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Landscapes and soils of the Katanning district

D N. Sawkins

Department of Agriculture and Food

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Landscapes and soils of the Katanning district
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Dr Bill Verboom and Heather Percy for their ideas, encouragement and critique in the development of this bulletin; Phil Goulding for the map images, and Peter White of the Western Australian Department of Environment and Conservation for assistance with editing and the indicator vegetation guide.

Developed and compiled by Doug Sawkins, Department of Agriculture and Food, Narrogin WA. February 2011.
Introduction

The agricultural areas of Western Australia are very diverse, with a wide range of landscapes, soils and associated native vegetation.

This bulletin was designed as an induction course for Department of Agriculture and Food employees who have been recently posted to the department’s district offices, but the information is fundamental for others who work in these districts.

This Bulletin provides readers with principles underlying the formation of local landscapes and soils, and information needed to identify landscapes and their associated soils. The emphasis is on field application.

It provides a basis for developing a more detailed knowledge of:

- Local soils and land capability
- Salinity and hydrology
- Local farming systems
- Landcare and nature conservation.

Table 1 Areas covered in this series (see also Figure 1)

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<tr>
<td>Northam</td>
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Each bulletin has been designed as a self-learning module that contains the following components:

1. Two information chapters
   These describe the development and distribution of the soils, landscapes and soil landscape systems in the district.

2. Decision aids for use in the field
   - Indicator vegetation guide that is useful for quickly understanding soil type variations from remnant vegetation.
   - Other decision aids to help you identify landscape types, land units and common soil types in the district.

3. A half-day documented field trip with specific stops to provide field examples of the information covered in the booklet, to give practice in using the decision aids.

4. Case studies
   These are areas in the district that have been displayed as a map with photographs of numbered points to illustrate the soils and landscape. These real-life examples show the diversity of landscapes that make up the soil landscape systems in the district, and explain the variations that occur. Distances are shown so that you can visit each area with the document as a guide.

5. An appendix containing supporting information, a glossary and references.

Figure 1 shows district boundaries and the proportion of the district that is allocated to agriculture.

Figure 1 Areas covered in this Bulletin series with reserves shown in green
Landscape development in the Katanning district

In this chapter, you will be introduced to factors influencing soil and landscape development in the Katanning district.

The north-east quadrant of the district and North Stirling area has subdued uplands and extensive poorly drained valleys. There are two major watersheds (see Figure 2).

On the eastern edge of the district the Median Watershed separates the Blackwood catchment from north-flowing salt lake chains of the Lockhardt catchment system. The Jarrahwood Axis separates south-flowing waterways from west-flowing waterways of the Blackwood River catchment.

![Figure 2: Broad drainage areas in the Katanning district](image)

The western edge of the district comprises a gently undulating uplifted plateau called the Darling Range that has been dissected by the Blackwood and Frankland rivers. Soils there are mainly sandy gravels and gravelly duplexes over granite or Eocene sediments, except where the plateau has been deeply incised by the Blackwood River. East of the Darling Range, grey shallow duplex soils are very common in the valleys with mixed, but mainly grey sandy, loamy and gravelly duplex soils on the uplands.

To the north, the Narrogin district (Bulletin 4807) has a clearly defined rejuvenated drainage zone that has active waterways and a higher proportion of soils formed on truncated laterites and underlying rock between the Darling Range and an ancient drainage zone to the east that has more subdued mainly lateritic uplands and broad valleys. The rejuvenated drainage zone continues in the Katanning district as the rejuvenated area, but is becomes variable due to the influence of the Jarrahwood Axis (that is discussed in the next chapter).
Factors and processes shown in Figure 3 have interacted to develop the landscapes and soils. These include:

**Geology and tectonic movement**

There are marked differences in the underlying rocks, which weather and erode in distinctive ways. Differential weathering of rock types, faulting and geological uplift have had large effects on landscape relief and soil type.

The geology of southern Western Australia is dominated by the Yilgarn Craton, an ancient and relatively stable area of granites and gneiss, a metamorphic banded rock (Western Australian Department of Mines 1990). Gneisses are metamorphosed igneous rocks that vary in their dark mineral content, ranging from light-coloured silica-rich rocks to dark-coloured mafic rocks.

You will notice in Figure 4 that many features such as faults, dykes, major rock formations and waterways trend north-west/south-east, east-west, or north-east/south-west. The north-west alignment of major rock bands of the Yilgarn Craton reflects its formation over many hundreds of million years as ‘rafts’ of land on tectonic plates collided to form bands of gneiss that were intruded by granites.

Bands of greenstone were formed when intra-plate rifts that were alternately filled by sediments and volcanic rocks, and extensively metamorphosed by ongoing plate collision.

Stresses associated with these events caused cracking and intrusion of dolerite as dykes throughout the craton.

On the southern edge of the district the Stirling Range is a line of uplifted metamorphosed sediments. (Lane P. 2004)
Figure 4  Geology of the Katanning district

Figure 5 shows a range of soils formed directly from felsic (acidic) rocks in Western Australia. These are the most common basement rocks, have relatively high amounts of quartz, and weather to sandy surfaced soils. They are mainly granites but include other igneous rocks such as felsic gneisses.

Figure 5  Felsic (quartz-rich) rocks and associated soils
February 2011

Figure 6 shows a range of soils formed directly from mafic (basic) rocks in the district. Examples include mafic gneiss, greenstone, dolerite and gabbro (coarse textured variant of dolerite).

These rocks contain large proportions of ‘dark’ minerals and high levels of calcium and iron. They weather to red-brown to brown clay loam to clay soils with alkaline and often calcareous subsoils.

More common to the east

More common to the west

Most mafic soils are found on the numerous narrow dolerite dykes that are scattered through the district. Larger areas occur on mafic gneiss and greenstone, particularly in the Dumbleyung area. Rock composition is variable, particularly in gneissic areas as shown in Figure 7.
The next chapter on soil landscape systems shows main areas in the district that have soils formed from felsic and mafic igneous rocks.

Although the district is underlain mainly by igneous rocks, in many areas these are overlain by sediments that have been modified to form present day soils (Figure 8). These include:

1. Eocene sediments with mainly laterites and sandy paleo-valleys in the west of the district, with mallee duplex soils amongst saline lakes in the North Stirlings

2. Valley sediments in main valleys in the east of the district that are overlain by more recent deposits. Duplex and clay soils support salmon gum and wandoo.

When Australia separated from India and Antarctica following the break up of the Gondwana supercontinent, resultant stresses had a significant effect on landscape formation in Western Australia. Extensive faulting and uplifts on the south and west of the Yilgarn craton caused marked changes to slope and drainage patterns. This will be discussed in the next chapter.

Native vegetation

In Western Australia, there is a very close relationship between soil types and native vegetation, with vegetation and associated soils often forming complex mosaics in the landscape. In most areas, the soil varies over short distances and intergrade soils such as sand over gravel over clay are common, as are duplex sandy gravel soils.

Figure 9 shows an example of soil gradation in the mallee zone, but similar changes are associated with a range of soils and vegetation communities that occur in Western Australia.
There is considerable evidence (Verboom, W H and Pate, J S (2003)), that plants can engineer soil conditions to deny water and nutrients to competitors. Plants and associated microorganisms create horizons in many of our soils, particularly through root secretions.

Common examples in the district are:

- Laterite formation by members of the \textit{Proteaceae} family and \textit{Allocasuarina} genus (particularly tammas) that control access to soil phosphorus in well-drained acidic situations.

- Mallee duplex soils with silica ‘seals’ and/or dense clay on or above the subsoil that generally restrict understorey access to stored water. The mallees themselves use their roots to store and access water using a process called hydraulic redistribution. Surface water may also be transmitted directly to these storage zones via macro pores which arise when roots shrink during heavy rain.

- Formation of lime deposits in subsoils of alkaline soils assist in soil water storage and may control access to soil phosphorus.

- Plants such as brown mallet that create water-repellent topsoils and can direct water by their shape and bark characteristics into the subsoil.

A general introduction to the role of biology in soil formation can be found in Sawkins et al (in prep).
Laterites are soils in which iron and aluminium have accumulated in the profile, usually as gravels. Figure 10 shows a common laterite profile. An old laterite developed on granite usually has a sandy surface overlying small round gravel, then a layer of blocky ironstone followed by mottled clay and then a pallid zone, sometimes referred to as 'pipe clay'. Saprock is a zone of partially weathered bedrock that is quite permeable for groundwater movement.

![Diagram of a typical laterite profile](10)

Most laterite formation involves plants and bacteria, which accounts for the observations that different laterites occur under different populations of plants and that laterite is still forming where there is sufficient rainfall. Figure 11 shows a simplified depiction of sandy gravel formation.

![Gravel and reticulite formation](11)
The following factors are required for laterite development:

1. Plants with proteoid roots and associated bacteria: Plants secrete organic molecules of low molecular weight carboxylates (LMCs) which form a compound with phosphorus (and iron and other minerals such as aluminium and silica) that is soluble in water and can be absorbed by plant roots. Most of the plants with proteoid roots are *Proteaceae* (most noticeably dryandras, banksias and hakeas), and *Casuarinaceae* (tammas and sheoaks). Bacteria use excess LMCs as food and so precipitate the minerals. Gradually iron becomes depleted near the soil surface and accumulates further down as ferricretes (gravels and reticulite). Minerals are also mined using chelation (binding to LMC's), and uplifted and concentrated in the upper regolith by plant hydraulic lift. This is a primary reason why very sandy materials can have stony ferricretes over sandy lower layers, and why lateritic pallid zones occur.

2. Low phosphate soils: *Proteaceae* and *Casuarinaceae* have a competitive edge over other vegetation in these soils. In more fertile soils other species are often more competitive.

3. Leaching (acidic) soil conditions: Many proteaceous plants and associated bacteria function best in acid to neutral soil conditions. Laterites will not form on poorly drained or alkaline soils (LMC's involved are deactivated by calcium). This explains why most laterites are found on well-drained ridges and slopes, or in valleys that have good internal drainage.

4. Enough rainfall to move the dissolved minerals down the soil: Rainfall is required to move the chelated iron down the soil profile. If not the iron would remain near the surface and the deeper laterite layers would not form. Typical laterite profiles are more common in higher rainfall areas of the district, such as the Darling Range.

Laterites in the district vary due to:

1. The type of parent material: for example Eocene siltstone lateritic soils tend to be grey duplex gravels that can be affected by waterlogging (see the Moodiarup case study), while quartz-rich materials form sandy laterites. Mafic laterites have darker, heavier, more iron-rich ferricrete with more clay in the soil matrix. Mafic laterites are often found on ridges or spurs, and can have a major influence on landscape.
development (Verboom & Galloway 2004). More information on mafic and sandy landscapes can be found in the landscape recognition guide.

2. Stage of laterite formation: Some laterites are very old but others have formed more recently with less well-developed profiles that may lack a pallid or mottled zone. In Figure 13, the young laterite to the left has loamy gravel over reddish-brown clay then weathering dolerite. Dolerite often weathers to red-brown loamy duplex and clay, but lateritisation can’t start until the soil becomes neutral. The much older mafic profile in the Darling Range in the image on the right has a 'pink' zone in contrast to the pallid zone of the adjacent granitic profile.

![Figure 13](image)

*Figure 13  Mafic laterites: left, young loamy gravel laterite over clay; right, older profile*

3. Competition between native vegetation communities, often reacting to changes in climate, land relief and hydrology, or parent material: Intergrade soils illustrated in Figure 9 are particularly common in the mallee zone where most gravel soils have duplex profiles.

Hard-setting or duplex soils supporting eucalypts tend to dominate in areas that don’t favour laterite development. These include fertile soils, alkaline soils, and situations with restricted water movement through the soil, such as winter-waterlogged, and heavy textured and poorly structured soils.

Duplex soils are very common in the Katanning district on all landscape positions. Salmon gum (alkaline shallow calcareous duplexes) and wandoo (mainly deeper sandy duplexes) are most common in major valleys. In the east of the district (particularly east of Broomehill) and north of the Stirling Range, mallees and moort replace wandoo on duplex and grey clay slopes and tributary valleys.

Mallee-melaleuca scrub associations are generally associated with shallow duplex soils. Mallees with associated bacteria and fungi have created these specific layers to deny access to soil water from potential competitors. Verboom and Pate (2006) describe mechanisms by which these species create a sandy surface horizon separated from the subsoil by a
relatively impermeable ‘seal’ composed of silica and sodic clay, and have roots that pump water from one layer to another as shown in Figure 14.

Deep grey sandy duplex soils are common east of the Darling Range on uplands and associated waterways. On slopes they tend to be deeper downslope due to colluvial action.

**Climate**

Climate changes cause changes in landscape and native vegetation. Figure 15 shows that over the past 6 million years our climate has fluctuated greatly.

**Rainfall regimes in arid and semi-arid regions**

**From the Miocene to recent**

- **Higher rainfall phases**
  - High sea levels
  - More vegetation
  - Less erosion, more stable landscapes
  - Deep weathering
  - Laterite formation on well-drained areas.

- **Arid phases**
  - Low sea levels
  - Less vegetation
  - Unstable landscapes, droughts, flash floods, saline lakes
  - Sandplains from laterites, oceans, waterways
  - Silcretes and red-brown hardpans are more common.

In wetter times the landscape tended to be more stable. Soils formed faster and were more protected by dense vegetation. Plants favouring laterite development flourished on stable well drained areas, probably with plants favouring duplex soils in lower slope areas.
During arid phases, the soil was barer and subject to erosion by flash floods and wind. Sandplain development was favoured at the expense of gravels, particularly in the east/north-east agricultural areas of Western Australia.

Aridity may also have been associated with very strong winds, and lower sea levels due to water being tied up as ice. Lower sea level increased slope to the sea, which favoured water erosion, and also exposed sea beds to wind erosion. Sands were blown from the exposed areas by strong winds to form our coastal dunes. Similarly, wind moved materials out of dry rivers and lakes inland forming lakeside sand and loamy soils. Some lateritic sandplain and duplex soils formed on this material when the climate became wetter again.

In low rainfall areas, salts and clays have accumulated in the valleys where there was insufficient rainfall to flush salts out of the system in rivers or groundwater.

**Soil movement processes.**

Soil particles are sorted and transported by the following processes.

Colluvial processes are most widespread with soil movement down slopes and on to valleys in both arid and wet climates. The soil moves downslope by raindrop action, biological activity such as burrowing, by flash floods or just gravity acting on loose soil. Colluvial pale sands (“spillway sands”) like the example in Figure 16 commonly occur in upland hollows and footslopes.

Alluvial processes (movement by water) were extensive in the major valleys more than 15 million years ago when the climate was wetter. These deposits are often buried now by sediments originating from redistributed materials sweeping down from uplands. Recent alluvial soils are confined mainly to some flat trunk valleys and river terrace soils on major rivers.

In reality, it is difficult to distinguish between alluvial and colluvial processes and there is also evidence of mixing of products from more than one mode of action. Soil profiles can also reveal complex sequences of differentiation where differing profiles overlay or overprint each other.

Aeolian processes (wind) have been active in arid climatic times with sands and loams being blown from ancient dry lakes, salt pans and river beds. Deposits in the Katanning district are mainly orange, yellow, and grey sands found near large valleys, lakes and swamps.
Significant aeolian deposits occur near Boscabel, between Wagin and Woodanilling, and generally south and east of Tambellup. These include dunes, but are more commonly thin sand sheets that have overlain igneous rock landscapes. Subsequent laterite and duplex soil formation has resulted in sandy gravel and sandy duplex soils in smooth landscapes that often have smooth valleys with seepages and salinity. The East Tambellup case study is a good example. To the north and east of the district aeolian calcareous silty loams supporting red morrel (Eucalyptus longicornis) become common.

Native vegetation tends to be similar on colluvial and aeolian pale sands, as these soils have similar poor water holding capacity. Colluvial pale sands tend to be localised and more frequent in lower slopes and hollows below sandy gravel or granite rises. Aeolian pale sands are usually south and east of valleys and are found in all landscape positions.

Figure 18 shows a general grouping of the main landscape areas in the Katanning district.

Darling Range laterites have been forming continuously for the longest time, due to higher rainfall. The lateritic topsoil tends to be more gravelly and often without the grey sandy surface of laterites further east. This is due to biological activity in the forest soils which mixes the topsoil.
Interplay of factors discussed above has resulted in a mosaic of soils, particularly on the uplands. This goes a long way to explaining the variation over short distances recorded by harvester yield monitors.
Katanning district soil landscape systems

Soil landscape mapping in much of the district initially characterised the main soils and grouped soil and landscape information into units often referred to as land units (or land surfaces).

A land unit has a single soil type or a group of soil types that correspond to broad topographical features such as valley floor, hill slopes and sandplain, or to a sequence of soils to each other. They are useful for understanding the landscape at paddock to farm level.

More recently the Department of Agriculture and Food, Western Australia has introduced a hierarchical classification system. Information is stored in a database to provide a uniform method of classification and information storage (Schoknecht et al. (2004)).

The relationship between the mapping methods is shown in Figure 19.

Soil landscape systems (also called systems here for brevity) consist of a range of land units. Different systems often contain the same land units but in differing proportions.

Systems are more useful for gaining an overview of major landscape areas in the district, particularly for areas where there are large differences in the proportion of land surfaces (for example, areas of different laterite types, differences in geology, or more or less dissected).

This section is an introduction to the main upland systems in the form of a greatly simplified story about the development of the geology and geomorphology of the district.

In reality, the situation is more complex, with unclear dates and often with events (for example, the uplift of the Darling Range) occurring as stages over long periods rather than
as a single event. However, this approach helps to appreciate the factors that led to the development of the systems.

First consider the crystalline bedrock that underlies the district. Most of the district is underlain by granites that weather to sandy surfaced soils. North-west/south-east or east-west trending dolerite dykes have intruded the granite and formed brown loam and clay soils, often in narrow strips.

Figure 20 depicts a north-south trending area generally east of Katanning of mixed gneisses that contain larger areas of mafic rock. This is particularly obvious in the Datatine soil landscape system land system that is dominated by a dissected mafic landscape with mainly red-brown alkaline soils. It is also reflected in York gum loams of the Upper Pallinup system around Gnowangerup, and the Dedatup system north east of the Stirling Range. A brief description of each soil landscape system is contained at the end of this chapter.

Figure 20  Soil landscape systems with mafic soils associated with gneiss (white shaded area)

Figure 21  Red-brown loamy duplex slope and mafic laterite hills in the Datatine system

Australia was once a part of a supercontinent called Gondwana. When this split about 150 million years ago, processes started that culminated in the separation of Australia from Antarctica and India. Extensive faulting and marginal uplifts that resulted from the rift caused marked changes to drainage patterns.

Figure 22 shows river systems in the late Cretaceous period that differed markedly from their present course.
As the tectonic plate containing India gradually separated from Western Australia, west-flowing rivers deposited sediments from the Yilgarn craton into a valley that is now the Swan coastal plain. There was also a rift developing on the south coast between Australia and Antarctica. A major ridge (the Median Watershed) separated rivers flowing south from those flowing west.

There was no Darling Range. Ancient rivers (paleorivers) in the Katanning district shown in Figure 23 apparently flowed west to north-west to the coast from the Median Watershed and the Stirling Range. Evidence of the paleorivers comes from uplifted sandy river channels.
Paleochannels are buried sandy river channels whose path is independent of the overlying landscape, and contain variable quality artesian to sub-artesian water supplies. There are also numerous roughly north-south orientated valleys.

About 66 million years ago an east-west rise that runs through Broomehill called the Jarrahwood Axis formed. This, and the Darling Range that was uplifted later, reduced river grades in the ancient drainage area and was a major contributor of the flat infilled valleys and subdued uplands of this area. Soil landscape systems in this area shown in Figure 24 tend to have more subdued uplands and more mallee duplex soils to the south and east of the district. Of particular note is the Tieline system, a poorly drained plain that straddles the Jarrahwood Axis (Figure 25).

Figure 24  Upland ancient drainage systems. More mallee soils to the south and east

Figure 25  Tieline mallee shallow grey sandy duplex flats

About 40 million years ago in the Eocene period, the ocean encroached on the south and west of the district to a level about 300 metres above present sea level. Sediments were laid down by a shallow sea in the south and lakes, swamps and rivers in the west.
About 20 million years ago in the Oligocene period, the Darling Range started slowly rising as an uplifted plateau on the eastern edge of the Darling Fault. The total uplift has been about 200 metres.

Laterite has formed on the uplifted Eocene sediments to create the Eulin Uplands system with grey duplex sandy gravel and deep sandy duplex plains that are susceptible to waterlogging in wet seasons. Similarly, laterites formed in surrounding igneous rock areas to create the undulating gravelly Darling Plateau system (Figure 27).
The Blackwood River has carved steep valleys through the Darling Range to form the Boyup valleys system that has mixed soils, including fresh soils from granite and dolerite. The Darkan system on the north-eastern edge of the Darling Plateau system is a mixture of flat sandy duplex plains and hilly mixed soil uplands.

The Moodiarup case study provides a detailed example of the landscape and soils in the Eulin Uplands, Boscabel, and Boyup valleys systems.

Between the Darling Range and the ancient drainage area, the rejuvenated drainage area tends to have more active upper waterways and hilly landscapes with very variable soils. This area has been divided into soil landscape systems according to major river catchment and degree of dissection. Landscape dissection has been greater generally south of the Jarrahwood Axis due to slumping on the southern side that increased the gradient.

The Darling Range uplift also blocked the outlet to water that flowed west from the North Stirlings. As a result, the North Stirlings area is a sump with salt lakes and large areas of shallow duplex flats that are threatened by salinity.

Rejuvenated drainage systems west of Katanning are shown in Figure 28. Figures 29 and 30 show southern systems.

Figure 28  Soil landscape systems in the rejuvenated drainage area adjoining the Darling Range

In the last million years there have been several cold and arid climatic phases resulting in less vegetation cover, particularly on large waterways that would have been sluggish and saline.

Aridity combined with very strong winds led to soil movement from these areas to adjoining uplands.
Most aeolian deposits are grey and pale yellow sands with major areas being:

1. The Boscabel system that has grey sands blown from the Beaufort flats to coat the slope to the south-east.

2. The Chillinup system flats in the Albany district on the Albany sandplain.

3. Three systems with grey sands blown from the North Stirling salt lakes. From west to east these are:
   - Mooliup system: grey sand dunes within a rejuvenated area landscape
   - Hydenup system: a subdued area with deep sands, deep sand over gravel or clay
   - Kokarinup system: a rejuvenated area coated with grey sand.

The North Stirlings system is a flat plain of salt lakes and mallee duplex soils on Eocene sediments. It was a west/north-west trending paleoriver that was blocked by the Darling Range uplift. The system is now a closed sump that is slowly becoming more waterlogged and saline from rising groundwaters that can only spill over into the Pallinup River to the east.

Soil landscape systems to the south of Broomehill are very mixed. In Figure 30 you can see from the landscape relief that the Upper Pallinup system is variable. The north and centre of the system are very dissected with York gum and flat-topped Yate granitic/gneissic sandy and loamy duplexes interspersed with wandoo deep grey sandy duplex soils. To the east, the landscape becomes smoother and grades into mallee gravelly and sandy duplex soils that are a feature of the Toompup system. The landscape becomes even gentler and more...
poorly drained to the south with frequent mallee grey duplexes, moort hard setting soils, and aeolian influenced areas adjoining the North Stirlings system.

Figure 30  Main soil landscape systems in the North Stirling sump and Pallinup river catchment

Figure 31  Main soil landscape systems in the Katanning district; see descriptions in following pages.
Katanning district soil landscape systems précis

This is a brief description of soil landscape systems in the district

You need to read the relevant land resources survey to properly understand each system.

### Ancient Drainage area

#### Uplands

Ancient Drainage area

An often irregularly undulating lateritic terrain formed on gneissic rocks on the Median Watershed. The gneissic parent rock is variable, and this is reflected in the landscape and soils. Uplands frequently have shallow yellow sand over gravel, duplex gravels and shallow gravels from granitic gneiss, with some sandy hollows and mallee sandy duplex on lower slopes. This is interspersed with moderately steep mafic stony and loamy gravel uplands with morrel-York gum-salmon gum loamy duplexes in waterways, and bands of relatively smooth grey sandy gravels with frequent deep sandy patches and grey sandy duplex soils formed from quartz-rich gneiss. Valleys are usually greyish alkaline duplex soils, with salmon gums intermixed with red morrel, York gum and mallee. The soils tend to have more colour and better subsoil structure than grey alkaline duplexes in the main valley systems due to the gneissic uplands.

#### Kukerin

Kukerin

Mafic areas on the Median Watershed with rock outcrops and narrow drainage lines. This system is based on mainly mafic gneisses that are interspersed with patches of the Kukerin and East Katanning systems. Major soils are mafic stony and loamy gravels and red-brown loamy duplex and clay loams. Associated valleys have well-structured York gum-salmon gum-morrel red-brown to yellow-brown loam and loamy duplex soils. Gilgai soils are also common on lower slopes and valleys.

#### Datatine

Datatine

Gently undulating to undulating rises and occasional low hills. This system has more granite and hence more grey sandy surfaced soils. Major soils are sandy gravels, grey duplex gravels and wandoo-sheoak grey deep and shallow sandy duplex. Valleys frequently have salmon gum-wandoo alkaline grey shallow duplex soils. There are small areas of sandy and loamy aeolian soils adjoining lakes. The Dongolocking system merges into Kukerin to the east and Whinbin (slightly more dissected) to the west.

#### Dongolocking

Dongolocking

This system consists of uplands surrounding the flat extensive Upper Blackwood drainage system.

In the east, it is interspersed with the Datatine system, with mainly wandoo-proteaceous heath grey sandy and duplex gravels and has deep sandy patches, and grey sandy duplex soils.

Further west it tends to have more mafic gravels soils with mesas and ridges and mixed soils in dissected areas, and merges into the Carrolup system that has more granitic sandy soils.

#### East Katanning

East Katanning

As with the Kukerin system, this system is on median watershed gneissic rocks, but is more subdued where it merges with the Jarrahwood axis (Tieline system). As a result the Nyabing system has less extensive gravelly ridges and more shallow sandy duplex soils on upper and mid slopes, with shallow alkaline duplex soils on lower slopes and valleys. Associated valleys tend to have salmon gum-mallee grey alkaline duplex soils.

#### Nyabing

Nyabing

A subdued landscape (gently undulating rises with valley flats and alluvial plains) of the Jarrahwood axis that separates ancient drainage to the north from the rejuvenated Pallinup river catchment to the south. Poor drainage has inhibited laterite development, with soils being mainly shallow alkaline sandy duplex (mallee), on flats and grey deep and shallow sandy duplex on the subdued uplands (wandoo in the west and mallee heath in the east).

#### Tieline

Tieline

A subdued landscape (gently undulating rises with valley flats and alluvial plains) of the Jarrahwood axis that separates ancient drainage to the north from the rejuvenated Pallinup river catchment to the south. Poor drainage has inhibited laterite development, with soils being mainly shallow alkaline sandy duplex (mallee), on flats and grey deep and shallow sandy duplex on the subdued uplands (wandoo in the west and mallee heath in the east).
Landscapes and soils of the Katanning district

Ancient Drainage area

Valley systems

<table>
<thead>
<tr>
<th>System</th>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coblinine</td>
<td>259Cb.</td>
<td>Broad valley floors of the ancient river system draining from the Kukerin system into the Avon and Blackwood catchments. Major soils are saline wet soils, and salmon gum alkaline shallow grey sandy and loamy duplexes, and wandoo-salmon gum sandy duplex. Tributary valleys with more mafic uplands have better structured soils supporting York gum and red morrel with the salmon gums.</td>
</tr>
<tr>
<td>Norring</td>
<td>259No.</td>
<td>Broad valley floor dominated by lakes with dunes and sandplain downstream of the Coblinine system Saline wet soils, salt lakes and grey deep sandy duplexes. In places, deep grey sands have blown from this system up the western side of adjoining systems.</td>
</tr>
<tr>
<td>Pingrup</td>
<td>250Pg.</td>
<td>Salt lake chains on broad valley floors in the far east of the district that comprise the ancient rivers that now run north into the Avon catchment. The western side of the lake chain has mainly salmon gum-mallee shallow alkaline grey sandy duplex soils, often merging into better structured valley soils of the Datatine and Kukerin systems.</td>
</tr>
</tbody>
</table>

Rejuvenated Drainage area

Uplands

<table>
<thead>
<tr>
<th>System</th>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Whinbin</td>
<td>257Wb</td>
<td>This system is more undulating that the Dongolocking system to the east. Wandoo-rock sheoak grey sandy duplex soils are still very common, but there are more soils formed from dissected laterites and underlying granites (more variable soil distribution, shallow gravels, and granitic deep sandy duplexes) with salmon gum-wandoo waterways. There are some mafic uplands with red brown rocky soils supporting salmon gum-York gum.</td>
</tr>
<tr>
<td>Dellyanine</td>
<td>257De</td>
<td>Dellyanine is even more undulating with frequent granitic-rocky and dissected laterite uplands, and more granitic sandy duplex soils on slopes. Upland waterways are narrower and more active with more wandoo, flooded gum and York gum vegetation.</td>
</tr>
<tr>
<td>Carrolup</td>
<td>257Ca</td>
<td>Much of this system landscape is a gently undulating with deep sandy duplex soils, few lateritic breakaway, and relatively narrow flooded gum-flat topped yate subsidiary valleys. Some areas have more duplex soils formed from igneous rock supporting York gum or flat topped yate.</td>
</tr>
<tr>
<td>Farrar</td>
<td>257Fa</td>
<td>This is the most deeply dissected system in the rejuvenated drainage area, having more rock outcrops and narrow laterite remnants of the Darling Range with jarrah marri vegetation. Mafic influence landscapes are common with steep mafic uplands and slopes with mixed soils formed from lower levels of mafic and granitic laterites and fresh crystalline rock. Flooded gums are common on the winter wet narrow valley floors.</td>
</tr>
<tr>
<td>Jingalup</td>
<td>257Jp</td>
<td>Jingalup is in the Tone River catchment It is similar to the Farrar system but has more lateritic gravels and less dissected slopes.</td>
</tr>
<tr>
<td>Boscabel</td>
<td>253Bo</td>
<td>This has been classified as being a part of the Darling Range, but most of the system is a dissected landscape that has been partially covered by aeolian gray sands blown from the Beaufort system. Subsequent laterite formation and geological erosion has created a sandy mildly dissected lateritic terrain with sandy uplands and swamps and low dunes on slopes and valleys. The main soils are pale coloured deep sandy gravels, with deep sandy duplex and duplex sandy gravels and small areas of pale deep sands. Vegetation is mainly wandoo in association with jarrah and/or marri.</td>
</tr>
</tbody>
</table>
Rejuvenated Drainage area

Valley systems

Arthur River
257Ar

Broad valley floor from Lake Toolibin to the Beaufort system with minor dunes and lakes in the north of the district. It is similar to the Coblinine system but has less alkaline duplexes, and more deep sandy duplex soils.

Beaufort
257Be

Broad level to very gently inclined alluvial plains of the Beaufort and Hillman Rivers. This system is less affected by salinity than the Coblinine and Arthur River Systems. Soils are mostly deep and shallow grey sandy duplexes with wandoo-sheoak-jam woodland.

Rejuvenated Drainage area south-east of Broomehill, and the North Stirlings

Uplands

This system has a dissected landscape forming the bulk of the Pallinup river catchment from the Jarrahwood axis to the Stirling Ranges. It is variable and can be grouped into four areas.

- Central area: This area has mainly eroded down to igneous rock to form grey and brown sandy and loamy duplex soils and red loams with York gum-jam and some salmon gum-red morrel vegetation. Some ridges and upper slopes have grey sandy duplex and less commonly gravelly soils with wandoo-rock sheoak (sandy surfaced soils) and red morrel (brown mafic gravels).

- Upper catchment to the east of Gnowangerup: This area is more gently undulating with more and often shallower duplex soils. Soils on slopes are often sandy duplex or hard setting loams and duplex, with moort and flat-topped yate vegetation on shallow sandy duplex on exposed pallid and mottled zones, mallee heath on deep sandy duplex, and mallee scrub and York gum-jam on brown loamy duplexes. Flat-topped yate tends to replace York gum in drainage lines as one travels east.

- Western edge of the catchment: This area tends to have less slope with more wandoo/flat- topped Yate duplex soils that are prone to waterlogging. Aeolian influence mallee sandy duplex soils occur near the North Stirlings flats.

- A complex dissected area north of the Stirling Range where an Eocene sedimentary plain has been dissected to reveal the underlying gneiss. The soil sequence comprises sandy duplex soils with mallee heath vegetation on the plain, moort soils on exposed underlying pallid zone. York gum and flat-topped yate are on more deeply dissected loamy areas with melaleucas and flat-topped yate in wet main waterways.

Dedatup
241Dd

Similar to the central and western slopes of the Upper Pallinup system, but with greater relief. Alkaline red shallow loamy duplex, grey shallow sandy duplex (commonly alkaline) and shallow gravel. York gum and flat-topped yate woodland and mallee.

Toompup
241Tp

A mallee slope on the eastern side of the Upper Pallinup catchment. The smoothly undulating terrain that is mostly mildly dissected and has sandy duplex gravels, pale deep sands, and deep sandy duplex soils on ridges with mainly mallee heath and scrub heath vegetation. Dissected areas and valleys are mainly sandy, loamy and alkaline duplex soils, with mallee scrub and with flat-topped yate in the main drainage lines. Aeolian sand has been deposited on the southern side of this system, and rock outcrops with rock sheoak/flat-topped yate/broombush vegetation are occasionally exposed.

Hydenup
241Hd

A level to gently undulating sandplain with a few very sluggish drainage areas that include numerous closed shallow depressions. Major soils are pale deep sands, sandy gravels and deep sandy duplex with heath-rock sheoak-wandoo vegetation, and flat-topped yate swamps.
Landscapes and soils of the Katanning district

Kokarinup
241Kb

A gently undulating plain and undulating rises with low dunes and sand sheets that have been deposited over a dissected Upper Pallinup type landscape. Alkaline grey sandy duplexes (mostly deep), pale deep sands and grey deep sandy duplexes, and some red shallow loamy duplexes. Wandoo-rock sheoak-York gum and flat-topped yate woodland and mallee.

Mooliup
257Mp

Undulating low rises and swampy plains overlain by linear dunes blown from the bed of the Gordon River. Grey deep and shallow duplexes and pale deep sands with duplex sandy gravels, some semi-wet and saline wet soils, and a few scattered granitic outcrops. Open flat-topped yate and wandoo woodland.

Valley systems

Mabinup
241Mb

A sluggish mainly saline valley floor with low dunes that drains from the north Stirling system into the Pallinup river.

North Stirlings
248Nt

An internally drained level to gently undulating plain with many salt lakes and low dunes. Saline wet soils, wet soils, salt lake soils, grey deep sandy duplexes with mallee-melaleuca heath and samphire.

Gordon flats
247Gd

Saline and sandy duplex soils of the Gordon River with east west trending sand dunes.

Valley systems

Boyup Brook
253Bv

Deeply incised valleys with some rock outcrops where tributaries of the Blackwood river have dissected the Eulin Uplands System. Duplex sandy gravels grey deep sandy duplexes and loamy duplexes.

Darling Range

Uplands

Darling Plateau
255Dp

A lateritic plateau, in the western Darling Range, with shallow, sandy, loamy, and duplex gravels, deep sands and wet soils. Jarrah-marri-wandoo forest and woodland.

Darkan
253Dk

Undulating rises and rolling low hills of the eroded Darling plateau remnants surrounding the Hillman flats, and associated grey sandy duplex valleys joining the Hillman flats to the Beaufort river. Upland soils are largely yellow-brown deep sandy, duplex and loamy gravels with some duplexes in dissected areas. Mafic gravelly uplands are moderately common. Jarrah-marri-wandoo woodland, with areas of rock sheoak, jam and flooded gum.

Eulin Uplands
253Eu

Plateau remnants, with waterlogging prone upland sandy and grey duplex gravel plains formed on Eocene sediments. Granitic hills project through the Eocene plains, with soils similar to the Darling Plateau system. Gravels, sandy duplex soils and wet soils. Jarrah-marri-wandoo forest and woodland.
Field tools

The following decision aids been developed to help you identify and integrate clues that are available to you in the field for interpreting the landscape and its soils.

In time, you will automatically recognise the association between clues that reinforce each other, and you will be able to recognise landscape changes as you travel.

Many surface clues can help—such as remnant vegetation, fragments on the surface, the shape of the landscape, topsoil colour, or man-made features such as banks, dams, roaded catchments and gravel pits.

Beware of reliance on road surface or road verge soil. Gravel has often been carted from gravel pits and spread along the road verge during road construction. Also sand may accumulate along fence lines and road reserves due to wind and water erosion.

Five field tools are supplied:

- Landscape investigation sheet
- Guide for recognising indicator remnant vegetation in the district
- Landscape recognition guide
- Soil texturing card for use in the field to manually texture soils
- Common soils in the Katanning district.
Katanning district soil/landscape investigation sheet

This is a summary sheet for you to identify and integrate clues in the field for interpreting the landscape and its soils. In time you will automatically recognise the association between clues that reinforce each other, and will be able to recognise landscape changes as you travel.

Remnant vegetation is a very handy guide. However, note that there are exceptions and you can be misled by:

- Introduced vegetation, particularly on roadsides and fence lines
- Remnant species that have taken over as the dominant species when the original vegetation was cleared or has degraded over time. Rock sheoak (Allocasuarina huegeliana), roadside tea tree (Leptospermum erubescens) and jam (Acacia acuminata) are common volunteer species
- Grazing that leaves only hardy species.

Figure 32 Volunteer roadside vegetation: grey sandy duplex soil with original wandoo rock sheoak vegetation on the right, and dense volunteer rock sheoak on the left (top); old gravel pit with volunteer roadside tea tree on residual gravel (below).

You can also gain clues from weeds such as perennial veldt grass that invades roadside sands, and tagasaste or pine plantations on poor sands, and barley grass on saline soils.
The decision aid also provides information to help you recognise clues such as landscape dissection and other surface clues. Landscape dissection and position in the landscape indicate likely soil forming materials and features like susceptibility to salinity or waterlogging.

Surface clues include rock outcrops, fragments on the surface, and man-made structures like dams, roaded catchments and clusters of windmills.

There are many surface clues that can help you.

- Rock outcrops - weathered or relatively unweathered crystalline rocks (eg granites, gneisses, mafic rocks), banded ironstone or quartz ridges, or other rock types and exposed parts of the lateritic profile like mottled or pallid zones or silcretes.

- Fragments on the surface
  1. Crystalline rock fragments associated with younger soils
  2. Gravels, pallid zone, silcrete or red brown hardpan rocks
  3. Lime nodules on calcareous and alkaline soils

- Farm dams (dam colour and rocks excavated), roaded catchments, banks and drains give you clues on subsoils

- Sandy ant mounds coming through gravel roads can indicate deep sand or a deep sandy duplex

- Soaks and clusters of windmills can indicate water accumulation from upslope light sandy slopes at a change of slope or low points in the landscape, or where less permeable clay or rock is coming closer to the surface

- Gravel and sand pits.
Table 2 *Katanning district soil/landscape investigation sheet*

<table>
<thead>
<tr>
<th>Soil landscape system</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td># soil landscape system précis</td>
<td>page 24</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Indicator vegetation</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td># see Indicator vegetation guide</td>
<td>page 32</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Where are you in the landscape?</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td># see landscape recognition guide.</td>
<td>Page 44</td>
</tr>
<tr>
<td>Look around and see where you are relative to other features.</td>
<td></td>
</tr>
<tr>
<td>Are you on a ridge a spur (a divide in a slope), or near a breakaway? (a water shedding area that often has shallower and/or more gravelly soils).</td>
<td></td>
</tr>
<tr>
<td>Are you in an area where soils may accumulate like saddles (a basin on a ridge between high points). Smooth hollows, breaks of slope or valleys?</td>
<td></td>
</tr>
<tr>
<td>Is there evidence of aeolian activity?</td>
<td></td>
</tr>
<tr>
<td>Is the area you are in sandy, mafic, or mafic influence?</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Fragments on the surface</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Granite or gneiss, quartz, mafic (dark) rock, silcrete, saprock, sedimentary rock, laterite gravel or reticulite, mottled or pallid zone rocks, lime nodules</td>
<td></td>
</tr>
</tbody>
</table>

| Other clues (e.g. dams, sand or gravel pits road cuttings, rock outcrops, erosion, salinity or waterlogging |  |

<table>
<thead>
<tr>
<th>Your conclusion on the landscape and soil(s)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Dig a hole, texture the soil (page 53) and identify the soil from the common soils list (page 54).</em></td>
<td></td>
</tr>
</tbody>
</table>
Indicator vegetation of the Katanning district

**Tree** - single trunk, with branches that usually start more than 1 metre above the ground and occupy about half of the tree's height. If the main trunk is damaged, many branches can resprout from the base or stems (epicormic growth). Examples include salmon and York gums, wandoo, marri and jarrah.

**Mallet** - single trunk with relatively steep angled branches and a terminal crown. Mallets are sensitive to fire and do not recover if the main trunk is lost. Examples include mallets, yates, gimlet and moort. Mallets often occur as pure or massed stands.

**Mallee** – multi-stemmed plants usually less than 10 metres high. Several stems come from a lignotuber that can replace them when one or more are lost. Mallees that have not had to regenerate may have a single stem, but also have the basal ‘mallee root’.

**Salmon gum** (*E. salmonophloia*) occurs on alkaline shallow duplex soils with calcareous subsoil, mainly east of the Great Southern Highway. It occurs on dissected generally mafic uplands as a red brown to yellow brown shallow loamy duplex, often mixed with York gum or red morrel.

Salmon gum is also very common on broad valley floors. In valleys with alkaline grey sandy and loamy duplex soils it can occur with wandoo (that becomes dominant on deeper and more acidic sandy duplex soils. Broad valleys that are surrounded by mafic uplands often have salmon gum- morrel-York gum woodland on alkaline duplex soils with darker coloured better structured subsoils.

Shiny leaves and layered foliage of the salmon gum in the image on the left distinguishes it from the dull-leafed wandoos that also have ‘bunchy foliage’.

**Wandoo** (*E. wandoo*) is very common on grey sandy and gravelly duplex soils. In the Darling Range, wandoo can occur on a range of soils but is frequently dominant on duplex soils. On uplands further east it tends to be the dominant vegetation on gravelly duplex to grey sandy duplex soils. In valleys, wandoo tends to be dominant on grey acidic duplex to grey alkaline deep sandy duplex soils.

Wandoo flower and bud.

See salmon gum buds on the next page
Silver mallet (*E. argyphea*) grows on stony usually mafic gravel uplands, particularly in the Nyabing-Kukerin area and further east. It can be mistaken for salmon gum but only occurs on upland gravels, and has the characteristic mallet form and distinctive buds.

Blue mallet (*E. gardneri*) often occurs with silver mallet, but also occurs further west and south, and is nearly always on mafic stony uplands.

Brown mallet (*E. astringens*) also occurs with silver and blue mallets, but becomes dominant below breakaways on poorly structured mottled zone soils ('mallet' soils), and can occur further downslope and occasionally in valleys on similar soils.
York gum (*E. loxophleba*) is widespread (except for the Darling Range), particularly in dissected rocky landscapes with mafic areas and pale brown to red brown sandy to clay loam soils. York gum also occurs with salmon gum or wandoo on valleys surrounded by mafic uplands. The soils are usually duplexes with a loamier darker topsoil and/or slightly better structured subsoil than normal grey duplexes. In wetter locations, flat-topped yate tends to dominate. In the north-east of the district York gums are often an intergrade between the tree and mallee subspecies with a more stocking bark form and often mallee form. Another species (*E. myriadena*) also occurs with York gum, has a similar appearance and soil preference, but has finer leaves, and is more common near salt lakes.

Red morrel (*E. longicornis*) indicates soils formed from lateritised or weathered igneous mafic and ultramafic rock generally east of Katanning. On uplands it usually grows on shallow to deep-brown loamy gravel soils that often grade into red-brown rocky soils with salmon and York gums. It also occurs on loamy and shallow sandy duplex soils in valleys below mafic uplands with other trees where the soil often has more colour and is better structured. In lower rainfall districts red morrel grows on aeolian fluffy calcareous loams near salt lakes. Red morrel tends to be a more upright tree than York gum, usually with less coarse bark and different buds.

Image on left: red morrel near a mafic ridge with wandoo and brown mallet.
Flat-topped yate (*E. occidentalis*) is a mallet that is common on winter-wet duplex valley soils, and granitic soils that are susceptible to waterlogging. Note the ivory coloured smooth upper branches.

Flooded gum (*E. rudis*) is a tree that also grows on winter-wet granitic duplex soils, but is more common in the west of the district, particularly in waterways and on granitic duplex slopes. It has lower salinity tolerance than flat-topped yate. Multiple stems often come from the base, and leaves are usually badly damaged by insects in late spring.

Both species have generally coarse rough bark and pale coloured upper branches (copper coloured on red morrel and York gum).

**Jarrah** (*E. marginata*) is common on Darling Range laterites, particularly on sandy gravels, ironstone ridges and some deep sandy uplands. Jarrah has glossy leaves and bark that peels in vertical strips.

**Marri** (*Corymbia calophylla*) often occurs with jarrah, but becomes more dominant on better lateritic soils such as the brown sandy gravel and yellow duplex gravel soils. It can also occur on a range of well drained sandy surfaced soils in the western rejuvenated drainage area. Marri has characteristic rough bark, large fruit, and glossy leaves with differing shades of green on leaf upper and lower sides.
February 2011

Tammas (mainly shrubs) and sheoaks (small trees) have needle type foliage with separate male (pollen) and female ('nut') plants. Salt sheoak (*Casuarina obesa*) favours saline and wet areas, but other sheoaks are *Allocasuarina* species that indicate well drained sandy or gravelly soils.

Rock sheoak (* Allocasuarina huegeliana *) is widespread. Before agriculture, it was mainly on granitic sandy surfaced soils, sandy gravels and deep sandy duplex soils. However it has colonised many different well drained soils on roadsides. Sheoak (*Allocasuarina fraseriana*) occurs on Darling Range sandy soils.

Black tamma (*Allocasuarina acutivalvis*) occurs mainly on mafic and yellow stony and shallow gravels, particularly in the Kukerin/Dumbleyung area.

The most common tamma (*Allocasuarina campestris*) occurs with black tamma, but tends to be more common in deeper or loamier gravels and yellow earths.

Compass bush (*Allocasuarina pinaster*) occurs in grey sand over gravel with banksia-tea tree heath.
Proteaceous species are major components of lateritic and sandy heaths, and as understorey species are a good guide to identifying mallee duplex gravels from other mallee duplexes.

**Banksias** are generally a good guide to sandy gravel and deep sandy soils.

**Dryandras** (now in the *Banksia* genus) with their prickly vegetation are a noticeable feature of shallow gravel and sandy gravel soils.

**Grevilleas** (note the distinctive flower on the right) are also noticeable in lower rainfall sandplain heath, particularly yellow sand over gravel, but also occur on other well drained upland soils.

**Hakeas** are widespread, but are very common on sandy gravel to shallow and loamy gravel soils. They have similar flowers to grevilleas, but have a woody fruit.

**Bull banksia** (*Banksia grandis*) is a common tree on Darling Range gravels.

**Acorn banksia** (*B. prionotes*) is a common tree on aeolian yellow sand.

**Slender banksia** (*B. attenuata*) occurs on deep grey sandy soils to the south and west.

**Woolly banksia** (*B. baueri*) is a feature of lateritic grey sandy soils to the east.
Sphere banksia (*Banksia sphaerocarpa*) occurs in many sand and gravel heaths.

Chittick (*Lambertia inermis*) is common on grey sand over gravel soils.

Woolly bush (*Adenanthos sericea*) is common on deep grey sandy soils.

Stinkwood (*Jacksonia sternbergiana*) is common on deep grey sandy soils.

Cauliflower hakea (*Hakea corymbosa*) is common on grey sandy surfaced soils to the south-east.

Parrot bush (*Banksia sessilis*) is common on Darling Range sandy gravels.

Prickly Dryandra (*Banksia armata*).

Dryandra rich shallow grey sandy ironstone at Tarin rock.
Roadside tea tree (Leptospermum erubescens), is common on well drained sandy surfaced soil. This and other tea trees are common on deep grey sands, but are colonising species that have spread to well drained disturbed areas.

Christmas tree (Nuytsia florabunda) (left) indicates deep grey sandy soils, with sheoak (Allocasuarina fraseriana) (right) that occurs on Darling Range sands and sandy gravels.

Melaleucas occur in most landscapes and soils. They are often dominant understorey plants in wetlands and mallee shallow duplex soils. Melaleuca thickets indicate soils that can be waterlogged in winter.

A common Melaleuca uncinata group species with typical melaleuca fruit and flowers.

Swamp paperbark (Melaleuca rhaphiophylla) is common in wetlands in the south and west of the district.
February 2011

Jam (Acacia acuminata) is a common understorey bush. It is often the main shrub, in association with York gum on soils formed from igneous rocks.

Manna wattle (Acacia microbotrya) occurs with, and can be mistaken for jam. It tends to be more common on lateritic soils.

Jam has slender pointed leaves, rod shaped flowers and flowers in spring, while manna wattle has dull broader sickle shaped leaves and globular flowers in late autumn.

Spiny rush (Dacutus sp.) is an introduced plant that is common on seepages.

Sword sedge (Lepidosperma sp.) is a common understorey plant on mallee sandy duplex and duplex gravel soils.

Mallees become very common to the east and south of the district where the upland landscape becomes more subdued and has more duplex soils on uplands. In these areas, soils are more commonly found in mosaics with several species of mallee on each soil type, although there is still a trend towards lateritic soils on rises and alkaline duplexes in valleys.

Apart from a few easily identifiable species like blue mallee (E. pleurocarpa), it is difficult to associate the many species with soil type without species identification keys.

In these areas, you can gain an idea of land management groups by noting the type of understorey in conjunction with landscape clues like slope, rock fragments, and topsoil features.
Shallow and loamy duplex soils

Low prickly melaleuca (*M. coronicarpa, M. adnata*) understorey occurs on hard shallow duplex soils, often below breakaways.

Moort (*E. platypus*) is a mallet found on poorly structured shallow duplexes, often formed from pallid zone. Acidic moort soils occur on dissected laterite uplands, alkaline types are more common on lower slopes and tributary valleys.

Ongerup mallee (*E. vegrandis*)
Brown mallet (*E. astringens*)

The images above show grey shallow hard setting duplex soils with mallee and very little (melaleuca) understorey remnant vegetation. Note however, that sheep remove most understorey species in paddocks. Other clues would be hard setting surfaces, kaolinite rock fragments or lime nodules. Fine leaved Ongerup mallee and its mallet equivalent swamp mallet (*E. spathulata*) are common on flats in the Tieline system.

Mixed melaleuca understorey on a shallow loamy duplex in the north Stirlings.

M. uncinata group understorey is common, often on better structured mallee subsoils.

The images above show mallee loamy duplex soils with a dense melaleuca understorey. Melaleuca species differ with location and soil type but the dense understorey indicates water gaining area or relatively better structured subsoil.
Bluebush volunteer roadside understorey on a shallow hard setting alkaline duplex.

**Mallee gravel and sandy duplex soils**

Low mafic influence rise on a Tieline system plain with dense dryandra understorey on very gravelly duplex ridge and yellow loamy sand duplex/loamy duplex slopes with melaleuca understorey.

Mafic stony gravel with *Grevillea insignis* and dryandra understorey at Tarin rock.
Landscapes and soils of the Katanning district

Shallow gravel pit with common duplex gravel soil and mallee with mixed understorey vegetation.

Blue mallee (E. pleurocarpa syn. E. tetragona) is a good indicator of sandier soils in mallee communities, particularly deep grey sand over gravel or clay. Proteaceae rich understorey on Kukerin grey sandy gravel. Other clues are loose grey sandy gravel surface in the paddock, and the kite leaf poison that is common on these soils.

Very deep grey sandy duplex with cauliflower hakea and tea tree understorey.

Deep sandy duplex soils with degraded understorey: perennial grass (right); wind eroded road and roadside sand deposited wind erosion of the road surface and paddocks (left).
Landscape recognition guide

Long-term stability of the Yilgarn craton and lateritisation of most uplands have produced distinctive upland landscape patterns that are influenced by slope and underlying rock types. This guide can help you recognise these patterns in the field.

This guide distinguishes three upland landscape types that usually merge into one another.

- **Sandy landscapes** quartz rich granites and gneisses, sandy sediments, and rocks with an aeolian sand overlay.
- **Mafic influence landscapes** granites and gneisses with frequent dolerite dykes or bands of rock such as mafic gneiss or banded ironstone.
- **Mafic landscapes** mafic gneiss, greenstone or large dolerite dyke areas.

<table>
<thead>
<tr>
<th>Sandy</th>
<th>Mafic influence</th>
<th>Mafic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Often upland plains and gentle slopes. Breakaways are generally small</td>
<td>Landscape varies according to rock composition and frequency of mafic dykes. Often mafic gravel ridges with frequent breakaways, mixed soils on surrounding slopes and less mafic rises</td>
<td>Hilly with active drainage and mafic ironstone or mafic rock outcrops</td>
</tr>
<tr>
<td>Sandy gravel or sandy duplex upper slopes and ridges. Can include shallow grey duplex and grey clays</td>
<td>Often similar mesas and mafic ridges on major ridges to mafic landscapes but these are usually interspersed with felsic rock areas, particularly on slopes and valleys</td>
<td>Dark stony and loamy gravel mesas on ridge tops that are often only isolated residuals in a dissected landscape with rocky red and brown loam and clay soils</td>
</tr>
<tr>
<td>Deep pale sand hollows on lateritic slopes</td>
<td>Mixed loamy and sandy gravels on lateritic backslopes, often with yellow to pale sandy hollows</td>
<td>Deep loamy gravel to yellow loamy sand on lateritic backslopes</td>
</tr>
<tr>
<td>Valleys often grey sandy duplex soils, and sometimes deep sands</td>
<td>Variable depending on the geology. Loamy, or more frequently, shallow sandy duplex colluvial valley soils but are often shallower, with more colour and better structured subsoils than sandy landscapes</td>
<td>Red-brown to brown loamy surfaced colluvial valley soils</td>
</tr>
<tr>
<td>Grey often coarse sandy surfaced soils in dissected areas, pale dam banks and often soakcs and seepages</td>
<td>Variable soils in dissected areas, frequently with granitic, pallid clay dams. More shallow sandy duplex soils than sandy landscapes</td>
<td>Red-brown soils and dams in dissected areas</td>
</tr>
</tbody>
</table>

Frequent gravel pits on mafic laterite ridges.
Sandy landscapes

These are either granite and quartz rich gneiss landscapes that may be intruded by narrow dolerite dykes (that are too narrow to have greatly affected the rest of the landscape), or landscapes formed on sandy deposits (eg Boscabel, Hydenup, Kokarinup systems).

Figure 33  Diagrammatic example of a sandy granite landscape

In Figure 34, the image on the right is a very old granitic profile with very deep mottled and pallid zones. The left image is sandy gravel formed on a Boscabel sand deposit. Iron has concentrated in upper layers to form grey sandy gravel over stony upper reticulite, with the lower reticulite being iron enriched sand. Sandy landscapes from sedimentary and aeolian deposits are shown in the Moodiarup and East Tambellup case studies.

Figure 34  Laterite formed from a Boscabel sand dune (left); kaolin mine pit in a very old granitic laterite (right).
Figures 35 and 36 feature a range of sandy landscapes.

35A Lateritic and granitic grey sandy duplex slope south east of Wagin

35B Deep grey sand and grey deep sandy duplex soils on a granitic hillside at Dardadine

35C Granitic grey deep sandy duplex soils on a hillside at Narrogin

Figure 35 Dissected sandy granitic landscapes
Sandy gravel  Grey sandy surfaced soils…  Christmas tree  Tagasaste plantation

36A Upland grey aeolian sandplain south of Toolibin; tagasaste has been planted in the sand hollow

Cabbage hakea  Pale dam  Grey deep sandy duplex.

36B Tieline system slope. Grey deep sand over gravel over clay with cabbage hakea surviving in degraded roadside vegetation.

Salmon gum alkaline grey duplex  Pines on sand  Pale dam  Proteaceae and tamma roadside vegetation

36C Mildly dissected landscape with mixed sandy surfaced soils east of Harrismith

Figure 36 Lateritic and deep sandy duplex landscapes
Mafic influence landscapes

This is where rock types are too intermixed to form distinct sandy or mafic landscapes. They are very common as basement rocks vary and dolerite dykes have intruded most underlying granites and gneisses. Dolerite dykes are frequently associated with uplands as mafic ridges, often lateritic, but soils on slopes are very variable due to sudden changes in rock type and colluvial merging of soils formed from them. Figure 37 is a conceptual diagram of a mafic influence landscape.

Note the characteristic hilly terrain and red brown mafic ridges.

Mafic rocks generally weather more quickly than quartz-rich igneous rocks like granite, but mafic areas commonly coincide with dissected hilly uplands that stand above surrounding granitic surfaces.

Two factors are involved.

1. The contact layer between dykes and the surrounding rock are often more erosion resistant due to ‘baking’ by heat from the molten dyke.

2. Granitic laterites are less resistant to erosion than dense iron rich mafic laterites. Differential weathering over long periods of time has left mafic ridges. When the dense mafic ironstone is penetrated, rapid erosion of the underlying clay layers result in steep slopes and incised waterways. Quartz-rich igneous rocks and sandy laterites form sandy surfaced soils that create less runoff. This and less resistant ironstone create more subdued landscapes with sandy surfaced soils and often less active waterways.

Figure 38 shows a relief map of an area east of Wickepin that illustrates a common pattern, with a smooth granitic laterite upland in the centre (within the dotted area) flanked by dissected areas of mixed geology. The colours show radiometric signals that are very useful for observing soil type patterns. In brief, red indicates potassium that is common in igneous rock feldspar minerals and associated soils formed from these rocks. Green indicates thorium and blue uranium, which are concentrated in laterites and clays. Dark colours
Landscapes and soils of the Katanning district indicate sandy surfaced soils, and green areas are more gravelly. This is only a general guide as white shading has also been used to emphasise landscape relief.

**Dissected mainly granitic area**

- Mixed dissected granitic laterite soils
- Breakaways

**Dissected mafic influence area**

- Sandy and loamy duplex soils from mixed rock (pink) in lower slopes, with lateritic influence further up.
- Mafic dyke

Figure 38  *Relief map with radiometric overlay of landscape components east of Wickepin*

Exceptions occur on poorly drained plains where heavy soils and waterlogging are more common, and there is insufficient slope for soil transport. An example is shown in Figure 39.

Figure 39.  *Exception to mafic influence rule.  Adjacent mafic loam (top) and sandy duplex soil (above) views of an upland plain west of Gnowangerup.*
Pingelly York gum mafic rocky loam ridge with granitic sandy duplex hollow.

Dellyanine system rocky landscape with mafic breakaway on the ridge and soils formed from granite (foreground) and dolerite dykes on the slope.

Farrar system mafic breakaway in the distance with mixed rocky and gravelly soils on slopes.

Kukerin mafic ridge with granitic gneiss duplex gravel and sandy duplex soils on slopes.

Figure 40  Mafic influence landscapes
Mafic landscapes

These are often on hilly uplands with red-brown soils with stony or loamy gravel residuals. Soils are alkaline and often calcareous loams, loamy duplexes and clays.

Figure 41  Mafic laterites. Mafic breakaway (A); dense ironstone boulder (B); iron rich reticulite (C) loamy gravel in a mafic gravel pit at Kulin (D)

Mallee scrub  Mafic gravel  Silver mallet on mafic ironstone  Red brown mottled zone

Red brown loamy duplex with York gum trees.  Loamy gravel with tamma shrubs

Figure 42  Mafic laterite surfaces near Kukerin.
Figure 43  **Mafic landscape views**

- **Mesa with wandoo-brown mallet woodland**
- **Wagin: wandoo-mallet stony ridge grading to loamy gravel then loamy duplex downslope**
- **Darling Range: wandoo brown loamy duplex with a mafic breakaway in the distance**
- **Datatine salmon gum, York gum, red morrel mafic landscape**
- **York gum-mallee upland**
- **Salmon gum ridge**
Soil field texture guide

The texture of a soil reflects the size distribution of mineral particles finer than 2 mm. If it is gravelly, remove the gravel by sieving.

Take a sample of soil that will sit comfortably in the palm of your hand from the layer of soil to be textured.

Form a bolus (ball) of soil by moistening the sample with water and kneading it. Knead the soil for 1–2 minutes while adding more water or soil until it just fails to stick to the fingers. The soil is now ready for shearing (ribboning). Note how the bolus feels when kneading it.

Press out the soil between the thumb and forefinger to form a ribbon. The ribbon should only be 2–3 mm thick.

The behaviour of the bolus and of the ribbon determines the field texture. **Do not decide texture solely on the length of the ribbon.**

<table>
<thead>
<tr>
<th>Texture group</th>
<th>Subgroup</th>
<th>Behaviour of bolus and ribbon</th>
</tr>
</thead>
<tbody>
<tr>
<td>CLAY</td>
<td>All clays</td>
<td>Plastic bolus like putty, smooth to touch, becomes stiffer as clay increases, forms ribbon of 50–75 mm or more</td>
</tr>
<tr>
<td></td>
<td>Clay loam</td>
<td>Coherent plastic bolus, smooth to manipulate, forms ribbon of 40–50 mm</td>
</tr>
<tr>
<td>LOAM</td>
<td>Sandy clay loam</td>
<td>Coherent bolus, feels sandy, forms ribbon of 25–40 mm</td>
</tr>
<tr>
<td></td>
<td>Loam</td>
<td>Coherent bolus, feels smooth and spongy, forms ribbon of about 25 mm</td>
</tr>
<tr>
<td></td>
<td>Sandy loam</td>
<td>Weakly coherent bolus, feels sandy, ribbon of 15–25 mm. Sand grains may be visible</td>
</tr>
<tr>
<td></td>
<td>Clayey sand</td>
<td>Clay stain on fingers, very slightly coherent bolus, ribbon of 5–15 mm</td>
</tr>
<tr>
<td>SAND</td>
<td>Loamy sand</td>
<td>Very slightly coherent bolus, dark staining of fingers, minimal ribbon of about 5 mm</td>
</tr>
<tr>
<td></td>
<td>Sand</td>
<td>Cannot form a bolus, non-coherent</td>
</tr>
</tbody>
</table>
Common soils of the Katanning district

The following soil information sheets provide a guide to the major soils of this district, and contain brief soil capability and land use information. Each soil is identified by common name, one or more WA soil groups, and soil series with a colour photo of representative soil profiles provided to aid visual identification.

The common name reflects natural soil units with broadly similar management characteristics.

Soil groups provide standard names for soils in Western Australia with emphasis on specific management characteristics that can vary rapidly across a field. They were developed to provide a simple, easy-to-understand way to recognise common soils across district boundaries. (Schoknecht 2005).

More detailed soil information can be found in the land resource surveys cited in the reference section.

Sandy duplex soils are the most common soil in the district, occurring in all zones in uplands and valleys, often amongst or merging into other soil types.

It is impossible to have a clear cut classification, and loose to firm textured sandy duplex soils have been divided into the following categories where there is some overlap.

1. Grey sand over gravel over clay, that occurs on slopes and better drained areas in valley that often has reticulate mottles in the underlying clay.

2. Upland grey sandy duplex developed in truncated laterite profile: this contains well drained mildly acidic sandy duplex soils derived from pallid zone material, with or without a gravel band above acidic or alkaline clay.

3. Wandoo loamy sand surfaced valley duplex: these have similar soils to upland lateritic grey sandy duplex, but have alkaline subsoils, and are more susceptible to waterlogging and salinity. They are often intermixed with alkaline shallow sandy duplex soils that support salmon gums.

4. Sandy surfaced granitic soils with a range of soils including grey deep sandy duplex soils: these are particularly in the Blackwood catchment where they are often similar to and intermixed with lateritic sandy duplex soils on slopes. The main distinguishing features are that they have grittier topsoils, and tend to have subsoils that are higher in potassium and more likely to permit deeper root penetration.

Shallow hard setting grey duplexes are also derived from pallid zone clays, but have hard setting topsoils, and are more difficult to manage.

Duplex soils (particularly grey variants) are noted for variable productivity and patchy plant growth. Major causes of this variability (Dracup and Belford 1992) are physical features of the subsoil clay and the sand/clay interface that reduce plant roots’ ability to penetrate and extract water from the underlying clay.
<table>
<thead>
<tr>
<th>Category</th>
<th>Soil</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deep sands: aeolian dunes and sheets, or colluvium in hollows or below gravels</td>
<td>Pale deep sand, pale sand over yellow sand</td>
<td>58</td>
</tr>
<tr>
<td></td>
<td>Pale deep sand over laterite , or yellow loamy sand</td>
<td>59</td>
</tr>
<tr>
<td></td>
<td>Deep brown/yellow sands, mainly aeolian deposits</td>
<td>60</td>
</tr>
<tr>
<td>Gravelly soils, loamy sand over gravel and sandy earths mainly on lateritic uplands, slopes and rises</td>
<td>Shallow sand or loam over ironstone or stony reticulite</td>
<td>62</td>
</tr>
<tr>
<td></td>
<td>Loamy gravel soils.</td>
<td>61</td>
</tr>
<tr>
<td></td>
<td>Darling Range or 'buckshot' yellow sandy gravels</td>
<td>63</td>
</tr>
<tr>
<td></td>
<td>Yellow sandy gravel over clay</td>
<td>64</td>
</tr>
<tr>
<td></td>
<td>Grey sandy gravel over clay</td>
<td>65</td>
</tr>
<tr>
<td>Sandy duplex, sand over gravel over clay soils on deeply weathered surfaces on uplands, below breakaways, or valleys where they grade into heavy valley soils</td>
<td>Grey loamy sand over gravel over clay, mainly on slopes</td>
<td>66</td>
</tr>
<tr>
<td></td>
<td>Deep grey sand over pale clay often with bleach between the sand and the clay. Mainly on uplands break of slope, and valleys grading into heavier valley soils.</td>
<td>67</td>
</tr>
<tr>
<td>Acidic to neutral poorly structured hard setting soils usually on deeply weathered slopes or below breakaways</td>
<td>Hard setting acidic soils usually upper slopes. Wandoo-mallee-mallet</td>
<td>69</td>
</tr>
<tr>
<td></td>
<td>Poorly structured acidic soils with orange pink subsoil below breakaways</td>
<td>70</td>
</tr>
<tr>
<td>Soils from igneous rock, often with rock outcrops or weathering rock fragments, and morrel loamy soils</td>
<td>Variable light coloured sandy surfaced soils from weathering granite</td>
<td>71</td>
</tr>
<tr>
<td></td>
<td>Near neutral loamy and red sandy duplexes usually supporting York gum (or wandoo in the Darling Range)</td>
<td>73</td>
</tr>
<tr>
<td></td>
<td>Alkaline calcareous loamy duplexes and clays</td>
<td>74</td>
</tr>
<tr>
<td>Salmon gum loam to clay valley soils</td>
<td>Hard setting grey shallow alkaline duplex soils</td>
<td>76</td>
</tr>
</tbody>
</table>
### Annual pasture legumes for common soils in the Katanning district

This table is a general guide only for soil type adaptation. Check species and varietal information. These can be found in 'Pasture Legumes for Temperate Farming Systems: The Ute Guide'.

<table>
<thead>
<tr>
<th></th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unsuitable</td>
<td></td>
<td></td>
<td>Poorly suited</td>
<td>Suited to some situations or soils</td>
<td>Moderately suitable</td>
</tr>
<tr>
<td>Sub clover</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Baiansa clover</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Bladder clover</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Eastern star clover</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
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<tr>
<td>Gland clover</td>
<td>4</td>
<td>2-3</td>
<td>3-4</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>Crimson clover</td>
<td>4</td>
<td>2-3</td>
<td>3-4</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>Gland clover</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Balansa clover</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Crimson clover</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Biserrula</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Barrel medic</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Burr medic</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Sphere medic</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>French serradella</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Yellow serradella</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
</tbody>
</table>

* Crimson clover is suitable for medium to high rainfall areas.
Pale deep sand

These soils commonly occur as colluvial deposits on slopes or hollows on uplands, often below gravel.

Soil series: Ravenscliffe series

Vegetation: Heath and tall heath (shrubland/dryandra) associations dominated by species from the Proteaceae family including, Banksia spp., Dryandra spp., Hakea spp. and chittick. Christmas trees Nuytsia floribunda are present. Rock sheoak and Jarrah also occur to the west.

Acidity
High risk due to high acidification rate low productivity, high leaching very low buffering capacity, and acidic pH

Soil structure
Sandy and loose throughout the profile

Water repellence
Extremely susceptible

Waterlogging
Not a problem

Water erosion
Low risk, runoff can occur from heavy rain on dry water repellent soils

Wind erosion
Very high risk

Water availability
Low to very low

Plant rooting depth
Deep

Other
Nutrient leaching is a problem on these soils. Soaks may occur downslope of them.

These soils are not suited for most agricultural annual species. Tagasaste and pine plantations are common.

Cereals
Very low potential

Canola
Very low potential

Grain legumes
Narrow leaf lupins, low to moderate yield potential if potassium is applied

Pastures
Most suited to perennials. See page 57.

A1 Loose grey to light grey medium to coarse grained loose sand. pH = 6.0 (in water)

A2 White to pale yellow medium to coarse grained sand. Single. pH = 6.5

B1 White to pale yellow medium to coarse grained sand with large ironstone gravel. pH = 6.5

(Note - this layer is not always present)
Pale sand over gravel/loamy sand  WA soil group: gravelly pale deep sand

Commonly pale sand over gravel at about 40 cm.

**Soil series:** Kauing series.

**Vegetation:** *Ancient and rejuvenated drainage:* Rock sheoak,-tea tree with scattered, Christmas tree and wandoo. *Darling Range:* Jarrah-marri-rock sheoak, some wandoo, slender banksia and bull banksia and roadside tea tree scrub.

**Acidity**  High risk due to high acidification rate low productivity, high leaching very low buffering capacity,) , and acidic pH

**Soil structure**  Sandy throughout the profile

**Water repellence**  Extremely susceptible

**Waterlogging**  Not a problem

**Water erosion**  Low risk, runoff can occur from heavy rain on dry water repellent soils

**Wind erosion**  Very high risk

**Water availability**  Low to very low

**Plant rooting depth**  Deep

**Other**  These soils are suited to deep rooted annual or perennial agricultural plants and pines

**Cereals**  Low potential generally

**Canola**  Unsuitable

**Grain legumes**  Narrow leaf lupins: low to moderate yield potential depending on depth to subsoil if potassium is applied

**Pastures**  Serradellas: low to moderate yield potential depending on depth to subsoil if potassium is applied. Tagasaste and pines are generally planted on deep variants. See page 57.

### Variant over reticulite

A1 Loose greyish brown to light grey medium to coarse sand. May contain ironstone gravel  pH 6.5

A2 Pale medium to coarse sand. May contain ironstone gravel  pH 7.0

A3 Pale medium to coarse sand. Large amounts of ironstone gravel  pH 7.0

B2 yellow, loamy sand to sandy loam, with red and pale mottles. May contain ironstone gravel.  pH 7.0

C Red, orange and yellow mottled reticulite sandy clay loam to sandy clay, pH 6.5
Brown deep sand

This soil comprises yellow brown sand sheets generally south-east of major valleys in the rejuvenated and ancient drainage areas. Yellow sand variants are more common in the east.

**Soil series:** Yowangup series

**Vegetation:** Banksia dominant (mainly Acorn banksia) shrub land. Other species include Chittick (*Lambertia inermis*), Christmas tree, rock sheoak, dryandras and hakeas.

**Acidity**
High risk due to high acidification rate (moderately low productivity, high leaching), and mildly acidic pH

**Soil structure**
Sandy throughout the profile

**Water repellence**
Very susceptible

**Waterlogging**
Not a problem

**Water erosion**
Low risk, runoff can occur from heavy rain on dry water repellent soils

**Wind erosion**
Very high risk

**Water availability**
Low

**Plant rooting depth**
Deep

**Other**
Nutrient leaching, and potassium deficiency are problems on these soils

**Cereals**
Generally low yield potential

**Canola**
Generally low yield potential

**Grain legumes**
Narrow leaf lupins: moderate to high yield potential

**Pastures**
See page 57. Suited to perennials like tagasaste

---

**Yowangup series**

0-17 cm light yellowish brown coarse sand; very weakly developed structure; non-wetting; pH 6.5

17-36 cm light olive brown coarse sand; pH 7.0.

36-65 cm light yellowish brown coarse sand; pH 7.0

65-110 cm brownish yellow coarse sand; pH 6.5
Loamy gravel

These soils often occur in relatively small areas, often in association with shallow ironstone and mafic loamy soils downslope formed from geological erosion through the laterite. Native vegetation can be red morrel, or tamma and prickly heath. These soils are often on ridges above dolerite soils.

**Soil series:** Cumming series (brown), Cundingup series (yellow brown), De Campo series (red)

**Vegetation:** *Ancient and rejuvenated drainage:* Red morrel, tamma and prickly heath. Some silver and blue mallet. *Darling Range:* Marri-jarrah-wandoow forest.

**Acidity**
Moderately low risk. Soils are mildly acidic but have a moderate buffering capacity

**Soil structure**
Firm to hard setting loamy gravel topsoil with abundant gravel pebbles over reticulate ironstone or clay

**Water repellence**
Low to moderate risk

**Waterlogging**
Low risk.

**Water erosion**
Moderate risk

**Wind erosion**
Low risk

**Water availability**
Moderately low to moderate depending on the clay content, and amount of gravel in the profile

**Plant rooting depth**
Variable due to variable depth of gravel over the reticulate, and some plant roots can travel down old root channels and cracks in the reticulate

**Other**
This soil has a high phosphate retention index, and manganese deficiency in cereals may be a problem

**Cereals**
Moderate to moderately high yield potential

**Canola**
Moderate yield potential

**Grain legumes**
Narrow leaf lupins may grow where there is sufficient acidic soil depth

**Pastures**
Clovers generally grow well. See page 57.

Very gravelly soils with a mildly acidic sandy loam matrix that grades to a mildly acidic to neutral gravelly clay loam to clay
Shallow ironstone

This category covers a range of lateritic sandy or gravelly soils with less than 30 (common) to 80cm of soil over dense ironstone reticulite. It is found on breakaways, crests, ridges and upper slopes within lateritic terrain, and is often grades into deeper lateritic sandy and gravelly soils.

Soil series: Worsley, Gorn 2 series.


<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acidity</td>
<td>Moderate risk.</td>
</tr>
<tr>
<td>Soil structure</td>
<td>Generally a loose or hard setting sandy gravel over impermeable reticulite ironstone</td>
</tr>
<tr>
<td>Water repellence</td>
<td>Moderate to high risk</td>
</tr>
<tr>
<td>Waterlogging</td>
<td>Low risk generally, but may occur in patches in the west of the district</td>
</tr>
<tr>
<td>Water erosion</td>
<td>Moderate to high risk as they tend to occur on uplands and can initiate runoff that can cause erosion downslope</td>
</tr>
<tr>
<td>Wind erosion</td>
<td>Low risk</td>
</tr>
<tr>
<td>Water availability</td>
<td>Low</td>
</tr>
<tr>
<td>Plant rooting depth</td>
<td>Generally shallow but variable due to variable depth of gravel over the reticulite, and some plant roots can travel down old root channels and cracks in the reticulite</td>
</tr>
<tr>
<td>Other</td>
<td>This soil has a low productivity due to the shallow soil with poor plant water availability</td>
</tr>
<tr>
<td>Cereals</td>
<td>Moderate to poor depending on depth to ironstone and cracks in the ironstone</td>
</tr>
<tr>
<td>Canola</td>
<td>Poor</td>
</tr>
<tr>
<td>Grain legumes</td>
<td>Narrow leaf lupins; low to moderate potential depending on depth to ironstone</td>
</tr>
<tr>
<td>Pastures</td>
<td>See page 57.</td>
</tr>
</tbody>
</table>

Acidity: Moderate risk.

Soil structure: Generally a loose or hard setting sandy gravel over impermeable reticulite ironstone.

Water repellence: Moderate to high risk.

Waterlogging: Low risk generally, but may occur in patches in the west of the district.

Water erosion: Moderate to high risk as they tend to occur on uplands and can initiate runoff that can cause erosion downslope.

Wind erosion: Low risk.

Water availability: Low.

Plant rooting depth: Generally shallow but variable due to variable depth of gravel over the reticulite, and some plant roots can travel down old root channels and cracks in the reticulite.

Other: This soil has a low productivity due to the shallow soil with poor plant water availability.

Cereals: Moderate to poor depending on depth to ironstone and cracks in the ironstone.

Canola: Poor.

Grain legumes: Narrow leaf lupins; low to moderate potential depending on depth to ironstone.

Pastures: See page 57.
Buckshot gravel

WA soil group: deep sandy gravel

Very gravelly soils that are common in the Darling Range, usually in association with shallow ironstone ridges, and yellow sandy gravel over clay soils.

**Soil series:** Yalanbee (yellow brown sandy gravel), Gibbs (most common, yellow brown sandy gravel grading to sandy loam gravel with depth), Gorn (grey sandy gravel).

**Vegetation:** *Ancient and rejuvenated drainage:* Wandoo or sandplain mallee with proteaceous heath. *Darling Range:* Tall, open forest of jarrah-marri, with wandoo and sheoak (that are more common on Gibbs series).

---

**Acidity**

These soils were originally mildly acidic, but have a moderately high acidification rate due to high leaching sandy matrix soils.

**Soil structure**

Loose to firm topsoils with friable very gravelly subsoils.

**Water repellence**

Very susceptible.

**Waterlogging**

Not a problem.

**Water erosion**

Winter moderately low, summer moderate. High runoff is common from summer storms due to the sloping landscape and water repellent soils.

**Wind erosion**

Low.

**Water availability**

Low to moderately low.

**Plant rooting depth**

Deep.

**Other**

High phosphate fixing soils. Manganese deficiency in cereals is common in dry seasons. Runoff from water repellency can delay germination.

**Cereals**

Moderately low to moderate depending on soil texture and soil depth.

**Canola**

Moderately low to moderate depending on soil texture and soil depth.

**Grain legumes**

Moderate to high narrow leaf lupin yield potential.

**Pastures**

See page 57.

---

**Gibbs series**

0-7 cm dark brown gravelly clayey medium sand; 20% fine and 10% medium ironstone gravel; pH 5.2 in water.

7-50 cm strong brown gravelly clayey medium sand; 30% fine, 20% medium ironstone gravel; pH 6.0.

50-70 cm Yellowish brown gravelly medium sandy loam; 30% fine, 20% medium and 10% coarse ironstone gravel.

70-100 Yellowish brown loamy gravel (heavy medium sandy loam); massive; 30% fine, 30% medium and 10% coarse ironstone gravel; pH 5.9.
February 2011

Yellow sandy gravel over clay  WA soil group: duplex sandy gravel

Gravelly, yellow loamy sand gravel over clay soils that are common on slopes within the Darling Range

Soil series: Lennard series

Vegetation: Wandoo-marri forest with the occasional jarrah and rock sheoak

Acidity Moderate risk
Soil structure Firm setting to loose surfaced soil
Water repellence Very susceptible
Waterlogging Very low risk
Water erosion Winter moderately low, summer moderate. Runoff is common from summer storms due to the sloping landscape and water repellent soil
Wind erosion Moderately low risk
Water availability Moderate
Plant rooting depth Moderate to deep
Other High phosphate fixing soils
Cereals Moderate to moderately high yield potential
Canola Moderate yield potential in the DRZ
Grain legumes Suitable for narrow leaf lupins
Pastures See page 57.

A1 Firm dark greyish brown to dark brown loamy sand, Usually with large amounts of ironstone gravel. pH = 6.0

A3/B1 Very gravelly yellowish brown to strong brown clayey sand to sandy loam. pH = 6.5

B2 Strong brown to brownish yellow sandy clay loam to Moderately structured medium clay.
Generally contains some ironstone gravel. pH = 6.5

A2 Firm dark greyish brown to dark brown loamy sand, Usually with large amounts of ironstone gravel. pH = 6.0

A3/B1 Very gravelly yellowish brown to strong brown clayey sand to sandy loam. pH = 6.5

B2 Strong brown to brownish yellow sandy clay loam to Moderately structured medium clay.
Generally contains some ironstone gravel. pH = 6.5

64
Grey sandy gravel over clay  

WA soil group: duplex sandy gravel

This soil is between 30 and 80 cm grey sandy gravel over bleached sandy gravel over clay. In the eastern Darling Range. It is more common in the Eulin Uplands and Boscabel soil landscape systems, and is the most common gravel soil in ancient and rejuvenated drainage areas. Hard setting shallow gravelly duplex (Wishbone series) typical of the mallee zone also occurs in the east of the district.

Soil series: Wahkinup series. Wishbone series (minor)

Vegetation: Ancient drainage: Wandoo-rock sheoak, mallee heath; Rejuvenated drainage and Darling range: Wandoo-marri-jarrah-rock sheoak.

Acidity  
High risk

Soil structure  
Firm setting or (often) loose surfaced soil

Water repellence  
Very susceptible

Waterlogging  
These are well drained soils but there is some risk of waterlogging depending on the depth to clay, position in the landscape, depth to clay, and rainfall zone

Water erosion  
Moderate risk, particularly from summer storms on water repellent soils

Wind erosion  
Moderately low risk due to the gravelly surface

Water availability  
Generally lower than yellow duplex sandy gravels. The topsoil often has low plant available water, but roots may be able to penetrate the subsoil, and plant may have access to water perched above the clay in low gradient areas.

Plant rooting depth  
Moderate to deep

Other  
Normal phosphorus retention

Cereals  
Moderate yield potential.

Canola  
Moderately low yield potential. Soil acidity may be a limiting factor

Grain legumes  
Narrow leaf lupins. Variable yields

Pastures  
See page 57.
Grey sand over gravel over clay  WA soil group: grey deep sandy duplex

This soil has grey sand/loamy sand over gravel over mottled clay to clay loam, usually with a bleached layer above the clay. Depth to clay ranges from 20 to 70 cm but is commonly 30 to 40 cm. It is common on slopes and tributary valleys, particularly those with lateritic uplands, with sandy duplex soils.

**Soil series:** Moojebin series mainly on upper/mid slopes. Eulanda series mainly on mid to lower slopes and some valleys. In valleys these soils occur with deep sandy duplex soils.

**Vegetation:** Wandoo, rock sheoak woodland. Mallees may occur in the east in hard setting variants that grade into duplex sandy gravel.

<table>
<thead>
<tr>
<th>Acidity</th>
<th>High risk due to high acidification rate, acidic topsoil pH and low buffering capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soil structure</td>
<td>Firm to loose surface. Loamy sands may respond to deep ripping. Subsoils vary in root penetration properties</td>
</tr>
<tr>
<td>Water repellence</td>
<td>Very susceptible</td>
</tr>
<tr>
<td>Waterlogging</td>
<td>Moderate to low, depending on depth to clay, position in the landscape, and permeability of the subsoil</td>
</tr>
<tr>
<td>Water erosion</td>
<td>Low to moderate risk</td>
</tr>
<tr>
<td>Wind erosion</td>
<td>High risk</td>
</tr>
<tr>
<td>Water availability</td>
<td>Moderately low to moderate depending on clay and gravel content, and depth to clay, and ability of roots to penetrate the subsoil. Water perched above the clay is an advantage in some seasons in soils with low gradients.</td>
</tr>
<tr>
<td>Plant rooting depth</td>
<td>Moderate to good, but depends on depth of sandy topsoil and subsoil structure</td>
</tr>
<tr>
<td>Other</td>
<td>These soils have a higher frost risk due to their grey sandy surface</td>
</tr>
<tr>
<td>Cereals</td>
<td>Moderate yields, unless waterlogged</td>
</tr>
<tr>
<td>Canola</td>
<td>Moderate yields, unless waterlogged</td>
</tr>
<tr>
<td>Grain legumes</td>
<td>Narrow leaf lupins: moderate potential on deeper types</td>
</tr>
<tr>
<td>Pastures</td>
<td>See page 57.</td>
</tr>
</tbody>
</table>

**Moojebin Series**

Moojebin series (left) has yellow or brown clay

**Eulanda series**

Eulanda series (right) has grey to pale brown clay. It is more commonly found on valley floors.
Grey deep sandy duplex

WA soil groups: grey deep sandy duplex; alkaline grey deep sandy duplex

This soil category covers (often) loose to firm grey sandy topsoils over pale reticulite or pallid zone clay with a bleached layer and sometimes a thin gravel layer above the clay. The soil is often associated with deeply weathered surfaces, but can merge into granitic deep grey sandy duplexes. In the west of the district they are very common on wandoo broad flat valleys like the Hillman flats. Depth to clay is variable, but is often from 30 to 60 cm.

Soil series: Indinup series (neutral subsoil in all slope positions). Ballard series (alkaline subsoils, more common on valley floors).

Vegetation: Wandoo and rock sheoak with associated salmon gum, York gum and flat topped Yate where the sand becomes shallower and they merge into salmon gum grey heavy valley soil. Mallee heath is also found on these soils in the Tieline system, Kukerin and Nyabing systems, and becomes the dominant vegetation on these soils further east.

Acidity
High risk due to high acidification rate, acidic topsoil pH and low buffering capacity

Soil structure
Firm to loose surface. Loamy sands may respond to deep ripping. Subsoils vary in root penetration properties, but tend to be more hostile than sand over gravel over clay

Water repellence
Very susceptible

Waterlogging
Moderate to high risk depending on depth to subsoil and slope

Water erosion
Low to moderate risk on slopes

Wind erosion
High risk

Water availability
Moderately low to moderate depending on depth of sandy layer and underlying soil structure. Water perched above the clay can be an advantage in some seasons, or limits yield from waterlogging in wet winters.

Plant rooting depth
Generally moderate, Depends on depth of sandy layer and underlying soil structure

Cereals
Average but variable. Yields can be restricted in both very dry (root restriction) and very wet (waterlogging) seasons. Oats have more stable yields due to better frost and waterlogging tolerance

Canola
Similar to cereals

Grain legumes
Narrow leaf lupins are grown on deeper variants with variable yields

Pastures
See page 57.
The soils below show a range, but all have a bleached layer above an abrupt change to pale clay loam or clay.

Indinup series valley soil showing a marked bleached layer and silica seal on the surface of the domed clay. Despite the seal, plants have more access to soil water than massive clays as the root can penetrate sandy cracks between the domes.

0-10 cm dark brown sand. pH 5.3 CaCl₂

10-25 cm pale brown sand. pH 5.4 CaCl₂

White silica seal on and between clay domes

25-80 cm pale brown clay with orange mottles. pH6 CaCl₂

80-140 cm brownish yellow clay with grey mottles. pH7.3 CaCl₂

140-170 cm grey calcareous clay with yellow mottles. pH8.2 CaCl₂
Landscapes and soils of the Katanning district

**Shallow hardsetting grey duplex**  
WA soil groups: grey shallow sandy and loamy duplex

Hardsetting, hard to manage, shallow, gritty, grey loamy sand to sandy loam overlying clay. White decomposing granite or pallid zone may be found on the soil surface. These soils include the moort soils of the mallee zone. They are generally moderately acidic but can be alkaline at depth.

**Soil series:** Kibbleup (loamy duplex), Eastwood (sandy duplex) series.

**Vegetation:** Mainly wandoo forest, with admixtures of York gum, rock sheoak flat-topped yate and jam. Mallee, moort and swamp mallet occur in the eastern edge of the district, and some flooded gum in the west.

<table>
<thead>
<tr>
<th>Acidity</th>
<th>Moderate risk. Mildly acidic topsoils but slow acidification rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soil structure</td>
<td>Hard setting poorly structured topsoil that is susceptible to surface sealing, over dense clay that inhibits root penetration. Can be boggy. Test for gypsum response.</td>
</tr>
<tr>
<td>Water repellence</td>
<td>Susceptible on some soils, but mostly low risk</td>
</tr>
<tr>
<td>Waterlogging</td>
<td>Waterlogging is a problem on lower slopes and break of slope</td>
</tr>
<tr>
<td>Water erosion</td>
<td>Very susceptible, as these hard setting soils often occur on slopes below breakaways</td>
</tr>
<tr>
<td>Wind erosion</td>
<td>Generally low risk, but erosion of sandy variants can leave the clay exposed</td>
</tr>
<tr>
<td>Water availability</td>
<td>Moderate to moderately low, but depends on depth of topsoil and subsoil bulk density</td>
</tr>
<tr>
<td>Plant rooting depth</td>
<td>Shallow</td>
</tr>
<tr>
<td>Other</td>
<td>No-till seeding has greatly improved yield reliability on these soils by enabling earlier seeding, and improving topsoil structure</td>
</tr>
<tr>
<td>Cereals</td>
<td>Low (poor soil structure very wet or dry seasons) to moderate (improved structure) yield potential</td>
</tr>
<tr>
<td>Canola</td>
<td>Variable</td>
</tr>
<tr>
<td>Grain legumes</td>
<td>Peas and vetches</td>
</tr>
<tr>
<td>Pastures</td>
<td>See page 57.</td>
</tr>
</tbody>
</table>

**Kibbleup series**

0-15 Very dark grey medium sandy loam; pH 5.1

15-20 Very pale brown clay loam, coarse sandy; common reddish yellow mottles; strongly developed structure; 10% fine quartz; pH 5.8

20-100 Light grey coarse sandy light medium clay; many strong brown mottles; strongly developed structure; pH 6.8

100-140 White light clay
Mallet hill soils

WA soil groups: acid shallow duplex; loamy earth

Acidic water-repellent loams to duplex soils with highly dispersive pink or orange mottled subsoils associated with breakaways. These are minor soils, but are distinctive and often grade into hard setting and sandy duplex soils.

**Soil series:** Balkuling (acidic variant).

**Vegetation:** Brown mallet, wandoo, mallees.

**Acidity**
Naturally acidic, and are occasionally highly acidic

**Soil structure**
These soils may have a firm surface that may be gravelly, or hard setting and dispersive. Subsoils are dispersive and can restrict root growth.

**Water repellence**
Often highly water repellent

**Waterlogging**
Waterlogging is a problem on lower slopes and break of slope

**Water erosion**
Very high risk, especially if on breakaways

**Wind erosion**
Low risk

**Water availability**
Moderately low to moderate, but water repellency and poor root growth are major limiting factors

**Plant rooting depth**
Moderately shallow to shallow

**Other**
These are poor agricultural soils that are best fenced and revegetated, to avoid erosion and salt leaching from the subsoil. The salty clay subsoils may attract livestock that denude the area and cause extensive soil erosion.

**Cereals**
Low

**Canola**
Not suitable

**Grain legumes**
None suited

**Pastures**
Poor pasture soils. See page 57.

Water repellent gravelly variant with brown mallet, wandoo and mallees
Landscapes and soils of the Katanning district

Granitic sandy surfaced soils

WA soil groups: grey deep and shallow sandy duplex; yellow brown deep and shallow sandy duplex; yellow brown shallow sand

Grey-yellow or yellow-brown gritty sand to loamy sand over grey to yellow brown clay and/or decomposing bedrock. These are variable soils often found adjacent to granitic outcrops. Rocky red soils from mafic rocks are frequently intermixed with these soils.

Soil series: Maleballing, Boyaminning, Warup, Tarwonga series.

Vegetation: Ancient and rejuvenated drainage; jam York gum and rock sheoak. Wandoo occurs in some areas.

Darling range: Wandoo, marri, rock sheoak and jam.

Acidity: These soils are generally mildly acidic to neutral. Moderate to high risk due to high acidification rate (high productivity, low buffering capacity)

Soil structure: Loose to firm setting gritty soils, generally with well structured subsoils

Water repellence: Moderately to highly susceptible

Waterlogging: In patches below rock outcrops or near bedrock highs due to shallow rock

Water erosion: Moderate risk, particularly downslope of rock outcrops

Wind erosion: Generally moderate risk, although the gritty texture reduces wind erosion

Water availability: Moderate to moderately high, depending on depth to rock

Plant rooting depth: Moderate to deep

Other: These are the quite productive soils except for very sandy and shallow soil over rock variants

Cereals: Generally moderate yields

Canola: Moderate yields

Grain legumes: Narrow leaf lupins yield well on deeper soils, although patches can be waterlogged in wet years. Peas also yield well but summer wind erosion risk is high

Pastures: Subclovers are well adapted to these soils, except for deep sandy variants. See page 57.

The diagrams on the next page illustrate the range of soils.
February 2011

Pale deep sand
50 cm coarse grey sand over clayey sand grading to sandy loam at 130 cm

Brown sandy earth
80 cm coarse sand, grading to sandy loam then sandy clay loam at 100 cm

Brown sandy earth
Boyaminning series
90 cm of loamy sand over sandy loam

Brown sandy earth
Boyaminning series
90 cm of loamy sand over sandy loam

Yellow brown deep sandy duplex
Maleballing 1 series
20 cm brown loamy sand over yellow brown coarse sand with yellow brown clay at 35 cm

Grey deep sandy duplex
Warup series
15 cm grey loamy coarse sand over light grey brown clayey sand with yellow brown clay at 30 cm

Loamy earth
Yellow brown loamy sand grading to yellow brown clay by 30 cm over weathering gneiss
**Rocky red brown loams and duplex soils**

WA soil group: red sandy earth, red shallow/deep loamy duplex, red deep sandy duplex

Rocky, red-brown to brown, loamy sand to sandy loam over clay and/or decomposing bedrock (gneiss or intermixed granite and mafic rocks). Soils are generally well structured with mildly acidic topsoils and neutral to alkaline clays.

**Soil series:** Muradup, Lowden series.

**Vegetation:** *Ancient and rejuvenated drainage*: York gum and jam, some flat topped Yate, salmon gum and red morrel.

*Darling Range*: Marri, wandoo, flooded gum and jam.

**Acidity**
Moderately low acidification rate but many soils now need lime due to their high productivity and because they were amongst the first soils cleared

**Soil structure**
Generally firm setting well structured soils

**Water repellence**
Low to moderately susceptible

**Waterlogging**
In patches below rock outcrops or near bedrock highs due to shallow rock

**Water erosion**
Moderate to high risk, particularly adjacent to rock outcrops

**Wind erosion**
Low to moderate risk

**Water availability**
Moderately high to high

**Plant rooting depth**
Moderate

**Other**
These are the most productive soils over a range of seasons

**Cereals**
Moderate to high yields

**Canola**
Moderate to high yields

**Grain legumes**
Narrow leaf lupins: moderate on sandier types. Well suited to peas, and deep loams are suitable for other pulses

**Pastures**
See page 57.

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**Brown loamy earth**

Deep red loamy duplex. Muradup series

- 0-15 cm red brown sandy loam. pH CaCl₂ 4.9
- 15-30 cm yellow red sandy loam. pH CaCl₂ 5.2
- 30-35 cm brown sandy loam
- 30-75 cm red brown heavy clay. pH CaCl₂ 7.9
- 75-115 cm olive medium clay with red and grey mottles. pH CaCl₂ 6.3
- 115 cm+ weathering gneiss
Mafic red brown calcareous soils

WA soil groups: self mulching cracking clay; alkaline red shallow loamy duplex; calcareous loamy earth

Red to brown, heavy textured soils formed from dolerite or similar fine grained mafic rocks. Soils in this group include (most commonly) loamy duplexes, cracking and self-mulching clays and calcareous loamy earths. They are all red-brown with loam to clay topsoils, and alkaline calcareous clay subsoils. These soils are most common in the Ancient and rejuvenated drainage areas, frequently in small areas associated with dolerite dykes. They are particularly common in the Datatine soil landscape system

Soil series: Winspear (alkaline red shallow loamy duplex), Filmer (calcareous loamy earth), Northam (minor, red cracking clay)

Vegetation: Ancient and rejuvenated drainage: salmon gum, York gum, red morrel

Acidity: Alkaline and calcareous subsoils
Soil structure: Firm to hardsetting with well structured calcareous subsoils. The topsoil is susceptible to compaction from cultivation and stock trampling when wet
Water repellence: Not a problem
Waterlogging: Low risk but boggy areas can occur below rock outcrops or near bedrock highs
Water erosion: High risk, particularly adjacent to rock outcrops
Wind erosion: Low risk on loamy duplex soils, but self mulching soils are susceptible
Water availability: Moderately high, but the high clay soils retain more water in the upper layers of the soil, increasing evaporation losses in dry seasons
Plant rooting depth: Moderate to shallow. The well structured clays permit root penetration but boron toxicity and high natural salt content of some subsoils limit root growth on some soils.
Other: These are fertile soils with very high yield potential when there is sufficient rainfall to fully wet the soil profile. Yields are greatly reduced in very dry seasons. No-till seeding has greatly improved yields on these soils by reducing surface compaction, and by reducing soil moisture loss.
Cereals: Moderate to high yields
Canola: Moderate yields
Grain legumes: Very suitable for pulses except narrow leaf lupins although loose rocks make pea harvesting difficult. Toxicity from sulfonylurea herbicide carryover is a risk.
Pastures: See page 57.
**Winspear series**: alkaline red shallow loamy duplex. This soil is common on dolerite dykes. The surface gravel is a colluvial deposit formed from eroded mafic laterite

0-10 cm. Dark reddish brown heavy clay loam; massive; 15% medium ironstone gravel; pH 6.6

10-25 cm. Red medium clay; moderately developed structure; very highly calcareous; pH 8.1

> 25 cm. Red; medium heavy clay; many soft calcareous (lime) segregations; highly calcareous; pH 8.5

**Filmer series**: calcareous loamy earth

0-10 cm. Reddish-brown heavy clay loam; very highly calcareous; pH 8.9

Below 10 cm. Yellowish red to red medium heavy clay; strongly developed structure; very highly calcareous; pH 9.6

**Northam series**: red shallow loamy duplex to red cracking clay

A Reddish brown sandy clay loam to medium clay. Often self-mulching with surface cracks. pH = 6.5

B Reddish brown medium clay. Strongly structured. Often contains dolerite rock. May contain lime at depth. pH = 6.5 to 8.5

C Decomposing dolerite rock
**Salmon gum grey valley soils**  
WA soil group: alkaline grey shallow sandy/loamy duplex.

These soils generally are characterised by a shallow hard-setting loamy sands or sandy loams, over structured grey to yellow-orange mottled clay that usually have finely divided free lime at depth. Some white lime nodules may be scattered on the surface.

**Soil series:** Fairclough (sandy duplex), Peterson series (loamy duplex).

**Vegetation:** *Ancient and rejuvenated drainage:* Salmon gum woodland.

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Acidity</strong></td>
<td>Very low risk.</td>
</tr>
<tr>
<td><strong>Soil structure</strong></td>
<td>Susceptible to surface compaction, particularly from heavy grazing early in the growing season. Dense sodic subsoil clays.</td>
</tr>
<tr>
<td><strong>Water repellence</strong></td>
<td>Low risk.</td>
</tr>
<tr>
<td><strong>Waterlogging</strong></td>
<td>Sandy duplex, high risk in wet years. Loamy duplex medium to high risk.</td>
</tr>
<tr>
<td><strong>Water erosion</strong></td>
<td>Low risk, except where water is concentrated along valley floors.</td>
</tr>
<tr>
<td><strong>Wind erosion</strong></td>
<td>Low (loamy surface) to moderate (sandy surface) risk.</td>
</tr>
<tr>
<td><strong>Water availability</strong></td>
<td>Moderate to good depending on plant rooting depth. These valley soils receive runoff from summer rains and have good water retention, but yield poorly in dry seasons</td>
</tr>
<tr>
<td><strong>Plant rooting depth</strong></td>
<td>Usually shallow to moderately shallow depending on subsoil structure. Slightly better plant root growth than shallow hard-setting grey duplex</td>
</tr>
<tr>
<td><strong>Other</strong></td>
<td>Often high salinity risk due to valley floor location. No-till seeding has greatly improved yield reliability on these soils by enabling earlier seeding, and improving topsoil structure</td>
</tr>
<tr>
<td><strong>Cereals</strong></td>
<td>Moderate to high potential</td>
</tr>
<tr>
<td><strong>Canola</strong></td>
<td>Moderate</td>
</tr>
<tr>
<td><strong>Grain legumes</strong></td>
<td>Faba beans, peas and vetches</td>
</tr>
<tr>
<td><strong>Pastures</strong></td>
<td>See page  57.</td>
</tr>
</tbody>
</table>

[Images of Fairclough series: Shallow loamy sand over clay, Peterson series: Shallow loam over clay]
Figure 44  Katanning field trip route (see next page)
Landscapes and soils of the Katanning district: field trip

The main objectives of the field trip are:

1. To give you practical experience in using the decision aids in your manual
2. To give you practical experience with relevant landscapes and soils.

Materials required for this trip:

1. A vehicle
2. A spade or soil auger, water for soil texturing, and cloth to clean hands
3. Insect repellent and protective clothing relevant to the season.

Tour Notes

Odometer 0.0   Leave Katanning Department of Agriculture and Food car park, proceed west through the centre of town to the Wagin Cranbrook Road. Turn left (south).

6.2 km   Turn right on to Greenhills Road.

6.3 km—Stop 1   GPS zone 50 553814/62677391. