

Understanding and Managing Soils in the Stanthorpe - Rosenthal Region

FIELD MANUAL

edited by J.M. Maher



Queensland Government Technical Report

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Edited by J.M. Maher

Department of Natural Resources
Brisbane 1996



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Mention must be made of the landholders throughout the region who freely allowed access to their properties and provided invaluable information on the local soils. Laboratory analysis of soil samples was carried out by staff of Agricultural Chemistry, Department of Natural Resources, Indooroopilly.

1. INTRODUCTION

The Land Management Manuals Project is a Department of Primary Industries 'self-help' initiative to aid decision making for sustainable land management and planning. This is achieved by increasing the awareness and aiding the understanding of land resources information within the community. The project is jointly funded by the Departments of Primary Industries and Natural Resources, and the National Landcare Program.

What is a Land Management Manual?

A Land Management Manual is a collation of currently available land resource data, combined with local knowledge and experience, primarily concerning soils and their management.

The preparation of the Manual involved a series of local workshops to obtain practical soil management information. This procedure ensured that the existing land resource information and its interpretation were up-to-date.

What area does the Manual cover?

The Manual discusses the attributes and limitations of the land types and soils used for primary production for some 462 000 hectares in the shires of Stanthorpe and that part of Warwick, previously called Rosenthal Shire.

The region includes the **Granite Belt** which is a popular term used to describe the large area of elevated granite between Dalveen and Wallangarra where horticulture is an important land use.

The major towns in the area are Stanthorpe, Leyburn, Dalveen and Wallangarra, and the city of Warwick (which lies just outside the Manual area boundary).

The project area and its relationship to Manuals in surrounding regions are shown in Map 1.

Why have a Land Management Manual?

Running a successful rural enterprise, over a long period of time, is dependent on the correct use of the available resources. Decision making should be determined by the ability of the resource to produce - not on historical practices which in some cases have led to resource degradation.

This Manual is designed to increase the awareness of the capabilities of the land types and soils within the region, and in so doing, minimise potential land degradation. It brings together the currently available resource data and practical management information in a format which is easy to use and understand.

The Manual provides a handy tool for users to identify and evaluate their land types and soils. The consideration of soils information is essential when developing long-term strategies for property management or for local planning.

What does the Manual contain?

The Land Management Manual package has three major parts contained within a ring-binder.

- The ***Field Manual***: the core and most important component of the package. It provides a summary of the region's soil and land characteristics, and provides recommendations for appropriate management and use. This section of the Manual also provides information on identifying the soils. Various visual aids are provided for this purpose, including maps, tables, land type sheets and landscape and soil photographs. Farmers and graziers will find the land type sheets that contain land use and management information for their soils particularly useful. An increased knowledge of soils and their behaviour helps decision making on optimising production on different soils while minimising land degradation.
- The ***Resource Information***: a reference document that provides a regional overview and places the soils information within this context. To support the information contained in the Field Manual, this document explains local land resource-related aspects in more detail. Land use problems encountered from local experience, and the solutions implemented are also dealt with.
- The ***Land Type Map***: full colour map showing the distribution of land types or landscapes (**not** soils) within the region.

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Who should use the Manual?

The Manual is a concise source of information for landholders, Departmental extension officers and groups or persons involved in farm planning (e.g. Landcare groups and Property Management Planning groups).

The following list illustrates the range of potential users of the Manual. Although the list only gives one example per user, the range of possible uses is more extensive.

Present landholders	- to re-assess the potential of their property
New landholders	- to assess the realistic potential of their property
Potential landholders	- to assess the realistic potential of a property
Property Management Planning (PMP) groups	- for resource-based property planning
Landcare groups	- for resource-based planning over large areas
Planners/consultants	- to assess property and land potential
Extension staff	- for sound advice on property potential
Educators	- for education on soils and their sound use
Land valuers	- for property potential and valuation
Rural banks	- for informed decision making
Local authorities	- for shire development plans
Dept. of Transport	- for better road construction and erosion control
Queensland Rail	- for erosion control
SWQEB	- for erosion control on line construction
Telecom	- for erosion control on line installation.



2. USING THE FIELD MANUAL

To use this Manual and the accompanying map effectively, it is essential to understand the two major notions that are the basis of the management information. These are the 'Land Types' and the 'Soils'. Although they are both defined elsewhere, it is important to re-emphasise these concepts here.

The whole landscape is divided into mapping units (called land types) which are based primarily on geology, slope and relief. Soils are described based on their probable occurrence and location within the landscape units. These landscape units help to reduce the complexity of the landscape to easily-handled proportions.

It must be stressed that for each land type, it is the *dominant* landform, soil and vegetation characteristics which are described. Depending on the complexity of the landscape, considerable variation in these features can occur within any individual land type. These variations arise because of the limitations imposed by the scale and intensity of the information collected. It is imperative that users of land resource maps understand these limitations.

Errors in interpretation or misleading conclusions will occur through incorrect usage (e.g. enlarging the map to create information at a larger scale), or if the user has unrealistic expectations of the map. Land and soils are a continuum, therefore map unit boundaries may not represent distinct changes, but rather a zone of gradual change (zone widths are also not defined). Regardless of the mapping scale used, there are always some areas which are too small to map accurately. Do not enlarge the map as this will not increase the accuracy of the information.

The landscape units (or land types) contain a number of different soils, which because of scale *are not mapped separately*. Although an indication is given of both the likely occurrence of dominant and minor soils within a map unit, any of the soils may be dominant locally, particularly at the field or farm scale. Once map units have been compiled they are not designed to identify the soils in a particular unit but to predict their probable occurrence. Field observations are necessary if positive confirmation is required, particularly for such uses as property planning or development of irrigation works. The principles of land use planning at farm scale are discussed at property management planning workshops which are conducted by officers of the DPI/DNR.

Each group of soils has a defined range of distinguishing properties i.e. they have similar profiles with similar horizon sequences, have developed from similar parent materials, and have many similar physical and chemical properties. However, they may occur on a range of different topography and have other land characteristics such as drainage, soil depth or stoniness which may influence management on these areas.

The Land Type Map enables a farmer to relate the broad-scale inventory information contained in the Manual, to on-farm features. The steps to make the link between the broad regional picture as presented on the Land Type Map, and the soils identified at the property level are set out below. In summary the steps in using this Manual are:

- establishing a specific land type;
- determining the range of soils present; and
- seeking the relevant land use and management information.

2.1 Determining the soil for any site

This Manual provides land use and management recommendations that apply to land types and soils which you can readily identify.

Step 1. First, **find your location on the Land Type Map**. Make a note of the land type and surrounding land types on the map. Due to the scale of mapping it has not been possible to map out all land types occurring. One of these unmapped areas may coincide with your location on the ground. Match your general landscape with the description shown on the map legend and in Table 2.1 to confirm your land type.

Table 2.2 shows the landform patterns, characterised by relief and the most common class of slope occurring, which are used to describe the land types presented in this Manual.

Step 2. Once you have confirmed the land type, **identify the soils that are likely to occur within that land type**. The reason for this is that the suitability and management information for the land type are based, where appropriate, on the characteristics of the dominant (or common) soil/s within each land type. Use the 'concept' descriptions, found on each land type sheet, for both the common and associated soils, to find the soil which *best* corresponds to your location. These brief descriptions should be used as a guide only. It is highly recommended that field inspections should be carried out to verify the soils on each area of the property.

Step 3. The field inspection will require you to dig a hole or examine a cutting e.g. bank or roadside, to verify the soil on different parts of the landscape. For example, it is probable that there will be different soils on an alluvial plain, on rolling slopes, hills, drainage lines, and so on. The soils can be further subdivided on the basis of topography, drainage, or other limitations such as rockiness, etc. into more detailed management units. Compare the description on the land type sheet and the representative soil photograph in the *Field Manual* with what you observe, and compare the landscape features. It must be stressed that the soil profile photo and accompanying description represent *one example* in the range of soils found within the soil group. Also, there are usually a number of soils occurring within each land type.

Table 2.1 Brief description of land types

Land Type	Brief description
<i>Land types developed on alluvium:</i>	
Mixed basalt alluvial plains	broad flood plains of the Condamine River; the slope of the plain is very gentle, 0-2%, and it is generally 1-2 km wide
Granite/traprock alluvial plains	narrow alluvial and colluvial flats which occur along minor creeks that run into the Condamine River off the northern slopes of the traprock; slopes are generally 0-1%
Traprock/sandstone alluvial plains	narrow alluvial and colluvial flats developed from material washed down from the traprock and sandstone hills; the slope of these creek flats ranges between 0-4% and their width is generally 1 km
<i>Land types developed on granite:</i>	
Rolling granite mountains	deeply dissected, rolling mountains; tors and boulders are very common
Granite hills	undulating to rolling hills, rocky knolls and narrow ridges; slopes average 10-15% but can reach 30%; very common rock outcrops and tors
Undulating low granite hills	undulating low hills with slopes ranging between 5-12%; rock outcrop common
Granite rises - uniform sands	gently undulating to undulating rises and colluvial, lower hillslopes; may have stony surfaces and rock outcrop; slopes generally 2-9%
Elevated granite plains	elevated flat plains, and gently undulating plains and rises, and colluvial slopes; occasional tor outcrops; average slopes 2-4%
Undulating granite plains	gently undulating to level valley floors, slopes 0-3%; and 3-9% on the adjacent, undulating to gently undulating colluvial slopes
Granite rises - texture contrast soils	gently undulating to undulating rises; slopes 1-6%, with rock outcrops and stony surfaces common
Flat granite plains	flat and gently undulating plains; found in some granite basins and along drainage lines; slopes 0-3%

Using the Field Manual

Land Type	Brief description
<i>Land types developed on sandstone:</i>	
Sandstone ridges	flat-topped ridges and steep scarps; slopes range from 0-15% on the ridge tops, up to vertical on the scarps
Undulating low sandstone hills	undulating hills of moderate relief; slopes 2-10%
Undulating sandstone rises	gently undulating to undulating rises; slopes 2-6%
Gently undulating sandy rises	gently undulating rises and plains; slopes 1-3%; mostly occur on the northern edge of the traprock near creek lines
Gently undulating sandstone plains	gently undulating plains; slopes 1-3%
<i>Land types developed on traprock:</i>	
Traprock mountains	deeply dissected mountains with slopes up to vertical and sharp, narrow ridges; stony surface
Undulating to rolling traprock hills	rolling hills, ridges and incised valley - slopes 10-30%; undulating hills and low hills in the Pikedale area - average slope 10%; very stony surface common with minor rock outcrops
Low traprock hills	undulating low hills and isolated traprock knolls; slopes 4-6%, may be up to 8%; stony surface
Traprock plains	gently undulating to undulating plains and rises - slope 1-6%; lower traprock hillslopes (3-5%) and colluvial slopes (1-3%) fringing flood plains; slightly stony surface
Elevated low traprock hills	gently undulating to undulating low hills; slopes 3-10%, may be steeper in some areas; stony surface common

Step 4. Continue to compare the information until a reasonable match is found. Matching descriptions does not imply that they must be 'identical', but rather that they should be similar in most aspects. For example, there may only be differences in profile pH trends, a different surface texture, or slight profile colour differences. If your soil matches one of the associated (or minor) soils, and it is not possible to include it with the 'named' soil of best fit, you should contact your local DPI/DNR office for suitability and management advice regarding the particular soil.

Step 5. Each area of your property can be mapped out as a management unit on a property plan. Where there is a change of topography, soil, drainage, erosion, geology, vegetation etc., which would necessitate a change in management practices, a new management unit should be identified and mapped out.

Step 6. Refer to the summary information on land use options and limitations, and management options for the selected land type and soil.

As you gain knowledge of the land resources it will be possible to identify both the land types and soils using the summary information from the *Field Manual*.

Table 2.2 Simple landform patterns characterised by relief and modal slope

Modal terrain slope							
Relief	Level <1%	Very gently inclined 1-3%	Gently inclined 3-10%	Moderately inclined 10-32%	Steep 32-56%	Very steep 56-100%	Precipitous >100%
Very high >300 m (about 500 m)	-	-	-	rolling mountains	steep mountains	very steep mountains	precipitous mountains
High 90-300 m (about 150 m)	-	-	undulating hills	rolling hills	steep hills	very steep hills	precipitous hills
Low 30-90 m (about 50 m)	-	-	undulating low hills	rolling low hills	steep low hills	very steep low hills	badlands
Very low 9-30 m (about 15 m)	-	gently undulating rises	undulating rises	rolling rises	steep rises	badlands	badlands
Extremely low <9 m (about 5 m)	level plain	gently undulating plain	undulating plain	rolling plain	badlands	badlands	badlands

Source: McDonald et al. 1990, Australian Soil and Land Survey, Field Handbook.



3. LAND TYPE SHEETS

READ THIS IN CONJUNCTION WITH A SET OF LAND TYPE SHEETS

The following sheets provide summary information about each land type and its associated soils, land use suitability and management. Soil and site descriptions presented here are directly relevant to decisions on land use and management. A set of limitations to land use has been deduced from these descriptions and local experience. Recommendations are also given for crop and pasture suitability.

It must be emphasised that comments regarding best management practices are based on local knowledge and experience. The soil information is provided to enable the landholder or manager to consider this information and its implications when making any land management decisions.

Land type information

Landform and geology: attributes such as slope, relief and parent material are used to describe the different land types. A photograph of the landscape is also provided.

Vegetation: lists the vegetation which is broadly associated with a given land type. A more detailed description of each floristic association is given in Table 5.1 of the *Resource Information*.

Soils: a brief description is given of the common and associated soils which occur within a given land type. It must be stressed that the description and photograph given is an *example* soil profile for the named soil. The range of distinguishing soil features, including chemical and physical attributes of the named soil which are relevant to land use, are briefly summarised. The soil profile photograph is also useful for identification purposes.

The soil description is simplified from the profile descriptions contained in Appendix 3 of the *Resource Information*, but is detailed enough to identify the soil. Soil colour, structure and types of segregations are defined in the Glossary.

Comments are made on the condition of the surface soil when it is dry.

Statements are made on the availability of nutrients in the top 10 cm of the soil at the *sampling site only*. The general ratings used for the interpretation of soil chemical analyses are given in Table 3.1 and in Section 4.

Table 3.1 Ratings used for interpretation of soil analyses

Ratings						
Soil Test	Units	Very low	Low	Medium	High	Very high
Cl	(%)	<0.01	0.01-0.03	0.03-0.06	0.06-0.20	>0.20
P _{ACID}	(mg/kg)	<10	10-20	20-40	40-100	>100
P _{BICARB}	(mg/kg)	<10	10-20	20-40	40-100	>100
Extr. K	(m.eq%)	<0.1	0.1-0.2	0.2-0.5	0.5-1.0	>1.0
Cu	(mg/kg)	<0.1	0.1-0.3	0.3-5	5-15	>15
Zn pH >7	(mg/kg)	<0.3	0.3-0.8	0.8-5	5-15	>15
pH <7	(mg/kg)	<0.2	0.2-0.5	0.5-5	5-15	>15
Mn	(mg/kg)	<1	1-2	2-50	50-500	>500
Total N	(%)	<0.05	0.05-0.15	0.15-0.25	0.25-0.5	>0.5
Org. C	(%)	<0.5	0.5-1.5	1.5-2.5	2.5-5.0	>5.0
Total P	(%)	<0.005	0.005-0.02	0.02-0.05	0.05-0.10	>0.10
Total K	(%)	<0.1	0.1-0.5	0.5-1.0	1.0-3.0	>3.0
Total S	(%)	<0.005	0.005-0.02	0.02-0.05	0.05-0.10	>0.10
PAWC	(mm)	<50	50-100	100-150	150-200	>200
Dispersion ratio			<0.6	0.6-0.8	>0.8	

pH - extremely acid <4.5; very strongly acid 4.5-5.0; strongly acid 5.1-5.5; medium acid 5.6-6.0; slightly acid 6.1-6.5; neutral 6.6-7.3; mildly alkaline 7.4-7.8; moderately alkaline 7.9-8.4; strongly alkaline 8.5-9.0; very strongly alkaline >9.0.

Surface soil and subsoil pH ranges are given for each soil. Further explanation of pH is given in the Glossary.

Salinity and sodicity within the profile are based on the chemical analyses of the soil samples taken for each example soil. Salinity is based on the electrical conductivity (EC) value and chloride ion (Cl⁻) values and relates to inherent salinity (that is, the presence of salts in the profile). Sodicity relates to the exchangeable sodium percentage (ESP) value. These terms are defined in the Glossary.

An estimate is given of the plant available water capacity (PAWC) within the rooting zone, i.e. the ability of the soil to retain moisture for use by the crop or pasture. Section 4.4 of the *Resource Information* gives a more detailed discussion of the soil chemical and physical properties.

Land use information

The land use information has been compiled from local knowledge and experience.

Land use options: the most suitable uses for the common (or dominant) soil within the land type are presented. If any information is required concerning the associated (or minor) soils, contact your local DPI or DNR office.

It must be understood however, that the ultimate decision on land use rests with the land manager who must take into consideration current climatic and economic conditions. The information provided in this Manual should be considered as a guide.

Land use limitations: includes aspects important to soil management.

Land management recommendations: lists important recommendations for responsible land management which allow optimal land use with minimum land degradation.

These recommendations are based on the known inherent properties of the soils and the limitations they present to any land use.

Nature conservation: comments are made regarding the conservation of flora and fauna within the land types.



LAND TYPE SHEETS

Stanthorpe - Rosenthal Land Management Manual



Mixed Basalt Alluvial Plains

LANDFORM AND GEOLOGY:

- Condamine River flat plains
- slopes mainly <1%, but may be up to 2% locally
- 1 to 2 km wide
- broad flood plains with mixed alluvium derived largely from basalt

VEGETATION:

- blue gum open forest; now cleared except for river banks



COMMON SOIL:

Pratten

Deep, self-mulching, black cracking clays, with an alkaline pH which increases with depth.

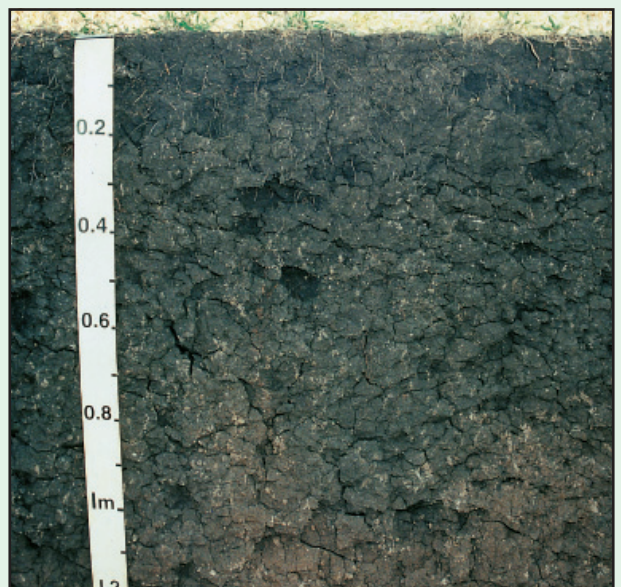
ASSOCIATED SOILS:

Dark loams - Deep soils, very dark grey to very dark brown, massive loams to clay loams of neutral pH.

EXAMPLE SOIL PROFILE: PRATTEN

DEPTH	DESCRIPTION
0 - 15 cm	black, heavy clay; self-mulching surface; strong blocky structure; pH 7.9
15 - 30 cm	black, heavy clay; strong blocky structure; few calcareous nodules; pH 8.7
30 - 80 cm	black, heavy clay; strong lenticular structure; common calcareous nodules; pH 8.9
80 - 140 cm	grey, heavy clay; strong lenticular to blocky structure; common calcareous nodules; pH 8.9 - 9.3

Australian Soil classification: Epicalcareous-Epiphypersodic, Self-mulching, Black Vertisol



Mixed Basalt Alluvial Plains

DISTINGUISHING SOIL FEATURES:

- **surface conditions**
self-mulching
- **effective rooting depth (ERD) range:**
50 to 80 cm
- **PAWC Range:**
93 to 133 mm (low to medium depending on ERD)
- **fertility:**
N - low; *P* - high; *K* - high;
Cu - high; *Zn* - low
- **pH trend:**
moderately alkaline surface; very strongly alkaline deep subsoils; carbonate from 15 cm
- **salinity:**
high below 50 cm
- **sodicity:**
strongly sodic below 50 cm

LAND USE OPTIONS:

- if good floodplain management practices are used it is suitable for grain cropping, including wheat, barley, maize and sorghum; however, low areas are unsuitable for cropping
- suitable for irrigated fodder cropping for dairying
- suitable for grazing native and sown pasture

LAND USE LIMITATIONS:

- erosive flooding
- stream bank erosion
- narrow moisture range for good workability
- occasional wetness and severe flooding
- susceptibility to compaction

LAND MANAGEMENT RECOMMENDATIONS:

CROPPING:

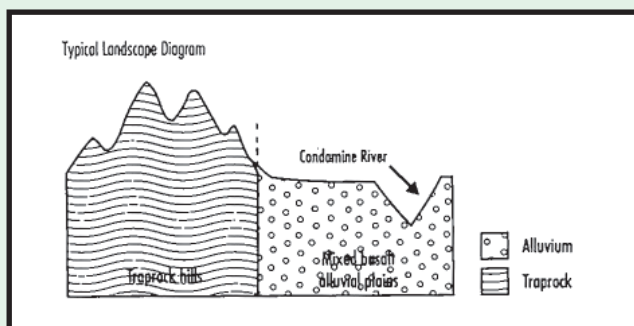
- practices such as minimum tillage, stubble mulching and chemical weed control will maintain soil structure, reduce erosion and maximise infiltration
- for areas where contours are sufficiently even, strip cropping is recommended for erosion control and spreading of over land flow and/or floodwater
- use pastures for erosion control on areas of uneven land surface which are not suitable for strip cropping

GRAZING:

- maintain vegetative cover on stream banks to reduce stream bank erosion
- restrict stock access along stream banks that are subject to erosion and where overland flow enters the watercourse
- locate watering points away from streams

NATURE CONSERVATION:

- **Extent:**
Restricted to fringes of the Condamine River and Tributaries. Largely cleared except for banks.
- **Ecological values:**
Important habitat for arboreal mammals and a range of bird species.
- **Reservation status:**
Little to no representation in conservation reserves.
- **Comments:**
Clearing inadvisable because of limited extent and values as riparian habitat.



