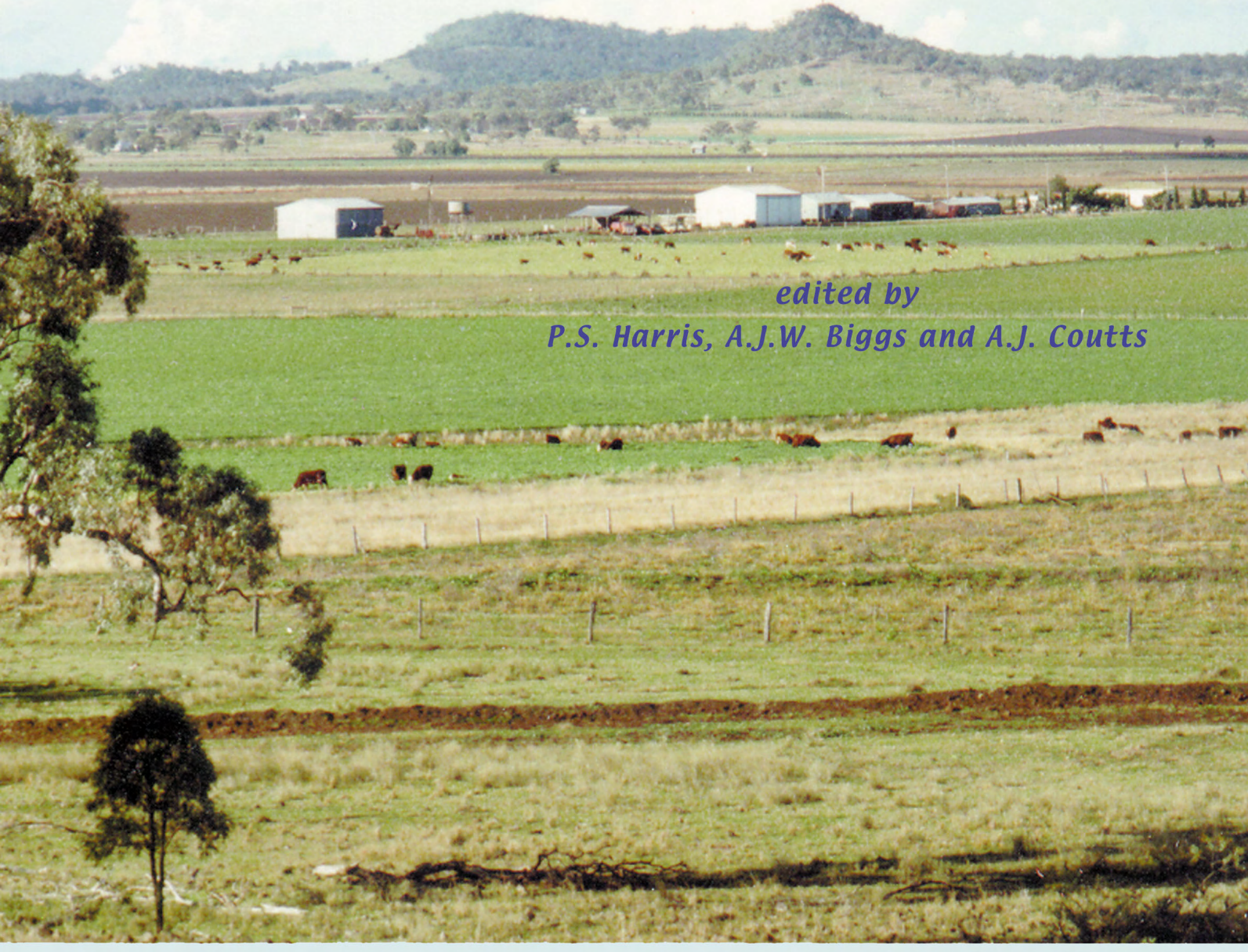
Central Darling Downs Land Management Manual

Field Manual



edited by
P.S. Harris, A.J.W. Biggs and A.J. Coutts

Understanding and Managing Land

in

Wambo, Pittsworth, Rosalie, Millmerran, Jondaryan Shires, Dalby Town and Toowoomba City

Department of Natural Resources
DNRQ990102

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Field Manual

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Department of Natural Resources
Queensland, 1999

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Maher, J.M., Harris, P.S. and Biggs, A.J.W. (1998). *Central Darling Downs Land Resource Areas Map (1:250 000)*. Department of Natural Resources, Queensland. 97-MCD-I-P3107.

Department of Natural Resources
Locked Bag 40
COORPAROO QLD 4151

soils@qld.gov.au

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Contributors

Field Manual Authors

Paul Harris
Andrew Biggs
Alistair Coutts

Other contributors to the Field Manual

Geoff Bass
Sandy Cameron
Justin Claridge
Neil Dalgleish
Nev Douglas
Mark Genrich
Ben Harms
Ian Heiner
Ernst Heijnen
David Lloyd
John Maher
John Marshall
Des McGarry
Nevin Olm
Geoff Sharp
Barry Stone
Jo Voller
Errol Weston

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The compilation of this manual has drawn upon data from numerous projects conducted over many years on the Central Darling Downs. It is the first time such a document has been compiled, and should provide a valuable resource for years to come.

Special mention is made of the landholders throughout the area who allowed access to their properties, particularly those who participated in over 30 soil field days and provided valuable local knowledge on management techniques.

Production of the Field Manual

Compilation – Alistair Coutts, Andrew Biggs, Paul Harris, Geoff Sharp and Ben Harms
Technical review – Paul Harris, Andrew Biggs, Barry Stone, Alistair Coutts, Dick Tucker and Ian Heiner
Photographs – Andrew Biggs, Ben Harms, Geoff Sharp, Paul Harris and Cliff Thompson

1. INTRODUCTION

The aim of the Central Darling Downs Land Management Manual is to increase awareness of land resource information within the community and provide a tool to support planning and management from the property level to catchment scale. This part, the ***Field Manual***, is one of four parts within the Central Darling Downs Land Management Manual. To be used as an aid to identifying soils in the Central Darling Downs, the *Field Manual* contains soil description sheets for 68 soils within the area.

Chapter 1 of the *Resource Information Book*, gives the following outline of the Central Darling Downs Land Management Manual:

- the components;
- the purpose;
- a collation of previous soil/land resource reports in the study area
- a reference to adjacent land management manuals; and
- a list of possible users.

This *Field Manual* provides a summary of the soil and land characteristics of the area, and makes recommendations for appropriate land use and management. This section also provides information on how to identify soils, using visual aids including diagrams, tables, summary sheets and landscape/soil photographs.

The area covered by the *Field Manual* largely includes the central Condamine catchment as shown in Map 1. This includes 14 Land Resource Areas (LRAs) for the 1.49 million hectares in the shires of Wambo, Pittsworth, Millmerran, Jondaryan, Rosalie (excluding Division 4), the town of Dalby and the city of Toowoomba.

The *Field Manual* incorporates data and information from new and historic land resource studies and correlates soil names adopted in those studies. The Appendix lists previous studies, correlates between the studies, and provides comments on similarities and differences between soil concepts.

Two key concepts — Land Resource Areas and Soils

To use the *Field Manual* and interpret the LRA Map effectively it is necessary to have a good understanding of the two key concepts of **Land Resource Areas** and **Soils**.

The whole landscape of the Central Darling Downs is divided into the mapping units called Land Resource Areas (LRAs). The soils in the area are described based on their location within the landscape, and their relationship to other soils in the landscape. This allows the complexity of the natural resources in an area to be broken down into easily handled portions.

Land Resource Areas are based on the combination of geology, landscape features like slope and relief, vegetation and groups of soils. LRAs contain a number of common and associated soils, which are unable to be mapped separately at the scale used to create the LRA Map. While the soils are described based on their location within landscape units, the LRA map units are not designed to strictly identify the soils in a particular map unit, but to predict their probable occurrence.

It is necessary to emphasise that for each LRA, it is the dominant landform, soil and vegetation characteristics that are described. Depending on the complexity of the landscape, considerable variation in these features can occur within any individual LRA. These variations arise due to the limitations imposed by the scale of mapping.

The LRA map is not a soils map. Errors in the use and interpretation of this map will occur by enlarging the map scale or by expecting map boundaries and LRA relationships to predict soil information without confirmation by field survey. Soils are a continuum, therefore map unit boundaries may not represent distinct changes, but rather a zone of gradual change. Field observations and soil analysis are necessary for positive confirmation.

Soils are used as the smallest descriptive unit. Each soil has a defined range of distinguishing properties such as colour, depth, stoniness, PAWC, texture, fertility etc. This means that each soil profile can be described using similar horizon sequences, landscape characteristics, landuse suitability, chemical and physical properties. Small scale landuse developments and urban uses often require detailed information about each soil type for environmental planning and management. While larger scale planning and development in rural areas may not require the same detail for landuse planning, it is logical to use individual soils as the smallest descriptive unit in the *Field Manual*.

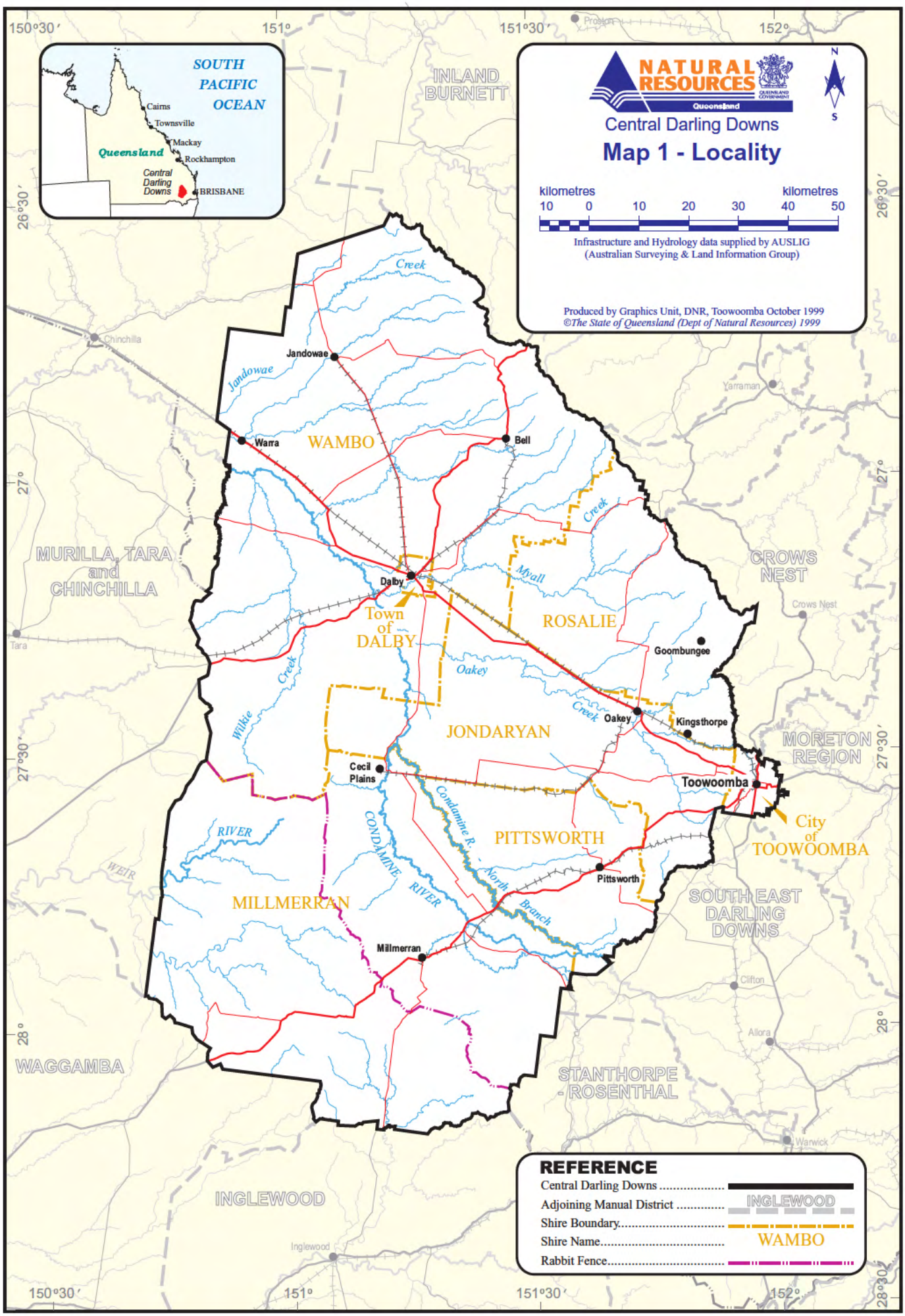
The descriptions of the Land Resource Areas within the Central Darling Downs are shown in Table 2.1 (*on page 12*). Table 2.2 (*on page 14*) shows the relationships between LRAs and soils and Table 2.3 (*on page 15*) shows the brief descriptions of the 68 soils described by the *Soil Summary Sheets* in the *Field Manual*.

The Land Resource Area map

Enclosed in this publication is the LRA map for the Central Darling Downs. While the general nature of the LRAs is well documented on the map, and within the text of this publication, the map only conveys a small portion of information available.

The original mapping (Forster, 1988) that the LRA map is based upon followed the concept of non-unique map units i.e. each delineated unit of a given LRA is assumed to have the same properties. In reality this is not true. The variation within and between the map units has been documented using the concepts of Unique Map Areas (UMAs). For the Central Darling Downs, the UMAs have been described to an extent, providing a greater degree of confidence in the use of the map.

The map and the associated data is available in digital (GIS) format. For further information, contact the Natural Resource Information Management Officer, Department of Natural Resources, Toowoomba.


NATURAL RESOURCES
Queensland
Central Darling Downs
Map 1 - Locality
kilometres
10 0 10 20 30 40 50
kilometres
Infrastructure and Hydrology data supplied by AUSLIG
(Australian Surveying & Land Information Group)
Produced by Graphics Unit, DNR, Toowoomba October 1999
©The State of Queensland (Dept of Natural Resources) 1999
SOUTH PACIFIC OCEAN
Cairns
Townsville
Mackay
Queensland
Rockhampton
Central Darling Downs
BRISBANE
INLAND BURNETT
Jandowae
Warra
WAMBO
Bell
Dalby
Town of DALBY
ROSALIE
Goombungee
Oakey
Kingsthorpe
JONDARYAN
Cecil Plains
Toowoomba
City of TOOWOOMBA
PITTSWORTH
Pittsworth
MILLMERRAN
Millmerran
MURILLA, TARA and CHINCHILLA
CROWS NEST
MORETON REGION
SOUTH EAST DARLING DOWNS
WAGGAMBA
STANTHORPE - ROSENTHAL
INGLEWOOD
Chinchilla
Tara
Yarraman
Crows Nest
Clifton
Allora
Warwick
Inglewood
Creek
Jandowae
Myall
Oakey
Wilkie
RIVER
CONDAMINE
Condamine R.
North
Branch
WEIR
REFERENCE
Central Darling Downs
Adjoining Manual District
INGLEWOOD
Shire Boundary
Shire Name
WAMBO
Rabbit Fence

2. USING THE FIELD MANUAL

The *Field Manual* can be used to:

- identify a particular soil;
- determine the range of soils present in an area;
- rapidly asses the attributes of a soil (e.g, geology, vegetation);
- assess relevant landuse and management information for soils of interest; and
- compare and contrast soil types.

The ***Land Resource Areas Map*** allows users to relate the broad scale inventory information contained in the Land Management Manual to local features. The steps to make the links between the broad scale regional picture and the soils identified at a property or site level are set out below. In summary, the steps to using this *Field Manual* are:

- define a specific land resource area;
- determine the range of soils present; and
- assess relevant landuse and management information for the soils of interest.

2.1 Determining the soil for any site

This *Field Manual* provides landuse and management recommendations that apply to soils which are readily identified by the user. The following steps will help identify the LRA and soils for any site—see also Figure 2.1.

Step 1. First, find the location of interest on the LRA map and note the LRA and surrounding LRAs of the site. (Due to the scale of mapping it has not been practical to delineate (map out) all LRAs, and it is possible that an unmapped area may coincide with the site of interest.) The general landscape description of the site should match that shown on the map legend (*see Table 2.1)* and the generalised relationships between LRAs (*Figure 2.2 on page 19*).

Step 2. Once the LRA has been confirmed, the soils that are likely to occur within that LRA can be identified using Table 2.2. This shows the soils which are likely to be found within an LRA. Figure 2.3 (on page 23) shows the generalised relationship between landscape position and soils. Note that because of the limitations of the scale of the map (1:250 000), it is possible that other soils may occur on individual properties. This will have to be verified by field inspections of each area of the property or specific site.

Step 3. Field inspections will be necessary to verify the occurrence of different soils within the landscape. This may be carried out using a soil auger or a backhoe to dig a hole, or by examining a cutting such as a bank or roadside.

Note: Become familiar with the description and identification aids provided in the Field Manual. Until experience is gained with the land resources of the district, the soils for any site can be determined using the following method.

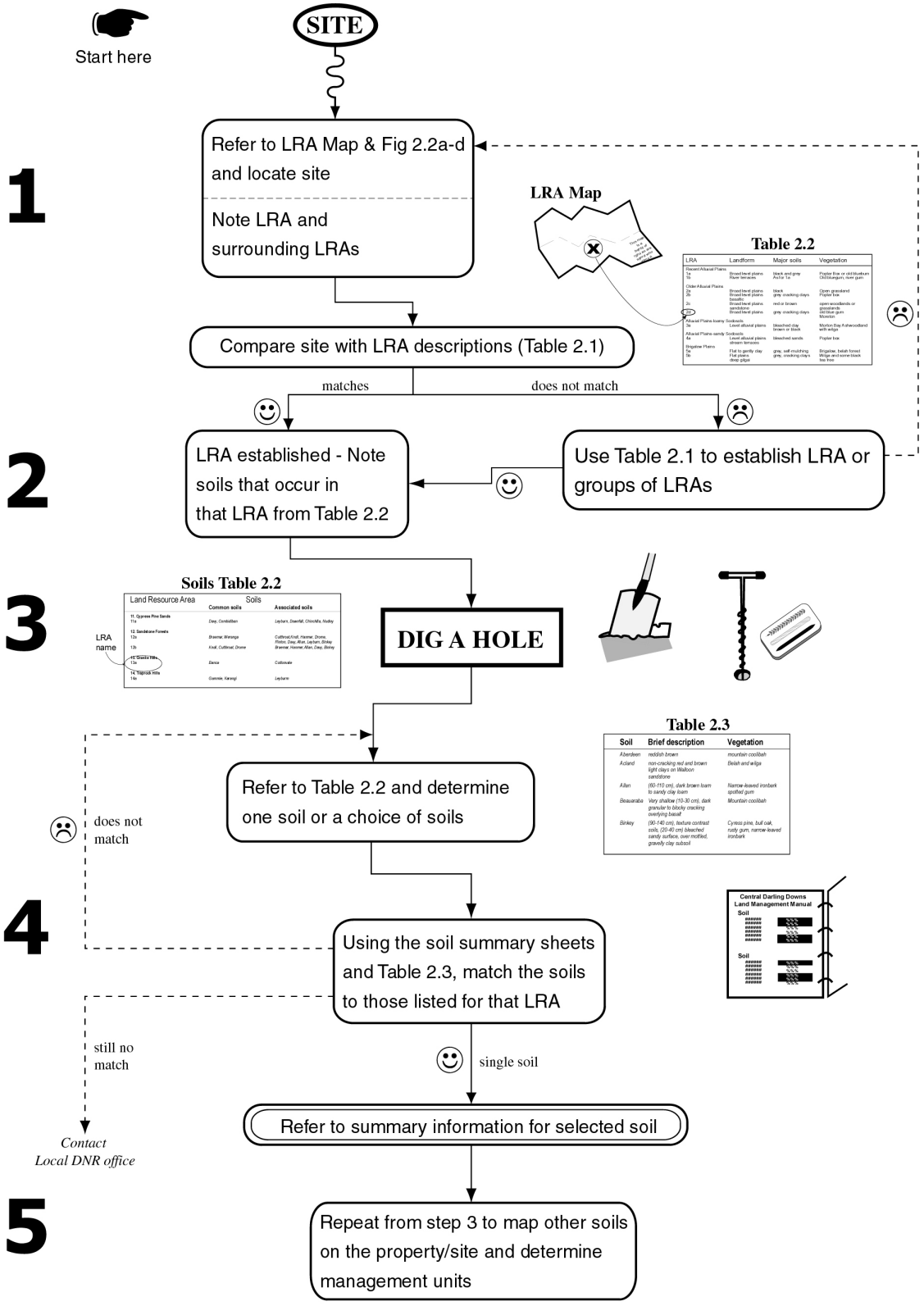


Figure 2.1 Determining LRA and soil type for any site

The soils can be further subdivided on the basis of topography, drainage, or other limitations such as rockiness, etc. into more detailed management units or 'land types'. The field observations and landscape features should be compared with the information and representative soil photographs on the *Soil Summary Sheets*.

Note that the soil profile photograph and accompanying description is a *representative* *example* of a soil, and does not encompass all of the likely variations. Also, there are usually a number of soils occurring within each LRA.

Step 4. Further field inspections (including soil profiles descriptions) should be made until all soils within the area of interest are identified and the boundaries of each soil type are reliably mapped.

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. It is more important to understand the properties of a soil and the way in which these properties affect land use, than to identify the specific soil type. Additional information, including analytical and morphological data for representative soils are given in the *Soil Chemical Data Book*.

Step 5. Each area of the property can be mapped out as a management unit on a property plan (*see Section 9.3, Property Planning, in Resource Information Book).* 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 or 'land type' should be identified and mapped out.

2.2 Determining landuse or land management for any site

Step 1. Map soil types as outlined above.

Step 2. Refer to the *Soil Summary Sheets* for information on land use options and limitations, and management options for each selected soil.

Step 3. Refer to the *Soil Chemical Data Book* to assess the likely nutrient requirements for soils within a land management unit. **Note that for specific crop and pasture requirements, a soil test should be undertaken for representative soils in each management unit.** The information provided in the *Soil Chemical Data Book* is from representative soil profiles within each LRA, and will not necessarily reflect the chemical properties of sites that may have a different history of landuse and management.

Step 4. Refer to the *Resource Information Book* for details of land use and land management techniques that may be possible for the area of interest. Chapter 7 contains information on agricultural landuse in the Central Darling Downs; Chapter 8 outlines land and environmental degradation issues; and Chapter 9 discusses strategies for sustainable landuse and management.

3. UNDERSTANDING THE SOIL SUMMARY SHEETS

The *Soil Summary Sheets* provide a summary of information about each soil and its associated land use suitability and management requirements. Comments on landuse limitations and landuse suitability have been collated from key scientists and extension officers in their respective fields, and the local knowledge of farmers. Many farmers have participated in soil field days and shared invaluable local knowledge on the sustainable management of particular soil types, and recommendations for future land use. The recommendations for best management practices for cropping and grazing have come directly from farmers and from previous land resource studies.

It should be emphasised that comments on best management practices come from existing knowledge. While advances in management skill and technology in the future may enable new practices to overcome landuse limitations and improve the best practice recommendations, the inherent properties and features of the soils will not change. It will be these inherent properties that will determine the feasibility and viability of new practices, technology and knowledge.

Details of the Soil Summary Sheets

The *Soil Summary Sheets* provide a range of information including photographs of the landscape and an example soil profile. A description to each of the sections on the *Soil Summary Sheets* is shown below.

Major LRAs: Land Resource Areas where that soil occurs as a dominant soil. These are coded with the same colour as illustrated on the *LRA Map* (in back pocket). Some soils only occur as an associated soil and therefore will not show a Major LRA.

Minor LRAs: Land Resource Areas where that soil occurs as an associated soil to a range of other dominant soils.

Brief Description: Describes the *soil concept* or key identifying features of the soil. Briefly describes depth, surface characteristics, colour, texture, any local relief such as presence of gilgai, and source material. It may also include soils, from previous studies as shown in the Appendix, with different names but a similar *soil concept*.

Landform and Distribution: The position of the soils within an LRA including attributes such as slope, relief and parent material and likely location.

Vegetation: The vegetation community usually associated with the soil, including key indicator species and minor associated species. Includes a comment on current level of development and clearing and the relevant Regional Ecosystem classification (*refer Table 6.2 in the Resource Information Book*). The *Resource Information Book* provides more detailed descriptions of the vegetation communities (*Table 6.1*) and a list of flora in the Central Darling Downs (Appendix 1).

Vegetation descriptions are not diagnostic for each soil, but can be used as a guide or indicator of the occurrence of a particular soil or to the presence of the some important properties that are related to certain soils. For example, the presence of poplar box and

termite nests may indicate light surface textures and crusting surfaces; while rough barked apple and tall cypress pine may indicate deep sands etc.

Example Soil Profile Description: Describes the features in the example soil photograph and includes the name from the Australian Soil Classification system. The soil profile description is a simplified version of that given in the *Soil Chemical Data Book*. Additional information, including analytical and morphological data for representative soils are given in the *Soil Chemical Data Book*.

Detailed soil descriptions in the *Soil Summary Sheets* describe ***representative*** soil profiles for that soil type. The nature of soils and landscapes is such that soil properties vary in the field. It is more important to understand the properties of a soil and the way in which these properties affect land use than to identify the specific soil type. For example, recognising the management implications of sandy clay surface texture, and saline and sodic subsoils, for a site similar to a *Cecilvale* or *Millmerran*, than a 'good match' from the *Soil Summary Sheets*.

Comments are made on the condition of the soil surface when it is dry. Statements are made on the availability of nutrients and likely response to fertilisers in the top 10 cm of the soil at the sampling site only. In some instances local farmer knowledge has been used to indicate likely response to other nutrients.

Section 4.4 of the *Resource Information Book* provides detailed information on the interpretations of soil chemical analysis, definitions of soil features and the ratings used to interpret results. Explanations for certain terms are also found in the Glossary.

General Soil Features: Detail for the *soil concept* includes depth, structure, texture, colour, surface relief, surface characteristics, cracking, pH, sodicity and salinity, plant available water capacity (PAWC), fertility and other associated features.

pH ranges for the surface soil and subsoil are given for each soil. 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 (i.e the presence of salts in the profile). Sodicity relates to the exchangeable sodium percentage (ESP) value. Further information on these terms is found in the Glossary and Section 4.4 of the *Resource Information Book*.

An estimate is given of the plant available water capacity (PAWC) within the root zone for the soil (i.e the ability of the soil to retain moisture for use by crop or pasture). Section 4.4 of the *Resource Information Book* provides detailed information on PAWC and effective rooting depth for soils within the Central Darling Downs.

Landuse Limitations: Includes inherent features of the soil which, if not understood and managed properly, can lead to land degradation.

Landuse Suitability: Outlines the most suitable uses for the particular soil, including grain and fodder cropping options, suitability to types of irrigation, suitable sown pasture species, key native pasture species, suitability for horticulture, honey production and farm timber where appropriate.

Best Management Practices: Lists important recommendations for responsible management that allows optimal landuse with minimal land degradation. These recommendations are based on the known inherent properties of the soil and the limitations they present to any landuse, local knowledge from scientists, extension officers, agribusiness and farmers.

Includes a statement on the conservation status of the remnant vegetation and whether planning guidelines and restrictions apply to clearing and land development. Explanation for certain terms are also found in the Glossary.

Table 2.1 Brief description of LRAs

Land Resource Area	Landform	Major soils	Vegetation	Areas (ha)
Recent Alluvial Plains				
1a	Broad level plains of mixed basaltic and sandstone alluvium.	Black and grey cracking clays with bleached sands or loams over brown or black clays	Poplar box or Qld bluegum open woodland, or grassland.	188 800
1b	River terraces, channels and associated alluvial plains, subject to flooding.	As for 1a.	Qld bluegum, river red gum and Moreton Bay Ash woodland.	19 020
Older Alluvial Plains				
2a	Broad level plains of basaltic alluvium.	Black, self-mulching cracking clays.	Open grassland.	156 550
2b	Broad level plains of mixed basaltic and sandstone alluvium.	Grey cracking clays.	Poplar box open woodland.	61 540
2c	Broad level plains of mixed basaltic and sandstone alluvium.	Red or brown loams over red or brown clays with black, self-mulching cracking clays.	Poplar box open woodland or grassland.	23 220
2d	Broad level plains of mixed basaltic and sandstone alluvium.	Grey cracking clays.	Poplar box, Qld blue gum, and Moreton Bay Ash woodland with belah and wilga.	28 680
Alluvial Plains - loamy Sodosols				
3a	Level alluvial plains and stream terraces.	Bleached clay loams over black, grey or brown clays.	Poplar box and Moreton Bay Ash woodland with wilga.	41 620
Alluvial Plains - sandy Sodosols				
4a	Level alluvial plains and stream terraces.	Bleached sands over brown or black clays.	Poplar box and Moreton Bay Ash woodland with wilga.	10 920
Brigalow Plains				
5a	Flat to gently undulating clay plains with shallow gilgai.	Grey, self-mulching, cracking clays.	Brigalow, belah forest with wilga.	44 050
5b	Flat plains with moderately deep to deep gilgai.	Grey, cracking clays.	Brigalow, belah forest with wilga and some black tea tree.	4 930
Brigalow Uplands				
6a	Gently undulating rises and plains on Walloon sandstone.	Grey-brown, cracking clays.	Brigalow, belah, wilga forest.	27 050
6b	Undulating to steep, low hills and rises of Walloon sandstone.	Grey-brown cracking clays with brown sands over brown clays.	Brigalow, belah open forest with wilga or softwood scrub with narrow leafed ironbark.	63 080
6c	Gently undulating rises and plains on Walloon sandstone.	Grey-brown, cracking clays.	Brigalow, belah, wilga forest with black tea tree.	40 670
6d	Gently undulating to undulating rises and plains on fine grained sediments and clay sheets.	Grey and brown cracking clays with grey-brown loams over brown clays	Brigalow, belah, open forest with box or poplar box open woodland.	28 460

Table 2.1 cont'd

Land Resource Area	Landform	Major soils	Vegetation	Areas (ha)
Basaltic Uplands				
7a	Undulating rises and rolling low hills.	Grey-brown and brown clays or clay loams.	Mountain coolibah open woodland.	203 040
7b	Level to gently undulating plains.	Reddish brown to greyish brown clays.	Poplar box open woodland.	14 680
7c	Steep hills and mountains.	Grey-brown and brown clays or clay loams.	Mountain coolibah open woodland.	44 960
7d	Gently undulating plains to undulating rises on the Toowoomba Plateau.	Red clays.	Mountain coolibah open woodland and Sydney blue gum, white stringybark, bloodwood open forest.	8 260
Poplar Box Walloons				
8a	Undulating rises and low hills on Walloon sandstone.	Self-mulching, black cracking clays.	Poplar box open woodland.	21 070
Poplar Box Sodosols				
9a	Gently undulating plains on sandstone.	Bleached sands and loams over brown and grey clays.	Poplar box and gum topped box open woodland.	60 800
9b	Undulating plains and rises on sandstone.	Bleached sands to loams over mottled, grey or yellow clays.	Poplar box and bull oak open woodland.	3 560
Ironbark/Bull Oak Sodosols				
10a	Gently undulating plains on sandstone.	Bleached sands to loams over mottled, grey or yellow clays.	Narrow leaved ironbark, bull oak, cypress pine, rusty gum and poplar box open forest.	63 030
10b	Undulating plains and rises on sandstone.	Bleached sands or loams over mottled, grey or yellow clays; or brown or red clays.	Narrow leaved ironbark, bull oak, cypress pine and poplar box open forest.	19 310
Cypress Pine Sands				
11a	Flat to gently undulating sandy alluvial plains.	Deep sands and deep bleached sands over mottled, yellow or grey clays.	Cypress pine, rough-barked apple, blue gum, rusty gum and poplar box open forest.	27 970
Sandstone Forests				
12a	Rises and undulating plains on sandstone; often lateritised.	Bleached sands to loams over mottled, grey or yellow clays.	Narrow leaved ironbark, bull oak, cypress pine, rusty gum and poplar box open forest.	177 320
12b	Plateaus and low sandstone hills to undulating plains; lateritic scarps are common.	Shallow, gravelly sands to loams; deep sands or bleached sands over mottled, grey or yellow clays.	Narrow leaved ironbark, spotted gum and rusty gum open forest; or cypress pine, bull oak, rusty gum and ironbark open forest.	99 320
Granite Hills				
13a	Steep granite hills with rock outcrops.	Gritty sands over a natural, impermeable hardpan; or coloured sands.	New England blackbutt, tumbledown gum, ironbark and stringybark woodland.	600
Traprock Hills				
14a	Steep traprock hills with rock outcrops.	Gravelly loams over reddish brown or yellowish brown clays or bleached loam to clay loam acid subsoils.	Ironbark and brown box woodland with grey, yellow and fuzzy box and wattles.	8 390

Source: Maher *et al*. 1998.

Table 2.2 Relationship of soils to LRAs

Land Resource Area	Soils	
	Common soils	**Associated soils**
1. Recent Alluvial Plains		
1a	*Condamine, Haslemere Mywybilla, Anchorfield*	*Downfall, Combidiban, Waco, Cecilvale*
1b	*Condamine, Haslemere*	*Cecilvale*
2. Older Alluvial Plains		
2a	*Waco*	*Anchorfield, Mywybilla, Cecilvale, Yargullen*
2b	*Cecilvale*	*Mywybilla, Haslemere, Downfall, Waco, Oakey*
2c	*Oakey, Waco*	*Formartin, Cecilvale, Mywybilla*
2d	*Millmerran*	*Downfall, Oakey*
3. Alluvial Plains - loamy Sodosols		
3a	*Downfall, Haslemere*	*Millmerran, Cecilvale, Oakey, Condamine, Leyburn*
4. Alluvial Plains - sandy Sodosols		
4a	*Leyburn, Haslemere*	*Millmerran, Chinchilla, Davy*
5. Brigalow Plains		
5a	*Kupunn*	*Belahville, Haslemere, Tara, Langlands*
5b	*Tara*	*Kupunn, Haslemere*
6. Brigalow Uplands		
6a	*Moola*	*Acland, Walker, Knoll, Edgefield, Kenmuir, Downfall*
6b	*Moola, Diamondy, Walker*	*Toolburra, East, Clayburn, Edgefield, Downfall, Knoll, Kenmuir*
6c	*Gate, Moola*	*Walker, Edgefield, Knoll, Downfall*
6d	*Calingunee, Kurumbul, Murra Cul Cul*	*Arden, Wynhari, Tandawanna, Moruya*
7. Basaltic Uplands		
7a	*Craigmore, Irving, Charlton, Purrawunda, Kenmuir*	*Beauaraba, Aubigny, Waco, Southbrook, Mallard, Burton, Aberdeen, Yargullen*
7b	*Nungil, Kenmuir*	*Beauaraba, Charlton, Purrawunda, Southbrook, Aubigny, Aberdeen*
7c	*Kenmuir, Beauaraba*	*Charlton, Purrawunda*
7d	*Drayton, Ruthven*	*Middle Ridge, Toowoomba*
8. Poplar Box Walloons		
8a	*Elphinstone*	*Talgai, Walker, Kenmuir, Charlton, Purrawunda, Toolburra*
9. Poplar Box Sodosols		
9a	*Leyburn, Downfall*	*Haslemere, Nudley, Combidiban, Drome*
9b	*Weranga*	*Braemar*
10. Ironbark/Bull Oak Sodosols		
10a	*Weranga, Braemar, Cutthroat*	*Channing, Knoll, Drome, Davy, Chinchilla, Combidiban*

Land Resource Area	Soils	
	Common soils	**Associated soils**
10b	*Weranga, Channing*	*Cutthroat, Drome, Braemar, Davy*
11. Cypress Pine Sands		
11a	*Davy, Combidiban*	*Leyburn, Downfall, Chinchilla, Nudley*
12. Sandstone Forests		
12a	*Braemar, Weranga*	*Cutthroat, Knoll, Hanmer, Drome, Flinton, Davy, Allan, Leyburn, Binkey*
12b	*Knoll, Cutthroat, Drome*	*Braemar, Hanmer, Allan, Davy, Binkey*
13. Granite Hills		
13a	*Banca*	*Cottonvale*
14. Traprock Hills		
14a	*Gammie, Karangi*	*Leyburn*

Table 2.3 Brief description of soils

Soil	Brief description	Vegetation (dominant species)	Occurrence by LRA[1]
Aberdeen	Moderately deep to deep (50-130 cm), reddish brown, coarse structured cracking clays on basalt	Mountain coolibah, rough barked apple	*7a, 7b*
Acland	Moderately deep to very deep (100-160 cm), uniform, non-cracking red and brown light clays on Walloon sandstone	Belah and wilga	*6a*
Allan	Moderately deep to deep (60-110 cm), texture contrast soil with a dark brown loam to sandy clay loam surface (frequently bleached) over brown to yellowish brown clay subsoils on sandstone	Narrow-leaved ironbark, spotted gum, bull oak, cypress pine	*12a, 12b*
Anchorfield	Deep to very deep (80-180 cm), self-mulching, very dark brown cracking clays on mixed basaltic and sandstone alluvium	Queensland bluegrass	**1a** *2a*
Arden	Moderately deep to deep (90-150 cm), self-mulching, red brown to cracking clays on sandstone and clay	Brigalow, belah, poplar box, wilga, false sandalwood	*6d*
Aubigny	Shallow to moderately deep (30-70 cm), brown to reddish brown light clays over red clay subsoils on basalt	Mountain coolibah, Moreton Bay Ash, poplar box	*7a, 7b*
Banca	Shallow to moderately deep (30-90 cm), very dark grey to brown, gritty, structureless siliceous sands amongst granite rock outcrops, frequently underlain by a colour B horizon of similar texture and/or a natural, impermeable hardpan	New England blackbutt, tumbledown gum, Youman's stringybark, Caley's ironbark, broad leaved stringybark	**13a**
Beauaraba	Very shallow (10-30 cm), dark granular to blocky cracking clays overlying basalt	Mountain coolibah	**7c** *7a, 7b*
Belahville	Texture contrast soil with a moderately thick (15-30 cm), sandy loam to sandy clay loam surface may be bleached, over brown or reddish brown clay subsoils	Poplar box, belah, yarran, limebush, false sandalwood	*5a*

[1] **Bold** = Common; *Italics* = Associated

Soil	Brief description	Vegetation (dominant species)	Occurrence by LRA[1]
Binkey	Moderately deep to deep (90-140 cm) texture contrast soils, with a (20-40 cm) bleached sandy surface, over mottled, gravelly clay subsoil	Cypress pine; bull oak; rusty gum; narrow-leaved ironbark	*12a, 12b*
Braemar	Texture contrast soil with a moderately thick (20-40 cm), bleached sandy surface, over mottled, yellow or grey clay subsoils on sandstone	Bull oak, cypress pine, narrow-leaved ironbark, rusty gum	**10a, 12a** *9b, 10b, 12b*
Burton	Moderately deep to deep (75-150 cm), reddish brown light clays, over red clay subsoils on strongly weathered basalt or red material	Mountain coolibah, narrow-leaved ironbark, rough bark apple	*7a*
Calingunee	Moderately deep to deep (60-150 cm), dark brown or grey self-mulching cracking clays with moderate gilgai on fine grained sediments	Brigalow, belah, poplar box, wilga	**6d**
Cecilvale	Deep (120-150 cm), grey cracking clays on mixed basalt / sandstone alluvial plains with poor surface structure and coarse blocky subsoils	Poplar box	**2b** *1a, 1b, 2a, 2c, 3a*
Channing	Texture contrast soil with a thin (<15 cm), bleached sandy loam to clay loam surface, over brown or red clay subsoils on sandstone	Narrow-leaved ironbark, cypress pine, bull oak	**10b** *10a*
Charlton	Moderately deep (50-100 cm), fine to coarse self-mulching, dark brown to black cracking clays	Mountain coolibah, narrow-leaved ironbark	**7a** *7b, 7c, 8a*
Chinchilla	Moderately deep to very deep (80-160 cm), reddish brown sands	Moreton Bay ash, cypress pine and wattle	*4a, 10a, 11a*
Clayburn	Texture contrast soil with a dark brown or grey clay loam surface (30 cm) over dark brown clays with moderate gilgai microrelief on Walloon sandstone	Brigalow, wilga, black teatree, gum top box, poplar box	*6b*
Combidiban	Deep texture contrast soil with a thick to very thick (30-100 cm), bleached, loose sandy surface, over mottled, yellow, grey or brown sandy clay subsoil on alluvial plains	Cypress pine, rusty gum and tumbledown gum	**11a** *1a, 9a, 10a*
Condamine	Deep to very deep (80-180 cm), coarse structured, black cracking clays on mixed basalt / sandstone alluvia adjacent to the Condamine River	Queensland blue gum, river red gum	**1a, 1b** *3a*
Cottonvale	Moderately deep (65-100 cm) gritty texture contrast soil with very dark grey, bleached, sandy surface to 30-45 cm over mottled, brown, grey and yellowish grey clay subsoils on granite	New England blackbutt, New England peppermint, manna gum, tumbledown gum, Youman's stringybark, Caley's ironbark, broad leaved stringybark	*13a*
Craigmore	Deep to very deep (100-180 cm), fine to coarse self-mulching, dark greyish brown to black cracking clays with reddish brown or brown subsoil on basalt or basaltic colluvium	Mountain coolibah, Queensland bluegrass	**7a**
Cutthroat	Texture contrast soil with a thick (>30 cm), bleached, loose sandy surface, over mottled, yellowish brown sandy clay subsoils on sandstone	Cypress pine, bull oak, some narrow-leaved ironbark, rusty gum and tumbledown gum	**10a, 12b** *10b, 12a*
Davy	Deep (100-150 cm), yellow or brown sands	Queensland blue gum, rough-barked apple, cypress pine, Moreton Bay ash	**11a** *4a, 10a, 10b, 12a, 12b*

[1] **Bold** = Common; *Italics* = Associated

Soil	Brief description	Vegetation (dominant species)	Occurrence by LRA[1]
Diamondy	Texture contrast soil with a thick brown to dark brown sandy surface (30 cm), over yellowish brown to brown sandy clay subsoils on sandstone	Bottle tree softwood scrub, narrow-leaved ironbark, brigalow, poplar box, gum top box	**6b**
Downfall	Texture contrast soil with a medium (15-20 cm), hardsetting, loam to clay loam surface, over yellowish brown or greyish brown clay subsoils on mixed sandstone / basalt alluvial plains	Poplar box, wilga	**3a, 9a** *1a, 2b, 2d, 6a, 6b, 6c, 11a*
Drayton	Moderately deep (50-100 cm) non-cracking red-brown to red clays over basalt on the Toowoomba Plateau	Narrow-leaved ironbark, mountain coolibah, white box	**7d**
Drome	Deep (100-120 cm) sand with a dark brown to light brownish grey, loamy sand surface, over a bleached sand, commonly becoming more yellow with depth on sandstone	Spotted gum, narrow-leaved ironbark, Queensland blue gum	**12b** *9a, 10a, 10b, 12a*
East	Moderately deep to deep soil (> 75 cm), brown clay loam to clay surface, over reddish brown clay subsoils on Walloon sandstone	Poplar box, belah, wilga, brigalow, softwood scrub	*6b*
Edgefield	Deep to very deep (100-180 cm) cracking grey clays, with dark grey surfaces grading to dark brown or dark grey subsoils on Walloon sandstone	Brigalow, belah, wilga	*6a, 6b, 6c*
Elphinstone	Deep (100-150 cm), fine self-mulching, dark cracking clays on Walloon sandstone	Poplar box, narrow-leaved ironbark and Queensland blue gum	**8a**
Flinton	Moderately deep to deep (50-105 cm) soils with red or brown loams over red or brown clay loam to clay subsoils on lateritised sandstone	Narrow leaved ironbark, spotted gum, quinine, wattles and red ash	*12a*
Formartin	Deep texture contrast soil with a thick (>30 cm), bleached sandy surface, over red clay subsoils on mixed basalt / sandstone alluvial plains	Poplar box, Moreton Bay ash	*2c*
Gammie	Very shallow to shallow (20-40 cm), gravelly, hardsetting brown loams to clay loams over a brown or bleached acid subsoil on Traprock	Brown box with fuzzy box and yellow box or mugga and broad leaved red ironbark	**14a**
Gate	Moderately deep to deep (70-120 cm), self-mulching grey clays with moderate gilgai on Walloon sandstone	Brigalow, belah, wilga, and black teatree, with gum top box	**6c**
Hanmer	Texture contrast soil with a shallow to moderately deep hardsetting, gravelly, dark brown, very acid loam surface (40 cm), frequently underlain by a bleached layer, over reddish brown to grey clay acid subsoils on sandstone	Narrow-leaved ironbark, Queensland blue gum, broad leaved stringybark, softwood scrub	*12a, 12b*
Haslemere	Deep texture contrast soil with a thin (<15 cm) sandy loam to clay loam surface, over black or dark brown clay subsoils on alluvial plains	Poplar box, Queensland blue gum, Moreton Bay ash and wilga	**1a, 1b, 3a, 4a** *2b, 5a, 5b, 9a*
Irving	Deep to very deep (100-180 cm), fine self-mulching, brownish black cracking clays with brown or reddish brown subsoils on basaltic colluvium	Mountain coolibah	**7a**
Karangi	Shallow to moderately deep texture contrast soil with a gravelly, medium, bleached, brown, sandy loam to clay loam surface (30 cm), over reddish brown or yellowish brown clays on Traprock	Narrow-leaved ironbark, dusky-leaved ironbark, tumbledown gum, grey box, yellow box, spotted gum and wattles	**14a**

[1] **Bold** = Common; *Italics* = Associated

Soil	Brief description	Vegetation (dominant species)	Occurrence by LRA[1]
Kenmuir	Very shallow (5-25 cm), gravelly or stony, brown to red brown loams or clay loams on basalt	Narrow-leaved ironbark, silver-leaved ironbark, mountain coolibah, softwood scrub	**7a, 7b, 7c** *6a, 6b, 8a*
Knoll	Very shallow (30 cm), gravelly, grey or dark reddish brown sandy loams to loams over sandstone	Broad-leaved red and blue-leaved ironbarks, rusty gum, spotted gum, softwood scrub, cypress pine, wattles	**12b** *6a, 6b, 6c, 10a, 12a*
Kupunn	Deep to very deep (100-160 cm), self-mulching, grey cracking clays with shallow to moderately deep gilgai on brigalow alluvial plains	Brigalow, belah, wilga	**5a** *5b*
Kurumbul	Deep texture contrast soil with a thin (<15 cm) brown clay loam over dark brown heavy clay on clay sheets	Belah, wilga, false sandalwood	**6d**
Langlands	Deep to very deep (100-160 cm), self-mulching, brown to greyish brown cracking clay with moderately deep to deep gilgai on the brigalow clay sheet	Brigalow	*5a*
Leyburn	Deep (100-150 cm) texture contrast soil with a shallow, hardsetting, bleached loamy sand to clay loam surface, frequently gravelly (20 cm), over yellowish brown and brown clay subsoils on mixed sandstone / traprock alluvium	Poplar box, gum top box	**4a, 9a** *3a, 11a, 12a, 14a*
Mallard	Very shallow to shallow soils (20-40 cm), brown to grey-brown clay loams, over gravelly, mottled, brown and red-brown clays on basalt	Mountain coolibah	*7a*
Middle Ridge	Deep (100-150 cm) non-cracking red clays on Toowoomba Plateau	Queensland blue gum, wattles	*7d*
Millmerran	Moderately deep to deep (90-150 cm), grey clays with brown to grey, hardsetting, light clay surfaces over grey clay subsoils on mixed alluvial plains	Poplar box	**2d** *3a, 4a*
Moola	Moderately deep to deep (75-150 cm), self-mulching, grey-brown cracking clays with very shallow gilgai on Walloon sandstone	Brigalow, belah, wilga	**6a, 6b, 6c**
Moruya	Texture contrast soil with a red brown or brown loam to clay loam with strong bleaching (10 cm) over red brown clays on labile sedimentary rocks	Belah, wilga, false sandalwood, occasional brigalow	*6d*
Murra Cul Cul	Texture contrast soil with a thin (<15 cm) bleached, brown or grey sandy clay loam over dark brown heavy clay on sandstone alluvium	Polar box, wilga, false sandalwood	**6d**
Mywybilla	Deep to very deep (100-180 cm), coarse structured, very dark grey cracking clays on mixed basalt / sandstone alluvial plains	Queensland bluegrass, Queensland blue gum	**1a** *2a, 2b, 2c*
Nudley	Moderately deep to deep (70-150 cm) clay loam or texture contrast soil with a brown loam to clay loam surface of 40-50 cm over grey clay loam to clay subsoils	Poplar box, cypress pine, Moreton Bay ash	*9a, 11a*
Nungil	Moderately deep to deep (60-140 cm)soils with a brown light clay surface, over dark reddish brown to dark brown clay subsoils on weathered basalt; shallow phase may contain weathered basalt from 20 cm, stony surface phase also exists	Poplar box	**7b**

[1] **Bold** = Common; *Italics* = Associated

Soil	Brief description	Vegetation (dominant species)	Occurrence by LRA[1]
Oakey	Texture contrast soil with a thin (10-20 cm), reddish brown to brown, loamy surface, over brown clay subsoils on mixed basalt / sandstone alluvial plains	Poplar box	**2c** *2b, 2d, 3a*
Purrawunda	Moderately deep (50-100 cm), fine self-mulching, brownish black cracking clay on basalt	Mountain coolibah	**7a** *7b, 7c, 8a*
Ruthven	Deep to very deep (100-180 cm) non-cracking red clays on Toowoomba Plateau	Queensland blue gum, narrow-leaved ironbark, wattles	**7d**
Southbrook	Moderately deep (50-100 cm) stony, brown clay loam surface, over red clay subsoils on basalt	Narrow-leaved ironbark, rough-barked apple, poplar box	*7a, 7b*
Talgai	Moderately deep to deep (75-130 cm), fine, self-mulching, black cracking clay surface, over brown clay subsoils on Walloon sandstone	Poplar box, wilga, narrow-leaved ironbark, gum top box	*8a*
Tandawanna	Deep (110-150 cm), weakly self-mulching, red or brown non-cracking clays on clay sheets	Belah, wilga, false sandalwood	*6d*
Tara	Very deep (180 cm) brown to grey cracking clays with moderately to very deep gilgai on brigalow plains	Brigalow, belah, wilga	**5b** *5a*
Toolburra	Moderately deep to deep (75-150 cm) red brown light clays over red clay subsoils on Walloon sandstone	Silver-leaved ironbark, poplar box, wattles	*6b, 8a*
Toowoomba	Deep (100-150 cm) non-cracking red clays on Toowoomba Plateau	Queensland blue gum, narrow-leaved ironbark, wattle	*7d*
Waco	Deep to very deep (100-180 cm), fine self-mulching, dark brown cracking clays on basaltic alluvium	Queensland bluegrass	**2a, 2c** *1a, 2b, 7a*
Walker	Moderately deep to deep texture contrast soil with a thin (10-20 cm) dark brown to greyish brown, sandy loam to clay loam surface, over brown, dark reddish brown or dark greyish brown clays on Walloon sandstone	Brigalow, wilga, softwood scrub (bottle trees and vine scrub), belah and poplar box	**6b** *6a, 6c, 8a*
Weranga	Texture contrast soil with a thin (<15 cm), bleached sandy loam to sandy clay loam surface, over mottled, grey or yellow sandy clay subsoil on sandstone	Poplar box, bull oak, narrow-leaved ironbark	**9b, 10a, 10b, 12a**
Wynhari	Deep (100 cm), dark brown non cracking clays on labile sedimentary rocks	Belah, wilga, false sandalwood	*6d*
Yargullen	Moderately deep (50-100 cm), soft, granular dark clay on soft calcareous material	Queensland bluegrass	*2a, 7a*

[1] **Bold** = Common; *Italics* = Associated

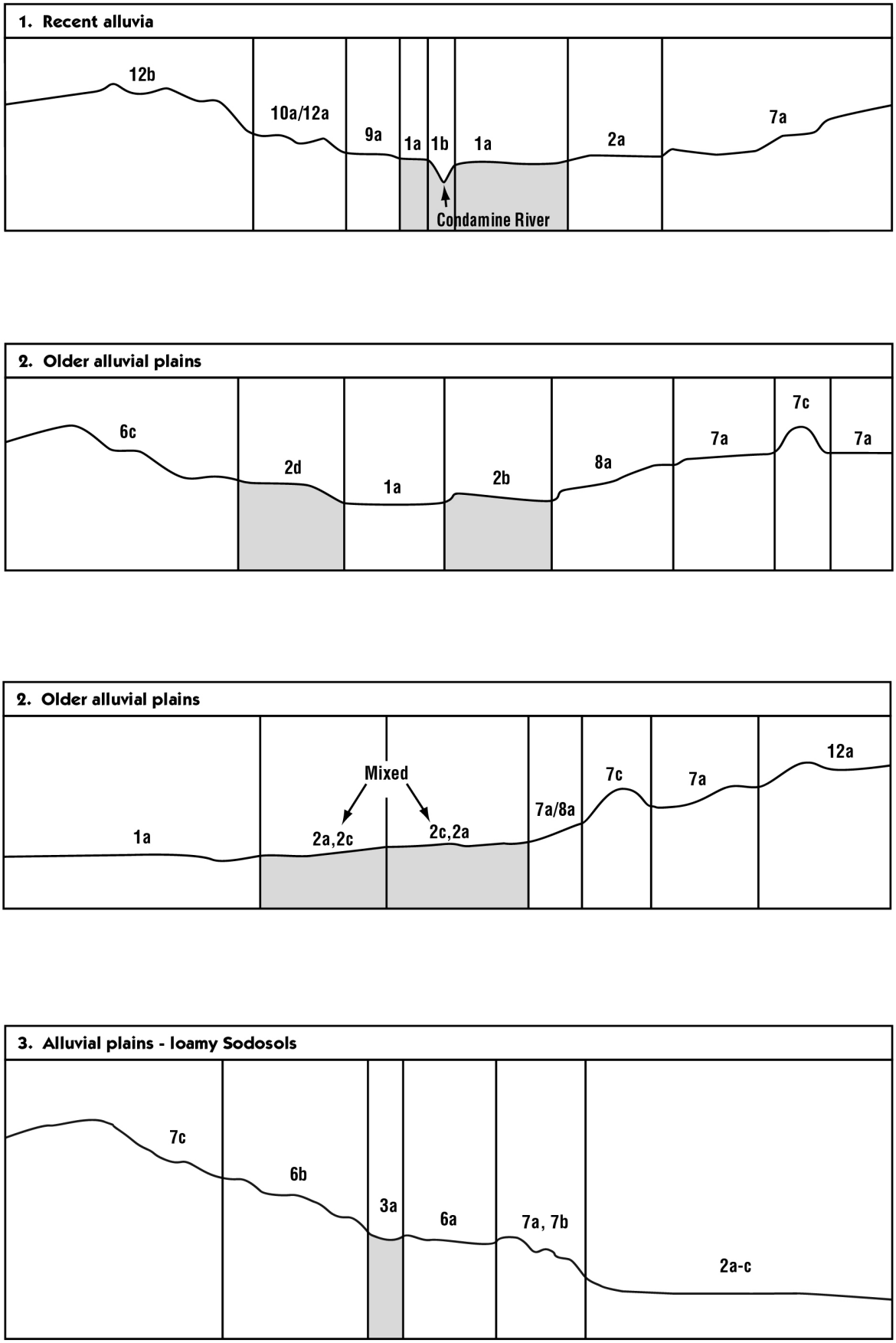


Figure 2.2 Generalised relationships between LRAs

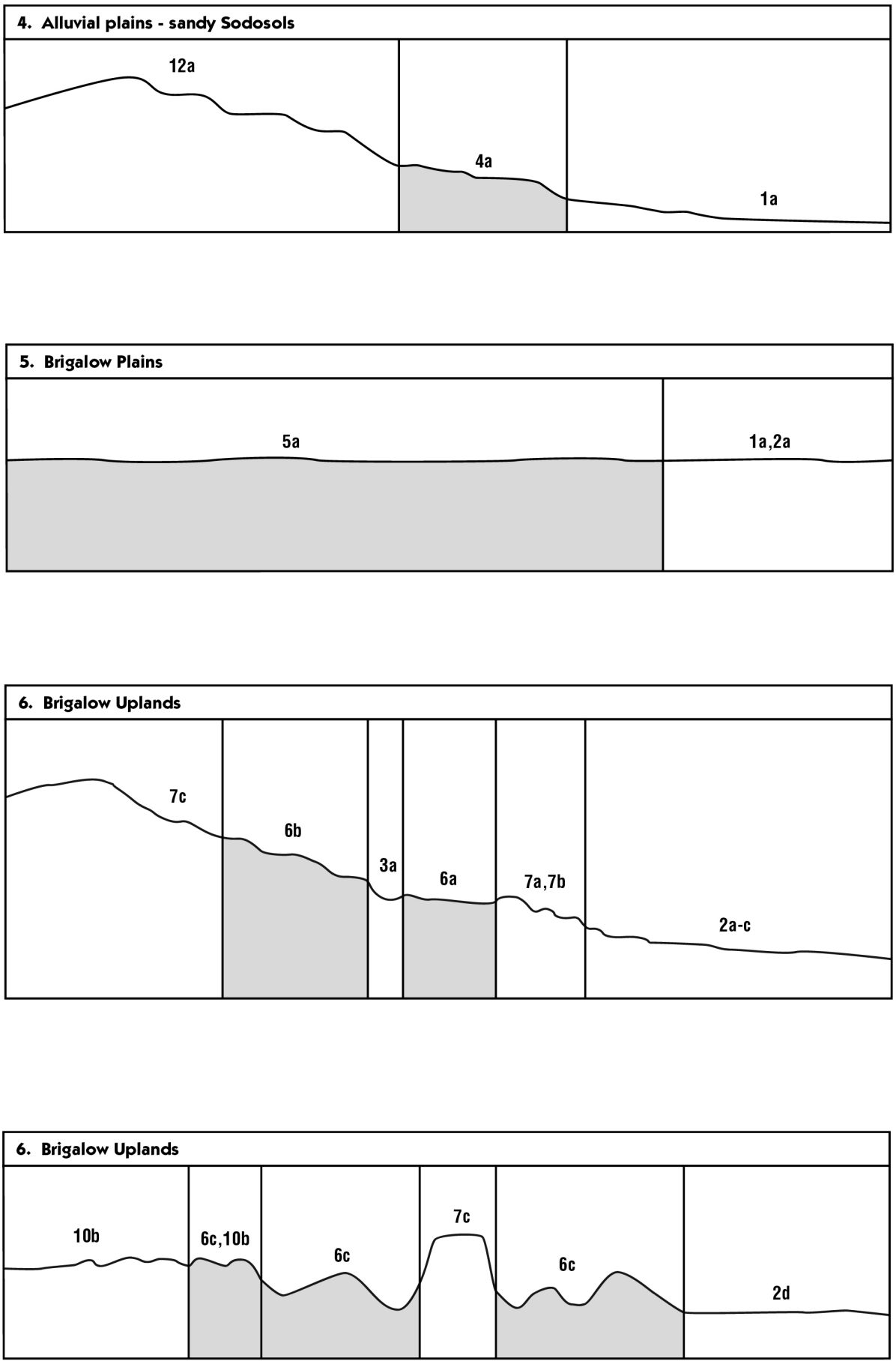
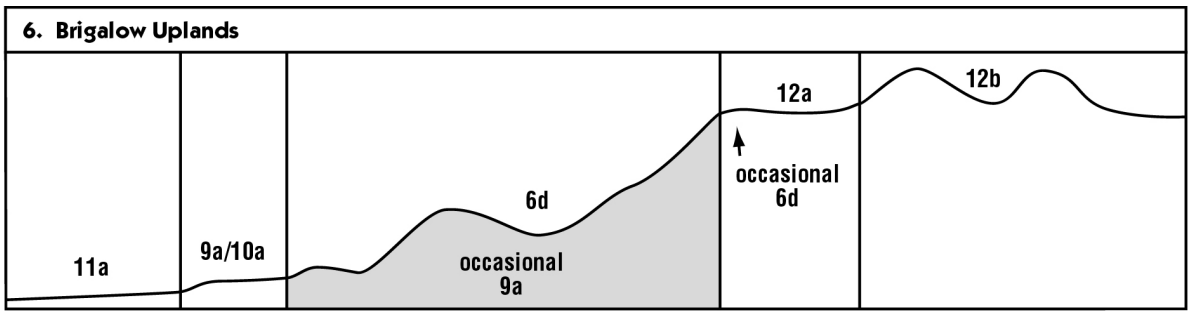
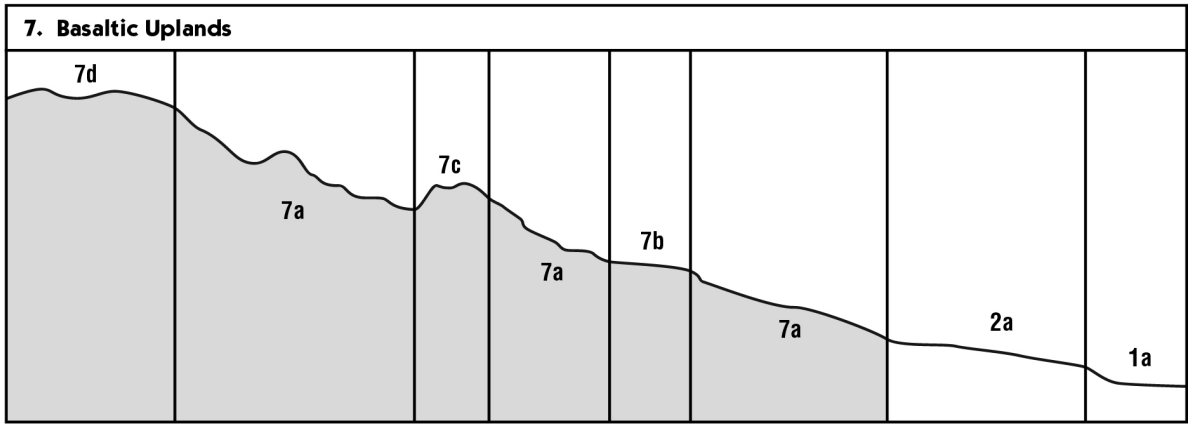
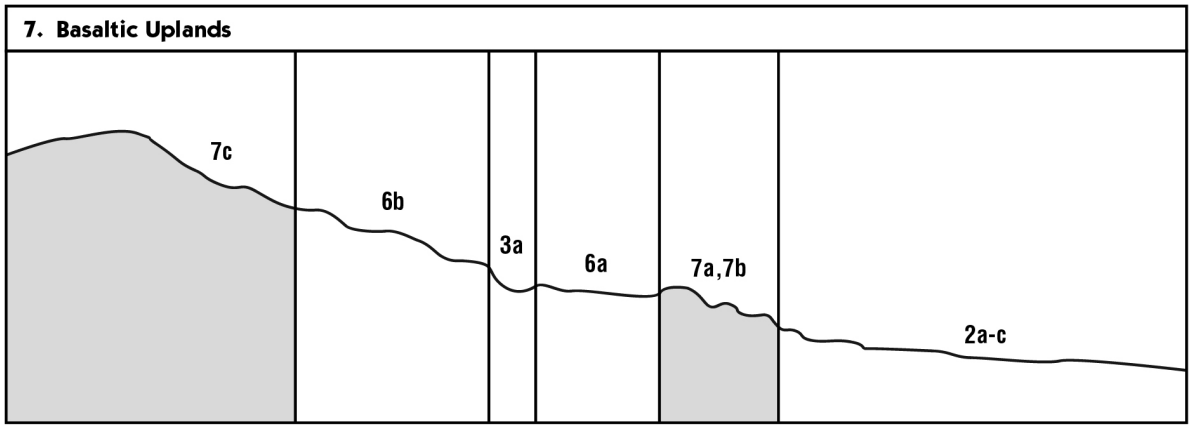
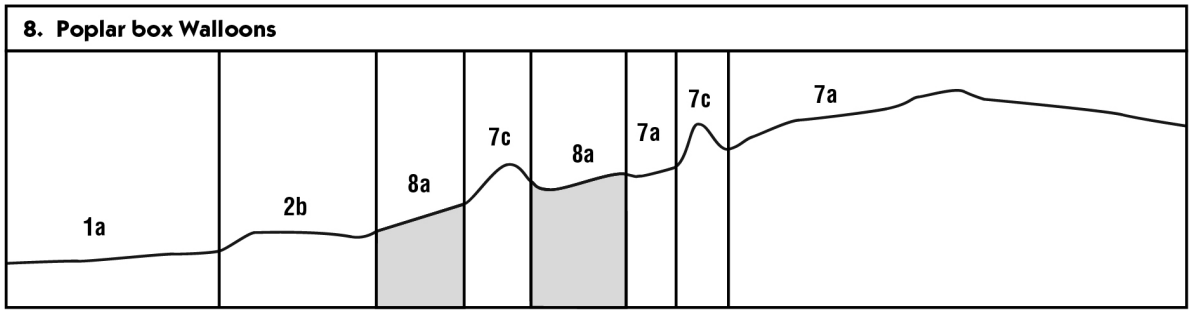


Figure 2.2 Generalised relationships between LRAs (cont'd)









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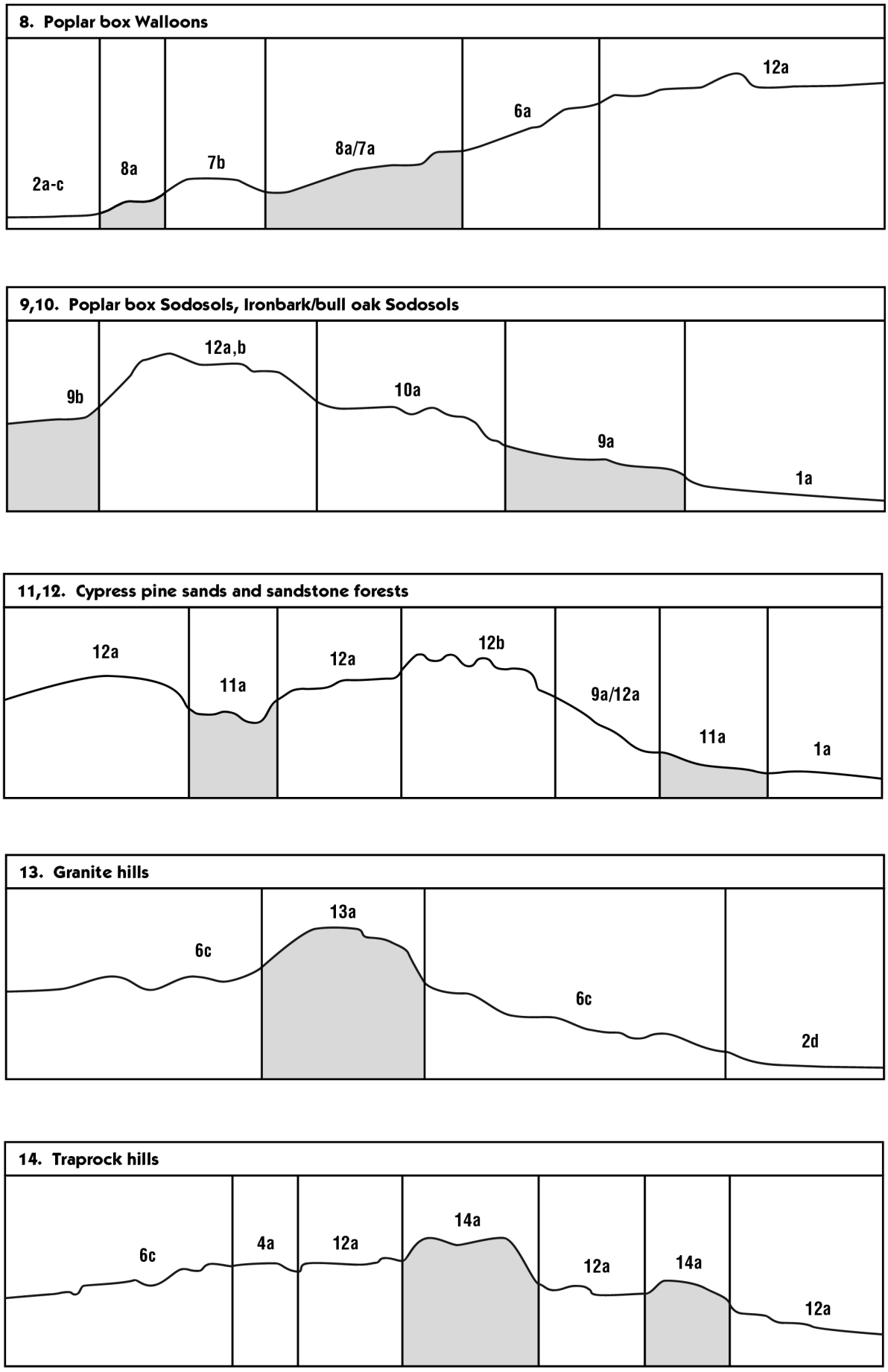

Figure 2.2 Generalised relationships between LRAs (cont'd)

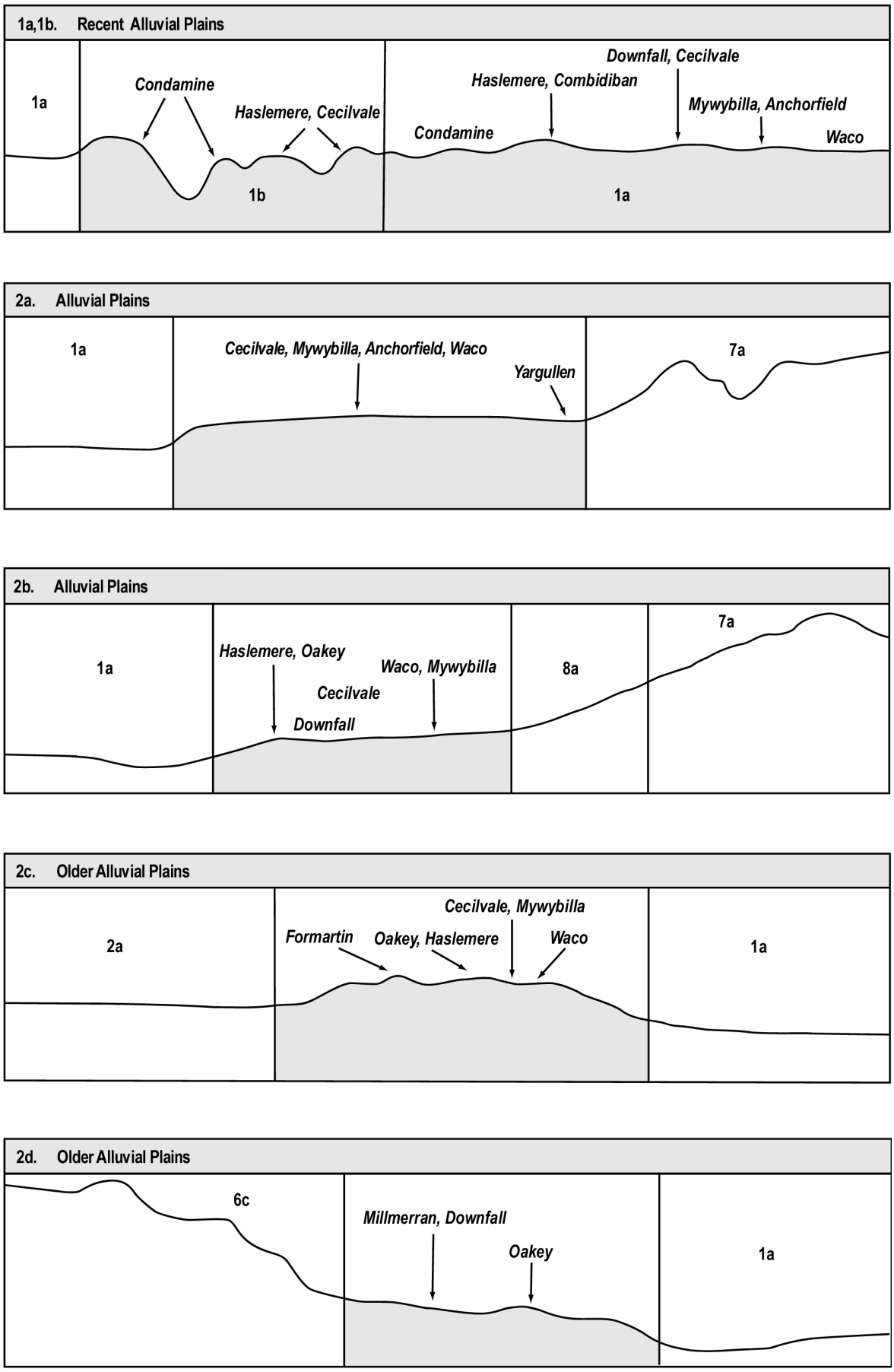

Figure 2.3 Generalised relationships between soils

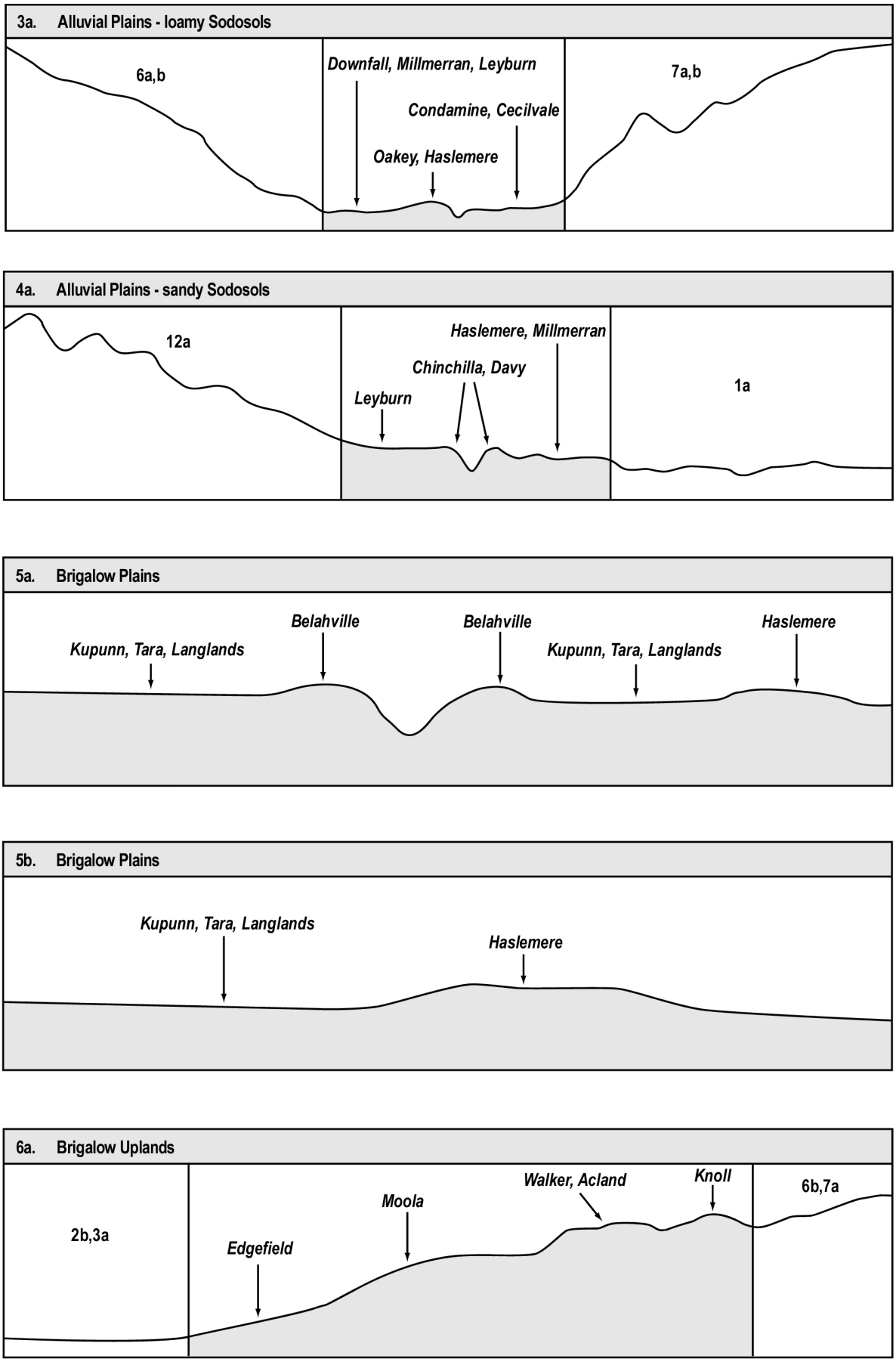

Figure 2.3 Generalised relationships between soils (cont'd)

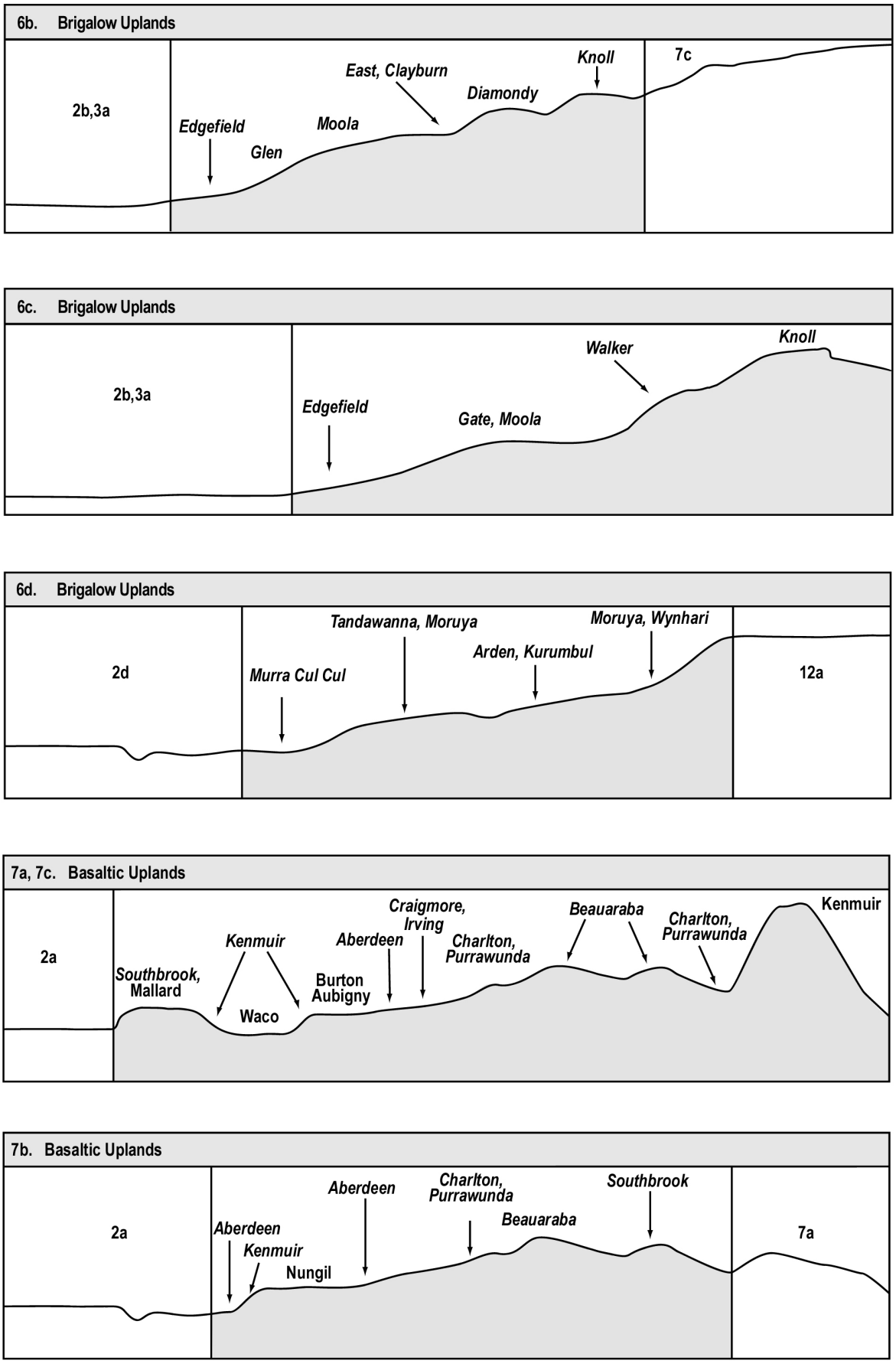

Figure 2.3 Generalised relationships between soils (cont'd)

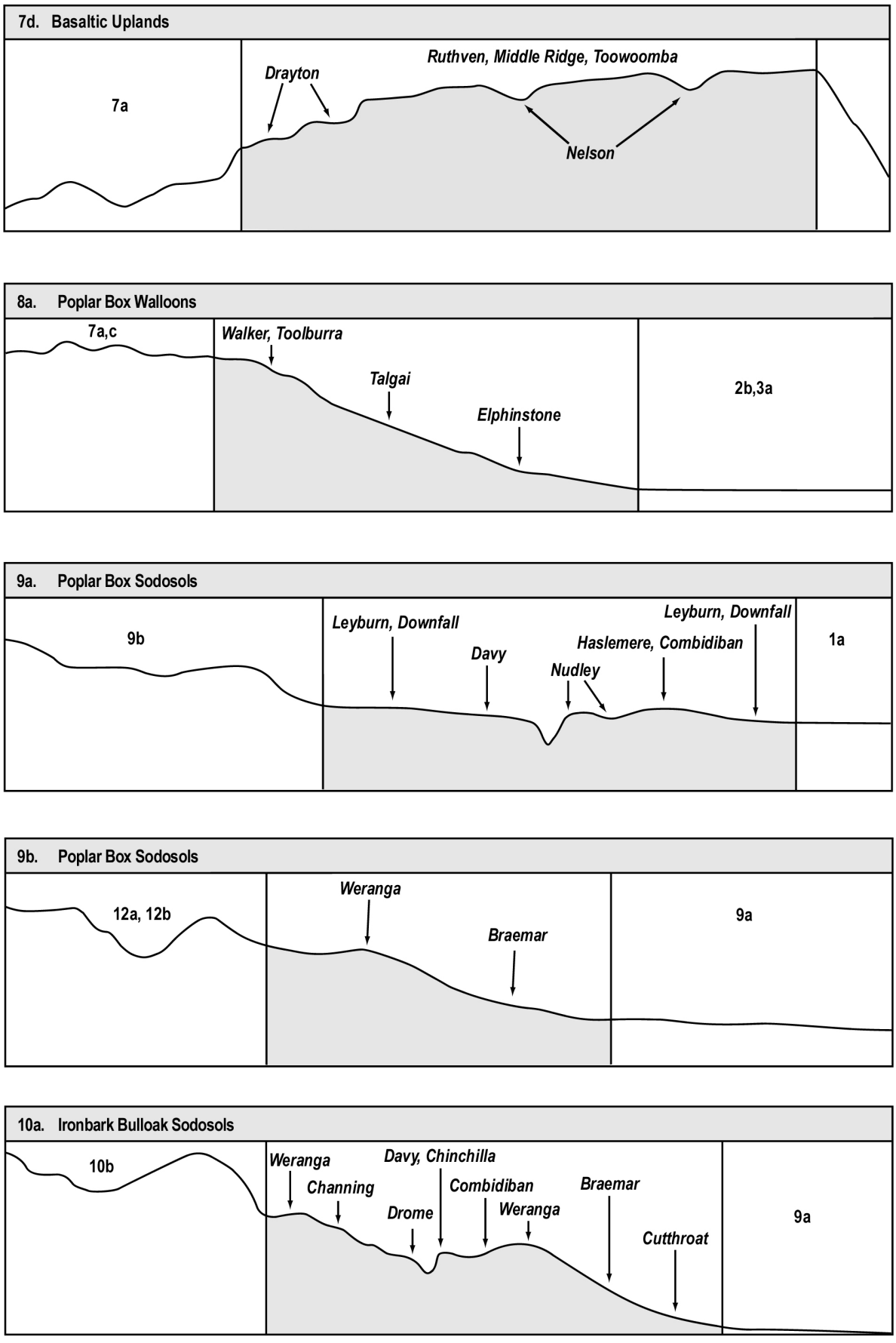

Figure 2.3 Generalised relationships between soils (cont'd)

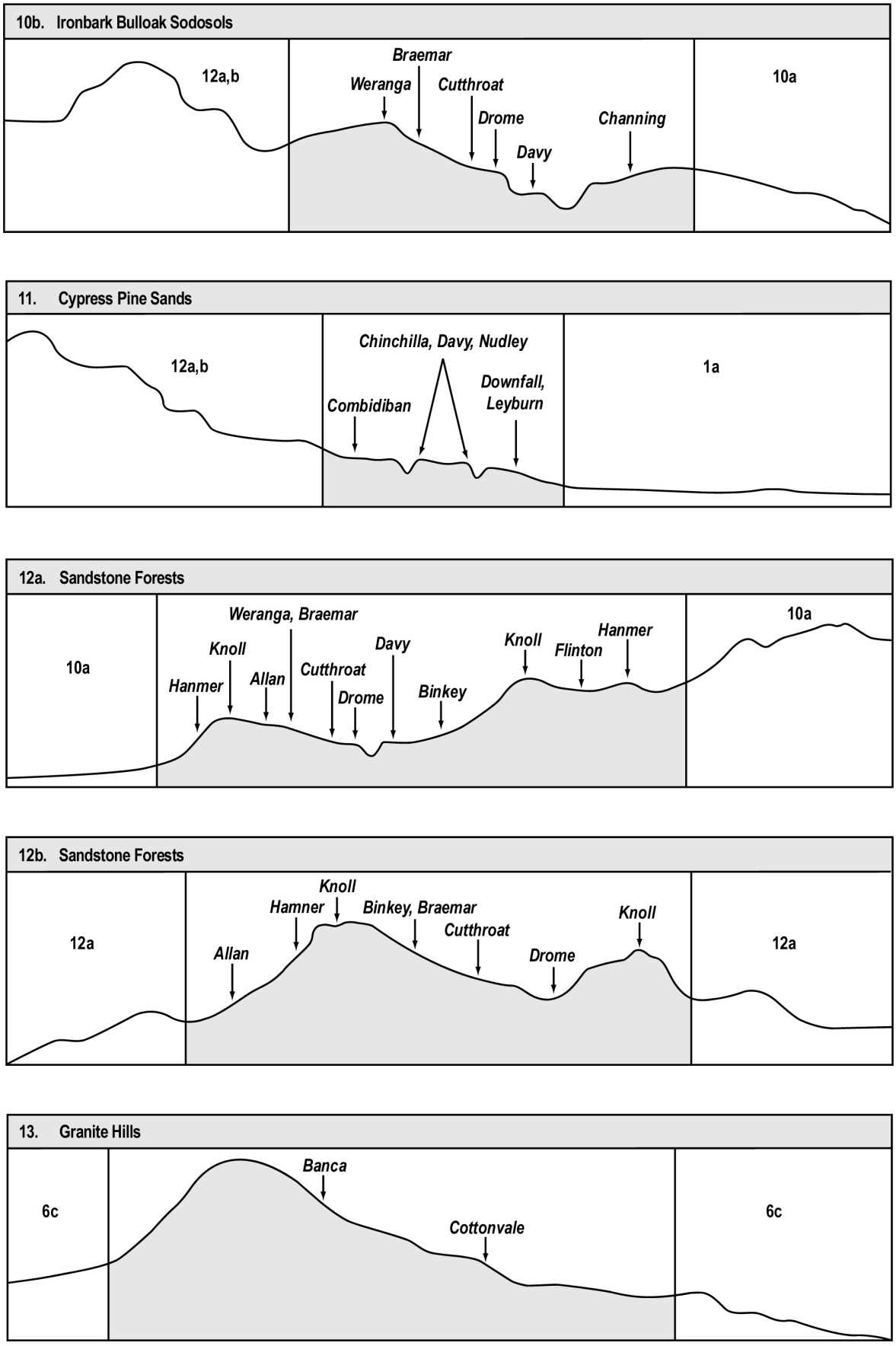

Figure 2.3 Generalised relationships between soils (cont'd)

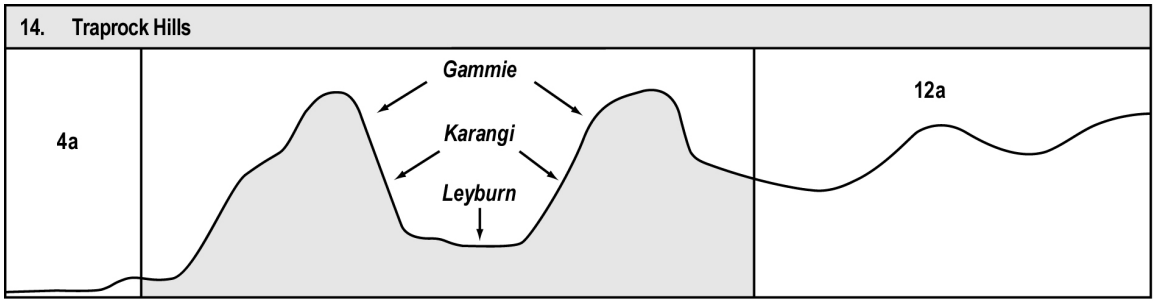

Figure 2.3 Generalised relationships between soils (cont'd)

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Appendix

The Central Darling Downs has experienced an extended history of land resource studies from the property scale to larger catchment or regional scales. A key aim of this manual was to collate the information from previous studies and establish new benchmarks for the description of soils and land resources in the area. Table 2.4 shows correlations between soil names used in this manual and soil names used in earlier studies (listed below). The soil names in bold indicate the origin of the concept used. It was not always possible to correlate soil types. Discussion of soil concept features, and correlations with previous studies follow Table 2.4. Table 2.5 lists soils from other studies that have not been correlated with soils in the Central Darling Downs Land Management Manual.

Previous land resource studies in the Central Darling Downs include:

- Thompson and Beckmann (1959) describing soils and land use in the Toowoomba area;
- Beckmann and Thompson (1960) describing soils and land use in the Kurrawa area;
- Dawson (1972a) describing landscapes and land capability in the Jandowae area;
- Dawson (1972b) describing landscapes and land capability in the Miles–Dalby area
- Vandersee (1975) describing landscapes and land capability in the Eastern Darling Downs area;
- Vandersee and Mullins (1977) describing soils of the Marburg Formation and poplar box Walloons of the eastern Darling Downs;
- Mullins (1978) describing soils of the eastern Darling Downs;
- Mullins (unpub.) describing soils of the brigalow-belah Walloons of the eastern Darling Downs;
- Marshall *et al.* (1988) describing soils and land use of the south-eastern Darling Downs
- Thwaites and Macnish (1991) describing soils and land use of Waggamba shire
- Maher (1996a) describing soils and land use of the Stanthorpe-Rosenthal region
- Maher (1996b) describing soils and land use of Murilla, Tara and Chinchilla shires
- Biggs (1999) describing the soils of three areas within the eastern Darling Downs

Table 2.4 Matching soil names with previous studies

Soil name	Thompson & Beckmann (1959)	Beckmann & Thompson (1960)	Dawson (1972a)	Dawson (1972b)	Vandersee (1975)	Vandersee & Mullins (1977)	Mullins (1978)[1]	Marshall *et al.* (1988)	Thwaites and Macnish (1991)	Maher (1996a)	Maher (1996b)
Aberdeen	*Type 7 clay*						*Type 7 clay*				
Acland			*Range*				***Acland***				
Allan					***Allan***, *Ridge*	*Ridge*	*AMU 4, AMU 12*			*Allan*	
Anchorfield		***Anchorfield***	*Bushgrove*		*Anchorfield*						
Arden									***Arden***		*Arden*
Aubigny	***Aubigny***										
Banca					*Herries*					***Banca***	
Beauaraba	***Beauaraba***, *Majuba*				*Beauaraba*		*Beauaraba*	*Beauaraba*			
Belahville			***Belahville***								
Binkey				***Binkey***	*Goombungee*	*Ellangowan*	*AMU 9*	*Ellangowan*	*Uranilla, Bendidee*	*Dalveen*	*Binkey*
Braemar			*Rifle, Golf*	***Braemar***			*AMU 2, AMU 7*			*Maxland*	*Braemar*
Burton	***Burton***				*Burton*		*Burton*	*Burton*			
Calingunee									***Calingunee***		
Cecilvale	***Cecilvale***	*Cecilvale*	*Thorn*	*Cecilvale*	*Cecilvale*			*Cecilvale*	***Cecilvale***		*Cecilvale*
Channing			*Logyard*		*Hendon*						***Channing***
Charlton	***Charlton***		*Mahen*		*Charlton*		*Charlton*	*Charlton*			
Chinchilla			***Chinchilla***						*Wai Wai*		*Chinchilla*
Clayburn			***Clayburn***								
Combidiban		*Group 5*									***Combidiban***
Condamine		***Condamine***	*Condamine*	*Lagoon, Macalister*	*Condamine*				*Kalanga*	*Pratten*	*Condamine*
Cottonvale					*Turner*					***Cottonvale***	
Craigmore	***Craigmore***, *Murlaggan*				*Craigmore*		*Craigmore*	*Craigmore*			
Cutthroat				***Cutthroat***		*Springburn*		*Springburn*		*Bonnie Doon*	*Cutthroat*
Davy			*Boyne*	***Davy***			*AMU 11*		*Wondoogle*		*Davy*
Diamondy			***Diamondy***		*Sugarloaf*						
Downfall			***Downfall***, *Sawmill, Warrego*		*Killarney*						
Drayton	***Drayton***, *Kynoch*				*Drayton, Kynock*						

[1] this column includes soils from Mullins (unpub.).

Table 2.4 cont'd

Soil name	Thompson & Beckmann (1959)	Beckmann & Thompson (1960)	Dawson (1972a)	Dawson (1972b)	Vandersee (1975)	Vandersee & Mullins (1977)	Mullins (1978)[1]	Marshall *et al.* (1988)	Thwaites and Macnish (1991)	Maher (1996a)	Maher (1996b)
Drome				*Highmount*	***Drome***	*Drome*	*AMU 10*	*Drome*		*Drome*	*Highmount*
East			***East***		*Norbell*	*Boundary*		*Boundary*			
Edgefield					*Malling,* ***Edgefield***		*Malling*				
Elphinstone	*Yarranlea*		*Cresley, Juan*			***Elphinstone***	*Elphinstone*	*Elphinstone*			
Flinton			*Spotted,*				*AMU 14*		***Flinton***		*Flinton*
Formartin											
Gammie					*Silverwood*					***Gammie***	
Gate					***Gate***		*Grays Gate*				
Hanmer										***Hanmer***	
Haslemere		***Haselmere*** *Dalmeny*	*Valley*	*Arubial, Wilkie, Bogandilla*	*Haselmere, Canal, Dalmeny*				*Yambocully*		*Arubial, Bogandilla*
Irving	***Irving***		*Mahen (deep)*		*Irving*		*Irving*	*Irving*			
Karangi					*Thane*					***Karangi***	
Kenmuir	***Kenmuir***				*Kenmuir*		*Kenmuir*	*Kenmuir*			
Knoll		*Group 1*	*Baking*	*Rugby*	*Bony,* ***Knoll,*** *Wattle Glen*	*Rock*	*AMU 6*	*Rock*	*Karbullah*		*Minnabilla*
Kupunn				***Kupunn***							*Kupunn*
Kurumbul									*Kurumbul*		
Langlands			***Langlands***	*Binda*							
Leyburn					***Leyburn***					*Leyburn*	
Mallard	***Mallard***						*Mallard*	*Mallard*			
Middle ridge	***Middle Ridge***				*Middle Ridge*						
Millmerran					***Cunningham***						
Moola			*School*		*Moola*		***Moola***				*Moola*
Moruya									***Moruya***		
Murra cul cul									***Murra Cul Cul***		
Mywybilla	*Glenmore*	***Mywybilla***	*Mywybilla, Tully*	*Mywybilla*	*Mywybilla*			***Mywybilla***			
Nudley											***Nudley***
Nungil											
Oakey					***Oakey***						
Purrawanda	***Purrawunda***		*Palmer, Mahen (shallow)*		*Purrawanda*		*Purrawanda*	*Purrawanda*			
Ruthven	*Ruthven*				*Ruthven*						
Southbrook	***Southbrook***				*Southbrook*		*Southbrook*	*Southbrook*			
Talgai					*Junabee*		***Talgai***	*Talgai*			
Tandawanna									***Tandawanna***		*Tandawanna*

Soil name	Thompson & Beckmann (1959)	Beckmann & Thompson (1960)	Dawson (1972a)	Dawson (1972b)	Vandersee (1975)	Vandersee & Mullins (1977)	Mullins (1978)[1]	Marshall *et al.* (1988)	Thwaites and Macnish (1991)	Maher (1996a)	Maher (1996b)
Tara			*Logie*	***Tara***							*Tara*
Toolburra			*Glen*			***Toolburra***	*Toolburra*	*Toolburra*			
Toowoomba	***Toowoomba***				*Toowoomba*						
Waco	***Waco***, *Waverly*	*Waco, Norillee, Waverly, Bongeen*	*Downs*	*Waco*	*Waco, Norillee*		*Waco*	*Waco*			
Walker		*Oakview*			***Walker***, *Douglas, Emlyn*						
Weranga				***Weranga***	*Hendon, Morgan*	*Oak*	*AMU 1, AMU 5*	*Oak*			*Weranga*
Wynhari									***Wynhari***		
Yargullen	***Yargullen***, *Edgecombe, Dalkeith*	*Yargullen, Edgecombe, Dalkeith*			*Yargullen*		*Calc. subsoil AMU*	*Calc. subsoil*			

Notes concerning soil correlation on the Central Darling Downs

Correlation between soils is often difficult, and may require some assumptions. For the Central Darling Downs, the number of assumptions made varied from soil to soil, and related to the amount of information and data available from previous studies. Many reports, particularly the land system reports of Vandersee (1975) and Dawson (1972a, 1972b), only provide very brief descriptions of soils, with limited chemical data. It is generally more difficult to correlate these soils than the fully described soils from recent publications.

The correlation of soils in Table 2.4 provides an interpretation that matches the scale of information required for the Central Darling Downs Land Management Manual i.e. 1:250 000. It does not imply necessarily that the descriptions of correlated soils are no longer relevant. In many cases, soils that have been correlated within this Manual would remain separate at more detailed scales of mapping. Further work, including morphological and analytical characterisation, is necessary to improve upon this current interpretation.

Comments concerning correlations of particular soils are as follows:

Beauaraba — the soil *Croxley* (Thompson and Beckmann, 1959) is generally less rocky, and slightly browner than *Beauaraba*.

Braemar — Dawson (1972b) described the concept of this soil as texture contrast with a neutral to alkaline soil reaction trend. Maher (1996b), used a similar morphological concept, but with an acid to neutral reaction trend. The *Maxland* concept from Maher (1996a) and the *Golf* concept from Dawson (1972a) fit well to the *Braemar* concept. *Rifle*, described by Dawson (1972a), typically has a neutral B horizon and fits the *Braemar* description of Maher (1996b).

Binkey — the concept of *Binkey* as used in this manual is much broader than that normally accepted for a soil. It was first described by Dawson (1972b), as a texture contrast soil with an acid to neutral subsoil. Maher (1996b) used a similar concept. From a morphological perspective, *Uranilla* and *Bendidee* (Thwaites and Macnish, 1991) are similar to *Binkey* although *Bendidee* usually lacks the subsoil gravel of *Binkey* and *Uranilla*, and the surface horizons of *Uranilla* are thinner than those of *Binkey*. The subsoils of *Uranilla* and *Bendidee* are alkaline and saline, whereas that of *Binkey* is typically acid to neutral, and non-saline. *Ellangowan* (Vandersee and Mullins, 1977) is similar to *Bendidee*, but less saline. *Goombungee* appears to correlate as an eastern equivalent of *Binkey*, although the original descriptions by Vandersee (1975) are vague. They indicate both acidic and neutral soil reaction trends. Maher (1996a) described *Dalveen* as texture contrast, non-sodic, non-saline and neutral soil reaction trend.

Coalbah — is similar in concept to *Belahville* (Dawson, 1972a), except that *Belahville* is limited to levees and terraces associated with dissecting creeks on the brigalow plains.

Craigmore — the concept of *Craigmore* (Thompson and Beckmann, 1959) has been broadened slightly to include *Murlaggan*. The latter is a soil similar in genesis and morphology to *Craigmore*, but is deposited over a sandstone substrate rather than basalt.

Cutthroat — was first described by Dawson (1972b) as a texture contrast soil with a neutral to alkaline subsoil. The *Bonnie Doon* concept from Maher (1996a) possesses many similar characteristics to *Cutthroat*, but the subsoil is acid. *Springburn,* as described by Vandersee and Mullins (1977) fits well to the neutral to alkaline subsoil concept of *Cutthroat*.

Davy — this alluvial sand was first described Dawson (1972b). *Woondoogle* (Thwaites and Macnish, 19991) is similar to, but slightly darker than, *Davy*.

East — the original concept of *East* was provided by Dawson (1972a) as a gradational to texture contrast red soil on Walloon Coal Measures. The description of *Norbell* given by Vandersee (1975) is a good correlation with *East*. *Boundary* (Vandersee and Mullins, 1977) appears to be a similar concept to *Norbell* and *East*, but with poplar box rather than softwood scrub.

Elphinstone — the concept of *Yarranlea* (Thompson and Beckmann, 1959) appears to fit reasonably well, although the description offered by Vandersee (1975) does not.

Flinton — the vegetation on this soil changes from east to west. In the eastern edge of its extent, it is commonly vegetated with red ash, spotted gum and narrow-leaved ironbark. Further west, it is more commonly vegetated with poplar box, kurrajong, sandalwood, wilga, cypress and silver leaf ironbark.

Haslemere — although *Haslemere* and *Dalmeny* have been correlated for the scale of this publication, they remain separate soils when mapped at finer scales. *Dalmeny* typically possesses a more columnar structure than *Haslemere*. The equivalent soils in Maher (1996b) are *Arubial* and *Bogandilla* respectively. *Yambocully*, from Thwaites and Macnish (1991) is similar to *Haslemere*.

Knoll — many authors have described very shallow soils on sandstones. They largely fall into three categories - sandy soils with no rock e.g. *Bony* (Vandersee, 1975), sandy soils with large amounts of stone or rock e.g *Knoll* (Vandersee, 1975); and loamy soils with large amounts of stone or rock e.g. *Minnabilla* (Maher, 1996b). Within this manual, all have been grouped together under the concept of *Knoll*.

Leyburn — the concept of *Leyburn* (Vandersee, 1977) primarily describes texture contrast alluvial soils on the Condamine plains in the vicinity of Leyburn. The soils have been derived from mixed traprock/sandstone alluvia. *Downfall* is a similar soil, but typically occurs on alluvial plains without traprock influence.

Mywybilla — was originally described by Beckmann and Thompson (1960). The concept has been broadened to include the soil *Glenmore* (Beckmann and Thompson 1960), which is also a moderate to coarse structured colluvial/alluvial clay formed from mixed basalt/walloon sandstone material.

Langlands, Kupunn and Tara — the primary distinction amongst the clay soils of the brigalow clay plains are the size of gilgai, and surface condition. *Langlands*, described by Dawson (1972a) has moderately deep to deep gilgai and weakly self-mulching surface. *Kupunn,* described by Dawson (1972b), has shallow to moderately deep gilgai and is strongly-self mulching. *Logie* described by Dawson (1972a) is a similar concept to *Tara*.

Toolburra — was originally described by Vandersee and Mullins (1977) as a texture contrast red soil occuring on Walloon sandstones. The concept of *Glen*, described by Dawson (1972a), is similar to *Toolburra*, but using the description provided by

Dawson it is impossible to determine if the soil is massive or structured. If massive, it may correlate more effectively to *Flinton*, if structured then *Toolburra*. Field investigations in the Jandowae East land system show minor occurrence of a well-structured red clay *vis Toolburra*. *Cadarga* (Maher, 1996b) is a similar concept to *Toolburra* but is not as well structured.

Waco — Thompson and Beckmann (1959) provide good discussion regarding the concept of this soil and its relationship to other soils. *Norillee* was described by those authors as possessing the upper morphology of a *Waco*, but poorer fertility. *Norillee* intergrades with *Mywybilla* at the inteface between the recent and older floodplains. *Bongeen* was described by Beckmann (1952) in a detailed study, but was later amalgamated with *Norillee* by Beckmann and Thompson (1960). *Waverly* was described by Thompson and Beckmann (1959) as occurring in minor drainage depressions within the plains of *Waco*. It is slightly darker in colour and coarser in surface structure than *Waco*.

