITE CHARACTERISTICS

Parent Material Age:	Silurian	**Depth to Seas. Watertable:**	< 1.5 m
Parent Material Lithology:	Metamorphosed sediments	**Flooding Risk:**	Nil
Landform Pattern:	Rolling hills	**Drainage:**	Moderately well drained
Landform Element:	Hillslope	**Rock Outcrop:**	< 10%
Slope a) common:	14%	**Depth to Hard Rock:**	> 1.5 m
Slope b) range:	11-20%		
Potential Recharge to Groundwater:	Moderate		
Major Native Vegetation Species:	Messmate, Narrow-leaved Peppermint		
Present Land Use:	Improved pasture, State Park		
Length of Growing Season:	8 months		

LAND DEGRADATION

Degradation Processes	Water Erosion sheet/rill	gully	Wind Erosion	Mass Movement	Salting	Acidification
Susceptibility	Low	Very low	Moderate	High	Low	Moderate
Incidence	Low	Low	Low	Moderate	Low	NA

B. SOIL PROFILE

PROFILE DESCRIPTION Site S41

A1 0-10 cm Very dark grey (10YR3/1) fine sandy loam, moderate subangular blocky structure, peds 10-20 mm, rough fabric, weak consistence, pH 5.3. Abrupt transition to:

A2 10-35 cm Pale brown (10YR6/3) fine sandy loam, bleached (10YR7/3) when dry, strong subangular blocky structure, peds 20-50 mm, rough fabric, weak consistence, abundant large subangular metamorphic pebbles, pH 5.6. Clear transition to:

B21 35-125 cm Light brownish grey (10YR6/2) fine sandy clay, many very coarse distinct orange mottles, weak polyhedral structure, peds 5-10 mm, rough fabric, firm consistence, pH 5.7. Gradual transition to:

B22 125-150 cm Light yellowish brown (10YR6/4) medium heavy clay, many very coarse distinct grey mottles and a few coarse prominent red mottles, moderate polyhedral structure, peds 20-50 mm, smooth fabric, very firm consistence, very few large subangular metamorphic pebbles, pH 5.6. Gradual transition to:

C 150 cm Weathered metamorphic rock.

CLASSIFICATION

Factual Key:	Dy3.41
Australian Soil Classification:	Bleached-Mottled, Magnesic, Yellow CHROMOSOL; thick, slightly gravelly, loamy/clayey, moderate (confidence level 2)
Unified Soil Group:	CH

INTERPRETATION OF LABORATORY ANALYSIS*

Horizon	pH ($CaCl_2$)	% Gravel	EC (salts)	Nutrient Status	P	K	Al	Organic Matter	Dispersibility
A1	4.3**	1	VL	L	D	D	T	VH	VL
A2	4.5	90	VL	VL	D	D	S	VL	VL
B21	4.2**	< 1	VL	L	D	D	T	VL	M
B22	4.3**	< 1	VL	M	D	D	T	VL	VL

VL: Very low L: Low M: Moderate H: High VH: Very high D: Deficient S: Satisfactory

T: Potentially Toxic NA: Not Available * see Appendix D for analytical results ** Strongly Acidic

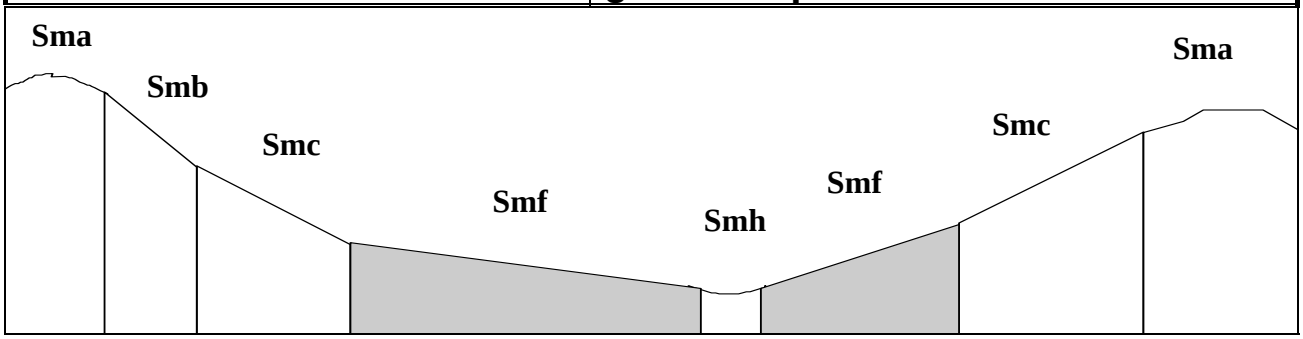
SOIL PROFILE CHARACTERISTICS:

Permeability:	Moderate (average 130 mm/day, range 40-230 mm/day)
Available Water Capacity:	Very high (> 200 mm H_2O)
Linear Shrinkage (B horizon):	Moderate (17.5 %)

C. LAND CAPABILITY ASSESSMENT

Land Use	Class	Major Limiting Feature(s)/Land Use
Agriculture	$C_2T_3S_5$	Gravel stone and boulder content (A2)
Effluent Disposal (septic tanks)	3	Slope, drainage
Farm Dams	4	Slope, depth to hardrock, permeability, susceptibility to slope failure
Building Foundations		
slab	5	Proportion of stones and boulders (A2)
stumps/footings	5	Proportion of stones and boulders (A2)
Secondary Roads	5	Proportion of stones and boulders (A2)
Rural Residential Development	5	Secondary roads, building foundations

MAP UNIT SYMBOL: **Smf** 92.3: ha	MAP UNIT: **Silurian metamorphics, gentle slope**



A. GENERAL DESCRIPTION

The soils occurring on gentle metamorphic slopes are related to the position in the landscape. The dominant soil type is a mottled yellow Chromosol with a bleached A2 horizon. A rock layer is common in the A2 horizon or on top of the B1. The fine sandy or silty A2 horizon has very weak structure which breaks down readily when excess water is added, making these slopes prone to sheet and rill erosion if the A2 horizon is exposed. Minor drainage lines may suffer from gully erosion. Because of the nature of the metamorphic aureole and the steepness of the metamorphic country there is only a small area of this unit in the Shire.

SITE CHARACTERISTICS

Parent Material Age:	Silurian	**Depth to Seas. Watertable:**	< 1.5 m
Parent Material Lithology:	Metamorphosed sediments	**Flooding Risk:**	Nil
Landform Pattern:	Rolling hills	**Drainage:**	Moderately well drained
Landform Element:	Hillslope	**Rock Outcrop:**	< 10%
Slope a) common:	7%	**Depth to Hard Rock:**	1.5 m
Slope b) range:	4-10%		
Potential Recharge to Groundwater:	Moderate		
Major Native Vegetation Species:	Messmate, Narrow-leaved Peppermint		
Present Land Use:	Improved pasture, State Park		
Length of Growing Season:	8 months		

LAND DEGRADATION

Degradation Processes	Water Erosion sheet/rill	Water Erosion gully	Wind Erosion	Mass Movement	Salting	Acidification
Susceptibility	Low	Low	Moderate	Low	Low	Low
Incidence	Low	Low	Low	Low	Low	NA

B. SOIL PROFILE

PROFILE DESCRIPTION Site S41

A1 0-10 cm Very dark grey (10YR3/1) fine sandy loam, moderate subangular blocky structure, peds 10-20 mm, rough fabric, weak consistence, pH 5.3. Abrupt transition to:

A2 10-35 cm Pale brown (10YR6/3) fine sandy loam, bleached (10YR7/3) when dry, strong subangular structure, peds 20-50 mm, rough fabric, weak consistence, abundant large subangular metamorphic pebbles, pH 5.6. Clear transition to:

B21 35-125 cm Light brownish grey (10YR6/2) fine sandy clay, many very coarse distinct orange mottles, weak polyhedral structure, peds 5-10 mm, rough fabric, firm consistence, pH 5.7. Gradual transition to:

B22 125-150 cm Light yellowish brown (10YR6/4) medium heavy clay, many very coarse distinct grey mottles and a few coarse prominent red mottles, moderate polyhedral structure, peds 20-50 mm, smooth fabric, very firm consistence, very few large subangular metamorphic pebbles, pH 5.6. Gradual transition to:

C 150 cm Weathered metamorphic rock.

CLASSIFICATION

Factual Key:	Dy3.41
Australian Soil Classification:	Bleached-Mottled, Magnesic, Yellow CHROMOSOL; thick, slightly gravelly, loamy/clayey, moderate (confidence level 2)
Unified Soil Group:	CH

INTERPRETATION OF LABORATORY ANALYSIS*

Horizon	pH ($CaCl_2$)	% Gravel	EC (salts)	Nutrient Status	P	K	Al	Organic Matter	Dispersibility
A1	4.3**	1	VL	L	D	D	T	VH	VL
A2	4.5	90	VL	VL	D	D	T	VL	VL
B21	4.2**	< 1	VL	L	D	D	T	VL	M
B22	4.3**	< 1	VL	M	D	D	T	VL	VL

VL: Very low L: Low M: Moderate H: High VH: Very high D: Deficient S: Satisfactory

T: Potentially Toxic NA: Not Available * see Appendix D for analytical results ** Strongly Acidic

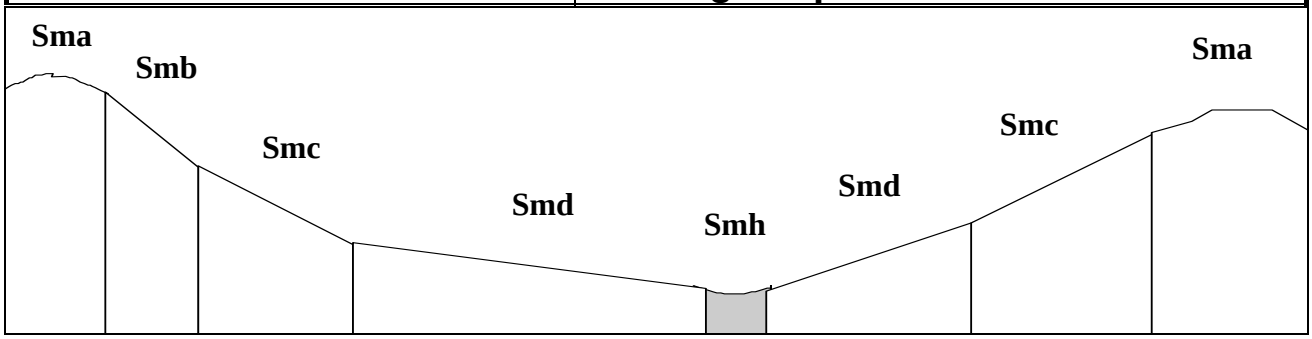
SOIL PROFILE CHARACTERISTICS:

Permeability:	Moderate (average 130 mm/day, range 40-230 mm/day)
Available Water Capacity:	Very high (> 200 mm H_2O)
Linear Shrinkage (B horizon):	Moderate (17.5 %)

C. LAND CAPABILITY ASSESSMENT

Land Use	Class	Major Limiting Feature(s)/Land Use
Agriculture	$C_2T_3S_5$	Gravel stone and boulder content (A2)
Effluent Disposal (septic tanks)	3	Slope, drainage
Farm Dams	4	Slope, depth to hardrock, permeability, susceptibility to slope failure
Building Foundations		
slab	5	Proportion of stones and boulders (A2)
stumps/footings	5	Proportion of stones and boulders (A2)
Secondary Roads	5	Proportion of stones and boulders (A2)
Rural Residential Development	5	Secondary roads, building foundations

MAP UNIT SYMBOL: **Smh** Area: 111 ha	MAP UNIT: **Silurian metamorphics, drainage depression**



A. GENERAL DESCRIPTION

The metamorphic terrain generally has slopes between 20-40 per cent and the minor drainage lines which dissect these slopes are generally narrow and steep. In some situations minor drainage lines may not have been mapped due to restrictions of scale, especially in the steeper units. Bleached and mottled grey Chromosol soils are common. Some gully erosion occurs in this unit. Waterlogging is a problem in winter and spring months. The soils are often acidic.

SITE CHARACTERISTICS

Parent Material Age:	Silurian	**Depth to Seas. Watertable:**	> 1.5 m
Parent Material Lithology:	Metamorphosed sediments	**Flooding Risk:**	Moderate
Landform Pattern:	Low hills	**Drainage:**	Imperfectly drained
Landform Element:	Drainage depression	**Rock Outcrop:**	< 10%
Slope a) common:	7%	**Depth to Hard Rock:**	> 1.5 m
Slope b) range:	2-15%		
Potential Recharge to Groundwater:	Moderate		
Major Native Vegetation Species:	Messmate, Narrow-leaved Peppermint		
Present Land Use:	Improved pasture, State Park		
Length of Growing Season:	8 months		

LAND DEGRADATION

Degradation Processes	Water Erosion sheet/rill	gully	Wind Erosion	Mass Movement	Salting	Acidification
Susceptibility	Low	Low	Low	Low	Low	Moderate
Incidence	Moderate	Moderate	Low	Low	Low	NA

B. SOIL PROFILE

PROFILE DESCRIPTION Site S42

A1 0-5 cm Dark greyish brown (10YR4/2) loam fine sandy, moderate subangular blocky structure, peds 2-5 mm, rough fabric, weak consistence, pH 5.3. Clear transition to:

A2 5-45 cm Pale brown (10YR6/3) sandy clay loam fine sandy, bleached (10YR7/3) when dry, weak polyhedral structure, peds 10-20 mm, rough fabric, weak consistence, many subrounded metamorphic cobbles (60-200 mm), pH 5.3. Clear transition to:

B2 45-80 cm Pale brown (10YR6/3) light clay, coarse prominent red mottles and coarse distinct orange mottles are common, strong polyhedral structure, peds 2-5 mm, smooth fabric, firm consistence, many subrounded metamorphic cobbles (60-200 mm), pH 5.5. Gradual transition to:

C 80^{+} cm Weathered metamorphic rock.

CLASSIFICATION

Factual Key:	Dy3.41
Australian Soil Classification:	Bleached-Mottled, Magnesic, Grey CHROMOSOL; thick, slightly gravelly, loamy/clayey, moderate (confidence level 2)
Unified Soil Group:	CL

INTERPRETATION OF LABORATORY ANALYSIS*

Horizon	pH ($CaCl_2$)	% Gravel	EC (salts)	Nutrient Status	P	K	Al	Organic Matter	Dispersibility
A1	4.2**	3	VL	VL	D	S	S	H	VL
A2	4.3**	26	VL	VL	D	D	S	VL	VL
B2	4.6	30	VL	L	D	D	S	VL	VL

VL: Very low L: Low M: Moderate H: High VH: Very high D: Deficient S: Satisfactory

T: Potentially Toxic NA: Not Available * see Appendix D for analytical results ** Strongly Acidic

SOIL PROFILE CHARACTERISTICS:

Permeability:	Moderate (average 50 mm/day, range 40-230 mm/day)
Available Water Capacity:	Moderate (125 mm H_2O)
Linear Shrinkage (B horizon):	Low (12%)

C. LAND CAPABILITY ASSESSMENT

Land Use	Class	Major Limiting Feature(s)/Land Use
Agriculture	$C_3T_2S_3$	Gravel stone and boulder content, depth to seasonal watertable
Effluent Disposal (septic tanks)	4	Drainage
Farm Dams	5	Suitability of subsoil, very low dispersibility of subsoil
Building Foundations		
slab	4	Proportion of stones and boulders, drainage
stumps/footings	4	Proportion of stones and boulders, drainage
Secondary Roads	4	Drainage, proportion of stones and boulders
Rural Residential Development	5	Farm dams

4.6 Silurian sedimentary map units (Ss)

The Silurian sedimentary landscape is limited to narrow bands south of Upper Beaconsfield, Pakenham Upper, and a strip running from Cockatoo North to Nangana. The sedimentary terrain ranges from steep rocky crests and highly dissected steep slopes near the metamorphic aureole, to low undulating hills and broader drainage depressions. Slopes range from 21-35 per cent, with an average gradient of 25 per cent in the steeper hill country, while in the low undulating hills, slopes range from 10-25 per cent, with an average gradient of 16 per cent.
Large areas of sedimentary material have been overlaid by volcanic material or have undergone metamorphism during igneous intrusions.
Grazing has taken place since early European settlement. Loss of vegetation cover through clearing, combined with periods of high grazing have modified the soils present. In many cases, erosion has removed much or all of the original topsoil, while cultivation has resulted in mixing of topsoil and subsoil. Many soil types present are considered to be modified soils and are likely to differ from undisturbed soils in their natural state.
Soils vary considerably due to marked changes in land use, topography and climate. Soil depth varies markedly, steep crests and slopes have shallow to very shallow soils while gentle crests have increased soil depth. The steep slopes are subject to significant erosion. Lower slopes are subject to a build up of colluvial material leading to the development of deeper soils. Flat areas and drainage depressions also have deep soils formed through alluvial deposition. In general, shallow stony brown Chromosol soils are common where rocky crests and steep rocky slopes occur. Weak, stony yellow Dermosol and Chromosol soils predominate where soil depth increases, especially when moderate slopes are encountered. Occasionally brown Chromosol and Dermosol soils occur in areas of good drainage. Surface stone is common on all crests and steep to moderate slopes.
Soils of the low undulating hills show less variation and soil depth regularly exceeds two metres in drainage lines. Soils present on gentle crests are mostly brown Chromosols . Where shallow rock outcrops, brown Dermosols may be present. Bleached, mottled brown Dermosol soils also dominate the very gentle slopes and broad drainage depressions. The presence of significant surface stone is restricted to isolated rocky crests and steep slopes.
Soils with bleached A2 horizons have high percentages of silt and fine sand. The A horizons therefore have low liquid limits, and when saturated these soils become sloppy and have little cohesive strength. If this horizon is exposed by the removal of vegetation and topsoil the A2 horizons are easily eroded.
On many of these units, excluding the flats and drainage depressions, a layer of stones exist in the A2 horizon and the top of the B1 horizon. These sedimentary stones appear as discreet layers, are generally angular in shape and range in size from 2-60 cm in diameter. Stone may comprise up to 80 per cent of the volume of the A2 horizon. Stones in the B2 horizon are well distributed, although there may be an accumulation of stones on top of the C horizon.
Various land degradation problems exist within this sedimentary landscape. In the steeper terrain, sheet and gully erosion occur where vegetation cover is sparse. The presence of highly fractured rock outcrop and shallow stony soils contributes to local and regional groundwater recharge. The sodic subsoils present in the low, undulating terrain have also contributed to significant gully erosion. Waterlogging is common along drainage lines and below leaking dams. In these situations, spiny rush is a good indicator of waterlogging and possible salinity.