Granite/Traprock Alluvial Plains

LANDFORM AND GEOLOGY:

- narrow alluvial and colluvial flats; major occurrences along Rodger and Greymare creeks and the Severn River
- slopes 0% to 1%
- soils are derived from mixed granite and traprock alluvium

VEGETATION:

- poplar box grassy woodland; or,
- Blakely's red gum and / or fuzzy box grassy woodland; or,
- manna gum open forest; or,
- New England peppermint, manna gum grassy woodland; or,
- grey box with fuzzy box and yellow box grassy woodland



COMMON SOIL:

Rodger

Deep, soil with a massive, very dark greyish brown, loam to clay loam surface, usually hard setting, over a bleached A2 horizon to 30-35 cm, over very dark grey to dark brown, blocky or columnar, alkaline clay subsoils

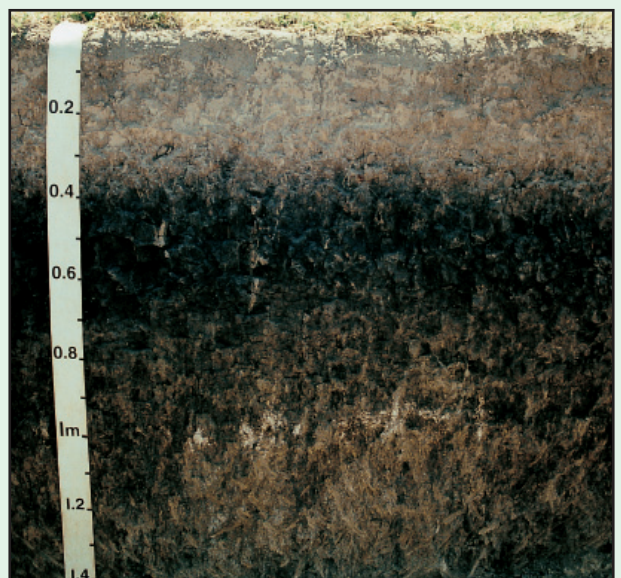
ASSOCIATED SOILS:

Deep, hard setting, very dark grey to dark brown gradational soils with acidic surfaces and permeable, neutral to alkaline clay subsoils; deep, dark brown, massive, sandy clay loams to clay loams of neutral pH; and deep, black to dark brown, alkaline clays

EXAMPLE SOIL PROFILE: RODGER

DEPTH	DESCRIPTION
0 - 10 cm	black, clay loams; weak granular structure; pH 6.8 - 7.1
10 - 30 cm	grey, clay loam; partially bleached when dry; massive; pH 6.1
30 - 65 cm	black, medium heavy clay; strong blocky structure; very firm consistence; pH 7.3
65 - 90 cm	black, medium heavy clay; strong blocky structure; pH 8.3
90 - 110 cm	grey, medium heavy clay; moderate blocky structure; many calcareous soft segregations
110 - 150 cm	brown, medium clay; massive; pH 8.9 - 8.8

Australian Soil Classification: Haplic, Hypercalcic, Black Chromosol



Granite/Traprock Alluvial Plains

DISTINGUISHING SOIL FEATURES:

- **surface conditions**
hard setting, may be weakly structured
- **effective rooting depth (ERD) range:**
110 cm, may be shallower depending on subsoil structure
- **PAWC Range:**
95 mm (low)
- **fertility:**
N - medium; *P* - medium; *K* - very high;
Cu - medium; *Zn* - medium
- **pH trend:**
neutral surface; strongly alkaline deep subsoils;
carbonate from 90 cm
- **sodicity:**
non-sodic

LAND USE OPTIONS:

- suitable for grazing native and sown pastures
- Rodger soils with partially permeable subsoils (not columnar structure) are suitable for growing lucerne
- limited suitability for cropping due to risk of erosive flooding
- low areas are unsuitable for cropping

LAND USE LIMITATIONS:

- prone to flooding
- slightly erosion prone
- hard setting surface
- seasonal waterlogging
- poorly structured, impermeable subsoils
- low water holding capacity

LAND MANAGEMENT RECOMMENDATIONS:

CROPPING:

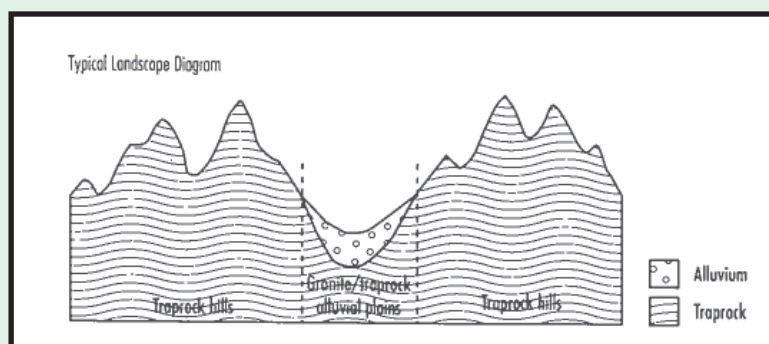
- floodplain management is required, but the size, shape and topography of cultivated areas makes them unsuitable for strip cropping
- apply a ley pasture rotation with crops using intensive conservation cropping practices

GRAZING:

- most desirable native grasses; Queensland bluegrass and pitted bluegrass
- maintain surface cover, especially on Rodger, to avoid scalds forming
- shallow ripping with chisel ploughs should be used to increase infiltration on scalded areas, but care is required if these areas are prone to erosive flooding

NATURE CONSERVATION:

- **Extent:**
Extensively cleared or modified. Poplar box virtually all cleared for crops and pastures. Manna gum communities are restricted to watercourses north of Dalveen.
- **Ecological values:**
Important habitat for arboreal mammals and a range of bird species. Habitat for a number of rare and threatened plant species.
- **Reservation status:**
Little to no representation in conservation reserves.
- **Comments:**
Additional clearing inadvisable because of limited extent and important habitat values.



Traprock/Sandstone Alluvial Plains

LANDFORM AND GEOLOGY:

- narrow alluvial and colluvial flats of the Thane, Back and Canal creeks
- slopes range from 0 - 4%
- soils are derived from mixed traprock and / or sandstone alluvium

VEGETATION:

- poplar box grassy woodland; or
- poplar box, gum topped box open forest



COMMON SOIL:

Leyburn

Moderately deep to deep soils with hard setting, loamy sand to clay loam surfaces, frequently gravelly, underlain by a bleached A2 horizon to 10-40 cm, over yellowish brown and brown, coarse blocky or columnar structured, neutral to alkaline, impermeable clay subsoils.

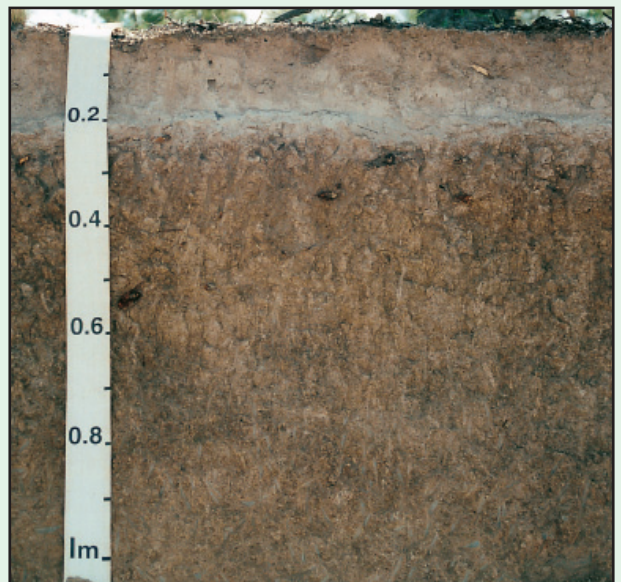
ASSOCIATED SOILS:

Red, acid texture contrast soils with sandy textured surface soils to 60 cm thick; red and brown, alkaline, structured earths; deep sandy loams; and brown, grey and black, neutral to alkaline, cracking clays.

EXAMPLE SOIL PROFILE: LEYBURN

DEPTH	DESCRIPTION
0 - 5 cm	brown, fine sandy clay loam; weak granular structure; pH 6.0 - 7.0
5 - 20 cm	grey, clay loam; bleached when dry; massive
20 - 60 cm	brown, medium clay; weak blocky structure; pH 6.1 - 6.8
60 - 110 cm	brown, medium clay; massive; strong consistence; pH 7.2 - 7.7

Australian Soil classification: Eutrophic, Subnatric, Brown Sodosol



Traprock/Sandstone Alluvial Plains

DISTINGUISHING SOIL FEATURES:

- **surface conditions**
hard setting, frequently gravelly
- **effective rooting depth (ERD) range:**
50 cm (surface soil depth)
- **PAWC Range:**
57 mm (low)
- **fertility:**
N - low; *P* - low; *K* - high;
Cu - medium; *Zn* - medium
- **pH trend:**
medium acid to neutral surface; mildly
alkaline deep subsoil
- **salinity:**
high from 50 to 90 cm
- **sodicity:**
strongly sodic from 50 cm

LAND USE OPTIONS:

- suitable for grazing native and sown pastures
- some areas (usually the associated soils)
suitable for grain and fodder cropping and
lucerne - low areas highly prone to erosive
flooding are unsuitable

LAND USE LIMITATIONS:

- seasonal waterlogging
- poorly structured, impermeable subsoils
- low water holding capacity
- erosive flooding

LAND MANAGEMENT RECOMMENDATIONS:

CROPPING:

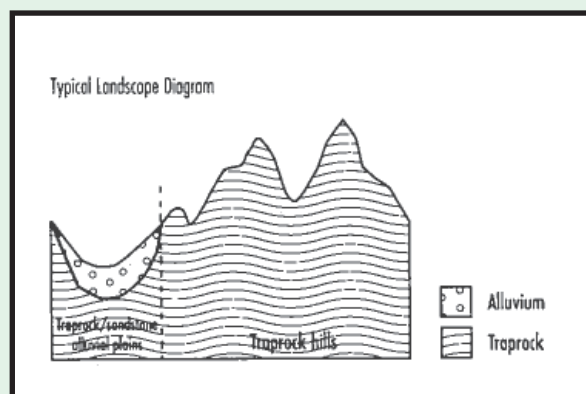
- practices such as minimum tillage, stubble munching and chemical weed control will improve surface structure, reduce erosion and maximise infiltration
- desirable to include pastures in rotation
- suitable crops include lucerne, oats, millet, cowpeas, medics or vetch

GRAZING:

- most desirable native grasses; Queensland bluegrass and pitted bluegrass
- suitable sown species include; premier digit grass, subclovers, rhodes grass, lucerne and kikuyu
- maintain surface cover (above 30% basal cover) to avoid scalds forming
- increase infiltration by shallow ripping with chisel ploughs on scalded areas
- avoid deep ripping on shallow surface soils with sodic subsoils
- apply floodplain management practices where prone to erosive flooding
- restrict stock access along stream banks that are subject to erosion
- strategically locate watering points to avoid areas of overgrazing; use centrally located watering points (one watering point per 200 hectares) - scalding may become a problem where there are insufficient or badly located watering points

NATURE CONSERVATION:

- **Extent:**
Extensively cleared or modified.
- **Ecological values:**
Important habitat for arboreal mammals and
a range of bird species.
- **Reservation status:**
Little to no representation in conservation
reserves.
- **Comments:**
Additional clearing inadvisable because of
limited extent and important habitat values.



Rolling Granite Mountains

LANDFORM AND GEOLOGY:

- deeply dissected granite mountains and outcrops of the Girraween National Park; includes Jibbinbar Mountain and Red Rock
- widespread for outcrops
- very stony surface
- slopes 10 - 30%

VEGETATION:

- New England blackbutt open forest / tall open forest; or
- mixed species shrubland; or
- swamp sedgeland



COMMON SOIL:

Banca

Shallow to moderately deep, very dark grey to brown, gritty, structureless siliceous sands amongst rock outcrops and frequently underlain by a colour B horizon of similar texture and / or a natural, impermeable hardpan; soil depth varies from 25 - 90 cm, commonly less than 50 cm

ASSOCIATED SOILS:

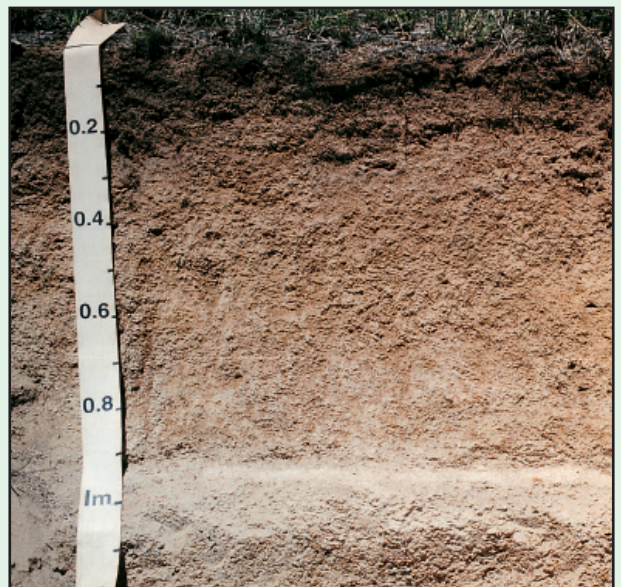
Shallow, gritty, loamy sands and sands with rock fragments to 30 cm; and moderately deep soils (Cottonvale) with loamy sand to sandy loam surfaces over a bleached gritty sand to 30 cm, over a yellow or yellow mottled, acid, clay subsoil

EXAMPLE SOIL PROFILE: BANCA

(soils of this depth more common on granite land types of lower relief)

DEPTH	DESCRIPTION
0 - 15 cm	brown, loamy coarse sand; loose surface; pH 6.4 - 6.1
15 - 40 cm	brown, clayey coarse sand; massive; gravelly quartz common; pH 6.5
40 - 80 cm	brown, clayey coarse sand with quartz gravel common; pH 6.3
80 - 120 cm	yellow, coarse sand; massive natural hardpan; pH 6.3 - 5.7

Australian Soil classification: Basic, Silpanic, Orthic Tenosol



Rolling Granite Mountains

DISTINGUISHING SOIL FEATURES:

- **surface conditions**
loose to firm
- **effective rooting depth (ERD) range:**
depth to hardpan or rock, usually 25 to 50 cm
- **PAWC Range:**
25 to 43 mm (very low - depends on profile depth)
- **fertility:**
N - low; *P* - low; *K* - medium;
Cu - low; *Zn* - medium
- **pH trend:**
slightly acid surface; medium acid to slightly acid subsoil
- **sodicity:**
non-sodic

LAND USE OPTIONS:

- nature conservation and tourism
- suitable honey producing areas
- some areas suitable for grazing native pastures

LAND USE LIMITATIONS:

- high erosion risk due to steep slopes
- stoniness / rockiness
- very infertile
- very low water holding capacity and shallow soil depth
- excessively drained

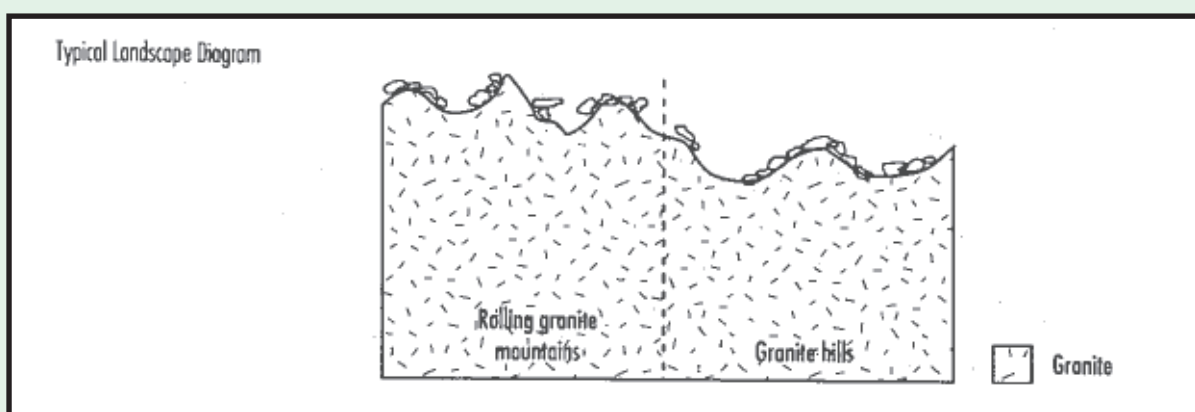
LAND MANAGEMENT RECOMMENDATIONS:

GRAZING:

- restrict grazing to retain pasture cover and prevent erosion
- clearing slopes >20% may result in erosion

NATURE CONSERVATION:

- **Extent:**
Some areas cleared through extensive areas remain.
- **Ecological values:**
Habitat for a number of rare and threatened plant species including some at the northern limit of their geographical range.
- **Reservation status:**
Well represented in Girraween National Park.
- **Comments:**
Terrain generally unsuitable for clearing.



Granite Hills

LANDFORM AND GEOLOGY:

- undulating to rolling granite hills and ridges in the Mt Magnus and Sandy Creek areas
- tors and rock outcrops common
- may have stony surface
- average slopes 10 - 15%
- mainly Stanthorpe adamellite and Ruby Creek granite

VEGETATION:

- New England blackbutt shrubby open forest to woodland; or
- tumbledown gum, Youman's stringy bark, Caley's ironbark and other species grass / shrubby woodland



COMMON SOIL:

Banca

Shallow to moderately deep, very dark grey to brown, gritty, structureless siliceous sands amongst rock outcrops and frequently underlain by a colour B horizon of similar texture and / or a natural, impermeable hardpan; soil depth varies from 25 - 90 cm, commonly less than 50 cm.

ASSOCIATED SOILS:

Shallow, gritty, loamy sands and sands with rock fragments to 30 cm; and moderately deep soils (Cottonvale) with loamy sand to sandy loam surfaces over a bleached gritty sand to 30 cm, over a yellow or yellow mottled, acid, clay subsoil

EXAMPLE SOIL PROFILE: BANCA

(soils of this depth more common on granite land types of lower relief)

DEPTH	DESCRIPTION
0 - 15 cm	brown, loamy coarse sand; loose surface; pH 6.4 - 6.1
15 - 40 cm	brown, clayey coarse sand; massive; gravelly quartz common; pH 6.5
40 - 80 cm	brown, clayey coarse sand with quartz gravel common; pH 6.3
80 - 120 cm	yellow, coarse sand; massive natural hardpan; pH 6.3 - 5.7

Australian Soil classification: Basic, Silpanic, Orthic Tenosol



Granite Hills

DISTINGUISHING SOIL FEATURES:

- **surface conditions**
loose to firm
- **effective rooting depth (ERD) range:**
depth to hardpan or rock, usually 25 to 50 cm
- **PAWC Range:**
25 to 43 mm (very low - depends on profile depth)
- **fertility:**
N - low; *P* - low; *K* - medium;
Cu - low; *Zn* - medium
- **pH trend:**
slightly acid surface; medium acid to slightly acid subsoil
- **sodicity:**
non-sodic

LAND USE OPTIONS:

- suitable for grazing native pastures
- small areas on gentle slopes suitable for sown pastures
- small areas suitable for irrigated and dryland horticultural crops on soils deeper than 45 cm on low slopes
- suitable honey producing areas
- nature conservation

LAND USE LIMITATIONS:

- erosion risk due to steep slopes
- stoniness / rockiness
- very infertile
- very low water holding capacity and shallow soil depth
- excessively drained
- waterlogging due to hardpans or rock

LAND MANAGEMENT RECOMMENDATIONS:

GRAZING:

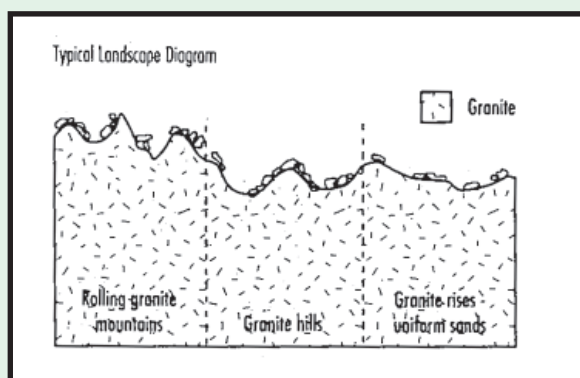
- most desirable native grasses; wallaby grass, summer grass and barbwire grass
- restrict grazing to retain pasture cover (above 30% basal cover) and prevent erosion
- continuous overgrazing will result in the invasion of unpalatable and inferior species such as bracken fern, bladey grass, sedges, african lovegrass, pinrush
- strategic grazing and spelling is required to maintain pasture vigour
- areas of tors and rocky outcrops are unsuitable for clearing
- suitable sown pasture species include white clover, sub clover, fescue, ryegrass and serradella (on the deeper sands)

NATURE CONSERVATION:

- **Extent:**
Some areas cleared though extensive areas remain
- **Ecological values:**
Habitat for a number of rare and threatened plant species including some at the northern limit of their geographical range
- **Reservation status:**
Well represented in Girraween National Park
- **Comments:**
Terrain generally unsuitable for clearing

CROPPING:

- suitable for tree (apples, pears, stone fruit), vine and vegetable crops
- on slopes >2%, plant tree crops in graded rows across the slope
- deep rip prior to planting (if a hardpan is present)
- sod culture is recommended where ample irrigation water is available
- reduced tillage with winter cover cropping is recommended
- use chemical weed control to prevent erosion
- erosion control layouts need to be implemented to ensure good drainage
- use mounds in tree and vine crops for an increase in soil depth, increased plant available water capacity and nutrients, and for better drainage
- for vegetable crops, use graded, raised beds within an erosion control layout



Undulating Low Granite Hills

LANDFORM AND GEOLOGY:

- predominantly low granite hills south of Greymare and in the Pikedale area
- slopes 5 - 12%
- minor rock outcrops and tors
- Ruby Creek granite and Greymare granodiorite

VEGETATION:

- broad leaved stringybark, blue gum grassy woodland



COMMON SOIL:

Banca

Shallow to deep, very dark grey to brown, gritty, siliceous sands amongst rock outcrops, and frequently underlain by a colour B horizon of similar texture and / a natural, impermeable hardpan; soil depth commonly 25-90cm

ASSOCIATED SOILS:

Shallow, gritty, loamy sands and sands with rock fragments to 30 cm; and moderately deep soils (Cottonvale) with loamy sand to sandy loam surfaces over a bleached gritty sand to 30 cm, over a yellow or yellow mottled, acid, clay subsoil

EXAMPLE SOIL PROFILE: BANCA

DEPTH	DESCRIPTION
0 - 15 cm	brown, loamy coarse sand; loose surface; pH 6.4 - 6.1
15 - 40 cm	brown, clayey coarse sand; massive; gravelly quartz common; pH 6.5
40 - 80 cm	brown, clayey coarse sand with quartz gravel common; pH 6.3
80 - 120 cm	yellow, coarse sand; massive natural hardpan; pH 6.3 - 5.7

Australian Soil classification: Basic, Silpanic, Orthic Tenosol



Undulating Low Granite Hills

DISTINGUISHING SOIL FEATURES:

- **surface conditions**
loose to firm
- **effective rooting depth (ERD) range:**
depth to hardpan or rock, usually 25 to 90 cm
- **PAWC Range:**
25 to 59 mm (very low to low - depends on profile depth)
- **fertility:**
N - low; *P* - low; *K* - medium;
Cu - low; *Zn* - medium
- **pH trend:**
slightly acid surface; medium acid to slightly acid subsoil
- **sodicity:**
non-sodic

LAND USE OPTIONS:

- suitable for grazing native pastures
- suitable for sowing improved pastures on gently sloping areas
- limited suitability for winter fodder cropping (on slopes <8% and with a soil depth <45cm)
- generally unsuitable for grain cropping
- suitable for horticulture if irrigation water is available

LAND USE LIMITATIONS:

- erosion risk
- stoniness / rockiness
- very infertile
- very low to low water holding capacity and shallow soil depth
- excessively drained
- waterlogging due to hardpans or rock

LAND MANAGEMENT RECOMMENDATIONS:

GRAZING:

- most desirable native grasses: barbwire grass, pitted blue grass and speargrass
- restrict grazing to retain pasture cover (above 30% basal cover) and prevent erosion
- continuous overgrazing will result in the invasion of unpalatable and inferior species such as bracken fern, bladey grass, sedges, african lovegrass, pinrush
- strategic grazing and spelling is required to maintain pasture vigour
- recommended sown pasture species included white clover, sub clover, fescue, ryegrass and serradella (on the deeper sands)
- areas of tors and rocky outcrops are unsuitable for clearing

NATURE CONSERVATION:

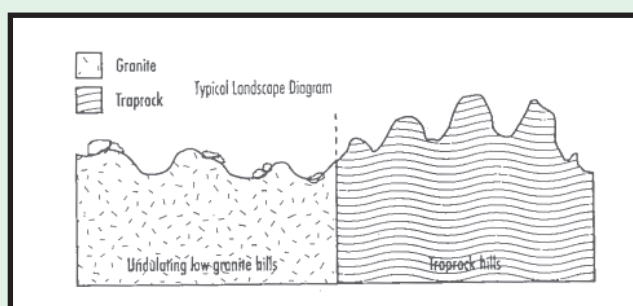
- **Extent:**
Extensively cleared.
- **Ecological values:**
Provides habitat for some rare and threatened plant species.
- **Reservation status:**
Not represented in conservation reserves.
- **Comments:**
Recommended strategic retention of representative patches as part of property planning because of widespread clearing within the restricted distribution of the community.

FODDER CROPPING:

- runoff control measures should be applied on slopes <1%
- practice conservation cropping measures

HORTICULTURAL CROPPING:

- suitable for tree (apples, pears, stone fruit), vine and vegetable crops
- on slopes >2%, plant tree crops in graded rows across the slope
- deep rip prior to planting (if a hardpan is present)
- sod culture is recommended where ample irrigation water is available
- reduced tillage with winter cover cropping is recommended
- use chemical weed control to prevent erosion
- erosion control layouts need to be implemented to ensure good drainage
- use mounds in tree and vine crops for an increase in soil depth, increased plant available water capacity and nutrients, and for better drainage
- for vegetable crops, use graded, raised beds within an erosion control layout



Granite Rises - Uniform Sands

LANDFORM AND GEOLOGY:

- gently undulating to undulating rises and granitic, colluvial, lower hillslopes
- may have stony surfaces and rock outcrop
- slopes generally 2-9%
- may occur in valleys and elevated areas of low relief

VEGETATION:

- New England blackbutt open forest / tall open forest



COMMON SOIL:

Pozieres

Moderately deep to deep, very dark grey to dark greyish brown, gritty, siliceous sands, overlying a natural, impermeable hardpan or becoming brighter coloured with depth; soil depth commonly 60 - 90 cm

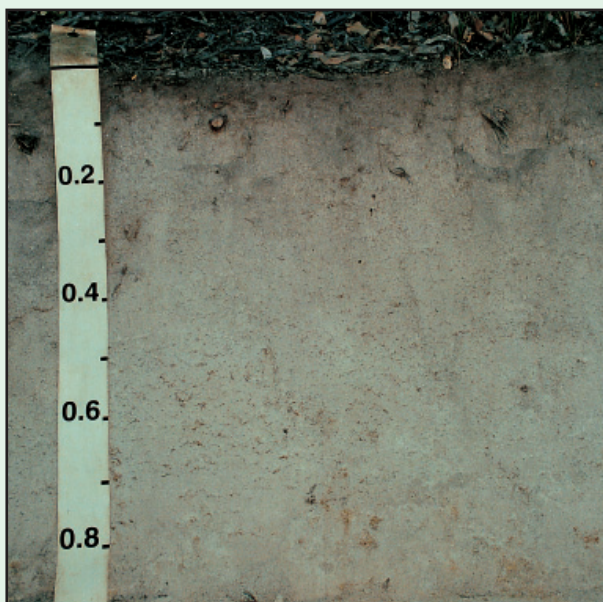
ASSOCIATED SOILS:

Deep soil (Cottonvale) with a bleached, sandy surface to 30 cm over yellow and grey, mottled, acid clay subsoil

EXAMPLE SOIL PROFILE: POZIERES

DEPTH	DESCRIPTION
0 - 10 cm	grey, coarse sandy loam; loose surface; pH 4.6-4.9
10 - 20 cm	grey, coarse sandy loam; massive
20 - 60 cm	grey loamy coarse sand; massive; pH 5.6-5.7
60 - 80	grey, loamy coarse sand; massive; very firm consistence; very few yellow mottles
80 - 90 cm	grey, clayey coarse sand; mottled yellow; very firm consistence; pH 5.6

Australian Soil classification: Basic, Regolithic, Bleached-Leptic Tenosol



Granite Rises - Uniform Sands

DISTINGUISHING SOIL FEATURES:

- **surface conditions**
loose to firm
- **effective rooting depth (ERD) range:**
depth to hardpan or rock, usually 60 to 90 cm
- **PAWC Range:**
39 to 59 mm (very low to low - depends on profile depth)
- **fertility:**
N - low; *P* - medium; *K* - medium;
Cu - medium; *Zn* - high
- **pH trend:**
very strongly acid surface; medium acid deep subsoil
- **sodicity:**
non-sodic

LAND USE OPTIONS:

- suitable for irrigated and dryland horticultural crops on soils deeper than 45 cm - particularly orchards and vegetables (traditionally the northern area is only used for grazing)
- suitable for grazing native and sown pastures
- suitable for short-term (1 - 3 yrs) winter fodder cropping to avoid erosion
- not suitable for grain cropping

LAND USE LIMITATIONS:

- erosion risk
- stoniness
- very low to low water holding capacity
- fertility usually low
- excessively drained
- waterlogging due to hardpan

LAND MANAGEMENT RECOMMENDATIONS:

GRAZING:

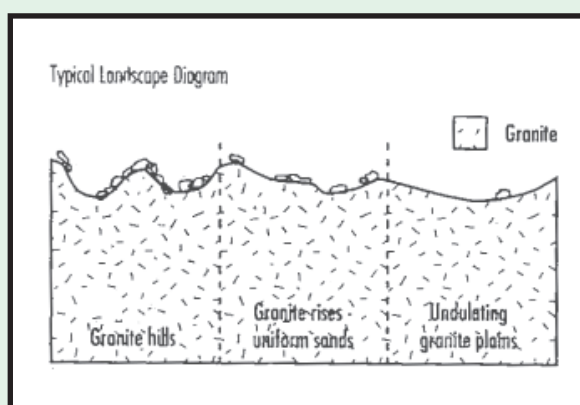
- most desirable native grasses; wallaby grass, summer grass and barbwire grass
- suitable sown pasture species include white clover, sub clover, fescue, ryegrass and serradella (on the deeper sands)
- restrict grazing to retain pasture cover (above 30% basal cover) and prevent erosion
- continuous overgrazing will result in the invasion of unpalatable and inferior species such as bracken fern, bladey grass, sedges, african lovegrass, pinrush
- strategic grazing and spelling is required to maintain pasture vigour
- areas of rock outcrops are unsuitable for clearing

NATURE CONSERVATION:

- **Extent:**
Some areas cleared on suitable terrain.
- **Ecological values:**
Habitat for a number of rare and threatened plant species including some at the northern limit of their geographical range
- **Reservation status:**
Well represented in Girraween National Park with smaller areas in Sundown.
- **Comments:**
Recommend strategic retention of representative patches as part of property planning.

CROPPING:

- do not crop on slopes >6%
- suitable for tree (apples, pears, stone fruit), vine and vegetable crops
- on slopes >2%, plant tree crops in graded rows across the slope
- deep rip prior to planting (if a hardpan is present)
- sod culture is recommended where ample irrigation water is available
- reduced tillage with winter cover cropping is recommended
- use chemical weed control to prevent erosion
- erosion control layouts need to be implemented to ensure good drainage
- use mounds in tree and vine crops for an increase in soil depth, increased plant available watering capacity and nutrients, and for better drainage
- for vegetable crops, use graded, raised beds within an erosion control layout



Elevated Granite Plains

LANDFORM AND GEOLOGY:

- elevated flat plains, and gently undulating plains and rises, and colluvial slopes in the Cottonvale - the Summit area
- occasional tor outcrops
- average slopes 2 - 4%
- found on Stanthorpe adamellite

VEGETATION:

- New England blackbutt open forest / tall open forest



COMMON SOIL:

Cottonvale

Deep soil with gritty, very dark grey, bleached, sandy surface to 30 - 45 cm over mottled, brown, grey and yellowish grey, acid, clay subsoils becoming more gritty with depth

ASSOCIATED SOILS:

Shallow to deep, gritty, siliceous sands (Pozieres); a moderately deep to deep soil with a bleached sandy clay loam surface to 20 - 30 cm over mottled, yellowish brown, neutral to alkaline clay subsoil; and a deep soil with a gritty, bleached, sandy surface to 60 - 75 cm grading into mottled, brown or yellow, acid, gritty, clay loam or clay subsoil

EXAMPLE SOIL PROFILE: COTTONVALE

DEPTH	DESCRIPTION
0 - 15 cm	black, coarse sandy loam; hard setting surface; pH 5.8 - 6.3
15 - 40 cm	yellow, coarse sandy clay loam; bleached when dry; pH 6.0
40 - 65 cm	grey, mottled orange, coarse sandy light clay; moderate blocky structure; pH 4.3
65 - 100	grey, mottled orange, coarse sandy light clay; massive: pH 4.5

Australian Soil classification: Bleached-Sodic, Magnesian-Natric, Grey Kurosol



Elevated Granite Plains

DISTINGUISHING SOIL FEATURES:

- **surface conditions**
hard setting, may be granular
- **effective rooting depth (ERD) range:**
30 to 45 cm (surface soil depth)
- **PAWC Range:**
37 to 50 mm (very low to low - depends on surface depth)
- **fertility:**
N - low; *P* - medium; *K* - high;
Cu - medium; *Zn* - high
- **pH trend:**
medium acid to slightly acid surface;
extremely acid deep subsoil
- **salinity:**
high from 50 to 60 cm
- **sodicity:**
strongly sodic subsoils

LAND USE OPTIONS:

- suitable for horticulture - predominantly orchards and vegetables with some vineyards
- most suitable for pomefruits due to temperature requirements
- suitable for grazing native and sown pastures

LAND USE LIMITATIONS:

- hard setting surface reduces infiltration rates
- poorly drained subsoils
- waterlogging may occur
- medium to low fertility
- very low to low water holding capacity

LAND MANAGEMENT RECOMMENDATIONS:

GRAZING:

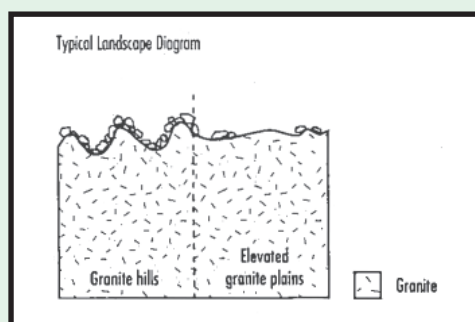
- most desirable native grasses; awnless, barnyard grass, speargrass, sedges
- restrict grazing to retain pasture cover (above 30% basal cover) and prevent erosion
- continuous overgrazing will result in the invasion of unpalatable and inferior species such as bracken fern, bladey grass, sedges, african lovegrass, pinrush
- strategic grazing and spelling is required to maintain pasture vigour
- areas of tors and rock outcrops are unsuitable for clearing
- suitable sown pasture species include white clover, sub clover, fescue, ryegrass and serradella (on the deeper sands)

CROPPING:

- suitable for tree (apples, pears, stone fruit), vine and vegetable crops
- on slopes >2%, plant tree crops in graded rows across the slope
- deep rip prior to planting (if a hardpan is present)
- sod culture is recommended where ample irrigation water is available
- reduced tillage with winter cover cropping is recommended
- use chemical weed control to prevent erosion
- erosion control layouts need to be implemented to ensure good drainage (however, they need not be as intensive as the steeper granite areas)
- use mounds in tree and vine crops for an increase in soil depth, increased plant available water capacity and nutrients, and for better drainage
- for vegetable crops, use graded, raised beds within an erosion control layout

NATURE CONSERVATION:

- **Extent:**
Extensively cleared on suitable terrain.
- **Ecological values:**
Habitat for a number of rare and threatened plant species including some at the northern limit of their geographical range.
- **Reservation status:**
Well represented in Girraween National Park.
- **Comments:**
Recommend strategic retention of representative patches as part of property planning.



Undulating Granite Plains

LANDFORM AND GEOLOGY:

- gently undulating to level valley floors, slopes 0 - 3%; and
- undulating to gently undulating colluvial lower slopes of rises and some low hills; occasional tors and rock outcrops; slopes 3-9%
- Bapaume to Ballandean area

VEGETATION:

- New England blackbutt open forest / tall open forest; or
- New England peppermint, manna gum grassy woodland; or
- tumbledown gum, Youman's stringybark, Caley's ironbark and other species grassy / shrubby woodland; or
- broad leaved stringybark, blue gum grassy woodland



COMMON SOIL:

Cottonvale

Deep soil with gritty, very dark grey, bleached, sandy surface to 30 - 45 cm over mottled, brown, grey and yellowish grey, acid, clay subsoils becoming more gritty with depth

ASSOCIATED SOILS:

Shallow to deep, gritty, siliceous sands (Pozières); a moderately deep to deep soil with a bleached sandy clay loam surface to 20 - 30 cm over mottled, yellowish brown, neutral to alkaline clay subsoil; and a deep soil with a gritty, bleached, sandy surface to 60 - 75 cm grading into mottled, brown or yellow, acid, gritty, clay loam or clay subsoil

EXAMPLE SOIL PROFILE: COTTONVALE

DEPTH	DESCRIPTION
0 - 15 cm	black, coarse sandy loam; hard setting surface; pH 5.8 - 6.3
15 - 40 cm	yellow, coarse sandy clay loam; bleached when dry; pH 6.0
40 - 65 cm	grey, mottled orange, coarse sandy light clay; moderate blocky structure; pH 4.3
65 - 100	grey, mottled orange, coarse sandy light clay; massive; pH 4.5

Australian Soil classification: Bleached-Sodic, Magnesian-Natric, Grey Kurosol



Undulating Granite Plains

DISTINGUISHING SOIL FEATURES:

- **surface conditions**
hard setting, may be granular
- **effective rooting depth (ERD) range:**
30 to 45 cm (surface soil depth)
- **PAWC Range:**
37 to 50 mm (very low to low - depends on surface depth)
- **fertility:**
N - low; *P* - medium; *K* - high;
Cu - medium; *Zn* - high
- **pH trend:**
medium acid to slightly acid surface;
extremely acid deep subsoil
- **salinity:**
high from 50 to 60 cm
- **sodicity:**
strongly sodic subsoils

LAND USE OPTIONS:

- suitable for horticulture - predominantly orchards (mainly stone fruits), vegetables and vineyard, particularly on lower sloping areas
- area around Storm King Dam has limited horticulture because of climatic limitations (conductive to disease problems)
- suitable for grazing native and sown pastures

LAND USE LIMITATIONS:

- hard setting surface reduces infiltration rates
- poorly drained subsoils
- waterlogging may occur
- medium to low fertility
- very low to low water holding capacity
- rock outcrops and water courses restrict cultivation opportunities (areas too small to be viable)

LAND MANAGEMENT RECOMMENDATIONS:

GRAZING:

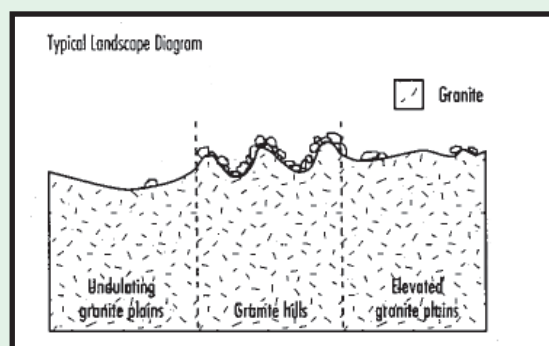
- most desirable native grasses; awnless, barnyard grass and speargrass
- restrict grazing to retain pasture cover (above 30% basal cover) and prevent erosion
- continuous overgrazing will result in the invasion of weed species such as bracken fern, bladey grass, sedges, african lovegrass, pinrush
- strategic grazing and spelling is required to maintain pasture vigour
- areas of tors and rocky outcrops are unsuitable for clearing
- suitable sown pasture species include white clover, sub clover, fescue, ryegrass and serradella (on the deeper sands)

NATURE CONSERVATION:

- **Extent:**
Extensively cleared on suitable terrain.
Restricted to the northern slopes of the Granite Belt.
- **Ecological values:**
Habitat for *Eucalyptus interstans*, a species with a patchy distribution.
- **Reservation status:**
Not represented in conservation reserves.
- **Comments:**
Recommend strategic retention of representative patches as part of property planning.