Yargullen — described by Thompson and Beckmann (1959) was referred to by Mullins (1978) and Marshall *et.al*. (1988) as *Calcareous subsoil agricultural management unit*. It typically occurs in footslopes and drainage depressions in the basaltic uplands. *Edgecombe* (Thompson and Beckmann, 1959) has been included with *Yargullen* in this manual. It is found on the floodplain, near Evanslea. *Yargullen* contains a soft calcareous subsoil of secondary origin, whereas *Edgecombe* is underlain at a similar depth by a hard calcareous material of unknown origin. *Canning* described by Mullins (1978), is a similar soil to *Yargullen*, but occurs on crests and upper slopes, and has ironstone gravel throughout the profile. *Canning* occurs in the scrub Walloon agricultural management unit south of the Central Darling Downs.

Weranga — the concepts of *Oak* (Vandersee and Mullins, 1977) and *Weranga* (Maher 1996b), are similar, although the photograph of *Oak* in Vandersee and Mullins (1977) doesn't show the columnar structure described.

Notes concerning unmatched soils

Some soils from the above publications were not included in this correlation exercise (Table 2.5). This may have been because their extent was very restricted, they occurred mostly outside of the Central Darling Downs, or there was insufficient information to produce a correlation. Discussion concerning these soils follows.

Knapdale, Irongate, Ramsay, Ellinthorp, Blackhill — there has been some confusion historically in the differentiation of soils which intergrade between basaltic areas and Walloon sandstones. It is apparent that many of the soil names used are all relating to a small number of concepts.

Knapdale, *Ramsay* and *Irongate* were all first described by Thompson and Beckmann (1959). *Knapdale* and *Ramsay* were both described as soils formed in basaltic colluvium, whereas *Irongate* is a mixed alluvial soil, with a slope phase. The description of *Knapdale* however, closely matches the concept of *Elphinstone*. Field investigations at Knapdale road near Mt Maria confirm the close correlation to the soil concepts for *Knapdale* and *Elphinstone* with surface microrelief of linear gilgai and rounded quartz, petrified wood and ironstone pebbles.

Table 2.5 Unmatched soils

Author (s)	Soils
Thompson and Beckmann (1959)	*Gabbinbar, Rangeville, Type 12, Harristown, Type 10, Type 11, Nelson, Type 15, Type 13, Type 14, Miscellaneous Group 6, Type 17, Type 4, Type 19, Type 8, Type 16, Wilton, Type 9, Miscellaneous Group 1, Type 18, Type 3, Ramsay, Type 2, Type 5, Gowrie, Type 1, Miscellaneous Group 3, Miscellaneous Group 4, Knapdale, Irongate, Miscellaneous Group 7, Group A, Group B, Group C, Group D to H*
Beckmann and Thompson (1960)	*Miscellaneous Group 7, Type 20 gilgai complex,* all soils described for the area west of the Condamine River.
Dawson (1972a)	*Hill, Warrego, Canaga*
Dawson (1972b)	*Tiereyboo, Stockyard, Nine, Miles, Marra, Dunrobin, MacDonald, Straun, Pelham, Auburn, Byrne, Dulacca, Coalbah, Rogers*
Vandersee (1975)	*Seven, Stock, Ironpot, Wash, Middle, Gabbinbar, Nelson, Gladfield, Jingarry, Dandaroo, Gully, Goomaren, Talgai, Yarranlea*
Vandersee and Mullins (1977)	*Victoria*
Mullins (1978)	Type 8, AMUs 3, 6, 8, 13, *Jingarry, Canning, Freestone*
Mullins (unpub.)	*Blackhill*
Marshall *et al.* (1988)	*Acacia, Victoria, Ellinthorp, Jingarry, Freestone, Canning*
Thwaites and Macnish (1991)	*Keetah, Bengalla, Weengallon, Jindabyne, Tarewinnabar, Yelarbon, Wondalli, Mt Carmel, Marella, Undabri, Westmar, Oonavale*
Maher (1996a)	*Rodger, Pozieres, Greymare, Lyra, Dalveen, Mardon, Glentanna*
Maher (1996b)	*Ulimoroa, Weengallon, Boonenne, Dulacca, Gordonbrook, Inglestone, Coalbah, Rogers, Cadarga, Nudley*

The *Irongate* slope phase may in fact be the concept of *Ellinthorp* (Marshall *et al*., 1988) i.e. mixed basalt/walloon sandstone colluvia. *Blackhill* was described by Mullins (unpub.) and appears to correlate with *Moola* or a mixed colluvial soil like *Ellinthorp*, with minor basaltic colluvial influence in the surface. Figure 2.4 illustrates the relationship between the key soils and surrounding basaltic and alluvial soils.

Victoria — The original concept for *Victoria* as described by Vandersee and Mullins (1977) is a minor soil in the Marburg sandstone landscape and is very similar to the gradational earth concept of *East* in the Walloon sandstone LRAs. Due to the variation with in the strata of the sandstones (i.e both coarse and fine grained sediments) these soils can be found in either the Walloon or Marburg LRAs.

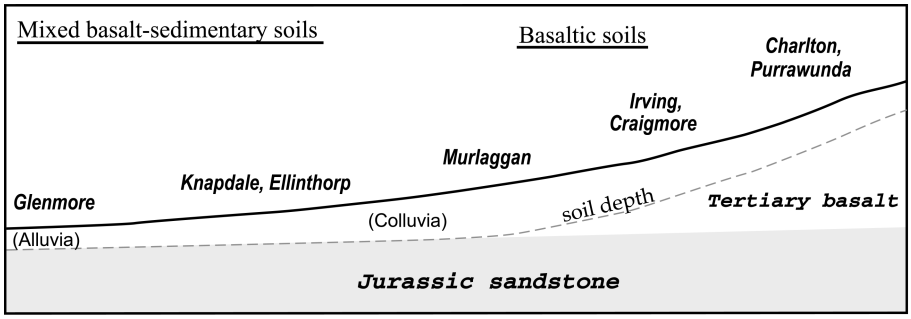


Figure 2.4 Soil relationships at the interface between basalt and sandstones

SOIL SUMMARY SHEETS

ACLAND

Associated soil in LRA: 6a

Brief description

Acland is a moderately deep to very deep (100-160 cm), "soft" red or brown, non-cracking, clay on upper slopes of belah and wilga on fine-grained sandstone (includes the soil *Range*).

Landform and distribution

- mid to upper slopes of undulating rises and low hills, mostly around Acland.
- slopes 4%-10%.

Vegetation

- belah and wilga, open layered forest.
- poplar box, brigalow and scrub species may occur.
- mostly cleared.
- Regional Ecosystem 11.9.5

Example soil profile description

Depth (cm)	Description
0-10	dark brown; fine sandy light clay; moderate polyhedral; clear to:
10-40	dark greyish brown; fine sandy medium clay; strong sub-angular blocky; few large quartz pebbles; clear to:
40-55	strong brown; fine sandy medium clay; strong sub-angular blocky; coarse soft calcareous segregations; clear to:
55-90	yellowish red; fine sandy medium clay; strong angular blocky; few coarse soft calcareous segregations; clear to:
90-130	light yellowish brown; light medium clay; moderate sub-angular blocky; clear to:
130-160	pale yellow; weathered sandstone.

Australian Soil Classification: Sodic, Eutrophic, Red Dermosol

General soil features

- moderately deep to deep, uniform, medium to heavy clays with shallow gilgai.
- *surface soil:* dark brown, or brown or brownish black light clay. Weak fine crumb or sub-angular blocky structure. Ironstone gravel may be present. Slightly acid (pH 6.0-6.5).
- *subsoil:* brown to reddish brown, medium to heavy clay. Strong coarse blocky structure. Ironstone gravel and nodules may be present. Neutral to moderately alkaline (pH 7.0-8.5). Strongly sodic and highly saline at depth.
- PAWC is moderate (100-150 mm).
- responds to N, P, S and occasionally Zn.
- decomposing sandstone may be encountered at 60 cm or shallower on upper slopes. Floating sandstone may occur throughout the profile.

Land use limitations

- surface structure deteriorates with continuous cultivation, results in a "powdery" surface subject to wind and water erosion.
- PAWC is limited by depth to sodic/saline subsoils.
- generally not suited to intensive livestock industries (eg. feedlots, piggeries) due to potential for contamination of ground-water.
- sandstone "floaters" may cause problems in cultivation.

Land use suitability

This is a very versatile soil and is well suited to most pastures, fodder and grain cropping. It is an excellent improved pasture soil.

- suitable for most field crops except cotton due to low PAWC.
- suitable field crops include: wheat, barley, chickpeas, mungbeans, sorghum, millets and panicums.
- suitable forage crops include: oats, forage sorghum, lucerne and lab lab.
- suitable for spray and trickle irrigation.
- summer crops will suffer from heat stress due to moderate PAWC.
- suitable for grazing native and most sown pastures.
- suitable sown pastures include: Katambora Rhodes grass, green and Gatton panic, purple pigeon grass, creeping bluegrass lucerne and medics.
- key native pasture species include: Queensland and pitted bluegrass, native clovers and trefoil.
- although highly suitable for grazing native and most sown pastures, very little is used for these purposes due to the economics of cropping.
- well suited to most horticultural crops provided adequate water is available.
- suitable for native flower production.

Best management practices

Cropping

- adopt conservation farming practices to maximise ground cover, infiltration and reduce water erosion, and assist in maintaining good surface soil structure.
- structural soil conservation measures will be required with cultivation on slopes.
- desirable to include pastures in rotation to maintain fertility and soil structure.
- easy workability with no germination problems.
- moisture levels will be the determining factor on crop choice. Responds well to small falls of rain in dry years and can produce better crops than the heavier clay soils.

Vegetation

- conservation status of remnant vegetation is *endangered*.
- planning guidelines and restrictions apply to clearing and land development.

Grazing

- strategic grazing and spelling of pastures is required to maximise pasture vigour.
- ley pasture rotations with cultivation is regarded by many farmers as being the best use for these soils.
- overgrazing is indicated by the invasion of inferior and unpalatable species such as cottonbush, couch and white speargrass.
- couch and urochloa can be useful sources of feed. Rhodes and buffel grass regarded as second grade feeds to the panic species.
- sulphur required to maintain sown species.
- adjust stocking rates to suit seasonal conditions.
- stocking rates *native pasture* 1 AE/2.0 ha. *sown pasture* 1 AE/1.0 ha.

ABERDEEN

Associated soil in LRAs: 7a and 7b

Brief description

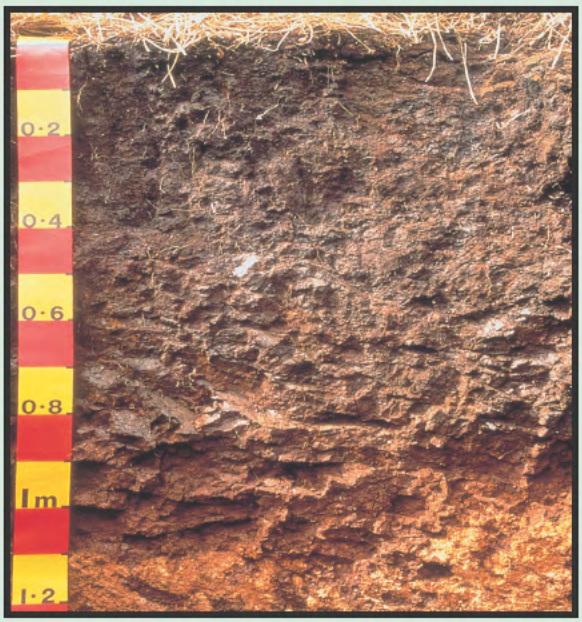
Aberdeen is a moderately deep to deep (50-130 cm), reddish brown coarsely structured clay which has a restricted occurrence in the Basalt Uplands. Commonly associated with *Craigmore* and *Burton*.

Landform and distribution

- occurs in marginal areas between dark cracking clays and red soils.
- gently undulating plains to rises.

Vegetation

- mountain coolibah and rough-barked apple, open woodland.
- mostly cleared.
- Regional Ecosystem 11.8.5



Example soil profile description

Depth (cm)	Description
0-5	dark; light medium clay; strong coarse granular structure; self-mulching; abrupt to:
5-100	dark; medium clay; strong coarse angular blocky to lenticular structure; clear to:
100-120	red-brown; light medium clay; strong coarse lenticular structure; few soft calcareous concretions; clear to:
120-130	red-brown; light clay; strong coarse lenticular structure; few calcareous concretions; gradual to weathered basalt.

Australian Soil Classification: Haplic, Self-mulching, Brown or Red Vertosol

General soil features

- deep, neutral to alkaline, cracking clays with coarse, self-mulching surfaces.
- *surface soil:* dark clay. Moderate to coarse, granular, self-mulching surface. Neutral to moderately alkaline (pH 7.0-8.0).
- *subsoil:* dark or brown, grading to reddish brown, light medium to heavy clay. Moderately to strongly alkaline (pH 8.0-9.0). Some carbonate nodules.
- PAWC is very high (>250 mm).
- responds to N, and Zn and possibly S.

ABERDEEN

Land use limitations

- susceptible to severe sheet, rill and gully erosion.
- often only occurs as narrow strips so use of the soil depends upon the adjacent soil types.

Land use suitability

This soil is ideally suited to continual grain and cotton cropping with good nutrition and rotations for weed and disease control.

- suitable for most dryland and irrigated field and forage crops. Small-seeded crops are difficult to establish (eg. millets, canary).
- suitable field crops include: wheat, barley, chickpeas, sorghum, cotton, sunflowers and mungbeans.
- suitable forage crops include: oats, forage sorghum, lucerne and lab lab.
- suitable for furrow, spray and trickle irrigation.
- suitable for grazing native and most sown pastures.
- suitable sown pasture species include: Katambora Rhodes grass, purple pigeon grass, bisset creeping blue grass, bambatsi panic, lucerne and medics.
- key native pastures species include: Queensland forest and pitted bluegrass; and native trefoils.

Best management practices

Cropping

- presswheels or rollers are useful in aiding crop establishment.
- adopt conservation farming practises to maximise ground cover, infiltration and reduce water erosion.

Vegetation

- conservation status of remnant vegetation is currently *not of concern*.
- planning guidelines and restrictions apply to clearing and land development.

Grazing

- strategic grazing and spelling of pastures is required to maximise pasture vigour.
- adjust stocking rates to suit seasonal conditions.
- stocking rates *native pasture* 1 AE/2.5-3.0 ha.
  sown pasture 1 AE/1.0 ha.

ANCHORFIELD

Common soil in LRA: 1a

Associated soil in LRA: 2a

Brief description

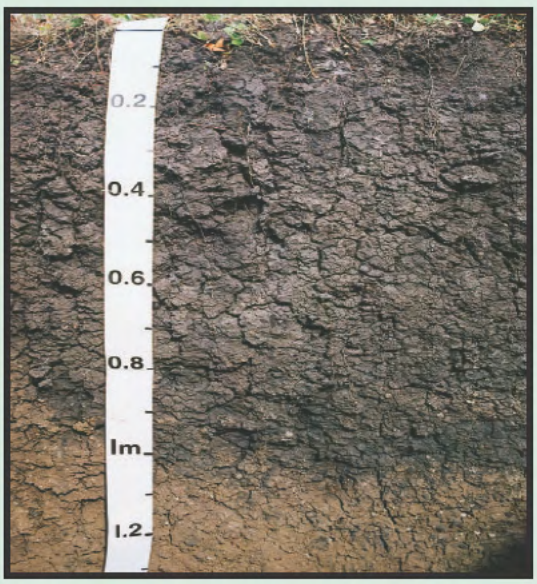
Anchorfield is a highly valued, deep to very deep (80-180 cm), fine, self-mulching, very dark brown cracking clay on alluvial plains of mixed origin (includes the soils *Bongeen* and *Bushgrove*).

Landform and distribution

- gently sloping to flat alluvial plains associated with the Condamine River and tributaries.

Vegetation

- Queensland bluegrass of open grassland.
- occasional poplar box and Queensland blue gum.
- mostly cleared.
- Regional Ecosystems 11.3.4, 11.3.21



Example soil profile description

Depth (cm)	Description
0-5	black; heavy clay; few medium angular chert pebbles; moderate granular structure; clear to:
5-30	black; heavy clay; moderate sub-angular blocky structure; gradual to:
30-80	brownish black; heavy clay; strong lenticular structure; few medium calcareous concretions; diffuse to:
80-110	brownish black heavy clay; moderate coarse lenticular structure; few coarse soft calcareous segregations, few medium calcareous concretions; gradual to:
110+	yellowish brown; heavy clay; moderate lenticular; common calcareous segregations.

Australian Soil Classification: Endohypersodic, Self-mulching, Black Vertosol

General soil features

- deep, neutral to alkaline, cracking clays with fine self-mulching surface.
- *surface soil:* dark grey and very dark brown cracking clays; become browner with depth. Weakly self-mulching, fine to medium granular structure. Mildly to moderately alkaline (pH 7.5-8.0).
- *subsoil:* greyish brown and yellowish brown heavy clay, medium to coarse blocky structure, becoming lenticular with depth. Strongly alkaline (pH 8.5-9.0). Sodic and moderately to highly saline in the deep subsoil.
- contains soft and nodular carbonate.
- PAWC is very high (>250 mm).
- responds to N, Zn, P and S.

ANCHORFIELD

Land use limitations

- occasional erosive flooding.

Land use suitability

This soil is ideally suited to continual field cropping with good nutrition and rotations for weed and disease control.

- like a *Waco*, this soil is easily worked and one of the most highly valued of the alluvial clays.
- suitable for most dryland and irrigated field crops.
- suitable field crops include: wheat, barley, chickpeas, sorghum, cotton, sunflowers, mungbeans and millets.
- suitable forage crops include: oats, forage sorghum, lucerne and lab lab.
- suitable for furrow, spray and trickle irrigation.
- suitable for grazing native and most sown pastures.
- suitable sown pasture species include: purple pigeon grass, bisset creeping bluegrass, bambatsi panic, lucerne and me
- key native pastures species include: Queensland, forest and pitted bluegrass and native trefoils.
- although highly suitable for grazing native and most sown pastures, very little is used for these purposes due to the hig from cropping.

Best management practices

Cropping

- strip cropping is recommended for erosion control and spreading of erosive overland runoff flows and/or flood water
- adopt conservation farming practices to maximise ground cover and infiltration to reduce water erosion, and assist in m good surface soil structure.
- ley pastures should be used in areas where high volumes of run-on water occurs. These should be managed to preve silt build-up which will concentrate and divert flows.
- gypsum is recommended as the most cost effective method of applying sulphur.

Vegetation

- conservation status of remnant vegetation is *endangered*.
- planning guidelines and restrictions apply to clearing and land development.

Grazing

- strategic grazing and spelling of pastures is required to maximise pasture vigour.
- sulphur required to maintain sown species.
- adjust stocking rates to suit seasonal conditions.
- stocking rates *native pasture* 1 AE/2.5-3.0 ha.
  sown pasture 1 AE/1.0 ha.

ALLAN

Associated soil in LRAs: 12a and 12b

Brief description

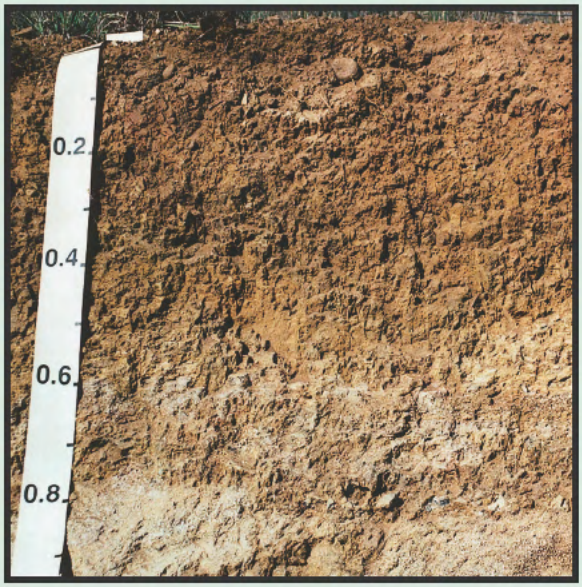
Allan is a moderately deep to deep (60-110 cm) texture contrast soil with a dark brown loam to sandy clay loam surface and brown to yellowish brown subsoils on coarse-grained sandstones (includes the soil *Ridge*).

Landform and distribution

- gently undulating sandstone plains and rises, often lateritised.
- slopes 0-6%.

Vegetation

- open forest of narrow-leaved ironbark, spotted gum, bull oak, cypress pine, rusty gum and poplar box.
- occasional brown box with yellow box and fuzzy box south of Millmerran.
- mostly cleared.
- Regional Ecosystems 11.3.23, 11.5.1, 11.7.4, 11.10.1



Example soil profile description

Depth (cm)	Description
0-15	brown; sandy clay loam; few quartz pebbles; moderate blocky structure; clear to:
15-65	brown; fine sandy medium clay; strong coarse blocky structure; few manganese/iron veins; clear to:
65-110	yellow; coarse sandy clay loam; massive; few manganese/iron veins; common soft carbonate segregations.

Australian Soil Classification: Calcic, Subnatric, Brown Sodosol

General soil features

- texture contrast soil with a sharp change between the surface and the subsoil.
- *surface soil:* dark brown to dark yellowish brown, hardsetting loamy sand to sandy clay loam. May be underlain by a bleached A2 horizon to 10-40 cm. Slightly acid to neutral (pH 6.0-7.0).
- *subsoil:* brown to yellowish brown strong blocky clay containing manganese and/or carbonate concretions. Moderately to strongly alkaline (pH 8.0-9.0). Generally strongly sodic and highly saline.
- generally, the thicker the bleached horizon, the less well drained and aerated are these soils. Because the subsurface is subject to periodic water logging, roots are likely to suffer damage due to wetness and a depleted oxygen supply.
- PAWC is low (50-100 mm).
- very low fertility - responds to N, P, K, Cu, Zn and Mo.

Land use limitations

- very low fertility, low PAWC, shallow rooting depth and hardsetting surfaces.
- shallow surface soil and impermeable subsoil make these soils extremely susceptible to erosion and waterlogging.
- sodic and impermeable subsoils susceptible to gully and tunnel erosion if exposed.
- root penetration into the subsoil is negligible due to the high bulk density of this horizon.
- regrowth, particularly of cypress pine and bull oak when cleared.
- siting of dams needs careful consideration.
- many farmers have found that developing this type of country provides very little return on initial investment.

Land use suitability

This soil is best left undeveloped and in its native state. Suitable for grazing native pastures only.

- suitable for low intensity grazing of native pastures in the summer for breeders and store cattle.
- very low suitability for the establishment of sown pastures on those soils with deeper A horizons such as Katambora Rhodes grass and Wynn cassia.
- good bee country and native conservation.
- narrow-leaved ironbark may be useful farm timber.

Best management practices

Cropping

- not recommended.

Vegetation

- conservation status of remnant vegetation is *threatened* (11.3.23)
- conservation status of remnant vegetation is currently *not of concern* (11.5.1, 11.7.4, 11.10.1)
- planning guidelines and restrictions apply to clearing and land development.

Grazing

- recommend strategic thinning of timber using chemical methods. Mechanical methods will only result in severe regrowth problems.
- superphosphate will improve pasture production.
- it is possible to decrease runoff and increase the amount of water for plant growth by ripping shallow pasture furrows along the contour. Erosion is likely if the subsoil is exposed.
- siting of dams and stock watering points requires careful consideration.
- adjust stocking rates to suit seasonal conditions.
- stocking rates *native pasture* 1AE/10.0-15.0 ha.

ARDEN

Associated soil in LRA: 6d

Brief description

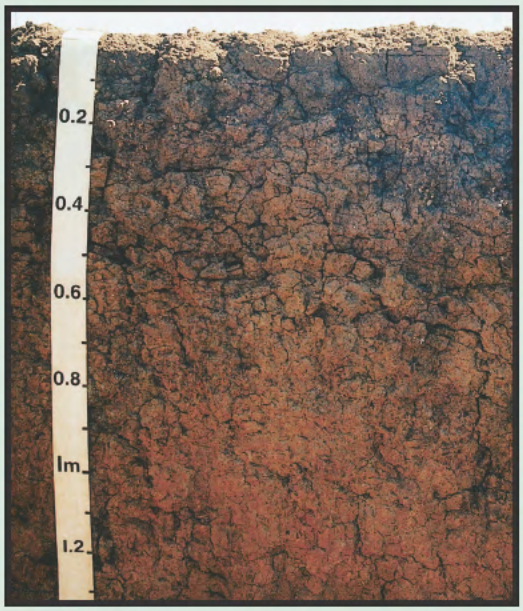
Arden is a moderately deep to deep (90-150 cm), self-mulching, cracking, red to red-brown clay with shallow gilgai on fine-grained sandstone and the brigalow clay sheet.

Landform and distribution

- lower slopes of gently undulating plains and rises - slopes between 1 and 3%.
- gently undulating plains or rises; scarp footslopes and broad valleys of the lowlands associated with the jump-ups, south-west of Cecil Plains and Millmerran.
- occurs west of the Kumbarilla Ridge.

Vegetation

- tall open forest of brigalow with belah and occasional poplar box.
- understorey of wilga and false sandalwood.
- mostly cleared.
- Regional Ecosystem 11.9.5



Example soil profile description

Depth (cm)	Description
0-2	brown; medium clay; loose, self-mulching surface; abrupt to:
2-60	reddish brown; medium heavy clay; well structured; a little gravel; a few soft carbonate segregations; clear to:
60-100	brown; heavy clay; faint mottles; moderately structured; a few carbonate segregations; gradual to:
100-150	reddish-brown; medium heavy clay; weakly structured.

Australian Soil Classification: Epihypersodic-Endoacidic, Self-mulching, Red Vertosol

General soil features

- very deep, moderately to strongly self-mulching, cracking red-brown clays.
- *surface soil:* brown to reddish brown, well structured, medium clays. Neutral to moderately alkaline (pH 7.0-8.0).
- *subsoil:* reddish brown to brown, moderately structured, heavy clays. Moderately to strongly alkaline (pH 8.0-9.0) at 40-60 cm grading to strongly acid (pH 4.5-5.5) in the deep subsoil. Lower subsoils are strongly sodic with high to extreme salinity levels but low dispersibility.
- gilgai may be present - where developed some variation in profile characteristics and surface condition may be seen, e.g. gilgai mounds are red and depressions are grey; the depth to carbonate layers and acid subsoils is usually greater in depressions than on mounds.
- PAWC is moderate (100-150 mm).
- responds to N, P and Zn.

Land use limitations

- moderately fertile soils with moderate PAWC.
- levelling gilgai may expose subsoils that are saline, sodic, or acidic with a subsequent reduction in crop growth.
- PAWC is limited by strongly sodic and saline subsoils.
- rooting depth may vary depending on depth to sodic/saline layer.
- surface structure deteriorates with continuous cultivation.
- can form a weak surface crust after rain.
- susceptible to water erosion.

Land use suitability

This soil is ideally suited to continual grain and cotton cropping with good nutrition and rotations for weed and disease control.

- suitable for most grain and forage crops.
- suitable field crops include: wheat, barley, chickpeas, sorghum, cotton and millets.
- suitable forage crops include: oats, forage sorghum, cowpea and lab lab.
- suitable for grazing native and most sown pastures.
- suitable sown pastures include: Katambora Rhodes grass, purple pigeon grass, buffel, bisset creeping bluegrass, bambatsi panic, lucerne and medics.
- key native pastures species include: Queensland bluegrass, fairy grass, curly windmill and creeping windmill grass, brigalow grass and creeping saltbush.
- although highly suitable for grazing native and most sown pastures, very little is used for these purposes due to the high returns from cropping.

Best management practices

Cropping

- adopt conservation farming practices to maximise ground cover and infiltration, reduce water erosion and assist in maintaining good surface soil structure.
- structural soil conservation measures will be required with cultivation on slopes.
- desirable to include pastures in rotation to maintain fertility and soil structure.
- subsoil salts will be leached downward with cereal cropping, increasing the effective rooting depth and hence the plant available water capacity.

Vegetation

- conservation status of remnant vegetation is *endangered.*
- planning guidelines and restrictions apply to clearing and land development.

Grazing

- grows prolific bluegrass after clearing and makes a highly productive native pasture.
- strategic grazing and spelling of pastures is required to maximise pasture vigour.
- overgrazing is indicated by the invasion of inferior and unpalatable species such as cottonbush, couch and white speargrass.
- fertilising with phosphorus and sulphur will improve pasture production.
- adjust stocking rates to suit seasonal conditions.
- stocking rates *native pasture* 1 AE/4.0-8.0 ha.
  sown pastures 1 AE/3.0-6.0 ha.

AUBIGNY

Associated soil in LRAs: 7a and 7b

Brief description

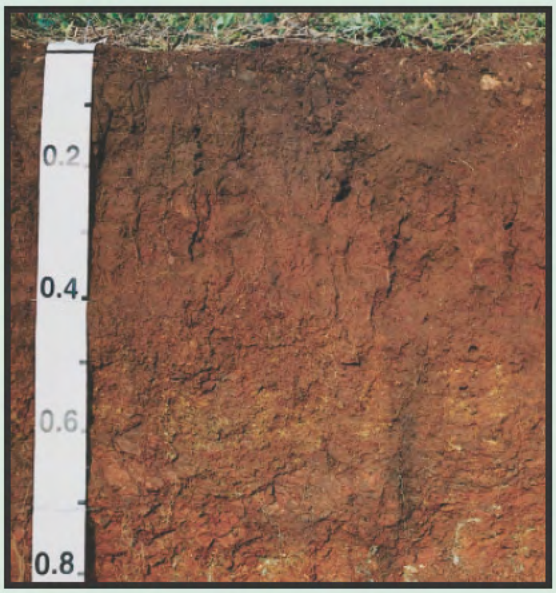
Aubigny is a shallow to moderately deep (30-70 cm), non-cracking, reddish brown clay with an alkaline subsoil on basalt.

Landform and distribution

- gently undulating low basalt hills and rises.

Vegetation

- Moreton bay ash, occasional poplar box and woodland.
- occasional mountain coolibah.
- mostly cleared.
- Regional Ecosystem 11.8.5



Example soil profile description

Depth (cm)	Description
0-5	dark or brown; light clay to light medium clay; strong granular; clear/abrupt to:
5-35	brown or red-brown; light medium clay to medium clay; strong angular blocky or lenticular, clear to:
35-45	red or red-brown; medium clay; strong angular blocky parting to strong lenticular; clear to:
45-55	red; medium clay; few angular basalt; strong angular blocky; common soft carbonate; clear/gradual to:
55+	basalt.

Australian Soil Classification: Haplic, Eutrophic, Red Ferrosol

General soil features

- moderately deep, neutral to alkaline, clays with fine, soft surfaces.
- *surface soil:* dark or brown, light to light medium clay. Fine granular structure. Neutral (pH 6.5-7.5).
- *subsoil:* brown or red-brown, grading to red, light medium to medium clay. Strong angular blocky structure. Mildly to strongly alkaline (pH 7.5-8.5). Carbonate in the weathered basalt.
- PAWC is low (50 mm).
- responds to N, Zn and S.

AUBIGNY

Land use limitations

- Phosphorus fixing.
- surface structure deteriorates with continuous cultivation, resulting in a 'powdery' surface subject to wind and water erosion.
- susceptible to moderate sheet and rill erosion depending on slope.
- susceptible to wind erosion if surface soil is unprotected.
- generally not suited to intensive livestock industries (e.g. feedlots, piggeries) due to for potential contamination of ground-water through the underlying permeable fractured basalt.
- PAWC can be low due to shallow soil depth.
- stoniness in stony surface phase.

Land use suitability

This soil is suited to grain and forage cropping, and is well suited to grazing native and sown pastures.

- suitable for most field crops except lucerne due to low PAWC.
- suitable field crops include: wheat, barley, oats, chickpeas, linseed, peanuts, mungbeans and navy beans, millets and panicums.
- suitable forage crops include: oats, forage sorghum, cowpea and lab lab. Not suitable for lucerne due to low PAWC.
- summer crops may be subject to heat stress due to low PAWC.
- suitable for spray and trickle irrigation.
- suitable for grazing native and sown pastures.
- suitable sown pasture species include: Katambora Rhodes grass, creeping bluegrass, green and Gatton panic and medics.
- key native pasture species include: Queensland and pitted bluegrass and trefoil.
- well suited to most horticultural crops provided adequate water is available.
- suitable for native flower production.
- the soil is often quarried for garden loam, and the basalt and gravel quarried for roads.
- non-cracking soil and underlying rock provide good foundations for buildings and structures.

Best management practices

Cropping

- adopt conservation farming practices to maximise ground cover, infiltration and reduce water and wind erosion.
- opportunity cropping practices are recommended to maximise production, ground cover and minimise erosion.
- structural soil conservation measures will be required with cultivation on slopes.
- desirable to include pastures in rotation to maintain fertility and soil structure.
- responds well to small falls of rain and can produce better crops than the heavier clay soils in dry years.

Vegetation

- conservation status of remnant vegetation is currently *not of concern.*
- planning guidelines and restrictions apply to clearing and land development.

Grazing

- strategic grazing and spelling of pastures is required to maximise pasture vigour.
- overgrazing is indicated by the invasion of inferior and unpalatable species such as chinese burr and white speargrass.
- fertilising with phosphorus and sulphur will improve sown pasture production.
- adjust stocking rates to suit seasonal conditions.
- stocking rates *native pasture* 1 AE/3.0-3.5 ha. *sown pasture* 1 AE/2.0 ha.

BANCA

Common soil in LRA: 13a

Brief description

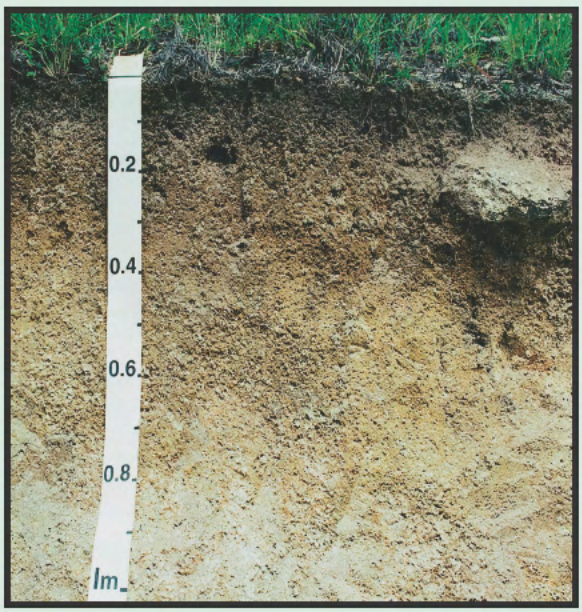
Banca is a shallow to moderately deep (30-90 cm) very dark grey to brown, gritty, structureless sand amongst rock outcrops on granite hills. It is underlain either by coloured subsoils or a natural impermeable hardpan (includes the soil *Herries*).

Landform and distribution

- only Pine Hill - an undulating to rolling granite hill and associated ridges in the Bringalily area south of Millmerran.
- granite tors and rock outcrops are common.

Vegetation

- New England blackbutt shrubby open forest to woodland with tumble-down gum, Youman's stringybark, Caley's ironbark and broad-leaved stringybark.
- partly cleared.
- Regional Ecosystem 13.12.2



Example soil profile description

Depth (cm)	Description
0-15	brown; loamy coarse sand; loose surface; gradual to:
15-40	brown; clayey coarse sand; massive; gravelly quartz common; gradual to:
40-80	brown; clayey coarse sand; gravelly quartz common; clear to:
80-120	yellow; coarse sand; massive; natural hardpan.

Australian Soil Classification: Basic, Silpanic, Orthic Tenosol

General soil features

- shallow to moderately deep sands which are highly permeable and well drained.
- *surface soil:* very dark grey to brown loamy coarse sands with a loose surface. Slightly acid (pH 6.0-6.5).
- *subsoil:* brown clayey coarse to sandy clay loam, massive with quartz gravel. Slightly acid (pH 6.0-6.5).
- a natural impermeable hardpan that is yellowish, coarse sandy and massive may occur in the subsoil.
- surface condition is loose to firm.
- PAWC is very low (<50 mm).
- responds to N, P, Cu, K and Zn.

BANCA

Land use limitations

- very low fertility, very low PAWC, and shallow rooting depth.
- erosion risk due to steep slopes.
- excessive rockiness prevents cultivation.
- excessively drained.
- waterlogging due to hardpans or rock.
- effective rooting depth is limited to depth to hardpan or rock, usually 25-50cm.
- generally not suited to intensive livestock industries (e.g. feedlots, piggeries) due to potential for contamination of ground-water.

Land use suitability

This soil is best left undeveloped and in its native state - suitable for grazing native pastures only. Small areas may be suitable for horticultural crops and sown pastures.

- small areas on gentle slopes with reasonable soil depth are suitable for sown pastures and irrigated and dryland horticultural crops.
- suitable sown pasture species include: white clover, sub-clover, fescue, ryegrass and serradella on the deeper sands.
- key native pasture species include: wallaby grass, summer grass and barbed-wire grass.
- suitable horticultural crops include: tree crops (apples, pears, stone fruit), vines and vegetable crops.
- good bee and nature conservation country if not cleared.
- stringybark and blackbutt may be useful farm timber.

Best management practices

Cropping

- on slopes greater than 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.
- erosion control layouts will be necessary on slopes to prevent erosion and ensure good drainage.
- use mounds in tree and vine crops to increase soil depth, drainage, PAWC and nutrients.
- use graded raised beds with erosion control layout for vegetable crops.
- use micro-sprinklers for water use efficiency for irrigated horticulture crops.
- rock picking may be necessary.

Vegetation

- conservation status of remnant vegetation is currently *not of concern*.
- planning guidelines and restrictions apply to clearing and land development.

Grazing

- restrict grazing so that 30% basal cover is retained to prevent erosion.
- overgrazing is indicated by the invasion of inferior and unpalatable species such as bracken fern, blady grass, sedges, african lovegrass and pinrush.
- strategic grazing and spelling is required to maintain pasture vigour.
- adjust stocking rates to suit seasonal conditions.
- stocking rates *native pasture* 1 AE/8.0-10.0 ha.
  sown pasture 1 AE/3.0-5.0 ha.

BEAUARABA

Common soil in LRA: 7c

Associated soil in LRAs: 7a and 7b

Brief description

Beauaraba is a very shallow (10-30 cm), very dark, cracking, clay overlying basalt (includes the soil *Majuba*).

Landform and distribution

- upper slopes on low basalt hills and crests of ridges which occur extensively in the north and east of the region.

Vegetation

- mountain coolibah and narrow-leaved ironbark woodland.
- may have a softwood scrub understorey.
- partly cleared.
- Regional Ecosystems 11.8.3/11.8.5/ 11.8.8

Example soil profile description

Depth (cm)	Description
0-5	dark; light to medium clay, few angular basalt; strong granular or sub-angular blocky; abrupt/clear to:
5-15	dark; light medium to medium heavy clay; sub-angular to angular basalt; strong angular blocky; abrupt/clear to:
15-20	dark; light medium to medium heavy clay; sub-angular to angular basalt; strong angular blocky; slickensides; clear to:
20-35	dark; medium to medium heavy clay; sub-angular to angular basalt; moderate to strong angular blocky; clear to:
35+	basalt.

Australian Soil Classification: Haplic, Eutrophic, Black Dermosol

General soil features

- shallow cracking clays.
- *surface soil:* black, very dark brown or very dark grey, medium clay. Moderate medium to strong, coarse granular structure. Occasional gravels. Neutral (pH 6.5-7.5).
- *subsoil:* black, very dark brown or very dark grey, heavy clay. Moderate medium to coarse blocky structure. Gravels increase with depth to hard weathered basalt with clay pockets. Mildly to strongly alkaline (pH 7.5-8.5).
- PAWC is very low (<50 mm).
- responds to N, S and occasionally P and K.
- shallow *Purrawanda* and *Charlton* soils (<45 cm) may occur in association with this soil.

BEAUARABA

Land use limitations

- stoniness.
- moderately susceptible to sheet and rill erosion.
- PAWC is very low due to shallow soil depth.
- generally not suited to intensive livestock industries (e.g. feedlots, piggeries) due to potential for contamination of ground-water supplies through the underlying fractured basalt.

Land use suitability

These soils are best suited to grazing of pastures. Limited suitability for forage and field crops.

- limited suitability for field crops - barley, millets and panicums.
- suitable for winter forage crops such as oats.
- forage crops may suffer from stress due to low PAWC.
- suitable sown pastures include: Katambora Rhodes grass, purple pigeon grass, medics, lucerne, creeping bluegrass and premier digitara.
- ideal for rural residential development.

Best management practices

Cropping

- not recommended for continuous grain or forage cropping.
- moisture levels will be the determining factor on crop choice. Responds well to small falls of rain in dry years and can produce better crops than the heavier clay soils.
- desirable to include pastures in rotations to maintain fertility and soil structure.
- adopt conservation farming practices to maximise groundcover and infiltration, reduce water erosion, and assist in maintaining good surface soil structure.

Vegetation

- conservation status of remnant vegetation is currently *of concern* (11.8.3/11.8.8).
- conservation status of remnant vegetation is currently *not of concern* (11.8.5).
- planning guidelines and restrictions apply to clearing and land development.

Grazing

- overgrazing is indicated by the invasion of inferior and unpalatable species such as wiregrass.
- strategic grazing and spelling of pastures is required to maximise pasture vigour.
- shallow surface disturbance is required with discs (to roll over the stones) during autumn when establishing or rejuvenating sown pastures.
- sulphur will be required to maintain sown species.
- adjust stocking rates to suit seasonal conditions.
- stocking rates *native pasture* 1 AE/4.0 ha.
  sown pasture 1 AE/2.0 ha (with some supplementary feed during winter).

BELAHVILLE

Associated soil in LRA: 5a

Brief description

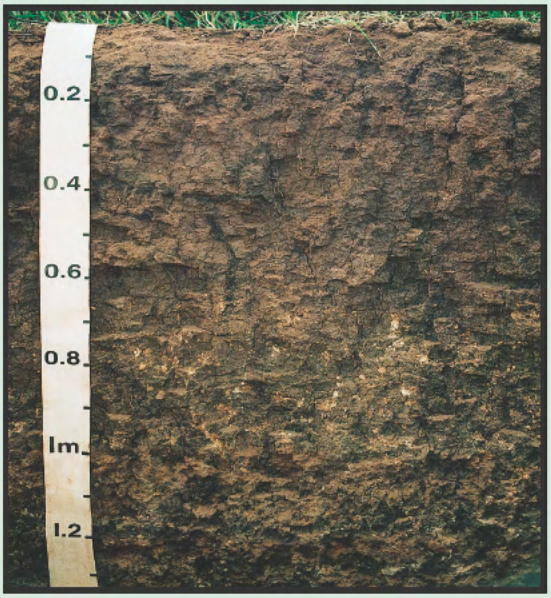
Belahville is a texture contrast soil with a hardsetting surface over brown or greyish brown clay subsoils on mixed sandstone and basalt alluvia on the brigalow claysheet (includes the soils *Coalbah* and *Oonavale*).

Landform and distribution

- small areas on levees and terraces of marginal and dissecting creeks within the brigalow plains.

Vegetation

- brigalow, poplar box, belah, sandalwood forest with lime bush and yarran.
- mostly cleared.
- Regional Ecosystem 11.4.10



Example soil profile description

Depth (cm)	Description
0-20	dark brown; sandy clay loam to clay loam; massive, hardsetting; clear to:
20-30	light brown; sandy clay loam to clay loam; conspicuously bleached; strong coarse blocky structure; sharp to:
30-80	brownish yellow; medium heavy clay; strong coarse blocky structure; few coarse soft calcareous segregations; clear to:
80-120	light yellowish brown; medium clay; strong coarse blocky to lenticular structure; some carbonate nodules; gradual to:
120-130	brown; coarse sandy medium clay; strong coarse angular blocky to lenticular sturcture; few fine manganiferous nodules.

Australian Soil Classification: Haplic, Eutrophic, Red Chromosol

General soil features

- texture contrast soil with a sharp change between the surface soil and the subsoil.
- *surface soil:* hardsetting, brown or very dark grey, sandy loam to sandy clay loam, occasionally clay loam. Partial or sporadic bleach frequently occurs. Neutral (pH 7.0).
- *subsoil:* brown, red-brown or brownish grey clays. Coarse blocky structure. Strongly alkaline (pH 9.0). May be sodic and moderately saline at depth.
- PAWC is low (50-100 mm).
- responds to N, P and Cu.

BELAHVILLE

Land use limitations

- moderately fertile soils with low PAWC and hardsetting surfaces.
- surface structure deteriorates with continuous cultivation.
- prone to forming a hard surface crust after heavy rain. This crust is extremely hard to penetrate with tined implements
  until the soil is wetted.
- abrasive on tines and other ground tools if soil worked dry.
- susceptible to wind erosion if worked fine when dry.
- rooting depth may vary depending on depth to sodic/saline layer.

Land use suitability

This soil is suited to grazing native and sown pastures along with winter grain crops and short term forage crops while developing and renovating land.

- suitable for winter grain and short term forage crops.
- suitable grain crops include: wheat , barley, millets, mungbeans.
- suitable for spray and trickle irrigation.
- suitable forage crops include: oats, forage sorghum, cowpeas and lab lab.
- summer forage crops will suffer from heat stress due to low PAWC.
- suitable for grazing native and most sown pastures.
- suitable sown pasture species include: Katambora Rhodes grass, creeping bluegrass, purple pigeon grass, buffel grass, green panic, digit grass and medics.
- key native species include: Queensland forest and pitted bluegrass
- responds well to small falls of rain.

Best management practices

Cropping

- adopt conservation farming practices to maximise ground cover and infiltration, reduce water and wind erosion.
- soil management is important as these soils do not crack and naturally repair themselves.
- pasture phase strongly recommended to maintain surface structure.
- crusting makes these soils relatively unsuitable to straight zero-till fallows.
- the use of presswheels or rollers are useful in aiding crop establishment. Difficult to establish millets and panicums.
- strip cropping is recommended for erosion control and spreading of overland flow and/or flood water.

Vegetation

- conservation status of remnant vegetation is *endangered.*
- planning guidelines and restrictions apply to clearing and land development.

Grazing

- grazing native and sown pastures is regarded by many farmers as being the best use for these soils.
- recommend species suited for crusting soils and low to moderate fertility levels.
- can withstand reasonable grazing pressure - overgrazing is indicated by the invasion of inferior and unpalatable species such as black cotton bush and white speargrass.
- strategic grazing and spelling of pastures is required to maximise pasture vigour.
- fertilising with phosphorus and sulphur will improve pasture production.
- adjust stocking rates to suit seasonal conditions.
- stocking rates *native pasture* 1 AE/3.0-3.5 ha.
  sown pasture 1 AE/2.5 ha.

BINKEY

Associated soil in LRAs: 12a and 12b

Brief description

Binkey is a moderately deep to deep (90-140 cm) gravelly, texture contrast soil, with a bleached sandy surface and mottled clay subsoil on sandstone (includes the soils *Goombungee, Ellangowan, Bendidee and Dalveen*).

Landform and distribution

- gently undulating plains and dissected low hills west of the Condamine River between Leyburn and Cecil Plains.
- mid to upper slopes (2-3%).

Vegetation

- some cypress pine and rusty gum; grassy woodland to open forest of narrow-leaved ironbark and bull oak.
- partly cleared.
- Regional Ecosystem 11.5.1

Example soil profile description

Depth (cm)	Description
0-20	brown; sandy loam; hardsetting, massive; clear to:
20-40	light grey; sandy loam; conspicuous bleach; much ironstone and quartz gravel; sharp to:
40-90	light yellowish brown; with red mottles; medium heavy clay; weak structure; much gravel; gradual to:
90-140	pale brown; medium heavy clay; weak prismatic to massive; some gravel.

Australian Soil Classification: Bleached, Natric, Brown Kurosol

General soil features

- texture contrast soil with a sharp change between the surface soil and the subsoil.
- this soil is a gravelly version of *Braemar*.
- abundant stone and gravel occur throughout the profile; rock outcrops occur.
- *surface soil:* brown to reddish brown, loamy sand to loam, but is usually sandy loam. Commonly 15-30 cm thick. A bleach occurs at the surface soil/subsoil boundary, indicating periodic waterlogging and sodic subsoils. Very strongly acid (pH 4.9).
- *subsoil:* grey or yellow clays with mottles. Depth to parent material varies, but is usually less than 80 cm. Strongly to very strongly acid (pH5.3-4.9). Generally strongly sodic and highly saline.
- PAWC is very low (<50 mm).
- very low fertility - responds to N, P, K, Cu, Zn & Mo.

Land use limitations

- very low fertility, very low PAWC, and shallow rooting depth.
- shallow surface soil and impermeable subsoil make these soils extremely susceptible to erosion and waterlogging.
- sodic and relatively impermeable subsoils are susceptible to gully and tunnel erosion if exposed.
- root penetration into the subsoil is negligible due to the high bulk density of this horizon.
- regrowth, particularly of cypress pine and bull oak when cleared.
- gravel and stone throughout the profile.
- siting of dams needs careful consideration.
- many farmers have found that developing this type of country will generally provide very little return on the initial investment.

Land use suitability

This soil is best left undeveloped and in its native state. Suitable for grazing native pastures only.

- suitable for low intensity grazing of native pastures in summer for breeders and store cattle.
- very low suitability for the establishment of sown pastures on deeper A horizons using Katambora Rhodes grass and Wynn cassia.
- good bee and nature conservation country.
- narrow-leaved ironbark may be useful farm timber.

Best management practices

Cropping

- not recommended.

Vegetation

- conservation status of remnant vegetation is currently *not of concern.*
- planning guidelines and restrictions apply to clearing and land development.

Grazing

- strategic grazing and spelling of pastures is required to maximise pasture vigour.
- development of this soil may cause severe wind and water erosion through exposing the dispersible, sodic subsoil.
- recommend strategic thinning of timber using chemical methods. Mechanical methods will only result in severe regrowth problems.
- siting of dams and stock watering points requires careful consideration.
- superphosphate will improve pasture production.
- it is possible to decrease runoff and increase the amount of water for plant growth by ripping shallow pasture furrows along the contour.
- adjust stocking rates to suit seasonal conditions.
- stocking rates *native pasture* 1 AE/10.0-20.0 ha.

BRAEMAR

Common soil in LRAs: 10a, 12a

Associated soil in LRAs: 9b, 10b and 12b

Brief description

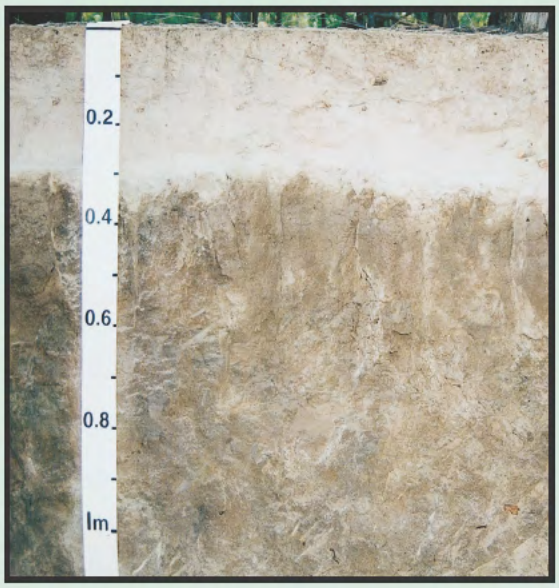
Braemer is a texture contrast soil with a bleached sandy surface over mottled, yellow or grey clay subsoils on coarse-grained sandstones (includes the soils *Golf, Rifle, Uranilla* and *Maxland*).

Landform and distribution

- gently undulating sandstone plains, mainly occurs west of the Condamine River on the Kumbarilla Ridge.

Vegetation

- open forest of bull oak or bull oak and cypress pine with associated narrow-leaved ironbark, rusty gum and occasionally paperbark tea tree.
- partly cleared.
- Regional Ecosystem 11.5.1



Example soil profile description

Depth (cm)	Description
0-5	very dark greyish brown; sandy loam; massive; clear to:
5-15	greyish brown; sandy loam; massive; clear to:
15-30	light grey; sandy loam; conspicuously bleached; massive; sharp to:
30-60	brown; sandy clay; strong coarse columnar structure; clear to:
60-120	mottled; greyish brown; sandy clay; massive.

Australian Soil Classification: Eutrophic, Hypernatric, Brown Sodosol

General soil features

- texture contrast soil with a sharp change between the surface soil and the subsoil.
- *surface soil*: greyish brown, dark brown or brown, hardsetting loamy sand to sandy loam, commonly 20-40 cm thick. A bleached subsurface layer varying in thickness occurs above the subsoil. Slightly acid to neutral (pH 6.0-7.0).
- *subsoil*: greyish brown, yellowish brown or brown clay, which is mottled and impermeable. Strongly alkaline (pH 8.5). Generally strongly sodic and highly saline.
- PAWC is very low (<50 mm).
- responds to N, P, K, Cu, Zn and Mo.

BRAEMAR

Land use limitations

- very low fertility, low PAWC, shallow rooting depth and hardsetting surfaces.
- shallow surface soil and impermeable subsoil make these soils extremely susceptible to erosion and waterlogging.
- sodic and relatively impermeable subsoils susceptible to gully and tunnel erosion if exposed.
- root penetration into the subsoil is negligible due to the high bulk density of this horizon.
- regrowth, particularly of cypress pine and bull oak when cleared.
- siting of dams needs careful consideration.
- many farmers have found that developing this type of country provides very little return on initial investment.

Land use suitability

This soil is best left in its native state, and used for timber production and nature conservation. Suitable for grazing native pastures only.

- key native pasture species include: black speargrass, wiregrass.
- good bee and native conservation country.
- narrow-leaved ironbark and cypress pine may be useful farm and millable timber.

Best management practices

Cropping

- not recommended.

Vegetation

- conservation status of remnant vegetation is currently *not of concern*.
- planning guidelines and restrictions apply to clearing and land development.

Grazing

- strategic grazing and spelling of pastures is required to maximise pasture vigour.
- development of this soil may cause severe loss of soil from wind and water erosion through exposure of the dispersible, sodic subsoil.
- siting of dams and stock watering points requires careful consideration.
- recommend strategic thinning of timber using chemical methods. Mechanical methods will only result in severe regrowth problems.
- adjust stocking rates to suit seasonal conditions.
- stocking rates *native pasture* 1 AE/10-15 ha.

BURTON

Associated soil in LRA: 7a

Brief description

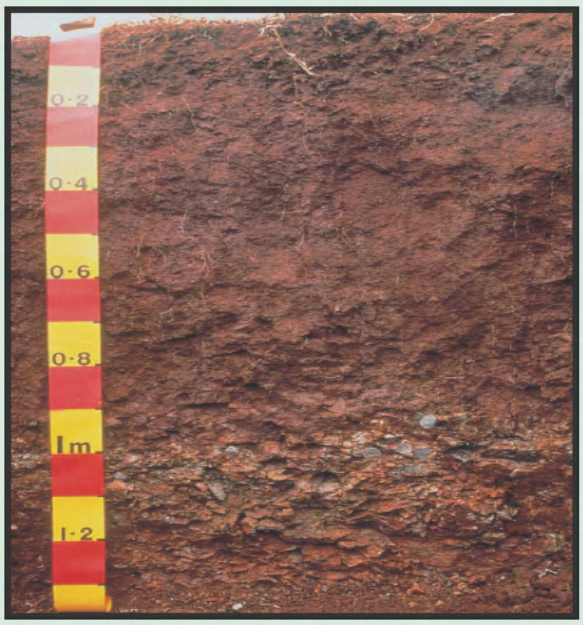
Burton is a moderately deep to deep (75-150 cm) non-cracking red-brown to red clay on strongly weathered basalt or red volcanic material.

Landform and distribution

- occurs on long gentle slopes (<5%) and on broad flat basalt ridges.

Vegetation

- open woodland of mountain coolibah, narrow-leaved ironbark, or rough-barked apple box.
- mostly cleared.
- Regional Ecosystems 11.8.4, 11.8.5



Example soil profile description

Depth (cm)	Description
0-15	dark reddish brown; clay loam to light clay; weak to moderate, fine blocky structure; clear to:
15-90	reddish brown; medium to heavy clay; strong angular blocky structure; few small black manganese concretions; diffuse to:
90-100	reddish brown; medium to heavy clay; strong angular blocky to lenticular structure; gradual to:
120+	strongly weathered basalt or red volcanic material.

Australian Soil Classification: Haplic, Eutrophic, Red Ferrosol

General soil features

- moderately deep, non-cracking, neutral clay soil.
- *surface soil*: dark reddish brown clay loam to light clay. Weak to moderate fine granular to moderate medium granular structure. Slightly acid to neutral (pH 6.5-7.0).
- *subsoil*: red to reddish brown, structured clays.
- Depth to weathered basalt varies from less than 60 cm to greater than 2 m.
- Moderate to strong, blocky structure with a few black manganese concretions. Slightly acid to neutral (pH 6.5-7.5), occasionally moderately alkaline (pH 8.0). Well drained.
- PAWC is moderate (100-150 mm).
- responds to N, P, and occasionally K.

Land use limitations

- often only occurs as small areas so use of the soil depends upon the adjacent soil types.
- surface structure deteriorates with continuous cultivation.
- susceptible to water erosion.
- susceptible to wind erosion if worked fine when dry.
- plough pans will develop if continually worked at the same depth under moist conditions.
- soil management is important as these soils don't crack and naturally repair themselves.
- acidification may be a problem under intense cropping systems.
- generally not suited to intensive livestock industries (eg. feedlots, piggeries) due to potential for contamination of ground-water through the underlying permeable fractured basalt.

Land use suitability

This soil is ideally suited to field cropping, including peanuts and navy beans, but a pasture phase is recommended to restore surface structure.

- suitable for most field crops except cotton due to low PAWC.
- summer crops may be subject to heat stress due to moderate PAWC.
- suitable field crops include: wheat, barley, chickpeas, sorghum, sunflowers, mungbeans, peanuts, navy beans, panicums and millets.
- suitable forage crops include: oats, forage sorghum, lucerne and lab lab.
- suitable for spray and trickle irrigation.
- suitable for horticultural crops where irrigation is available.
- suitable for grazing native and most sown pastures.
- suitable sown pastures include: Katambora Rhodes grass, green and Gatton panic, purple pigeon grass, creeping bluegrass and medics.
- suitable for native flower production.

Best management practices

Cropping

- adopt conservation farming practices to maximise ground cover and infiltration, reduce water and wind erosion and assist in maintaining surface soil structure.
- structural soil conservation measures will be required for cultivation on slopes.
- desirable to include pastures in rotation to maintain fertility and soil structure.
- responds well to small falls of rain in dry years and can produce better crops than the heavier clay soils.

Vegetation

- conservation status of remnant vegetation is currently *not of concern.*
- planning guidelines and restrictions apply to clearing and land development.

Grazing

- overgrazing is indicated by the invasion of inferior and unpalatable species such as foxtail and white speargrass.
- strategic grazing and spelling of pastures is required to maximise pasture vigour and encourage better native species (e.g. bluegrass).
- fertilising with phosphorus and sulphur will improve pasture production.
- native couch and urochloa can be useful sources of feed.
- adjust stocking rates to suit seasonal conditions.
- stocking rates *native pasture* 1 AE/2.5-3.0 ha.
  sown pasture 1 AE/1.0 ha.

CALINGUNEE

Common soil in LRA: 6d

Brief description

Calingunee is a moderately deep to deep (60-150 cm), self-mulching, dark or grey cracking clay with gilgai on fine-grained standstone.

Landform and distribution

- gently undulating plains or rises, scarp footslopes and broad valleys of the lowlands associated with the jump-ups, south-west of Cecil Plains and Millmerran.
- occurs west of the Kumbarilla Ridge.
- melonhole gilgai present.

Vegetation

- tall, open forest of brigalow with belah and occasional poplar box. Understorey of wilga and false sandalwood.
- mostly cleared.
- Regional Ecosystem 11.9.5

Example soil profile description

Depth (cm)	Description
0-5	dark; medium clay; strong medium granular structure; abrupt to:
5-20	dark; heavy clay; strong coarse blocky structure; minor quartz gravel; clear to:
20-60	grey; heavy clay; strong coarse lenticular to blocky structure; minor quartz gravel; some soft carbonate segregations; diffuse to:
60-150	brown; heavy clay; moderate coarse lenticular structure; minor quartz gravel.

Australian Soil Classification: Epihypersodic-Endocidic, Self-mulching, Grey Vertosol

General soil features

- very deep cracking clays with firm or self-mulching surface, and with shallow gilgai (15-30 cm).
- *surface soil:* dark greyish brown or grey clay (weak surface flake after rain). Neutral to mildly alkaline (pH 7.0-7.5).
- *subsoil:* dark grey structured clay, becoming browner with depth. Strongly alkaline (pH 9.0) in the upper subsoils, to strongly acid (pH 5.5-5.0) in the deep subsoil. Strongly sodic and saline at depth.
- PAWC is moderate (100-150 mm).
- responds to N, P and Cu.

CALINGUNEE

Land use limitations

- PAWC is limited by the depth to the sodic and highly saline subsoil.
- workability is difficult because of soil variation and microrelief associated with melonholes.
- levelling will expose strongly sodic and highly saline subsoils which will increase plant growth problems.
- when cultivated, the mounds seal readily and shed water into the depressions which drain extremely slowly.
- regrowth, particularly of limebush, false sandalwood and brigalow.

Land use suitability

This soil is suited to continual grain and cotton cropping with good nutrition and rotations for weed and disease control.

- suitable for most field crops.
- suitable field crops include: wheat, barley, chickpeas, sorghum, cotton, sunflowers, mungbeans, canola, safflower, triticale and millets.
- suitable forage crops include: oats, forage sorghum, cowpea and lab lab.
- suitable for grazing native and most sown pastures.
- suitable sown pastures include: Katambora Rhodes grass, purple pigeon grass, bambatsi panic, creepi ng bluegrass, lucerne and medics.
- key native pastures species include: Queensland bluegrass, curly windmill grass, Warrego grass, fairy grass, weeping panic and slender canegrass.
- although highly suitable for grazing native and most sown pastures, very little is used for this purpose due to the high returns from cropping.

Best management practices

Cropping

- adopt conservation farming practices to maximise ground cover and infiltration, reduce water erosion, and assist in maintaining good surface soil structure.
- presswheels or rollers are useful in aiding crop establishment.
- apply phosphorus with crops and annual forages at planting.
- levelling of melonholes may be required before production of dryland cotton and grain legumes.

Vegetation

- conservation status of remnant vegetation is *endangered.*
- planning guidelines and restrictions apply to clearing and land development.

Grazing

- strategic grazing and spelling of pastures is required to maximise pasture vigour.
- overgrazing is indicated by the invasion of inferior and unpalatable species such as speargrass, dog burr and sedges.
- sulphur required to maintain sown species.
- adjust stocking rates to suit seasonal conditions.
- stocking rates *native pasture* 1 AE/4.0-8.0 ha.
  sown pasture 1 AE/3.0-5.0 ha.

CECILVALE

Common soil in LRA: 2b

Associated soil in LRAs: 1a, 2a and 3a

Brief description

Cecilvale is a deep, crusting, grey cracking clay on alluvial plains of mixed orgin (includes the soil *Thorn*). A brown variant occurs in upland valleys supporting yarran and poplar box. A slightly better surface structured variant supporting belah and occasional poplar box occurs south of Dalby.

Landform and distribution

- elevated plains of mixed alluvium associated with the Condamine River.
- the major occurrences are from Warra to Bowenville and around Brookstead.
- there are minor occurrences in drainage lines and lower areas on flat plains east of Millmerran.

Vegetation

- poplar box grassy woodland with some scattered wilga.
- mostly cleared.
- Regional Ecosystems 11.3.2, 11.3.17

Example soil profile description

Depth (cm)	Description
0-2	dark greyish brown; light clay; moderate granular structure; sharp to:
2-10	dark greyish brown; light medium clay; strong angular blocky; very few ferro-manganiferous nodules; clear to:
10-25	dark greyish brown; medium clay; strong angular blocky; very few soft calcareous segregations and very few ferro-manganiferous nodules; clear to:
25-65	greyish brown; medium heavy clay; strong angular blocky; some hard and soft carbonate and ferro-manganiferous nodules; clear to:
65-120	dark greyish brown; medium heavy clay; moderate sub-angular blocky; soft calcareous segregations and few ferro-manganiferous nodules; gradual to:
120-150	dark greyish brown; medium heavy clay; weak sub-angular blocky.

Australian Soil Classification: Endohypersodic, Crusty, Grey Vertosol

General soil features

- deep, neutral to alkaline, cracking clays with crusting surfaces.
- *surface soil:* grey, light brownish grey or dark grey. Usually sandy clay to light clay, structureless to weakly structured and about 2 cm thick. Neutral to moderately alkaline (pH 6.6-8.2).
- *subsoil:* grey to dark brownish grey clays. Very coarse blocky structure which may become massive with depth. Strongly alkaline (pH 8.5). Sodic to strongly sodic. Moderately saline, becoming strongly saline with depth.
- PAWC is high (200-250 mm).
- responds to N, P and Zn.

Land use limitations

- when cultivated, these soils puddle badly following rain and form a hard surface crust or seal making it difficult to maintain a fine seedbed condition.
- the surface crust results in impaired infiltration, poor germination and seedling emergence of small seeded crops and pastures.
- workability is difficult.
- abrasive on tines and other ground tools if soil is worked dry.
- occasional erosive flooding.
- flooding may limit crop choice and reduce production potential due to waterlogging.
- susceptible to wind and water erosion if surface soil is unprotected. "Sand blasting" of young crops associated with wind erosion.

Land use suitability

This soil is suited to grain, cotton and forage cropping along with grazing pastures but requires good management techniques.

- suitable for most dryland and irrigated field crops. Small seeded crops are difficult to establish (e.g. millets, canary).
- suitable field crops include: wheat, barley, chickpeas, sorghum, cotton, sunflowers and mungbeans.
- suitable forage crops include oats, forage sorghum, lucerne and lab lab.
- suitable for furrow and trickle irrigation.
- many farmers find this soil produces good malting barley.
- suitable for grazing native and selected sown pastures.
- suitable sown pastures include: purple pigeon grass, bisset creeping bluegrass, bambatsi panic, lucerne and medics.
- key native pastures species include: Queensland, forest and pitted bluegrass.
- although suitable for grazing native and most sown pastures, little is used for this purpose due to returns from cropping.

Best management practices

Cropping

- management of the surface soil is the key to successful use of these soils.
- presswheels or rollers are useful in aiding crop establishment.
- adopt conservation farming practices to maximise ground cover and infiltration, reduce water erosion and assist in maintaining good surface soil structure.
- desirable to include pastures in rotation to maintain fertility and soil structure.
- gypsum recommended to improve surface structure and infiltration - farmers commonly apply gypsum once every 5 to 6 years at 2 to 3.5 t/ha or 5.6 t/ha once every 10 years.
- strip cropping is recommended for erosion control and spreading of overland flow and/or flood water.

Vegetation

- conservation status of remnant vegetation is *endangered*.
- planning guidelines and restrictions apply to clearing and land development.

Grazing

- overgrazing will result in the invasion of unpalatable and inferior species such as wire grass, white spear grass and slender bamboo grass.
- strategic grazing and spelling is required to maximise pasture vigour.
- adjust stocking rates to suit seasonal conditions.
- stocking rates *native pasture* 1 AE/2.5-3.0 ha. *sown pasture* 1 AE/1.0-2.0 ha.

CHANNING

Common soil in LRA: 10b

Associated soil in LRA: 10a

Brief description

Channing is a texture contrast soil with a bleached surface over red or brown clay subsoils on coarse-grained sandstone (includes the soil *Logyard* and *Hendon*).

Landform and distribution

- low sandstone hills and undulating sandstone plains. Mainly occurs west of the Condamine River on the Kumbarilla Ridge.

Vegetation

- mainly open forest narrow-leaved ironbark with cypress pine, bull oak, rusty gum and wattles, or
- layered open forest of grey box, rough-barked apple, tumbledown gum and narrow-leaved ironbark with some poplar box, in the south.
- partly cleared.
- Regional Ecosystem 11.5.1

Example soil profile description

Depth (cm)	Description
0-10	brown; sandy loam; hardsetting, massive; abrupt to:
10-15	very pale brown; sandy loam; conspicuously bleached when dry; massive; sharp to:
15-40	reddish brown; medium clay; strong coarse prismatic structure; gradual to:
40-80	brown; medium clay; weak coarse blocky structure to massive; minor gravel; gradual to:
80-120	mottled; brown; medium clay; massive.

Australian Soil Classification: Bleached-Sodic, Magnesic-Natric, Red Kurosol

General soil features

- texture contrast soils with a sharp change between the surface soil and the subsoil.
- *surface soil:* dark reddish brown, greyish brown or dark brown, sandy loam to clay loam. A bleach usually occurs in the lower portion of the surface layer. Strongly acid (pH 5.0-5.5).
- *subsoil:* reddish brown, brown or yellowish brown clays which may be mottled and contain gravel throughout. Shallow profiles are usually acid, deeper profiles are often alkaline. Strongly sodic with high to extreme salinity.
- surface soils set hard when dry.
- PAWC is very low (<50 mm).
- responds to N, P, K, Cu and Zn.

CHANNING

Land use limitations

- very low fertility, very low PAWC, shallow rooting depth and hardsetting surfaces.
- shallow surface soils and impermeable subsoils make these soils extremely susceptible to erosion and waterlogging.
- sodic and relatively impermeable subsoils are susceptible to gully and tunnel erosion if exposed.
- root penetration into the subsoil is negligible due to the high bulk density.
- regrowth, particularly of cypress pine and bull oak when cleared.
- siting of dams needs careful consideration.
- many farmers have found that developing this type of country will provide very little return on initia l investment.

Land use suitability

This soil is best left in its native state, and used for timber production and nature conservation. Suitable for grazing native pastures only.

- key native pasture species include: pitted and forest bluegrass.
- good bee and native conservation country if not cleared.
- narrow-leaved ironbark and cypress pine may be useful farm and millable timber.

Best management practices

Cropping

- not recommended.

Vegetation

- conservation status of remnant vegetation is currently *not of concern*.
- planning guidelines and restrictions apply to clearing and land development.

Grazing

- strategic grazing and spelling of pastures is required to maximise pasture vigour.
- development of this soil may cause loss of soil from severe wind and water erosion leading to exposure of the dispersible, sodic subsoil.
- siting of dams and stock watering points requires careful consideration.
- recommend strategic thinning of timber using chemical methods. Mechanical methods will only result in severe regrowth problems.
- adjust stocking rates to suit seasonal conditions.
- stocking rates *native pasture* 1 AE/10.0-15.0 ha.

CHARLTON

Common soil in LRA: 7a

Associated soil in LRAs: 7b, 7c and 8a

Brief description

Charlton is a moderately deep (50-100 cm), coarse self-mulching, black cracking clay on basalt (includes the soil *Mahen*). Commonly associated with *Beauaraba* and *Craigmore*.

Landform and distribution

- mid to upper slopes on basalt rises and low hills (4-8%); or as extensive areas on broad rounded crests (1-3%) of low basalt hills.

Vegetation

- mountain coolibah and narrow-leaved ironbark open woodland.
- partly cleared.
- Regional Ecosystems 11.8.4, 11.8.5

Example soil profile description

Depth (cm)	Description
0-15	dark; medium to heavy clay; strong coarse granular structure; gradual to:
15-45	black; medium to heavy clay; sub-angular blocky to angular blocky structure; few carbonate nodules; gradual to:
45-70	black; very dark grey, mottled heavy clay; lenticular structure; some carbonate nodules; large amounts of basalt gravel; gradual to:
70+	basalt

Australian Soil Classification: Haplic, Self-mulching, Black Vertosol

General soil features

- *surface soil*: black or very dark grey, medium to heavy clay. Moderate, medium to strong coarse granular structure. Slightly acid to neutral (pH 6.5-7.5).
- *subsoil*: black or very dark grey to dark brown, heavy clay. Strong coarse blocky structure. Occasional gravel and few carbonate nodules. Neutral to very strongly alkaline (pH 7.0-9.0).
- stone-free profile but surface stone may occur.
- PAWC is moderate (100-150 mm).
- responds to N, P, S and possibly Zn.
- coarse granular surface structure distinguishes this soil from *Purrawanda*.
- a shallow phase with 30-50 cm of soil to weathered rock occurs in upper slope positions.

Land use limitations

- susceptible to severe rill and gully erosion.
- the coarse structure of this soil creates problems with tillage, and crop and pasture establishment.
- cracking in contour banks may result in breakages.
- growing some summer crops such as cotton, or lucerne pastures, will be limited by PAWC.

Land use suitability

This soil is suited to continual grain crops with good nutrition and rotations for weed and disease control.

- suitable for most dryland and irrigated grain and forage crops. Small seeded crops are difficult to establish (e.g. millets, canary).
- suitable grain crops include: wheat, barley, chickpeas, sorghum, sunflowers and mungbeans.
- suitable forage crops include: oats, forage sorghum and lab lab.
- suitable for spray and trickle irrigation.
- suitable for grazing native and most sown pastures.
- suitable sown pastures include: Katambora Rhodes grass, purple pigeon grass, bisset creeping bluegrass and medics.
- key native pastures species include: Queensland, forest and pitted bluegrass and native trefoils.
- although highly suitable for grazing native and most sown pastures, very little exists due to the high returns from cropping.
- narrow-leaved ironbark may be a useful source of farm timber.

Best management practices

Cropping

- adopt conservation farming practices to maximise ground cover, infiltration and reduce water erosion, and assist in maintaining good surface soil structure.
- structural soil conservation measures will be required for cultivation on slopes.
- broad-based contour banks or broad-based topside banks which can be cultivated are recommended to prevent cracking problems.
- the use of presswheels or rollers are essential in aiding crop establishment.

Vegetation

- conservation status of remnant vegetation is currently *not of concern.*
- planning guidelines and restrictions apply to clearing and land development.

Grazing

- overgrazing is indicated by the invasion of inferior and unpalatable species such as foxtail and white speargrass.
- strategic grazing and spelling is required to maximise pasture vigour.
- adjust stocking rates to suit seasonal conditions.
- stocking rates *native pasture* 1 AE/2.5-3.0 ha.
  sown pasture 1 AE/1.0 ha.

CHINCHILLA

Associated soil in LRAs: 4a, 10a and 11a

Brief description

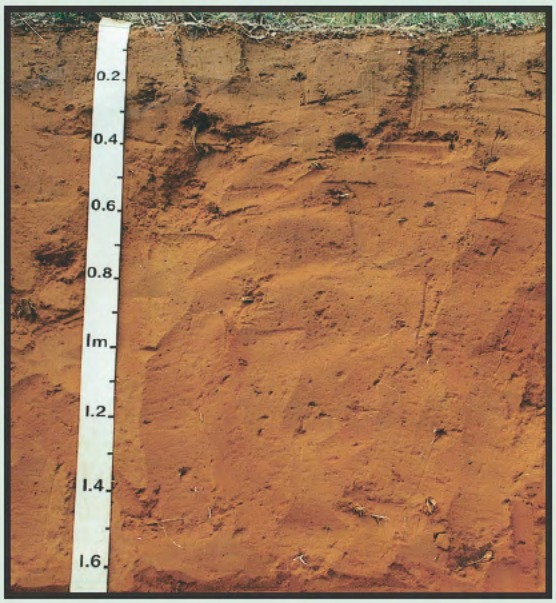
Chinchilla is a moderately deep to very deep (80-160 cm), reddish brown sand on alluvial plains.

Landform and distribution

- terraces, sand ridges and flats of alluvial plains and creek channels draining the weathered sandstone hills.

Vegetation

- forest of rough-barked apple, Moreton Bay ash and sally wattle.
- associated species include poplar box, cypress pine, wilga and false sandalwood.
- partly cleared.
- Regional Ecosystem 11.3.14



Example soil profile description

Depth (cm)	Description
0-30	brown; sandy loam; massive; clear to:
30-80	yellowish red; clayey sand; massive; diffuse to:
80-160	red; loamy sand; massive.

Australian Soil Classification: Basic, Arenic Orthic Teriosal

General soil features

- very deep sands which are highly permeable and very well drained.
- *surface soil:* dark reddish, brown, loose sand to sandy loam. Neutral (pH 7.0).
- *subsoil:* red, loamy sand to light sandy clay loam, massive. Slightly to strongly acid (pH 6.0-5.5).
- PAWC is low (50-100 mm).
- responds to N, P, K, Cu, Zn and Mo.

CHINCHILLA

Land use limitations

- very low fertility and low PAWC.
- susceptible to wind and water erosion if surface soil is unprotected. "Sand-blasting" of young crops associated with wind erosion.
- although this soil has a loose to weakly structured surface under pasture, with cultivation it will often become massive and set hard or surface seal.
- generally not suited to intensive livestock industries (e.g. feedlots, piggeries) due to potential for contamination of ground-water.

Land use suitability

This soil is best suited to grazing native and sown pastures as well as a limited range of grain and forage crops. It is a good horticultural soil.

- suitable for some grain crops and short-season and tap-rooted forage crops.
- suitable grain crops include: barley and millets.
- suitable forage crops include: oats, forage sorghum and lab lab.
- suitable for trickle or spray irrigation.
- suitable for grazing native and sown pastures.
- suitable sown pastures species include: Katambora Rhodes grass, serradella, buffel grass, Wynn cassia, lucerne, panics and premier digit grass.
- key native pasture species include: black speargrass and wire grass.
- suitable for horticultural crops if irrigation water is available - melons, grapes, pumpkins, stonefruit and citrus.

Best management practices

Cropping

- adopt conservation farming practices to maximise ground-cover and reduce wind erosion.
- pasture phase recommended.
- fertilisers are essential for cropping; slow release fertilisers are preferred to reduce losses through leaching.
- nematodes can be a problem.
- these soils require very careful management to reduce degradation.
- windbreaks necessary to reduce wind erosion potential.

Vegetation

- conservation status of remnant vegetation is currently *not of concern*.
- planning guidelines and restrictions apply to clearing and land development.

Grazing

- native pastures need to be grazed prior to maturity.
- if pimelea is present animal husbandry problems occur.
- recommend using phosphate when growing serradella.
- recommend species suited to low to moderate fertility levels.
- overgrazing will result in the invasion of unpalatable and inferior species such as wiregrass and cottontails.
- strategic grazing and spelling is required to allow seed to set and pastures to bulk up.
- adjust stocking rates to suit seasonal conditions.
- stocking rates *native pasture* 1 AE/6.0-12.0 ha.
  sown pasture 1 AE/4.0-10.0 ha.

CLAYBURN

Associated soil in LRA: 6b

Brief description

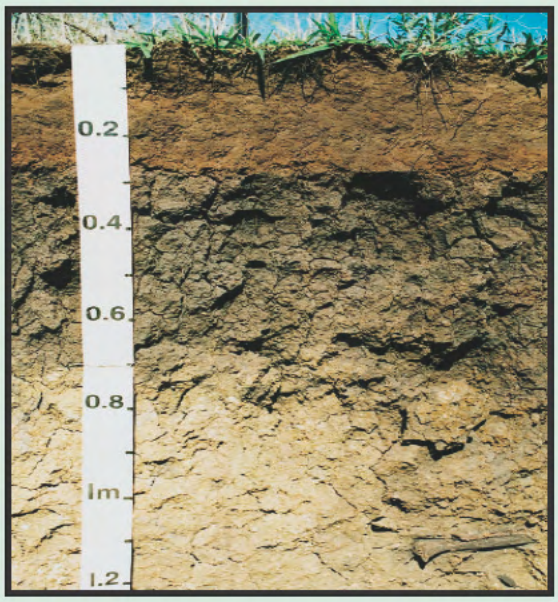
Clayburn is a very deep texture contrast soil, with red-brown or to dark grey-brown clay loam over dark brown clay subsoils with moderate gilgai under brigalow/belah with black tea tree on sandstone.

Landform and distribution

- mid to lower slopes of undulating rises and low hills in the Jandowae, Quinalow and Rosalie areas.
- slopes 1-4%

Vegetation

- layered open forest of brigalow, wilga and black tea tree associated with melonholes.
- some gum-topped or poplar box in clumps on "rises" or puffs of melonholes.
- narrow-leaved ironbark and belah can occur.



Example soil profile description

Depth (cm)	Description
0-20	very dark brown; with a few fine distinct orange mottles;clay loam; weak polyhedral structure; clear to:
20-30	brown; clay loam; weak polyhedral structure; sharp to:
30-70	very dark grey; with distinct orange mottles; fine sandy medium heavy clay; few medium quartz pebbles; moderate polyhedral structure; clear to:
70-140	dark yellowish brown; common distinct grey mottles; few medium quartz pebbles; few medium calcareous soft segregations; gradual to:
140+	weathered sandstone.

Australian Soil Classification: Halpic, Eutrophic, Grey Kandosol over Black Vertosol

General soil features

- texture contrast soil with a hardsetting surface and moderately to deep gilgai (30-150 cm).
- *surface soil:* red-brown or brown clay loam on the puff, 5-10 cm thick. Dark grey-brown clay loam, 10-30 cm thick in depression. Hardsetting. Ironstone gravel occurs in patches on puffs. Bleached subsurface layer may occasionally occur. Slightly acid (pH 6-6.5).
- *subsoil:* dark brown or occasionally dark yellowish brown clay. Commonly mottled. Strongly alkaline (pH 8-9.0). Ironstone.
- PAWC is moderate (100-150 mm).
- virgin country is especially P deficient; responds to N, P, K, Cu, S and possibly Zn.
- It is thought *Clayburn* has formed from the erosion and deposition of upslope soils such as *East*.

CLAYBURN

Land use limitations

- moderately fertile soils with moderate PAWC and hardsetting surface.
- susceptible to severe water erosion.
- susceptible to wind erosion if worked fine when dry.
- surface structure deteriorates with continuous cultivation and forms a hard surface crust after heavy rain.
- workability is difficult due to hardsetting surface soil and in areas of deep gilgai.
- works up very fine with continual cultivation and readily forms a hard surface crust. Reducing high levels of runoff by increasing infiltration is one of the biggest challenges.
- very abrasive on tines and other ground tools.
- limited effective soil depth - levelling will expose sodic subsoils, which will increase plant growth problems.

Land use suitability

This soil is best suited to winter grain cropping, short-season pulse crops. However, sound management is required use of pasture rotations. It is an excellent sown pasture soil.

- suitable for some grain and forage crops.
- suitable grain crops include: wheat, barley, millets, caloona peas and mungbeans.
- suitable forage crops include oats, forage sorghum and lab lab.
- summer crops will suffer from heat stress due to moderate PAWC.
- suitable for grazing native and most sown pastures.
- suitable sown pastures species include: Katambora Rhodes grass, green and Gatton panic, purple pigeon, digit and creeping bluegrass, lucerne and medics.
- legumes and medics grow well if sufficient rain in winter.

Best management practices

Cropping

- adopt conservation farming practices to maximise ground-cover and infiltration, reduce water erosion and assist in maintaining good surface soil structure.
- structural soil conservation measures will be required with cultivation on slopes.
- desirable to include pastures in rotation to maintain fertility and soil structure.
- moisture levels will be the determining factor on crop choice. Responds well to small falls of rain and can produce better crops than the heavier clay soils in dry years.
- crusting makes these soils relatively unsuitable to straight zero till fallows.

Vegetation

- conservation status of remnant vegetation is *endangered*.
- planning guidelines and restrictions apply to clearing and land development.

Grazing

- grazing native and sown pastures is regarded by many farmers as being the best use for these soils.
- strategic grazing and spelling of pastures is required to maximise pasture vigour.
- overgrazing is indicated by the invasion of inferior and unpalatable species such as cottonbush, couch and white speargrass.
- green panic grazed continuously may lead to calcium deficiency.
- sulphur required to maintain sown species.
- native couch and urochloa can be a useful source of feed.
- adjust stocking rates to suit seasonal conditions.
- stocking rates *native pasture* 1 AE/3-4 ha.
  sown pasture 1 AE/1.5-2.5 ha.

COMBIDIBAN

Common soil in LRA: 11a

Associated soil in LRAs: 1a, 9a and 10a

Brief description

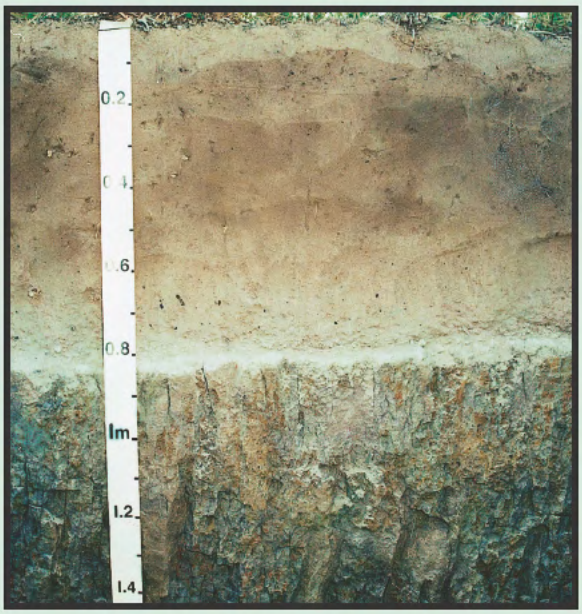
Combidiban is a deep texture contrast soil with a thick to very thick (30-100 cm), bleached, loose sandy surface and mottled, yellow, grey or brown sandy clay subsoils on alluvial plains.

Landform and distribution

- low sandy banks in flat to gently undulating alluvial plains occurring mainly from Millmerran to Cecil Plains.
- flat to undulating alluvial plains of the Weir River and its tributaries.

Vegetation

- open forest of cypress pine, rusty gum and tumbledown gum; associated species include rough-barked apple, Queensland blue gum and Moreton Bay ash; occasional bull oak on thinner surface soils.
- partly cleared.
- Regional Ecosystem 11.3.14



Example soil profile description

Depth (cm)	Description
0-10	dark greyish brown; sandy loam; loose; clear to:
10-65	dark yellowish brown; clayey sand; loose; clear to:
65-85	light brownish grey; loamy sand; conspicuously bleached; many ironstone nodules; sharp to:
85-120	dark greyish brown to grey; with red or yellow mottles; light medium clay, coarse sandy; strong coarse columnar to prismatic structure; gradual to:
120-160	as above, but blocky structure.

Australian Soil Classification: Bleached-Mottled, Eutrophic, Grey Chromosol

General soil features

- texture contrast soil with a sharp change between the surface soil and the subsoil.
- *surface soil:* brownish grey, greyish brown or greyish yellow-brown sand to sandy loam. Loose when dry. An obvious feature of these soils is the variability in surface soil depth (30-100 cm). Slightly acid to neutral (pH 6.0-7.0). High permeability.
- *subsoil:* brownish grey, light brown or light yellowish brown, mottled clays. Neutral (pH 7.0). Sodic and impermeable.
- PAWC is very low (<50 mm).
- low fertility - responds to N, P, K, Cu and Mo.

COMBIDIBAN

Land use limitations

- very low fertility; very low PAWC, and variable effective rooting depth due to sodic and relatively impermeable subsoils.
- PAWC is limited by depth of topsoil and nature of subsoil.
- sub-soils have a high bulk density.
- when the strongly sodic subsoils are exposed they erode easily resulting in severe gully and tunnel erosion.
- highly susceptible to wind erosion when cultivated.
- topsoils can become waterlogged in low sloping country making the surface boggy or "spewy".

Land use suitability

This soil is best suited to grazing native and sown pastures as well as horticultural crops.

- suitable for forage crops with limited suitability for winter grain crops in deeper topsoils.
- suitable winter cereals include: wheat and barley.
- suitable forage crops include: oats, forage sorghum and lab lab.
- suitable for horticultural crops where the surface soils are deep and there is adequate water for trickle irrigation including melons, pumpkins, grapes, citrus and stonefruit.
- suitable for grazing native and sown pastures
- suitable sown pasture species include: Katambora Rhodes grass, serradella, buffel grass, premier digit grass and Wynn cassia.
- key native pastures species include: black spear grass and wire grass.

Best management practices

Cropping

- adopt conservation farming practices to maximise ground cover and reduce wind erosion.
- pasture phase recommended in crop rotation.
- fertilisers are essential for cropping; slow release fertilisers are preferred to reduce losses through leaching.
- nematodes can be a problem.
- these soils require very careful management to reduce degradation.
- windbreaks necessary to reduce wind erosion potential.

Vegetation

- conservation status of remnant vegetation is currently *not of concern*.
- planning guidelines and restrictions apply to clearing and land development.

Grazing

- native pastures need to be grazed prior to maturity.
- if pimelea is present animal husbandry problems occur.
- recommend using phosphate when growing serradella.
- recommend species suited to crusting soils and low to moderate fertility levels.
- overgrazing will result in the invasion of unpalatable and inferior species such as wiregrass.
- strategic grazing and spelling is required to allow seed to set and pastures to bulk up.
- adjust stocking rates to suit seasonal conditions.
- stocking rates *native pasture* 1 AE/6.0-12.0 ha.
  sown pasture 1 AE/4.0-10.0 ha.

CONDAMINE

Common soil in LRAs: 1a, 1b

Associated soil in LRA: 3a.

Brief description

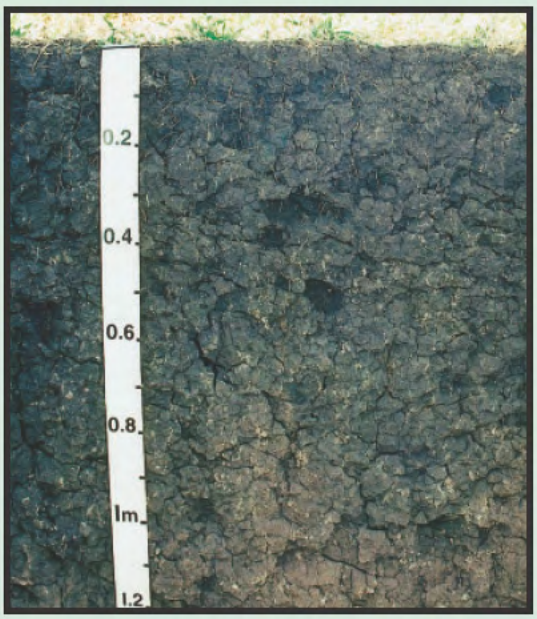
Condamine is a deep to very deep (80-180 cm), coarse self-mulching black cracking clay on recent alluvial plains and mixed orgin (includes the soils *Unabri* and *Pratten*).

Landform and distribution

- found along the active floodplain of the Condamine River and tributaries including river terraces, stream banks, old river channels and plains.

Vegetation

- fringing woodland to open forest of river red gum, Queensland blue gum, and some acacia species.
- mostly cleared.
- Regional Ecosystem 11.3.4



Example soil profile description

Depth (cm)	Description
0-5	very dark greyish brown; medium heavy clay; self-mulching; clear to:
5-15	very dark grey; medium heavy clay; well structured; clear to:
15-60	very dark greyish brown; heavy clay; well structured; few soft carbonate segregations; clear to:
60-140	dark greyish brown; heavy clay; well structured; very few soft carbonate segregations.

Australian Soil Classification: Calcareous-epihypersodic, Self-mulching, Black Vertosol

General soil features

- deep, neutral to alkaline cracking clays with coarse self-mulching surfaces, visible coarse sand throughout the profile.
- *surface soil:* dark greyish brown, black or light grey medium to heavy clay. Moderate to coarse, granular, self-mulching surface. Sometimes lightly crusted. Neutral to mildly alkaline (pH 7.1-7.5).
- *subsoil:* black or dark grey clays. Sodic. Deep subsoils are moderately to highly saline.
- water-worn gravel and coarse sand is evident throughout the profile, particularly on terraces and old river channels.
- general soil features may vary because the soil has a recent alluvial origin.
- PAWC is high (150-200 mm).
- responds to N, Cu and Zn.

Land use limitations

- the coarse structure of this soil creates problems with tillage and crop establishment.
- landscape is often dissected by gullies close to main drainage lines.
- *Haslemere* and *Combidiban* occurs as low sandy rises with this soil.
- subject to gullying from erosive flooding.
- occasional flooding may limit crop choice and reduce production potential due to waterlogging.
- workability is difficult due to a narrow moisture range.
- all pastures subject to invasion of Lippia.

Land use suitability

This soil is suited to dryland and irrigated cropping where the risks from inundation and erosion from flooding is acceptable. Active floodplains, riparian zones and old river channels are best suited to grazing native pastures.

- suitable for most dryland and irrigated field crops.
- suitable field crops include: wheat, barley, chickpeas, sorghum, cotton, sunflowers and mungbeans.
- suitable forage crops include: oats, forage sorghum, lucerne and lab lab.
- suitable for furrow, spray and trickle irrigation.
- suitable for grazing native and most sown pastures.
- suitable sown pastures include: bambatsi.
- key native pastures species include: Queensland, forest and pitted bluegrass and native trefoils.

Best management practices

Cropping

- avoid cultivation of breakaway gullies.
- gypsum recommended to improve surface structure and infiltration.
- presswheels or rollers are useful in aiding crop establishment.
- adopt conservation farming practices to maximise ground cover and infiltration, reduce water erosion.
- opportunity cropping practices are recommended to maximise production.
- strip cropping is recommended for erosion control and spreading of overland flow and/or flood water.

Vegetation

- conservation status of remnant vegetation is *endangered*.
- planning guidelines and restrictions apply to clearing and land development.

Grazing

- overgrazing native pastures may lead to invasion of Lippia.
- pastures difficult to establish due to the coarse surface structure of the soil.
- establish pastures in strips to reduce the risk of erosive flooding.
- presswheels are advantageous for pasture establishment.
- selection of pasture species will be based on frequency and tolerance to inundation.
- adjust stocking rates to suit seasonal conditions.
- stocking rates *native pasture* 1 AE/3.0-8.0 ha.
  sown pasture 1 AE/1.0 ha.

COTTONVALE

Associated soil in LRA: 13a

Brief description

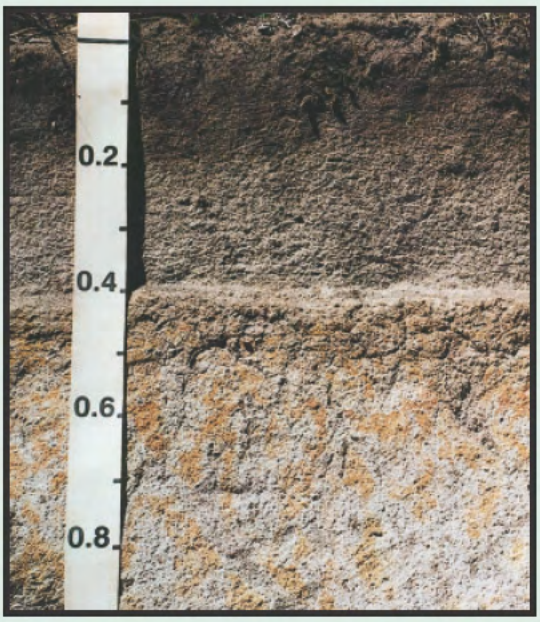
Cottonvale is a deep (65-100 cm) texture contrast soil with gritty, dark grey sandy surface to 35-40 cm over mottled brown, grey and yellowish grey acidic clay subsoils on granite hills (includes the soil *Turner*).

Landform and distribution

- Pine Hill - an undulating to rolling granite hill and associated ridges in the Bringalily area south of Millmerran.
- granite tors and rock outcrops are common.

Vegetation

- New England blackbutt shrubby open forest to woodland with New England peppermint, tumbledown gum, Youman's stringybark, Caley's ironbark and broad-leaved stringybark.
- partly cleared
- Regional Ecosystem 13.12.2



Example soil profile description

Depth (cm)	Description
0-15	black; coarse sandy clay loam; hardsetting massive; clear to:
15-40	yellow; coarse sandy clay loam; bleached massive; abrupt to:
40-65	grey; with orange mottle; coarse sandy light clay; moderate blocky structure; gradual to:
65-100	grey; with orange mottle, coarse sandy light clay; massive.

Australian Soil Classification: Bleached-Sodic, Magnesic-Natric, Grey Kurosol

General soil features

- texture contrast soil with a sharp change between the surface soil and the subsoil.
- *surface soil:* very dark grey to black hardsetting sandy clay loam grading to yellow, bleached coarse sandy clay loam to 30-45 cm. Medium to slightly acid (pH 5.5-6.5).
- *subsoil:* grey coarse sandy light clay with orange mottles becoming more gritty with depth. Moderate blocky structure. Very strongly acid (pH 4.5).
- PAWC is very low (<50 mm).
- responds to N, P and Cu.

Land use limitations

- very low fertility; very low PAWC, shallow rooting depth and hardsetting surfaces.
- shallow surface soils and impermeable subsoils make these soils susceptible to erosion and waterlogging.
- hardsetting surface reduces infiltration rates.
- effective rooting depth is limited to depth of the surface soil.

Land use suitability

This soil is best left undeveloped and in its native state - suitable for grazing native pastures only. Small areas may be suitable for horticultural crops and sown pastures.

- small areas on gentle slopes with reasonable soil depth are suitable for sown pastures and irrigated and dryland horticultural crops.
- suitable sown pasture species include: white clover, sub-clover, fescue, ryegrass and serradella on the deeper sands.
- key native pasture species include: awnless barnyard grass, speargrass and sedges.
- suitable horticultural crops include: tree crops (apples, pears, stonefruit), vines and vegetable crops.
- good bee and nature conservation country if not cleared.
- stringybark and blackbutt may be useful farm timber.

Best management practices

Cropping

- on slopes greater than 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.
- erosion control layouts will be necessary on slopes to prevent erosion and ensure good drainage.
- use mounds in tree and vine crops to increase soil depth, drainage, PAW and nutrients.
- use graded raised beds with erosion control layout for vegetable crops.

Vegetation

- conservation status of remnant vegetation is currently *not of concern*.
- planning guidelines and restrictions apply to clearing and land development.

Grazing

- restrict grazing to retain pasture cover above 30% basal cover to prevent erosion.
- overgrazing is indicated by the invasion of inferior and unpalatable species such as bracken fern, bladey grass, sedges, african lovegrass and pinrush.
- strategic grazing and spelling is required to maintain pasture vigour.
- adjust stocking rates to suit seasonal conditions.
- stocking rates *native pasture* 1 AE/8.0-10.0 ha.
  sown pasture 1 AE/3.0-5.0 ha.

CRAIGMORE

Common soil in LRA: 7a

Brief description

Craigmore is a deep to very deep (100-180 cm), coarse self-mulching, black cracking clay with a distinct red-brown subsoil on basalt. Typically associated with *Charlton.*

Landform and distribution

- mid to lower slopes of basalt rises and hills throughout the basaltic uplands.
- linear gilgai are common.

Vegetation

- mountain coolibah open woodland to grassland.
- mostly cleared.
- Regional Ecosystem 11.8.5

Example soil profile description

Depth (cm)	Description
0-15	black; heavy clay; strong coarse granular structure; gradual to:
15-60	black; heavy clay; strong coarse blocky structure; few carbonate nodules; gradual to:
60-90	black; heavy clay; strong coarse lenticular structure; some carbonate nodules; gradual to:
90-120	brown and red; medium clay; strong coarse lenticular structure; soft and nodular carbonate.

Australian Soil Classification: Haplic or Endocalcareous, Self-mulching, Black Vertosol

General soil features

- very deep, coarse structured cracking clays; commonly with linear gilgai.
- *surface soil:* black medium to heavy clays. Strong coarse granular structure. Neutral (pH 7.5).
- *subsoil:* black heavy clay, grading to red-brown or brown in the deep subsoil. Strongly alkaline (pH 8.5-9.0). Strong coarse blocky to lenticular structure. Nodular and/or soft carbonate throughout.
- PAWC is very high (>250 mm).
- responds to N, P, S, and possibly Zn.
- usually stone-free.
- coarse granular surface structure distinguishes this soil from *Irving*.

CRAIGMORE

Land use limitations

- susceptible to severe rill and gully erosion.
- the coarse structure of this soil creates problems with tillage, crop and pasture establishment.
- cracking in contour banks may result in breakages.

Land use suitability

This soil is ideally suited to continual grain and cotton cropping with good nutrition and rotations for weed and disease control.

- suitable for most dryland and irrigated field crops. Small seeded crops are difficult to establish (eg. millets, canary).
- suitable field crops include: wheat, barley, chickpeas, sorghum, cotton, sunflowers and mungbeans.
- suitable forage crops include: oats, forage sorghum, lucerne and lab lab.
- suitable for furrow, spray and trickle irrigation.
- suitable for grazing native and most sown pastures.
- suitable sown pastures include: Katambora Rhodes grass, purple pigeon grass, bisset creeping bluegrass, lucerne and medics.
- key native pastures species include: Queensland forest and pitted bluegrass and native trefoils.
- although highly suitable for grazing native and most sown pastures, very little exists due to the economics of cropping.

Best management practices

Cropping

- adopt conservation farming practices to maximise ground cover and infiltration, reduce water erosion, and assist in maintaining good surface soil structure.
- structural soil conservation measures will be required with cultivation on slopes.
- broad-based contour banks or broad-based topside banks which can be cultivated are recommended to prevent cracking problems.
- presswheels or rollers are essential in aiding crop establishment.

Vegetation

- conservation status of remnant vegetation is currently *not of concern*.
- planning guidelines and restrictions apply to clearing and land development.

Grazing

- overgrazing is indicated by the invasion of inferior and unpalatable species such as foxtail and white speargrass.
- strategic grazing and spelling is required to maximise pasture vigour.
- adjust stocking rates to suit seasonal conditions.
- stocking rates *native pasture* 1 AE/2.5-3.0 ha.
  sown pasture 1 AE/1.0 ha.

CUTTHROAT

Common soil in LRAs: 10a, 12b

Associated soil in LRAs: 10b and 12a

Brief description

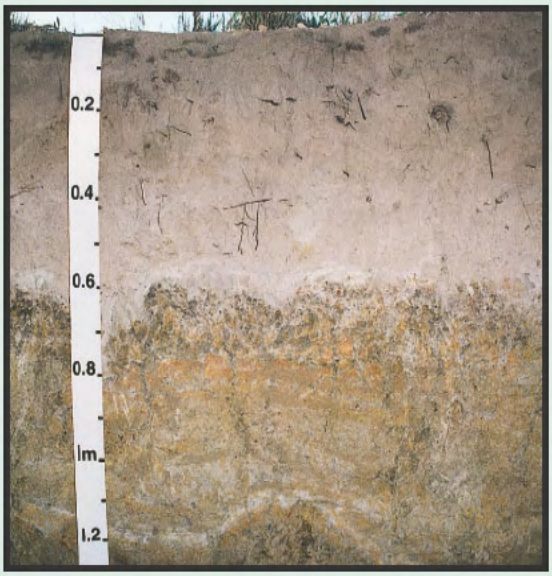
Cutthroat is a texture contrast soil with a bleached, sandy surface over mottled, yellowish brown clay subsoil on coarse-grained sandstones (includes the soils *Springburn* and *Bonnie Doon*).

Landform and distribution

- low sandstone hills and gently undulating sandstone plains; mainly occurs west of the Condamine River on the Kumbarilla Ridge.
- usually occupies lower slope positions.

Vegetation

- open forest of cypress pine and bull oak with associated species including narrow-leaved ironbark, rusty gum-topped box and tumbledown gum.
- partly cleared.
- Regional Ecosystems 11.5.1/11.5.4/ 11.10.9



Example soil profile description

Depth (cm)	Description
0-20	dark brown; loamy sand; loose; clear to:
20-40	brown; loamy sand; loose; clear to:
40-60	light grey; loamy sand; conspicuously bleached; some gravel; loose; abrupt to:
60-85	brown, mottled yellow and red; sandy clay; massive; some gravel; clear to:
85-120	brown; mottled yellow; sandy clay; massive; some gravel; clear to:
120-140	yellowish brown; coarse sandy clay loam; massive.

Australian Soil Classification: Eutrophic, Mottled-Mesonatric, Brown Sodosol

General soil features

- texture contrast soil with a sharp change between the surface soil and the subsoil.
- *surface soil:* brown to greyish yellow-brown sand to sandy loam with a bleached layer. Loose when dry or weakly hardsetting. Variable surface depth (40-100 cm). Strongly to slightly acid (pH 5.0 -6.5).
- *subsoil:* brown to yellowish brown or light grey, mottled, sandy clay to heavy clay. Impermeable with a massive or weakly columnar to blocky structure. Neutral to strongly alkaline (pH 6.5-8.9) (profiles sometimes acid throughout). Generally strongly sodic and highly saline.
- infiltration rates and drainage of surface soils are high, and on sloping sites the soils dry out rapidly.
- PAWC is very low (<50 mm).
- low fertility - responds to N, P, K, Cu, Zn and Mo.

CUTTHROAT

Land use limitations

- very low fertility, low PAWC, and hardsetting surfaces.
- impermeable subsoil make these soils extremely susceptible to erosion and waterlogging.
- sodic subsoils susceptible to gully and tunnel erosion if exposed.
- susceptible to wind erosion if the soil surface is not protected.
- root penetration into the subsoil is negligible due to high bulk density.
- regrowth, particularly of cypress pine and bull oak when cleared.
- siting of dams needs careful consideration.
- many farmers have found that developing this type of country will provide very little return on initial investment.

Land use suitability

This soil is best suited to grazing of native and sown pastures. Cutthroat has a limited suitability for horticultural, winter grain and forage cropping as a means of regrowth control prior to establishing sown pastures.

- suitable for fodder crops with limited suitability for winter crops in soils with deeper A horizons.
- suitable winter grain crops include: wheat and barley.
- suitable forage crops include: oats and forage sorghum.
- suitable for grazing native and sown pastures.
- suitable sown pastures include: Katambora Rhodes grass, premier digitaria, serradella and Wynn cassia.
- suitable for horticultural crops where the surface soils are deep and there is adequate water for trickle irrigation including melons, pumpkins, grapes, citrus and stonefruit on the deeper soils.
- good bee and native conservation country if not cleared.
- cypress pine and narrow-leaved ironbark may be useful farm and millable timber.

Best management practices

Cropping

- limited potential for forage cropping and winter grain crops when clearing to establish pastures.
- work when moist to reduce wear on machinery.

Vegetation

- conservation status of remnant vegetation is currently *not of concern*.
- planning guidelines and restrictions apply to clearing and land development.

Grazing

- recommend strategic thinning of timber using chemical methods. Mechanical methods will only result in severe regrowth problems.
- shallow pasture furrows along the contour.
- if pimelea is present animal husbandry problems occur.
- recommend species suited to for crusting soils and low to moderate fertility levels.
- use phosphate when growing serradella.
- strategic grazing and spelling of pastures is required to maximise pasture vigour.
- overgrazing is indicated by the invasion of inferior and unpalatable species such as wiregrass.
- adjust stocking rates to suit seasonal conditions.
- stocking rates *native pasture* 1 AE/10.0-15.0 ha.
  sown pasture 1 AE/10.0-12.0 ha.

DAVY

Common soil in LRA: 11a

Associated soil in LRAs: 4a, 10a, 10b, 12a and 12b

Brief description

Davy is a deep (100-150 cm), yellow or brown alluvial sand (includes the soils *Boyne* and *Wondoogle*).

Landform and distribution

- flat to gently undulating alluvial plains, terraces or stream-banks, where creeks and rivers drain the sandstone hills.

Vegetation

- open forest of Queensland blue gum, rough-barked apple, cypress pine, rusty gum and tumbledown gum.
- partly cleared.
- Regional Ecosystem 11.3.14

Example soil profile description

Depth (cm)	Description
0-15	brown; sandy loam; loose; clear to:
15-40	pale brown; loamy sand; conspicuously bleached; massive; diffuse to:
40-100	pale yellowish brown; loamy sand; massive.

Australian Soil Classification: Basic, Arenic Orthic Terosol

General soil features

- very deep, brown to yellow or greyish brown uniform sands, which are highly permeable and very well drained.
- in some instances the soils may be more coherent instead of loose.
- slightly acid to neutral throughout the profile (pH 6.5-7.0).
- PAWC is low (50-100 mm).
- responds to N, P, K, Cu and Mo.

Land use limitations

- very low fertility soils with low PAWC.
- susceptible to wind erosion if surface soil is unprotected. "Sand blasting" of young crops associated with wind erosion.
- generally not suited to intensive livestock industries (e.g. feedlots, piggeries) due to potential for contamination of ground-water.

Land use suitability

This soil is best suited to grazing native and sown pastures as well as a limited range of horticultural crops.

- suitable for some short-season and tap-rooted forage crops.
- suitable forage crops include: oats, caloona peas and lab lab.
- suitable for trickle or spray irrigation.
- suitable for grazing native and sown pastures.
- suitable sown pasture species include: Katambora Rhodes grass, serradella, buffel grass, premier digit grass and Wynn cassia.
- key native pasture species include: black spear grass and wire grass.
- suitable for a limited range of horticultural crops if irrigation water is available such as melons, grapes, pumpkins, stonefruit and citrus.

Best management practices

Cropping

- adopt conservation farming practices to maximise ground cover and reduce wind erosion.
- pasture phase recommended.
- fertilisers are essential for cropping; slow release fertilisers are preferred to reduce losses through leaching.
- nematodes can be a problem.
- these soils require very careful management to reduce degradation.
- windbreaks necessary to reduce wind erosion potential.

Vegetation

- conservation status of remnant vegetation is currently *not of concern*.
- planning guidelines and restrictions apply to clearing and land development.

Grazing

- native pastures need to be grazed prior to maturity.
- if pimelea is present animal husbandry problems occur.
- recommend using phosphate when growing serradella.
- recommend species suited to low to moderate fertility levels.
- overgrazing will result in the invasion of unpalatable and inferior species such as wiregrass and cottontails.
- strategic grazing and spelling is required to allow seed to set and pastures to bulk up.
- adjust stocking rates to suit seasonal conditions.
- stocking rates *native pasture* 1 AE/6.0-12.0 ha.
  sown pasture 1 AE/4.0-10.0 ha.

DIAMONDY

Common soil in LRA: 6b

Brief description

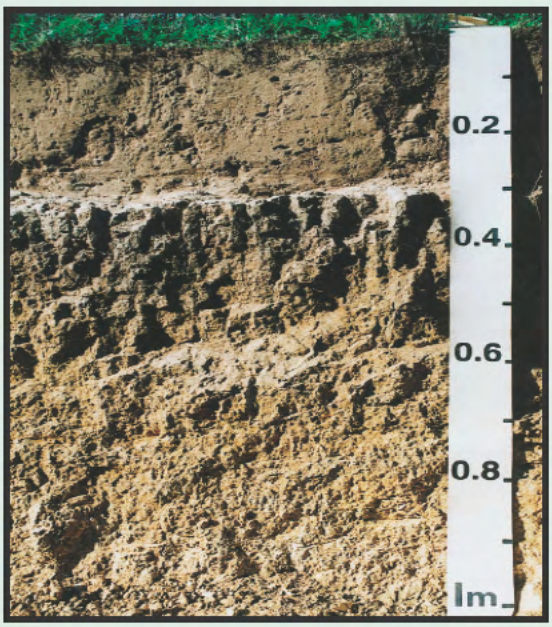
Diamondy is a texture contrast soil with a moderately thick (20-40 cm) brown to dark brown sandy loam surface over mottled, red sandy clay subsoils on sandstone (includes the soil *Sugarloaf*).

Landform and distribution

- upper slopes (2-4%) of undulating sandstone rises and undulating broad sandstone ridges.
- associated with coarse sandstone outcrops within areas of mainly fine-grained calcareous sandstones.

Vegetation

- softwood scrub or shrubby forest of, bottle tree narrow-leaved ironbark and poplar box with softwood scrub species.
- occasional brigalow.
- partly cleared with thick green panic understorey on roadsides.
- Regional Ecosystem 11.9.4



Example soil profile description

Depth (cm)	Description
0-25	yellowish brown to dark brown; sandy loam; massive; clear to:
25-30	very pale brown; sandy loam; weak massive; clear to:
30-40	brown; few faint orange mottles; medium clay; strong coarse angular blocky structure; diffuse to:
40-90	yellowish brown; medium clay; moderate to strong coarse angular blocky structure; gradual to:
90-100	brownish yellow; medium clay; weak coarse sub-angular blocky structure, very few medium calcareous nodules; gradual to:
100+	standstone.

Australian Soil Classification: Eutrophic, Mesonatric, Brown Sodosol

General soil features

- texture contrast soil with a hardsetting surface and impermeable subsoil.
- *surface soil:* brown or grey brown, hardsetting, sandy loam to sandy clay loam. Commonly 20-40 cm thick. Some deeper phases occur on the crests of broad ridges. A bleached layer can occur above the subsoil. Slightly acid (pH 6.0).
- *subsoil:* brown or yellowish brown, medium clay. Moderately to strongly alkaline (pH 8.0-9.0). Strongly sodic and highly saline at depth.
- PAWC is low (50-100 mm).
- responds to N, P, Cu and occasionally S and K.

DIAMONDY

Land use limitations

- very low fertility, low PAWC, shallow rooting depth and hardsetting surfaces.
- susceptible to severe water erosion.
- susceptible to wind erosion if worked fine when dry.
- surface structure deteriorates with continuous cultivation and forms a hard surface crust after heavy rain.
- workability difficult due to hardsetting surface soil.
- very abrasive on tines and other ground tools.
- when the sodic subsoils are exposed they erode easily resulting in severe gully and tunnel erosion.
- root penetration into the subsoil is low due to high bulk density.
- timber regrowth can be a problem in pastures.

Land use suitability

This soil is best suited to grazing sown pastures along with winter grain and forage cropping while developing and renovating land.

- suitable for some winter grain and forage crops.
- suitable grain crops include: wheat, barley, and oats.
- suitable forage crops include: oats, forage sorghum and lab lab.
- suitable for spray and trickle irrigation.
- suitable for grazing native and sown pastures.
- suitable sown pastures species include: Katambora Rhodes grass, buffel grass, creeping bluegrass, green and Gatton panic and medics.
- key native pasture species include: Queensland and pitted bluegrass, black speargrass and trefoil.
- suitable for native flower production on hillslopes.

Best management practices

Cropping

- adopt conservation farming practices to maximise ground cover and infiltration, reduce water erosion and assist in maintaining good surface soil structure.
- structural soil conservation measures will be required with cultivation on slopes.
- desirable to include pastures in rotation to maintain fertility and soil structure.
- moisture levels will be the determining factor on crop choice. Responds well to small falls of rain and can produce better crops than the heavier clay soils in dry years.
- crusting makes these soils relatively unsuitable to straight zero-till fallows.
- may be more economically viable as pasture.

Vegetation

- conservation status of remnant vegetation is *endangered*.
- planning guidelines and restrictions apply to clearing and land development.

Grazing

- grazing native and sown pastures is regarded by many farmers as being the best use for these soils.
- strategic grazing and spelling of pastures is required to maximise pasture vigour.
- overgrazing is indicated by the invasion of inferior and unpalatable species such as cottonbush, couch and white speargrass.
- quinine, bitterbark, flannel bush, ironwood and sally wattle are common woody weeds in pastures.
- sulphur required to maintain sown species.
- adjust stocking rates to suit seasonal conditions.
- stocking rates *native pasture* 1 AE/3.0-3.5 ha. *sown pasture* 1 AE/2.5 ha.

DOWNFALL

Common soil in LRAs: 3a, 9a

Associated soil in LRAs: 1a, 2b, 2d, 6a, 6b, 6c and 11a

Brief description

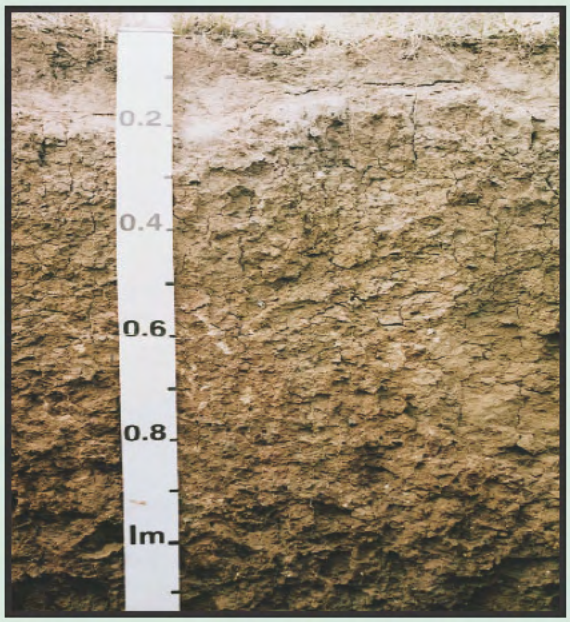
Downfall is a texture contrast soil with a hardsetting surface over yellowish brown or greyish brown clay subsoils on mixed sandstone and basaltic alluvial plains (includes the soils *Killarney, Warrego* and *Sawmill*).

Landform and distribution

- flat plains and very gently sloping (<1%) valley floors of mixed sandstone and basaltic alluvium.

Vegetation

- poplar box grassy woodland with wilga.
- occasional bull oak and grey box.
- rough-barked apple and Moreton Bay Ash also occur where the surface soils are sandier.
- mostly cleared.
- Regional Ecosystem 11.3.2/11.3.18



Example soil profile description

Depth (cm)	Description
0-15	very dark greyish brown; fine sandy clay loam; hardsetting; very few fine ferromanganiferous concretions; abrupt to:
15-30	brown; medium clay; common distinct orange mottles; columnar; gradual to:
30-50	olive brown, medium heavy clay; angular blocky; few coarse soft calcareous segregations; gradual to:
50-110	yellowish red; medium clay; few medium sub-rounded ironstone pebbles; coarse blocky structure; gradual to:
110-140	greyish brown; medium clay; coarse blocky structure.

Australian Soil Classification: Eutrophic, Mottled-Subnatric, Brown Sodosol

General soil features

- texture contrast soil with a sharp change between the surface soil and the subsoil.
- *surface soil:* brown to grey-brown, sandy loam to clay loam. Hardsetting. Usually includes a bleached subsurface layer. Slightly acid (pH 6.0).
- *subsoil:* yellowish brown, brown or greyish brown clays. Coarse blocky or prismatic structure. Neutral to moderately alkaline (pH 7.0-8.5). Sodic to strongly sodic. Moderately saline at depth.
- PAWC is moderate (100-150 mm).
- responds to N, P and Cu.

Land use limitations

- moderately fertile soils with moderate PAWC and hardsetting surfaces.
- surface structure deteriorates with continuous cultivation.
- prone to forming a hard surface crust after heavy rain. This crust is extremely hard to penetrate with tined implements until the soil is wetted.
- abrasive on tines and other cultivation if soil worked dry.
- sodic and relatively impermeable subsoils susceptible to gullying if exposed.
- occasional overland erosive flooding and wind erosion if worked fine when dry.
- rooting depth may vary depending on depth to saline layer.
- surface very "spewy" when wet.

Land use suitability

This soil is suited to grazing native and sown pastures along with winter grain crops and short-term forage crops while developing and renovating land.

- suitable for winter grain and short term forage crops.
- suitable grain crops include: wheat , barley, millets, mungbeans.
- suitable forage crops include: oats, forage sorghum, cowpeas and lab lab.
- suitable for spray and trickle irrigation.
- summer forage crops will suffer from heat stress due to low PAWC.
- suitable for grazing native and most sown pastures.
- suitable sown pasture species include: Katambora Rhodes grass creeping bluegrass, purple pigeon grass, buffel grass, green panic, digit grass, and medics.
- key native species include: Queensland forest and pitted bluegrass.
- responds well to small falls of rain.

Best management practices

Cropping

- adopt conservation farming practices to maximise ground cover and infiltration, reduce water and wind erosion and assist in maintaining good surface soil structure.
- soil management is important as these soils do not crack and naturally repair themselves.
- pasture phase strongly recommended to maintain surface structure.
- crusting makes these soils relatively unsuitable to straight zero-till fallows.
- presswheels or rollers are useful in aiding crop establishment. Difficult to establish millets, panicums and sunflowers.
- strip cropping is recommended for erosion control and spreading of overland flow and/or flood water.

Vegetation

- conservation status of remnant vegetation is *of concern* (11.3.2).
- conservation status of remnant vegetation is currently *not of concern* (11.3.18).
- planning guidelines and restrictions apply to clearing and land development.

Grazing

- grazing native and sown pastures is regarded by many farmers as being the best use for these soils.
- recommend species suited for crusting soils and low to moderate fertility levels.
- can withstand reasonable grazing pressure - overgrazing is indicated by the invasion of inferior and unpalatable species such as black cotton bush and white speargrass.
- strategic grazing and spelling of pastures is required to maximise pasture vigour.
- fertilising with phosphorus and sulphur will improve pasture production.
- adjust stocking rates to suit seasonal conditions.
- stocking rates *native pasture* 1 AE/3.0-3.5 ha. *sown pasture* 1 AE/2.5 ha.

DRAYTON

Common soil in LRA: 7d

Brief description

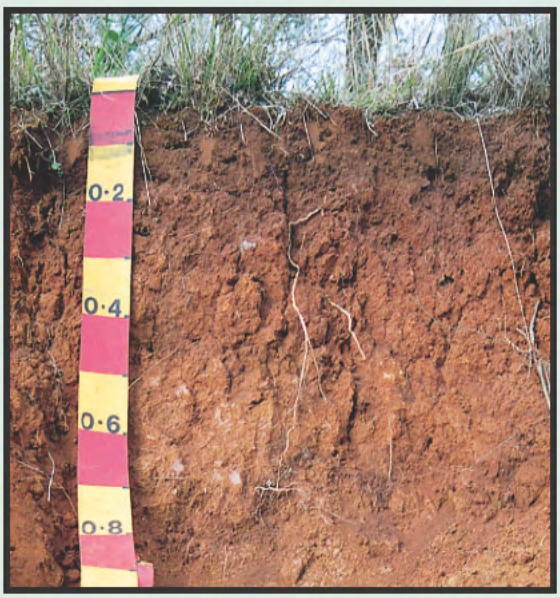
Drayton is a moderately deep (50-100 cm), neutral, non-cracking, red clay soil on basalt on the Toowoomba Plateau

Landform and distribution

- gently undulating plains on the western and southern edges of the Toowoomba Plateau.

Vegetation

- mountain coolibah, narrow-leaved ironbark, white box woodland.
- mostly cleared.
- Regional Ecosystems 11.8.2/11.8.8



Example soil profile description

Depth (cm)	Description
0-4	dark or red-clay loam to light clay; strong medium granular structure; clear to:
4-20	red; light medium clay; moderate to strong blocky structure; firm; clear to:
25-55	red-brown or red; light medium clay to medium clay; strong blocky structure; clear/gradual to:
55-95	red-brown; medium clay; strong coarse angular blocky; few to common ferruginous or manganiferous nodules; gradual to:
95-110	brown or red-brown; few distinct red, orange or yellow mottles; light clay to medium clay; moderate to strong coarse angular blocky structure; few to common ferruginous or manganiferous nodules; gradual to:
110+	basalt.

Australian Soil Classification: Haplic, Eutrophic, Red Ferrosol

General soil features

- moderately deep, neutral to alkaline, clay with soft to firm surfaces.
- *surface soil:* dark to red-brown clay loam to light medium clay. Strong granular to sub-angular blocky structure. Slightly acid to neutral (pH 6.0-7.0).
- *subsoil:* red-brown or red, light medium to medium clay. Moderate to strong angular blocky. Neutral to moderately alkaline (pH 6.5-8.0).
- PAWC is moderate (100-150 mm).
- responds to N and K.

Land use limitations

- shallow rooting depth and moderate PAWC.
- available water capacity.
- Phosphorous fixing.
- surface structure deteriorates wtih continuous cultivation, results in a "powdery" surface subject to wind and water erosion.
- generally not suited to intensive livestock industries (e.g. feedlots, piggeries) due to potential for contamination of ground-water through the underlying permeable fractured basalt.

Land use suitability

This soil is ideally suited to field cropping, including peanuts and navy beans, but a pasture phase is recommended to restore surface structure.

- suitable for most field crops except cotton due to low PAWC.
- summer crops may be subject to heat stress due to moderate PAWC.
- suitable field crops include: wheat, barley, chickpeas, sorghum, sunflowers, mungbeans, peanuts, navy beans, panicums and millets.
- suitable forage crops include: oats, forage sorghum, lucerne and lab lab.
- suitable for spray and trickle irrigation.
- suitable for horticultural crops where irrigation is available.
- suitable for grazing native and most sown pastures.
- suitable sown pastures include: Katambora Rhodes grass, green and Gatton panic, purple pigeon grass, creeping bluegrass and medics.
- suitable for native flower production.
- much of the land suitable for agriculture has been used for urban development.

Best management practices

Cropping

- adopt conservation farming practices to maximise ground cover, infiltration and reduce water and wind erosion.
- opportunity cropping recommended to maximise ground cover and infiltration, reduce erosion and runoff and assist in maintaining good surface soil structure.
- structural soil conservation measures will be required with cultivation on slopes.
- desirable to include pastures in rotation to maintain fertility and soil structure.
- responds well to small falls of rain in dry years and can produce better crops than the heavier clay soils.

Vegetation

- conservation status of remnant vegetation is *endangered* (11.8.8).
- conservation status of remnant vegetation is currently *not of concern* (11.8.2)
- planning guidelines and restrictions apply to clearing and land development.

Grazing

- overgrazing is indicated by the invasion of inferior and unpalatable species such as foxtail and white speargrass.
- strategic grazing and spelling of pastures is required to maximise pasture vigour and encourage better native species to increase (e.g. bluegrass).
- fertilising with phosphorus and sulphur will improve pasture production.
- native couch and urochloa can be useful sources of feed.
- adjust stocking rates to suit seasonal conditions.
- stocking rates *native pasture* 1 AE/2.5-3.0 ha. *sown pasture* 1 AE/1.0 ha.

DROME

Common soil in LRA: 12b

Associated soil in LRAs: 9a, 10a, 10b and 12a.

Brief description

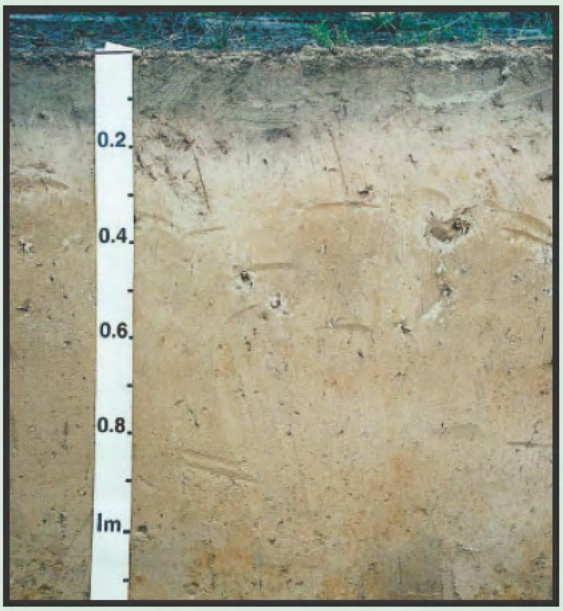
Drome is a deep yellow-brown sand formed on coarse grained sandstone (includes the soil *Highmount*).

Landform and distribution

- gently undulating sandstone rises and plains. Mainly occurs west of the Condamine River on the Kumbarilla Ridge.

Vegetation

- open forest of Queensland blue gum, rough-barked apple, cypress pine, rusty gum, narrow-leaved ironbark, open forest.
- partly cleared.
- Regional Ecosystem 11.5.4



Example soil profile description

Depth (cm)	Description
0-5	brown; sandy loam; loose; gradual to:
5-60	yellowish-brown; loamy sand; single grain; gradual to:
60-100	yellow with very few red mottles; loamy sand; single grain; diffuse to:
100-120	yellow with red mottles; sandy loam; single grain.

Australian Soil Classification: Basic, Arenic, Orthic Tenosol

General soil features

- deep, brown, yellowish brown or greyish brown uniform sands which are highly permeable and moderately well drained.
- in some instances the soils may be more coherent instead of loose.
- moderately to slightly acid throughout the profile (pH 5.5-6.5).
- PAWC is low (50-100 mm).
- responds to N, P, K, Cu, Zn and Mo.

Land use limitations

- very low fertility soils with low PAWC.
- poor drainage may be a feature of some soils. This may increase PAWC.
- susceptible to wind erosion if surface soil is unprotected. "Sand-blasting" of young crops is associated with wind erosion.

Land use suitability

This soil is best suited to grazing native and sown pastures as well as a limited range of horticultural crops.

- suitable for some short-season and tap-rooted forage crops.
- suitable forage crops include: oats, caloona peas and dolichos lab lab.
- suitable for trickle or spray irrigation.
- suitable for grazing native and sown pastures.
- suitable sown pasture species include: Katambora Rhodes grass, serradella, buffel grass, premier digit grass and Wynn cassia.
- key native pasture species include: black spear grass and wire grass.
- suitable for a limited range of horticultural crops if irrigation water is available such as melons, grapes, pumpkins, stonefruit and citrus.
- good bee and native conservation country if not cleared.
- cypress pine and ironbark can be a good source of farm and millable timber.

Best management practices

Cropping

- adopt conservation farming practices to maximise ground cover and reduce wind erosion.
- pasture phase recommended.
- fertilisers are essential for cropping; slow release fertilisers are preferred to reduce losses through leaching.
- nematodes can be a problem.
- these soils require very careful management to reduce degradation.
- windbreaks necessary to reduce wind erosion potential.

Vegetation

- conservation status of remnant vegetation is currently *not of concern*.
- planning guidelines and restrictions apply to clearing and land development.

Grazing

- native pastures need to be grazed prior to maturity.
- if pimelea is present animal husbandry problems occur.
- recommend using phosphate when growing serradella.
- recommend species suited for low to moderate fertility levels.
- overgrazing will result in the invasion of unpalatable and inferior species such as wiregrass and cottontails.
- strategic grazing and spelling is required to allow seed to set and pastures to bulk up.
- adjust stocking rates to suit seasonal conditions.
- stocking rates *native pasture* 1 AE/6.0-12.0 ha.
  sown pasture 1 AE/4.0-10.0 ha.

EAST

Associated soil in LRA: 6b

Brief description

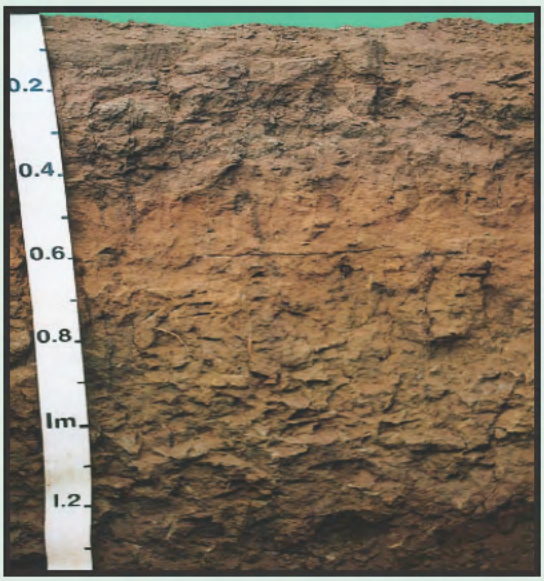
East is a moderately deep to deep soil with a brown clay loam to light clay surface and reddish brown clay subsoils on fine-grained sandstone (includes the soil *Norbell*).

Landform and distribution

- gently undulating to undulating broad sandstone ridges in the Bell to Jandowae area.
- slopes 1-5%.

Vegetation

- layered open forest of poplar box and wilga intermixed with softwood scrub species.
- occasional brigalow, belah, bottle trees, crows ash and narrow-leaved ironbark.
- thick green panic understorey on roadsides.
- mostly cleared.
- Regional Ecosystems 11.9.4/11.9.7/



Australian Soil Classification:
Haplic, Eutrophic, Brown Chromosol

Example soil profile description

Depth (cm)	Description
0-15	dark brown; sandy loam; massive; few small sub-rounded quartz pebbles; clear to:
15-20	brown; sandy loam; many small rounded ironstone pebbles; massive; abrupt to:
20-30	dark brown; clay loam; few small sub-rounded ironstone pebbles; moderate to strong coarse blocky structure abrupt to:
30-40	brown; clay loam; moderate to strong coarse structure; very few fine manganiferous nodules; clear to:
40-65	yellowish brown; medium clay; few small sub-rounded ironstone pebbles; very few fine manganiferous nodules; strong coarse blocky or lenticular structure; clear to:
65-170	dark yellowish brown, medium heavy clay; strong coarse angular blocky or lenticular structure.

General soil features

- moderately deep to deep, soils with hardsetting surfaces.
- *surface soil:* dark brown or reddish brown, hardsetting, massive, sandy loam to sandy clay loam. Strongly to slightly acid (pH 5.0-6.5).
- *subsoil:* red, reddish brown, brown or greyish brown, light to heavy clay. Well drained. Slightly acid to neutral (pH 6.0-7.5).
- ironstone gravel increases with depth.
- PAWC is moderate (100-150 mm).
- will respond to N, P and occasionally S and K.
- decomposing sandstone may be encountered at 60 cm or shallower on upper slopes.

Land use limitations

- moderate fertility; moderate PAWC.
- susceptible to severe water erosion.
- susceptible to wind erosion if worked fine when dry.
- surface structure deteriorates with continuous cultivation and forms a hard surface crust after heavy rain.
- workability difficult due to hardsetting surface soil.
- very abrasive on tines and other cultivation equipment.
- low pH may cause nutrient imbalances.
- generally not suited to intensive livestock industries (e.g. feedlots, piggeries) due to potential for contamination of ground-water.

Land use suitability

This soil is best suited to winter grain cropping and pasture production, however sound management is required.

- suitable for some grain and forage crops.
- suitable grain crops include: wheat, barley, chickpeas, millets, panicums, peanuts, navy and mungbeans.
- suitable forage crops include: oats, forage sorghum and lab lab.
- suitable for spray and trickle irrigation.
- summer crops will suffer from heat stress due to moderate PAWC.
- suitable for grazing native and most sown pastures.
- suitable sown pasture species include: Katambora Rhodes grass, green and Gatton panic, purple pigeon grass, creeping bluegrass, lucerne and medics.
- key native pasture species include: Queensland and pitted bluegrass, black speargrass and trefoil.
- well suited to most horticultural crops provided adequate water is available.
- suitable for native flower production.

Best management practices

Cropping

- adopt conservation farming practices to maximise ground cover, infiltration and reduce water erosion, and assist in maintaining good surface soil structure.
- structural soil conservation measures will be required with cultivation on slopes.
- desirable to include pastures in rotation to maintain fertility and soil structure.
- moisture levels will be the determining factor on crop choice. Responds well to small falls of rain in dry years and can produce better crops than the heavier clay soils.
- crusting makes these soils relatively unsuitable to straight zero-till fallows.

Vegetation

- conservation status of remnant vegetation is *endangered.*
- planning guidelines and restrictions apply to clearing and land development.

Grazing

- strategic grazing and spelling of pastures is required to maximise pasture vigour.
- ley pasture rotations with cultivation is regarded by many farmers as being the best use for these soils.
- overgrazing is indicated by the invasion of inferior and unpalatable species such as cottonbush, couch and white speargrass.
- couch and urochloa can be useful sources of feed. Rhodes and buffel grass regarded as second grade feeds compared to the panic species.
- sulphur required to maintain sown species.
- adjust stocking rates to suit seasonal conditions.
- stocking rates *native pasture* 1 AE/2.5-3.0 ha. *sown pasture* 1 AE/1.0 ha.

EDGEFIELD

Associated soil in LRAs: 6a, 6b and 6c

Brief description

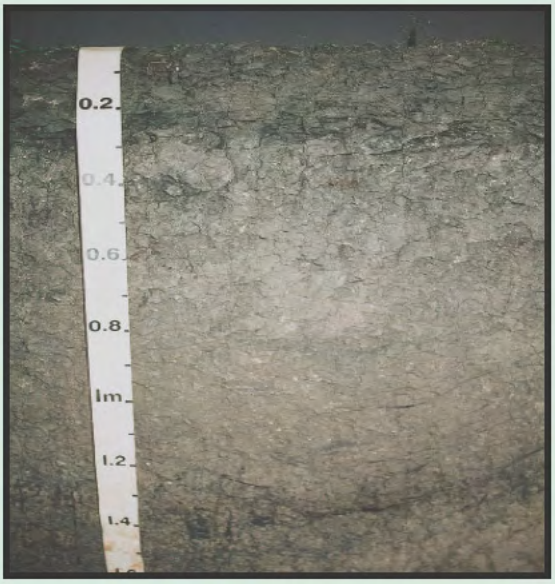
Edgefield is a deep to very deep (100-180 cm), self-mulching, cracking grey clay formed from fine-grained sandstone (includes the soil *Malling*).

Landform and distribution

- lower slopes (1-3%) and valley floors of gently undulating plains to rises and low hills.

Vegetation

- layered open forest of brigalow, belah and wilga.
- occasional myall, yarran, and poplar box.
- mostly cleared.
- Regional Ecosystem 11.9.5



Example soil profile description

Depth (cm)	Description
0-5	dark grey; medium clay; self-mulching granular structure; abrupt to:
5-30	dark grey; medium heavy clay; moderate platy; very few medium calcareous concretions; abrupt to:
30-60	dark grey; medium heavy clay; moderate sub-angular blocky; common medium calcareous concretions; gradual to:
60-120	greyish brown; heavy clay; moderate sub-angular blocky to lenticular; few medium calcareous concretions; gradual to:
120-160	brown; heavy clay; weak sub-angular blocky; many fine manganiferous veins; gradual to:
160-170	light brownish grey; few distinct orange mottles; heavy clay; weak sub-angular blocky.

Australian Soil Classification: Epicalcareous-Endohypersodic, Self-mulching, Grey Vertosol

General soil features

- deep, self-mulching, cracking clays with occasional shallow linear and melonhole gilgai.
- *surface soil:* very dark grey, very dark greyish brown, medium clay, occasionally light clay. Weakly to moderately self-mulching with moderate surface cracking. Mildly to moderately alkaline (pH 7.5-8.0).
- *subsoil:* dark grey, dark brown or dark greyish brown, medium to heavy clay. Strongly alkaline (pH 8.5-9.0). Sodic and very highly saline subsoils.
- PAWC is moderately high (150-200 mm).
- responds to N, Zn and K.

Land use limitations

- susceptible to severe water erosion and overland erosive flooding,
- PAWC is limited in areas by depth to the sodic subsoil.

Land use suitability

This soil is ideally suited to continual grain cropping with good nutrition and rotations for weed and disease control.

- like a *Waco*, this soil is easily worked and one of the most highly valued of the clays.
- suitable for most field and forage crops.
- suitable field crops include: wheat, barley, chickpeas, sorghum, cotton, sunflowers, mungbeans and millets.
- suitable forage crops include: oats, forage sorghum, lucerne and lab lab.
- suitable for furrow, spray and trickle irrigation.
- suitable for grazing native and most sown pastures.
- suitable sown pastures include: Katambora Rhodes grass, purple pigeon grass, bisset creeping bluegrass, bambatsi panic, lucerne and medics.
- key native pastures species include: Queensland forest and pitted bluegrass and native trefoils.
- although highly suitable for grazing native and most sown pastures, very little is used for this purpose due to high returns from cropping.

Best management practices

Cropping

- strip cropping is recommended for erosion control and spreading of overland flow and/or flood water.
- adopt conservation farming practices to maximise ground cover and infiltration, reduce water erosion, and assist in maintaining good surface soil structure.
- structural soil conservation measures will be required with cultivation on slopes.
- presswheels or rollers are useful in aiding crop establishment.
- ley pastures should be used in areas where high volumes of runoff water occurs. These should be managed to prevent excessive silt build-up which will divert flows.

Vegetation

- conservation status of remnant vegetation is *endangered*.
- planning guidelines and restrictions apply to clearing and land development.

Grazing

- strategic grazing and spelling of pastures is required to maximise pasture vigour.
- overgrazing is indicated by the invasion of inferior and unpalatable species such as black cotton bush and speargrass.
- sulphur required to maintain sown species.
- adjust stocking rates to suit seasonal conditions.
- stocking rates *native pasture* 1 AE/2.5-3.0 ha.
  sown pasture 1 AE/1.0 ha.

ELPHINSTONE

Common soil in LRA: 8a

Brief description

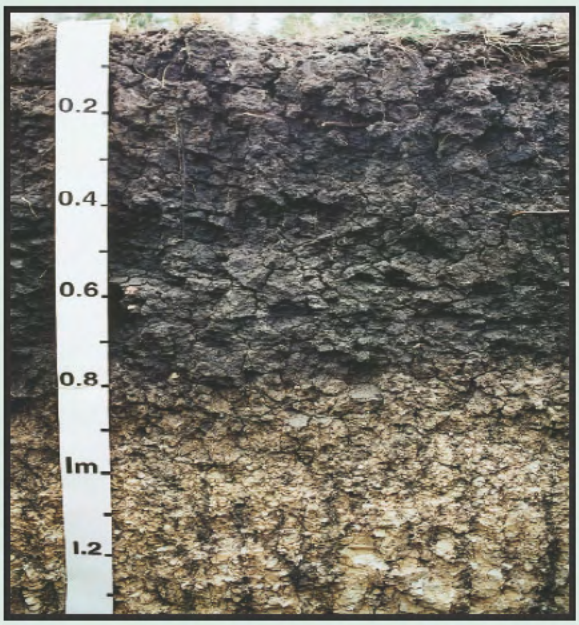
Elphinstone is a deep (100-150 cm), fine self-mulching, black cracking clay on fine-grained sandstone (includes the soils *Cresley* and *Juan*).

Landform and distribution

- slopes (2-6%) of gently undulating to undulating plains and rises.
- mostly found in a narrow, roughly north-south band from Kaimkillenbun to Pittsworth.
- linear gilgai are a feature

Vegetation

- open woodland of poplar box.
- associated species include narrow-leaved ironbark and Queensland blue gum.
- mostly cleared.
- Regional Ecosystem 11.9.7



Example soil profile description

Depth (cm)	Description
0-40	black; fine sandy medium clay to heavy clay; strong fine granular structure; diffuse to:
40-75	black with brownish grey mottle; fine sandy heavy clay to heavy clay; strong medium blocky to lenticular structure; diffuse to:
75-95	black with brownish grey mottle; fine sandy heavy clay to heavy clay; strong coarse to medium lenticular structure; calcium carbonate; diffuse to:
95-115	yellowish brown and yellowish grey, light medium clay to heavy clay; strong coarse to medium blocky or lenticular structure; calcium carbonate.

Australian Soil Classification: Epihypersodic, Self-mulching, Black Vertosol

General soil features

- deep, self-mulching, cracking clay with linear gilgai.
- *surface soil:* dark grey to black, light medium to medium heavy clay. Finely self-mulching with moderate surface cracking. Slightly acid (pH 6.5).
- *subsoil:* dark grey to black, with brownish grey mottles, grading to yellowish brown or yellowish grey with depth. Strongly sodic and highly saline at depth. Strongly alkaline (pH 8.5).
- gilgai microrelief is apparent under native pasture but disappears with cultivation.
- good workability.
- PAWC is moderate (100-150 mm).
- 60-70% of PAW is held in the top 45 cm of the soil.
- responds to P and N and perhaps S and K.

Land use limitations

- susceptible to severe sheet, rill and gully erosion.
- subsoils highly sodic and saline at depth.
- PAWC is limited by depth to sodic and saline subsoils.
- crops will suffer from heat stress and low moisture due to moderate PAWC. This will be very noticeable on the "puffs" of gilgai.
- prone to surface structure decline under continuous cultivation, and surface crusting may occur.
- prone to wind erosion when surface structure becomes powdery.
- shallow saline water tables and seepages may cause salinity at the boundary between sandstone and basalt soils in mid to lower slope positions.

Land use suitability

This soil is suitable for continual grain and forage cropping.

- suitable for most grain and fodder crops.
- suitable grain crops include: wheat, barley, chickpeas, sorghum, sunflowers, mungbeans and millets.
- suitable forage crops include: oats, forage sorghum and lab lab.
- suitable for furrow, spray and trickle irrigation.
- suitable sown pasture species include: Katambora Rhodes grass, creeping bluegrass, bambatsi, lucerne and medics.
- key native pasture species include: Queensland forest and pitted bluegrass.
- subsoil salts will be leached downward with cereal cropping, increasing the effective rooting depth and hence the plant available water capacity.
- although highly suitable for grazing native and most sown pastures, very little is used due to the high returns from cropping.

Best management practices

Cropping

- excellent soil for planting and germinating small seeds.
- adopt conservation farming practices to maximise ground cover, infiltration and reduce water erosion, and assist in maintaining good surface soil structure.
- structural soil conservation measures will be required with cultivation on slopes. Recommend broad based contour banks to prevent failure from cracking.
- phosphorus better at planting as a starter fertilizer.
- desirable to include pastures in rotation to maintain fertility and soil structure.

Vegetation

- conservation status of remnant vegetation is *endangered*.
- planning guidelines and restrictions apply to clearing and land development.

Grazing

- strategic grazing and spelling of pastures is required to maximise pasture vigour.
- overgrazing is indicated by the invasion of inferior and unpalatable species such as black cotton bush, wire grass and speargrass.
- sulphur required to maintain sown species.
- adjust stocking rates to suit seasonal conditions.
- stocking rates *native pasture* 1 AE/2.5-3.0 ha.
  sown pasture 1 AE/1.0 ha.

FLINTON

Associated soil in LRA: 12a

Brief description

Flinton is a moderately deep to deep (50-100 cm) soil, with sandy loam to loam surface, and red or brown clay loam to clay structureless subsoil on lateritised sandstone (includes the soils *Spotted* and *Glen*).

Landform and distribution

- minor soil of sandstone rises and undulating plains west of the Condamine.
- mid slopes (1-3%) of undulating rises and broad lateritised sandstone crests north and east of Jandowae.

Vegetation

- open forest of narrow-leaved ironbark and spotted gum with red ash, quinine bush, black wattle and other acacia species.
- long-fruited bloodwood on sandier areas, good forbs and herbage amongst the native grasses.
- partly cleared
- Regional Ecosystems 11.5.9/11.10.1

Example soil profile description

Depth (cm)	Description
0-35	dark brown; sandy loam; weakly structured; clear to:
35-65	dark reddish brown; coarse sandy clay loam; massive; clear to:
65-85	red; light clay; massive; abundant ironstone gravel; clear to:
85-105	yellowish red; light clay; massive.

Australian Soil Classification: Acidic, Mellic, Red Kandosol

General soil features

- soils of variable depth (50 cm to >100 cm) depending on slope position. Increases in clay content with depth.
- *surface soil:* reddish brown to dark brown with textures varying from sandy loam to sandy clay loam. Medium acid (pH 5.5 to 6.0).
- *subsoil:* colours are redder on mid and upper slopes and become yellower on lower slopes. Structure usually massive. Textures vary from clay loam to light clay or occasionally medium clay. Strongly to very strongly acid (pH 4.5-4.8).
- PAWC is moderate (100-150 mm).
- ironstone gravels are a common feature of these soils; manganese may occur at depth.
- usually occurs below *Knoll* and above *Channing* in the landscape with *Arden* on footslopes.
- low fertility - responds to N, P, K, Cu, Zn & Mo.

Land use limitations

- low fertility and moderate PAWC.
- generally not suited to intensive livestock industries (e.g. feedlots, piggeries) due to potential for contamination of ground-water.
- surface structure deteriorates with cultivation making it prone to forming hard surface crusts.
- wattle, spotted gum, quinine and bitterbark regrowth after clearing.
- plough pans will develop if continually worked at the same depth under moist conditions.
- very abrasive on tines and other ground tools if worked dry.

Land use suitability

This soil is suited to grazing native and sown pastures along with short term cropping while developing and renovating land. Sandier phase is suitable to dryland horticultural crops.

- suitable for short term cropping and fodder crops while developing and renovating land.
- suitable crops include barley and triticale forage.
- suitable forage crops include: oats and forage sorghum.
- summer crops will suffer from heat stress due to moderate PAWC.
- suitable for grazing native and most sown pastures.
- suitrable sown pastures species include: Katambora Rhodes grass, creeping bluegrass, buffel grass, digit grass, Wynn cassia and lucerne.
- key native species include: pitted bluegrass, black speargrass and wire grass.
- suitable timber species for milling and farm use.
- good bee and native conservation country - if not cleared.

Best management practices

Cropping

- short-term cropping (barley, triticale or forage crops) is carried out to control regrowth and before sowing pastures, when developing land.
- responds well to small falls of rain but crops will suffer water stress earlier than heavier clay soils.
- adopt conservation farming practices to maximise ground cover and infiltration, reduce water erosion, and assist in maintaining good surface soil structure.
- desirable to include pastures in rotation to maintain fertility and soil structure.
- avoid concentration of water to avoid gully erosion.

Vegetation

- conservation status of remnant vegetation is currently *not of concern*.
- planning guidelines and restrictions apply to clearing and land development.

Grazing

- grazing native and sown pastures is regarded by many farmers as being the best use for these soils. Ripping opens up the soil to increase infiltration and reduce runoff.
- developed areas will be susceptible to regrowth.
- avoid "hot" fires that may encourage wattle regrowth.
- wattle regrowth is a major problem if mechanically cleared.
- strategic grazing and spelling of pastures is required to maximise pasture vigour.
- fertilising with phosphorus and sulphur will improve pasture production.
- low phosphorus has been known to lead to "bone chewing" by grazing animals.
- adjust stocking rates to suit seasonal conditions.
- stocking rates *native pasture* 1 AE/4.0-10.0 ha.
  sown pasture 1 AE/3.0-8.0 ha.

FORMARTIN

Associated soil in LRA: 2c.

Brief description

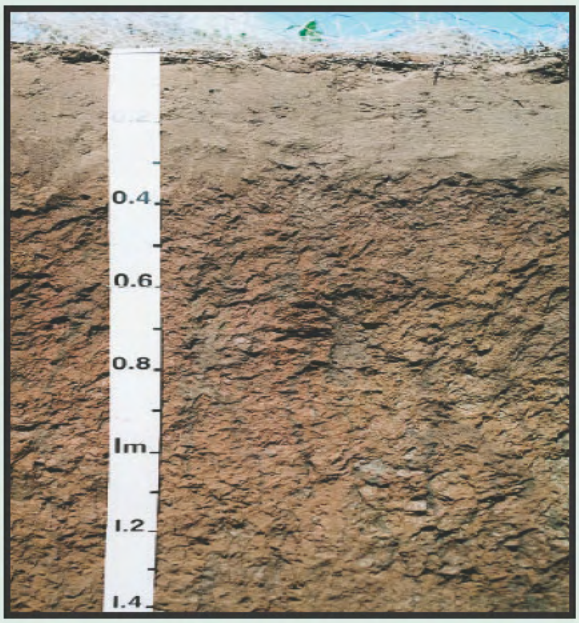
Formartin is a deep texture contrast soil on mixed basaltic and sandstone alluvial plains with a thick (30-60 cm), reddish brown, hardsetting loamy surface, over red-brown clay subsoils.

Landform and distribution

- minor component on the Oakey/ Jondaryan flat alluvial plains occurring from Oakey through Formartin to the Condamine River.
- exists as small "islands"; slightly higher than the rest of the plain.

Vegetation

- grassy open woodland of poplar box and occasionally Moreton Bay ash.
- mostly cleared.
- Regional Ecosystem 11.3.2



Example soil profile description

Depth (cm)	Description
0-15	dark greyish brown; sand; loose; abrupt to:
15-80	pale brown; sand; loose; abrupt to:
80-140	grey; sandy clay loam; massive; abrupt to:
140-160	light brownish grey; sandy clay loam; massive.

Australian Soil Classification: Haplic, Eutrophic, Brown Chromosol

General soil features

- texture contrast soils with a sharp change between the surface and the subsoils.
- *surface soil:* reddish brown crusting to hardsetting loamy sand to light sandy clay loam. Slightly acid (pH 6.0).
- *subsoil:* dark reddish brown to dark brown light to medium clay with occasional sand lenses. Slightly acid to moderately alkaline (pH 6.5-8.0).
- PAWC is low (50-100 mm).
- responds to N, P, Cu and occasionally K and Zn.

FORMARTIN

Land use limitations

- moderately fertile soils with low PAWC and hardsetting surfaces.
- surface structure deteriorates with continuous cultivation and forms a hard surface crust after heavy rain.
- workability difficult due to hardsetting surface soil.
- susceptible to wind and water erosion if surface soil is unprotected. "Sand blasting" of young crops is associated with wind erosion.
- very abrasive on tines and other ground tools.
- commonly occurs in association with clay soils such as *Waco* and *Cecilvale*. Seepage zones can be present along the boundary where it meets these soils.
- occasional manganese toxicity associated with acidification.
- acidification may be a problem.
- generally not suited to intensive livestock industries (e.g. feedlots, piggeries) due to potential for contamination of ground-water.

Land use suitability

With good management techniques this soil is suitable for cropping and grazing pastures.

- suitable for most grain and forage crops.
- suitable grain crops include: wheat, barley, chickpeas, mungbeans and millets.
- suitable forage crops include: oats, forage sorghum, lucerne, cowpeas and lab lab.
- suitable for spray and trickle irrigation.
- summer crops will suffer from heat stress due to low PAWC.
- suitable for grazing native and most sown pastures.
- suitable sown pasture species include: Katambora Rhodes grass, creeping bluegrass, purple pigeon grass, buffel grass, digit grass and medics.
- key native pasture species include: Queensland and pitted bluegrass.
- responds well to small falls of rain.
- used for building construction in preference to associated heavy black soils.

Best management practices

Cropping

- adopt conservation farming practices to maximise ground cover and infiltration, reduce water and wind erosion and assist in maintaining good surface soil structure.
- soil management is important as these soils do not crack and naturally repair themselves.
- pasture phase strongly recommended to maintain surface structure.
- crusting makes these soils relatively unsuitable to straight zero-till fallows.
- strip cropping is recommended for erosion control and spreading of overland flow and/or flood water.

Vegetation

- conservation status of remnant vegetation is *endangered*.
- planning guidelines and restrictions apply to clearing and land development.

Grazing

- grazing native and sown pastures is regarded by many farmers as being the best use for these soils.
- can withstand reasonable grazing pressure - heavy overgrazing is indicated by the invasion of inferior and unpalatable species black cotton bush and white spear grass.
- strategic grazing and spelling of pastures is required to maximise pasture vigour.
- fertilising with sulphur will improve pasture production.
- adjust stocking rates to suit seasonal conditions.
- stocking rates *native pasture* 1 AE/3.0-3.5 ha. *sown pasture* 1 AE/2.5 ha.

GAMMIE

Common soil in LRA: 14a

Brief description

Gammie is a very shallow to shallow (20-40 cm), gravelly, hardsetting brown loam over a bleached brown acid subsoil on traprock (includes the soil *Silverwood)*.

Landform and distribution

- undulating low traprock hills and isolated traprock knolls in the Koorongara, Sandy Creek and Mt Bodumba area south of Millmerran.
- slopes 6-15%.

Vegetation

- grassy woodland of brown box with fuzzy box and yellow box or
- shrubby open forest of mugga ironbark and broad-leaved red ironbark.
- partly cleared.
- Regional Ecosystems 13.3.3/13.11.4/ 13.11.5

Example soil profile description

Depth (cm)	Description
0-10	dark brown; clay loam; hardsetting; massive; gravelly; gradual to:
10-20	yellowish brown; bleached when dry; clay loam; massive; gravelly; gradual to:
20-40	as above; interspersed with weathered rock; gradual to:
40+	rock.

Australian Soil Classification: Haplic, Eutrophic, Brown Kandosol

General soil features

- very shallow to shallow, gravelly, clay loams.
- *surface soil:* brown to dark brown, gravelly, hardsetting loams to clay loams. Slightly acid (pH 6.5).
- *subsoil:* brown to yellowish brown or bleached clay loam. Massive and gravelly. Grading to weathered rock between 30-40cm. Medium acid to mildly alkaline (pH 6.0-7.5).
- stony surface.
- PAWC is very low (<50 mm).
- very low fertility - responds to N, P, Cu and Zn.

GAMMIE

Land use limitations

- very low fertility and very low PAWC; shallow rooting depth and hardsetting surfaces.
- high erosion risk due to steep slopes.
- stoniness and rockiness.
- waterlogging - depending on slope.
- overgrazed areas are susceptible to scalding.
- regrowth, particularly of eucalypt and wattle when cleared.
- effective rooting depth is 20-30cm or depth to rock.
- generally not suited to intensive livestock industries (e.g. feedlots, piggeries) due to potential for contamination of groundwater through the underlying permeable rock.

Land use suitability

This soil is best suited to native conservation. Suitable for grazing native pastures only. Limited suitability for grazing sown pastures on lower slopes.

- small areas on gentle slopes with reasonable soil depth are suitable for sown pastures.
- suitable sown pastures species include: Katambora Rhodes grass, premier digit grass, and medics.
- key native pasture species include: Queensland bluegrass and pitted bluegrass.
- good bee and nature conservation country - if not cleared.
- ironbark is only of medium quality (hollow or cracks), may be useful farm timber.
- protect as valuable watershed country.

Best management practices

Cropping

- not recommended.

Vegetation

- conservation status of remnant vegetation is *endangered*.
- planning guidelines and restrictions apply to clearing and land development.

Grazing

- ensure there is a follow-up plan for controlling regrowth after clearing.
- restrict grazing to retain pasture cover (above 30% basal cover) to ensure that more desirable species are not grazed out and to prevent erosion.
- increase infiltration by shallow ripping with chisel ploughs on scalded areas.
- strategic grazing and spelling is required to allow pastures to bulk up and set seed
- if band-seeding, use a chisel plough with narrow points on the contour.
- strategically locate watering points to avoid areas of overgrazing; use centrally located watering points/200ha). Scalding may become a problem where there are insufficient or badly located watering points.
- on gentle slopes with reasonable soil depth, use fully prepared seedbeds with superphosphate application (150 kg/ha) for establishing sown pastures.
- topdress sown pastures with 100 kg/ha of superphosphate after 2 years.
- adjust stocking rates to suit seasonal conditions.
- overgrazing will result in the surface scalding and the invasion of unpalatable and inferior species such as wire grass, slender bamboo grass, windmill grass and woody weeds (wild rosemary, wattle regrowth).
- use rotational grazing to suppress wire grass.
- weaner ill health can arise in badly rundown pastures due to poor pasture nutrition.
- stocking rates *native pasture* 1 AE/8.0-10.0 ha.
  sown pasture 1 AE/3.0-5.0 ha.

GATE

Common soil in LRA: 6c

Brief description

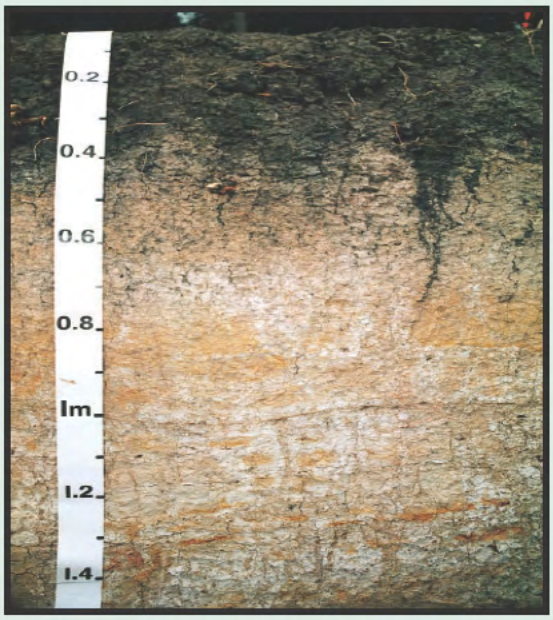
Gate is a moderately deep to deep grey-brown to grey clay over grey or yellowish grey clays with moderate gilgai under brigalow/belah with black tea tree on fine-grained sandstone.

Landform and distribution

- mid to upper slopes and broad ridges of slightly undulating Brigalow Uplands south of Millmerran.
- slopes 2-6%.

Vegetation

- layered open forest of brigalow, belah and wilga with black tea tree.
- occasional gum-topped box.
- mostly cleared.
- Regional Ecosystem 11.9.5



Example soil profile description

Depth (cm)	Description
0-20	dark grey; light medium clay; moderate angular blocky; clear to:
20-45	dark grey; medium heavy clay; strong coarse blocky to lenticular; clear to:
45-70	pale brown: medium clay; strong coarse blocky to lenticular; gradual to:
70-120	medium clay.
120+	weathered sandstone.

Australian Soil Classification: Endohypersodic, Crusty, Grey Vertosol

General soil features

- moderately deep to deep, uniform, medium to heavy clays with moderate gilgai.
- *surface soil:* dark greyish brown to very dark grey, cracking clays. Weakly self-mulching. Slightly acid to neutral (pH 6.5-7.0).
- *subsoil:* grey to yellowish brown, medium to heavy clays. Neutral to strongly alkaline in the upper subsoil (pH 7.0-8.5), to moderately to strongly acid (pH 5.0-6.0) at depth. Strongly sodic and moderately saline at depth.
- PAWC is moderate (100-150 mm).
- responds to N, P, Cu, S and possibly Zn.

Land use limitations

- susceptible to severe water erosion.
- PAWC is limited by depth to sodic/saline subsoils.
- workability is difficult on areas of moderate gilgai (during establishment and harvesting).

Land use suitability

This is a very versatile soil and is well suited to most pastures and short -season forage and grain crops. It is excellent for improved pastures.

- suitable for winter grain and short season fodder crops.
- suitable grain crops include: wheat, barley, mung beans, millets and panicums.
- suitable forage crops include: oats, forage sorghum and lab lab.
- suitable for spray and trickle irrigation.
- summer crops will suffer from heat stress due to moderate PAWC.
- suitable for grazing native and most sown pastures.
- suitable sown pastures species include: Katambora Rhodes grass, premier digit grass, green and Gatton panic, purple pigeon grass, creeping bluegrass, lucerne and medics.
- key native pasture species include: Queensland and pitted bluegrass, native clovers and treefoil.

Best management practices

Cropping

- adopt conservation farming practices to maximise ground cover, infiltration and reduce water erosion, and assist in maintaining good surface soil structure.
- structural soil conservation measures will be required with cultivation on slopes.
- presswheels or rollers are useful in aiding crop establishment.
- desirable to include pastures in rotation to maintain fertility and soil structure.
- easy workability with no germination problems.
- moisture levels will be the determining factor on crop choice.

Vegetation

- conservation status of remnant vegetation is *endangered.*
- planning guidelines and restrictions apply to clearing and land development.

Grazing

- pasture rotation with cultivation is regarded by many farmers as being the best use for these soils.
- strategic grazing and spelling of pastures is required to maximise pasture vigour.
- overgrazing is indicated by the invasion of inferior and unpalatable species such as cottonbush, couch and white speargrass.
- sulphur required to maintain sown species.
- couch and urochloa can be useful sources of feed. Rhodes and buffel grass regarded as second grade feeds to the panic species.
- adjust stocking rates to suit seasonal conditions.
- stocking rates *native pasture* 1 AE/3.0 ha.
  sown pasture 1 AE/1.5 ha.

HANMER

Associated soil in LRAs: 12a and 12b

Brief description

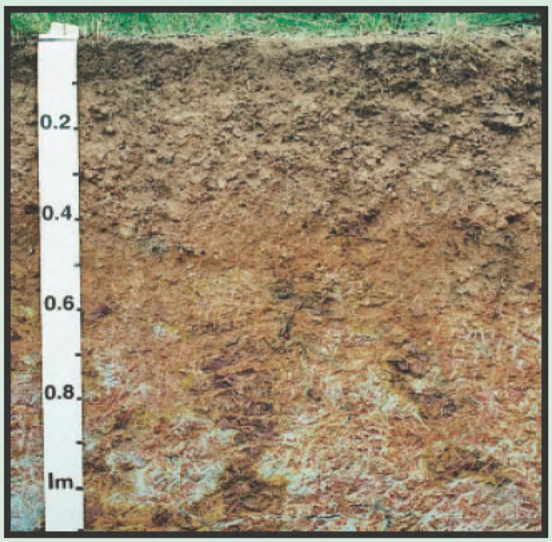
Hanmer is a shallow to moderately deep, minor texture contrast acid soil with hardsetting, dark brown gravelly loams over red to grey clay subsoils on coarse-grained sandstone.

Landform and distribution

- flat topped sandstone ridges and steep scarps (jump-ups) south east of Millmerran.
- slopes range from 0-15% on the ridge tops. Steeper slopes on scarps to vertical on the scarps.
- some rock outcrops with associated shallow stony sands.

Vegetation

- shrubby/grassy woodland of narrow-leaved ironbark and Queensland blue gum with tumble down gum and broad-leaved stringybark.
- vine thicket or "softwood scrub".
- partly cleared.
- Regional Ecosystem 11.7.4



Example soil profile description

Depth (cm)	Description
0-10	grey; sandy loam; many coarse fragments; weakly structured; clear to:
10-45	brown; sandy loam; abundant gravel; massive; gradual to:
45-55	red; heavy clay; weak polyhedral structure; few coarse fragments; gradual to:
55-90	red with grey mottles; medium clay; weak blocky structure; quartz and ironstone fragments common; diffuse to:
90+	grey with red mottles; light clay; weak polyhedral structure; sandstone fragments.

Australian Soil Classification: Mottled, Magnesic, Red Kurosol.

General soil features

- texture contrast soil with a sharp change between the surface soil and subsoil.
- *surface soil:* brown to dark brown, hardsetting, gravelly loam to clay loam. A bleached sub-surface layer varying in thickness occurs above the subsoil. Medium acid (pH 5.5-6.0).
- *subsoil:* red to reddish brown to grey, blocky clays. Impermeable and mottled at depth. Very strongly acid (pH 4.5-5.0).
- PAWC is very low to low (<50-100 mm).
- responds to N, P, K, Cu and Zn.

Land use limitations

- very low fertility and very low to low PAWC, shallow rooting depth and hardsetting surfaces.
- shallow surface soils and impermeable subsoils make these soils extremely susceptible to erosion and waterlogging.
- root penetration into the subsoil is negligible due to the high bulk density.
- regrowth, particularly of eucalypts when cleared.
- steep slopes in some areas.
- many farmers have found that developing this type of country will provide very little return on initial investment.

Land use suitability

This soil is best left suited to native timber production and native conservation. Suitable for grazing native pastures only.

- suitable for low intensity grazing of native pastures in the summer for breeders and store cattle.
- very low suitability for the establishment of sown pastures on the deeper A horizons such as Katambora Rhodes grass and Wynn Cassia.
- good bee and native conservation country, if not cleared.
- narrow-leaved ironbark useful for farm timber - some milling timber may be available.

Best management practices

Cropping

- not recommended.

Vegetation

- conservation status of remnant vegetation is currently *not of concern*.
- planning guidelines and restrictions apply to clearing and land development.

Grazing

- recommend strategic thinning of timber using chemical methods. Mechanical methods will only result in severe regrowth problems.
- native pastures are wiregrass (*Aristida spp*) dominated; management should encourage opening of wire grass clumps and the growth of less dominant grasses (eg. 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.
- superphosphate will improve pasture production.
- strategic grazing and spelling of pastures is required to maximise pasture vigour.
- adjust stocking rates to suit seasonal conditions.
- stocking rates *native pasture* 1AE/10.0-15.0 ha.

HASLEMERE

Common soil in LRAs: 1a, 1b, 3a, 4a

Associated soil in LRAs: 2b, 5a, 5b and 9a

Brief description

Haslemere is a deep texture contrast soil with a thin (<20 cm), bleached, sandy loam to clay loam surface, over black, dark brown or grey clay subsoils on alluvial plains of mixed origin (includes the soils *Dalmeny, Arubial, Canal, Bogandilla, Yambocully* and *Valley).*

Landform and distribution

- slight rises on the Condamine River floodplain.
- also found on valley floors and flat plains associated with local drainage lines.

Vegetation

- grassy open woodland of poplar box and wilga with scattered Queensland blue gum and Moreton Bay ash. Occasional fuzzy box, grey box, narrow-leaved ironbark, belah, false sandalwood and wattles.
- mostly cleared.
- Regional Ecosystem 11.3.2

Example soil profile description

Depth (cm)	Description
0-5	dark greyish brown; sandy clay loam to clay loam; hard-setting; massive; sporadic bleach at subsoil interface; abrupt to:
5-30	very dark grey; medium to heavy clay; strong coarse blocky or prismatic structure; clear to:
30-100	dark grey; heavy clay; strong coarse to lenticular structure; few coarse soft calcareous segregations; clear to:
100-120	brown; few very coarse distinct orange mottles; medium to heavy clay; moderate blocky to lenticular structure; very few coarse soft calcareous segregations.

Australian Soil Classification: Sodic, Eutrophic, Brown Chromosol

General soil features

- texture contrast soil with a sharp change between the surface and the subsoil.
- *surface soil*: thin, commonly 10-15 cm. Dark brown to very dark grey sandy loam to clay loam. Sporadic bleach occurs (occasionally a conspicuous bleach), indicating poorly drained and sodic subsoils. Massive. Slightly acid to neutral (pH 6.0-7.0).
- *subsoil*: dark brown, black, to brownish grey clays which may be mottled. Strong blocky structure with conspicuous domes at top of B horizon. Moderately to strongly alkaline (pH 8.0-9.0). Strongly sodic and moderately to highly saline.
- PAWC is low (50-100 mm).
- responds to N, P, S, and Zn.

HASLEMERE

Land use limitations

- moderately fertile soils with low PAWC and restricted rooting depth due to strongly sodic and relatively impermeable subsoils.
- subsoils have a high bulk density.
- workability difficult due to hardsetting surface soil.
- susceptible to wind and water erosion if surface soil is unprotected. "Sand blasting" of young crops associated with wind erosion.
- *Haslemere* is often surrounded by heavy clays such as *Mywybilla, Condamine, Cecilvale and Anchorfield.*

Land use suitability

Management of this soil is difficult where it occurs in cultivation with other more arable floodplain soils. Where it occurs in large areas it is best suited to pastures. It is a very marginal cropping soil requiring good management for success.

- if in large areas on its own and not in association with high value black clays, many farmers would advise against developing this soil as it would return little on investment.
- suitable for furrow, spray and trickle irrigation.
- summer forage crops will suffer from heat stress due to low PAWC.
- suitable for grazing native and most sown pastures.
- suitable sown pasture species include: Katambora Rhodes grass, bisset creeping bluegrass, buffel grass and medics.
- key native species include: Queensland forest and pitted bluegrass.
- responds well to small falls of rain.
- used for building construction in preference to associated heavy black soils.

Best management practices

Cropping

- this soil is generally not recommended for cropping. It often occurs as small isolated islands in larger paddocks of good black alluvial clays making separate management extremely difficult. Where large areas can be cultivated separately, the following management options are recommended:
  - adopt conservation farming practices to maximise groundcover and infiltration, reduce water erosion and assist in maintaining good surface soil structure.
  - strip cropping is recommended for erosion control and spreading of overland flow and/or flood water.
  - pasture phase strongly recommended to maintain surface structure.

Vegetation

- conservation status of remnant vegetation is *threatened*.
- planning guidelines and restrictions apply to clearing and land development.

Grazing

- strategic grazing and spelling of pastures is required to maximise pasture vigour.
- overgrazing will result in the invasion of unpalatable and inferior species such as white spear or wiregrass.
- buffel will run down without medics, medics have difficulty surviving dry winters.
- adjust stocking rates to suit seasonal conditions.
- stocking rates *native pasture* 1 AE/4.0-8.0 ha.
  sown pasture 1 AE/3.0-8.0 ha.

IRVING

Common soil in LRA: 7a

Brief description

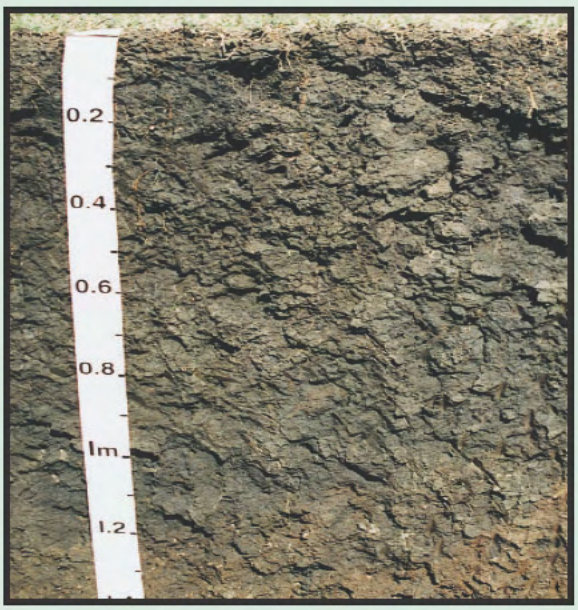
Irving is a deep to very deep (100-180 cm), fine self-mulching, brownish black cracking clay with brown or reddish brown subsoils on basaltic colluvium (includes the soil *Mahen*).

Landform and distribution

- occurs on mid and lower slopes of low basalt hills and rises.

Vegetation

- open woodland with mountain coolibah.
- mostly cleared to grassland.
- Regional Ecosystem 11.8.5



Example soil profile description

Depth (cm)	Description
0-15	very dark grey; medium to heavy clay; strong fine granular structure; gradual to:
15-30	very dark grey; medium heavy to heavy clay; coarse sub-angular blocky to blocky structure; diffuse to:
30-60	very dark grey-brown; heavy clay; coarse blocky to lenticular structure; some soft and nodular carbonate; gradual to:
60-120	reddish brown; heavy clay; lenticular to blocky structure; soft and nodular carbonate;
145-175	brown; medium heavy clay; strong lenticular; few calcareous soft segregations.

Australian Soil Classification: Haplic, Self-mulching, Black Vertosol

General soil features

- deep, neutral to alkaline, cracking clays with fine, self-mulching surface.
- linear gilgai may occur.
- *surface soil:* brownish black to very dark brown, heavy clay. Neutral to mildly alkaline (pH 7.0-7.5). Structure is strong fine granular. Very friable to friable when moist.
- *subsoil:* dark brownish black to reddish brown medium heavy clay. Strong, fine to medium blocky structure, becoming medium coarse blocky to lenticular with increasing depth. Nodular carbonate throughout.
- PAWC is very high (>250 mm).
- responds to N, P, S, & possibly Zn.

Land use limitations

- susceptible to severe sheet, rill and gully erosion.

Land use suitability

This soil is ideally suited to continual grain and cotton cropping with good nutrition and rotations for weed and disease control.

- like a *Waco*, this soil is easily worked and one of the most highly valued of the basalt clays.
- suitable for most dryland and irrigated grain and fodder crops.
- suitable field crops include: wheat, barley, chickpeas, sorghum, cotton, sunflowers, mungbeans and millets.
- suitable forage crops include: oats, forage sorghum, lucerne and lab lab.
- suitable for furrow, spray and trickle irrigation.
- suitable for grazing native and most sown pastures.
- suitable sown pastures include: Katambora Rhodes grass, purple pigeon grass, bisset creeping bluegrass, bambatsi panic, lucerne and medics.
- key native pastures species include: Queensland forest and pitted bluegrass and native trefoils.
- although highly suitable for grazing native and most sown pastures, very little is used for this purpose due to the high returns from cropping.

Best management practices

Cropping

- adopt conservation farming practices to maximise ground cover and infiltration, reduce water erosion, and assist in maintaining good surface soil structure.
- structural soil conservation measures will be required with cultivation.

Vegetation

- conservation status of remnant vegetation is currently *not of concern*.
- planning guidelines and restrictions apply to clearing and land development.

Grazing

- overgrazing is indicated by the invasion of inferior and unpalatable species such as foxtail, white speargrass.
- strategic grazing and spelling of pastures is required to maximise pasture vigour.
- sulphur required to maintain sown species.
- adjust stocking rates to suit seasonal conditions.
- stocking rates *native pasture* 1 AE/2.5-3.0 ha.
  sown pasture 1 AE/1.0 ha.

KARANGI

Common soil in LRA: 14a

Brief description

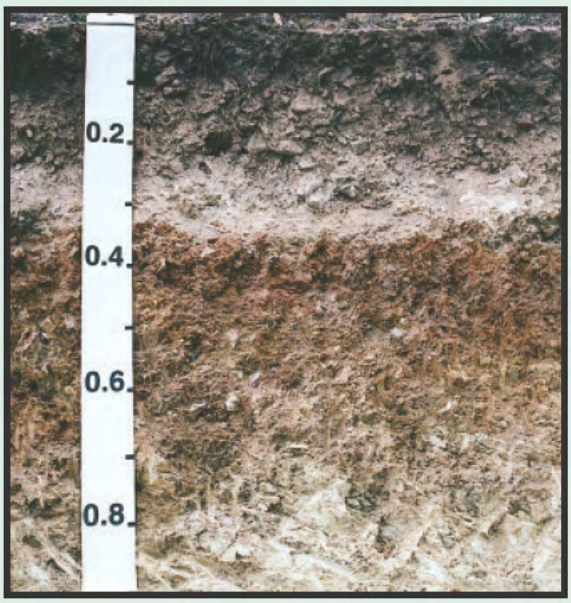
Karangi is a shallow to moderately deep texture contrast soil with a gravelly, hardsetting, brown loamy surface over reddish brown or yellowish brown clays on traprock (includes the soil *Thane).*

Landform and distribution

- undulating to rolling low traprock hills and ridges in the Koorongara, Sandy Creek and Mt Bodumba area south of Millmerran.
- slopes 6-15%.

Vegetation

- layered open forest of narrow-leaved ironbark, dusky-leaved ironbark and tumbledown gum with some grey box, yellow box, spotted gum and wattles.
- mostly cleared.
- Regional Ecosystems 13.11.3/13.11.5



Example soil profile description

Depth (cm)	Description
0-20	brown; clay loam; hardsetting; massive; very abundant large pebbles; clear to:
20-35	grey; bleached when dry; sandy clay loam; very abundant large pebbles; massive; clear to:
35-55	brown; with yellow mottles; medium heavy clay; moderate coarse blocky structure; very few small pebbles; gradual to:
55-70	yellow, mottled red, medium clay; massive; rock fragments; diffuse to:
70+	weathered rock.

Australian Soil Classification: Eutrophic, Subnatric, Brown Sodosol

General soil features

- texture contrast soils with a sharp change between the surface and the subsoils.
- *surface soil*: brown to dark brown, thin to thick (15-30 cm), frequently hardsetting, massive and gravelly. Textures vary from sandy loam to clay loam, usually loam or sandy clay loam. Conspicuously bleached sub-surface layer. Medium acid (pH 6.0).
- *subsoil:* from reddish brown, brown or yellowish brown clays with red or yellow mottles. Structure is moderate to coarse blocky or columnar. Slightly acid to mildly alkaline (pH 6.5-7.5). Sodic to strongly sodic and highly saline below 50 cm.
- PAWC is very low to low (<50-100 mm).
- low fertility - responds to P, N, Cu and occasionally Zn and K.

KARANGI

Land use limitations

- low fertility with very low to low PAWC, shallow rooting depth and hardsetting surfaces.
- erosion risk due to steep slopes.
- stoniness and rockiness.
- waterlogging - depending on slope.
- overgrazed areas are susceptible to scalding.
- subsoils are strongly sodic and highly saline.
- moderate workability restriction due to hardsetting surface soil.
- with gentle slopes and resonable soil depths areas are suitable for cultivation to establish sown pastures.
- regrowth, particularly of eucalypts and wattle when cleared.
- effective rooting depth and PAWC depends on rock content and depth to rock.

Land use suitability

This soil is best suited to nature conservation; suitable for grazing native pastures with some potential for grazing sown pastures in better soils with deeper A horizons on lower slopes.

- suitable for grazing native and sown pastures.
- suitable sown pasture species include: Katambora Rhodes grass, premier digitaria and forest bluegrass with cluster, rose, sub-soil and white clover.
- key native pasture species include: Queensland forest and pitted bluegrass.
- good bee and nature conservation country if not cleared.
- ironbark is only of medium quality (hollows or cracks); may be useful farm timber.
- protect as valuable watershed country.

Best management practices

Cropping

- not recommended.

Vegetation

- conservation status of remnant vegetation is currently *not of concern*.
- planning guidelines and restrictions apply to clearing and land development.

Grazing

- ensure there is a follow-up plan for regrowth when clearing.
- restrict grazing to retain pasture cover (above 30% basal cover) to ensure more desirable species are not grazed out and to prevent erosion.
- increase infiltration by shallow ripping with chisel ploughs on scalded areas.
- strategic grazing and spelling is required to allow pastures to bulk up and set seed.
- if band-seeding, use a chisel plough with narrow points along contour.
- strategically locate watering points to avoid areas of overgrazing, use centrally located watering points (1 watering point / 200ha) - scalding may become a problem where there are insufficient or badly located watering points.
- on areas with gentle slopes and deeper A horizons, use fully prepared seedbeds with superphosphate application (150 kg/ha) for establishing sown pastures.
- top-dress sown pastures with 100 kg/ha of superphosphate after 2 years.
- adjust stocking rates to suit seasonal conditions.
- overgrazing will result in surface scalding and the invasion of unpalatable and inferior species such as wire grass, slender bamboo grass, windmill grass and woody weeds (wild rosemary, wattle regrowth).
- use of heavy rotational grazing to suppress wire grass.
- weaner ill health can arise in badly run-down pastures due to poor pasture nutrition.
- stocking rates *native pasture* 1AE/8.0-10.0 ha. *sown pasture* 1AE/3.0-5.0 ha.

KENMUIR

Common soil in LRAs: 7a 7b 7c

Associated soil in LRAs: 6a, 6b and 8a

Brief description

Kenmuir is a very shallow (5-25 cm) gravelly or stony, brown loam or clay loam on basalt (includes the soil *Marley*).

Landform and distribution

- steep hillslopes and scarps (10-20% or steeper) and crests of flat-topped and rounded low hills to hills on basalt.

Vegetation

- grassy forest to tall woodland of narrow-leaved ironbark or mountain coolibah.
- may have a softwood scrub understorey.
- partly cleared.
- Regional Ecosystems 11.8.3/11.8.4/ 11.8.5/11.8.8

Example soil profile description

Depth (cm)	Description
0-10	brown; clay loam; weak to moderate granular structure; abundant gravel; abrupt/clear to:
10-25	dark reddish brown; light clay; moderate to strong blocky structure; common gravel or stone; gradual to:
25+	basalt

Australian Soil Classification: Haplic Eutrophic Brown Dermosol

General soil features

- very shallow gravelly or stony, loams or clay loams.
- *surface soil:* brown to dark reddish brown, loam to clay loam. Strong fine to medium granular structure. Slightly acid to neutral (pH 6.5-7.0). Abundant gravel and cobbles (floaters) with some rock outcrop.
- *subsoil:* brown to dark reddish brown, clay loam to light clay. Increasing amounts of gravel and stone with depth. Moderate, fine to medium blocky structure. Red, reddish brown or yellowish brown clay occurs as pockets amongst the stone in lower subsoils. Well drained.
- PAWC is very low (<50 mm).
- responds to N, P, S and occasionally K.

Land use limitations

- low fertility, very low PAWC and shallow rooting depth.
- rockiness severely limits any use of machinery on these soils. Can be dominated by boulders.
- susceptible to erosion due to snuffy surface and structure breakdown resulting from overgrazing.
- generally not suited to intensive livestock industries (e.g. feedlots, piggeries) due to potential of contamination of ground-water supplies through the underlying permeable fractured basalt.

Land use suitability

This soil is best suited to native timber production and nature conservation.

- suitable sown pasture species include: creeping blue grass, Katambora Rhodes grass and some barrel medics.
- key native pasture species include: Queensland and pitted bluegrass, native clovers and trefoil.
- ideal for rural residential development.
- non-cracking soil and underlying rock provide good foundations for buildings and structures.
- good source of gravel.
- good bee and nature conservation country.
- ironbark can be a good source of farm and millable timber.

Best management practices

Cropping

- not recommended.

Vegetation

- conservation status of remnant vegetation is *endangered*.
- planning guidelines and restrictions apply to clearing and land development.

Grazing

- overgrazing is indicated by the invasion of inferior and unpalatable species such as foxtail, white speargrass.
- strategic grazing and spelling of pastures is required to maximise pasture vigour.
- when establishing or rejuvenating sown pastures, shallow surface disturbance is required with discs (to roll over the stones) during autumn.
- sulphur required to maintain sown species.
- adjust stocking rates to suit seasonal conditions.
- stocking rates *native pasture* 1 AE/10.0-12.0 ha (with some supplementary feed during winter).

KNOLL

Common soil in LRA: 12b

Associated soil in LRAs: 6a, 6b, 6c, 10a and 12a

Brief description

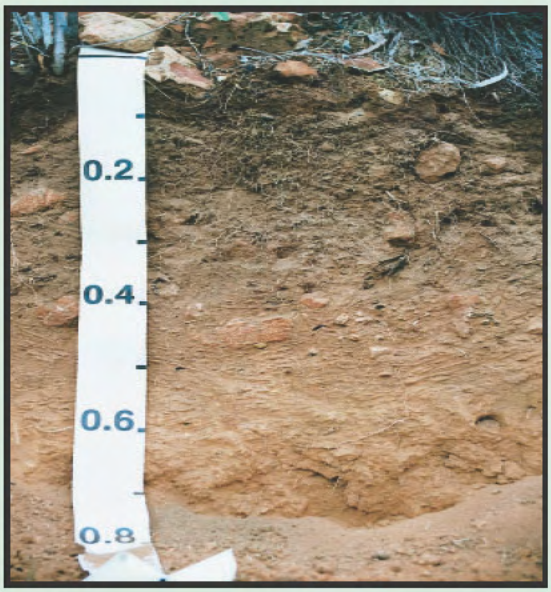
Knoll is a very shallow, gravelly soil on sandstone. It varies from grey to reddish brown sandy loams (includes the soils *Minnabilla*, *Karbullah*, *Rock*, *Bony* and *Wattle Glen*).

Landform and distribution

- rocky hilltops, or steep hillslopes (5-15%) and jump-ups of lateritised sandstone.

Vegetation

- layered open forest of narrow-leaved, broad-leaved red and blue-leaved ironbark, spotted gum, rusty gum, and some cypress pine, wattles and poplar box.
- partly cleared.
- Regional Ecosystem 11.7.4



Example soil profile description

Depth (cm)	Description
0-5	dark brown; loamy sand; loose; sandstone gravel; gradual to:
5-30	yellowish brown to brown; sand to loamy sand; loose; sandstone gravel; clear to:
30+	decomposing sandstone.

Australian Soil Classification: Paralithic, Leptic Rudosol

General soil features

- uniform texture profiles; texture varies from sandy loam to loam, occasionally sand. Texture may occasionally increase with depth.
- usually <45 cm deep, gravelly with rock outcrops common.
- colour varies considerably, usually dark grey, grey or reddish brown. May occasionally be black.
- slightly acid throughout (pH 6.5).
- PAWC is very low (<50 mm).
- very low fertility - responds to N, P, K, Cu and Zn.

KNOLL

Land use limitations

- very low fertility, very low PAWC and shallow rooting depth.
- shallow soil depth and steep slopes.
- rockiness severely limits any use of machinery on these soils.
- regrowth difficult to control.
- susceptible to erosion and requires a continuous cover to reduce soil loss from water erosion.
- generally not suited to intensive livestock industries (e.g. feedlots, piggeries) due to potential for contamination ground-water supplies through the underlying permeable sandstone.

Land use suitability

This soil is best left in its native state, and used for timber production and nature conservation. Suitable for grazing native pastures only.

- key native pasture species include: hooky grass, slender panic, gilgai grass, purple lovegrass, curly windmill grass and poverty grass.
- good bee and native conservation country if not cleared .
- narrow leaved ironbark and spotted gum may be useful farm and millable timber.
- non-cracking soil and underlying rock provide good foundations for buildings and structures.

Best management practices

Cropping

- not recommended.

Vegetation

- conservation status of remnant vegetation is currently *not of concern*.
- planning guidelines and restrictions apply to clearing and land development.

Grazing

- unsuitable for sown pasture development.
- clearing and overgrazing should be avoided; tree and grass cover will reduce runoff and soil loss.
- adjust stocking rates to suit seasonal conditions.
- stocking rates *native pasture* 1 AE/20.0-30.0 ha.

KUPUNN

Common soil in LRA: 5a

Associated soil in LRA: 5b

Brief description

Kupunn is a deep to very deep (100–160 cm) self-mulching, grey or greyish brown cracking clay, with shallow gilgai, on the brigalow claysheet.

Landform and distribution

- flat to very gently undulating brigalow clay plains north of Warra and around Kupunn, west of Dalby.

Vegetation

- brigalow, belah, wilga scrub, black tea tree in low lying areas.
- mostly cleared.
- Regional Ecosystem 11.4.3

Example soil profile description

Depth (cm)	Description
0-5	dark greyish brown; light medium clay; weakly self-mulching; weak angular blocky; abrupt to:
5-20	dark greyish brown; light medium clay to medium heavy clay; strong angular blocky; few soft carbonate segregations; clear to:
20-70	greyish brown; medium clay; moderate lenticular; some gravel and soft carbonate segregations; clear to:
70-120	brown; medium heavy clay; weak coarse lenticular; some gravel and soft carbonate segregations; gradual to:
120-150	brown; medium heavy clay, weak coarse lenticular; slickensides.

Australian Soil Classification: Endohypersodic or Epihypersodic, Self-Mulching, Grey Vertosol

General soil features

- very deep, self-mulching, cracking clays with shallow gilgai (15-30 cm).
- *surface soil:* dark greyish brown or grey clays, angular blocky structure. Strongly alkaline (pH 8.5).
- *subsoil:* dark grey structured clays, becoming browner with depth. Strongly to mildly alkaline (pH 9.0-7.8) upper subsoils, to strongly acid (pH 4.5-5.5) in the deep subsoil. Structure weakens with depth. Strongly sodic and saline at depth.
- PAWC is high (200-250 mm).
- responds to N, Cu and recommend using starter phosphate.

Land use limitations

- PAWC is limited by strongly sodic and saline subsoils.
- occasional erosive flooding.
- regrowth, particularly of brigalow.

Land use suitability

This soil is ideally suited to continual grain and cotton cropping with good nutrition and rotations for weed and disease control.

- like a *Waco*, this soil is easily worked and one of the most highly valued of the clays.
- suitable for most grain and forage crops.
- suitable field crops include: wheat, barley, chickpeas, sorghum, cotton, sunflowers, mungbeans and millets.
- suitable forage crops include: oats, forage sorghum, lucerne and lab lab.
- suitable for furrow, spray and trickle irrigation.
- suitable for grazing native and most sown pastures.
- suitable sown pasture species include: purple pigeon grass, bisset creeping bluegrass, bambatsi panic, lucerne and medics.
- key native pastures species include: Queensland forest and pitted bluegrass and native trefoils.
- although highly suitable for grazing native and most sown pastures, very little exists due to the economics of cropping.

Best management practices

Cropping

- strip cropping is recommended for erosion control and spreading of overland flow and/or flood water.
- adopt conservation farming practices to maximise groundcover and infiltration, reduce water erosion, and assist in maintaining good surface soil structure.
- the use of presswheels or rollers are useful in aiding crop establishment.
- ley pastures used in high water run-on areas to disperse the water should be managed to prevent excessive silt build up which will divert flows.

Vegetation

- conservation status of remnant vegetation is *endangered*.
- planning guidelines and restrictions apply to clearing and land development.

Grazing

- strategic grazing and spelling of pastures is required to maximise pasture vigour.
- overgrazing is indicated by the invasion of inferior and unpalatable species such as speargrass, dog burr and sedges.
- sulphur required to maintain sown species.
- adjust stocking rates to suit seasonal conditions.
- stocking rates *native pasture* 1 AE/2.5-3.0 ha.
  sown pasture 1 AE/1.0 ha.

KURUMBUL

Common soil in LRA: 6d

Brief description

Kurumbul is a deep, friable, dark or brown, texture contrast soil on fine-grained sandstone and the brigalow claysheet.

Landform and distribution

- elevated, level plains and undulating rises south-west of Cecil Plains and Millmerran.
- occurs west of the Kumbarilla Ridge.

Vegetation

- tall, open forest of belah with occasional brigalow, poplar box or gum-topped box.
- understorey of wilga and false sandalwood.
- mostly cleared.
- Regional Ecosystem 11.3.17

Example soil profile description

Depth (cm)	Description
0-5	brown; clay loam; massive; minor quartz gravel; sharp to:
5-7	as above, slight bleaching; sharp to:
7-15	dark; heavy clay; moderate coarse blocky structure; minor quartz gravel; abrupt to:
15-85	grey; heavy clay; strong coarse blocky to lenticular structure; minor quartz gravel; few soft carbonate segregations, some gypsum crystals between 60 and 85 cm; abrupt to:
85-150	grey; heavy clay; moderate coarse lenticular structure; minor quartz gravel; few gypsum crystals.

Australian Soil Classification: Gypsic, Subnatric, Grey Sodosol

General soil features

- texture contrast soil with a sharp change between the surface soil and the subsoil.
- *surface soil:* dark or brown, clay loam. Poorly structured. Neutral (pH 7.0).
- *subsoil:* grey, well structured, heavy clays. Strongly alkaline upper subsoils, (pH 9.0) to moderately acid (pH 5.5-6.0) in the deep subsoil. Strongly sodic and highly saline at depth.
- PAWC is moderate (100-150 mm).
- responds to N, P, Cu and Zn.

KURUMBUL

Land use limitations

- moderately fertile soils low to moderate water holding capacity and hardsetting surfaces.
- surface structure deteriorates with continuous cultivation.
- prone to forming a hard surface crust after heavy rain. This crust is extremely hard to penetrate with tined implements until the soil is wetted.
- abrasive on tines and other cultivation equipment if soil worked dry.
- sodic and relatively impermeable subsoils are susceptible to gullying if exposed.
- rooting depth may vary depending on depth to saline layer.

Land use suitability

This soil is suited to continual grain and cotton cropping with good nutrition and rotations for weed and disease control.

- suitable for most grain and forage crops.
- suitable grain crops include: wheat, barley, chickpeas, sorghum, sunflowers, mungbeans, canola, safflower, triticale and millets.
- suitable forage crops include: oats, forage sorghum, cowpea and lab lab.
- suitable for flood, spray or trickle irrigation.
- suitable for grazing native and most sown pastures.
- suitable sown pastures include: Katambora Rhodes grass, buffell grass, purple pigeon grass, bambatsi panic, creeping bluegrass, lucerne and medics.
- key native pastures species include: Queensland bluegrass, curly windmill grass, Warrego grass, fairy grass, weeping panic and slender canegrass.
- although highly suitable for grazing native and most sown pastures, very little is used for this purpose due to the high returns from cropping.

Best management practices

Cropping

- adopt conservation farming practices to maximise ground cover and infiltration, reduce water erosion and assist in maintaining good surface soil structure.
- presswheels or rollers are useful in aiding crop establishment.
- pasture phase strongly recommended to maintain surface structure.
- apply phosphorus with crops and annual forages at planting.

Vegetation

- conservation status of remnant vegetation is *endangered*.
- planning guidelines and restrictions apply to clearing and land development.

Grazing

- strategic grazing and spelling of pastures is required to maximise pasture vigour.
- overgrazing is indicated by the invasion of inferior and unpalatable species such as speargrass, dog burr and sedges.
- sulphur required to maintain sown species.
- adjust stocking rates to suit seasonal conditions.
- stocking rates *native pasture* 1 AE/4.0-8.0 ha.
  sown pasture 1 AE/3.0-5.0 ha.

LANGLANDS

Associated soil in LRA: 5a

Brief description

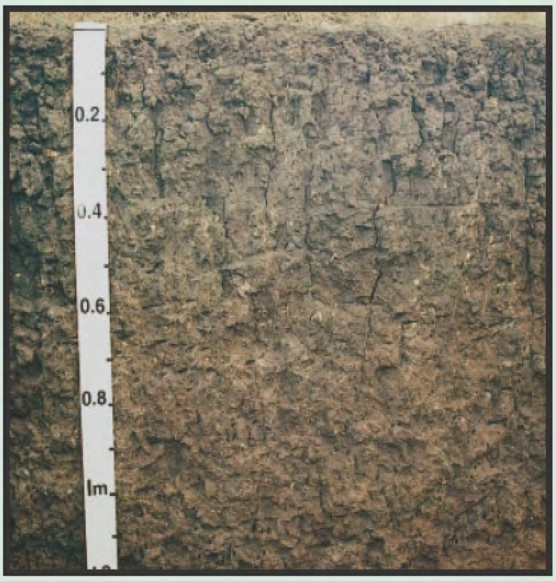
Langlands is a deep to very deep (100-160 cm), weakly self-mulching, brown to greyish brown cracking clay with moderately deep to deep gilgai on the brigalow claysheet.

Landform and distribution

- flat to very gently undulating brigalow plains north of Warra and around Kupunn, west of Dalby.
- common in the Langlands/Wychie area associated with Dead Man Gully and Canaga Creek.

Vegetation

- brigalow, belah, wilga scrub, black tea tree in low lying areas.
- higher proportion of belah indicates lighter clay surface soils and often larger, rolling melonholes.
- brigalow/tea tree mix indicates heavier surface conditions.
- mostly cleared.
- Regional Ecosystem 11.4.3



Example soil profile description

Depth (cm)	Description
0-5	brownish grey; light clay; clear to:
5-35	brownish grey; few fine faint orange mottles; heavy clay; coarse blocky structure; very few medium calcareous concretions; gradual to:
35-100	brownish grey; heavy clay; coarse lenticular structure; very few medium manganiferous nodules; gradual to:
100-160	brownish grey; greyish yellow-brown; medium heavy clay; coarse lenticular structure.

Australian Soil Classification: Epihypersodic, Self-mulching, Grey Vertosol (depression)
Epihypersodic-Acidic, Epipedal Brown Vertosol (mound)

General soil features

- very deep, weakly self-mulching, cracking clays with moderately deep to deep gilgai (30-150cm).
- *surface soil:* brown to greyish brown clays. Weakly self mulching to surface, crusting. Mounds pale brown. Neutral to moderately alkaline (pH 7.0-8.0).
- *subsoil:* grey brown becoming browner with depth. Strongly alkaline (pH 9.0) in upper subsoils to strongly acid (pH 5.5) in the deep subsoil. Variable with gilgai. Strongly sodic and saline at depth.
- PAWC is moderate (100-150 mm).
- responds to N, P and Zn - especially after land levelling.

Land use limitations

- PAWC is limited by depth to the sodic and highly saline subsoil.
- workability is difficult because of soil variation and microrelief associated with melonholes.
- levelling will expose strongly sodic and highly saline subsoils which causes plant growth problems.
- occasional overland erosive flooding.
- breaks down to a fine powder with excessive cultivation - wind erosion may occur.
- more abrasive on points than heavier *Kupunn* brigalow soils.
- regrowth, particularly of limebush and brigalow is a problem.

Land use suitability

This soil is ideally suited to continual grain cropping with good nutrition and rotations for weed and disease control.

- suitable for most field and forage crops except cotton due to insufficient PAWC.
- suitable grain crops include: wheat, barley, chickpeas, sorghum, sunflowers, mungbeans and millets.
- suitable forage crops include: oats, forage sorghum, lucene and lab lab.
- suitable for furrow, spray and trickle irrigation.
- suitable sown pasture species include: Katambora Rhodes grass, purple pigeon grass, bambatsi, green panic, lucerne, snail and barrel medics. Buffel grass is best suited to the lighter surface textures in the belah country.
- key native pasture species include: Queensland bluegrass, fairy grass, curly windmill and creeping windmill grass, brigalow grass, creeping saltbush and swamp couch in melonholes.

Best management practices

Cropping

- strip cropping is recommended for erosion control and spreading of overland flow and/or flood water.
- adopt conservation farming practices to maximise groundcover and infiltration, reduce water erosion, and assist in maintaining good surface soil structure.
- presswheels or rollers are useful in aiding crop establishment.
- desirable to include pastures in rotation to maintain or improve organic matter levels.

Vegetation

- conservation status of remnant vegetation is *endangered*.
- planning guidelines and restrictions apply to clearing and land development.

Grazing

- strategic grazing and spelling of pastures is required to maximise pasture vigour.
- overgrazing is indicated by the invasion of inferior and unpalatable species such as speargrass, dog burr and sedges.
- sulphur required to maintain sown species.
- adjust stocking rates to suit seasonal conditions.
- stocking rates *native pasture* 1 AE/2.5-3.0 ha.
  sown pasture 1 AE/1.0 ha.

LEYBURN

Common soil in LRAs: 4a, 9a

Associated soil in LRAs: 3a, 11a, 12a and 14a.

Brief description

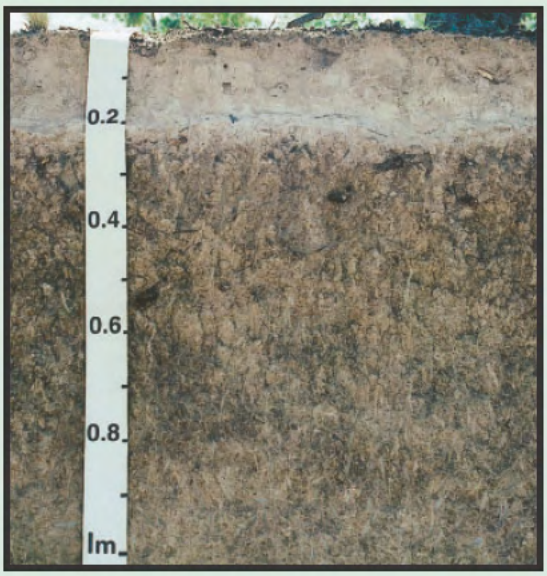
Leyburn is a deep (100-150 cm) texture contrast soil with a shallow, hardsetting surface, underlain by a bleached A2 and a yellowish brown to brown clay subsoil (includes the soils *Gully* and *Wilkie*).

Landform and distribution

- flat plains and very gently sloping (<1%) valley floors of mixed sandstone and traprock alluvium.

Vegetation

- poplar box grassy woodland with wilga; or
- poplar box, gum topped box open forest.
- mostly cleared.
- Regional Ecosystem 11.3.2/11.3.26



Example soil profile description

Depth (cm)	Description
0-5	dark yellowish brown; fine sandy clay loam; massive; clear to:
5-20	brown; bleached when dry; clay loam; massive; abrupt to:
20-60	yellowish brown; medium clay; moderate coarse angular blocky or prismatic structure; gradual to:
60-110	brown; medium clay; weak to moderate coarse prismatic structure.

Australian Soil Classification: Eutrophic, Subnatric, Brown Sodosol

General soil features

- texture contrast soil with a sharp change between the surface and the subsoil.
- *surface soil*: hardsetting, loamy sand to clay loams underlain by a bleached A2 to 10-40 cm. Occasional gravel. Slightly acid to neutral (pH 6.0-7.0).
- *subsoil*: yellowish brown and brown, coarse blocky or columnar structured impermeable clays. Neutral to strongly alkaline (pH 7.0-8.5). Strongly sodic from 50 cm and highly saline from 50-90cm.
- PAWC is low (50 mm).
- responds to N, P and Cu.

LEYBURN

Land use limitations

- moderately fertile soil with low PAWC and shallow effective rooting depth due to sodic and saline subsoils.
- surface structure deteriorates with cultivation and forms a hard surface crust after heavy rain.
- workability difficult due to hardsetting surface soil.
- susceptible to wind and water erosion if surface soil is unprotected.
- subsoils have a high bulk density.
- seasonal waterlogging due to impermeable subsoils.
- very abrasive on tines and other cultivation equipment if worked dry.
- sodic and relatively impermeable subsoils susceptible to gullying if exposed.

Land use suitability

This soil is suited to grazing native and sown pastures only.

- suitable sown pasture species include: Katambora Rhodes grass, creeping bluegrass, purple pigeon grass, buffel grass, premier digit grass, medics and subclovers.
- key native grasses include: Queensland and pitted bluegrass.

Best management practices

Cropping

- not recommended.

Vegetation

- conservation status of remnant vegetation is *of concern* (11.3.2).
- conservation status of remnant vegetation is currently *not of concern* (11.3.26).
- planning guidelines and restrictions apply to clearing and land development.

Grazing

- restrict grazing to retain pasture cover (above 30% basal cover) to ensure more desirable species are not grazed out and to prevent scalds forming.
- strategically locate watering points to avoid areas of overgrazing, use centrally located watering points (1 watering point / 200ha) - scalding may become a problem where there are insufficient or badly located watering points.
- recommend species suited for crusting soils and low to moderate fertility levels.
- strategic grazing and spelling is required to allow seed to set and pastures to bulk up.
- fertilising with phosphorus and sulphur will improve pasture production.
- adjust stocking rates to suit seasonal conditions.
- stocking rates *native pasture* 1 AE/3.0-3.5 ha.
  sown pasture 1 AE/2.5 ha.

MALLARD

Associated soil in LRA: 7a

Brief description

Mallard is a very shallow to shallow soil (20-40 cm), with brown to grey-brown clay loams, over gravelly, mottled, brown and red clay on basalt.

Landform and distribution

- occurs on upper slopes and broad flat ridges on basalt.

Vegetation

- woodland of mountain coolibah.
- partly cleared.
- Regional Ecosystem 11.8.5

Example soil profile description

Depth (cm)	Description
0-15	brown to dark brown; clay loam to light clay; moderate granular to fine blocky structure; gradual to:
15-30	dark reddish brown and brown; medium clay; moderate coarse blocky structure; some weathered basalt gravel; diffuse to:
30-45	mottled yellow, reddish brown and white clay; large amounts of basalt gravel.

Australian Soil Classification: Halpic, Eutrophic, Black Dermosol

General soil features

- *surface soil:* black, very dark grey or dark brown, clay loam. Weak fine crumb to moderate fine granular structure. Slightly acid to neutral (pH 6.5-7.0).
- *subsoil:* very dark grey or dark brown grading to dark brown, dark reddish brown or reddish brown, light clay to medium clay. Slightly acid to neutral (pH 6.5-7.5). Increasing basalt gravel with depth. Moderate to strong fine blocky structure.
- easy workability.
- PAWC is low (50 mm).
- responds to N, P, and S.

MALLARD

Land use limitations

- surface structure deteriorates with continuous cultivation.
- moderately susceptible to sheet, and rill and wind erosion when cultivated.
- PAWC is low due to shallow depth of soil and light texture.

Land use suitability

This soil is best suited to improved pastures and forage cropping. Possible opportunities for some grain crops.

- too shallow for continuous cropping.
- limited suitability for grain crops such as millets, panicums and barley.
- suitable for forage crops such as oats, lab lab, forage sorghum and cowpeas.
- suitable for grazing native and sown pastures such as Katambora Rhodes grass, purple pigeon grass, creeping bluegrass, lucerne and medics.

Best management practices

Cropping

- not recommended for continuous grain or forage cropping.
- pasture phase is recommended to maintain surface structure.
- structural soil conservation measures will be required with cultivation on slopes.
- adopt conservation farming practices to maximise groundcover and infiltration, reduce water erosion, and assist in maintaining good surface soil structure.

Vegetation

- conservation status of remnant vegetation is currently *not of concern*.
- planning guidelines and restrictions apply to clearing and land development.

Grazing

- sown pastures easily established.
- overgrazing is indicated by the invasion of inferior and unpalatable species such as wire grass.
- strategic grazing and spelling of pastures is required to maximise pasture vigour.
- sulphur will be required to maintain sown species.
- adjust stocking rates to suit seasonal conditions.
- stocking rates *native pasture* 1 AE/3.0 ha.
  sown pasture 1 AE/1.5 ha (with some supplementary feed during winter).

MIDDLE RIDGE

Associated soil in LRA: 7d

Brief description

Middle Ridge is a deep (100-150 cm), acid to neutral, non-cracking red clay soil on basalt on the Toowoomba Plateau.

Landform and distribution

- gently undulating plains on the Toowoomba Plateau.

Vegetation

- Queensland blue gum woodland.
- mostly cleared.
- Regional Ecosystem 11.8.2

Example soil profile description

Depth (cm)	Description
0-5	dark or red-brown; clay loam to light clay; strong granular; clear/abrupt to:
5-25	red-brown; light medium clay; moderate to sub-angular blocky or polyhedral; clear to:
25-60	red-brown or red; medium clay; moderate to strong sub-angular blocky or polyhedral, gradual/diffuse to:
60-160	red-brown or red; light medium clay to medium clay; moderate to strong sub-angular blocky or polyhedral.

Australian Soil Classification: Snuffy, Eutrophic, Red Ferrosol

General soil features

- deep, acid to neutral, clays with soft snuffy surfaces.
- *surface soil:* dark or red-brown clay loam to light medium clay. Strong granular to sub-angular blocky or polyhedral structure. Moderately acid to neutral (pH 6.0-7.0).
- *subsoil:* red-brown or red, light medium to medium clay. Strong sub-angular blocky or polyhedral structure. Moderately acid to neutral (pH 6.0-7.5).
- PAWC is moderate (100-150 mm).
- responds to N, P and K.

MIDDLE RIDGE

Land use limitations

- Phosphorus fixing.
- surface structure deteriorates with continuous cultivation, results in a "powdery" surface subject to wind and water erosion.
- high permeability and deep drainage.
- generally not suited to intensive livestock industries (e.g. feedlots, piggeries) due to potential pollution of underground water supplies through the underlying permeable fractured basalt.

Land use suitability

This soil is ideally suited to grain cropping, including peanuts and navy beans, but a pasture phase is recommended to restore surface structure.

- suitable for most field crops except cotton due to insufficient PAWC.
- suitable grain crops include: wheat, barley, chickpeas, sorghum, sunflowers, mungbeans, peanuts, navy beans, panicums and millets.
- suitable forage crops include: oats, forage sorghum, lucerne and lab lab.
- suitable for spray and trickle irrigation.
- summer crops may be subject to heat stress due to moderate PAWC.
- suitable for grazing native and most sown pastures.
- suitable sown pastures include: Katambora Rhodes grass, green and Gatton panic, purple pigeon grass, creeping bluegrass and medics.
- key native pasture species include: Queensland forest and pitted bluegrass.
- suitable for native flower production.
- suitable for horticultural crops if irrigation water is available - melons, grapes, pumpkins, stonefruit and citrus.
- much of the land suitable for agriculture has been used for urban development.

Best management practices

Cropping

- adopt conservation farming practices to maximise ground cover and infiltration, reduce water and wind erosion and assist in maintaining good soil surface structure.
- structural soil conservation measures will be required with cultivation on slopes.
- desirable to include pastures in rotation to maintain fertility and soil structure.
- responds well to small falls of rain in dry years and can produce better crops than the heavier clay soils.

Vegetation

- conservation status of remnant vegetation is currently *not of concern*.
- planning guidelines and restrictions apply to clearing and land development.

Grazing

- overgrazing is indicated by the invasion of inferior and unpalatable species such as foxtail and white speargrass.
- strategic grazing and spelling of pastures is required to maximise pasture vigour and encourage better native species to increase (e.g. bluegrass).
- fertilising with phosphorus and sulphur will improve pasture production.
- native couch and urochloa can be useful sources of feed.
- adjust stocking rates to suit seasonal conditions.
- stocking rates *native pasture* 1 AE/2.5-3.0 ha.
  sown pasture 1 AE/1.0 ha.

MILLMERRAN

Common soil in LRA: 2d

Associated soil in LRAs: 3a and 4a

Brief description

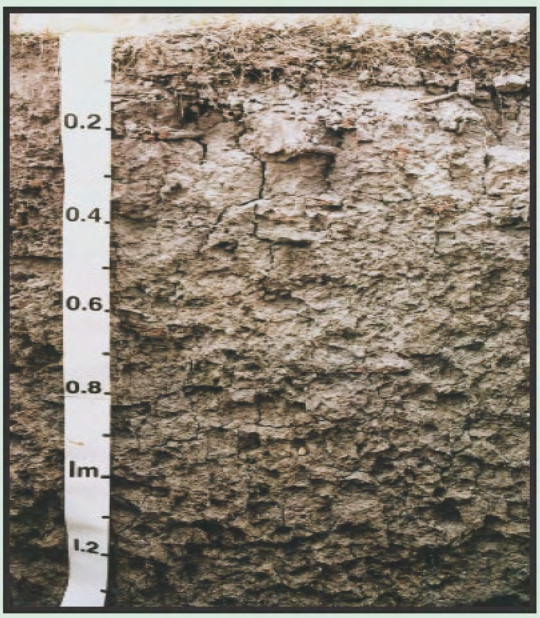
Millmerran is a moderately deep to deep (90-150 cm), grey cracking clay with a hardsetting surface which occurs on the mixed basaltic and sandstone alluvial plains (includes the soil *Cunningham*).

Landform and distribution

- elevated plains and very gently sloping (<1%) valley floors of mixed sandstone and basalt alluvium west of the Condamine River at Millmerran.

Vegetation

- poplar box grassy woodland with some wilga, belah and Queensland blue gum.
- occasional clumps of brigalow, wilga and the odd belah.
- mostly cleared.
- Regional Ecosystems 11.3.2/11.3.17



Example soil profile description

Depth (cm)	Description
0-10	very dark brown; fine sandy light clay; weak blocky structure; clear to:
10-15	light grey; light clay; few medium rounded ironstone pebbles; moderate blocky structure; clear to:
15-40	dark grey; medium heavy clay; strong prismatic; structure; gradual to:
40-70	greyish brown; medium heavy clay; strong lenticular structure; few medium manganiferous nodules; gradual to:
70-90	greyish brown, common medium faint brown mottles; medium heavy clay; moderate lenticular structure; few coarse calcareous concretions; gradual to:
90-130	light brownish grey; few fine faint yellow mottles; moderate lenticular structure; few coarse calcareous concretions.

Australian Soil Classification: Haplic, Epipedal, Grey Vertosol

General soil features

- deep, slightly acid to alkaline, cracking clays with hardsetting surfaces.
- *surface soil:* brown to grey-brown, light clay. Hardsetting. Moderately cracking. Occasionally a bleached sub-surface layer may occur. Coarse blocky structure. Medium acid (pH 5.5-6.0).
- *subsoil:* grey clays. Coarse blocky structure which may become massive at depth. Neutral to strongly alkaline (pH 7.0-8.5). Sodic to strongly sodic.
- PAWC is moderate (100-150 mm).
- responds to N, P, Zn and possibly K.

Land use limitations

- when cultivated, these soils puddle badly following rain and form a hard surface crust or seal making it difficult to maintain a fine seedbed condition.
- the surface crust results in impaired infiltration, poor germination and seedling emergence of small seeded crops and pastures.
- workability is difficult.
- abrasive on tines and other cultivation equipment if soil worked dry.
- occasional erosive flooding.
- flooding may limit crop choice and reduce production potential due to waterlogging.
- susceptible to wind and water erosion if surface soil is unprotected. "Sand blasting" of young crops associated with wind erosion.

Land use suitability

This soil is best suited to grain and forage cropping along with grazing pastures, however sound management is required.

- suitable for most grain and forage crops.
- suitable grain crops include: cotton, wheat, barley, millets, mungbeans.
- suitable forage crops include: oats, cowpeas, forage sorghum, lucerne and lab lab.
- suitable for furrow, spray and trickle irrigation.
- suitable for grazing native and most sown pastures.
- suitable sown pasture species include: Katambora Rhodes grass, creeping bluegrass, purple pigeon grass, digit grass, bambatsi, lucerne and medics.
- key native pastures include: Queensland bluegrass and native trefoils or medics.
- many farmers find these soils produce good malting barley.

Best management practices

Cropping

- management of the surface soil is the key to the management of these soils.
- presswheels or rollers are useful in aiding crop establishment.
- adopt conservation farming practices to maximise ground cover and infiltration, reduce water erosion and assist in maintaining good surface soil structure.
- desirable to include pastures in rotation to maintain fertility and soil structure.
- small seeded crops are difficult to establish (eg. millets, canary).
- because these soils are difficult to wet up, maintaining a protective mulch of stubble is especially important, or a rough surface condition in times of low cover.
- crusting makes these soils relatively unsuitable to straight zero-till fallows.
- summer crops will suffer from heat stress due to moderate PAWC.
- gypsum recommended to improve surface structure and infiltration - farmers commonly apply gypsum once every 3 to 4 years at 2 to 3.5 t/ha.
- strip cropping is recommended for erosion control and spreading of overland flow and/or flood water.

Vegetation

- conservation status of remnant vegetation is *endangered*.
- planning guidelines and restrictions apply to clearing and land development.

Grazing

- recommend species suited to crusting soils and low to moderate fertility levels.
- can withstand reasonable grazing pressure - overgrazing will result in the invasion of unpalatable and inferior species such as white speargrass or wire grass.
- strategic grazing and spelling is required to maximise pasture vigour.
- adjust stocking rates to suit seasonal conditions.
- stocking rates *native pasture* 1 AE/3.0 ha. *sown pasture* 1 AE/2.0 ha.

MOOLA

Common soil in LRAs: 6a 6b 6c

Brief description

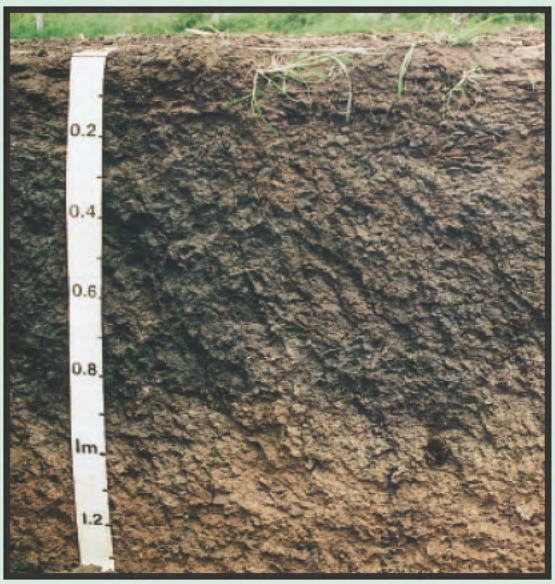
Moola is a moderately deep to deep (75-150 cm), self-mulching, grey-brown cracking clay with shallow gilgai on fine-grained sandstone (includes the soils *School)*.

Landform and distribution

- lower and mid slopes and broad ridges of undulating to rolling rises and low sandstone hills.
- slopes 1-5%.

Vegetation

- open forest of brigalow, belah and wilga.
- occasional sandalwood and softwood scrub species.
- mostly cleared.
- Regional Ecosystem 11.9.5



Example soil profile description

Depth (cm)	Description
0-20	dark brown; light clay; moderate blocky structure; some ironstone gravel; gradual to:
20-60	dark greyish brown; medium heavy clay; strong medium blocky structure; some ironstone gravel; gradual to:
60-100	dark yellowish brown; medium heavy clay; strong coarse lenticular structure; some ironstone gravel and carbonate nodules; clear to:
100+	pale yellow with yellow mottles; strong coarse lenticular structure; light clay.

Australian Soil Classification: Endohypersodic, Epipedal or Self-Mulching, Grey Vertosol

General soil features

- moderately deep to deep, uniform, medium to heavy clays with shallow gilgai.
- *surface soil:* greyish brown or dark brown clays. Usually self-mulching in depressions and surface sealing on mounds with moderate surface cracking. Moderately alkaline (pH 8.0).
- *subsoil:* very dark grey, light grey or dark greyish brown clays. Strongly alkaline (pH 8.5-9.0). Strongly sodic and highly saline at depth.
- gilgai tend to disappear with cultivation.
- PAWC is moderate (100-150 mm).
- responds to N, Zn, K, Cu and P.
- decomposing sandstone may be encountered at 60 cm or shallower on upper slopes. Floating sandstone may occur throughout the profile.

Land use limitations

- susceptible to severe water erosion.
- PAWC is limited by depth to sodic/saline subsoils.
- susceptible to wind erosion if worked fine when dry.
- sandstone "floaters" may cause problems in cultivation.

Land use suitability

This is a very versatile soil and is well suited to most pastures, forage and grain cropping. It is an excellent improved pasture soil.

- suitable for most grain and forage crops.
- suitable grain crops include: wheat, barley, chickpeas, mungbeans, sorghum, millets and panicums.
- not suited to cotton and growing lucerne (as a fodder crop) due to insufficient PAW.
- suitable forage crops include: oats, forage sorghum and lab lab.
- suitable for spray and trickle irrigation.
- summer crops will suffer from heat stress due to moderate PAWC.
- suitable for grazing native and most sown pastures.
- suitable sown pasture species include: Katambora Rhodes grass, bambatsi, purple pigeon grass, creeping bluegrass, lucerne and medics.
- key native pasture species include: Queensland and pitted bluegrass, native clovers and trefoils.
- although highly suitable for grazing native and most sown pastures, very little is used for this purpose due to the high returns of cropping.

Best management practices

Cropping

- adopt conservation farming practices to maximise groundcover and infiltration, reduce water erosion, and assist in maintaining good surface soil structure.
- structural soil conservation measures will be required with cultivation on slopes.
- the use of presswheels or rollers are useful in aiding crop establishment.
- desirable to include pastures in rotation to maintain fertility and soil structure.

Vegetation

- conservation status of remnant vegetation is *endangered.*
- planning guidelines and restrictions apply to clearing and land development.

Grazing

- strategic grazing and spelling of pastures is required to maximise pasture vigour.
- overgrazing is indicated by the invasion of inferior and unpalatable species such as cottonbush, couch and white speargrass.
- couch can be a useful source of feed.
- sulphur required to maintain sown species.
- adjust stocking rates to suit seasonal conditions.
- stocking rates *native pasture* 1 AE/2.5-3.0 ha.
  sown pasture 1 AE/1.0 ha.

MORUYA

Associated soil in LRA: 6d

Brief description

Moruya is a hardsetting, red-brown or brown texture contrast soil on fine-grained sandstone in the west and south-west.

Landform and distribution

- gently undulating plains or rises, scarp footslopes and broad valleys of the lowlands associated with the jump-ups, south-west of Cecil Plains and Millmerran.
- occurs west of the Kumbarilla Ridge. Local relief is less than 30m with most slopes between 1 and 3%.

Vegetation

- tall open forest of belah with occasional brigalow.
- understorey of wilga and false sandalwood.
- mostly cleared.
- Regional Ecosystem 11.9.5

Example soil profile description

Depth (cm)	Description
0-10	brown loam; massive; abrupt to:
10-15	red-brown clay loam with strong bleaching; massive; sharp to:
15-80	red-brown; medium clay; strong coarse blocky structure; some soft carbonate segregations and nodules mainly between 50 cm and 80 cm; clear to:
80-150	brown; slightly mottled, medium clay; moderate coarse blocky structure.

Australian Soil Classification: Eutrophic, Subnatric, Red Sodosol

General soil features

- texture contrast soil with a sharp change between the surface soil and the subsoil.
- *surface soil:* brown loam changing in the sub-surface to red-brown clay loam with strong bleach. Poorly structured. Moderately alkaline (pH 7.5-8.0).
- *subsoil:* red-brown to brown medium clay. Well structured. Strongly alkaline (pH 9.0-9.5) upper subsoils, to strongly acid (pH 5.5) in the deep subsoil. Strongly sodic and highly saline at depth.
- PAWC is low to moderate (50-150 mm).
- responds to N, P, Cu and Zn.

Land use limitations

- moderately fertile soils with low to moderate water holding capacity and hardsetting surfaces.
- surface structure deteriorates with continuous cultivation.
- prone to forming a hard surface crust after heavy rain.
- workability difficult due to hardsetting surface soil.
- abrasive on tines and other cultervation equipment if soil worked dry.
- sodic and relatively impermeable subsoils susceptible to gullying if exposed.
- rooting depth may vary depending on depth to saline layer.
- regrowth, particularly of limebush and brigalow is a problem.

Land use suitability

This soil is best suited to winter grain cropping and pasture production, however sound management is required.

- suitable for some grain and short-term forage crops.
- suitable grain crops include: wheat, barley, millets.
- suitable for most forage crops including: oats, forage sorghum, cowpea and lab lab.
- suitable for grazing native and sown pastures.
- suitable sown pasture species include: Katambora Rhodes grass, purple pigeon grass, buffel grass, creeping bluegrass and medics.
- key native species include: Queensland bluegrass, curly windmill grass, Warrego grass, fairy grass, weeping panic and slender canegrass.
- responds well to small falls of rain.

Best management practices

Cropping

- adopt conservation farming practices to maximise ground cover and infiltration, reduce water erosion, and assist in maintaining good surface soil structure.
- presswheels or rollers are useful in aiding crop establishment.
- pasture phase strongly recommended to maintain surface structure.
- apply phosphorus with crops and annual forages at planting.

Vegetation

- conservation status of remnant vegetation is *endangered*.
- planning guidelines and restrictions apply to clearing and land development.

Grazing

- strategic grazing and spelling of pastures is required to maximise pasture vigour.
- adjust stocking rates to suit seasonal conditions.
- overgrazing is indicated by the invasion of inferior and unpalatable species such as speargrass.
- sulphur required to maintain sown species.
- stocking rates *native pasture* 1 AE/7.0-10.0 ha.
  sown pasture 1 AE/3.0-5.0 ha.

MURRA CUL CUL

Common soil in LRA: 6d

Brief description

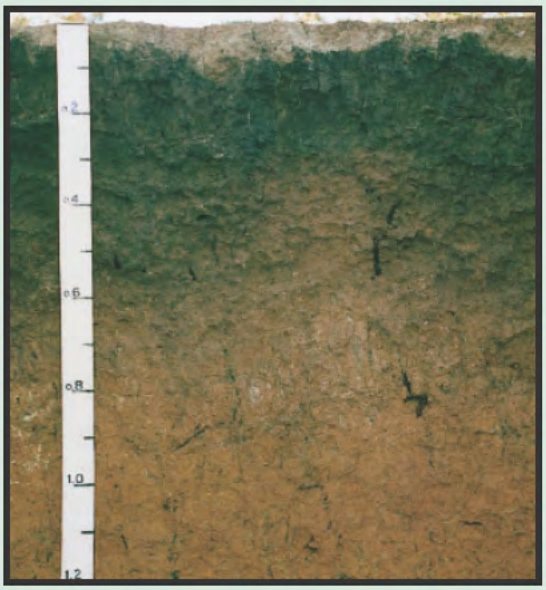
Murra Cul Cul is a dark or brown texture contrast soil, with poplar box woodland on narrow, alluvial plains of major creeks (includes the soil *Rogers*).

Landform and distribution

- level or gently undulating narrow alluvial plains and drainage floors of major creeks, west and south of Cecil Plains and Millmerran. Local relief is less than 9m with most slopes between 1 and 3%.

Vegetation

- tall open woodland of poplar box with occasional belah or myall. Understorey of false sandalwood and wilga.
- Regional Ecosystems 11.3.2/11.3.17



Example soil profile description

Depth (cm)	Description
0-5	brown; sandy clay loam; massive; minor gravel; abrupt to:
5-10	grey;strong bleaching when dry; sandy clay loam; massive; sharp to:
10-25	dark; heavy clay; moderate coarse blocky or prismatic structure; clear to:
25-85	brown; heavy clay; moderate coarse blocky or lenticular structure; minor gravel; a few soft carbonate segregations and nodules; some gypsum crystals and slight mottling below 60 cm; clear to:
85-150	yellow-brown; strongly mottled; medium clay; moderate coarse blocky structure; minor gravel.

Australian Soil Classification: Gypsic, Subnatric, Black Sodosol

General soil features

- texture contrast soils with a sharp change between surface and subsoil.
- *surface soil:* brown to grey sandy clay loam; massive; minor gravel ; neutral (pH 7.0), upper subsoil moderately to strongly alkaline (pH 8.0-8.5).
- *subsoil:* dark to brown heavy clay with minor gravel blocky structure.Lower subsoil mildly alkaline to very strongly acid (pH 7.5-5.0), to medium acid (pH 5.6-6.0) in the deep subsoil. Strongly sodic and high to extremely saline, below 20 cm. Salinity variable below 60 cm.
- effective rooting depth (40-80) cm.
- PAWC low to moderate (50-150 mm).
- responds to Cu.

MURRA CUL CUL

Land use limitations

- low fertility; low to modeerate PAWC and hardsetting surfaces.
- surface structure deteriorates with cultivation and forms a hard surface crust after heavy rain.
- workability difficult due to hardsetting surface.
- sodic and relatively impermeable subsoils succeptible to gullying if exposed.
- abrasive on tines and other cultivation equipment if worked dry.
- surface very "spewy" when wet.

Land use suitability

This soil suited to grazing native and sown pastures along with winter grain cropping and short-term forage crops while developing and renovating land.

- suitable for winter grain and short-term forage crops.
- suitable grain crops include: wheat, barley.
- suitable forage crops include: oats, forage sorghum, lab lab, snail medic and cowpea.
- suitable for grazing native and most sown pastures.
- suitable sown pasture species include: Katambora Rhodes grass, bambatsi, purple pigeon grass, creeping bluegrass, lucerne and barrel medic.
- key pasture species include: pitted bluegrass, rough speargrass, cordscrew grass, slender bluegrass, windmill grass, tall chloris, common fringerush and small saltbush.
- responds well to small falls of rain.

Best management practices

Cropping

- adopt conservation farming practices to maximise ground cover and infiltration, reduce water and wind erosion and assist in maintaining good soil surface structure.
- soil management is important as these soils do not crack and naturally repair themselves.
- pasture phase strongly recommended to maintain surface structure.
- crusting makes these soils relatively unsuitable to straight zero-till fallows.
- rotate crops with forages.
- presswheels or rollers are useful in aiding establishment of crops, forages and pastures.
- apply phosphorus fertilizer with crops and annual forages at planting.

Vegetation

- conservation status of remnant vegetation is *endangered.*
- planning guidelines and restrictions apply to clearing and land development.

Grazing

- grazing native and sown pastures is regarded by many farmers as being the best use for these soils.
- recommend species suited for crusting soils and low to moderate fertility levels.
- overgrazing is indicated by the invasion of unpalatable species such as speargrass, dog burr and sedges.
- strategic grazing and spelling of pastures is required to maximise pasture vigour.
- fertilizing with phosphorus and sulphur will improve pasture production.
- adjust stocking rates to suit seasonal conditions.
- stocking rates *native pasture* 1 AE/5.6 ha.
  sown pasture 1 AE/2.5 ha.

MYWYBILLA

Common soil in LRA: 1a

Associated soil in LRAs: 2a, 2b and 2c

Brief description

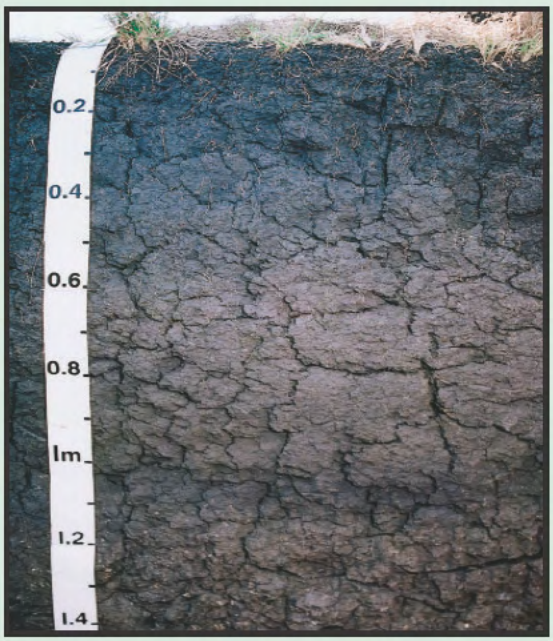
Mywybilla is a deep to very deep (100-180 cm) coarse self-mulching dark grey to black, cracking clay on alluvial plains of mixed origin (includes the soils *Tully* and *Glenmore*).

Landform and distribution

- gently sloping to flat alluvial plains associated with the Condamine River and tributaries.

Vegetation

- grassland of Queensland bluegrass or grassy tall open woodland with Queensland blue gum.
- mostly cleared.
- Regional Ecosystems 11.3.4/11.3.21



Example soil profile description

Depth (cm)	Description
0-12	brownish black; medium heavy clay; strong coarse granular structure; abrupt to:
12-27	brownish black; medium heavy clay; strong coarse blocky structure; clear to:
27-90	brownish black; medium heavy clay; moderate coarse lenticular structure; gradual to:
90-120	brownish grey; few medium prominent brown mottles; medium heavy clay; strong coarse lenticular structure; few medium calcareous nodules; gradual to:
120-170	brownish grey; very few coarse prominent brown mottles; medium heavy clay; strong coarse lenticular structure; few medium calcareous nodules.

Australian Soil Classification: Haplic, Self-mulching, Black Vertosol

General soil features

- deep, neutral to alkaline, cracking clays with coarse self-mulching surfaces; with visible sand throughout the profile.
- *surface soil:* grey, very dark brown or black clay. Moderate to coarse, granular, self-mulching surface. Neutral to moderately alkaline (pH 7.0-8.0).
- *subsoil:* black or very dark grey, grading to light brownish grey, heavy clay. Moderately to strongly alkaline (pH 8.0-9.0). Sodic and moderately saline at depth. Some carbonate nodules.
- PAWC is very high (>250 mm).
- responds to N, P, Zn and possibly S.

Land use limitations

- the coarse structure of this soil creates problems with tillage, crop establishment, water infiltration and wetting up the profile.
- occasional overland erosive flooding.
- flooding may limit crop choice and reduce production potential due to waterlogging.
- workability is difficult.
- PAWC is limited in areas by depth to the sodic subsoil.

Land use suitability

This soil is ideally suited to continual grain and cotton cropping with good nutrition and rotations for weed and disease control.

- suitable for most dryland and irrigated field crops. Small-seeded crops are difficult to establish (eg. millets, canary).
- suitable field crops include: wheat, barley, chickpeas, sorghum, cotton, sunflowers and mungbeans.
- suitable forage crops include: oats, forage sorghum, lucerne and lab lab.
- suitable for furrow, spray and trickle irrigation.
- suitable for grazing native and most sown pastures.
- suitable sown pastures include: purple pigeon grass, bisset creeping bluegrass, bambatsi panic, lucerne and medics.
- key native pastures species include: Queensland forest and pitted bluegrass and native trefoils.
- although highly suitable for grazing native and most sown pastures, very little is used for this purpose due to the high returns from cropping.

Best management practices

Cropping

- presswheels or rollers are useful in aiding crop establishment.
- adopt conservation farming practices to maximise ground cover, infiltration and reduce water erosion.
- strip cropping is recommended for erosion control and spreading of overland flow and/or flood water.

Vegetation

- conservation status of remnant vegetation is *endangered*.
- planning guidelines and restrictions apply to clearing and land development.

Grazing

- sulphur required to maintain sown species.
- strategic grazing and spelling of pastures is required to maximise pasture vigour.
- adjust stocking rates to suit seasonal conditions.
- stocking rates *native pasture* 1 AE/2.5-3.0 ha.
  sown pasture 1 AE/1.0 ha.

NUDLEY

Associated soil in LRAs: 9a and 11a

Brief description

Nudley is a moderately deep to deep (70-150 cm), texture contrast soil with a hardsetting surface overlying grey clay subsoils on alluvial plains of mixed origin.

Landform and distribution

- alluvial plains and terraces (slopes <2%) associated with local creeks and those fringing the Brigalow Plains or the lateritised sandstone remnants.

Vegetation

- poplar box woodland with associated cypress pine.
- understorey of false sandalwood, wilga, sally wattle, myall and beefwood.
- Moreton Bay ash, Queensland blue gum and rough-barked apple occur on creek terraces.
- partly cleared.
- Regional Ecosystems 11.3.2/11.3.4

Example soil profile description

Depth (cm)	Description
0-30	dark greyish brown; clay loam; massive; clear to:
30-45	light grey; when dry conspicuously bleached; clay loam; massive; sharp to:
45-70	very dark grey; medium clay; moderate coarse blocky structure; gradual to:
70-150	dark grey; medium clay; weak coarse blocky structure.

Australian Soil Classification: Bleached-sodic, Eutrophic, Grey Chromosol

General soil features

- very deep loamy surfaced soils which may increase in texture slowly or abruptly with depth.
- *surface soil:* reddish brown, yellowish brown or greyish brown, hardsetting loam to clay loam. Slightly acid to neutral (pH 6.5-7.0).
- *subsoil:* reddish brown to grey; sandy clay loam, clay loam or clay. Mildly to moderately alkaline (pH 7.5-8.5). Deep subsoils are sodic with low to moderate salinity levels.
- surface soil texture may be lighter on levees.
- PAWC is moderate (100-150 mm).
- responds to N, P, Cu and Zn.

NUDLEY

Land use limitations

- low fertility, moderate PAWC, and hardsetting surfaces.
- PAWC is limited by depth to the sodic and impermeable clay subsoil.
- sodic and impermeable subsoils are susceptible to gullying and tunnelling if exposed.
- root penetration is negligible in subsoil due to the high bulk density of subsoil.
- surface very "spewy" when wet.
- prone to forming a hard surface crust after heavy rain. This crust is extremely hard to penetrate with tined implements until the soil is wetted.
- surface structure deteriorates with cultivation.
- occasional overland erosive flooding and wind erosion if worked fine when dry.
- abrasive on tines and other ground tools if soil worked dry.

Land use suitability

This soil is suited to grazing native and sown pastures along with short-term cropping while developing and renovating land.

- suitable for winter grain and short-term forage crops.
- suitable short-term grain crops include: barley, wheat and triticale.
- suitable forage crops include: oats, forage sorghum and lab lab on better soils.
- suitable for spray and trickle irrigation.
- summer forage crops will suffer from heat stress due to moderate PAWC.
- suitable for grazing native and most sown pastures.
- suitable sown pasture species including: Katambora Rhodes grass, bambatsi, purple pigeon grass, creeping bluegrass, digit grass, Wynn cassia and medics.
- key native pasture species include: Queensland forest and pitted bluegrass.
- responds well to small falls of rain.

Best management practices

Cropping

- adopt conservation farming practices to maximise groundcover and infiltration, reduce water and wind erosion and assist in maintaining good soil surface structure.
- soil management is important as these soils do not crack and naturally repair themselves.
- fertilisers are essential for cropping; slow release fertilisers preferred to reduce losses through leaching.
- pasture phase strongly recommended to maintain surface structure.
- crusting makes these soils relatively unsuitable to straight zero-till fallows.
- presswheels or rollers are useful in aiding crop establishment. Difficult to establish millets, panicums and sunflowers.
- nematodes can be a problem.
- windbreaks are necessary to reduce wind erosion potential.

Vegetation

- conservation status of remnant vegetation is *endangered.*
- planning guidelines and restrictions apply to clearing and land development.

Grazing

- grazing native and sown pastures is regarded by many farmers as being the best use for these soils.
- recommend species suited for crusting soils and low to moderate fertility levels.
- native pastures need to be grazed prior to maturity.
- if pimelea is present animal husbandry problems occur.
- can withstand reasonable grazing pressure - overgrazing is indicated by the invasion of inferior and unpalatable species such as wire grass.
- wattle regrowth is a major problem if mechanically cleared. Avoid "hot" fires as they encourage wattle regrowth.
- strategic grazing and spelling of pastures is required to maximise pasture vigour.
- fertilising with phosphorus and sulphur will improve pasture production.
- adjust stocking rates to suit seasonal conditions.
- stocking rates *native pasture* 1 AE/6.0-12.0 ha. *sown pasture* 1 AE/4.0-10.0 ha.

NUNGIL

Common soil in LRA: 7b

Brief description

Nungil is a moderately deep to deep (60-140 cm), reddish brown light clay on basalt, supporting a poplar box grassy woodland.

Landform and distribution

- gently sloping rises (0-3%), benches or mid to lower slopes in the basalt uplands.
- occurs east of Dalby along the Nungil Road and south to Oakey and Charlton along the basalt uplands. Previously mapped as poplar box walloons.

Vegetation

- poplar box grassy woodland with Moreton Bay Ash.
- mostly cleared.
- Regional Ecosystem 11.8.15

Example soil profile description

Depth (cm)	Description
0-20	dark brown; fine sandy light clay; few large sub-angular basalt pebbles; weak to moderate fine polyhedral structure; clear to:
20-40	dark brown; medium clay; few large sub-angular basalt pebbles; moderate polyhedral; weak fine sub-angular blocky; gradual to:
40-60	dark yellowish brown medium clay; few large sub-angular basalt pebbles; weak to moderate polyhedral structure; gradual to:
60-100	dark yellowish brown; medium clay; many large angular basalt pebbles; weak fine polyhedral structure; gradual to:
100-140	dark grey.

Australian Soil Classification: Haplic, Eutrophic, Red or Brown Ferrosol

General soil features

- moderately deep red-brown non-cracking uniform clays.
- *surface soil:* reddish brown to brown clay loam to light clay. Moderate fine granular or sub-angular blocky structure. Non cracking. Slightly acid to neutral (pH 6.0-7.0).
- *subsoil:* dark reddish brown to dark brown clays. Strong sub-angular or angular blocky. Slightly acid to neutral (pH 6.0-7.0).
- soil depth over weathered basalt varies from 50-120 cms.
- a stony surface phase also exists, commonly with small to medium flat oval basalt stones.
- finer and more friable than *Southbrook*.
- PAWC varies with soil depth from low to moderate (50-150 mm).
- responds to N, P, S and possibly Zn.

Land use limitations

- surface structure deteriorates with continuous cultivation, resulting in 'powdery' surface subject to wind and water erosion.
- PAWC can be low due to shallow soil depth.
- stoniness in stony surface phase.
- generally not suited to intensive livestock industries (e.g. feedlots, piggeries) due to potential for contamination of ground-water through the underlying permeable fractured basalt.

Land use suitability

This soil is ideally suited to grain and forage cropping with good nutrition and rotations for weed and disease control.

- suitable for a wide range of grain crops.
- suitable grain crops include: wheat, barley, oats, chickpeas, linseed, peanuts, mungbeans, navy beans, panicums and millets.
- suitable fodder crops include: oats, forage sorghum, cowpea and lab lab.
- summer crops may be subject to heat stress due to low to moderate PAWC.
- suitable for spray and trickle irrigation.
- suitable for grazing native and most sown pastures.
- suitable sown pasture species include: Katambora Rhodes grass, creeping bluegrass, green and gatton panic and medics.
- key native pastures species include: Queensland forest and pitted bluegrass, trefoils.
- well suited to most horticultural crops provided adequate water is available.
- suitable for native flower production.
- the soil is often quarried for garden loam, and the basalt and gravel quarried for roads.
- non-cracking soil and underlying rock provide good foundations for buildings and structures.

Best management practices

Cropping

- adopt conservation farming practices to maximise ground cover and infiltration, reduce water erosion, and assist in maintaining good surface soil structure.
- structural soil conservation measures will be required with cultivation on slopes.
- desirable to include pastures in rotation to maintaining fertility and soil structure.
- responds well to small falls of rain and can produce better crops than the heavier clay soils in dry years. Surface structure improves with less cultivation. Water erosion increases as surface structure deteriorates.

Vegetation

- conservation status of remnant vegetation is currently *of concern.*
- planning guidelines and restrictions apply to clearing and land development.

Grazing

- overgrazing is indicated by the invasion of inferior and unpalatable species such as foxtail and white spear grass.
- strategic grazing and spelling of pastures is required to maximise pasture vigour.
- fertilising with phosphorus and sulphur will improve sown pasture production.
- adjust stocking rates to suit seasonal conditions.
- stocking rates *native pasture* 1 AE/3.0-3.5 ha.
  sown pasture 1 AE/2 ha.

OAKEY

Common soil in LRA: 2c

Associated soil in LRAs: 2b, 2d and 3a.

Brief description

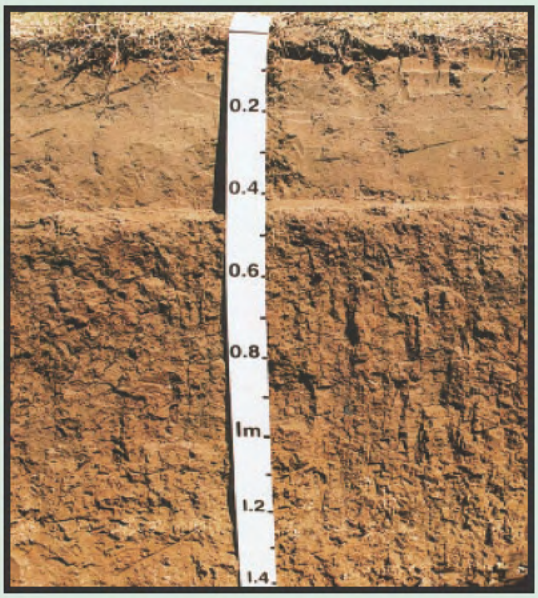
Oakey is a texture contrast soil with a thin (10-30cm), reddish brown, hardsetting loamy surface, and red-brown clay subsoils on alluvial plains of mixed origin.

Landform and distribution

- flat plains, very gently sloping valley floors, or low slopes (<2%) on the edge of the plain from east of Oakey to Formartin.
- closer to the Condamine river, these soils occur as small islands within the *Waco* or *Condamine* soils.

Vegetation

- poplar box grassy open woodland.
- mostly cleared.
- Regional Ecosystem 11.3.2



Example soil profile description

Depth (cm)	Description
0-10	brownish black; fine sandy clay loam; massive; hard-setting; clear to:
10-30	dark reddish brown; fine sandy clay loam; massive; clear to:
30-40	dark reddish brown; medium heavy clay; strong coarse prismatic or angular blocky; clear to:
40-70	dark reddish brown; medium heavy clay; strong coarse prismatic angular blocky; gradual to:
70-100	dark brown; medium heavy clay; strong coarse angular blocky; few calcareous concretions and soft segregations; gradual to:
100-150	brown; medium clay; moderate coarse angular blocky; few calcareous concretions.

Australian Soil Classification: Eutrophic, Subnatric, Red Sodosol

General soil features

- texture contrast soil with a sharp change between the surface soil and the subsoil.
- *surface soil:* dark reddish brown to dark brown, loam to sandy clay loam, commonly 10-30 cm thick, but may occasionally be thicker. Massive, hardsetting. Slightly acid (pH 6.5).
- *subsoil:* dark reddish brown, dark brown or occasionally yellowish brown, light to medium clay. Strong prismatic to blocky structure. Moderately permeable. Sodic to strongly sodic, and occasionally moderately saline. Moderately to strongly alkaline (pH 8.0-9.0).
- PAWC is moderate (100-150 mm).
- responds to N and P.

OAKEY

Land use limitations

- moderately fertile soils with moderate PAWC and hardsetting surfaces.
- surface structure deteriorates with continuous cultivation and forms a hard surface crust after heavy rain.
- workability difficult due to hardsetting surface soil.
- susceptible to wind and water erosion if surface soil is unprotected. "Sand blasting" of young crops associated with wind erosion.
- very abrasive on tines and other cultivation equipment.
- commonly occurs in association with clay soils such as *Waco* and *Cecilvale*. Seepage zones can be present along the boundary where the two soils meet.
- occasional manganese toxicity associated with acidification.

Land use suitability

This soil is best suited to winter grain cropping and pasture production, however sound management is required.

- suitable for some grain and short-term forage crops.
- suitable grain crops include: wheat, barley, sorghum, millets, mungbeans.
- summer crops will suffer from heat stress due to moderate PAWC.
- suitable for most forage crops including: oats, forage sorghum and lab lab.
- suitable for spray and trickle irrigation.
- suitable for grazing native and most sown pastures.
- suitable sown pasture species include: Katambora Rhodes grass, bisset, creeping bluegrass, buffel grass, digit grass, and medics.
- key native species include: Queensland forest and pitted bluegrass.
- responds well to small falls of rain.
- used for building construction in preference to associated heavy black soils.

Best management practices

Cropping

- adopt conservation farming practices to maximise ground cover and infiltration, reduce water and wind erosion and assist in maintaining good soil surface structure.
- soil management is important as these soils do not crack and naturally repair themselves.
- pasture phase strongly recommended to maintain surface structure.
- crusting makes these soils relatively unsuitable to straight zero-till fallows.
- presswheels or rollers are useful in aiding crop establishment. Difficult to establish millets, panicums and sunflowers.
- strip cropping is recommended for erosion control and spreading of overland flow and/or flood water.

Vegetation

- conservation status of remnant vegetation is *endangered.*
- planning guidelines and restrictions apply to clearing and land development.

Grazing

- recommend species suited for crusting soils and low to moderate fertility levels.
- can withstand reasonable grazing pressure - overgrazing is indicated by the invasion of inferior and unpalatable species black cotton bush and white speargrass.
- strategic grazing and spelling of pastures is required to maximise pasture vigour.
- fertilising with sulphur will improve pasture production.
- adjust stocking rates to suit seasonal conditions.
- stocking rates *native pasture* 1 AE/3.0-3.5 ha. *sown pasture* 1 AE/2.5 ha.

PURRAWUNDA

Common soil in LRA: 7a

Associated soil in LRAs: 7b, 7c and 8a

Brief description

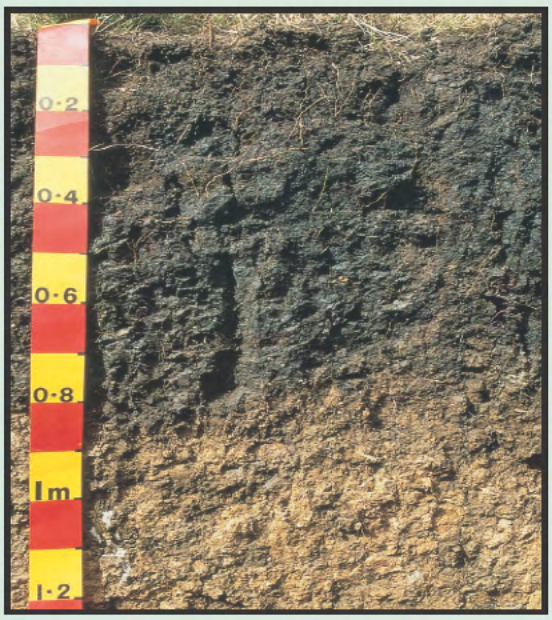
Purrawunda is a moderately deep (50-100 cm), fine self-mulching, brownish black cracking clay on basalt (includes the soil *Palmer*).

Landform and distribution

- mid to lower slopes (4-8%) of basalt rises and low hills, or as extensive areas on broad rounded crests (1-3%) on low basalt hills.

Vegetation

- mountain coolibah woodland.
- mostly cleared.
- Regional Ecosystem 11.8.5



Example soil profile description

Depth (cm)	Description
0-3	dark; light medium to heavy clay; self-mulching; strong fine granular structure; gradual to:
3-15	dark; medium heavy clay; strong fine sub-angular blocky; clear to:
15-70	dark; medium heavy clay; strong fine lenticular; very few soft calcareous segregations; clear to:
70-80	dark; medium heavy clay; strong medium lenticular; very few soft calcareous segregations; clear to:
80-100	dark brown; medium clay; moderate medium lenticular; very few soft and few concretionary calcareous segregations; clear to:
100-120	brown; sandy light clay; gradual to:
120+	weathered basalt with clay pockets and some carbonate nodules.

Australian Soil Classification: Haplic, Self-mulching, Black Vertosol

General soil features

- moderately deep, neutral to alkaline, cracking clays with fine self-mulching surface.
- *surface soil:* black, dark brown or very dark grey, medium to heavy clay. Moderate fine to medium granular structure. Slightly acid to neutral (pH 6.5-7.5).
- *subsoil:* very dark brown or very dark grey becoming browner or redder with depth, heavy clay. Moderate, fine to medium lenticular and blocky structure. Basalt gravels and few carbonate nodules, increasing with depth. Neutral to very strongly alkaline (pH 7.0-9.5).
- PAWC is moderate (100-150 mm).
- responds to N, P, S and possibly K and Zn.

Land use limitations

- susceptible to sheet, rill and gully erosion.
- low PAWC in the shallower soils.
- generally not suited to intensive livestock industries (e.g. feedlots, piggeries) due to potential for contamination of ground-water through the underlying permeable fractured basalt.

Land use suitability

This soil is ideally suited to grain cropping with good nutrition and rotations for weed and disease control.

- like *Waco*, this soil is easily worked and is one of the most highly valued of the basalt clays.
- suitable for most grain and forage crops.
- suitable grain crops include: wheat, barley, chickpeas, sorghum, sunflowers, mungbeans and millets.
- suitable forage crops include: oats, forage sorghum, lucerne and lab lab.
- suitable for spray and trickle irrigation.
- suitable for grazing native and most sown pastures.
- suitable sown pasture species include: Katambora Rhodes grass, purple pigeon grass, bisset creeping bluegrass, bambatsi panic and medics.
- key native pastures species include: Queensland forest aqnd pitted bluegrass and native trefoils.
- although highly suitable for grazing native and most sown pastures, very little is used for this purpose s due to the high returns from cropping.

Best management practices

Cropping

- adopt conservation farming practices to maximise groundcover and infiltration, reduce water erosion, and assist in maintaining good surface soil structure.
- structural soil conservation measures will be required with cultivation.

Vegetation

- conservation status of remnant vegetation is currently *not of concern*.
- planning guidelines and restrictions apply to clearing and land development.

Grazing

- overgrazing is indicated by the invasion of inferior and unpalatable species such as foxtail and white speargrass
- strategic grazing and spelling of pastures is required to maximise pasture vigour.
- sulphur required to maintain sown species
- adjust stocking rates to suit seasonal conditions.
- stocking rates *native pasture* 1 AE/2.5-3.0 ha.
  sown pasture 1 AE/1.0 ha.

RUTHVEN

Common soil in LRA: 7d

Brief description

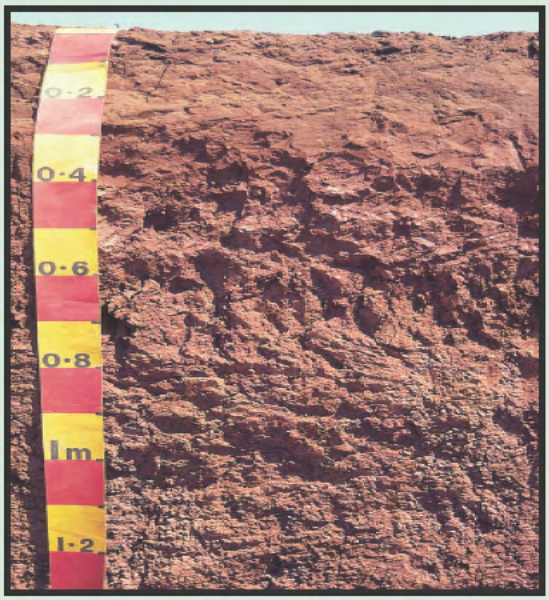
Ruthven is a deep to very deep (100-180 cm), acid to neutral, structured red clay on basalt on the Toowoomba Plateau.

Landform and distribution

- gently undulating plains on the Toowoomba Plateau.

Vegetation

- Queensland blue gum woodland.
- mostly cleared.
- Regional Ecosystem 11.8.8



Example soil profile description

Depth (cm)	Description
0-5	dark or red-brown; clay loam to light clay; medium granular; clear/abrupt to:
5-25	red-brown; light medium clay; moderate to strong parting to sub-angular blocky or polyhedral; clear to:
20-60	red-brown or red; medium clay; moderate to strong sub-angular blocky or polyhedral; firm; gradual/diffuse to:
60-160	red-brown; light medium clay to medium clay; moderate sub-angular blocky or polyhedral.

Australian Soil Classification: Haplic, Eutrophic, Red Ferrosol

General soil features

- deep, acid to neutral, clays with soft to firm surfaces.
- *surface soil:* dark or red-brown clay loam to light medium clay. Strong granular to strong sub-angular blocky or polyhedral structure. Moderately acid to neutral (pH 6.0-7.0).
- *subsoil:* red-brown or red, light medium to medium clay. Strong sub-angular blocky or polyhedral structure. Moderately acid to neutral (pH 6.0-7.5).
- PAWC is moderately high (150-200 mm).
- responds to P and N.

Land use limitations

- Phosphorus fixing.
- surface structure deteriorates with continuous cultivation, result in a "powdery" surface subject to wind and water erosion.
- high permeability and deep drainage.
- generally not suited to intensive livestock industries (e.g. feedlots, piggeries) due to potential for contamination of groundwater supplies through the underlying fractured basalt.

Land use suitability

This soil is ideally suited to grain cropping, including peanuts and navy beans, but a pasture phase is recommended to restore surface structure.

- suitable for most field crops except cotton due to insufficient PAWC.
- suitable grain crops include: wheat, barley, chickpeas, sorghum, sunflowers, mungbeans, peanuts, navy beans, panicums and millets.
- suitable forage crops include: oats, forage sorghum, lucerne and lab lab.
- suitable for spray and trickle irrigation.
- summer crops may be subject to moisture stress due to moderate PAWC.
- suitable for grazing native and most sown pastures.
- suitable sown pastures include: Katambora Rhodes grass, green and Gatton panic, purple pigeon grass, creeping bluegrass and medics.
- key native pasture species include: Queensland forest and pitted bluegrass
- suitable for native flower production.
- suitable for horticultural crops such as melons, grapes, pumpkins, stonefruit and citrus.if irrigation water is available.

Best management practices

Cropping

- much of the land suitable for agriculture has been used for urban development.
- adopt conservation farming practices to maximise ground cover and infiltration, reduce water and wind erosion and assist in maintaining good surface soil structure.
- structural soil conservation measures will be required with cultivation on slopes.
- desirable to include pastures in rotation to maintain fertility and soil structure.
- responds well to small falls of rain in dry years and can produce better crops than the heavier clay soils.

Vegetation

- conservation status of remnant vegetation is currently *not of concern*.
- planning guidelines and restrictions apply to clearing and land development.

Grazing

- overgrazing is indicated by the invasion of inferior and unpalatable species such as foxtail and white speargrass.
- strategic grazing and spelling of pastures is required to maximise pasture vigour and encourage better native species to increase (e.g. bluegrass).
- fertilising with phosphorus and sulphur will improve pasture production.
- native couch and urochloa can be useful sources of feed.
- adjust stocking rates to suit seasonal conditions.
- stocking rates *native pasture* 1 AE/2.5-3.0 ha.
  sown pasture 1 AE/1.0 ha.

SOUTHBROOK

Associated soil in LRAs: 7a and 7b

Brief description

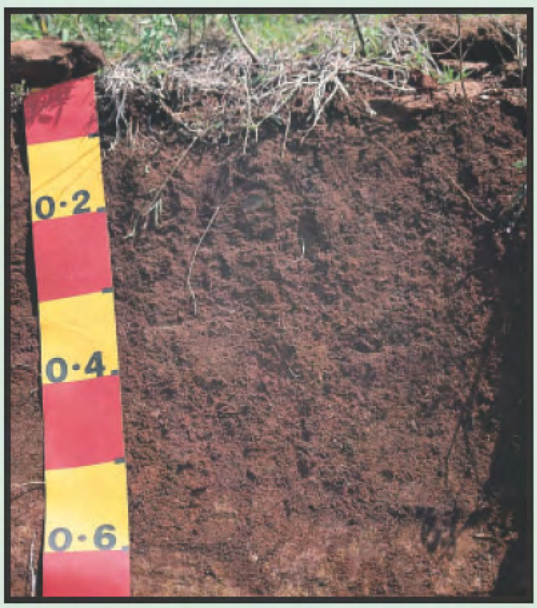
Southbrook is a moderately deep (50-100 cm), stony, non-cracking, red clay on basalt.

Landform and distribution

- occurs on upper slopes, benches and flat-topped ridges of undulating basalt rises and low hills.
- often in association with *Kenmuir* soils.

Vegetation

- woodland of narrow-leaved ironbark, rough-barked apple and mountain coolibah woodland.
- partly cleared.
- Regional Ecosystem 11.8.4



Example soil profile description

Depth (cm)	Description
0-5	dark reddish brown; clay loam to light clay; moderate granular structure; considerable stone; gradual to:
5-15	dark reddish brown; clay loam to light clay; moderate to strong, medium blocky structure; some basalt gravel and cobbles; clear to:
15-40	reddish brown; medium to heavy clay; moderate coarse blocky structure: clear to:
40-70	reddish brown and yellowish brown; clay; strong coarse blocky structure; overlies weathered basalt.

Australian Soil Classification: Haplic, Eutrophic, Red Ferrosol

General soil features

- moderately deep, non-cracking red clay
- *surface soil:* very dark grey to dark reddish brown, clay loam. Weak to moderate granular structure. Slightly acid to neutral (pH 6.0-7.5). Moderate amounts of basalt gravel and cobbles.
- *subsoil:* dark reddish brown to reddish brown, becoming yellowish red with depth. Light clay, grading to medium to heavy clay with depth. Moderate to strong, medium to coarse blocky structure. Neutral to moderately alkaline (pH 7.0-8.5).
- PAWC is low to moderate (50-150 mm).
- responds to N, P, and S.

Land use limitations

- large amounts of near-surface stone may cause problems with cultivation and crop establishment (areas are frequently stone-picked to improve workability).
- susceptible to moderate sheet and rill erosion depending on the amount of stone; erosion is more severe when stone is removed.
- surface structure deteriorates with continuous cultivation, resulting in a 'powdery' surface subject to wind and water erosion.
- PAWC is low to moderate.
- generally not suited to intensive livestock industries (e.g. feedlots, piggeries) due to potential for contamination of groundwater through the underlying permeable fractured basalt.

Land use suitability

This soil is suited to grain and forage cropping after stone-picking. It is well suited to grazing native and sown pastures.

- suitable grain crops include: wheat, barley, millets and oats.
- suitable forage crops include: oats, forage sorghum, cowpea and lab lab.
- suitable for spray and trickle irrigation.
- suitable for grazing native and sown pastures
- suitable sown pasture species include: Katambora Rhodes grass, creeping bluegrass, green and Gatton panic and medics.
- key native pasture species include: Queensland and pitted bluegrass and trefoil.
- suitable for native flower production on hillslopes.
- non-cracking soil and underlying rock provide good foundations for buildings and structures.
- ironbark can provide a useful source of farm timber.

Best management practices

Cropping

- adopt conservation farming practices to maximise groundcover, infiltration and reduce water and wind erosion, and assist in maintaining good surface soil structure.
- structural soil conservation measures will be required with cultivation on slopes.
- desirable to include pastures in rotation to maintain fertility and soil structure.
- moisture levels will be the determining factor on crop choice. Responds well to small falls of rain in dry years and can produce better crops than the heavier clay soils.
- may be more economically viable as a pasture due to high development costs.

Vegetation

- conservation status of remnant vegetation is currently *not of concern*.
- planning guidelines and restrictions apply to clearing and land development.

Grazing

- strategic grazing and spelling of pastures is required to maximise pasture vigour.
- overgrazing is indicated by the invasion of inferior and unpalatable species such as foxtail and white speargrass.
- sulphur required to maintain sown species.
- adjust stocking rates to suit seasonal conditions.
- stocking rates *native pasture* 1 AE/3.0-3.5 ha.
  sown pasture 1 AE/2.0 ha.

TALGAI

Associated soil in LRA: 8a

Brief description

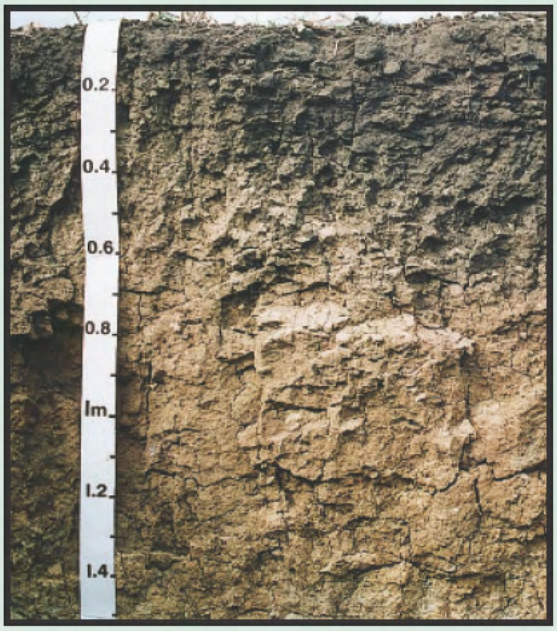
Talgai is a moderately deep to deep (75-130 cm) black or grey cracking clay and brown clay subsoils with moderate gilgai on fine-grained sandstones (includes the soil *Junabee*).

Landform and distribution

- slopes (3-6%) and hilltops of dissected low sandstone hills and very gently sloping rises.
- found in a narrow, roughly north-south band from Kaimkillenbun to Pittsworth.

Vegetation

- woodland of poplar box with some narrow-leaved ironbark; often with a thick understorey of wilga.
- mostly cleared.
- Regional Ecosystem 11.9.7



Example soil profile description

Depth (cm)	Description
0-3	very dark grey; medium clay; blocky with slight surface seal; some ironstone and sandstone gravel; gradual to:
3-35	black; medium to heavy clay; strong coarse blocky to prismatic; abrupt to:
35-95	brown with grey mottles; heavy clay; some gravel; strong coarse blocky to lenticular; few medium soft calcareous segregations; diffuse to:
95-120	light brown with mottle; heavy clay; strong coarse blocky to lenticular; some gravel and carbonate concretions; diffuse to:
130-190	grey-brown with many coarse distinct orange mottles; fine sandy medium clay; strong coarse lenticular to blocky.

Australian Soil Classification: Vertic or Sodic, Eutrophic, Grey Dermosol

General soil features

- deep cracking clays with crusting surfaces and moderate gilgai.
- gilgai microrelief disappears with cultivation.
- *surface soil:* dark brown to black, medium to heavy clay. Strong fine blocky structure. Weakly to moderately self-mulching and weakly cracking. Slightly acid to neutral (pH 6.0-7.0). Calcium carbonate nodules occur on the surface and throughout the profile on mounds of gilgai.
- *subsoil:* black, heavy clay changing abruptly to a brown layer with depth. A bleached layer may occasionally occur above the brown layer. Medium to coarse blocky structure. Slightly acid to strongly alkaline (pH 6.5-9.0). Acid to neutral subsoils tend to occur in upper slope positions.
- sodic and moderately saline in the deep subsoil.
- PAWC is moderate (100-150 mm).
- 60-70% of PAW is held in the top 45cm of the soil.
- responds to P, N, Cu and perhaps S and K.

Land use limitations

- prone to surface structure decline under cultivation and surface crusting may occur.
- susceptible to severe sheet, rill and gully erosion.
- prone to wind erosion when surface structure becomes powdery.
- crops will suffer from heat stress and low moisture due to moderate PAWC. This will be very noticeable on the "puffs" usually if loose - otherwise 'mounds' of gilgai.

Land use suitability

This soil is suitable for continual grain and forage cropping.

- suitable for most grain and forage crops.
- suitable grain crops include: wheat, barley, millets, panicums, chickpeas, sorghum, sunflowers and mungbeans.
- suitable forage crops include: oats, forage sorghum and lab lab.
- suitable for spray and trickle irrigation.
  suitable sown pasture species include: Katambora Rhodes grass, creeping bluegrass, bambatsi, lucerne and medics.
- key native pasture species include: Queensland forest and pitted bluegrass.

Best management practices

Cropping

- adopt conservation farming practices to maximise ground cover and infiltration, reduce water erosion, and assist in maintaining good surface soil structure.
- structural soil conservation measures will be required with cultivation on slopes. Recommend broad based contour banks to prevent failure from cracking.
- phosphorus is better applied at planting as a starter fertilizer.
- desirable to include pastures in rotation to maintain fertility and soil structure.

Vegetation

- conservation status of remnant vegetation is *endangered*.
- planning guidelines and restrictions apply to clearing and land development.

Grazing

- strategic grazing and spelling of pastures is required to maximise pasture vigour.
- overgrazing is indicated by the invasion of inferior and unpalatable species such as black cotton bush, wiregrass and speargrass.
- sulphur required to maintain sown species.
- adjust stocking rates to suit seasonal conditions.
- stocking rates *native pasture* 1 AE/2.5-3.0 ha.
  sown pasture 1 AE/1.0 ha.

TANDAWANNA

Associated soil in LRA: 6d

Brief description

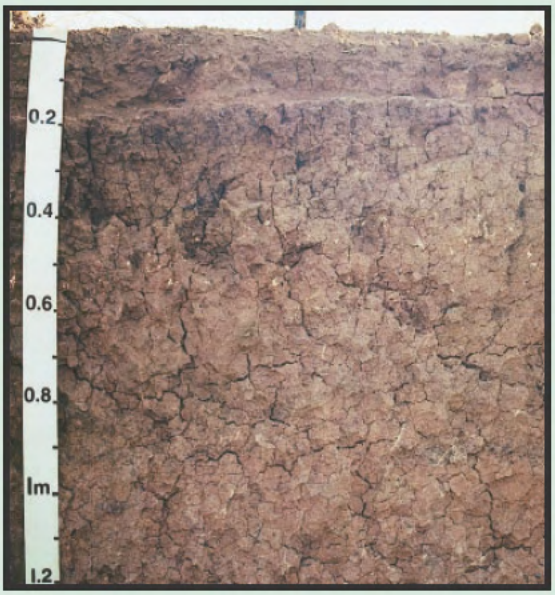
Tandawanna is a deep (110-150 cm), hardsetting, texture contrast red-brown soil on fine-grained sandstones. It may be weakly self-mulching and non-cracking when cultivated.

Landform and distribution

- elevated, level plains and undulating rises south-west of Cecil Plains and Millmerran.
- occurs west of the Kumbarilla Ridge.

Vegetation

- belah forest, occasionally with brigalow and some poplar box.
- understorey: false sandalwood and wilga.
- mostly cleared
- Regional Ecosystem 11.9.5



Example soil profile description

Depth (cm)	Description
0-17	dark brown; clay loam; hardsetting, massive; abrupt to:
17-18	as above, but partially bleached; sharp to:
18-45	dark reddish brown; heavy clay; strong coarse blocky structure; few manganese nodules; gradual to:
45-60	brown; medium heavy clay; strong coarse blocky structure; trace amounts of soft carbonate segregations; few manganese nodules; gradual to:
60-110	reddish brown; medium heavy clay; strong coarse blocky or prismatic structure; gradual to:
110-150	brown; heavy clay; weakly structured.

Australian Soil Classification: Sodic, Eutrophic, Red Chromosol

General soil features

- texture contrast soils with a sharp change between the surface soil and the subsoil.
- where surface soils are very thin and the soils are cultivated, they appear to be weakly self-mulching, non-cracking clays.
- *surface soil:* dark brown, clay loam (light clay after cultivation). Poorly structured. Neutral (pH 7.0).
- *subsoil:* dark brown to dark reddish brown, well structured, heavy clays. Strongly alkaline (pH 8.0-9.0) upper subsoils, to very strongly acid (pH 4.5-5.0) in the deep subsoil. Strongly sodic and highly saline at depth.
- subsurface bleach may occur but its presence is dependent on conditions of restricted surface drainage.
- PAWC is moderate (100-150 mm).
- responds to N, P, Cu and Zn.

Land use limitations

- moderate fertility soils with moderate PAWC and hardsetting surfaces.
- PAWC is limited by depth to strongly sodic and saline subsoils.
- surface structure deteriorates with continuous cultivation.
- regrowth, particularly of limebush and brigalow is a problem.

Land use suitability

This soil is suited to continual grain and forage cropping with good nutrition and rotations for weed and disease control.

- suitable for most grain and forage crops.
- suitable grain crops include: wheat, barley, chickpeas, sorghum.
- suitable forage crops include: oats, forage sorghum, cowpea and lab lab.
- suitable for flood, spray or trickle irrigation.
- suitable for grazing native and most sown pastures.
- suitable sown pastures include: Katambora Rhodes grass, buffell grass, purple pigeon grass, bambatsi panic, creeping bluegrass, lucerne and medics.
- key native pastures species include: Queensland bluegrass, curly windmill grass, Warrego grass, fairy grass, creeping windmill grass, brigalow grass and slender canegrass.
- although highly suitable for grazing native and most sown pastures, very little is used for this purpose due to the higher returns from cropping.

Best management practices

Cropping

- adopt conservation farming practices to maximise groundcover and infiltration, reduce water erosion, and assist in maintaining good surface soil structure.
- presswheels or rollers are useful in aiding crop establishment.
- pasture phase is strongly recommended to maintain surface structure.
- apply phosphorus with crops and annual forages at planting.

Vegetation

- conservation status of remnant vegetation is *endangered*.
- planning guidelines and restrictions apply to clearing and land development.

Grazing

- strategic grazing and spelling of pastures is required to maximise pasture vigour.
- adjust stocking rates to suit seasonal conditions.
- overgrazing is indicated by the invasion of inferior and unpalatable species such as speargrass, dog burr and sedges.
- sulphur required to maintain sown species.
- stocking rates *native pasture* 1 AE/4.0-8.0 ha.
  sown pasture 1 AE/3.0-5.0 ha.

TARA

Common soil in LRA: 5b

Associated soil in LRA: 5a

Brief description

Tara is a very deep, brown to grey cracking clay with moderately to very deep gilgai on the brigalow claysheet (includes the soil *Logie*).

Landform and distribution

- flat to very gently undulating brigalow plains north of Warra and around Kupunn, west of Dalby.

Vegetation

- brigalow, belah scrub.
- black tea-tree in low lying areas.
- mostly cleared.
- Regional Ecosystem 11.4.3

Example soil profile description

Depth (cm)	Description
0-15	grey-brown; heavy clay; extensively cracked; gradual to:
15-30	grey; heavy clay; coarse blocky structure; gradual to:
30-150	greyish brown; heavy clay; massive to lenticular structure.

Australian Soil Classification: Endohypersodic-Endoacidic, Pedal or Crusty, Grey Vertosol

General soil features

- very deep, cracking clays with moderately deep to very deep melonhole gilgai (30-150 cm).
- *surface soil:* grey to dark brown clay. Surface structure varies from weakly self-mulching to hardsetting. Neutral to moderately alkaline (pH 7.0-8.0).
- *subsoil:* grey to greyish brown, occasionally dark reddish brown clay. Coarse blocky structure. Strongly alkaline (pH 9.0), becoming strongly acid in the deep subsoil. Strongly sodic and saline at depth.
- PAWC is moderate (100-150 mm).
- responds to N, P, Zn and occasionally Cu.

Land use limitations

- moderately fertile soils with moderate water holding capacity.
- PAWC is limited by depth to the sodic and highly saline subsoil.
- workability is difficult because of hardsetting surface, soil variation and microrelief associated with melonholes.
- levelling will expose strongly sodic and highly saline subsoils which will increase plant growth problems.
- difficult to blade plough effectively.
- when cultivated, mounds seal readily running water into depressions which drain extremely slowly.
- regrowth, particularly of limebush and brigalow is a problem.

Land use suitability

This soil is best suited to grazing native and sown pastures after clearing.

- has limited grain and forage cropping potential while developing and renovating land by culture.
- suitable grain crops include: wheat and barley.
- suitable forage crops include: oats, forage sorghum and lab lab.
- suitable for grazing native and sown pastures.
- suitable sown pasture species include: Katambora Rhodes grass, bambatsi and purple pigeon grass.
- key native pasture species include: Queensland bluegrass, fairy grass, curly windmill and creeping windmill grass, brigalow grass and creeping saltbush.

Best management practices

Cropping

- recommend growing fodder crops during regrowth control phase prior to establishing sown pastures.
- presswheels or rollers are useful in aiding crop establishment.
- adopt conservation farming practices to maximise groundcover and infiltration, reduce water erosion, and assist in maintaining good surface soil structure.
- size of melonholes causes workability problems during harvest and planting.

Vegetation

- conservation status of remnant vegetation is *endangered*.
- planning guidelines and restrictions apply to clearing and land development.

Grazing

- mechanical timber regrowth control is very difficult due to the melonholes.
- strategic grazing and spelling of pastures is required to maximise pasture vigour.
- overgrazing will result in the invasion of unpalatable and inferior species such as speargrass, dog burr and sedges.
- use improved pasture species capable of handling limited periods of waterlogging.
- sulphur required to maintain sown species.
- adjust stocking rates to suit seasonal conditions.
- stocking rates *native pasture* 1 AE/4.0-8.0 ha.
  sown pasture 1 AE/3.0-6.0 ha.

TOOLBURRA

Associated soil in LRAs: 6b and 8a

Brief description

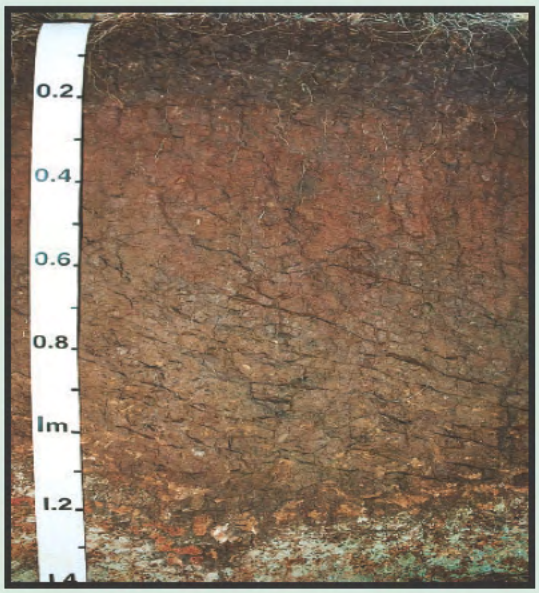
Toolburra is a moderately deep to deep, red brown, cracking, light clay with silver popular box or leaved ironbark on fine-grained sandstone.

Landform and distribution

- gently undulating to undulating broad sandstone ridges to the east of Jandowae.
- slopes 1-4%.

Vegetation

- woodland of popular box or silver-leaved ironbark with wilga, wattles and occasional softwood scrub species.
- mostly cleared.
- Regional Ecosystems 11.9.2/11.9.7



Example soil profile description

Depth (cm)	Description
0-20	dark reddish brown; light clay; moderate sub-angular blocky; soft surface; gradual to:
20-100	dark reddish brown; medium heavy clay; very few medium rounded ironstone pebbles; strong sub-angular blocky to lenticular; very few fine manganiferous nodules; diffuse to:
100-120	dark reddish brown; medium clay; very few medium angular ironstone pebbles; strong coarse blocky or lenticular; few coarse soft calcareous segregations; very few fine manganiferous nodules; clear to:
120-150	dark reddish brown weathered sandstone.

Australian Soil Classification: Halpic, Eutrophic, Red Dermosol

General soil features

- moderately deep to deep, uniform, light to medium heavy clays.
- *surface soil:* red to reddish brown, light clay. Moderately cracking. Moderate blocky structure. Some ironstone gravel. Slightly acid (pH 6.0-6.5).
- *subsoil:* red to reddish brown, medium heavy clay. Strong coarse blocky or lenticular structure. Ironstone gravel and carbonate nodules increase with depth. Moderately alkaline (pH 8.0-8.5).
- PAWC is moderately high (150-200 mm).
- good fertility - responds to N, Zn and occasionally S and K.

Land use limitations

- susceptible to severe water erosion.
- surface, structure deteriorates with continuous cultivation, resulting in a 'powdery' surface subject to wind erosion.
- can be abrasive on tines and other cultivation equipment.
- insufficient drainage for citrus, native flower production and horticultural crops.
- shrink-swell characteristics causing cracks and effects on buildings.
- generally not suited to intensive livestock industries (e.g. feedlots, piggeries) due to potential for contamination of groundwater through the underlying permeable sandstone.

Land use suitability

This is a very versatile soil and is well suited to most pastures, forage and grain cropping. It is an excellent improved pasture soil.

- suitable for most grain and field crops except cotton due to insufficient PAWC.
- suitable grain crops include: wheat, barley, chickpeas, mungbeans, sunflowers, sorghum, navy beans, soybeans, peanuts, millets and panicums.
- suitable forage crops include: oats, forage sorghum, lucerne and lab lab.
- suitable for furrow, spray and trickle irrigation.
- suitable for grazing native and most sown pastures.
- suitable sown pastures species include: Katambora Rhodes grass, green and Gatton panic, purple pigeon grass, creeping bluegrass, buffel grass, lucerne and medics.
- key native pasture species include: Queensland and pitted bluegrass, native clovers and trefoils.
- although highly suitable for grazing native and most sown pastures, very little is used for this purpose due to high returns from cropping.

Best management practices

Cropping

- adopt conservation farming practices to maximise ground cover and infiltration, reduce water erosion, and assist in maintaining good surface soil structure.
- structural soil conservation measures will be required for cultivation on slopes.
- presswheels or rollers are useful in aiding crop establishment.
- desirable to include pastures in rotation to maintain fertility and soil structure.
- easy workability with no germination problems.
- moisture levels will be the determining factor on crop choice. Responds well to small falls of rain in dry years and can produce better crops than the heavier clay soils.
- summer crops will suffer from moisture stress due to moderate PAWC.
- desirable to include pastures in rotation to maintain fertility and soil structure.

Vegetation

- conservation status of remnant vegetation is *threatened*.
- planning guidelines and restrictions apply to clearing and land development.

Grazing

- strategic grazing and spelling of pastures is required to maximise pasture vigour.
- overgrazing is indicated by the invasion of inferior and unpalatable species such as cottonbush, couch and white speargrass.
- couch and urochloa can be useful sources of feed. Rhodes and buffel grass regarded as second grade feeds to the panics.
- sulphur required to maintain sown species.
- adjust stocking rates to suit seasonal conditions.
- stocking rates *native pasture* 1 AE/2.0 ha. *sown pasture* 1 AE/1.0 ha.

TOOWOOMBA

Associated soil in LRA: 7d

Brief description

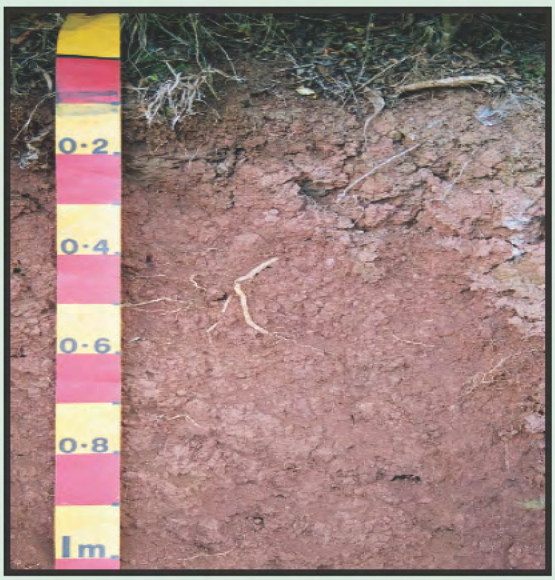
Toowoomba is a deep (100-150 cm), acid to neutral, structured red clay on basalt on the Toowoomba Plateau.

Landform and distribution

- gently undulating plains on the Toowoomba Plateau.

Vegetation

- Queensland blue gum woodland.
- mostly cleared.
- Regional Ecosystem 11.8.8



Example soil profile description

Depth (cm)	Description
0-20	dark reddish brown; loam; strong fine granular structure grading to fine blocky with depth; much organic matter; lateritic fragments; clear to:
20-40	yellow-red; loam; strong fine blocky structure; lateritic fragments; diffuse to:
40-60	red-brown; gravelly clay loam; weak blocky structure; pisolitic lateritic gravel; fragmentary laterite; gradual to:
60-110	red-brown; gravelly light clay; moderate to strong blocky or polyhedral structure; diffuse to:
110-150	red-brown; gravelly medium clay; weak to moderate blocky or polyhedral structure; diffuse to:
150-200	yellowish red; gravelly medium clay; weak to moderate blocky or polyhedral structure.

Australian Soil Classification: Snuffy Magnesic, Red Ferrosol

General soil features

- deep, acid to neutral, clays with soft to firm surfaces.
- *surface soil:* dark or red-brown clay loam to light medium clay. Strong granular to strong sub-angular blocky or polyhedral structure. Moderately acid to neutral (pH 6.0-7.0).
- *subsoil:* red-brown or red, light medium to medium clay. Strong sub-angular blocky or polyhedral structure. Moderately acid to neutral (pH 6.0-7.0).
- PAWC is moderately high (150-200 mm).
- responds to P and N.

Land use limitations

- Phosphorus fixing.
- surface structure deteriorates with continous cultivation resulting in a 'powdery' surface.
- susceptible to wind erosion if surface soil is unprotected.
- high permeability and deep drainage.
- generally not suited to intensive livestock industries (e.g. feedlots, piggeries) due to potential of contamination of ground-water supplies through the underlying fractured basalt.

Land use suitability

This soil is ideally suited to grain cropping, including peanuts and navy beans, but a pasture phase is recommended to restore surface structure.

- suitable for most field crops except cotton due to insufficient PAWC.
- suitable grain crops include: wheat, barley, chickpeas, sorghum, sunflowers, mungbeans, peanuts, navy beans, panicums and millets.
- suitable forage crops include: oats, forage sorghum, lucerne and lab lab.
- suitable for spray and trickle irrigation.
- summer crops may be subject to heat stress due to moderate PAWC.
- suitable for grazing native and most sown pastures.
- suitable sown pastures include: Katambora Rhodes grass, green and Gatton panic, purple pigeon grass, creeping bluegrass and medics.
- key native pasture species include: Queensland forest and pitted bluegrass
- suitable for native flower production.
- suitable for horticultural crops such as melons, grapes, pumpkins, stonefruit and citrus if irrigation water is available.
- much of the land suitable for agriculture has been used for urban development.

Best management practices

Cropping

- adopt conservation farming practices to maximise ground cover and infiltration to reduce water and wind erosion.
- structural soil conservation measures will be required with cultivation on slopes.
- desirable to include pastures in rotation to maintain fertility and soil structure.
- responds well to small falls of rain in dry years and can produce better crops than the heavier clay soils.

Vegetation

- conservation status of remnant vegetation is currently *not of concern*.
- planning guidelines and restrictions apply to clearing and land development.

Grazing

- overgrazing is indicated by the invasion of inferior and unpalatable species such as foxtail and white speargrass.
- strategic grazing and spelling of pastures is required to maximise pasture vigour and encourage better native species to increase (e.g. bluegrass).
- fertilising with phosphorus and sulphur will improve pasture production.
- native couch and urochloa can be useful sources of feed.
- adjust stocking rates to suit seasonal conditions.
- stocking rates *native pasture* 1 AE/2.5-3.0 ha.
  sown pasture 1 AE/1.0 ha.

WACO

Common soil in LRAs: 2a, 2c

Associated soil in LRAs: 1a, 2b and 7a

Brief description

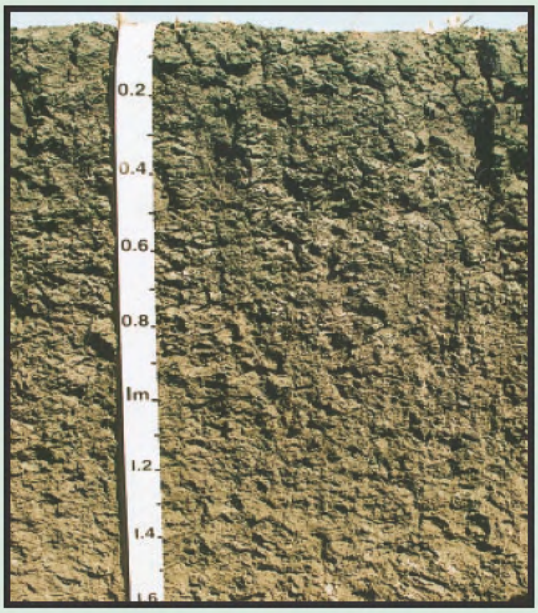
Waco is a highly valued, deep to very deep (100-180 cm) fine, self-mulching, dark cracking clay on basaltic alluvium (includes the soils *Norillee* and *Waverley*).

Landform and distribution

- gently sloping to flat alluvial plains associated with the Condamine River and tributaries, particularly on the flat valley floors and alluvial fans originating from the basaltic uplands.

Vegetation

- open grassland mainly of Queensland bluegrass.
- mostly cleared.
- Regional Ecosystem 11.3.21



Example soil profile description

Depth (cm)	Description
0-15	black; heavy clay; fine granular structure; gradual to:
15-90	black; heavy clay; strong medium lentucular structure; soft and nodular carbonate; gradual to:
90-120	greyish brown; brown and yellowish brown; heavy clay; strong coarse lenticular structure; moderate amounts of soft and nodular carbonate.

Australian Soil Classification: Endohypersodic, Self-mulching, Black Vertosol

General soil features

- deep, neutral to alkaline, cracking clays with fine self-mulching surface.
- *surface soil*: black, dark grey and very dark brown clays; becomes browner with depth. Fine granular surface that is strongly self-mulching and cracks extensively when dry. Mildly to moderately alkaline (pH 7.5-8.0).
- *subsoil:* brown heavy clay. Structure is fine to medium blocky to lenticular, becoming coarser with depth. Soft and nodular carbonate. Strongly alkaline (pH 8.5-9.0). May be sodic and moderately saline at depth.
- PAWC is very high (>250 mm).
- responds to N, P and Zn.

Land use limitations

- occasional erosive flooding.

Land use suitability

This soil is ideally suited to continual grain and cotton cropping with good nutrition and rotations for weed and disease control.

- like *Anchorfield*, this soil is easily worked, and is one of the most highly valued of the alluvial clays.
- suitable for most field crops.
- suitable field crops include: wheat, barley, chickpeas, sorghum, cotton, sunflowers, mungbeans and millets.
- suitable forage crops include: oats, forage sorghum, lucerne and lab lab.
- suitable for furrow, spray and trickle irrigation.
- suitable for grazing native and most sown pastures.
- suitable sown pasture species include: Katambora Rhodes grass, purple pigeon grass, bisset creeping bluegrass, bambatsi panic, lucerne and medics.
- key native pastures species include: Queensland forest and pitted bluegrass and native trefoils.
- although highly suitable for grazing native and most sown pastures, very little is used for this purpose due to the high returns from cropping.

Best management practices

Cropping

- strip cropping is recommended for erosion control and spreading of overland flow and/or flood water.
- adopt conservation farming practices to maximise groundcover and infiltration, reduce water erosion, and assist in maintaining good surface soil structure.
- ley pastures used in high water run-on areas to disperse the water should be managed to prevent excessive silt build up which will divert flows.

Vegetation

- conservation status of remnant vegetation is *endangered*.
- planning guidelines and restrictions apply to clearing and land development.

Grazing

- strategic grazing and spelling of pastures is required to maximise pasture vigour.
- adjust stocking rates to suit seasonal conditions.
- stocking rates *native pasture* 1 AE/2.5-3.0 ha.
  sown pasture 1 AE/1.0 ha.

WERANGA

Common soil in LRAs: 9b, 10b, 10a, 12a

Brief description

Weranga is a texture contrast soil with a bleached surface, over mottled, grey or yellow sandy clay subsoil on coarse grained sandstone (includes the soils *Oak*, *Hendon* and *Morgan*).

Landform and distribution

- gently undulating sandstone plains, mainly west of the Condamine River on the Kumbarilla Ridge.

Vegetation

- shrubby woodland of poplar box with bull oak and narrow-leaved ironbark.
- some cypress pine on the sandier surfaced soils.
- partly cleared.
- Regional Ecosystem 11.5.1

Example soil profile description

Depth (cm)	Description
0-15	very dark greyish brown; fine sandy clay loam to sandy clay loam; massive, hardsetting; thin bleached layer at subsoil interface; abrupt to:
15-50	yellowish brown; sandy medium to heavy clay; strong coarse columnar; structure; gradual to:
50-70	brown; medium to heavy clay; strong, medium to coarse blocky structure; some manganese concretions; gradual to:
70-120	brown; medium to heavy clay; strong, medium to coarse blocky structure; carbonate concretions.

Australian Soil Classification: Magnesic, Mottled-Hypernatric, Brown Sodosol

General soil features

- texture contrast soil with a sharp change between the surface soil and the subsoil.
- *surface soil:* thin very dark greyish brown to dark brown, massive, sandy loam to clay loam. A thin bleach occurs above the impermeable subsoil. Slightly acid (pH 6.0-6.5).
- *subsoil:* greyish brown, brownish grey or light yellowish brown strongly columnar clays. Colour and degree of mottling vary considerably. Neutral to moderately alkaline (pH 7.0-8.0). Strongly sodic and highly saline in the deep subsoil.
- PAWC is very low (<50 mm).
- very low fertility - responds to N, P, K, Cu, Zn and Mo.
- Stronger columnar structure than *Channing*, and a thinner, darker A horizon than *Braemer*.

Land use limitations

- very low fertility with low PAWC, shallow rooting depth and hardsetting surfaces.
- shallow surface soil and impermeable subsoil make these soils extremely susceptible to erosion and waterlogging.
- sodic and impermeable subsoils susceptible to gully and tunnel erosion if exposed.
- root penetration into the subsoil is negligible due to high bulk density.
- regrowth, particularly of cypress pine and bull oak when cleared.
- siting of dams needs careful consideration.
- many farmers have found that developing this type of country will provide very little return on initial investment.

Land use suitability

This soil is best left in its native state, and used for timber production and nature conservation. Suitable for grazing native pastures only.

- key native pasture species include: pitted and forest bluegrass, dainty lovegrass, kangaroo grass, grey lovegrass, rough speargrass, fairy grass, windmill grass and climbing saltbush.
- good bee and nature conservation country, if not cleared.
- narrow-leaved ironbark and cypress pine may be useful farm and millable timber.

Best management practices

Cropping

- not recommended.

Vegetation

- conservation status of remnant vegetation is currently *not of concern*.
- planning guidelines and restrictions apply to clearing and land development.

Grazing

- strategic grazing and spelling of pastures is required to maximise pasture vigour.
- development of this soil may cause severe wind and water erosion through exposing the dispersible, sodic subsoil.
- siting of dams and stock watering points requires careful consideration.
- recommend strategic thinning of timber using chemical methods. Mechanical methods will only result in severe regrowth problems.
- adjust stocking rates to suit seasonal conditions.
- stocking rates *native pasture* 1 AE/6.0-12.0 ha.
  sown pasture 1 AE/4.0-10.0 ha.

WALKER

Common soil in LRA: 6b

Associated soil in LRAs: 6a, 6c and 8a

Brief description

Walker is a moderately deep to deep, texture contrast soil with a moderately thick (10-20 cm) dark brown to grey-brown sandy loam to clay loam surface over dark brown to dark grey-brown clay on sandstone (includes the soils *Norbell, Douglas, Yarranlea, Emlyn, Oakview*).

Landform and distribution

- upper slopes of undulating sandstone rises.

Vegetation

- brigalow, belah, wilga open forest with poplar box and softwood scrub species. Tree pear is a common weed of the area.
- mostly cleared.
- Regional Ecosystem 11.9.5

Example soil profile description

Depth (cm)	Description
0-30	dark brown; clay loam; massive; hardsetting; clear to:
30-60	dark greyish brown; faint yellow mottles; medium clay; coarse blocky structure; acid; gradual to:
60-90	brownish yellow, faint brown mottles; medium clay, coarse blocky structure; neutral, gradual to:
90-130	brownish yellow; clay loam; weathered sandstone.

Australian Soil Classification: Sodic, Eutrophic, Grey Chromosol

General soil features

- texture contrast soil with a hardsetting surface and moderately impermeable subsoil.
- *surface soil:* dark brown to grey-brown, sandy loam to clay loam, massive to weakly structured, 10-20 cm thick. Slightly acid (pH 6.0-6.5).
- *subsoil:* brown, dark reddish-brown or dark grey-brown heavy clay. Coarse blocky structure. Neutral to moderately alkaline (pH 7.0-8.5). Sodic to strongly sodic throughout. Highly saline at depth.
- PAWC is moderate (100-150 mm).
- responds to N, P and Cu.

WALKER

Land use limitations

- moderately fertile soil with moderate water holding capacity.
- surface structure deteriorates with continuous cultivation, resulting in a "powdery surface subject to wind and water erosion.
- prone to form a hard surface crust after heavy rain.
- workability difficult due to hardsetting surface soil.
- very abrasive on tines and cultivation equipment.
- sandstone "floaters" may cause problems in cultivation.
- generally not suited to intensive livestock industries (e.g. feedlots, piggeries) due to potential for contamination of ground-water.

Land use suitability

This soil is best suited to winter grain cropping and pasture production, however sound management is required.

- suitable for some grain and forage crops.
- suitable grain crops include: wheat, barley, millets and panicums.
- suitable forage crops include: oats, forage sorghum and lab lab.
- suitable for spray and trickle irrigation.
- summer crops will suffer from heat stress due to moderate PAWC.
- suitable for grazing native and most sown pastures.
- suitable sown pasture species include: Katambora Rhodes grass, buffel grass, green and Gatton panic, purple pigeon grass, creeping bluegrass, lucerne and medics.
- key native pasture species include: Queensland and pitted bluegrass, black speargrass and trefoil.
- country is generally too rich for grapes causing uneven ripening.

Best management practices

Cropping

- adopt conservation farming practices to maximise groundcover and infiltration, reduce water erosion, and assist in maintaining good surface soil structure.
- structural soil conservation measures will be required with cultivation on slopes.
- desirable to include pastures in rotation to maintain fertility and soil structure.
- moisture levels will be the determining factor on crop choice. Responds well to small falls of rain in dry years and can produce better crops than the heavier clay soils.
- crusting makes these soils relatively unsuitable to straight zero-till fallows.

Vegetation

- conservation status of remnant vegetation is *endangered*.
- planning guidelines and restrictions apply to clearing and land development.

Grazing

- strategic grazing and spelling of pastures is required to maximise pasture vigour.
- ley pasture rotation with cultivation is regarded by many farmers as being the best use for these soils.
- overgrazing is indicated by the invasion of inferior and unpalatable species such as cottonbush, couch and white speargrass.
- couch and urochloa can be useful sources of feed. Rhodes and buffel grass regarded as second grade feeds to the panic species.
- sulphur required to maintain sown species.
- adjust stocking rates to suit seasonal conditions.
- stocking rates *native pasture* 1 AE/3.0-3.5 ha. *sown pasture* 1 AE/2.5-3.0 ha.

WYNHARI

Associated soil in LRA: 6d

Brief description

Wynhari is a deep, dark or brown, non-cracking clay on fine grained sandstone.

Landform and distribution

- gently undulating plains or rises, scarp footslopes and broad valleys of the lowlands associated with the jump-ups, south-west of Cecil Plains and Millmerran.
- occurs west of the Kumbarilla Ridge.

Vegetation

- tall open forests of belah with occasional brigalow.
- understorey of wilga and false sandalwood.
- mostly cleared.
- Regional Ecosystem 11.9.5

Example soil profile description

Depth (cm)	Description
0-5	dark grey; light clay; moderate granular structure; abrupt to:
5-35	dark grey; medium clay; strong coarse blocky structure; few carbonate nodules; clear to:
35-100	grey-brown; slightly mottled; heavy clay; strong coarse blocky to lenticular structure; many soft carbonate segregations and nodules; abrupt to:
100+	weathering sandstone and siltstone.

Australian Soil Classification: Epiphypersodic-Endocalcareous, Epipedal, Brown Vertosol

General soil features

- deep, firm or self-mulching, non-cracking clays.
- *surface soil:* brown light clay. Moderately structured. Strongly alkaline (pH 8.5).
- *subsoil:* brown to yellow brown medium to heavy clay. Well structured with a few carbonate nodules. Strongly alkaline (pH 9.0-8.5). Strongly sodic and highly saline at depth.
- PAWC is moderate (100-150 mm).
- responds to N, P, Cu and Zn.

WYNHARI

Land use limitations

- moderately fertile soils with moderate water holding capacity.
- PAWC is limited by strongly sodic and saline subsoils.
- surface structure deteriorates with continuous cultivation.
- can form a weak surface crust after rain.
- susceptible to water erosion.
- regrowth, particularly of limebush, false sandalwood and brigalow is a problem.

Land use suitability

This soil is suited to continual grain cropping with good nutrition and rotations for weed and disease control.

- suitable for most grain and forage crops.
- suitable grain crops include: wheat, barley, chickpeas, sorghum, canola, safflower, mungbeans, triticale, and millets.
- suitable forage crops include: oats, forage sorghum, lucerne, cowpea and lab lab.
- suitable for grazing native and most sown pastures.
- suitable sown pasture species include: Katambora Rhodes grass, purple pigeon grass, buffel, bisset creeping bluegrass, bambatsi panic, lucerne and medics.
- key native pastures species include: Queensland bluegrass, fairy grass, Warrego grass, curly windmill, slender canegrass and weeping panic.
- although highly suitable for grazing native and most sown pastures, very little is used for this purpose due to the high returns from cropping.

Best management practices

Cropping

- adopt conservation farming practices to maximise groundcover and infiltration, reduce water erosion and assist in maintaining good surface soil structure.
- structural soil conservation measures will be required with cultivation on slopes.
- desirable to include pastures in rotation to maintain fertility and soil structure.
- the use of presswheels or rollers are useful in aiding crop establishment.
- subsoil salts will be leached downward with cereal cropping, increasing the effective rooting depth and hence the plant available water capacity.

Vegetation

- conservation status of remnant vegetation is *endangered*.
- planning guidelines and restrictions apply to clearing and land development.

Grazing

- grows prolific bluegrass after clearing and makes a highly productive native pasture.
- strategic grazing and spelling of pastures is required to maximise pasture vigour.
- overgrazing is indicated by the invasion of inferior and unpalatable species such as cottonbush, couch and white speargrass.
- fertilising with phosphorus and sulphur will improve pasture production.
- adjust stocking rates to suit seasonal conditions.
- stocking rates *native pasture* 1 AE/4.0-8.0 ha.
  sown pasture 1 AE/3.0-6.0 ha.

YARGULLEN

Associated soil in LRAs: 2a and 7a

Brief description

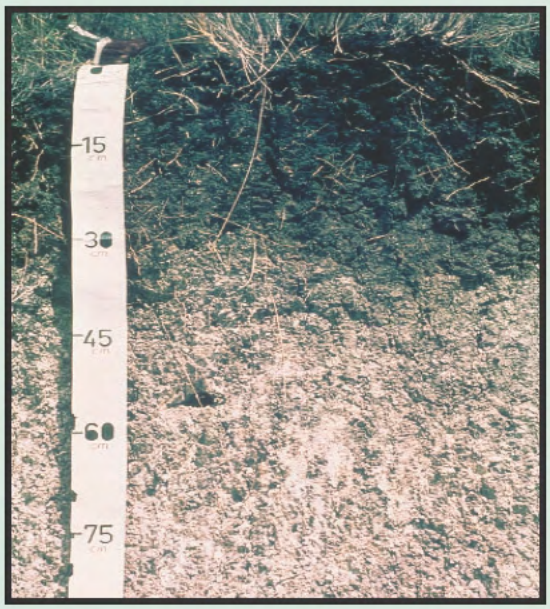
Yargullen is a moderately deep, black heavy clay with a fine to moderate granular surface over soft white, carbonate rich material. *Edgecombe* is a similar soil where the subsoil material is hard limestone. Both *Yargullen* and *Edgecombe* have similar limitations and management characteristics.

Landform and distribution

- lower slopes, valley floors and alluvial fans in the Basaltic Uplands.

Vegetation

- open grassland of Queensland bluegrass.
- occasional Queensland blue gum.
- mostly cleared.
- Regional Ecosystem 11.3.21



Example soil profile description

Depth (cm)	Description
0-20	black; heavy clay; moderate to strong; medium granular structure; diffuse to:
20-40	black; with grey mottles; heavy clay; strong medium blocky to lenticular structure; moderate amounts of soft carbonate; clear to:
40 -100	white to grey; marly clay; moderate blocky or lenticular structure; predominantly soft; carbonate rich material.

Australian Soil Classification: Endocalcareous, Self-mulching, Black Vertosol

General soil features

- shallow, fine, cracking clays.
- *surface soil:* black, dark grey and very dark brown clay. Very soft, fine to medium granular surface. Moderately to strongly alkaline (pH 8.0-9.0).
- *subsoil:* the upper subsoil is black or dark grey mottled clay with moderate amounts of soft carbonate. Becomes paler, marly clay of predominantly soft carbonate with depth. Strongly alkaline (pH 9.0-9.5).
- Edgecombe is more finely structured than Yargullen and overlies hard carbonate rich material.
- PAWC is low (50-100 mm).
- responds to N, Cu and Zn.

Land use limitations

- PAWC is limited by depth of the darker surface soil - only minor amounts of PAW is stored in the calcareous subsoil.
- crops will suffer heat stress due to low PAWC.
- subject to surface sealing under high intensity rainfall and can be difficult to wet up.
- severe wind erosion when cultivated.
- occasional overland erosive flooding.
- occasional flooding may limit crop choice and reduce production potential due to waterlogging.
- depth of the calcareous subsoil prevents the construction of water storages.
- occupies small discrete areas amongst soils such as *Waco*. Often exposed in drainage lines on lower slopes and valley floors.
- generally not suited to intensive livestock industries (e.g. feedlots, piggeries) due to potential for contamination of ground-water.

Land use suitability

These soils are highly fertile but their available water capacity is limited by shallow effective soil depth, and lower yields can be expected in dry years. They are best suited to winter grain and fodder cropping along with grazing pastures but require good management techniques.

- suitable for most grain and forage crops.
- suitable grain crops include: wheat, barley, millets and panicums.
- suitable forage crops include: oats, forage sorghum and lab lab. Summer forage crops will suffer from heat stress due to low PAWC.
- suitable sown pasture species include: Katambora Rhodes grass, creeping bluegrass, purple pigeon grass, digit grass, snail and barrel medics.
- key native pasture species include: Queensland pitted and forest bluegrass.

Best management practices

Cropping

This soil is generally not recommended for continuous cropping. It often occurs as small isolated islands in larger paddocks of good black alluvial clays making separate management extremely difficult. Where large areas can be cultivated separately, the following management options are recommended:

- adopt conservation farming practices to maximise groundcover and infiltration, reduce water and wind erosion.
- strip cropping is recommended for erosion control and spreading of overland flow and/or flood water.
- pasture phase recommended to maintain surface structure.
- responds well to small falls of rain.

Vegetation

- conservation status of remnant vegetation is *endangered*.
- planning guidelines and restrictions apply to clearing and land development.

Grazing

- strategic grazing and spelling of pastures is required to maximise pasture vigour.
- overgrazing will result in the invasion of unpalatable and inferior species such as white spear or wiregrass.
- sulphur will be required to maintain sown species.
- adjust stocking rates to seasonal conditions.
- stocking rates *native pasture* 1 AE/4.0 ha.
  sown pasture 1 AE/2.0 ha (with some supplementary feed during winter).

GLOSSARY

A horizon See *Soil horizon.*

A2 horizon See *Subsurface soil; Bleach.*

Acid soil A soil giving an acid reaction throughout most of 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.

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 soil 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 (plural. alluvia) Deposits of gravel, sand, silt, clay or other debris, moved by streams from higher to lower ground.

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*). Hence Arenaceous.

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).

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 or decomposed rock or saprolite; or unconsolidated mineral materials. The term is used as a definition for a Tensile Sub-order in the Australian Soil Classification (Isbell, 1996).

Buffering capacity Ability of a soil to resist change (usually chemical). It is affected by factors such as clay content, clay type, organic matter levels and pH.

C horizon Layer(s) below the B horizon which may be weathered parent material, not bedrock, little affected by soil-forming processes.

Calcic 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.

Cation A positively charged ion.

Cation exchange capacity (CEC) 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 reserves in the soil and it therefore an indicator of inherent soil fertility. An imbalance in the ration of cations can result in soil structural problems. High levels of individual cations (e.g. aluminium and manganese) can also be toxic to plants.

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 0.2m 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.

Concretion 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.*

Crusting See *Surface crust.*

Crusty Soils with a massive or weakly structured surface crusty horizon 0.03 m or less thick, often of lighter texture than the underlying pedal clay which is not self-mulching. It is used as a Subgroup definition for Vertosols in the Australian Soil Classification (Isbell, 1996).

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.*

Dermosol A Soil Order of the Australian Soil Classification (Isbell, 1996). Soils with structured B2 horizons and lacking strong texture contrast between A and B horizons.

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 hour after water addition.
- rapidly drained: no horizon remains wet except shortly after water addition.

Duplex soil See *Texture contrast soil.*

Duricrust A cemented layer at or near the surface resulting from the concentration of breakdown products of rock weathering.

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.

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.

Endohypersodic Soils in which an ESP of 15 or greater occurs in some subhorizon below 0.5 m. It is used as a Subgroup definition for Vertosols in the Australian Soil Classification (Isbell, 1996).

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).

Epipedal Soils with a pedal A horizon which is either not or weakly self-mulching, and there is no surface crusty horizon. It is used as a Subgroup definition for Vertosols in the Australian Soil Classification (Isbell, 1996).

Epihypersodic Soils with at least one sub-horizon 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).

ESP Exchangeable sodium percentage. See *Sodicity.*

Eutrophic See *Base Status.*

Eutrophication Process by which water becomes enriched with nutrients, primarily nitrogen and phosphorus, which stimulate the growth of aquatic flora and/or fauna.

Feldspar Any of a group of alkaline aluminium silicate minerals, an important part of igneous rocks, such as granite.

Ferrosol A Soil Order of the Australian Soil Classification (Isbell, 1996). Soils with B horizons which are high in free oxide, and which lack strong texture contrast between A and B horizons.

Floating sandstone Loose sandstone rock fragments that are often found in the soil on a slope.

Floodplain Alluvial plains formed by flooding streams or rivers and prone to inundation from flooding.

Gilgai Surface microrelief associated with soils containing shrink-swell clays. Characterised by the presence of mounds and depressions.

- ***crabhole*** — irregularly distributed small depressions and mounds, separated by a more or less continuous shelf. Vertical interval usually less than 0.3 m. Horizontal interval usually 3-20 m, surface almost level.
- ***linear*** — long, narrow, parallel, elongate mounds and broader, elongate depressions more or less at right angles to the contour; usually in sloping lands.
- ***melonhole*** — large depressions, usually greater than 3 m diameter and deeper than 0.3 m, which have a sub-circular or irregular shape and are separated by elongate mounds or set in an almost level surface.
- ***normal*** — small, irregularly distributed mounds and sub-circular depressions, usually with less than 0.3 m vertical interval between the mound tops and bottom of depressions.

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.

Granite tors Tower-like blocks of unweathered granite rock standing above the surrounding area.

Gypsic Soils with a gypsic horizon. This is one that contains more than 20% of visible gypsum that is apparently of pedogenic origin, and has a minimum thickness of 0.1 m. This term is used as a definition within a number of Soil Orders in the Australian Soil Classification (Isbell, 1996).

Gypsum A naturally occurring soft crystalline material which is a hydrated form of calcium sulphate. Gypsum contains approximately 23% calcium and 18% sulphur. 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.

Hardsetting Surface soil that becomes hard and apparently structureless on the periodic drying of the soil.

Hillslope Landform pattern with a gently inclined to precipitous slope.

Horizon See *Soil horizon,* also *Soil horizon boundary*

Humus Dark organic material in soils, produced by the decomposition of animal or vegetable matter.

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).

Hypernatric Soils in which the major part of the upper 0.2 m of the B2 horizon has an ESP greater than 25. It is used as a Subgroup definition for Sodosols in the Australian Soil Classification (Isbell, 1996).

Igneous rock 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).

Interbasaltic Lying between layers of basalt.

Jump-ups 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).

Kurosol A Soil Order of the Australian Soil Classification (Isbell, 1996). Soils with strong texture contrast between A horizons and strongly acid B horizons. Many of these soils have some unusual subsoil chemical features (high magnesium, sodium and aluminium).

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.

Levee An embankment constructed to contain floods from a river. Can refer to natural embankments formed by deposition of sediments from flood flows.

Lithology Nature of rocks as seen in hand specimens, on the basis of colour, grain size and composition.

Local relief The altitude difference between the base and crest of slopes in undulating or hilly areas.

Low hills Landform pattern of low relief (30-90 m) and gentle to very steep slopes.

Magnesic 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.

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.

Plain Level to undulating or rarely, rolling landform pattern of extremely low relief (less than 9 m).

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.

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).

Rises Landform pattern of very low relief (9-30 m) and very gentle to steep slopes.

Rudosol A Soil Order of the Australian Soil Classification (Isbell, 1996). This order is designed to accommodate soils that have negligible pedologic organisation. They are usually young soils in the sense that soil forming factors have had little time to pedologically modify parent rocks or sediments.

Salinity The presence of sufficient soluble salts to adversely affect plant growth and/or land use. The main salt involved is sodium chloride, but sulphates, 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:

Clay-sized grains:	Mudstone
Sand-sized grains:	Sandstone
Silt-sized grains:	Siltstone
Gravel-sized grains:	Conglomerate

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:
90% or more of grains are quartz: Quartzose sandstone.
less than 75% of grains are quartz: Labile sandstone.

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) nature for example, calcareous (carbonate), gypseous (gypsum), manganiferous (manganese) and ferro-manganiferous (iron-manganese).

2)abundance

very few (trace or occasional)	<2%
few (slight)	2-10%
common (light)	10-20%
many (moderate)	20-50%
very many (heavy)	>50%

3) form

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.
Veins	- fine (<2 mm wide) linear segregations.
Laminae	- planar, plate-like or sheet-like segregations.

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.

Silicified Materials in which silica dominant minerals e.g. quartz, opal, have permeated and filled pores.

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.

Snuffy Soils with an A horizon having a very fine granular structure (,2 mm) and a dry consistence strength that is weak to very weak. The horizon usually has a low bulk density and may be water repellent.

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%

Sodosol A Soil 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 sub-plastic.

Soft segregations 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.

The following depth ranges are used in this manual to describe the soil surface and soil profile depths.

Soil depth

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 intergrade A soil which contains properties of more than one described soil type. They are common between two related soils.

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 district in undisplaced soil; when displaced more the two-thirds of the soil material consists of aggregates (ie well structured)
— *moderate* Natural soil aggregates are well formed and evident but not distinct in undisplaced soil; when displaced more then one-third of the soil material consists of aggregates (ie 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 20mm 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 5mm 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 multiangled.
— *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	Less than 5
	Loamy Sand	5 to 10
	Sandy Loam	10 to 20
Medium	Loam	≈ 25
	Sandy clay loam	20 to 30 + sand
	Clay loam	30 to 35
Fine	Sandy clay	35 to 40 + sand
	Light clay	35 to 40
	Medium clay	40 to 50
	Heavy clay	more than 50

Solodic soils

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

Structured earths

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.*

Vertic Soils with a B horizon in which at least 0.3 m has a clayey field texture or 35% or more clay, which cracks strongly when dry and has slickensides and/or lenticular peds. It is used as a Subgroup definition in the Australian Soil Classification (Isbell, 1996).

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.