Land management considerations

The steep sedimentary terrain, especially nearer the metamorphic aureole, has obvious hazards for all rural residential land uses. The major limitations are steep slopes, depth to hard rock and shallow soil depth. The steep terrain is highly susceptible to sheet and gully erosion, especially where vegetation cover is poor.
The siting of access tracks, building foundations, septic tanks and dams is made extremely difficult by steep slopes, depth to rock and shallow soils. Soil conservation measures will be required to minimise erosion during site construction.
The low undulating hills are more suited to a range of land uses. The major concerns include subsoil permeability and dispersibility. Shallow depth to hard rock may be a problem on crests.
With rural residential development rapidly increasing in these areas, careful design of effluent disposal fields, farm dams and secondary roading is required. Consideration must also be given to dam construction and the impact upon environmental streamflows.
Soil conditions do not favour intensive agriculture on these map units. Limitations on grazing are less severe and can be overcome with appropriate stocking rates and improved land management.

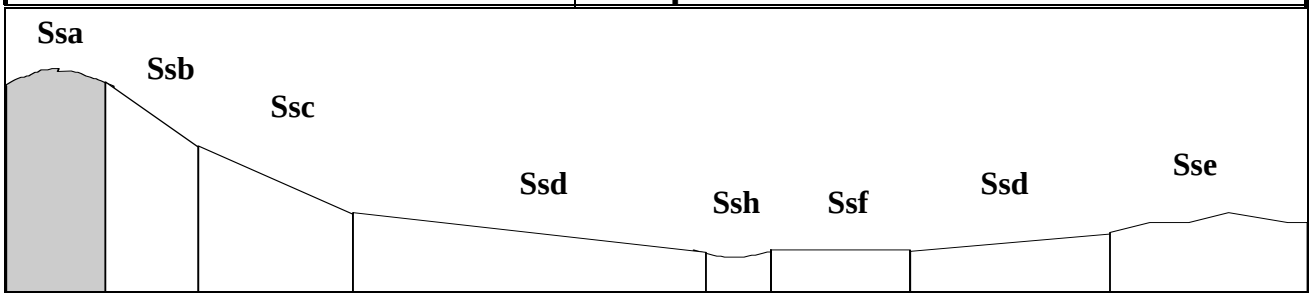
SOILS OF SILURIAN SEDIMENTARY ORIGIN

Plate 17 **Map Units: Ssa, Sse, Ssb**
Brown Chromosol

Plate 18 **Map Units: Ssc, Ssd, Ssf**
Yellow Dermosol

Plate 19 **Map Units: Ssh, Ssi Ssg**
Brown Chromosol

MAP UNIT SYMBOL: **Ssa** Area: 111 ha	MAP UNIT: **Silurian sediments, steep crest**



A. GENERAL DESCRIPTION

Steep sedimentary crests occur in the north of the Shire adjacent to the granitic terrain. A shallow, stony brown Dermosol soil is common tending towards a yellow or brown Chromosol where soil depth increases. Soil depth varies from 50-120 cm in this unit. Surface rock is common and may cover 20 per cent of the surface in uncleared areas. Stone is common in the A2 horizon, usually at a depth of 25-30 cm. These stones cause significant problems in horticultural situations, however for construction and development they can be removed. The bleached A2 horizons have a high content of fine sand and silt. If these horizons are exposed, they will erode rapidly. After construction, vegetation should be replaced where possible.

SITE CHARACTERISTICS

Parent Material Age:	Silurian	**Depth to Seas. Watertable:**	> 1.5 m
Parent Material Lithology:	Sediments	**Flooding Risk:**	Nil
Landform Pattern:	Rolling hills	**Drainage:**	Well drained
Landform Element:	Crest	**Rock Outcrop:**	< 20%
Slope a) common:	7%	**Depth to Hard Rock:**	0.5-1.3 m (variable)
Slope b) range:	3-15%		
Potential Recharge to Groundwater:	High		
Major Native Vegetation Species:	Narrow-leaved Peppermint, Long-leaved Box, Messmate		
Present Land Use:	Grazing		
Length of Growing Season:	8 months		

LAND DEGRADATION

Degradation Processes	Water Erosion sheet/rill	Water Erosion gully	Wind Erosion	Mass Movement	Salting	Acidification
Susceptibility	Low	Low	Very low	Very low	Low	Low
Incidence	Low	Low	Very low	Low	Low	NA

B. SOIL PROFILE

PROFILE DESCRIPTION Site S35

A1 0-15 cm Greyish brown (10YR5/2) silty loam, strong subangular blocky structure, peds 5-10 mm, rough fabric, firm consistence, a few medium (6-20 mm) subangular sedimentary pebbles, pH 6.0. Clear transition to:

A2 15-30 cm Reddish yellow (7.5YR6/6) silty clay loam, moderate polyhedral structure, peds 20-50 mm rough fabric, weak consistence, many large subrounded sedimentary pebbles, pH 6.2. Gradual transition to:

B2 30-90 cm Strong brown (7.5YR5/6) light medium clay, many coarse distinct yellowish red mottles, strong subangular blocky structure, peds 5-10 mm, smooth fabric, very firm consistence, large (20-60 mm) subrounded sedimentary pebbles are common, pH 5.9. Gradual transition to:

C 90^{+} cm Weathered sedimentary rock.

CLASSIFICATION

Factual Key:	Gn3.84 (major), Dy3.41 (minor)
Australian Soil Classification:	Mottled, Magnesic, Brown DERMOSOL; thick, gravelly, silty/clayey, moderate (confidence level 2)
Unified Soil Group:	CH

INTERPRETATION OF LABORATORY ANALYSIS*

Horizon	pH ($CaCl_2$)	% Gravel	EC (salts)	Nutrient Status	P	K	Al	Organic Matter	Dispersibility
A1	5.5	17	VL	M	S	S	S	H	VL
A2	5.5	20	VL	L	D	S	S	L	L
B2	5.5	12	VL	M	D	S	S	VL	L

VL: Very low L: Low M: Moderate H: High VH: Very high D: Deficient S: Satisfactory

T: Potentially Toxic NA: Not Available * see Appendix D for analytical results ** Strongly Acidic

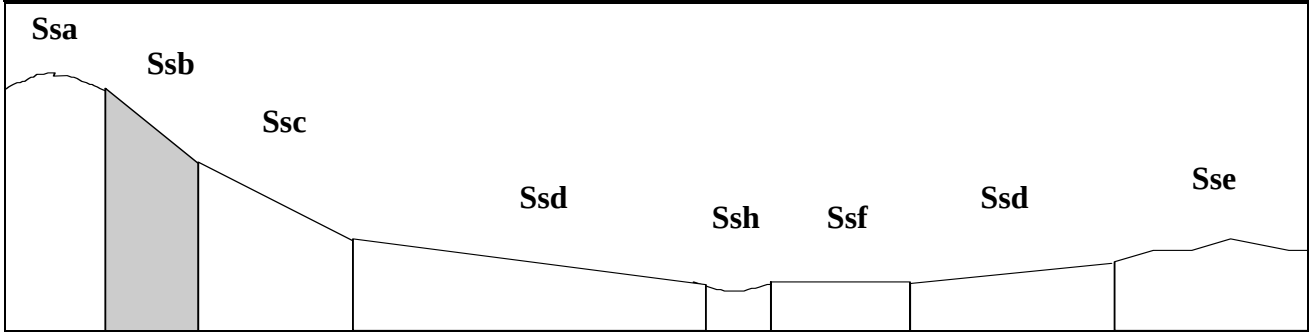
SOIL PROFILE CHARACTERISTICS:

Permeability:	Moderate (average 130 mm/day, range 15-260 mm/day)
Available Water Capacity:	Moderate (135 mm H_2O)
Linear Shrinkage (B horizon):	Low (12%)

C. LAND CAPABILITY ASSESSMENT

Land Use	Class	Major Limiting Feature(s)/Land Use
Agriculture	$C_2T_2S_{3-4}$	Depth to hardrock (variable)
Effluent Disposal (septic tanks)	3-4	Depth to impermeable layer (variable)
Farm Dams	4-5	Depth to hardrock (variable)
Building Foundations		
slab	3	Slope
stumps/footings	3-2	Depth to hardrock (variable)
Secondary Roads	3	Slope, proportion of stones and boulders, USG
Rural Residential Development	4-5	Farm dams

MAP UNIT SYMBOL: **Ssb** Area: 173 ha	MAP UNIT: **Silurian sediments, steep slope**



A. GENERAL DESCRIPTION

Steep sedimentary slopes are present adjacent to the granitic terrain in the north of the Shire. Soils are similar to those of the crests (Ssa) situated above them, with stony Brown Dermosol soils common, and occasional brown Chromosol and yellow Dermosol soils present. Soil depth may vary from 50-100 cm. These slopes are prone to sheet erosion. Rock outcrop is common on these slopes. A stone layer is common in the A2 horizon or on top of the B1 horizon.

SITE CHARACTERISTICS

Parent Material Age:	Silurian	**Depth to Seas. Watertable:**	> 1.3 m
Parent Material Lithology:	Sediments	**Flooding Risk:**	Nil
Landform Pattern:	Rolling hills	**Drainage:**	Well drained
Landform Element:	Hillslope	**Rock Outcrop:**	< 30%
Slope a) common:	35%	**Depth to Hard Rock:**	0.5-1.3 m
Slope b) range:	> 33%		
Potential Recharge to Groundwater:	High		
Major Native Vegetation Species:	Narrow-leaved Peppermint, Long-leaved Box, Messmate		
Present Land Use:	Grazing		
Length of Growing Season:	8 months		

LAND DEGRADATION

Degradation Processes	Water Erosion sheet/rill	Water Erosion gully	Wind Erosion	Mass Movement	Salting	Acidification
Susceptibility	High	Moderate	Very low	High	Low	Low
Incidence	High	Moderate	Low	Low	Low	NA

B. SOIL PROFILE

PROFILE DESCRIPTION Site S35

A1 0-10 cm Greyish brown (10YR5/2) silty loam, strong subangular blocky structure, peds 5-10 mm, rough fabric, firm consistence, few medium (6-20 mm) subangular sedimentary pebbles, pH 6.0. Clear transition to:

A2 10-30 cm Reddish yellow (7.5YR6/6) silty clay loam, moderate polyhedral structure, peds 20-50 mm, rough fabric, weak consistence, many large subrounded sedimentary pebbles, pH 6.2. Gradual transition to:

B2 30-85 cm Strong brown (7.5YR5/6) light medium clay, many coarse distinct yellowish red mottles, strong subangular blocky structure, peds 5-10 mm, smooth fabric, very firm consistence, large (20-60 mm) subrounded sedimentary pebbles are common, pH 5.9. Gradual transition to:

C 85^{+} cm Weathered sedimentary rock.

CLASSIFICATION

Factual Key:	Gn3.84 (major), Dy3.41 (minor)
Australian Soil Classification:	Mottled, Magnesic, Brown DERMOSOL; thick, gravelly, silty/clayey, moderate (confidence level 2)
Unified Soil Group:	CH

INTERPRETATION OF LABORATORY ANALYSIS*

Horizon	pH ($CaCl_2$)	% Gravel	EC (salts)	Nutrient Status	P	K	Al	Organic Matter	Dispersibility
A1	5.5	17	VL	M	S	S	S	H	VL
A2	5.5	20	VL	L	D	S	S	L	L
B2	5.5	12	VL	M	D	S	S	VL	L

VL: Very low L: Low M: Moderate H: High VH: Very high D: Deficient S: Satisfactory

T: Potentially Toxic NA: Not Available * see Appendix D for analytical results ** Strongly Acidic

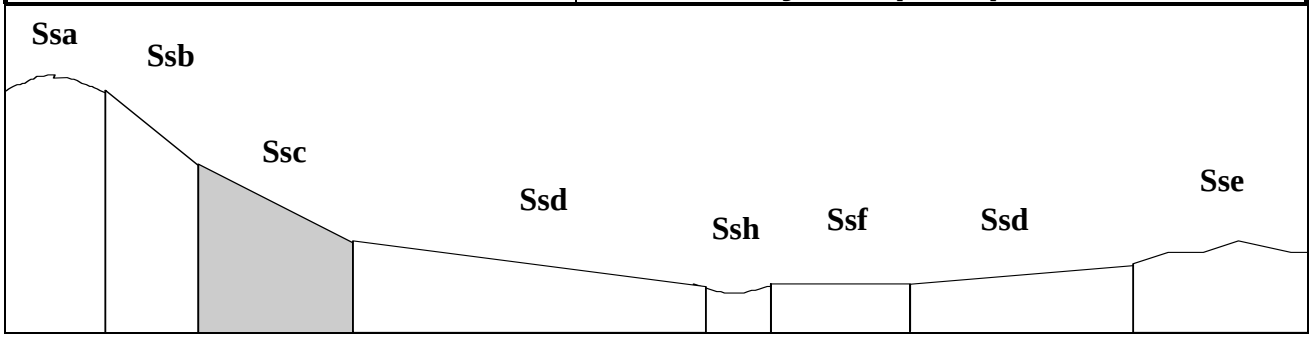
SOIL PROFILE CHARACTERISTICS:

Permeability:	Moderate (average 130 mm/day, range 15-260 mm/day)
Available Water Capacity:	Moderate (130 mm H_2O)
Linear Shrinkage (B horizon):	Low (12%)

C. LAND CAPABILITY ASSESSMENT

Land Use	Class	Major Limiting Feature(s)/Land Use
Agriculture	$C_2T_5S_4$	Steep slope
Effluent Disposal (septic tanks)	5	Steep slope
Farm Dams	5	Steep slope
Building Foundations		
slab	5	Steep slope
stumps/footings	4	Steep slope, susceptibility to slope failure
Secondary Roads	5	Steep slope
Rural Residential Development	5	Secondary roads, farm dams, effluent disposal, building foundations (slab)

MAP UNIT SYMBOL: **Ssc** Area: 1392 ha	MAP UNIT: **Silurian sediments, moderately steep slope**



A. GENERAL DESCRIPTION

Moderately steep slopes are found mostly in the north of the Shire near the metamorphic aureole. Stony yellow Dermosol soils with bleached A2 horizons are common; minor soil types include yellow and brown Chromosols. Soil depth is between 75-130 cm. These slopes are prone to sheet and rill erosion. A stone layer is common in the A2 horizon or on top of the B1 horizon. The fine sandy or silty A2 horizon has very weak structure which breaks down readily when excess water is added, making these slopes prone to sheet and rill erosion if the A2 horizon is exposed.

SITE CHARACTERISTICS

Parent Material Age:	Silurian	**Depth to Seas. Watertable:**	> 1.5 m
Parent Material Lithology:	Sediments	**Flooding Risk:**	Nil
Landform Pattern:	Rolling hills	**Drainage:**	Well drained
Landform Element:	Hillslope	**Rock Outcrop:**	20%
Slope a) common:	25%	**Depth to Hard Rock:**	0.5-1.3 m (variable)
Slope b) range:	21-32%		
Potential Recharge to Groundwater:	Moderate		
Major Native Vegetation Species:	Narrow-leaved Peppermint, Long-leaved Box, Messmate		
Present Land Use:	Grazing		
Length of Growing Season:	8 months		

LAND DEGRADATION

Degradation Processes	Water Erosion sheet/rill	Water Erosion gully	Wind Erosion	Mass Movement	Salting	Acidification
Susceptibility	Moderate	Low	Moderate	Moderate	Low	Low
Incidence	Moderate	Moderate	Low	Low	Low	NA

B. SOIL PROFILE

PROFILE DESCRIPTION Site S34

A1 0-10 cm Brown (10YR5/2) silty loam, moderate polyhedral structure, peds 10-20 mm, rough fabric, firm consistence, pH 5.5. Abrupt transition to:

A2 10-40 cm Brown (7.5YR5/4) light clay, bleached (10YR8/2) when dry, a few coarse faint brownish yellow mottles, moderate polyhedral structure, rough fabric, peds 10-20 mm, firm consistence, a few large subrounded sedimentary pebbles, pH 5.7. Gradual transition to:

B21 40-70 cm Brownish yellow (10YR6/6) heavy clay, coarse prominent yellowish red mottles are common, moderate polyhedral structure, peds 2-5 mm, rough fabric, firm consistence, a few large subrounded sedimentary pebbles, pH 5.8. Gradual transition to:

B22 70-110 cm Light yellowish brown (10YR6/4) heavy clay, many very coarse prominent yellowish red mottles and very coarse distinct pale brown mottles, moderate polyhedral structure, peds 2-5 mm, rough fabric, firm consistence, a few large subrounded sedimentary pebbles, pH 6.2. Gradual transition to:

C 110+ cm Weathering sedimentary rock.

CLASSIFICATION

Factual Key:	Gn4.64 (major), Dy3.41 (minor)
Australian Soil Classification:	Bleached-Sodic, Magnesic, Yellow DERMOSOL; thick, slightly gravelly, silty/clayey, deep (confidence level 2)
Unified Soil Group:	CH

INTERPRETATION OF LABORATORY ANALYSIS*

Horizon	pH ($CaCl_2$)	% Gravel	EC (salts)	Nutrient Status	P	K	Al	Organic Matter	Dispersibility
A1	4.6	8	VL	L	D	D	T	H	VL
A2	4.6	18	VL	VL	D	D	S	VL	VL
B21	4.7	7	VL	M	D	D	S	VL	VL
B22	5.4	5	VL	M	D	D	S	VL	L

VL: Very low L: Low M: Moderate H: High VH: Very high D: Deficient S: Satisfactory

T: Potentially Toxic NA: Not Available * see Appendix D for analytical results ** Strongly Acidic

SOIL PROFILE CHARACTERISTICS:

Permeability:	Moderate (average 155 mm/day, range 90-300 mm/day)
Available Water Capacity:	Moderate (150 mm H_2O)
Linear Shrinkage (B horizon):	Moderate (16.5%)

C. LAND CAPABILITY ASSESSMENT

Land Use	Class	Major Limiting Feature(s)/Land Use
Agriculture	$C_2T_4S_{3-4}$	Slope
Effluent Disposal (septic tanks)	4	Slope
Farm Dams	5	Slope
Building Foundations		
slab	4	Slope
stumps/footings	3	Slope, susceptibility to slope failure, linear shrinkage
Secondary Roads	4	Slope
Rural Residential Development	5	Farm dams

MAP UNIT SYMBOL: **Ssd** Area: 3248 ha	MAP UNIT: **Silurian sediments, moderate slope**

A. GENERAL DESCRIPTION

This unit occurs where there is a noticeable break between steep and gentle slopes. These moderate slopes are found throughout the sedimentary terrain. Under normal circumstances colluvial material accumulates at the bottom of these moderate slopes leading to much variation in soil development. The dominant soil type is a mottled yellow Dermosol soil with a bleached A2 horizon, however brown Dermosols and yellow Chromosols will occur where soil depth varies. A stone layer is common in the A2 horizon or on the top of the B1 horizon. The fine sandy or silty A2 horizon has a very weak structure which breaks down readily when excess water is added, making these slopes prone to sheet and rill erosion if the A2 horizon is exposed. Minor drainage lines in this unit may suffer from gully erosion.

SITE CHARACTERISTICS

Parent Material Age:	Silurian	**Depth to Seas. Watertable:**	> 1.3 m
Parent Material Lithology:	Sediments	**Flooding Risk:**	Nil
Landform Pattern:	Rolling hills	**Drainage:**	Well drained
Landform Element:	Hillslope	**Rock Outcrop:**	< 10%
Slope a) common:	16%	**Depth to Hard Rock:**	0.8-1.5 m
Slope b) range:	11-20%		
Potential Recharge to Groundwater:	Moderate		
Major Native Vegetation Species:	Narrow-leaved Peppermint, Long-leaved Box, Messmate		
Present Land Use:	Grazing		
Length of Growing Season:	8 months		

LAND DEGRADATION

Degradation Processes	Water Erosion sheet/rill	gully	Wind Erosion	Mass Movement	Salting	Acidification
Susceptibility	Moderate	Low	Moderate	Moderate	Low	Low
Incidence	Moderate	Moderate	Low	Low	Low	NA

B. SOIL PROFILE

PROFILE DESCRIPTION Site S34

A1 0-10 cm Brown (10YR5/2) silty loam, moderate polyhedral structure, peds 10-20 mm, rough fabric, firm consistence, pH 5.5. Abrupt transition to:

A2 10-40 cm Brown (7.5YR5/4) light clay, bleached (10YR8/2) when dry, a few coarse faint brownish yellow mottles, moderate polyhedral structure, rough fabric, peds 10-20 mm, firm consistence, a few large subrounded sedimentary pebbles, pH 5.7. Gradual transition to:

B21 40-70 cm Brownish yellow (10YR6/6) heavy clay, coarse prominent yellowish red mottles are common, moderate polyhedral structure, peds 2-5 mm, rough fabric, firm consistence, a few large subrounded sedimentary pebbles, pH 5.8. Gradual transition to:

B22 70-115 cm Light yellowish brown (10YR6/4) heavy clay, many very coarse prominent yellowish red mottles and many very coarse distinct pale brown mottles, moderate polyhedral structure, peds 2-5 mm, rough fabric, firm consistence, a few large subrounded sedimentary pebbles, pH 6.2. Gradual transition to:

C 115 cm Weathered sedimentary rock.

CLASSIFICATION

Factual Key:	Gn4.64 (major), Dy3.41 (minor)
Australian Soil Classification:	Bleached-Sodic, Magnesic, Yellow DERMOSOL; thick, slightly gravelly, silty/clayey, deep (confidence level 2)
Unified Soil Group:	CH

INTERPRETATION OF LABORATORY ANALYSIS*

Horizon	pH ($CaCl_2$)	% Gravel	EC (salts)	Nutrient Status	P	K	Al	Organic Matter	Dispersibility
A1	4.6	8	VL	L	D	D	T	H	VL
A2	4.6	18	VL	VL	D	D	S	VL	VL
B1	4.7	7	VL	M	D	D	S	VL	VL
B2	5.4	5	VL	M	D	D	S	VL	L

VL: Very low L: Low M: Moderate H: High VH: Very high D: Deficient S: Satisfactory

T: Potentially Toxic NA: Not Available * see Appendix D for analytical results ** Strongly Acidic

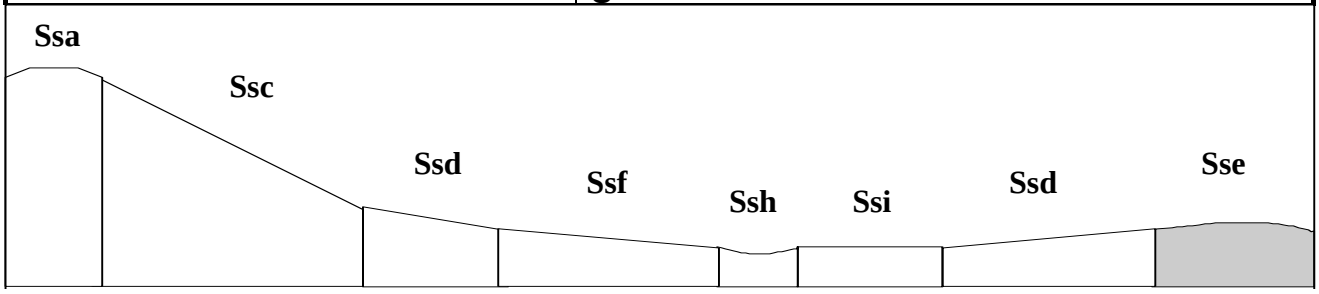
SOIL PROFILE CHARACTERISTICS:

Permeability:	Moderate (average 155 mm/day, range 90-300 mm/day)
Available Water Capacity:	Moderate - High (150 mm H_2O)
Linear Shrinkage (B horizon):	Moderate (16.5%)

C. LAND CAPABILITY ASSESSMENT

Land Use	Class	Major Limiting Feature(s)/Land Use
Agriculture	$C_2T_3S_3$	Slope, topsoil condition (A2), available water capacity, susceptibility to sheet erosion, susceptibility to sheet and wind erosion
Effluent Disposal (septic tanks)	3-4	Depth to impermeable layer (variable)
Farm Dams	4-5	Depth to hardrock (variable)
Building Foundations		
slab	4	Slope
stumps/footings	3	Slope, susceptibility to slope failure, linear shrinkage
Secondary Roads	4	Slope
Rural Residential Development	4-5	Secondary roads, farm dams, building foundations (slab)

MAP UNIT SYMBOL: **Sse** Area: 132 ha	MAP UNIT: **Silurian sediments, gentle crest**



A. GENERAL DESCRIPTION

Gentle sedimentary crests are common throughout the Shire. Soils are shallow with surface rock common in some areas. Stony, mottled brown Dermosols are the dominant soils and usually contain a distinct bleached A2 horizon. Brown Chromosols may be present where soils are deeper. These soils generally have a stone layer in the A2 at about 25-30 cm in depth. Bleached A2 horizons have poor structure, however erosion is limited on this unit because of the gentle slopes.

SITE CHARACTERISTICS

Parent Material Age:	Silurian	**Depth to Seas. Watertable:**	> 1.5 m
Parent Material Lithology:	Sediments	**Flooding Risk:**	Nil
Landform Pattern:	Low hills	**Drainage:**	Well drained
Landform Element:	Crest	**Rock Outcrop:**	0-20%
Slope a) common:	4%	**Depth to Hard Rock:**	0.75-1.3 m (variable)
Slope b) range:	2-7%		

Potential Recharge to Groundwater:	High
Major Native Vegetation Species:	Narrow-leaved Peppermint, Long-leaved Box, Messmate
Present Land Use:	Grazing
Length of Growing Season:	8 months

LAND DEGRADATION

Degradation Processes	Water Erosion sheet/rill	Water Erosion gully	Wind Erosion	Mass Movement	Salting	Acidification
Susceptibility	Low	Low	Very low	Very low	Low	Low
Incidence	Low	Low	Very low	Very low	Low	NA

B. SOIL PROFILE

PROFILE DESCRIPTION Site S35

A1 0-15 cm — Greyish brown (10YR5/2) silty loam, strong subangular blocky structure, peds 5-10 mm, rough fabric, firm consistence, a few medium (6-20 mm) subangular sedimentary pebbles, pH 6.0. Clear transition to:

A2 15-30 cm — Reddish yellow (7.5YR6/6) silty clay loam, moderate polyhedral structure, peds 20-50 mm, rough fabric, weak consistence, many large subrounded sedimentary pebbles, pH 6.2. Gradual transition to:

B2 30-90 cm — Strong brown (7.5YR5/6) light medium clay, many coarse distinct yellowish red mottles, strong subangular blocky structure, peds 5-10 mm, smooth fabric, very firm consistence, large (20-60 mm) subrounded sedimentary pebbles are common, pH 5.9. Gradual transition to:

C 90^{+} cm — Weathered sedimentary rock.

CLASSIFICATION

Factual Key:	Gn3.74 (major) Dy3.41 (minor)
Australian Soil Classification:	Mottled, Magnesic Brown DERMOSOL; thick, gravelly, silty/clayey, moderate (confidence level 2)
Unified Soil Group:	CH

INTERPRETATION OF LABORATORY ANALYSIS*

Horizon	pH ($CaCl_2$)	% Gravel	EC (salts)	Nutrient Status	P	K	Al	Organic Matter	Dispersibility
A1	5.5	17	VL	M	S	S	S	H	VL
A2	5.5	20	VL	L	D	S	S	L	L
B2	5.5	12	VL	M	D	S	S	VL	L

VL: Very low L: Low M: Moderate H: High VH: Very high D: Deficient S: Satisfactory

T: Potentially Toxic NA: Not Available * see Appendix D for analytical results ** Strongly Acidic

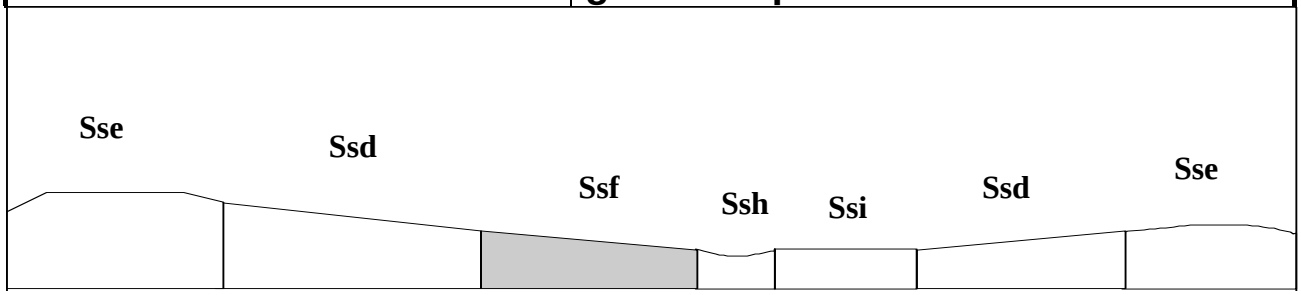
SOIL PROFILE CHARACTERISTICS:

Permeability:	Moderate (average 130 mm/day, range 15-260 mm/day)
Available Water Capacity:	Moderate (115 mm H_2O)
Linear Shrinkage (B horizon):	Low (12%)

C. LAND CAPABILITY ASSESSMENT

Land Use	Class	Major Limiting Feature(s)/Land Use
Agriculture	$C_2T_2S_3$	Available water capacity, gravel/stone/boulder content
Effluent Disposal (septic tanks)	3	Depth to impermeable layer
Farm Dams	4	Depth to hardrock, permeability, dispersibility of subsoil
Building Foundations		
slab	2	Nil
stumps/footings	2	Nil
Secondary Roads	3	Proportion of stones and boulders, USG
Rural Residential Development	4	Farm dams

MAP UNIT SYMBOL: **Ssf** Area: 16220 ha	MAP UNIT: **Silurian sediments, gentle slope**



A. GENERAL DESCRIPTION

The gentle sedimentary slopes are common throughout the sedimentary area. The dominant soil type is a yellow Dermosol with a bleached A2 horizon and a mottled light medium to heavy clay subsoil. This unit may have a deeper soil profile due to to the deposition of colluvial material. These slopes are less prone to erosion, but may become waterlogged lower in the landscape or adjacent to drainage depressions.

SITE CHARACTERISTICS

Parent Material Age:	Silurian	**Depth to Seas. Watertable:**	> 1.5 m
Parent Material Lithology:	Sediments	**Flooding Risk:**	Very low
Landform Pattern:	Low hills	**Drainage:**	Imperfectly drained
Landform Element:	Hillslope	**Rock Outcrop:**	< 5%
Slope a) common:	7%	**Depth to Hard Rock:**	> 1.5 m
Slope b) range:	4-10%		
Potential Recharge to Groundwater:	Low		
Major Native Vegetation Species:	Narrow-leaved Peppermint, Long-leaved Box, Messmate		
Present Land Use:	Grazing		
Length of Growing Season:	8 months		

LAND DEGRADATION

Degradation Processes	Water Erosion sheet/rill	Water Erosion gully	Wind Erosion	Mass Movement	Salting	Acidification
Susceptibility	Low	Low	Low	Very low	Low	Low
Incidence	Low	Low	Low	Very low	Low	NA

B. SOIL PROFILE

PROFILE DESCRIPTION Site S34

A1 0-10 cm Brown (10YR5/2) silty loam, moderate polyhedral structure, peds 10-20 mm, rough fabric, firm consistence, pH 5.5. Abrupt transition to:

A2 10-40 cm Brown (7.5YR5/4) light clay, bleached (10YR8/2) when dry, a few coarse faint brownish yellow mottles, moderate polyhedral structure, rough fabric, peds 10-20 mm, firm consistence, a few large subrounded sedimentary pebbles, pH 5.7. Gradual transition to:

B1 40-75 cm Yellowish brown (10YR6/6) heavy clay, coarse prominent yellowish red mottles are common, moderate polyhedral structure, peds 2-5 mm, rough fabric, firm consistence, a few large subrounded sedimentary pebbles, pH 5.8. Gradual transition to:

B2 75-115 cm Light yellowish brown (10YR6/4) heavy clay, many very coarse prominent yellowish red mottles and many very coarse distinct pale brown mottles, moderate polyhedral structure, peds 2-5 mm, rough fabric, firm consistence, a few large subrounded sedimentary pebbles, pH 6.2. Gradual transition to:

C 115+ cm Weathered sedimentary rock.

CLASSIFICATION

Factual Key:	Gn4.64 (major) Dy3.41(minor)
Australian Soil Classification:	Bleached-Sodic, Magnesic, Yellow DERMOSOL; thick, slightly gravelly, silty/clayey, deep
Unified Soil Group:	CH

INTERPRETATION OF LABORATORY ANALYSIS*

Horizon	pH ($CaCl_2$)	% Gravel	EC (salts)	Nutrient Status	P	K	Al	Organic Matter	Dispersibility
A1	4.6	8	VL	L	D	D	T	H	VL
A2	4.6	18	VL	VL	D	D	S	VL	VL
B1	4.7	7	VL	M	D	D	S	VL	VL
B2	5.4	5	VL	M	D	D	S	VL	L

VL: Very low L: Low M: Moderate H: High VH: Very high D: Deficient S: Satisfactory

T: Potentially Toxic NA: Not Available * see Appendix D for analytical results ** Strongly Acidic

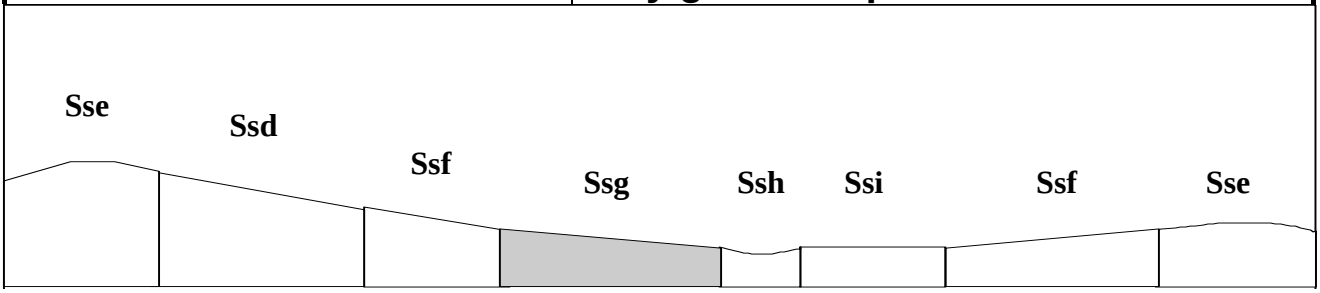
SOIL PROFILE CHARACTERISTICS:

Permeability:	Moderate (average 155 mm/day, range 90-300 mm/day)
Available Water Capacity:	Moderate (150 mm H_2O)
Linear Shrinkage (B horizon):	Moderate (16.5%)

C. LAND CAPABILITY ASSESSMENT

Land Use	Class	Major Limiting Feature(s)/Land Use
Agriculture	$C_2T_2S_3$	Condition of topsoil (A2), available water capacity
Effluent Disposal (septic tanks)	4	Drainage
Farm Dams	4	Permeability
Building Foundations		
slab	4	Drainage
stumps/footings	4	Drainage
Secondary Roads	4	Drainage
Rural Residential Development	4	Secondary roads, farm dams, effluent disposal, building foundations

MAP UNIT SYMBOL: **Ssg** Area: 398 ha	MAP UNIT: **Silurian sediments, very gentle slope**



A. GENERAL DESCRIPTION

The very gentle sedimentary slopes have similar soils to the flats (Ssi). Bleached and mottled, brown Chromosol soils are common. Drainage of these soils is slow, and waterlogging is common in winter and spring. Soil depth is greater on these slopes and may reach 1.5 metres. The bleached A2 horizons are susceptible to erosion, but sheet and rill erosion are less common because of the gentle slopes. Gully erosion is also present.

SITE CHARACTERISTICS

Parent Material Age:	Silurian	**Depth to Seas. Watertable:**	> 1.5 m
Parent Material Lithology:	Sediments	**Flooding Risk:**	Low
Landform Pattern:	Low hills	**Drainage:**	Imperfectly drained
Landform Element:	Hillslope	**Rock Outcrop:**	< 5%
Slope a) common:	2%	**Depth to Hard Rock:**	> 1.5 m
Slope b) range:	1-3%		
Potential Recharge to Groundwater:	Low		
Major Native Vegetation Species:	Narrow-leaved Peppermint, Long-leaved Box, Messmate		
Present Land Use:	Grazing		
Length of Growing Season:	8 months		

LAND DEGRADATION

Degradation Processes	Water Erosion sheet/rill	Water Erosion gully	Wind Erosion	Mass Movement	Salting	Acidification
Susceptibility	Low	Low	Low	Very low	Low	Low
Incidence	Low	Low	Low	Very low	Low	NA

B. SOIL PROFILE

PROFILE DESCRIPTION SITE S38

A1 0-10 cm — Dark greyish brown (10YR4/2) silty loam, moderate structure, peds 5-10 mm, rough fabric, weak consistence, pH 6.1. Abrupt transition to:

A2 10-40 cm — Very pale brown (10YR7/3) sandy clay loam fine sandy, bleached (10YR8/2) when dry, coarse faint very pale brown mottles are common, weak subangular blocky structure, peds 10-20 mm, rough fabric, firm consistence, very few large subrounded and rounded sedimentary pebbles, pH 6.1. Clear transition to:

B21 40-80 cm — Light yellowish brown (7.5YR5/6) medium clay, many medium faint red and orange mottles, strong polyhedral structure, peds 2-5 mm, smooth fabric, firm consistence, subrounded sedimentary stones are common, pH 5.9. Gradual transition to:

B22 80-110 cm Yellowish brown (10YR5/4) medium clay, many coarse prominent red mottles and medium faint orange mottles, strong polyhedral structure, peds 20-50 mm, breaking down to 2-5 mm, smooth fabric, firm consistence, pH 6.1. Gradual transition to:

C 110-145+ cm Weathered sedimentary rock.

CLASSIFICATION

Factual Key:	Dy3.41 (major), Gn3.84 (minor)
Australian Soil Classification:	Bleached-Sodic, Magnesic, Brown CHROMOSOL; thick, slightly gravelly, silty/clayey, deep
Unified Soil Group:	CH

INTERPRETATION OF LABORATORY ANALYSIS*

Horizon	pH ($CaCl_2$)	% Gravel	EC (salts)	Nutrient Status	P	K	Al	Organic Matter	Dispersibility
A1	5.0	3	VL	L	D	D	S	H	VL
A2	4.9	15	VL	VL	D	D	S	VL	L
B21	4.7	11	VL	M	D	D	T	VL	VL
B22	5.0	10	VL	M	D	D	S	VL	L

VL: Very low L: Low M: Moderate H: High VH: Very high D: Deficient S: Satisfactory

T: Potentially Toxic NA: Not Available * see Appendix D for analytical results ** Strongly Acidic

SOIL PROFILE CHARACTERISTICS:

Permeability:	Slow (average 15 mm/day, range 10-25 mm/day)
Available Water Capacity:	High (155 mm H_2O)
Linear Shrinkage (B horizon):	Moderate (17%)

C. LAND CAPABILITY ASSESSMENT

Land Use	Class	Major Limiting Feature(s)/Land Use
Agriculture	$C_2T_1S_3$	Condition of topsoil (A2), permeability-rainfall index
Effluent Disposal (septic tanks)	4	Drainage, slow permeability
Farm Dams	3	Low dispersibility of subsoil, linear shrinkage, permeability, suitability of subsoil, depth to seasonal watertable, depth to hardrock
Building Foundations		
slab	4	Drainage
stumps/footings	4	Drainage
Secondary Roads	4	Drainage
Rural Residential Development	4	Secondary roads, effluent disposal, building foundations

MAP UNIT SYMBOL: **Ssh** Area: 1982 ha	MAP UNIT: **Silurian sediments, drainage depression**

A. GENERAL DESC RIPTION

Drainage lines running through sedimentary terrain are generally wide and contain soils greater than two metres in depth. In many situations minor drainage lines may not have been mapped due to restrictions of scale, especially in steeper units. Bleached and mottled, brown Chromosol soils are common. Salting and gully erosion occur in this unit. Seasonal flooding is common. Waterlogging is a problem in winter and spring.

SITE CHARACTERISTICS

Parent Material Age:	Silurian	**Depth to Seas. Watertable:**	> 1.5 m
Parent Material Lithology:	Sediments	**Flooding Risk:**	Moderate
Landform Pattern:	Low hills	**Drainage:**	Imperfectly drained
Landform Element:	Drainage depression	**Rock Outcrop:**	Nil
Slope a) common:	3%	**Depth to Hard Rock:**	> 1.5 m
Slope b) range:	0-7%		
Potential Recharge to Groundwater:	Low		
Major Native Vegetation Species:	Narrow-leaved Peppermint, Long-leaved Box, Messmate		
Present Land Use:	Grazing		
Length of Growing Season:	8 months		

LAND DEGRADATION

Degradation Processes	Water Erosion sheet/rill	Water Erosion gully	Wind Erosion	Mass Movement	Salting	Acidification
Susceptibility	Low	Low	Low	Very low	Moderate	Low
Incidence	Low	Moderate	Low	Very low	Low	NA

B. SOIL PROFILE

PROFILE DESCRIPTION Site S38

A1 0-10 cm Dark greyish brown (10YR4/2) silty loam, moderate structure, peds 5-10 mm, rough fabric, weak consistence, pH 6.1. Abrupt transition to:

A2 10-40 cm Very pale brown (10YR7/3) sandy clay loam fine sandy, bleached (10YR8/2) when dry, coarse faint very pale brown mottles are common, weak subangular blocky structure, peds 10-20 mm, rough fabric, firm consistence, very few large subrounded and rounded sedimentary pebbles, pH 6.1. Clear transition to:

B21 40-80 cm Light yellowish brown (7.5YR5/6) medium clay, many medium faint red and orange mottles, strong polyhedral structure, peds 2-5 mm, smooth fabric, firm consistence, subrounded sedimentary stones are common, pH 5.9. Gradual transition to:

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C 110-145+ cm Weathered sedimentary rock.

CLASSIFICATION

Factual Key:	Dy3.41 (major), Gn3.84 (minor)
Australian Soil Classification:	Bleached-sodic, Magnesic, Brown CHROMOSOL; thick, slightly gravelly, silty/clayey, deep (confidence level 2)
Unified Soil Group:	CH

INTERPRETATION OF LABORATORY ANALYSIS*

Horizon	pH ($CaCl_2$)	% Gravel	EC (salts)	Nutrient Status	P	K	Al	Organic Matter	Dispersibility
A1	5.0	3	VL	L	D	D	S	H	VL
A2	4.9	15	VL	VL	D	D	S	VL	L
B21	4.7	11	VL	M	D	D	S	VL	VL
B22	5.0	10	VL	M	D	D	S	VL	L

VL: Very low L: Low M: Moderate H: High VH: Very high D: Deficient S: Satisfactory

T: Potentially Toxic NA: Not Available * see Appendix D for analytical results ** Strongly Acidic

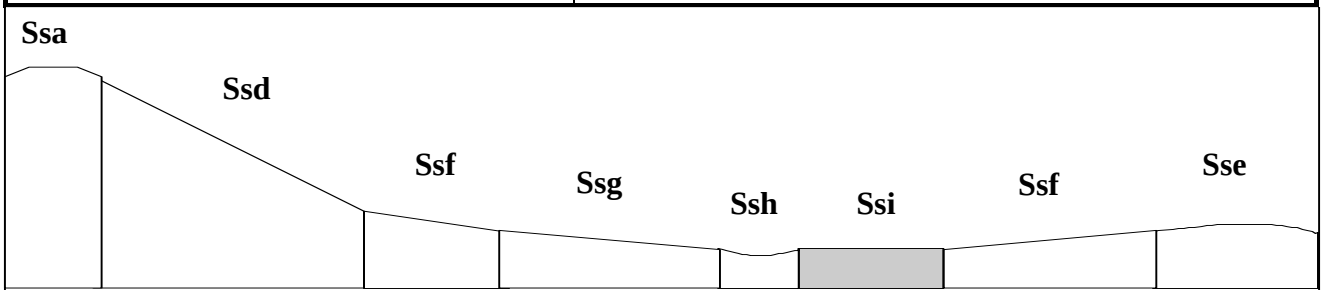
SOIL PROFILE CHARACTERISTICS:

Permeability:	Slow (average 15 mm/day, range 10-25 mm/day)
Available Water Capacity:	High (160 mm H_2O)
Linear Shrinkage (B horizon):	Moderate (17%)

C. LAND CAPABILITY ASSESSMENT

Land Use	Class	Major Limiting Feature(s)/Land Use
Agriculture	$C_2T_1S_3$	Topsoil condition (A2), permeability-rainfall index
Effluent Disposal (septic tanks)	4	Imperfect drainage, slow permeability
Farm Dams	3	Linear shrinkage, permeability, dispersibility of subsoil, depth to hardrock, suitability of subsoil, depth to seasonal watertable
Building Foundations		
slab	4	Drainage
stumps/footings	4	Drainage
Secondary Roads	4	Drainage
Rural Residential Development	4	Secondary roads, effluent disposal, building foundations

MAP UNIT SYMBOL: **Ssi** Area: 1982 ha	MAP UNIT: **Silurian sediments, flats**



A. GENERAL DESCRIPTION

Flats are associated with some of the major drainage lines in the gently undulating sedimentary areas, especially in the north of the Shire around Nangana. Soils of this unit have been subjected to some alluvial and colluvial build-up, and may exceed two metres in depth. Soils are generally brown Chromosols with bleached A2 horizons. These soils may be waterlogged for a number of months during the year, flooding may also occur. In many situations, minor flats may not have been mapped due to restrictions of scale.

SITE CHARACTERISTICS

Parent Material Age:	Silurian	**Depth to Seas. Watertable:**	> 1.5 m
Parent Material Lithology:	Sediments	**Flooding Risk:**	Moderate
Landform Pattern:	Low hills	**Drainage:**	Imperfectly drained
Landform Element:	Flat	**Rock Outcrop:**	Nil
Slope a) common:	1%	**Depth to Hard Rock:**	> 1.5 m
Slope b) range:	0-1%		
Potential Recharge to Groundwater:	Low		
Major Native Vegetation Species:	Narrow-leaved Peppermint, Long-leaved Box, Messmate		
Present Land Use:	Grazing		
Length of Growing Season:	8 months		

LAND DEGRADATION

Degradation Processes	Water Erosion sheet/rill	Water Erosion gully	Wind Erosion	Mass Movement	Salting	Acidification
Susceptibility	Low	Low	Low	Very low	Low	Low
Incidence	Low	Low	Low	Very low	Low	NA

B. SOIL PROFILE

PROFILE DESCRIPTION Site 38

A1 0-10 cm Dark greyish brown (10YR4/2) silty loam, moderate structure, peds 5-10 mm, rough fabric, weak consistence, pH 6.1. Abrupt transition to:

A2 10-40 cm Very pale brown (10YR7/3) sandy clay loam fine sandy, bleached (10YR8/2) when dry, coarse faint very pale brown mottles are common, weak subangular blocky structure, peds 10-20 mm, rough fabric, firm consistence, very few large subrounded and rounded sedimentary pebbles, pH 6.1. Clear transition to:

B21 40-80 cm Light yellowish brown (7.5YR5/6) medium clay, many medium faint red and orange mottles, strong polyhedral structure, peds 2-5 mm, smooth fabric, firm consistence, subrounded sedimentary stones are common, pH 5.9. Gradual transition to:

B22 80-110 cm Yellowish brown (10YR5/4) medium clay, many coarse prominent red mottles and medium faint orange mottles, strong polyhedral structure, peds 20-50 mm, breaking down to 2-5 mm, smooth fabric, firm consistence, pH 6.1. Gradual transition to:

C 110-145+ cm Weathered sedimentary rock.

CLASSIFICATION

Factual Key:	Dy3.41 (major), Dy3.81, Dy3.11(minor)
Australian Soil Classification:	Bleached-Sodic, Magnesic, Brown CHROMOSOL; thick slightly gravelly, silty/clayey, deep (confidence level 2)
Unified Soil Group:	CH

INTERPRETATION OF LABORATORY ANALYSIS*

Horizon	pH ($CaCl_2$)	% Gravel	EC (salts)	Nutrient Status	P	K	Al	Organic Matter	Dispersibility
A1	5.0	3	VL	L	D	D	S	H	VL
A2	4.9	15	VL	VL	D	D	S	VL	L
B1	4.7	11	VL	M	D	D	T	VL	VL
B2	5.0	10	VL	M	D	D	S	VL	L

VL: Very low L: Low M: Moderate H: High VH: Very high D: Deficient S: Satisfactory

T: Potentially Toxic NA: Not Available * see Appendix D for analytical results ** Strongly Acidic

SOIL PROFILE CHARACTERISTICS:

Permeability:	Slow (average 15 mm/day, range 10-25 mm/day)
Available Water Capacity:	High (160 mm H_2O)
Linear Shrinkage (B horizon):	Moderate (17%)

C. LAND CAPABILITY ASSESSMENT

Land Use	Class	Major Limiting Feature(s)/Land Use
Agriculture	$C_2T_1S_3$	Condition of topsoil (A2), permeability-rainfall index
Effluent Disposal (septic tanks)	4	Imperfect drainage, slow permeability
Farm Dams	3	Depth to hardrock, linear shrinkage, permeability, low dispersibility of subsoil, suitability of subsoil, depth to seasonal watertable
Building Foundations		
slab	4	Drainage
stumps/footings	4	Drainage
Secondary Roads	4	Drainage
Rural Residential Development	4	Secondary roads, effluent disposal, building foundations

5. ACKNOWLEDGMENTS

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APPENDIX A. NOTES TO ACCOMPANY LAND CAPABILITY RATING TABLES

A.1 Total amount of water available to plants

Available Water Capacity (AWC) is a measure of the amount of useable water in the soil for plant growth. It is determined from the difference between the amount of water retained by the soil after drainage (field capacity) and the moisture content of a soil at wilting. (permanent wilting point). There is a reasonable correlation between soil texture and AWC (Salter and Williams 1969) (Table A.1).

Table A.1 Available water capacity of soils.

Range (mm/m)	Average value for calculations (mm/m)	Sands	Sandy loams	Loams	Clay loams	Clays
76 - 100	90	KS				
101 - 125	110	LKS	KSL			
126 - 150	130	S				SC, C
151 - 175	160	CS, LS	SL	L	SCL	
176 - 200	190	FS	FSL	CL, ZL	ZCL	ZC
201 - 225	210	LFS				

The total amount of water available to plants can be calculated by adding the amount of available water in each horizon down to a maximum depth of two metres.
Note that gravel content of the soil horizons should be taken into account.

Soil horizon	Texture	Depth of horizon (m)	AWC of horizon (mm/m)	Available water in horizon (mm)
A	SL	0.15	160	24
B2	SC	1.25	130	143

For example, the total amount of water in the worked example above = 167 (Class 2)

A.2 Bearing capacity

Measurements were not taken of bearing capacities.

A.3 Coarse fragment sizes

Gravel:	2 - 60 mm
Cobbles:	60 - 200 mm
Stones:	200 - 600 mm
Boulders:	600 - 2000 mm

A.4 Linear shrinkage

The Linear Shrinkage and depth of solum can replace the value for reactivity of a soil. Reactivity is used in the Australian Standard AS 2870.2 (SAA 1977), and is based on the depth of the clay layer and its shrink-swell capacity. Different areas of Victoria are identified, with 0.6 m depth being a common cut-off mark between two categories.

A.5 Condition of the topsoil

The texture, organic matter content and the size/strength of soil aggregates all influence the general behaviour of soils when subjected to different agricultural land uses and management practices. The lack of knowledge relating the performance of soils to specific attributes does not allow values for the above criteria to be divided into meaningful classes - certainly not the 5-class system used in these land capability rating tables. The concept of "Condition of topsoil" combines the score placed on each criteria to give a total score that is then compared to a 5-class rating, (Table A.2).

Table A2 Rating for topsoil condition.

Criteria	Description	Score
Texture	Sands	1
	Sandy loams	2
	Loams	5
	Clay loams	4
	Clays	3
Structure (grade)	Apedal, massive	1
	Apedal, loose	2
	Weak	3
	Moderate	4
	Strong	5
Structure(size)	Very large (> 200 mm)	1
	Large (50 - 200 mm)	2
	Moderate (10 - 50 mm)	4
	Small (2 - 10 mm)	5
	Very small (< 2 mm)	3
Organic matter content (org.C x 1.72)	Very low (< 1%)	1
	Low (1 - 2%)	2
	Moderate (2 - 3%)	4
	High (> 3%)	5
Nutrient status of topsoil (sum of exch. Ca, Mg, K)	Very low (< 4 meq/100g)	1
	Low (4-8 meq/100g)	2
	Moderate (9-18 meq/100g)	3
	High (19-30 meq/100g)	4
	Very high (> 30 meq\100g)	5
Rating for topsoil condition:	**Class**	**Total score**
	1	21 - 25
	2	16 - 20
	3	11 - 15
	4	6 - 10
	5	5

For profiles with more than one A horizon, i.e. A1 and A2, top soil conditions should be determined separately for each horizon and then averaged.

Nutrient status of topsoil: The topsoil is considered the major source of nutrients for plant growth whereas the subsoil is the more reliable source of moisture. Nutrient status of topsoil = sum of exchangeable base cations (Ca, Mg, K) (Lorimer and Schoknecht 1987).

A.6 Depth to hard rock or impermeable layer

This criterion provides a measure of the effectiveness of the soil profile in filtering the nutrient and bacterial content from the effluent. The Septic Tank Code of Practice (Environment Protection Authority *et. al.* 1990) requires a depth of at least one metre.

A.7 Depth to seasonal watertable

The Septic Tank Code of Practice (Environment Protection Authority *et. al.* 1990) requires a minimum of one m depth of unsaturated soil for the proper functioning of effluent disposal trenches. Ideally the groundwater table should be much lower than one m, thereby reducing the risk of a rising groundwater table influencing the effectiveness of the absorption trenches. The risk of surface salting problems also increases when a saline groundwater table rises to within 1 - 1.5 m of the soil surface.

A.8 Depth of topsoil

Topsoil depth is considered during dam construction and is used when measuring the susceptibility of topsoils to erosion (Table A.10). Depth of topsoil influences the quantity of overburden that needs to be scraped clear and kept for spreading back on a dam embankment to establish a grass cover, once the construction is completed.

A.9 Dispersibility

Sustainable land use requires that the soil be able to withstand the physical forces of cultivation and compaction without adverse structural change. Soil aggregate stability can be measured by the Emerson Aggregate Test (Emerson, 1977). In the case of secondary roads, dispersion can significantly effect the condition of the road when slopes are greater than 4%. Because of the close correlation between dispersible soils and high exchangeable sodium percentages in those soils, it is unnecessary to include both criteria in the capability rating table.

A.10 Drainage

This parameter is the combination of several criteria that influence the moisture status of the soil profile, *viz* slope, subsurface and surface flow, water holding capacity, level of groundwater tables, perched or permanent, and permeability. Only because of its general usage, reasonable definition (McDonald *et. al*., 1984) and direct relevance to effluent disposal fields, building foundations and secondary roads has this criterion been retained.

A.11 Electrical conductivity

The following correlation in Table A.3 between the electrical conductivity of soil samples taken from the 0 - 50 cm layer of the soil profile and soil salinity has been established.

Table A.3 The effects of soil salting on plant growth.

Class	Severity of salting	E.C. dS/m *	Site characteristics
1	Nil/very low	< 0.3	Plant growth unaffected
2	Low	0.30 - 0.53	Growth of salt-sensitive plants, eg cereals and clover is restricted
3	Moderate	0.53 - 1.26	Patchy pasture growth; salt-sensitive plants are replaced with species that are more salt-tolerant
4	High	1.26 - 2.5	Small areas of bare ground; surviving plant species have high salt tolerance
5	Very high/severe	> 2.5	Large areas of bare ground; highly salt-tolerant plants; trees may be dead or dying

*** NB: 1000 μS/cm = 1 dS/m**

A.12 Flooding risk

Building regulations prohibit building on flood-prone land, therefore land with some risk of flooding must be identified. Flooding is unlikely to cause a septic tank to fail, however the risk of polluting the floodwaters with phosphorus, nitrogen and bacterial organisms increases with the number of effluent disposal fields involved. The dilution factor will be dependent on the quantity of floodwater.

Dams are built to intercept and store run-off water. It is not possible in these tables to distinguish between seasonal run-off and seasonal flooding; the latter poses a threat to the stability of the dam, and the risk of flooding will depend on the intensity and duration of rainfall, the run-off characteristics of the catchment and the land use within the catchment. Flooding risk is rated in Table A.4.

Table A.4 Flooding risk.

Risk	Class	Limitation	Condition of flood
Nil	1	No limitation	No flooding
Low	2	Minor	Minor inundation No debris Flood return period: annual
Moderate	3	Significant	Broad, slow moving No debris Flood return period: 1 in 20 to 1 in 50 years
High	4	Major	Broad, slow moving Little debris Flood return period: 1 in 100 years
Severe	5	Prohibitive	Deep channel, fast flowing Debris carrying Flood return period: 1 in 100 years

A.13 Length of the growing season

Agricultural production is governed by moisture, temperature and photoperiod (photoperiod is taken to be consistent throughout Victoria).

Length of Growing Season (months) = 12 - (P + T)

P = Number of months where monthly evapotranspiration > average monthly rainfall

T = Number of months where mean monthly temperature < 6^{o} C

A.14 Number of months per year when average daily rainfall > K_{sat}

This parameter is included (although it is closely aligned to drainage) to provide an indication from climatic, rather than soil and topographic data, of the period of time each year when effluent absorption trenches might cease to function.

Data required:

* Average monthly rainfall figures.
* Average number of wet days for each month.
* K_{sat} values.

Assumptions made:

* Evapotranspiration <1 for winter months.
* Winter-early spring months are when problems arise.
* The soil profile is at field capacity.
* Where slope is significant, run-off = run-on.

A.15 Permeability of a soil profile (K_{sat})

Permeability is controlled by the least permeable layer of a soil profile and its ability to transmit water. Permeability is independent of climate and surface drainage. The rate at which water moves down through the soil profile is an indicator of the tendency of a soil to saturate, it is an important feature if plant growth is to be maintained in areas where rainfall is spasmodic or unreliable.

Permeability provides a measure of the rate at which a saturated soil profile will conduct water to depth. K_{sat} measurements may over-estimate the value for the disposal of effluent because the soil macropores are transmitting water, whereas the real situation must take into account the clogging effect of effluent on the bottom of effluent disposal trenches, thereby reducing the rate of water movement into the soil.

The measurement of K_{sat} often produces quite variable results even between replicates on the same site, so the setting of class limits is difficult and by necessity must be very broad. Estimates of permeability can be made using the features of the least permeable soil horizon if K_{sat} values are not available, however it should be clearly indicated where estimates have been made (Table A.5).

Table A.5 permeability characteristics of a soil profile.

Estimated permeability	K_{sat} range (mm/day)	Time taken for saturated soil to drain to field capacity	Soil features
Very Slow	< 10	Months	Absence of visible pores
Slow	10 - 100	Weeks	Some pores visible
Moderate	100 - 500	Days	Clearly visible pores
Rapid	500 - 1500	Hours	Large, continuous clearly visible pores
Very Rapid	1500 - 3000	Rarely saturated	Abundant large pores
Excessive	> 3000	Never saturated	No restriction to water movement through the soil profile

A.16 Index for permeability/rainfall

This relationship has been included to take into account the situation where a strongly structured soil with very high permeability would be assessed as having a major limitation. In a dry climate, this would be correct as the soil would be drought-prone most of the year, however in a high rainfall area such a soil may be highly productive. Conversely a soil with low permeability may experience waterlogging for extended periods in a high rainfall area, but store sufficient moisture to extend the average growing season of a low rainfall area. A method of combining permeability and rainfall is shown in Table A.6.

Table A.6 Index for permeability/rainfall.

Permeability		Average annual rainfall (mm/year)				
Estimated	K_{sat} (mm/day)	< 400	400 - 600	600 - 800	800 - 1000	> 1000
Very Slow	< 10	High	High	Moderate	Low	Very low
Slow	10 - 100	High	Very high	High	Moderate	Low
Moderate	100 - 500	Moderate	High	Very high	High	Moderate
Rapid	500 - 1500	Low	Moderate	High	Very high	High
Very Rapid	> 1500	Very low	Low	Moderate	High	Very high

A.17 Rock outcrop

This estimate has not been included as a parameter that influences the performance of earthen dams because the parameter, depth to hard rock, is inversely correlated to the proportion of rock outcropping at the soil surface, and is a good surrogate.

A.18 Slope

As the slope increases, so too does the chance of run-on water entering effluent disposal trenches and saturating the system. In addition, run-off of unfiltered effluent is more likely to enter minor drainage depressions and water courses. The increasing incidence of algal blooms in water storages emphasises the need to eliminate the entry of unfiltered effluent into watercourses.

The best ratio of earth moved to water stored in dams occurs on land with slopes between 3-7%. Gentler slopes involve greater expense as the above ratio approaches unity, whereas steeper slopes require higher embankments for proportionally less water stored.

A.19 Susceptibility to gully erosion

No single factor can adequately represent the susceptibility of an area to the gully erosion process. A number of factors are involved and each should be scored independently and then the sum of the scores can be related back to a 5 - class rating (Table A.7).

Table A.7 Susceptibility to gully erosion.

Criteria	Description	Score
Slope	< 1%	1
	1 - 3%	2
	4 - 10%	3
	11 - 32%	4
	> 32%	5
Sub-soil dispersibility	E1	5
	E2, E3(3), E3(4)	4
	E3(1), E3(2)	3
	E4, E5	2
	E6, E7, E8	1
Depth to rock/hardpan	0 - 0.5m	1
	0.6 - 1.0m	2
	1.1 - 1.5m	3
	1.6 - 2.0m	4
	> 2.0m	5
Subsoil structure	Apedal, massive	1
	Weak	
	fine < 2 mm	3
	mod. 2 - 10 mm	2
	coarse > 10 mm	1
	Moderate	
	fine < 2 mm	4
	mod. 2 - 10 mm	3
	coarse > 10 mm	2
	Strong	
	fine < 2 mm	5
	mod. 2 - 10 mm	3
	coarse > 10 mm	1
	Apedal, single grained	5
Lithology of substrate	Basalt	1
	Volcanic	2
	Rhyodacite	2
	Granite	4
	Alluvium	3
	Colluvium	5
	Tillite	4
	Ordovician sandstone/mudstone	5
	Silurian sandstone/mudstone	4
Rating for susceptibility to gully erosion:	**Class**	**Total score**
	1. Very low	6 - 10
	2. Low	11 - 13
	3. Moderate	14 - 17
	4. High	18 - 20
	5. Very high	21 - 25

Note: The ratings for the Shire of Cardinia have been improved by one rating due to the high growth rate and ground cover during the summer months.

A.20 Susceptibility to slope failure

The instability of slopes in a catchment area of a dam poses a threat to the storage capacity of that dam. Additional costs are also involved if the dam requires regular desludging. This assessment considers that land slips are the result of factors such as soil depth, slope, soil texture, volume of water held in the soil, permeability of the solum and the underlying parent material. Since the quantity of water in a profile is itself a function of soil texture, depth and permeability, the table below is presented as a first attempt to assess the susceptibility of land to slope failure by relating the total amount of water in the soil profile to the slope (Table A.8).

Table A.8 Susceptibility to slope failure.

Slope %	Total amount of water in the soil profile		
	Low (< 70 mm H_20)	Moderate (70-170 mm H_20)	High (> 170 mm H_20)
Gentle < 10	Very low	Very low	Low
Moderate 10-32	Low	Moderate	High
Steep > 33	Moderate	High	Very high

A.21 Suitability of subsoil for earthen dams

In the building of earthen dams, suitability of subsoil is dependent on the nature of the material, which is represented by the Unified Soil Group classification, and depth of the material. Refer to Table A.9.

Table A.9 Suitability of subsoil for earthen dams.

Unified soil group of subsoil					
DEPTH OF SUBSOIL (m)	SP, SW, GP, GW, Pt, OH, OL	ML, MH	GM, CH, SM	CL	GC, SC
< 0.5	Very low	Very low	Very low	Very low	Very low
1.0 - 0.5	Very low	Low	Moderate	Moderate	Moderate
1.5 - 1.0	Very low	Moderate	High	High	High
> 1.5	Very low	Moderate	High	High	Very high

A.22 Susceptibility of soil to sheet and rill erosion by water

The following table (Table A.10) has been adapted from Elliott and Leys (1991). The erodibility index for a range of soil properties closely relates to the susceptibility of soils to erosion by water, and in the tables below, the same soil properties have been used (texture, structure grade, topsoil depth and dispersibility (Emerson aggregate test)) and then related to slope to determine a rating for susceptibility. The final rating for susceptibility to sheet/rill erosion is read from Table A.11 once the erodibility of the topsoil and the slope of the area have been assessed.

Table A.10 Erodibility of topsoils.

Soil parameters			Soil Dispersibility		
Texture group (A1)	**Structure grade (A1)**	**Horizon depth (A1 + A2)**	**Very Low - Low E3(1), E3(2), E4,E5, E6, E7, E8**	**Medium - High E3(3), E3(4), E2**	**Very High E1**
Sand	apedal	< 0.2 m	M		
		0.2 - 0.4 m	L		
		> 0.4 m	L		
Sandy loam	apedal	< 0.2 m	M	H	
		0.2 - 0.4 m	L	M	
		> 0.4 m	L		
	weakly pedal	< 0.2 m	H	E	
		0.2 - 0.4 m	M	V	
		> 0.4 m	M		
Loam	apedal	< 0.2 m	M	H	
		0.2 - 0.4 m	L	M	
		> 0.4 m	L		
	weakly pedal	< 0.2 m	H	E	
		0.2 - 0.4 m	M	V	
		> 0.4 m	M		
	peds evident	< 0.2 m	H	E	
		0.2 - 0.4 m	H		
		> 0.4 m	H		
Clay loam	apedal	< 0.2 m	M	H	
		0.2 - 0.4 m	L	M	
		> 0.4 m	L		
	weakly pedal	< 0.2 m	H	E	
		0.2 - 0.4 m	M	V	
		> 0.4 m	M		
	peds evident	< 0.2 m	H	E	
		0.2 - 0.4 m	H	E	
		> 0.4 m	M		
Light clay	weakly pedal	< 0.2 m	H	E	E
		0.2 - 0.4 m	M	V	E
		> 0.4 m	M	V	E
	peds evident	< 0.2 m	M	V	E
		0.2 - 0.4 m	M	H	E
		> 0.4 m	M	H	E
	highly pedal	< 0.2 m	H	E	
		0.2 - 0.4 m	M	V	
		> 0.4 m	M	V	
Medium to heavy clay	weakly pedal	< 0.2 m	M	H	E
		0.2 - 0.4 m	M	H	V
		> 0.4 m	M	H	V
	peds evident	< 0.2 m	H	E	E
		0.2 - 0.4 m	M	V	E
		> 0.4 m	M	V	E
	highly pedal	< 0.2 m	H	E	E
		0.2 - 0.4 m	M	V	E
		> 0.4 m	M	V	E

L - Low M - Moderate H - High V - Very high E - Extreme

Table A.11 Susceptibility of soil to sheet and rill erosion.*

Slope %	Topsoil erodibility (from Table A.10)				
	Low	**Moderate**	**High**	**Very high**	**Extreme**
< 1 %	Very low	Very low	Low	Low	Moderate
1 - 3 %	Very low	Low	Moderate	Moderate	High
4 - 10%	Low	Moderate	Moderate	High	Very high
11 - 32%	Moderate	Moderate	High	Very high	Very high
> 32%	Moderate	High	Very high	Very high	Very high

***Note:** Topsoil erodibility is determined from the texture, structure, depth and dispersibility of the topsoil (Table A.10). The susceptibility of the topsoil to sheet and rill erosion relates to the combined effect of slope and topsoil erodibility (Table A.11).

The ratings for the Shire of Cardinia have been improved by one rating due to the high growth rate and ground cover during the summer months.

A.23 Susceptibility of soil to erosion by wind

The susceptibility of land to wind erosion is a function of soil erodibility, the probability of erosive winds when the soil is dry and the exposure of the land component to wind (Lorimer 1985). Soil erodibility is a very important factor to consider in land capability rating tables (Table A.12).

Table A.12 Soil erodibility.

	Soil type	Rating
1	Surface soil has a strong blocky structure (aggregates > 0.8 mm), or is apedal and cohesive or has a dense layer of stones, rock or gravel	Very low
	Surface soil has strong fine structure (aggregates < 0.8 mm)	Moderate
	Surface soil has a weak-moderate structure or is apedal and loose	Go to 2
2	Surface soils with organic matter > 20%	High
	Surface soils with organic matter 7 - 20%	Moderate
	Surface soils with organic matter < 7%	Go to 3
3	Surface soils with the following textures:	
	Fine-medium sands	Very high
	Loamy sands	High
	Sandy loams, silty loams	High
	Loams, coarse sands	Moderate
	Clay loams	Low
	Clays	Very low

Note: The ratings for the Shire of Cardinia have been improved by one rating due to the high growth rate and ground cover during the summer months.

A.24 Susceptibility to acidification

Soil acidification is usually observed over time as a decrease in soil pH. It may take place in the topsoil or subsoil. Soil acidification will cause contrasting effects depending upon the initial pH of the soil. In general, soil pH below 4.5 ($CaCl_2$) will cause toxic aluminium and manganese to be released. This causes retarded root growth in plants and may increase leaching of soluble salts and nutrients into groundwater, rivers and streams.

Measurement of susceptibility to acidification for this report is based upon the following table (Table A.13) and analysis of topsoils from each map unit.

Table A.13 Susceptibility of soil to acidification.

Susceptibility	Texture	pH ($CaCl_2$)	Annual rainfall
Low	Medium	< 4.5	> 450mm
	Heavy	All	> 450 mm
Moderate	Medium	> 4.5	> 450 mm
	Light	< 4.5	> 450 mm
High	Light	> 4.5	> 450 mm

Note: Land management, such as pasture species and stocking rates can contribute to acidification. Organic matter is not used as an indicator for susceptibility as its effects are complex

APPENDIX B. WORKING TABLES FOR LAND CAPABILITY CLASSES

B.1 Agriculture.

MAP UNITS	Qa1	Qa2	Qa3	Qa4	Qa5	Qa6	Qa7	Qa8	Qa9	Qa10	Qa11	Qa12	Tvb1
Climate	2	2	2	2	2	2	2	2	2	2	2	2	2
Topography	1	1	1	1	1	1	1	1	1	1	1	1	5
Topsoil conditions A1, A2	2	2	1	2	2	1	2	2	2	2	2	1	2
Depth of topsoil	1	1	1	2	2	1	1	1	2	1	1	1	2
Depth to hard rock/pan	1	1	1	1	1	1	1	1	1	3-4	1	1	1-2
Depth to seasonal watertable	2	2	2	2	2	2	2	2	2	2	2	2	1
Available water capacity	1	1	1	1	1	1	2	1	1	3-4	1	1	1
Permeability-rainfall index	2	2	3	2	3	3	2	3	3	3	3	3	2
Dispersibility of topsoil	2	1-2	1	1	1	1	2	1	2	1	1	1	2
Gravel/stone/boulder content	2	1	1	1	1	1	2	1	2	2	2	1	1
Electrical conductivity	1	1	1	1	1	1	1	1-2	1	1	1	1	1
Susceptibility to sheet erosion	1	1	1	1	2	1	1	2	2	1	1	1	3
Susceptibility to gully erosion	2	1	1	1	1	2	2	2	2	1	2	2	2
Susceptibiltiy to wind erosion	1	1	1	1	1	1	1	1	1	3	1	1	1

MAP UNITS	Tvc1	Tvd1	Tve1	Tvf1	Tvh1	Tvb2	Tvc2	Tvd2	Tve2	Tvf2	Tsd	Tse	Tsf
Climate	2	2	2	2	2	2	2	2	2	2	2	2	2
Topography	4	3	1	2	2-3	5	4	3	1	2	3	2	2
Topsoil conditions A1, A2	2	2	2	2	2	2	2	2	2	2	2	2	2
Depth of topsoil	2	2	1	1	1	2	2	2	1	1	1	1	1
Depth to hard rock/pan	1-2	1-2	1-2	1-2	1	1-2	1-2	1-2	1-2	1-2	1	2	1
Depth to seasonal watertable	1	1	1	1	2	1	1	1	1	1	2	2	2
Available water capacity	1	1	1	1	1	1	1	1	1	1	1	2	1
Permeability-rainfall index	2	2	2	2	2	2	2	2	2	2	2	2	3
Dispersibility of topsoil	2	2	2	2	2	2	2	2	2	2	1	2	1
Gravel/stone/boulder content	1	1	2	1	1	1	1	1	2	1	3	3	3
Electrical conductivity	1	1	1	1	1	1	1	1	1	1	1	1	1
Susceptibility to sheet erosion	2-3	2-3	2	2-3	2-3	3-4	2-3	2-3	2	3-2	2	2	2
Susceptibility to gully erosion	2-3	2	1	2	2-3	2-3	2-3	2	1	2	2	2	2
Susceptibiltiy to wind erosion	1	1	1	1	1	1	1	1	1	1	1	1	1

B.1 Agriculture (continued).

MAP UNITS	Tsg	Tsh	Dga	Dgb	Dgc	Dgd	Dge	Dgf	Dgg	Dgh	Dgi	Ssa	Ssb
Climate	2	2	2	2	2	2	2	2	2	2	2	2	2
Topography	1	1	2	5	4	3	2	2	1	2	1	2	5
Topsoil conditions A1, A2	2	2	3	3	3	3	3	4(A12)	4(A12)	2	2	2(A2)	2(A2)
Depth of topsoil	1	1	2	1	1	1	2	2	2	1	1	1	1
Depth to hard rock/pan	1	1	2	4	2	2	2	2	2	1	1	3-4	3-4
Depth to seasonal watertable	2	2	1	1	1	1	1	2	2	5	5	1	1
Available water capacity	1	1	2	3	3	3	2	3	3	3	3	3	3
Permeability-rainfall index	3	3	3	3	3	3	4	3	3	4	4	2	2
Dispersibility of topsoil	1	1	1	1	1	1	1	2	2	3(A2)	3	1	1
Gravel/stone/boulder content	3	2	4	4	2	3	3	2	2	1	1	3	3
Electrical conductivity	1	2	1	1	1	1	1	1	1	1	1	1	1
Susceptibility to sheet erosion	1	2	3	4	3	3	2	2	1	2	2	2	4
Susceptibility to gully erosion	2	2	3	3	3	3	2	2	1	2	2	2	3
Susceptibiltiy to wind erosion	1	1	3	3	3	3	3	2	2	2	2	1	1

MAP UNITS	Ssc	Ssd	Sse	Ssf	Ssg	Ssh	Ssi	Sma	Smb	Smc	Smd	Smf	Smh
Climate	2	2	2	2	2	2	2	2	2	2	2	2	2
Topography	4	3	2	2	1	1	1	2	5	4	3	3	2
Topsoil conditions A1, A2	3(A2)	3(A2)	2(A2)	3(A2)	3(A2)	3(A2)	3(A2)	2	3	2-3	2-3	2-3	2-3
Depth of topsoil	1	1	1	1	1	1	1	2	1	1	1	1	1
Depth to hard rock/pan	3-4	2-3	2	2	2	2	2	3-4	3-4	3-4	2	2	2
Depth to seasonal watertable	1	1	1	1	1	1	1	1	1	1	2	2	3
Available water capacity	3	3	3	3	2	2	2	3	3	3	2	2	2
Permeability-rainfall index	2	2	2	2	3	3	3	2	2	2	2	2	2
Dispersibility of topsoil	1	1	1	1	1	1	1	1	1	1	1	1	1
Gravel/stone/boulder content	3	2	3	2	2	2	2	3	3	4	5	5	3
Electrical conductivity	1	1	1	1	1	1	1	1	1	1	1	1	1
Susceptibility to sheet erosion	3	3	2	2	2	2	2	2	3	3	2	2	2
Susceptibility to gully erosion	2	2	2	2	2	2	2	2	2	2	1	2	2
Susceptibiltiy to wind erosion	3	3	1	2	2	2	2	2	3	2	3	3	2

B.2 Effluent disposal.

MAP UNITS	Qa1	Qa2	Qa3	Qa4	Qa5	Qa6	Qa7	Qa8	Qa9	Qa10	Qa11	Qa12	Tvb1	Tvc1
Slope	1	1	1	1	1	1	1	1	1	1	1	1	5	4
Flooding risk	2	2	2	2	2	2	2	2	2	2	2	2	1	1
Drainage	5	4	3	3	3	3	3	3	3	3	3	3	2	2
Depth to seasonal watertable	2	2	2	2	2	2	2	2	2	1	2	2	1	1
Depth to impermeable layer	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Number of months per year when average rainfall >Ksat	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Permeability	2	2	4	2	3-4	4	2	4	4	3	4	4	1	1

MAP UNITS	Tvd1	Tve1	Tvf1	Tvh1	Tvb2	Tvc2	Tvd2	Tve2	Tvf2	Tvh2	Tsd	Tse	Tsf
Slope	3	1	2	2-3	5	4	3	2	2	2-3	3	1-2	2
Flooding risk	1	1	1	1	1	1	1	1	1	1	1	1	2
Drainage	2	2	2	3	2	2	2	2	2	3	2	2	4
Depth to seasonal watertable	1	1	1	2	1	1	1	1	1	2	1	1	1
Depth to impermeable layer	1	1	1	1	1	1	1	1	1	1	1	1	1
Number of months per year when average rainfall >Ksat	1	1	1	1	1	1	1	1	1	1	1	1	1
Permeability	1	1	1	2	1	1	1	1	1	2	2	2	4

MAP UNITS	Tsg	Tsh	Dga	Dgb	Dgc	Dgd	Dge	Dgf	Dgg	Dgh	Dgi	Ssa	Ssb
Slope	1	1-2	3	5	4	3	2	2	1	2	1	2	5
Flooding risk	2	3	1	1	1	1	1	1	1	3	3	1	1
Drainage	4	4	3	2	3	4	5	4	4	4	4	2	2
Depth to seasonal watertable	1	2	1	1	1	1	1	2	3	4	4	1	1
Depth to impermeable layer	1	1	1	4	2	2	2	1	1	1	1	3-4	3-4
Number of months per year when average rainfall >Ksat	1	1	1	1	1	1	5	1	1	5	5	1	1
Permeability	4	4	4-3	4	4	4	5	4	4	5	5	2	2

B.2 Effluent disposal (continued).

MAP UNITS	Ssc	Ssd	Sse	Ssf	Ssg	Ssh	Ssi	Sma	Smb	Smc	Smd	Smf	Smh
Slope	4	3	2	2	1	2	1	2	5	4	3	2	2
Flooding risk	1	1	1	1-2	2	3	3	1	1	1	1	1	3
Drainage	2	2	2	4	4	4	4	2	2	2	3	3	4
Depth to seasonal watertable	1	1	1	2	2	2	2	1	1	2	2	2	2
Depth to impermeable layer	3-4	3-4	3	2	2	1	1	3-4	3-4	3-4	2	1	1
Number of months per year when average rainfall >Ksat	1	1	1	1	1	1	1	1	1	1	1	1	1
Permeability	2	2	2	2	4	4	4	2	4-3	2	2	2	2

B.3 Farm dams.

MAP UNITS	Qa1	Qa2	Qa3	Qa4	Qa5	Qa6	Qa7	Qa8	Qa9	Qa10	Qa11	Qa12	Tvb1
Slope	2	1	2	2	2	2	2	2	2	2	2	2	5
Linear shrinkage	3	3	2-3	3	3	3	3	2	3	2	2	3	3
Suitability of subsoil	2	2	2	3	2	5	2	2	2	2	3	5	2
Depth to seasonal watertable	3	3	3	3	3	3	3	3	3	1-3	3	3	1
Depth to hard rock	2	2	2	2	2	2	2	1	2	1	2	2	3
Permeability	3-4	4	3	3-4	3	3	4	3	3	3	3	3	4
Dispersibility of subsoil	3	3	3	2	2-3	2	2	3	4	2	2	2	3
Susceptibility to slope failure	2	2	2	2	2	2	2	2	1	2	2	2	5

MAP UNITS	Tvc1	Tvd1	Tve1	Tvf1	Tvh1	Tvb2	Tvc2	Tvd2	Tve2	Tvf2	Tsd	Tse	Tsf
Slope	5	4	2	1-3	3-4	5	5	4	2	1-3	4	1	1-3
Linear shrinkage	3	3	3	3	3	3	3	3	3	3	3	2	3
Suitability of subsoil	2	2	3	3	2	2	2	2	3	3	2	2	2
Depth to seasonal watertable	1	1	1	1-3	3	1	1	1	1	1-3	1	1	1
Depth to hard rock	3	3	3	3	3	3	3	3	3	3	1	4	1
Permeability	4	4	4	4	4	4	4	4	4	4	4	4	3
Dispersibility of subsoil	3	3	3	3	3	3	3	3	3	3	3	2	3
Susceptibility to slope failure	4	4	2	2	4	5	4	4	2	2	3	2	2

B.3 Farm dams (continued).

MAP UNITS	Tsg	Tsh	Dga	Dgb	Dgc	Dgd	Dge	Dgf	Dgg	Dgh	Dgi	Ssa	Ssb
Slope	2	1	3	5	5	4	1	3	2	1	2	1-3	5
Linear shrinkage	3	2	3	3	3	3	3	3	3	3	3	2	2
Suitability of subsoil	2	2	5	3	3	3	5	3	3	3	3	3	3
Depth to seasonal watertable	1	3	3	1	1	1	1	3	3	5	5	1	1
Depth to hard rock	1	1	4	4-3	4-3	4-3	4-3	3	3	3	3	4-5	4-5
Permeability	3	3	3	3	3	2	2	3	3	2	2	4	4
Dispersibility of subsoil	3	1	3	3	3	3	3	3	3	5	5	4	4
Susceptibility to slope failure	2	2	3	4	3	1	1	1	1	1	1	1	4

MAP UNITS	Ssc	Ssd	Sse	Ssf	Ssg	Ssh	Ssi	Sma	Smb	Smc	Smd	Smf	Smh
Slope	5	4	1	1-3	2	1	2	1-3	5	5	4	1-3	1
Linear shrinkage	3	3	2	3	3	3	3	3	3	2	3	3	2
Suitability of subsoil	3	3	3	3	3	3	3	3	3	5	3	3	5
Depth to seasonal watertable	3	3	1	3	3	3	3	1	1	3	3	3	3
Depth to hard rock	4-5	4-5	4	3	3	3	3	5	4-5	4-5	4	4	4
Permeability	4	4	4	4	3	3	3	3	3	4	4	4	4
Dispersibility of subsoil	3	3	4	3	3	3	3	5	3	5	2	2	5
Susceptibility to slope failure	3	3	1	1	1	1	1	1	4	3	4	2	2

B.4 Building foundations, i) slab, ii) stumps.

MAP UNITS	Qa1	Qa2	Qa3	Qa4	Qa5	Qa6	Qa7	Qa8	Qa9	Qa10	Qa11	Qa12	Tva1	Tvb1
Slope i), ii)	i)1 ii)1	i)1 ii)1	i)1 ii)1	i)1 ii)1	i)1 ii)1	i)1 ii)1	i)1 ii)1	i)1 ii)1	i)1 ii)1	i)1 ii)1	i)1 ii)1	i)1 ii)1	i)1 ii)1	i)5 ii)4
Drainage	5	4	3	3	3	3	3	3	3	3	3	3	2	2
Depth to seasonal watertable	3	3	3	3	3	2	2	3	2	2	2	2	1	1
Proportion of stone and boulder	1	1	1	1	1	2	2	1	2	2	2	2	1	1
Depth to hard rock	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Susceptibility to slope failure	2	2	2	2	2	2	2	2	2	2	2	2	2	5
Linear shrinkage	i)2 ii)3	i)2 ii)3	i)2 ii)3	i)2 ii)3	i)2 ii)3	i)2 ii)3	i)2 ii)3	i)1 ii)2	i)2 ii)3	i)1 ii)1	i)1 ii)2	i)2 ii)3	i)2 ii)3	i)2 ii)3
Flooding risk	2	2	2	2	2	2	2	2	2	2	2	2	1	1

B.4 Building foundations, i) slab, ii) stumps (continued).

MAP UNITS	Tvc1	Tvd1	Tve1	Tvf1	Tvh1	Tvb2	Tvc2	Tvd2	Tve2	Tvf2	Tsd	Tse	Tsf
Slope i), ii)	i)4 ii)3	i)4 ii)3	i)2 ii)1	i)3 ii)2	i)4 ii)3	i)5 ii)4	i)4 ii)3	i)4 ii)3	i)2 ii)1	i)3 ii)2	i)4 ii)3	i)2 ii)1	i)3 ii)2
Drainage	2	2	2	2	3	2	2	2	2	2	2	2	4
Depth to seasonal watertable	1	1	1	1	3	1	1	1	1	1	2	2	2
Proportion of stone and boulder	1	1	1	1	1	1	1	1	1	1	3	3	3
Depth to hard rock	1	1	1	1	1	1	1	1	1	1	1	2-1	1
Susceptibility to slope failure	4	4	2	2	4	5	4	4	2	2	3	2	2
Linear shrinkage	i)2 ii)3	i)2 ii)3	i)2 ii)3	i)2 ii)3	i)2 ii)3	i)2 ii)3	i)2 ii)3	i)2 ii)3	i)2 ii)3	i)2 ii)3	i)2 ii)3	i)1 ii)2	i)2 ii)3
Flooding risk	1	1	1	1	1	1	1	1	1	1	1	1	2

MAP UNITS	Tsg	Tsh	Dga	Dgb	Dgc	Dgd	Dge	Dgf	Dgg	Dgh	Dgi	Ssa	Ssb
Slope i), ii)	i)2 i i)1	i)2 ii)1	i)3 ii)2	i)5 ii)4	i)4 ii)3	i)4 ii)3	i)2 ii)1	i)3 ii)2	i)2 ii)1	i)1 ii)2	i)1 ii)1	i)3 ii)2	i)5 ii)4
Drainage	4	4	3	2	3	4	5	4	4	4	4	2	2
Depth to seasonal watertable	2	2	1	1	1	1	1	3	3	4	4	1	1
Proportion of stone and boulder	3	2-3	4	4	2	3	3	1	1	1	1	2	2
Depth to hard rock	1	1	1	1	1	1	1	1	1	1	1	3-2	3-2
Susceptibility to slope failure	2	2	3	4	3	3	1	1	1	1	1	1	4
Linear shrinkage	i)2 ii)3	i) ii)2	i)2 ii)3	i)2 ii)3	i)2 ii)3	i)2 ii)3	i)2 ii)3	i)2 ii)3	i)2 ii)3	i)2 ii)3	i)2 ii)3	i)1 ii)2	i)1 ii)2
Flooding risk	2	3	1	1	1	1	1	3	3	3	1	1	1

MAP UNITS	Ssc	Ssd	Sse	Ssf	Ssg	Ssh	Ssi	Sma	Smb	Smc	Smd	Smf	Smh
Slope i), ii)	i)4 ii)3	i)4 ii)3	i)2 ii)1	i)3 ii)2	i)2 ii)1	i)2 ii)1	i)1 ii)1	i)3 ii)2	i)5 ii)4	i)4 ii)3	i)4 ii)3	i)3 ii)2	i)2 ii)1
Drainage	2	2	2	4	4	4	4	2	2	2	3	3	4
Depth to seasonal watertable	1	3-2	1	3-2	3-2	3-2	3-2	1	1	3	2	3	1
Proportion of stone and boulder	2	2	2	2	2	2	2	3	4	3	5(A2)	5(A2)	4
Depth to hard rock	3-2	2	2	2	2	1	1	3-2	3-2	3-2	2	2	1
Susceptibility to slope failure	3	3	1	1	1	1	1	1	4	3	4	2	2
Linear shrinkage	i)2 ii)3	i)2 ii)3	i)1 ii)2	i)2 ii)3	i)2 ii)3	i)2 ii)3	i)2 ii)3	i)2 ii)3	i)2 ii)3	i)1 ii)2	i)2 ii)3	i)2 ii)3	i)1 ii)2
Flooding risk	1	1	1	1-2	2	3	3	1	1	1	1	1	3

B.5 Secondary roads.

MAP UNITS	Qa1	Qa2	Qa3	Qa4	Qa5	Qa6	Qa7	Qa8	Qa9	Qa10	Qa11	Qa12	Tvb1	Tvc1
Slope	1	1	1	1	1	1-2	2	1	2	1-2	2	1-2	5	4
Drainage	5	4	3	3	3	3	3	3	3	3	3	3	2	2
Depth to seasonal watertable	2-3	2-3	2-3	2-3	2-3	2	2	2-3	2	2	2	2	1	1
Proportion of stone and boulder	1	1	1	1	1	2	2	1	2	2	2	2	1	1
Depth to hard rock	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Susceptibility to slope failure	2	2	2	2	2	2	2	2	2	2	2	2	5	4
Linear shrinkage	3	4	3	3	3	3	3	2	3	1	2	3	3	3
Flooding risk	2	2	2	2	2	2	2	2	2	2	2	2	1	1
Dispersibility of subsoil (> 4%slope)	-	-	-	-	-	-	-	-	-	-	-	-	2	2
USG subsoil	3	3	3	3	3	5	3	3	3	3	3	5	3	3

MAP UNITS	Tvd1	Tve1	Tvf1	Tvh1	Tvb2	Tvc2	Tvd2	Tve2	Tvf2	Tvh2	Tsd	Tse	Tsf
Slope	4	2	2-3	2-4	5	4	4	2	2-3	2-4	4	2	3
Drainage	2	2	2	3	2	2	2	2	2	3	2	2	4
Depth to seasonal watertable	1	1	1-2	2	1	1	1	1	1-2	2	2	2	2
Proportion of stone and boulder	1	2	1	1	1	1	1	2	1	1	3	3	3
Depth to hard rock	1	1	1	1	1	1	1	1	1	1	1	2	1
Susceptibility to slope failure	4	2	2	4	5	4	4	2	2	4	3	2	2
Linear shrinkage	3	3	3	3	3	3	3	3	3	3	3	2	3
Flooding risk	1	1	1	1	1	1	1	1	1	1	1	1	2
Dispersibility of subsoil (> 4%slope)	2	-	2	2	2	2	2	-	2	2	3-2	3	3-2
USG subsoil	3	3	3	3	3	3	3	3	3	3	3	3	3

B.5 Secondary roads (continued).

MAP UNITS	Tsg	Tsh	Dga	Dgb	Dgc	Dgd	Dge	Dgf	Dgg	Dgh	Dgi	Ssa	Ssb
Slope	2	2	3	5	4	4	2-3	3	2	2	1	3	5
Drainage	4	4	3	2	3	4	5	4	4	4	4	2	2
Depth to seasonal watertable	2	2	1	1	1	1	1	3	3	4	4	1	1
Proportion of stone and boulder	3	2	4	4	2	3	3	1	1	1	1	3	3-4
Depth to hard rock	1	1	1	2-3	1	1	1	1	1	2	1	3-2	3-2
Susceptibility to slope failure	2	2	3	4	3	3	1	1	1	1	1	1	4
Linear shrinkage	3	2	3	3	3	3	3	3	3	3	3	2	2
Flooding risk	2	3	1	1	1	1	1	1	1	3	3	1	1
Dispersibility of subsoil (> 4%slope)	-	4	2	2	2	2	2	2	-	1	-	2	2
USG subsoil	3	3	3	3	3	3	3	3	3	3	3	3	3

MAP UNITS	Ssc	Ssd	Sse	Ssf	Ssg	Ssh	Ssi	Sma	Smb	Smc	Smd	Smf	Smh
Slope	4	4	2	3	2	2-3	1	3	5	4	4	3	2
Drainage	2	2	2	4	4	4	4	2	2	2	3	3	4
Depth to seasonal watertable	1	1	1	3-2	3-2	3-2	3-2	1	1	1	2	2	3
Proportion of stone and boulder	3	2	3	2	2	2	2	3	4	4	5(A2)	5(A2)	4
Depth to hard rock	3-2	2	2	2	2	1	1	3-2	3-2	3-2	2	2	1
Susceptibility to slope failure	3	3	1	1	1	1	1	1	4	3	4	2	2
Linear shrinkage	3	3	2	3	3	3	3	3	3	2	3	3	2
Flooding risk	1	1	1	1-2	2	3	3	1	1	1	1	1	3
Dispersibility of subsoil (> 4%slope)	2	2	-	2	-	-	-	1	2	1	1	1	1
USG subsoil	3	3	3	3	3	3	3	3	3	3	3	3	3

B.6 Rural residential development.

MAP UNITS	Qa1	Qa2	Qa3	Qa4	Qa5	Qa6	Qa7	Qa8	Qa9	Qa10	Qa11	Qa12	Tvb1
Effluent disposal	5	4	4	3	4	4	3	4	4	3	4	4	5
Farm dams	3-4	4	3	3-4	3	5	4	3	4	3	3	5	5
Secondary roads	5	4	3	3	4	5	3	3	3	3	3	5	5
Building foundation i);ii)	5	4	3	3	3	3	3	3	3	3	3	3	5

MAP UNITS	Tvc1	Tvd1	Tve1	Tvf1	Tvh1	Tvb2	Tvc2	Tvd2	Tve2	Tvf2	Tsd	Tse	Tsf
Effluent disposal	4	3	2	2	3	5	4	3	2	2	3	3	4
Farm dams	5	4	4	4	4	5	5	4	4	4	4	4	3
Secondary roads	4	4	3	3	4	5	4	4	3	3	4	3	4
Building foundation i);ii)	4	4	3	3	4	5	4	4	3	3	4	3	4

MAP UNITS	Tsg	Tsh	Dga	Dgb	Dgc	Dgd	Dge	Dgf	Dgg	Dgh	Dgi	Ssa	Ssb
Effluent disposal	4	4	4-3	5	4	4	5	4	4	5	5	3-4	5
Farm dams	3	3	5	5	5	4	5	3	3	5	5	4-5	5
Secondary roads	4	4	4	5	4	4	5	4	4	4	4	3	5
Building foundation i);ii)	4	4	4	5	4	4	5	4	4	4	4	3	5

MAP UNITS	Ssc	Ssd	Sse	Ssf	Ssg	Ssh	Ssi	Sma	Smb	Smc	Smd	Smf	Smh
Effluent disposal	4	3-4	3	4	4	4	4	3-4	5	4	3	3	4
Farm dams	5	4-5	4	4	3	3	3	5	5	5	4	4	5
Secondary roads	4	4	2	4	4	4	4	3	5	4	5	5	4
Building foundation i);ii)	4	4	3	4	4	4	4	3	5	4	5	5	4

APPENDIX C. SPECIFIC METHODOLOGY

C.1 Map unit determination

Map units were delineated according to geology and slope category (McDonald *et. al.*, 1984) using geological mapping, topographical mapping, aerial photography and field survey techniques.

C.2 Field observations

Most field descriptions are based on McDonald *et. al.* (1984), Northcote (1979) and Isbell (1994). The definition for soil horizon boundaries is listed below.

S	Sharp	< 5 mm
A	Abrupt	5 - 20 mm
C	Clear	20 - 50 mm
G	Gradual	50 - 100 mm
D	Diffuse	> 100 mm
+	Continuing	

C.3 Field tests

C.3.1 Saturated hydraulic conductivity

Site selection:

Considerable time and effort is required to obtain meaningful permeability (K_{sat}) values. It is imperative that sites are chosen carefully prior to the day of measurement. The sites should have nil, or at most, minimal disturbance.

Procedure:

i) Insert five small (35 cm diameter) and five large (40 cm diameter) infiltration rings with the small rings placed inside the large rings, so that each ring is approximately 100 mm into the main clay horizon. Remove some topsoil if necessary but care should be taken to cause minimal soil disturbance.

ii) Rings need to be at least two metres apart and located at random. Relocate rings if obstacles such as stones or roots prevent an even downward movement of the ring into the soil.

iii) Fill rings with water and set up reservoir tanks so that water is added when the level drops below the outlet tube. Record the time and date on field sheets.

iv) Place lids on rings to minimise evaporation and interference.

v) Check that all containers are full and will last overnight to allow soil to saturate and conductivity rate to equilibrate.

vi) Record water levels at various times during the day (depending upon infiltration rate), and leave for 24 hour period without any interruptions to the water flow, if possible .

vii) Next day dig out each ring taking care not to disturb the soil contained within the ring. Up-end the ring and record the proportion of soil area that has been transmitting water for each ring and record if water movement has been evenly distributed or confined to root/worm holes or structural cracks. Note any other differences, ie. rocks, sand, clay patches.

C.4 Laboratory analysis

Samples collected for each soil horizon were air dried, ground with a mortar and pestle and separated with 4.75 and 2 mm sieves into a gravel fraction (4.75 - 2 mm), and soil. The gravel fraction was reported as a percentage of the air dried field sample and discarded, while all subsequent tests were carried out on the soil samples and reported in terms of oven dried (105 ^{O}C) samples (except for EC, pH and Cl).

C.4.1 Physical properties

1. Particle size analysis

The method used for particle size analysis is based upon that of Hutton (1955), which divides the soil sample into the following four principal size groups:

Coarse sand	2.0 - 0.20 mm
Fine sand	0.20 - 0.02 mm
Silt	0.02 - 0.002 mm
Clay	< 0.002 mm

In this method the soil sample is mechanically dispersed using pentasodium triphosphate (sodium tripolyphosphate), shaken in a sedimentation cylinder, and silt and clay percentages determined on a 2% soil water mixture using a plummet balance. After hand decanting the silt and clay suspension, the sand fractions are determined by sieving and weighing the oven dried (105 ^{O}C) sand fractions.

Due to the presence of both organic material and solutes in the soil and also due to the limitations of the technique used, the sum of the four fractions does not always equal 100%. Limits of 4% variation for surface horizons and 2% variation for lower horizons are regarded as acceptable. The determination is

repeated for samples outside these limits. If repeat samples still remain outside these limits, then the closest result is accepted.

2. Emerson class

Soil dispersion is tested using the method of Emerson, (1967), and based upon the Australian Standard AS1289, C8.1, (1980). This gives eight dispersion classes from E1 to E8, where E1 is the most dispersive class and E8 the least dispersive class. Class E5 was further divided into four sub-classes E5(A), E5(B), E5(C) and E5(D), where E5(A) is more dispersive than E5(D). Also, classes E2 and E3 were each divided into four sub-classes according to the modification of Loveday and Pyle (1973), as quoted in Craze and Hamilton (1991). In this classification E2(1) is less dispersive than E2(4) and E3(1) is less dispersive than E3(4).

The order of soil dispersion from most dispersive to least dispersive is therefore:

E1
E2(4), E2(3), E2(2), E2(1)
E3(4), E3(3), E3(2), E3(1)
E4
E5(A), E5(B), E5(C), E5(D)
E6
E7
E8

3. Atterberg limits

Atterberg investigated the behaviour of fine grained soil with varying water content. He used the following definitions, quoted in Hicks (1991):

(a) The liquid limit is the water content at which a trapezoidal groove of specified shape, cut in moist soil held in a special cup, is closed after 25 taps on a hard rubber plate.

(b) The plastic limit is the water content at which the soil begins to break apart and crumble when rolled by hand into threads three mm in diameter.

(c) The shrinkage limit is the water content at which the soil reaches its theoretical minimum volume, as it dries out from a saturated condition.

The plasticity index is the difference between the liquid and plastic limits, and represents the range of water contents that the soil remains in the plastic state.

Atterberg limits are determined on a sieved soil fraction with particles < 0.425 mm in size. The methods are based upon the Australian Standard 1289 (1977), as follows:

Liquid limit AS1289. C1.1
Plastic limit AS1289. C2.1
Plasticity index AS1289. C3.1
Linear shrinkage AS1289. C4.1

C.4.2 Chemical properties

Soil chemical analyses were carried out at the Pivotest Laboratory, Geelong.

APPENDIX E. CRITERIA USED FOR ESTABLISHING RECHARGE VALUES

Characteristics of Very High Recharge Areas

permeability of profile:	> 1000 mm/day

Characteristics of High Recharge Areas

Soil depth:	< 25 cm
and/or outcropping bed-rock:	> 10%
and/or permeability of profile:	200 - 1000 mm/day
and/or clay content of clayiest layer:	< 25%
and/or soil type	Uniform soils: uniform sands, loamy sands, uniform loams, sandy silt loams, loams (Uc, Um, Gc) Duplex soils: red and whole coloured A2 present but not bleached high Fe_2O_3 content throughout B horizon
Side slopes:	> 25%

Characteristics of Moderate Recharge Areas

Soil depth:	25 - 100 cm
Outcropping bed-rock:	1 - 10%
Profile permeability:	50 - 200 mm/day
Clay content of clayiest layer:	> 25 - 35%
Soil type:	Gradational Duplex acid, whole coloured Duplex, A2 may be present and sporadically bleached

Characteristics of Low-Nil Recharge Areas

Soil depth:	> 100 cm
Outcropping bed-rock:	= 0
Profile permeability:	< 50 mm/day
Clay content of clayiest layer:	> 35%
Soil type:	Uniform clays (Uf) Uniform cracking clays (Ug) Duplex soils with conspicuously bleached A2, mottled B horizons and/or gleying characteristics.

APPENDIX F.

Table F1 Map unit nomenclature.

Geological age		Lithology		Landform element	
Q:	Quaternary	a:	alluvium	a: steep crest/ridge	
T:	Tertiary	b:	basalt	b: steep slope	>32%
K:	Cretaceous	c:	colluvium	c: moderately steep slope	21-32%
P:	Permian	f:	fans	d: moderate slope	11-20%
D:	Devonian	g:	granite/granodiorite	e: gentle crest	
S:	Silurian	r:	rhyodacite	f: gentle slope	4-10%
O:	Ordovician	s:	sedimentary	g: very gentle slope	1-3%
C:	Cambrian	t:	tillite	h: drainage depression	
		v:	volcanics	i: flat	<1%
		m:	metamorphic	l: former lake bed	
				p: plain	<1%
				r: rocky	
				x: plateau	
				1-5: river terraces	

N.B: If differentiating geology by different characteristics such as soil or site characteristics, a number is allocated. The appropriate number goes after the geological symbol.

e.g. Tvf2 = Tertiary volcanic, remnant capping, gentle slope

GLOSSARY

The following definitions have been extracted from Charman and Murphy (1991) and McDonald *et al.* (1984).

Acidification:

An increase in acidity in the soil due to changes in land use, particularly agriculture. Soils that are most susceptible are generally of light texture in high rainfall areas.

Aluminium (Al) toxicity:

Plant growth in agricultural crops may be affected if aluminium levels are greater than 15 µg/g. For the purposes of this report soils with aluminium levels greater than 15 µg/g are regarded as being potentially toxic and lime may be required to promote plant growth. (State Chemistry Laboratory, pers. comm.).

Apedal:

Describes a soil in which none of the soil material occurs as peds in the moist state. Such a soil is without apparent structure and is typically massive or single-grained.

Available water for plant growth:

The amount of water in the soil that can be held between field capacity and the moisture content at which plant growth ceases.

Bleaching:

The near-white colouration of an A_2 horizon which has been subject to chemical depletion as a result of soil-forming processes including eluviation. The colour is defined for all hues as having a value greater than or equal to 7 with a Chroma less than or equal to 4 on dry soils. Conspicuous bleaching means that > 80% of the horizon is bleached whereas sporadic bleaching means that < 80% of the horizon is bleached.

Consistence:

Consistence refers to the strength of cohesion and adhesion in soil. Strength will vary according to soil water status.

Dispersibility:

Value (Emerson)	*Interpretation*
E6, E7, E8	Very low
E3(1), E3(2), E4, E5	Low
E3(3), E3(4)	Moderate
E2	High
E1	Very high

Drainage:

Drainage is a term used to summarise local soil wetness conditions. It is affected by internal attributes which include soil structure, texture, porosity, hydraulic conductivity, water holding capacity, and external attributes such as evapotranspiration, gradient and length of slope and position in the landscape.

Categories are as follows:

Very poorly drained: Free water remains at or near the surface for most of the year. Soils are usually strongly gleyed. Typically a level or depressed site and/or a clayey subsoil.

Poorly drained: All soil horizons remain wet for several months each year. Soils are usually gleyed, strongly mottled and/or have orange or rusty linings of root channels.

Imperfectly drained: Some soil horizons remain wet for periods of several weeks. Subsoils are often mottled and may have orange or rusty linings of root channels.

Moderately well-drained: Some soils may remain wet for a week after water addition. Soils are often whole coloured, but may be mottled at depth and of medium to clayey texture.

Well-drained: No horizon remains wet for more than a few hours after water addition. Soils are usually of medium texture and not mottled.

Rapidly drained: No horizon remains wet except shortly after water addition. Soils are usually of coarse texture, or shallow, or both, and are not mottled.

Duplex soil:

A soil in which there is a sharp change in soil texture between the A and B horizons (such as loam overlying clay).

The soil profile is dominated by the mineral fraction with a texture contrast of 1.5 soil texture groups or greater between the A and B horizons. Horizon boundaries are clear to sharp.

Electrical conductivity (EC):

A measure of the conductivity of electricity through a 1:5 soil water suspension. It is used to determine the soluble salts in the extract. The unit of electrical conductivity is the 'Siemens' and soil salinity is expressed here as decisiemens per metre at 25^{o}C.

Value range (dS/m)	*Interpretation*
< 0.30	Very low
0.30 - 0.53	Low
0.53 - 1.26	Moderate
1.26 - 2.50	High
> 2.50	Very high

Flooding:

Includes overbank flow from streams and overland-channel flow along drainage depressions.

Gradational soil:

A soil in which there is a gradual change in soil texture between the A and B horizons (for example, loam over clay loam over light clay). The soil is dominated by the mineral fraction and shows more clayey texture grades on passing down the solum of

such an order that the texture of each successive horizon changes gradually to that of the one below. Horizon boundaries are usually gradual or diffuse. The texture difference between consecutive horizons is less than 1.5 soil texture groups, while the range of texture throughout the solum exceeds the equivalent span of one texture group.

Gully erosion:

Erosion of soil or soft rock material by running water that forms channels larger and deeper than rills (i.e 300 mm).

Hardpan:

A hardened and/or cemented horizon, or part thereof, in the soil profile. The hardness is caused by mechanical compaction or cementation of soil particles with organic matter or with materials such as silica, sesquioxides or calcium carbonate. Such pans frequently reduce soil permeability and root penetration, and thus may give rise to plant growth and drainage problems.

Land capability assessment:

A systematic and rational method of determining the relative ability of different areas of land to sustain a specific land use under a nominated level of management without being degraded or causing any long term off-site degradation.

Land units or components:

An area of land, distinct from adjacent units or components because of specific slope, soil, or geomorphological characteristics, eg. crest, lower slope.

Land pattern/system:

An area of land, distinct from surrounding terrain, that has a specific climatic range, parent material and modal slope. Made up of a recurring sequence of land elements or components, eg. sedimentary rolling hills.

Linear shrinkage:

See Shrink/swell potential.

Mottling:

Irregular patches of colour interspersed with and different from the dominant soil colour, that vary in number and size. Mottling can indicate impeded drainage but may also be a result of parent material weathering.

Nutrient status:

Sum of exchangeable base cations (Ca, Mg, K)

Value range (meq/100g)	*Interpretation*
< 4	Very low
4 - 8	Low
9 - 18	Moderate
19 - 30	High
> 30	Very high

Organic matter:

All constituents of the soil arising from living matter ie. plant and microfauna detritus, fresh or decomposed. The following values for organic matter have been used in this report:

Value range (%)	*Interpretation*
< 1	Very low
1 - 2	Low
2 - 3	Moderate
> 3	High

(***** indicates etimated value)

(organic matter % = organic C% x 1.72)

Parent material/rock:

The geologic material from which a soil profile develops. It may be bed-rock or unconsolidated materials including alluvium, colluvium, aeolian deposits or other sediments.

Permeability:

The characteristic of a soil, soil horizon or soil material which governs the rate at which water moves through it. It is a composite expression of soil properties and depends largely on soil texture, soil structure, the presence of compacted or dense soil horizons and the size and distribution of pores in the soil. In this study, the permeability has been measured as K_{sat} (saturated hydraulic conductivity). Where estimates have been made, based on the properties of the soil profile, this is clearly indicated.

Value range (mm/day)	*Interpretation*
< 10	Very slow
10 - 100	Slow
100 - 500	Moderate
500 - 1500	Rapid
1500 - 3000	Very rapid
> 3000	Excessive

pH (soil reaction):

A measure of the acidity or alkalinity of a soil. A pH (H_2O) of 7.0 denotes neutrality, higher values indicate alkalinity and lower values indicate acidity. Strictly, it represents the negative logarithm of the hydrogen ion concentration in a specified 1:5 soil water suspension on a scale of 0 to 14. Soil pH (H_2O) levels generally fall between 5.5 and 8.0 with most plants growing best in this range.

Phosphorus (P):

Deficient when less than 6 μg/g

Plasticity index:

The plasticity index of a soil is the numerical difference between the plastic limit and the liquid limit.

Potassium (K):

K deficiency	
Light textures	< 80 μg/g
Medium textures	< 110 μg/g
Heavy textures	< 120 μg/g

Marginal levels of K	
Light textures	80-120 μg/g
Medium textures	110-160 μg/g
Heavy textures	120-180 μg/g

Rill erosion:

Erosion by small channels less than 300 mm deep which can be completely smoothed by normal cultivation.

Recharge:

Movement of surface water down into the underlying groundwaters.

Rock outcrop:

Any exposed area of rock that is inferred to be continuous with the underlying parent material.

Sheet erosion/sheet wash:

The relatively uniform removal of soil from an area without the development of conspicuous channels.

Shrink/swell potential:

The capacity of soil material to change volume with changes in moisture content, frequently measured by a laboratory assessment of the soil's linear shrinkage. It relates to the soil's content of montmorillonite type clays. High shrink swell potential in soils, such as cracking clays, can give rise to problems in earth foundations and soil conservation structures. Categories used are:

Shrink/swell potent. (%)	*Linear shrinkage*
0 - 6	Very low
7 - 12	Low
13 - 17	Medium
18 - 22	High
> 22	Very high

Slaking:

The partial breakdown of soil aggregates in water due to the swelling of clay and the expulsion of air from pore spaces. It is a component, along with soil dispersion and soil detachment, of the process whereby soil structure is broken down in the field.

Slope:

Landform element that is neither a crest or a depression and that has an inclination greater than 1%. Slope can be broken up into the following categories:

Value range (%)	*Interpretation*
< 1%	Level
1 - 3%	Very gentle slope
4 - 10%	Gentle slope
11 - 20%	Moderate slope
21 - 32%	Moderately steep slope
> 32%	Steep slope

Soil colour:

Determined by comparison with a standard Munsell soil colour chart or its equivalent. It includes three variables of colour; hue, value and chroma.

Soil horizon:

A layer within the soil profile with distinct morphological characteristics which are different from the layers above and/or below. Horizons are more or less parallel to the land surface, except that tongues of material from one horizon may penetrate neighbouring horizons.

Soil profile:

A portion of a soil exposed in a vertical section, extending usually from the land surface to the parent material. In very general terms, a profile is made of three major layers designated A, B and C horizons. The A and B horizons are those modified by soil development. The C horizon is weathering parent material that has not yet been significantly altered by soil forming processes.

Soil texture:

The relative proportions of sand, silt and clay particles in a sample of soil. The field assessment of texture is based on the

characteristics of a bolus of wetted soil moulded by hand. Six main soil texture groups are recognised

	Texture group	*Approx. clay content*
1.	Sands	< 10%
2.	Sandy loams	10 - 20%
3.	Loams	20 - 30%
4.	Clay loams	30 - 35%
5.	Light clays	35 - 40%
6.	Heavy clays	> 45%

Unified soil group:

A soil classification system based on the identification of soil materials according to their particle size, grading, plasticity index and liquid limit. These properties have been correlated with the engineering behaviour of soils including soil compressibility and shear strength. The system is used to determine the suitability of soil materials for use in earthworks, optimal conditions for their construction, special precautions which may be needed, such as soil ameliorates, and final batter grades to be used to ensure stability.

GW: Well graded gravels, gravel-sand mixtures
GP: Poorly graded gravels, gravel-sand mixtures
GM: Silty gravels, poorly graded gravel-sand-silt mixtures
GC: Clayey gravels, poorly graded gravel-sand-clay mixtures
SW: Well graded sands
SP: Poorly graded sands
SM: Silty sands, poorly graded sand-silt mixtures
SC: Clayey sands, poorly graded sand-clay mixtures
ML: Inorganic silts and very fine sands, clayey fine sands with slight plasticity
CL: Inorganic clays of low to medium plasticity, sandy clays, silty clays
OL: Organic silts or organic silt-clays of low plasticity
MH: Inorganic silts, micaceous fine sandy or silty soils
CH: Inorganic clays of high plasticity
OH: Organic clays of moderate to high plasticity
Pt: Peat

Uniform soil:

A soil in which there is little, if any change in soil texture between the A and B horizons (for example, loam over loam, sandy clay over silty clay). The soil is dominated by the mineral fraction and shows minimal texture difference throughout, such that no clearly defined texture boundaries are to be found. The range of texture throughout the solum is not more than the equivalent span of one soil texture group.