HORTICULTURE:

- suitable for tree (apples, pears, stone fruit), vine and vegetable crops
- on slopes >2%, plant tree crops in graded rows across the slope
- deep rip prior to planting (if a hardpan is present)
- sod culture is recommended where ample irrigation water is available
- reduced tillage with winter cover cropping is recommended
- use chemical weed control to prevent erosion
- erosion control layouts need to be implemented to ensure good drainage
- use mounds in tree and vine crops for an increase in soil depth, increased plant available water capacity and nutrients, and for better drainage
- for vegetable crops, use graded, raised beds within an erosion control layout



Granite Rises - Texture Contrast Soils

LANDFORM AND GEOLOGY:

- gently undulating to undulating rises on weathered adamellite and granodiorite
- slopes 1-6%, with rock outcrops and stony surfaces common; and
- lower granite and granodiorite hillslopes (average slope 3%)

VEGETATION:

- tumbledown gum, Youman's stringybark, Caley's ironbark and other species grassy / shrubby woodland; or
- broad leaved stringybark, blue gum grassy woodland



COMMON SOIL:

Greymare

Moderately deep to deep soil with very dark greyish brown to yellowish brown, bleached, sandy loam to loamy sand surface soil to 30 cm to 60 cm, over coarse blocky or columnar, mottled, greyish yellow-brown to pale yellow, gritty, acid to neutral, clay subsoil

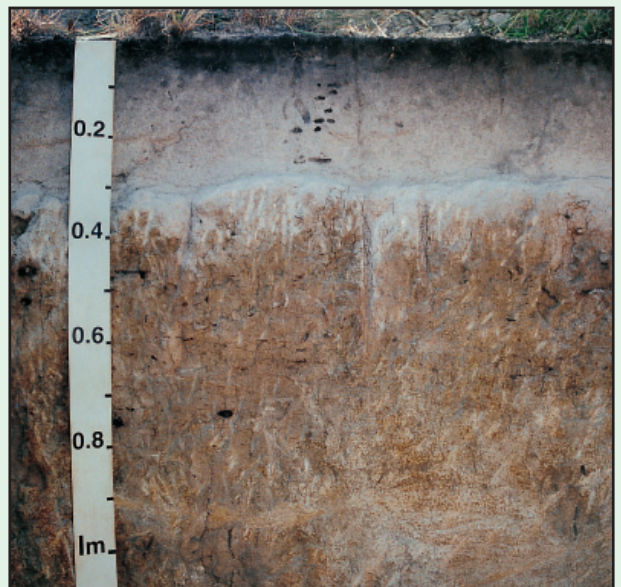
ASSOCIATED SOILS:

Lyra - moderately deep soil with a bleached, light sandy clay loam surface soil to 20 cm over mottled, yellowish brown, alkaline clay subsoil becoming gritty with depth

EXAMPLE SOIL PROFILE: GREYMARE

DEPTH	DESCRIPTION
0 - 10 cm	black, coarse sandy clay loam; hard setting surface; pH 7.0 - 7.5
10 - 30 cm	grey, clayey coarse sand; bleached when dry; massive; moderately firm consistence; pH 7.4
30 - 60 cm	grey, mottled red, coarse sandy medium heavy clay; strong columnar structure; pH 7.0
60 - 80 cm	yellow, mottled red, coarse sandy medium clay; weak blocky structure
80 - 120 cm	yellow, mottled red, coarse sandy clay loam; massive; pH 7.1-7.0

Australian Soil classification: Eutrophic, Mottled Subnatric, Grey Sodosol



Granite Rises - Texture Contrast Soils

DISTINGUISHING SOIL FEATURES:

- **surface conditions**
hard setting
- **effective rooting depth (ERD) range:**
30 to 60 cm (surface soil depth)
- **PAWC Range:**
36 to 58 mm (very low to low - depends on surface depth)
- **fertility:**
N - low; *P* - low; *K* - high;
Cu - low; *Zn* - low
- **pH trend:**
neutral surface; acid to neutral deep subsoils
- **salinity:**
high from 50 cm
- **sodicity:**
sodic to strongly sodic subsoils

LAND USE OPTIONS:

- suitable for grazing native and sown pastures
- suitable for short-term, winter fodder cropping with annual fertilising

LAND USE LIMITATIONS:

- low fertility
- very low to low water holding capacity
- waterlogging because of poorly structured subsoils

LAND MANAGEMENT RECOMMENDATIONS:

GRAZING:

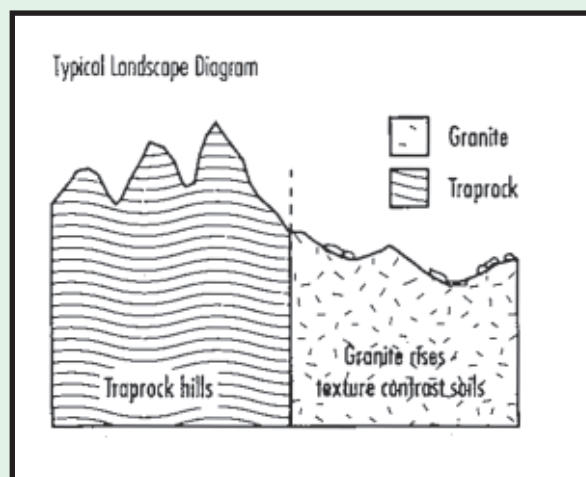
- most desirable native grasses; pitted bluegrass and barbwire grass
- restrict grazing to retain pasture cover (above 30% basal cover) and prevent erosion
- suitable sown pastures include premier digit grass, rhodes grass, sub clover and white clover
- sow to pasture for 3-6 years then rotate into fodder cropping for up to 3 years
- continuous overgrazing will result in the invasion of weed species
- strategic grazing and spelling is required to maintain pasture vigour
- areas of tors and rocky outcrops are unsuitable for clearing

CROPPING:

- suitable forage crops include millets, oats, cowpeas and lucerne
- implement runoff control measures on slopes > 1%
- practice conservation cropping measures, rotate with pastures after 3 years

NATURE CONSERVATION:

- **Extent:**
Extensively cleared on suitable terrain.
- **Ecological values:**
No special attributes, but representation a concern
- **Reservation status:**
Nil to poor.
- **Comments:**
Fuzzy box, brown box and Blakely's gum extensively cleared and not represented in conservation reserves. Recommend strategic retention of representative patches as part of property planning.



Flat Granite Plains

LANDFORM AND GEOLOGY:

- flat and gently undulating plains on weathered adamellite
- slopes 0-3%, up to 5% in basins
- alluvial flats occurring on these plains, above the usually incised main channels

VEGETATION:

- Blakely's red gum and / or fuzzy box grassy woodland; or
- grey box with fuzzy box and yellow box grassy woodland



COMMON SOIL:

Lyra

Moderately deep to deep soil with a hard setting, greyish brown to dark brown, bleached, light sandy clay loam to clay loam surface soil to 10-35cm, over coarse columnar, dull reddish brown to light yellowish brown, alkaline clay subsoil

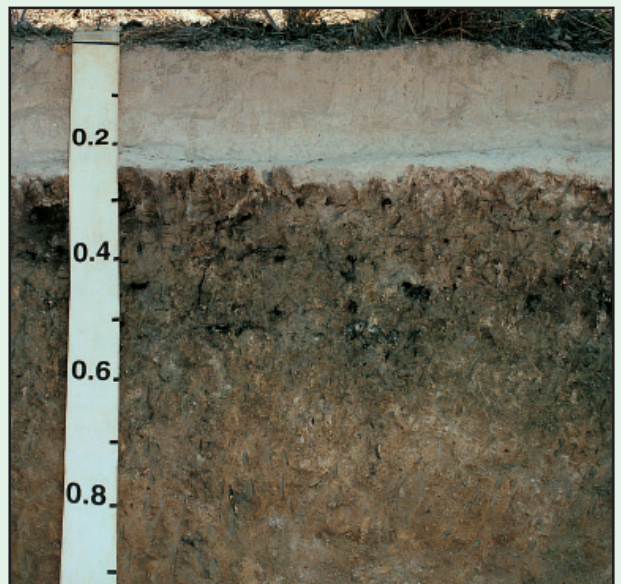
ASSOCIATED SOILS:

Greymare - moderately deep soils with a hard setting, bleached, sandy loam to sandy clay loam surface soil to 30-60 cm, over mottled, yellowish brown to grey, acid to neutral clay subsoil

EXAMPLE SOIL PROFILE: LYRA

DEPTH	DESCRIPTION
0 - 10 cm	grey, clay loam; hard setting surface; pH 6.3-6.6
10 - 25 cm	grey, clay loam; bleached when dry; massive
25 - 60 cm	grey, medium heavy clay; weak blocky structure; pH 6.6-8.3
60 - 80 cm	brown, coarse sandy light clay; massive
80-100 cm	yellow, coarse sandy light medium clay; massive pH 8.9

Australian Soil classification: Magnesic, Mesonatric, Grey Sodosol



Flat Granite Plains

DISTINGUISHING SOIL FEATURES:

- **surface conditions**
hard setting
- **effective rooting depth (ERD) range:**
10 to 35 cm (surface soil depth)
- **PAWC Range:**
15 to 36 mm (very low)
- **fertility:**
N - low; *P* - low; *K* - medium;
Cu - low; *Zn* - very high
- **pH trend:**
slightly acid to neutral surface; moderately
alkaline to strongly alkaline subsoils
- **sodicity:**
strongly sodic subsoils

LAND USE OPTIONS:

- suitable for grazing native pastures
- limited suitability for sod seeding sown pastures

LAND USE LIMITATIONS:

- waterlogging due to impermeable, poorly structured subsoils
- low fertility
- very low water holding capacity
- prone to tunnel and gully erosion, particularly if subsoils exposed
- patchy scalding due to salinity in low lying areas

LAND MANAGEMENT RECOMMENDATIONS:

CROPPING:

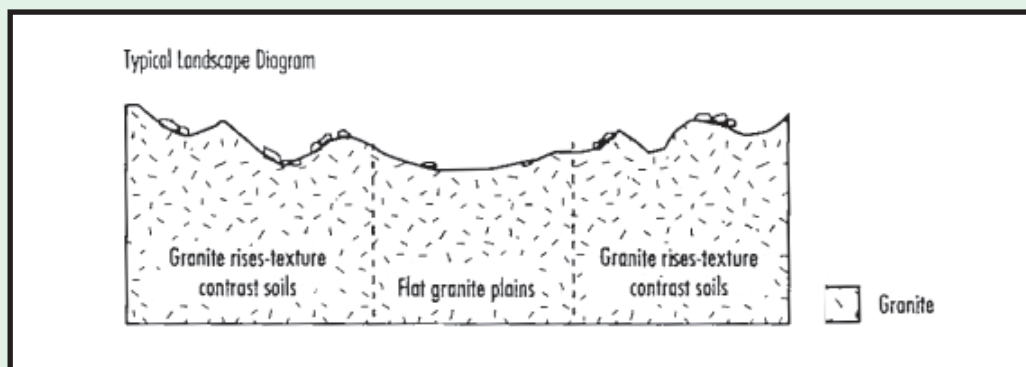
- not recommended

GRAZING:

- most desirable native grasses; pitted bluegrass and barbwire grass
- restrict grazing to retain pasture cover (above 30 % basal cover) and prevent erosion
- strategic grazing and spelling is required to maintain pasture vigour
- continuous overgrazing will result in the invasion of weed species
- improve native pastures by band seeding to improve production, increase infiltration and reduce runoff
- suitable sown pasture species include rhodes grass, premier digit grass and medics
- when constructing dams, tracks etc. on Lyra, care should be taken not to expose dispersible subsoils

NATURE CONSERVATION:

- **Extent:**
Extensively cleared on suitable terrain
- **Ecological values:**
No special attributes but representation a concern.
- **Reservation status:**
Nil to poor
- **Comments:**
Fuzzy box, brown box and Blakely's gum extensively cleared and not represented in conservation reserves. Recommend strategic retention of representative patches as part of property planning.



Sandstone Ridges

LANDFORM AND GEOLOGY:

- flat-topped sandstone ridges and steep scarps (jumpups) predominately found south of Leyburn
- slopes range from 0-15% on the ridge tops, up to vertical on the scarps
- some rock outcrops

VEGETATION:

- broad leaved stringybark, blue gum grassy woodland; or
- vine thicket or 'softwood scrub'; or
- narrow leaved ironbark, blue gum shrubby/grassy woodland; or
- narrow leaved ironbark, tumbledown gum mixed species grassy / shrubby woodland



COMMON SOIL:

Hanmer

Shallow to moderately deep soil with hard setting, gravelly, dark brown, very acid loam to clay loam surface, frequently underlain by a bleached layer (less than 5 cm thick) to 5 to 25 cm, over reddish brown to grey, blocky, acid clay subsoil

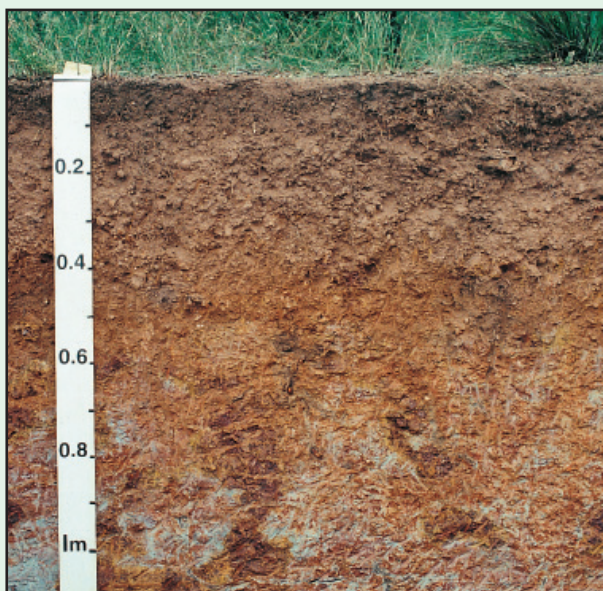
ASSOCIATED SOILS:

Shallow, stony sands

EXAMPLE SOIL PROFILE: HANMER

DEPTH	DESCRIPTION
0 - 10 cm	grey, sandy loam; many coarse fragments; weakly structured; pH 5.6
10 - 45 cm	brown, sandy loam; abundant gravel; massive; pH 5.7
45 - 55 cm	red, heavy clay; weak polyhedral structure; few coarse fragments; pH 5.1
55 - 90 cm	red, mottled grey, medium clay; weak blocky structure; quartz and ironstone fragments common; pH 5.2
90+ cm	grey, mottled red, light clay; weak blocky structure; sandstone fragments; pH 4.8

Australian Soil classification: Mottled, Magnesian, Red Kurosol



Sandstone Ridges

DISTINGUISHING SOIL FEATURES:

- **surface conditions**
hard setting, gravelly, may be weakly structured
- **effective rooting depth (ERD) Range:**
50 cm
- **PAWC Range:**
37 to 62 mm (very low to low - depending on gravel and stone content)
- **fertility:**
N - medium; *P* - very low; *K* - medium;
Cu - low; *Zn* - very high
- **pH trend:**
medium acid surface; strongly acid to very strongly acid deep subsoils
- **sodicity:**
non-sodic

LAND USE OPTIONS:

- suitable for light grazing native pastures
- some milling timber may be available
- bee keeping

LAND USE LIMITATIONS:

- fertility usually low
- very low to low water holding capacity
- steep slopes in some areas
- regrowth problems following clearing

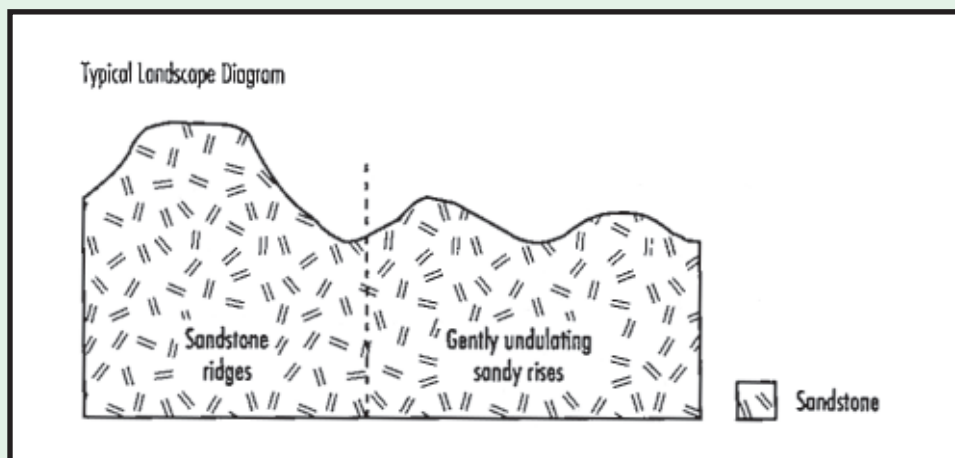
LAND MANAGEMENT RECOMMENDATIONS:

GRAZING:

- retain native vegetation
- native pastures are wiregrass (*Aristida* spp.) dominated; management should encourage opening of wiregrass clumps and the growth of less dominant grasses (e.g. lovegrasses) and small herbage plants
- avoid clearing shallow, stony soils which will not produce economic pasture growth
- restrict grazing to retain pasture cover (above 30% basal cover) and prevent erosion
- strategic grazing and spelling is required to maintain pasture vigour

NATURE CONSERVATION:

- **Extent:**
Extensively cleared
- **Ecological values:**
Vine thicket areas have high conservation value because of the presence of plants and animals with specific habitat needs,
- **Reservation status:**
Not represented in conservation reserves.
- **Comments:**
Recommend strategic retention of representative patches as part of property planning. Inadvisable to clear vine thicket because of limited occurrence and dependence of some species on this habitat type.



Undulating Low Sandstone Hills

LANDFORM AND GEOLOGY:

- undulating sandstone hills of moderate relief south of Warwick
- slopes 2-10%
- some flat-topped ridges and scarps

VEGETATION:

- grey box with fuzzy box and yellow box grassy woodland



COMMON SOIL:

Dalveen

Moderately deep to deep soil with an occasionally gravelly, usually hard setting and bleached, dark brown sandy surface soil to 10-60cm, over yellowish brown to brown, commonly mottled, acid neutral, blocky, clay subsoil

Mardon

Moderately deep to deep soil with a frequently gravelly, dark reddish brown to dark brown, sandy clay loam surface soil grading into a massive, red or brown, acid to neutral, sandy clay loam to sandy clay subsoils.

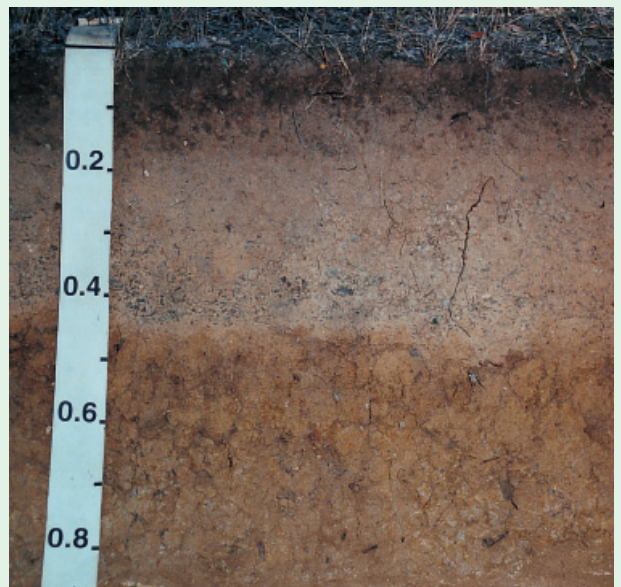
ASSOCIATED SOILS:

Neutral to alkaline, yellow texture contrast soils; deep sandy loams; shallow, stony soils (Hanmer); and brown, hard setting clays

EXAMPLE SOIL PROFILE: DALVEEN

DEPTH	DESCRIPTION
0 - 10 cm	black, sandy clay loam; weak granular structure; few pebbles; pH 6.5-6.7
10 - 20 cm	brown, sandy clay loam; massive; few quartz pebbles
20 - 40 cm	yellow, sandy loam; many large quartz and sandstone pebbles; pH 7.0
40 - 70 cm	brown, medium clay; weak blocky structure; few faint red mottles; pH 6.7
70- 90 cm	brown, coarse sandy medium clay; few red grey mottles; weak blocky structure; pH 6.8
90+ cm	clayey coarse sand

Australian Soil Classification: Haplic, Eutrophic, Brown Chromosol



Undulating Low Sandstone Hills

EXAMPLE SOIL PROFILE: MARDON

DEPTH	DESCRIPTION
0 - 10 cm	brown, coarse sandy loam; granular structure; few quartz and sandstone pebbles; pH 5.7 - 6.3
10 - 30 cm	red, coarse sandy clay loam; massive; many large quartz and sandstone pebbles; very weak consistence; pH 6.5
30 - 60 cm	red, coarse sandy light clay; abundant large quartz and sandstone pebbles; massive; moderately weak consistence; pH 6.5
60 - 90 cm	red, coarse sandy light clay; massive; abundant cobbles; pH 7.1



Australian Soil classification: Haplic, Eutrophic, Red Kandosol

DISTINGUISHING SOIL FEATURES:

Dalveen

- **surface conditions**
hard setting
- **effective rooting depth (ERD) range:**
10 to 60 cm (surface soil depth)
- **PAWC Range:**
15 to 53 mm (very low to low - depends on surface soil depth)
- **fertility:**
N - low; *P* - low; *K* - high;
Cu - medium; *Zn* - medium
- **sodicity:**
non-sodic

Mardon

- **surface conditions**
loose to firm
- **effective rooting depth (ERD) range:**
90 cm (profile depth)
- **PAWC Range:**
37 to 68 mm (very low to low - depending on gravel and rock content)
- **fertility:**
N - medium; *P* - high; *K* - medium;
Cu - medium; *Zn* - high
- **sodicity:**
non-sodic

LAND USE OPTIONS:

Dalveen

- suitable for grazing native pastures
- soils with thick surfaces (>30 cm) are suitable for sown pastures

Mardon

- suitable for short-term fodder cropping (summer and winter fodder crops)
- suitable for grazing native and sown pastures
- suitable for stone fruits and vines

LAND USE LIMITATIONS:

Dalveen

- very low to low water holding capacity
- low to medium fertility
- impermeable subsoils
- erodible on slopes >2%

Mardon

- very low to low water holding capacity
- erodible when cultivated on slopes >2%

Undulating Low Sandstone Hills

LAND MANAGEMENT RECOMMENDATIONS:

GRAZING:

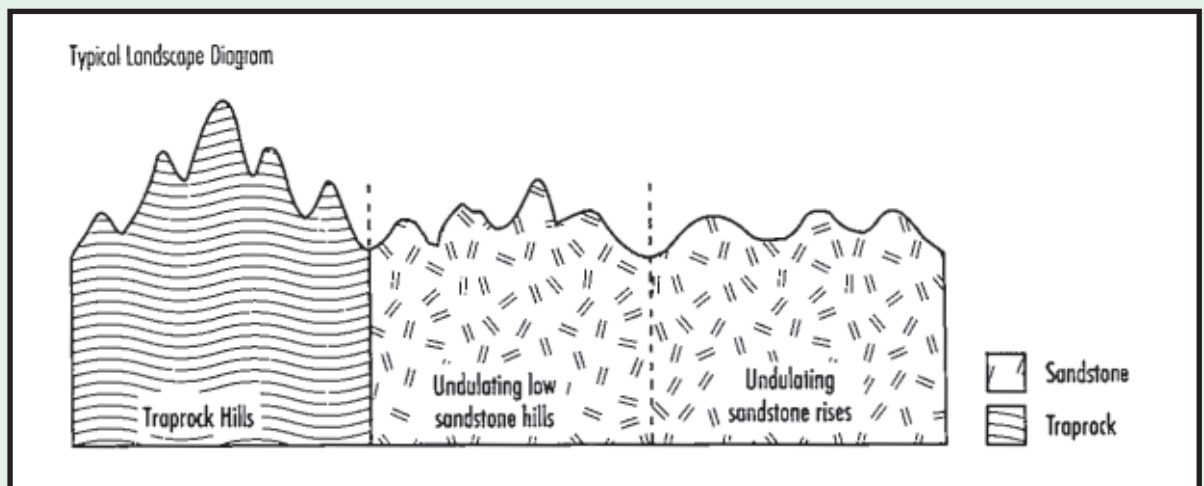
- most desirable native grasses; Queensland bluegrass and pitted bluegrass
- suitable sown pastures include clovers, vetches, premier digit grass, rhodes grass, medics and lucerne
- when clearing, ensure there is a follow-up plan to control regrowth
- band seed native pasture when the surface is only of medium thickness (10-30cm)
- restrict grazing to retain pasture cover (above 30% basal cover) and prevent erosion

CROPPING:

- suitable crops include sudan grass cross forage sorghums, millets, cowpeas and lab lab (usually for one year only)
- may have limited suitability for barely
- runoff control measures are required where slopes are cultivated
- practices such as minimum tillages, stubble mulching and chemical weed control will improve surface structure, reduce erosion and maximise infiltration

NATURE CONSERVATION:

- **Extent:**
Extensively cleared.
- **Ecological values:**
High conservation value because of limited occurrence. Supports many plant species with restricted distribution in the region and is likely to provide diverse fauna habitat.
- **Reservation status:**
Not represented in conservation reserves.
- **Comments:**
Recommend strategic retention of representative patches as part of property planning.



Undulating Low Sandstone Hills



Undulating Sandstone Rises

LANDFORM AND GEOLOGY:

- gently undulating to undulating sandstone rises west of Warwick in the Allan, Leslie and Cunningham areas; slopes 2-6%
- some flat to gentle undulating plains, slopes 0-2%

VEGETATION:

- grey box with fuzzy box and yellow box grassy woodland



COMMON SOIL:

Allan

Deep soil with dark brown to dark yellowish brown, loamy sand to sandy clay loam surface soil, may be underlain by bleached A2 horizon to 10-40 cm, over brown to yellowish brown, neutral to alkaline, blocky clay subsoil containing manganese and / or carbonate concretions

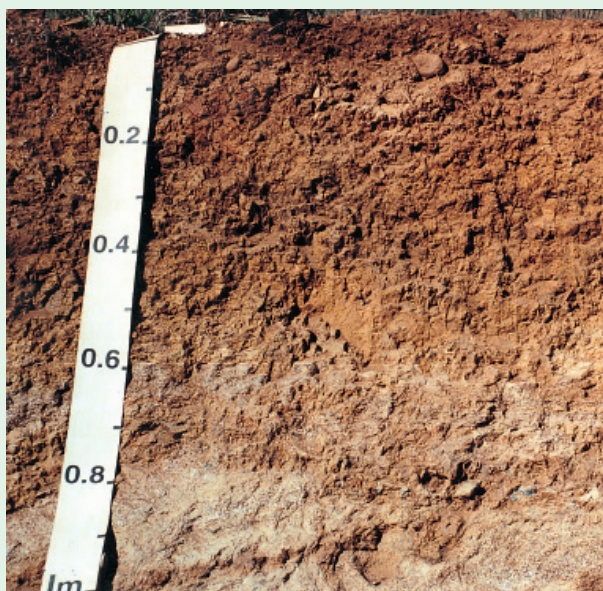
ASSOCIATED SOILS:

Grey, brown and dark, alkaline, cracking clays; and a deep texture contrast soil similar to the dominant soil but with bleached A2 horizon over a mottled, yellow to brown, coarse blocky or coarse columnar, alkaline clay subsoil

EXAMPLE SOIL PROFILE: ALLAN

DEPTH	DESCRIPTION
0 - 15 cm	brown, sandy clay loam; few quartz pebbles; moderate blocky structure; pH 6.7-7.0
15 - 65 cm	brown, fine sandy medium clay; strong blocky structure; few manganese / iron veins; pH 6.7-9.2
65 - 110 cm	yellow; clay loam coarse sandy; massive; few manganese / iron veins; soft carbonate segregations common; pH 9.0-9.2

Australian Soil classification: Calcic, Subnatric, Brown Sodosol



Undulating Sandstone Rises

DISTINGUISHING SOIL FEATURES:

- **surface conditions**
hard setting
- **effective rooting depth (ERD) range:**
65 cm
- **PAWC Range:**
80 mm (low)
- **fertility:**
N - low; *P* - low; *K* - medium;
Cu - low; *Zn* - medium
- **pH trend:**
neutral surface; very strong alkaline deep
subsoils
- **salinity:**
high to medium in deep subsoil (below 80 cm)
- **sodicity:**
strongly sodic subsoils

LAND USE OPTIONS:

- limited suitability for barely on soils with thicker surfaces (>30cm) - mainly prior to pasture establishment and for regrowth control
- suitable for fodder cropping
- suitable for grazing native and sown pastures
- some areas suitable for stone fruits and vines

LAND USE LIMITATIONS:

- low fertility
- low water holding capacity
- hard setting surfaces reduce infiltration rates
- susceptible to erosion

LAND MANAGEMENT RECOMMENDATIONS:

CROPPING:

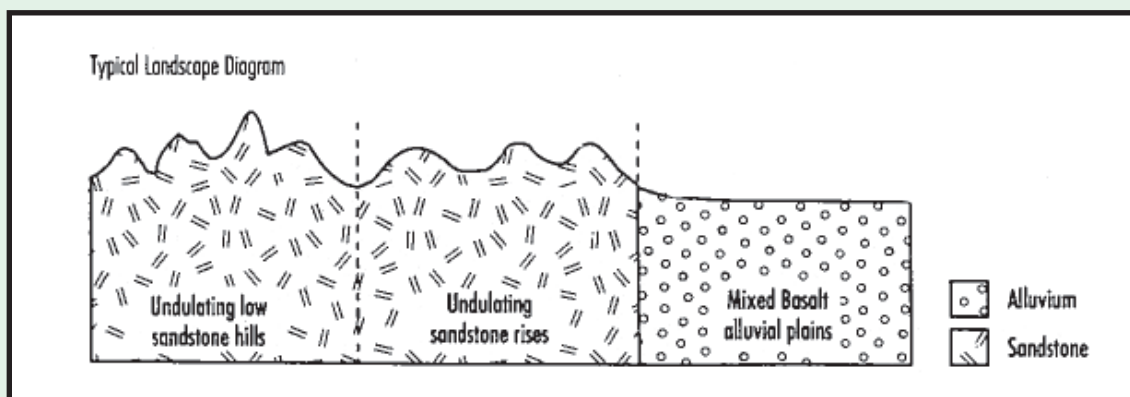
- most desirable native grasses; Queensland bluegrass and pitted bluegrass
- suitable fodder crops include forage sorghum, millets, lab lab, cowpeas and lucerne
- runoff control measures needed on cultivated slopes >1%
- practices such as minimum tillage, stubble mulching and chemical weed control will reduce erosion and maximise infiltration

GRAZING:

- suitable sown pastures include clovers, vetches, premier digit grass, rhodes grass, medics and lucerne
- when clearing, ensure there is a follow-up plan to control regrowth
- sow pastures into fully prepared seed bed or use band seeding
- restrict grazing to retain pasture cover (above 30% basal cover) and prevent erosion

NATURE CONSERVATION:

- **Extent:**
Extensively cleared.
- **Ecological values:**
No special attributes but representation a concern.
- **Reservation status:**
Not represented in conservation reserves
- **Comments:**
Recommend strategic retention of representative patches as part of property planning.



Gently Undulating Sandy Rises

LANDFORM AND GEOLOGY:

- gently undulating sandstone rises and plains in the Leyburn area
- slopes 1 -3 %

VEGETATION:

- spotted gum, narrow leaved ironbark shrubby / grassy open forest



COMMON SOIL:

Bonnie Doon

Moderately deep to deep soil with a frequently gravelly, bleached, dark brown to grey sand to sandy clay loam surface soil to 30-60cm, over greyish brown to brown, frequently mottled, acid clay subsoils

Drome

Deep sand with a brown to light brownish grey, loamy sand surface soil, over a bleached sand, commonly becoming more yellow and clayey at 70 cm

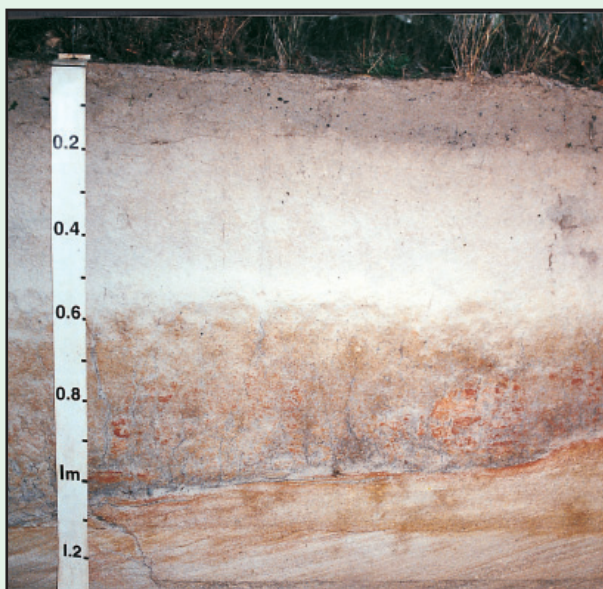
ASSOCIATED SOILS:

Yellow, acid texture contrast soils with massive subsoils; deep sands with reddish brown subsoils; neutral to alkaline, texture contrast soils (Maxland); and red, acid, texture contrast soils

EXAMPLE SOIL PROFILE: BONNIE DOON

DEPTH	DESCRIPTION
0 - 15 cm	Brown, sandy clay loam; setting surface; weak consistence: pH 6.0-6.2
15 - 55 cm	grey, loamy coarse sand; bleached when dry; massive; pH 6.1
55 - 85 cm	grey, mottled red, light medium clay coarse sandy; pH 5.5
85 - 100 cm	grey mottled orange, medium clay coarse sandy; weak blocky structure; pH 5.4
100+ cm	weathered sandstone

Australian Soil Classification: Bleached-Mottled, Natric, Grey Kurosol

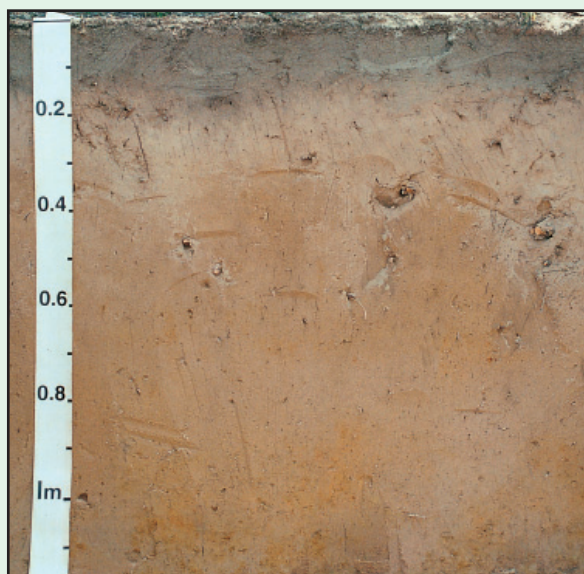


Gently Undulating Sandy Rises

EXAMPLE SOIL PROFILE: DROME

DEPTH	DESCRIPTION
0 - 2 cm	organic debris
2 - 15 cm	brown, sandy loam; weak granular structure; pH 5.6-5.8
15 - 60 cm	yellow, loamy sand; single grain; pH 6.3-6.6
60 - 100 cm	yellow, very few red mottles loamy sand; single grain; pH 6.5
100- 120 cm	yellow, mottled red, sandy loam; single grain; pH 4.8

Australian Soil classification: Basic, Arenic, Orthic Tenosol



DISTINGUISHING SOIL FEATURES:

Bonnie Doon

- **surface conditions**
usually hard setting
- **effective rooting depth (ERD) range:**
30 to 60 cm (surface soil depth)
- **PAWC Range:**
37 to 56 mm (very low to low)
- **fertility:**
N - low; *P* - low; *K* - medium;
Cu - medium; *Zn* - medium to high
- **pH trend:**
medium acid to slightly acid surface; strongly acid deep subsoil
- **sodicity:**
non-sodic to sodic deep subsoils

Drome

- **surface conditions**
loose
- **effective rooting depth (ERD) range:**
110 cm (profile depth)
- **PAWC Range:**
66mm (low - depends on profile depth)
- **fertility:**
N - very low; *P* - low; *K* - low;
Cu - very low; *Zn* - medium
- **pH trend:**
medium acid surface; slightly acid to neutral deep subsoil
- **sodicity:**
non-sodic

LAND USE OPTIONS:

- suitable for low intensity grazing of native pastures
- suitable for grazing sown pastures

LAND USE LIMITATIONS:

Bonnie Doon

- low to very low fertility
- very low to low water holding capacity
- waterlogging due to impermeable subsoils
- erodible subsoils if exposed

Drome

- very low fertility
- low water holding capacity
- hardpan at depth causes perched watertable

Gently Undulating Sandy Rises

LAND MANAGEMENT RECOMMENDATIONS:

GRAZING:

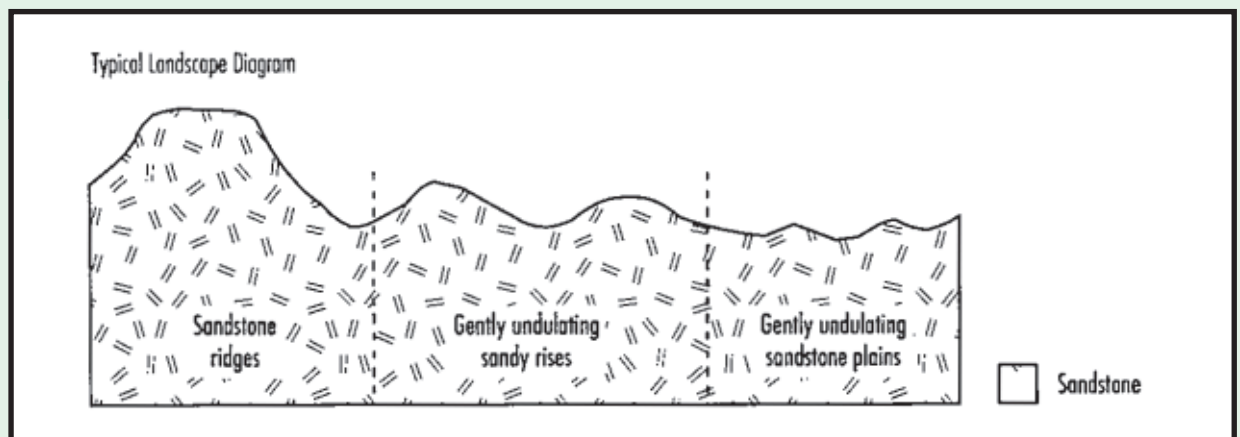
- native pastures are wiregrass (*Aristida* spp.) dominated; management should encourage opening of wiregrass clumps and the growth of less dominant grasses (e.g. lovegrasses) and small herbage plants
- suitable sown pastures include premier digit grass, rhodes grass and serradella (on the deeper sands)
- when clearing, ensure there is a follow-up plan to control regrowth
- adjusting stocking rates to seasonal conditions to maintain surface cover and prevent erosion
- when constructing dams, tracks etc. on Bonnie Doon, care should be taken not to expose dispersible subsoils

CROPPING:

- not recommended

NATURE CONSERVATION:

- **Extent:**
Extensively cleared.
- **Ecological values:**
No special attributes but representation a concern
- **Reservation status:**
Not represented in conservation reserves.
- **Comments:**
Recommend strategic retention of representative patches as part of property planning.



Gently undulating Sandy Rises



Gently Undulating Sandstone Plains

LANDFORM AND GEOLOGY:

- gently undulating sandstone plains in the Leyburn area
- Slopes 1-3%

VEGETATION:

- spotted gum, narrow leaved ironbark shrubby / grassy open forest; or
- gum topped box grassy open forest



COMMON SOIL:

Maxland

Moderately deep to deep soil with a hard setting, frequently gravelly, dark brown to greyish brown, bleached, loamy sand to sandy clay loam surface soil to 20-40 cm, over a greyish brown or frequently mottled, greyish brown to yellowish brown, coarse blocky or columnar, neutral to alkaline clay subsoil

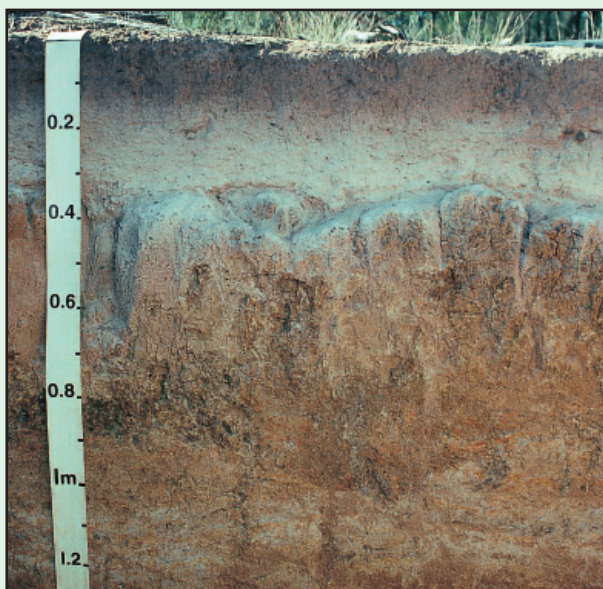
ASSOCIATED SOILS:

Yellow, acid, texture contrast soils (Bonnie Doon); and moderately deep clay with a hard setting, dark reddish brown surface soil over a red, gravelly, blocky, acid subsoil

EXAMPLE SOIL PROFILE: MAXLAND

DEPTH	DESCRIPTION
0 - 15 cm	brown, loamy sand; hard setting surface; pH 6.1-6.5
15 - 30 cm	grey, loamy sand; bleached when dry; massive; pH 6.5
30 - 80 cm	grey, mottled orange, sandy medium clay; strong columnar structure; pH 8.5
80 - 130 cm	brown, mottled orange and grey, coarse sandy light clay; massive; pH 9.1

Australian Soil classification: Eutrophic, Mesonatric, Grey Sodosol



Gently Undulating Sandstone Plains

DISTINGUISHING SOIL FEATURES:

- **surface conditions**
hard setting, frequently gravelly
- **effective rooting depth range (ERD) range:**
20 to 40 cm (depending on surface soil depth)
- **PAWC Range:**
26 to 42 mm (very low - depends on surface depth)
- **fertility:**
N - low; *P* - low; *K* - low;
Cu - very low; *Zn* - low
- **pH trend:**
slightly acid surface; very strongly alkaline deep subsoil
- **salinity:**
medium below 110 cm
- **sodicity:**
strongly sodic subsoils

LAND USE OPTIONS:

- suitable for light grazing of native pastures
- suitable for grazing sown pastures

LAND USE LIMITATIONS:

- very low fertility
- very low water holding capacity
- waterlogging
- impermeable, disersible subsoils

LAND MANAGEMENT RECOMMENDATIONS:

GRAZING:

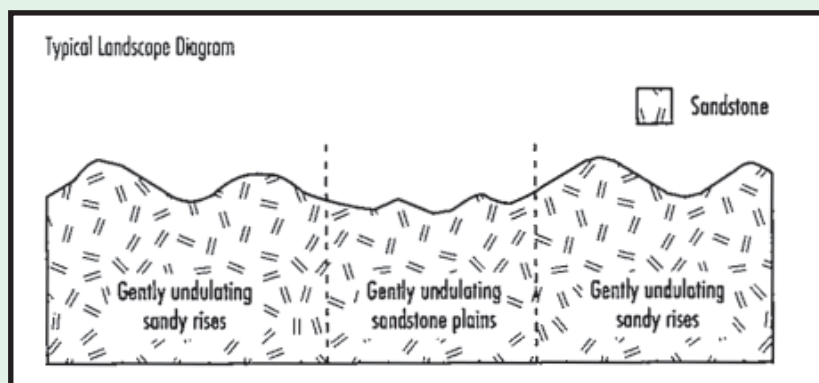
- most desirable native grasses: pitted bluegrass
- restrict grazing to retain pasture cover (above 30% basal cover) and prevent erosion
- when constructing dams, tracks, etc., care should be taken not to expose dispersible subsoils
- use band seeding / sod seeding to introduce sown pastures
- suitable sown pasture species include premier digit grass, rhodes grass and serradella (on the deeper sands)
- restrict stock access along stream banks that are subject to erosion and where overland flow enters the watercourse
- locate watering points away from streams

CROPPING:

- unsuitable for cultivation due to very low fertility, low water holding capacity and erodible subsoils

NATURE CONSERVATION:

- **Extent:**
Extensively cleared
- **Ecological values:**
No special attributes but representation a concern
- **Reservation status:**
Not represented in conservation reserves.
- **Comments:**
Recommend strategic retention of representative patches as part of property planning.



Traprock Mountains

LANDFORM AND GEOLOGY:

- deep dissected traprock mountains south of Wyberba and in the Rats Castle and High Pinnacle areas of Sundown National Park
- slopes steep (14-25% up to vertical)
- stony surface

VEGETATION:

- grey box with fuzzy box and yellow box grassy woodland; or
- closed forest (dry rainforest); or
- silvertop stringybark, rough barked apple open forest



COMMON SOIL:

Gammie

Very shallow to shallow, gravelly, hard setting loams to clay loams with dark brown to brown surface soil, over a brown yellowish brown or bleached acid subsoil

Karangj

Shallow to moderately deep, gravelly soil with a hard setting brown to dark brown, loam to sandy clay loam surface soil over a bleached A2 horizon with increasing gravel to 15-30cm, over coarse blocky or columnar, reddish brown, brown or yellowish brown acid to neutral clay subsoil

ASSOCIATED SOILS:

Shallow to deep gravelly soil with a hard setting sandy loam to sandy clay loam surface soil over a pale A2 horizon grading into gravelly, acid clay loam to clay subsoil; and shallow gravelly clays

EXAMPLE SOIL PROFILE: GAMMIE

DEPTH	DESCRIPTION
0 - 10 cm	brown, clay loam; hard setting; gravelly; pH 6.8
10 - 20 cm	grey, clay loam; bleached when dry; massive; gravelly
20 - 40 cm	as above, interspersed with weathered rock; pH 7.7
40+ cm	Rock

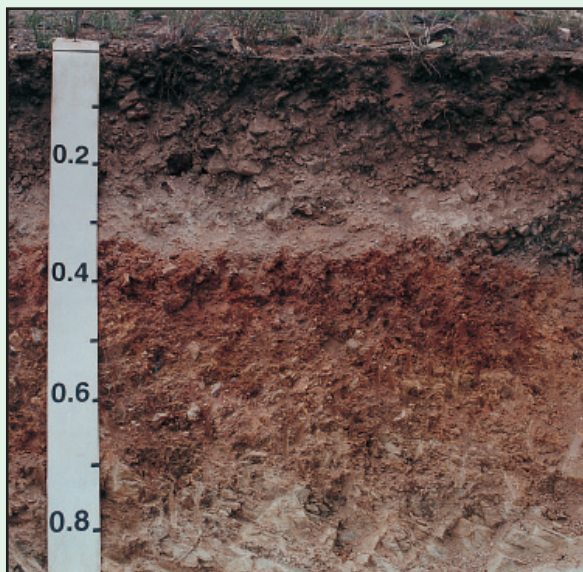
Australian Soil Classification: Basic, Paralithic, Bleached-Leptic Tenosol



Traprock Mountains

EXAMPLE SOIL PROFILE: KARANGI

DEPTH	DESCRIPTION
0 - 20 cm	brown, clay loam; hard setting; very abundant large pebbles; pH 6.0
20 - 35 cm	grey, sandy clay loam; bleached when dry; very abundant large pebbles; pH 6.0
35 - 55 cm	brown, mottled yellow, medium heavy clay; moderate blocky structure; very small pebbles; pH 6.0
55 - 70 cm	yellow, mottled red, medium clay; massive; rock fragments; pH 6.3
70+ cm	weathered rock



Australian Soil classification: Eutrophic, Subnatric, Brown Sodosol

DISTINGUISHING SOIL FEATURES:

Gammie

- **surface conditions**
hard setting, gravelly
- **effective rooting depth (ERD) range:**
20 cm (depth to rock)
- **PAWC Range:**
29 mm (very low)
- **fertility:**
N - low; *P* - medium; *K* - high;
Cu - low; *Zn* - medium
- **pH trend:**
neutral surface, mildly alkaline subsoil
- **salinity:**
non-saline
- **sodicity:**
non-sodic

Karangi

- **surface conditions**
hard setting, gravelly
- **effective rooting depth (ERD) range:**
50 cm (includes top layer of subsoil)
- **PAWC Range:**
22 to 64 mm (very low to low - depending on rock content)
- **fertility:**
N - medium; *P* - very low; *K* - medium;
Cu - low; *Zn* - medium
- **pH trend:**
medium acid surface; slightly acid to mildly alkaline subsoils
- **salinity:**
high in subsoil (below 50cm)
- **sodicity:**
sodic to strongly sodic subsoils

Traprock Mountains

LAND USE LIMITATIONS:

- limited suitability for light grazing of native pastures in accessible areas
- bee keeping
- watershed

LAND USE LIMITATIONS:

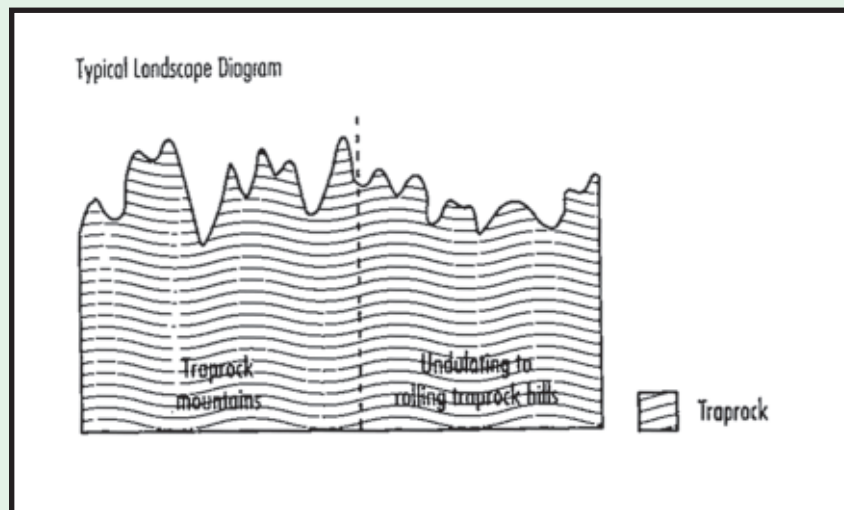
- steep slopes
- surface stone and profile gravel and rock content
- very low to low water holding capacity
- low fertility
- sodic to strongly sodic layers

LAND MANAGEMENT RECOMMENDATIONS:

- most desirable native grasses: Queensland bluegrass and pitted bluegrass
- limited clearing only on slopes <15% to minimise erosion
- retain standing timber on slopes >15%
- strategically locate watering points to avoid areas of overgrazing

NATURE CONSERVATION:

- **Extent:**
Some clearing of eucalypt shrub woodland in less rugged terrain. a naturally restricted community of closed forest occurs in rugged gorges in Sundown National Park.
- **Ecological values:**
Closed forests have high conservation value.
- **Reservation status:**
Woodland and closed forest communities well represented in Sundown National Park.
- **Comments:**
Communities are generally unsuitable for development because of slope and terrain.



Traprock Mountains



Undulating to Rolling Traprock Hills

LANDFORM AND GEOLOGY:

- rolling traprock hillslopes, ridges and incised valleys from Thane to Pikedale; slopes 10-30%
- undulating hills and low hills in the Pikedale area; average slope 10%
- very stony surface common with minor rock outcrops

VEGETATION:

- spotted gum, narrow leaved ironbark shrubby / grassy open forest; or
- narrow leaved ironbark, tumbledown gum mixed species grassy / shrubby woodland



COMMON SOIL:

Gammie

Very shallow to shallow, gravelly, hard setting loams to clay loams with dark brown to brown surface soil, over a brown yellowish brown or bleached acid subsoil

Karangj

Shallow to moderately deep, gravelly soil with a hard setting brown to dark brown, loam to sandy clay loam surface soil over a bleached A2 horizon with increasing gravel to 15-30cm, over coarse blocky or columnar, reddish brown, brown or yellowish brown acid to neutral clay subsoil

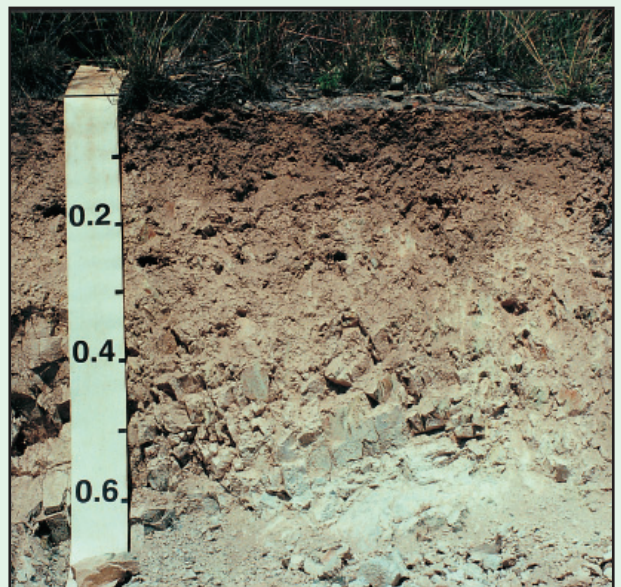
ASSOCIATED SOILS:

Shallow to deep gravelly soil with a hard setting sandy loam to sandy clay loam surface soil over a pale A2 horizon grading into gravelly, acid clay loam to clay subsoil; and shallow gravelly clays

EXAMPLE SOIL PROFILE: GAMMIE

DEPTH	DESCRIPTION
0 - 10 cm	brown, clay loam; hard setting; gravelly; pH 6.8
10 - 20 cm	grey, clay loam; bleached when dry; massive; gravelly
20 - 40 cm	as above, interspersed with weathered rock; pH 7.7
40+ cm	rock

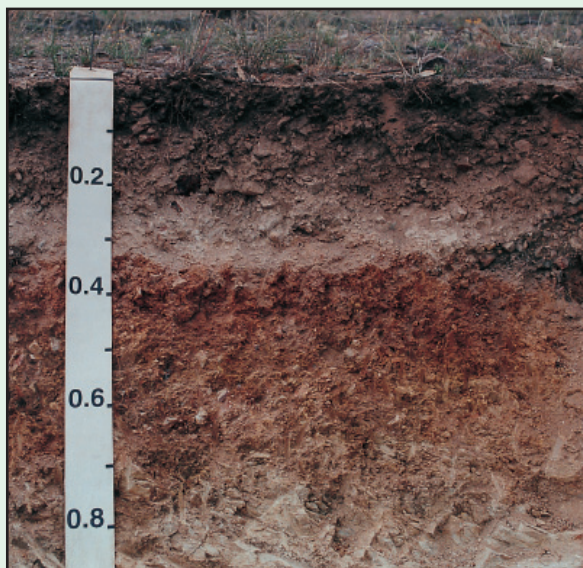
Australian Soil Classification: Basic, Paralithic, Bleached-Leptic Tenosol



Undulating to Rolling Traprock Hills

EXAMPLE SOIL PROFILE: KARANGI

DEPTH	DESCRIPTION
0 - 20 cm	brown, clay loam; hard setting; very abundant large pebbles; pH 6.0
20 - 35 cm	grey, sandy clay loam; bleached when dry; very abundant large pebbles; pH 6.0
35 - 55 cm	brown, mottled yellow, medium heavy clay; moderate blocky structure; very small pebbles; pH 6.0
55 - 70 cm	yellow, mottled red, medium clay; massive; rock fragments; pH 6.3
70+ cm	weathered rock



Australian Soil classification: Eutrophic, Subnatric, Brown Sodosol

DISTINGUISHING SOIL FEATURES:

Gammie

- **surface conditions**
hard setting, gravelly
- **effective rooting depth (ERD) range:**
20 cm (depth to rock)
- **PAWC Range:**
29 mm (very low)
- **fertility:**
N - low; *P* - medium; *K* - high;
Cu - low; *Zn* - medium
- **pH trend:**
neutral surface, mildly alkaline subsoil
- **salinity:**
non-saline
- **sodicity:**
non-sodic

Karangi

- **surface conditions**
hard setting, gravelly
- **effective rooting depth (ERD) range:**
50 cm (includes top layer of subsoil)
- **PAWC Range:**
22 to 64 mm (very low to low - depending on rock content)
- **fertility:**
N - medium; *P* - very low; *K* - medium;
Cu - low; *Zn* - medium
- **pH trend:**
medium acid surface; slightly acid to mildly alkaline subsoils
- **salinity:**
high in subsoil (below 50cm)
- **sodicity:**
sodic to strongly sodic subsoils

LAND USE OPTIONS:

- Suitable for light grazing of native pastures in accessible areas
- bee keeping
- watershed

LAND USE LIMITATIONS:

- steep slopes
- surface stone and profile gravel and rock content
- very low to low water holding capacity
- low fertility
- regrowth
- overgrazed areas are susceptible to scalding

Undulating to Rolling Traprock Hills

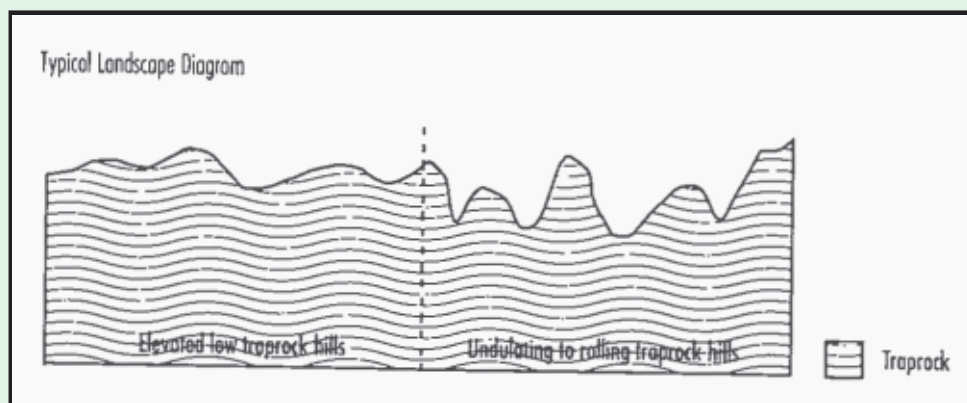
LAND MANAGEMENT RECOMMENDATIONS:

GRAZING:

- most desirable native grasses: Queensland bluegrass and pitted bluegrass
- limited clearing only on slopes <15% to minimise erosion
- retain standing timber on slopes >15%
- when clearing, ensure there is follow-up plan to control regrowth
- strategically locate watering points to avoid areas of overgrazing
- maintain surface cover (above 30% basal cover) to avoid scalds forming
- increase infiltration by shallow ripping with chisel ploughs in scalded areas
- continuous overgrazing will result in the invasion of unpalatable and inferior species such as wiregrasses
- implement a system of heavy rotational grazing to suppress wiregrasses
- adjust stocking rates to seasonal conditions

NATURE CONSERVATION:

- **Extent:**
Extensively community strategically developed as slope and terrain allows
- **Ecological values:**
The recently described *Eculayptus terria* occurs in this vegetation type, occurring in a small area south of Mt Burrabaranga
- **Reservation status:**
Represented in Sundown National Park
- **Comments:**
Widespread community generally.



Undulating to Rolling Traprock Hills



Low Traprock Hills

LANDFORM AND GEOLOGY:

- undulating low traprock hills and lower, valley side slopes in the Karara, Pikedale and Wallangarra areas
- isolated traprocks knolls
- slopes 4-6%, may be up to 8%
- stony surface

VEGETATION:

- grey box with fuzzy box and yellow box grassy woodland; or
- mugga ironbark and broad leaved red ironbark shrubby open forest



COMMON SOILS:

Gammie

Very shallow to shallow, gravelly, hard setting loams to clay loams with dark brown to brown surface soil, over a brown yellowish brown or bleached acid subsoil

Karang

Shallow to moderately deep, gravelly soil with a hard setting brown to dark brown, loam to sandy clay loam surface soil over a bleached A2 horizon with increasing gravel to 15-30cm, over coarse blocky or columnar, reddish brown, brown or yellowish brown acid to neutral clay subsoil

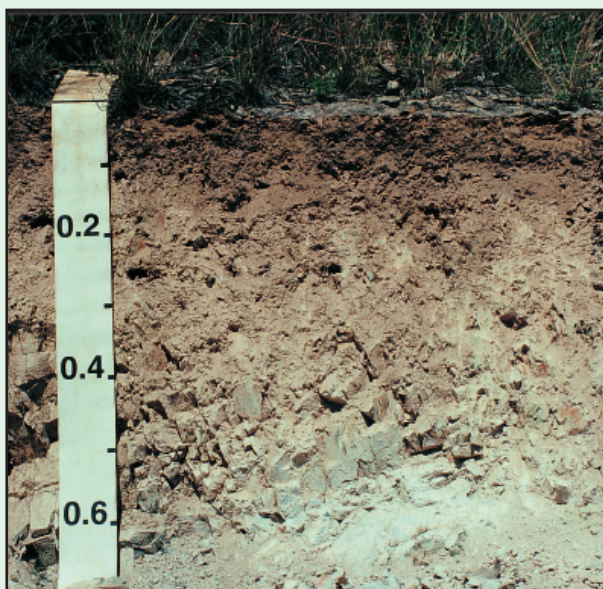
ASSOCIATED SOILS:

Shallow to deep gravelly soil with a hard setting sandy loam to sandy clay loam surface soil over a pale A2 horizon grading into gravelly, acid clay loam to clay subsoil; and shallow gravelly clays

EXAMPLE SOIL PROFILE: GAMMIE

DEPTH	DESCRIPTION
0 - 10 cm	brown, clay loam; hard setting; gravelly; pH 6.8
10 - 20 cm	grey, clay loam; bleached when dry; massive; gravelly
20 - 40 cm	as above, interspersed with weathered rock; pH 7.7
40+ cm	rock

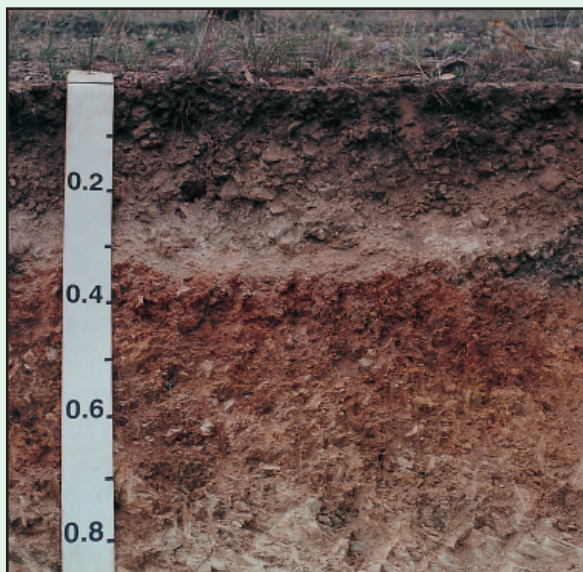
Australian Soil Classification: Basic, Paralithic, Bleached-Leptic Tenosol



Low Traprock Hills

EXAMPLE SOIL PROFILE: KARANGI

DEPTH	DESCRIPTION
0 - 20 cm	dark brown, clay loam; hard setting; gravelly pH 6.0
20 - 35 cm	grey, sandy clay loam; bleached when dry; very abundant large pebbles; pH 6.0
35 - 55 cm	brown, mottled yellow, medium heavy clay; moderate blocky structure; very few small pebbles; pH 6.0
55 - 70 cm	yellow, mottled red, medium clay; massive; rock fragments; pH 6.3
70+ cm	weathered rock



Australian Soil Classification: Eutrophic, Subnatric, Brown Sodosol

DISTINGUISHING SOIL FEATURES:

Gammie

- **surface conditions**
hard setting, gravelly
- **effective rooting depth (ERD) range:**
20 cm (depth to rock)
- **PAWC Range:**
29 mm (very low)
- **fertility:**
N - low; *P* - medium; *K* - high;
Cu - low; *Zn* - medium
- **pH trend:**
neutral surface, mildly alkaline subsoil
- **salinity:**
non-saline
- **sodicity:**
non-sodic

Karangi

- **surface conditions**
hard setting, gravelly
- **effective rooting depth (ERD) range:**
50 cm (includes top layer of subsoil)
- **PAWC Range:**
22 to 64 mm (very low to low - depending on rock content)
- **fertility:**
N - medium; *P* - very low; *K* - medium;
Cu - low; *Zn* - medium
- **pH trend:**
medium acid surface; slightly acid to mildly alkaline subsoils
- **salinity:**
high in subsoil (below 50cm)
- **sodicity:**
sodic to strongly sodic subsoils

LAND USE OPTIONS:

- suitable for grazing of native pastures
- limited suitability for grazing sown pastures on the lower sloping, deeper soils

LAND USE LIMITATIONS:

- surface stone and profile gravel and rock content
- very low to low water holding capacity
- low fertility
- waterlogging, depending on slope
- overgrazed areas are susceptible to scalding

Low Traprock Hills

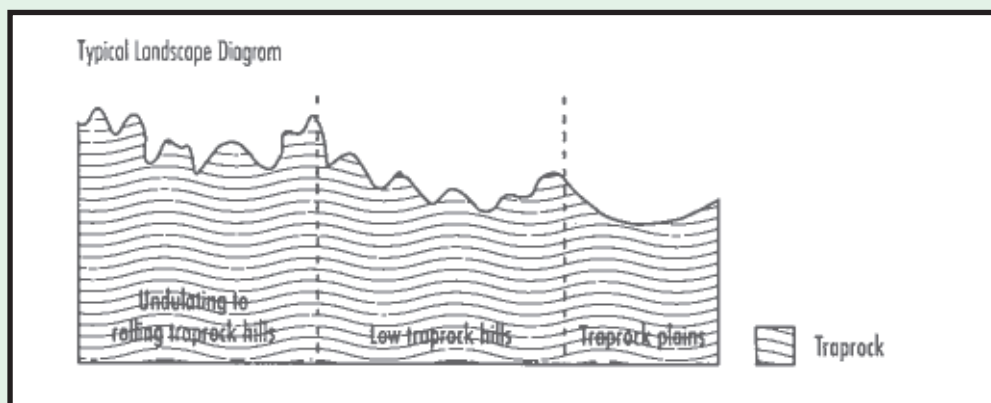
LAND MANAGEMENT RECOMMENDATIONS:

GRAZING:

- most desirable native grasses: Queensland bluegrass and pitted bluegrass
- suitable sown species include premier digit grass, rhodes grass, medics and lucerne
- when clearing, ensure there is a follow-up plan to control regrowth
- on Karangi use fully prepared seed beds, with super application; on Gammie, band seed for pasture improvement, super is required
- restrict grazing to retain pasture cover (above 30% basal cover) to ensure more desirable species are not grazed out and to prevent erosion
- implement a system of heavy rotational grazing to suppress wiregrasses
- increase infiltration by shallow ripping with chisel ploughs on scalded areas
- strategic grazing and spelling is required to maintain pasture vigour
- strategically locate watering points to avoid areas of overgrazing; use centrally located watering points (one watering point per 200 ha) - scalding may become a problem where there are insufficient or badly located watering points
- if band seeding, use a chisel plough with narrow points on the contour

NATURE CONSERVATION:

- **Extent:**
Very extensively cleared or modified
- **Ecological values:**
No special attributes but representation a concern
- **Reservation status:**
Poorly represented in Sundown National Park.
- **Comments:**
Recommend strategic retention of representative patches as part of property planning.



Low Traprock Hills



Traprock Plains

LANDFORM AND GEOLOGY:

- gently undulating to undulating traprock plains and rises, mainly in the Thane to Karara area, slopes 1-6%; and
- lower traprock hillslopes (3-5%) and colluvial slopes (1-3%) fringing flood plains
- slightly stony surface

VEGETATION:

- grey box with fuzzy box and yellow box grassy woodland



DOMINANT SOIL:

Karang

Shallow to moderately deep soil with a gravelly, hard setting dark brown to brown, sandy loam to clay loam surface soil usually underlain by a bleached A2 horizon to 10-30 cm, over brown, reddish brown or yellowish brown clay subsoil

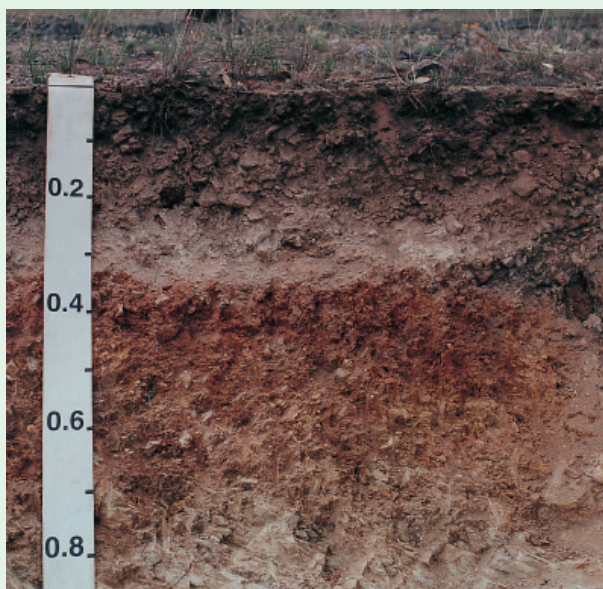
ASSOCIATED SOILS:

Shallow, gravelly loams (Gammie); deep soil with a gravelly, massive, dark brown, bleached, sandy loam to clay loam surface soil to 10-30 cm, over reddish brown to yellowish brown, acid to alkaline clay subsoil (similar to Karang but profile is deeper and occurs in lower parts of the landscape)

EXAMPLE SOIL PROFILE: KARANG

DEPTH	DESCRIPTION
0 - 20 cm	brown, clay loam; hard setting; very abundant large pebbles; pH 6.0
20 - 35 cm	grey, sandy clay loam; bleached when dry; very abundant large pebbles; pH 6.0
35 - 55 cm	brown, mottled yellow, medium heavy clay; moderate blocky structure; very few small pebbles; pH 6.0
55-70 cm	yellow, mottled red, medium clay; massive; rock fragments; pH 6.3
70+ cm	weathered rock

Australian Soil Classification: Eutrophic, Subnatric, Brown Sodosol



Traprock Plains

DISTINGUISHING SOIL FEATURES:

- **surface conditions**
hard setting, frequently gravelly
- **effective rooting depth (ERD) range:**
50 cm (includes top layer of subsoil)
- **PAWC Range:**
22 to 64 mm (very low to low - depending on gravel and rock content)
- **fertility:**
N - medium; *P* - very low; *K* - medium;
Cu - low; *Zn* - medium
- **pH trend:**
medium acid surface; slightly acid to mildly alkaline subsoils
- **salinity:**
high in subsoil (below 50 cm)
- **sodicity:**
sodic to strongly sodic subsoils

LAND USE OPTIONS:

- suitable for grazing native pastures
- limited suitability for sown pastures

LAND USE LIMITATIONS:

- very low to low water holding capacity
- low fertility common
- gravel content
- impermeable, erodible subsoil
- overgrazed areas are susceptible to scalding

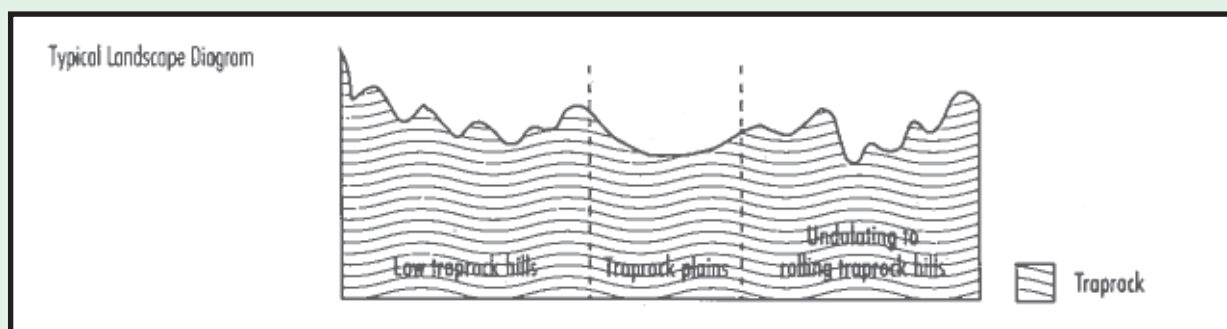
LAND MANAGEMENT RECOMMENDATIONS:

GRAZING:

- most desirable native grasses: Queensland bluegrass and pitted bluegrass
- suitable sown pasture species include premier digit grass, rohodes grass medics and lucerne
- on Karangi use fully prepared seed beds, with super application
- restrict grazing to retain pasture cover (above 30% basal cover) and avoid scalds forming
- increase infiltration by shallow ripping with chisle ploughs on scalded areas
- strategic grazing and spelling of pastures is required to allow seed -setting
- strategically locate watering points to avoid areas of overgrazing; use centrally located watering points (one watering point per 200 hectares) - scalding may become a problem where there are insufficient or badly located watering points
- continuous overgrazing will result in the invasion of unpalatable and inferior species such as wiregrasses
- implement a system of heavy rotational grazing to suppress wiregrasses
- if band seeding, use a chisel plough with narrow points on the contour

NATURE CONSERVATION:

- **Extent:**
Very extensively cleared or modified.
- **Ecological values:**
No special attributes but representation a concern.
- **Reservation status:**
Not represented in conservation reserves.
- **Comments:**
Recommend strategic retention off representative patches as part of property planning.



Elevated Low Traprock Hills

LANDFORM AND GEOLOGY:

- gently undulating to undulating low traprock hills west of Dalveen; a small area occurs south of Morgan Park
- average slope 3-10%, may be steeper in some areas
- stony surface common

VEGETATION:

- narrow leaved ironbark, tumbledown gum mixed species grassy / shrubby woodland
- mugga ironbark and broad leaved red ironbark shrubby open forest



COMMON SOIL:

Glentanna

Shallow to moderately deep soil with a hard setting, gravelly, dark brown to brown loam, to clay loam surface soil, infrequently underlain by a bleached A2 horizon to 10-20 cm, over brown or reddish brown, blocky, acid to neutral clay subsoil

ASSOCIATED SOILS:

Deep soil with greyish brown to dark brown, loam surface soil over a bleached A2 horizon to 25-30 cm, over a yellow or dark brown, neutral to alkaline clay subsoil; shallow, gravelly loams (Gammie); and a deep soil with a dark brown, crumb structured, clay loam surface soil grading into a blocky, brown, acid clay subsoil

EXAMPLE SOIL PROFILE: GLENTANNA

DEPTH	DESCRIPTION
0 - 20 cm	black, sandy clay loam; weak blocky structure; abundant large pebbles; pH 6.3
20 - 40 cm	brown, light medium clay; strong blocky structure; few pebbles; pH 6.7
40 - 60 cm	brown, medium clay; strong blocky structure; few pebbles; pH 7.5
60-110 cm	clay pockets in weathered traprock

Australian Soil Classification: Haplic, Eutrophic, Brown Chromosol



Elevated Low Traprock Hills

DISTINGUISHING SOIL FEATURES:

- **surface conditions**
hard setting or firm
- **effective rooting depth (ERD) range:**
60 cm (profile depth or depth to hard rock; profile usually shallow)
- **PAWC Range:**
87 to 101 mm (low to medium - depending on profile depth and stone content)
- **fertility:**
N - high; *P* - high; *K* - very high;
Cu - medium; *Zn* - medium
- **pH trend:**
slightly acid to neutral surface; mildly alkaline to moderately alkaline subsoils
- **sodicity:**
non-sodic

LAND USE OPTIONS:

- suitable for grazing native and sown pastures
- suitable for short-term fodder cropping (winter and summer) on the better of the associated soils, eg. 2 years fodder cropping then return to pasture

LAND USE LIMITATIONS:

- low to medium water holding capacity
- hard setting surface reduces infiltration rate
- stony surface
- erodible when cultivated on slopes >2% (this point refers to associated cropping soils)

LAND MANAGEMENT RECOMMENDATIONS:

GRAZING:

- most desirable native grasses: Queensland bluegrass and pitted bluegrass
- suitable sown pasture species include premier digit grass, rhodes grass medics and lucerne
- when clearing, ensure there is a follow-up plan to control regrowth
- restrict grazing to retain pasture cover (above 30% basal cover) and avoid scalds forming
- increase infiltration by shallow ripping with chisle ploughs on scalded areas
- strategic grazing and spelling of pastures is required to allow seed -setting
- strategically locate watering points to avoid areas of overgrazing; use centrally located watering points (one watering point per 200 hectares) - scalding may become a problem where there are insufficient or poorly located watering points
- continuous overgrazing will result in the invasion of unpalatable and inferior species such as wiregrasses
- implement a system of heavy rotational grazing to suppress wiregrasses
- if band seeding, use a chisel plough with narrow points on the contour
- apply superphosphate when undersowing legumes

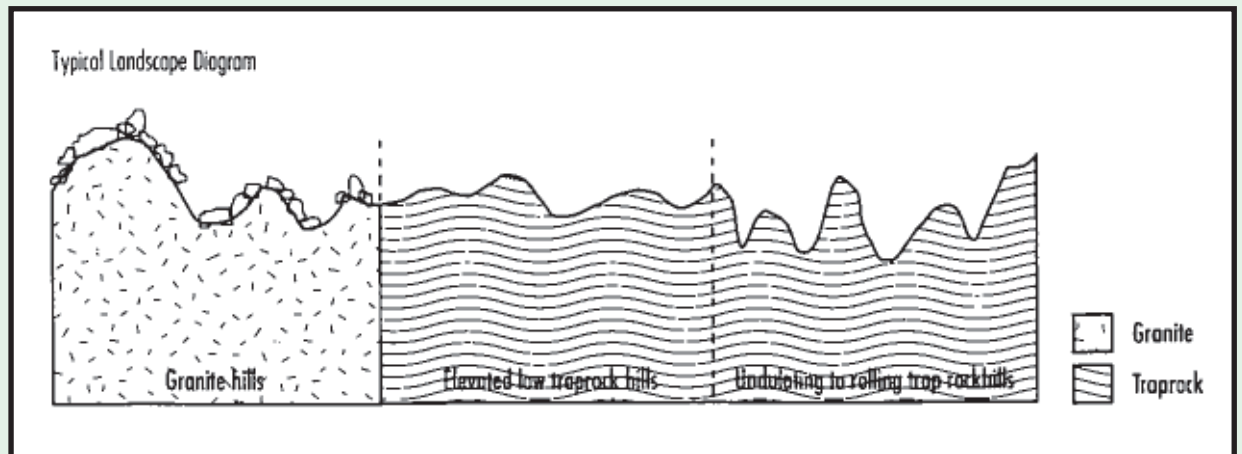
FODDER CROPPING:

- suitable fodder crops include oats (undersown with vetch or medics) and forage sorghum (undersown with lab lab)
- runoff control measures are required when slopes are cultivated

Elevated Low Traprock Hills

NATURE CONSERVATION:

- **Extent:**
Occurs in scattered patches on traprock country and sandstone.
- **Ecological values:**
This community provides habitat for the rare and threatened regent honeyeater and plant species with restricted distribution.
- **Reservation status:**
Represented in Sundown National Park.
- **Comments:**
Clearing inadvisable because of naturally restricted distribution and association with a rare and threatened bird species.



Elevated Low Traprock Hills



GLOSSARY

- A horizon* See *Soil horizon*.
- A2 horizon* See *Subsurface soil*; *Bleach*.
- Acid soil* A soil giving an acid reaction throughout most or all of the soil profile (precisely, below a pH of 7.0; practically, below a pH of 6.5). Generally speaking, when the pH drops below 5.5 the following specific problems may occur - aluminium toxicity, manganese toxicity, calcium deficiency and/or molybdenum deficiency. Such problems adversely affect plant growth and root nodulation, which may result in a decline in plant cover and increase in erosion hazard. See *pH*.
- Adamellite* A variety of granite containing a calcium-bearing plagioclase, and a potassium feldspar, in roughly equal amounts.
- Aeolian* A process whereby soil forming material is transported and deposited by wind.
- Alkaline soil* A soil giving an alkaline reaction throughout most or all of the soil profile (precisely, above a pH of 7.0; practically, above a pH of 8.0). Many alkaline soils have a high pH indicated by the presence of calcium carbonate, and are suitable for agriculture. However, others are problem soils because of salinity and/or sodicity. Soils with a pH above 9.5 are generally unsuitable for agriculture. See *pH*.
- Alluvial plain* A plain formed by the accumulation of alluvium on a floodplain over a considerable period of time; this accumulation may be still occurring at present (recent alluvium) or may have ceased (relict alluvium).
- Alluvium* (*pl. alluvia*) Deposits of gravel, sand, silt, clay or other debris, moved by streams from higher to lower ground.
- Aquifer* A body of permeable rock, for example, unconsolidated gravel or sand, that is capable of storing significant quantities of water, is underlain by impermeable material, and through which groundwater moves.

- Arenic** Soils in which at least the upper 0.5 m of the profile is non-gravelly and of sandy texture throughout. It is also loosely or weakly coherent (see *Consistence*), and may have aeolian (wind-blown) cross-bedding. This term is used in the Australian Soil Classification (Isbell 1996) to describe Tenosols (see *Tenosol*).
- Aureole** A zone surrounding an igneous intrusion in which contact metamorphism of the country rock has taken place.
- B horizon** See *Soil horizon*.
- Backplain** Large alluvial flat occurring some distance from the stream channel; often characterised by a high watertable and the presence of swamps or lakes.
- Base status** This refers to the sum of exchangeable basic cations (Ca, Mg, K and Na) expressed in cmol (+) kg^{-1} clay. It is used as an indicator of soil fertility and is calculated by multiplying the sum of the reported basic cations by 100 and dividing by the clay percentage of the sample. Three classes are defined: **Dystrophic** - the sum is less than 5; **Mesotrophic** - the sum is between 5 and 15 inclusive; and **Eutrophic** - the sum is greater than 15. It is used for some Great Group or Subgroup distinctions within the Australian Soil Classification (Isbell 1996).
- Basic** A term used in the Australian Soil Classification (Isbell 1996) to describe a soil containing a layer (usually the B horizon) that is not strongly acid and not calcareous.
- Bleach** Subsurface soil (A2 horizon) that is white, near white or much paler than adjacent soil layers. It occurs in varying proportions:
- | | |
|------------------------------|--|
| conspicuous bleach - | 80% or more of the layer is white or almost so, when the soil is dry. |
| sporadic or partial bleach - | the bleaching occurs irregularly through the subsurface layer, or as blotches or, as nests of bleached grains of soil material often at the interface of the surface and subsoil layers. |

- Bleached-Leptic*** Soils with a conspicuously bleached A2 horizon which directly overlies a hard, continuous, discontinuous or broken layer of calcrete which may be massive, concretionary or nodular; or hard unweathered rock or other hard materials; or partially weathered or decomposed rock or saprolite; or unconsolidated mineral materials. The term is used as a definition for a Tenosol Suborder in the Australian Soil Classification (Isbell 1996).
- C horizon*** Layer(s) below the B horizon which may be weathered parent material, not bedrock, little affected by soil-forming processes.
- Calciic*** These soils have a layer containing 2-20% soft carbonate and <20% hard carbonate. This term is used to describe a number of Soil Orders in the Australian Soil Classification (Isbell 1996).
- Calcrete*** A layer of cemented carbonate accumulation. The material must be hard.
- CEC (Cation Exchange Capacity)*** The measure of the capacity of a soil to hold the major cations: calcium, magnesium, sodium and potassium (including hydrogen, aluminium and manganese in acid soils). It is a measure of the potential nutrient reserve in the soil and is therefore an indicator of inherent soil fertility. An imbalance in the ratio of cations can result in soil structural problems. High levels of individual cations (e.g. aluminium and manganese) can also be toxic to plants.
- Chlorotic*** An abnormal yellow colour of a plant.
- Chromosol*** A Soil Order of the Australian Soil Classification (Isbell 1996). Soils have a clear or abrupt textural B horizon where the pH is 5.5 (water) or greater in the upper 0.2 m of the B2 horizon.
- Clays*** Soils with a uniform clay texture throughout the surface soil and subsoil.
- *cracking* Clay soils that develop vertical cracks when dry.
 - *non-cracking* Clay soils that do not develop vertical cracks when dry.

- Colluvium** (*pl. colluvia*) Slope deposits of soil and rock material.
- Colour** See *Soil colour*.
- Compaction** The process whereby soil density is increased as a result of tillage, stock trampling and/or vehicular trafficking. Compaction can lead to lower soil permeability, poor soil aeration resulting in increased erosion hazard and poorer plant productivity. Deep ripping and conservation tillage can alleviate the condition.
- Concretion** (*in soil*) See *Segregation*.
- Consistence** (*of soil*) Refers to the degree of resistance to breaking or deformation when a force is applied.
- Cracking clays** See *Clays, cracking*.
- Deep weathering** The process by which earthy or rocky materials are slowly broken down into finer particles and soil by chemical processes over a long period of time. The chemical alteration of the rocks involved:
- leaching of the calcium-rich cement which previously bound the constituent particles together to form the rocks;
 - a progressive transformation of feldspar minerals, clay minerals and labile fragments to form a new matrix of kaolinite white clay;
 - the alteration of iron-rich minerals to form iron oxides (red colour); and
 - mobilising and recrystallising of silica produced from the breakdown of minerals; more resistant quartz grains were relatively unaffected. See *Laterite*.
- Dispersion** The process whereby soils break down and separate into their constituent particles (clay, silt, sand) in water. Dispersible soils tend to be highly erodible and present problems for earth works. Dispersion is associated with sodicity levels. See *Sodicity*.
- Dissection** The process of streams or erosion cutting the land into hill, ridges and flat areas.

Drainage
(soil profile)

The rate of downward movement of water through the soil, governed by both soil and site characteristics. Categories are as follows:

- Very poorly drained: free water remains at or near the surface for most of the year.
- Poorly drained: all soil horizons remain wet for several months each year.
- Imperfectly drained: some soil horizons remain wet for periods of several weeks.
- Moderately well drained: some soil horizons remain wet for a week after water addition.
- Well drained: no horizon remains wet for more than a few hours after water addition.
- Rapidly drained: no horizon remains wet except shortly after water addition.

Duplex soil

See *Texture contrast soil*.

Dystrophic

See *Base status*.

Earths

Soils with a sandy to loamy (including clay loam) surface soil, gradually increasing to a loamy to light clay subsoil.

- *massive*

Earths in which the subsoil is not arranged into natural soil aggregates and appears as a coherent, or solid mass.

- *structured*

Earths in which the subsoil is arranged into natural soil aggregates which can be clearly seen.

Effective rooting depth (ERD)

Depth to which most plant feeder roots will penetrate. This is taken here to be the depth either to which salts have been leached and have therefore accumulated, or to an impeding layer. This represents the long-term depth of wetting.

Epicalcareous

A soil in which the major part of the top 0.5 m of the profile is calcareous. It is used to describe Vertosols in the Australian Soil Classification (Isbell 1996).

Epihypersodic

Soils with at least one subhorizon within the top 0.5 m of the profile having an ESP greater than 15. It is used as a Subgroup definition for Vertosols in the Australian Soil Classification (Isbell 1996).

- Electrical conductivity (EC)*** A measure of the conduction of electricity through water, or a water extract of soil. The value can reflect the amount of soluble salts in an extract and therefore provide an indication of soil salinity.
- Erodibility (soil)*** The susceptibility of a soil to the detachment and transportation of soil particles by erosive agents. It is a function of the mechanical, chemical and physical characteristics of the soil, and is independent of the other factors influencing soil erosion such as topography, land use, rainfall intensity and plant cover. It may be changed by management.
- Erosion hazard*** The susceptibility of a parcel of land to the prevailing agents of erosion. It is dependent on a combination of climate, landform, soil, land use and land management factors.
- ESP*** Exchangeable sodium percentage. See *Sodicity*.
- Eutrophic*** See *Base status*.
- Feldspar*** Any of a group of alkaline aluminium silicate minerals. An important part of igneous rocks, such as granite.
- Floristic association*** The dominant or diagnostic species used to classify vegetation.
- Gradational*** The term describes a soil with a gradual increase in texture (i.e. becomes more clayey) as the profile deepens.
- Granite/granitic rocks*** A coarse-grained, *igneous* rock formed beneath the earth's surface and consisting essentially of 20-40% quartz, alkali feldspars (which are a source of sodium and potassium) and very commonly a mica.
- Gypsum*** A naturally occurring soft crystalline material which is a hydrated form of calcium sulphate. Gypsum contains approximately 23% calcium and 18% sulfur. It is used to improve soil structure and reduce crusting in hard setting clayey soils.

- Haplic** A term used in the Australian Soil Classification (Isbell 1996) which indicates that the major part of the upper 0.5 m of the soil profile is whole coloured.
- Hard setting** Surface soil that becomes hard and apparently structureless on the periodic drying of the soil.
- Horizon** See *Soil horizon*, also *Soil horizon boundary*.
- Hypercalcic** These soils have a B horizon or subsurface layer containing more than 20% of mainly soft, finely divided carbonate, and less than 20% of hard calcrete fragments and/or carbonate nodules, and/or carbonate coated gravel. The term is used as a definition for a number of Orders in the Australian Soil Classification (Isbell 1996).
- Igneous rocks** Rock crystallised from molten rock material (magma). It may be extruded to the Earth's surface (*volcanic*) or cool at variable depths below the surface (intrusive, and plutonic).
- Infiltration** The movement of water through the soil surface. Soils with a high infiltration capacity allow more rain to enter the soil than soils with a low capacity. Runoff will occur when the rate of rainfall exceeds the soil's infiltration capacity. Surface soil structure and texture are important determinants of the infiltration capacity of a soil.
- Jumpups** Local term used to describe stony, lateritised ridges and scarps.
- Kandosol** A Soil Order of the Australian Soil Classification (Isbell 1996). These soils lack strong texture contrast and have massive or only weakly structured B horizons. The B2 horizon is well developed and has a maximum clay content in some part of the B2 horizon which exceeds 15%. They are also not calcareous throughout.
- Kaolinisation** Breakdown of minerals (particularly feldspars) under intense weathering to form kaolinite clay (china clay). See also *Laterite*.

- Kurosol*** A Soil Order of the Australian Soil Classification (Isbell 1996). These soils have a clear or abrupt textural B horizon in which the major part of the top 0.2 m of the B2 horizon is strongly acid i.e. less than pH 5.5 (water).
- Laterite*** A profile formed by intense weathering. Many deeply weathered profiles termed 'lateritic' exhibit a distinct series of layers including a surface duricrust, ironstone and mottled and pallid (kaolinised) zones. The word laterite is used for any profile in which ironstone is a major feature. See *Duricrust*.
- Lateritised rocks*** Rocks which have been partially or completely weathered to laterite.
- Leaching*** The removal in solution of soluble minerals and salts as water moves through the soil profile.
- Local relief*** The altitude difference between the base and crest of slopes in undulating or hilly areas.
- Magnesian*** Soils with an exchangeable Ca/Mg ratio of less than 0.1 in the major part of the B2 horizon. This term is used as a definition within a number of Soil Orders in the Australian Soil Classification (Isbell 1996).
- Massive earths*** See *Earths, massive*.
- Massive structure*** See *Soil structure, apedal*.
- Mesonatric*** Soils in which the major part of the upper 0.2 m of the B2 horizon has an ESP between 15 and 25. Used as a Great Group definition for Sodosols in the Australian Soil Classification (Isbell 1996).
- Metamorphic rocks*** Rocks that were originally igneous or sedimentary that have been physically and/or chemically altered by high temperatures and/or pressures beneath the Earth's surface.
- Mineralisation*** The breakdown of soil organic matter and crop and animal residues by micro-organisms to inorganic (available) forms.
- Mottle*** Spots, blotches or streaks of subdominant colours different from the main soil colour.

- Mycorrhizae*** Soil fungi which act as rootlets and increase the amount of nutrients (particularly phosphorus and zinc) available to plants. Following, excessive tillage and soil fumigation can cause mycorrhizae to die out. Plants growing with mycorrhizae are generally healthier and more resistant to disease, particularly root rots.
- Natric*** Soils in which the major part of the upper 0.2 m of the B2 horizon is sodic. Used as a Great Group definition for Kurosols in the Australian Soil Classification (Isbell 1996).
- Nodules (in soil)*** See *Segregation*.
- Non-cracking clays*** See *Clays, non-cracking*.
- Orthic*** Soils which usually have a weakly developed B horizon (in terms of contrast between A horizons above and adjacent horizons below), or a B horizon with 15% clay (SL-) or less, or a transitional horizon (C/B) occurring in fissures in the parent rock which contains between 10 and 50% of B horizon material (including pedogenic carbonate).
- Pans*** A hard and/or cemented soil horizon e.g. cultivation pan.
- Paralithic*** A term used in the Australian Soil Classification (Isbell 1996) to define soil material which directly overlies partially weathered or decomposed rock or saprolite.
- Parent material*** The rock from which a soil profile develops.
- Permeability*** The capacity for transmission under gravity of water through soil or sediments.
- Plant available water capacity (PAWC)*** The quantity of water held in a soil that can be extracted by plant roots. It is expressed as millimetres of plant available water within the root zone.
- pH*** A measure of the acidity or alkalinity of a soil. A pH of 7.0 indicates neutrality, higher values indicate alkalinity and lower values indicate acidity. Each unit change in pH represents a 10-fold change in either the acidity or alkalinity of the soil. For example, a pH of 5.0 is 10 times more acid than a pH of 6.0. Soil pH affects the amount of different nutrients that are

soluble in water and therefore the amount of nutrient available to plants.

Porosity (of soil)

The degree of pore space in a soil (i.e. the percentage of the total space between solid particles). The extent and type of soil porosity indicates the ease with which water, air and roots can move through the soil. Without sufficient pores of the right size, soil is unproductive because plant roots cannot move through the soil easily, air and water movement are poor, and there is insufficient water for plant growth.

There are two types of pores. Macropores are large pores, greater than 0.03 mm in diameter, and most can be seen by the naked eye. They include the spaces between soil aggregates caused by cultivation, shrinking and cracking, channels made by roots of plants, and earthworm and other animal and insect tunnels. Macropores are vitally important in allowing water and air to move freely, but provide little water for plant uptake because they are readily drained.

Micropores are small pores less than 0.03 mm in diameter occurring mainly within aggregates. Water drains through them very slowly so they act as water reservoirs for plant roots.

Regolithic

A term used to describe soils with a layer of unconsolidated mineral material beneath the soil profile. The term is used in the Australian Soil Classification (Isbell 1996).

Salinity

The presence of sufficient soluble salts to adversely affect plant growth and/or land use. The main salt involved is sodium chloride, but sulfates, carbonates and magnesium salts occur in some soils. It is expressed as a level of electrical conductivity (EC). See *Electrical conductivity*.

Sands

Soils with a uniform sand (including sandy loam) texture throughout the surface soil and subsoil.

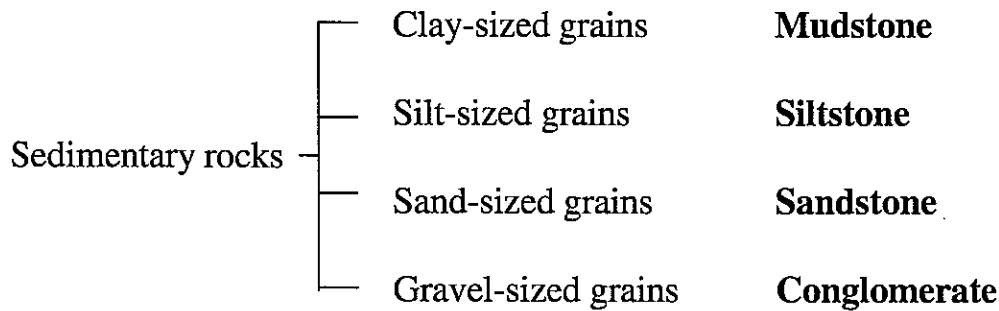
Saprolite

Decomposed rock that has maintained characteristics that were present as an unweathered rock.

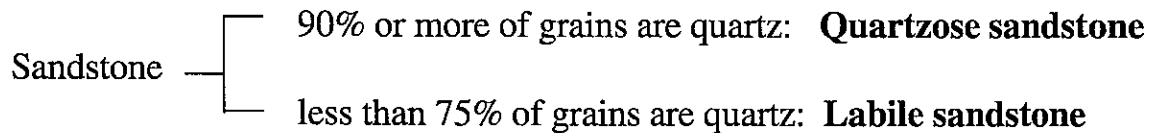
Sedimentary rocks

Rocks formed from the accumulation of material which has been weathered and eroded from pre-existing rocks, then transported and deposited as sediment by wind (aeolian) or water (fluvial, marine).

Sedimentary rocks have been classified according to grain size and constituent minerals:



Sandstone is further subdivided on the basis of the dominant minerals making up the clasts (solid inclusions) or the matrix which cements the clasts together:



Segregation

Discrete accumulations of minerals in the soil because of the concentration of some constituent, usually by chemical or biological action. Segregations are described by their nature, abundance and form.

- | | | |
|---------------------|--|---|
| 1) <i>nature</i> | for example, calcareous (carbonate), gypseous (gypsum), manganiferous (manganese) and ferromanganiferous (iron-manganese). | |
| 2) <i>abundance</i> | very few (trace or occasional) | <2% |
| | few (slight) | 2-10% |
| | common (light) | 10-20% |
| | many (moderate) | 20-50% |
| | very many (heavy) | >50% |
| 3) <i>form</i> | concretions | - spheroidal formations (concentric in nature). |
| | nodules | - irregular rounded formations (not concentric or symmetric). Can have a hollow interior. |
| | fragments | - broken pieces of segregations. |
| | crystals | - single or complex clusters of visible crystals. |
| | soft segregations | - finely divided soft segregations accumulated in the soil through chemical |

action with water. They contrast with surrounding soil in colour and composition but are not easily separated from the soil as separate bodies.

Self-mulching

A condition of well-structured surface soil, notably of clays, in which the aggregates fall apart naturally as the soil dries to form a loose mulch of soil aggregates.

In cultivated soils, ploughing when wet may appear to destroy the surface mulch which, however, will re-form upon drying.

Slickensides

Subsoil structural features which develop as a result of two masses moving past each other, polishing and smoothing the surfaces. These are common in Vertosols.

Sodicity

A characteristic of soils (usually subsoils) containing exchangeable sodium to the extent of adversely affecting soil stability, plant growth and/or land use. It is measured as a percentage of the cation exchange capacity of the soil.

The classes are defined as follows:

non-sodic	- less than 6%
sodic	- between 6% and 15%
strongly sodic	- more than 15%

Sodic or strongly sodic soils would be dispersible and may be improved by the addition of gypsum.

Sodosol

A Soil Order of the Australian Soil Classification (Isbell 1996). These soils have a clear or abrupt textural B horizon in which the major part of the upper 0.2 m of the B2 horizon is sodic and is not strongly subplastic.

***Soft segregations
(in soil)***

See *Segregation*.

Soil colour

The colour of soil material is determined by comparison with a standard Munsell soil colour chart. The colours are described for moist soils unless otherwise stated.

- Soil depth** The following depth ranges are used in this manual to describe the soil surface and soil profile depths.
- | | | |
|-----------------|------------------|------------|
| 1) soil surface | thin | 0-15 cm |
| | moderately thick | 15-30 cm |
| | thick | 30-60 cm |
| | very thick | >60 cm |
| 2) soil profile | very shallow | <25 cm |
| | shallow | 25-50 cm |
| | moderately deep | 50-100 cm |
| | deep | 100-150 cm |
| | very deep | 150-500 cm |
- Soil horizon** A layer of soil material within the *soil profile* with distinct characteristics and properties produced by soil-forming processes, and which are different from those of the layers above and/or below. The three main horizons are: A (topsoil); B (subsoil); C (see C horizon).
- Soil horizon boundary** Boundaries between horizons take many forms. The terms used in the soil descriptions of the Field Manual soil photographs and Appendix 3 (Resource Information) are:
Sharp - less than 5 mm wide;
Abrupt - 5 to 20 mm wide;
Clear - 20 to 50 mm wide;
Gradual - 50 to 100 mm wide;
Diffuse - more than 100 mm wide.
- Soil profile** A vertical cross-sectional exposure of a soil, from the surface to the parent material or *Substrate*.
- Soil reaction trend** The general direction of the change in pH with depth.
- Soil structure** The arrangement of natural soil aggregates that occur in soil; structure includes the distinctness, size and shape of these aggregates.
- 1) *distinctness*
- *strong* The natural soil aggregates are quite distinct in undisplaced soil; when displaced more than two-thirds of the soil material consists of aggregates (i.e. well structured).

- *moderate* Natural soil aggregates are well formed and evident but not distinct in undisplaced soil; when displaced more than one-third of the soil material consists of aggregates (i.e. moderately structured).
 - *weak* The natural soil aggregates are indistinct and barely observable in undisplaced soil; when displaced up to one-third of the soil material consists of soil aggregates (poorly structured).
- 2) *size*
- *coarse* The natural soil aggregates are relatively large; an average size of 20 mm or more is coarse for the purposes of this manual.
 - *medium* The average size of the natural soil aggregates is between fine and coarse.
 - *fine* The natural soil aggregates are relatively small; an average size of 5 mm or less is fine for the purposes of this manual.
- 3) *shape*
- *apedal* There are no observable natural soil aggregates (structureless); the soil may be either a coherent mass (massive) or a loose, incoherent mass of individual particles such as sand grains (single grain).
 - *blocky* The natural soil aggregates have the approximate shape of cubes with flat and slightly rounded sides.
 - *prismatic* The natural soil aggregates have the approximate shape of elongated blocks.
 - *columnar* The natural soil aggregates are like those of *prismatic* but have domed tops.
 - *polyhedral* The natural soil aggregates are irregular, many sided and multi-angled.
 - *lenticular* The natural soil aggregates are like large vertical lens shapes with curved cracks between the aggregates.
 - *platy* The soil particles are arranged around a horizontal plane and bounded by relatively flat horizontal faces.

- *granular* The natural soil aggregates are rounded, porous, stable and less than 12 mm in diameter. They usually occur in the surface horizons.

Soil texture

The coarseness or fineness of soil material as it affects the behaviour of a moist ball of soil when pressed between the thumb and forefinger. It is generally related to the proportion of clay, silt and sand within a soil. Texture classes used in this manual are defined primarily by the total clay content:

	Group	Clay content (%)
Coarse	Sand Loamy sand Sandy loam	less than 5 5 to 10 10 to 20
Medium	Loam Sandy clay loam Clay loam	≈ 25 20 to 30 + sand 30 to 35
Fine	Sandy clay Light clay Medium clay Heavy clay	35 to 40 + sand 35 to 40 40 to 50 more than 50

Solodic soils

Soils with strong texture contrast between A horizons and sodic B horizons which are not strongly acid.

Structural formation class (of vegetation)
Structured earths

Vegetation grouping based on attributes of the tallest layer e.g. growth form, crown separation and height.
See *Earths, structured*.

Subnatric

A Great Group of the Australian Soil Classification (Isbell 1996). A major part of the upper 0.2 m of the B horizon has an ESP between 6 and less than 15. These soils are considered to be sodic (See *Sodicity*).

Subsoil

Soil layers below the surface with one of the following attributes:

- a larger content of clay, iron, aluminium, organic material (or several of these) than the surface and subsurface soil;
- stronger colours than those of the surface and subsurface soil above, or the *substrate* below. The B horizon.

- Substrate*** The material below the soil profile which may be the parent material or may be unlike the material from which the soil has formed; substrate which is not parent material for the soil above may be layers of older alluvium, rock strata unrelated to the soil or the buried surface of a former landscape.
- Subsurface soil*** Soil layers immediately under the surface soil which usually have less organic matter, paler colours and may have less clay than the surface soil. The A2 horizon.
- Surface crust*** Distinct surface layer, often laminated, ranging in thickness from a few millimetres to a few tens of millimetres, which is hard and brittle when dry and cannot be readily separated from and lifted off the underlying soil material.
- Surface soil*** The soil layer extending from the soil surface down which has some organic matter accumulation and is darker in colour than the underlying soil layers. The A horizon.
- Tenosol*** A Soil Order of the Australian Soil Classification (Isbell 1996). These soils generally have weak pedological organisation throughout the profile apart from the A horizons.
- Texture*** See *Soil texture*.
- Texture contrast soil*** A soil in which there is a sharp change in soil texture between the A and B horizons (surface and subsoil) over a distance of 10 cm or less. Also known as a duplex soil.
- Traprock*** A popular term used to describe a complex mixture of highly deformed sandstone and mudstone, interbedded conglomerate, limestone and volcanics.
- Uniform clays*** See *Clays*.
- Vertosol*** A Soil Order of the Australian Soil Classification (Isbell 1996). These are clay soils with shrink/swell properties that display strong cracks when dry and have slickensides and/or lenticular structural aggregates at depth.

Volcanic rocks

Igneous rocks which have cooled from magma extruded to the Earth's surface. The size of the rock crystals depends on its duration of cooling - rapid cooling forms very fine crystals or even volcanic glass.

- acid

Contain 10% or more quartz and proportions of magnesium, iron and calcium. Usually light coloured.

- basic

Basalt or basaltic rocks containing minimal or no quartz. Usually dark coloured because of a high proportion of iron and manganese minerals.

- intermediate

Contain less than 10% quartz and mixed amounts of other minerals that are intermediate between the typical acid and basic igneous rocks.

Waterlogging

A situation in which all the pores in the soil have filled with water. Excess water may lie on the surface of the soil. All the air in the pores has been displaced by water, so no oxygen is available to plant roots or for soil microbial activity. If waterlogging continues for a long period, plants die. Under waterlogged conditions, nitrate, the most available form of nitrogen, breaks down and is lost as a gas.

Workability

The ease or otherwise of working the soil with machinery.

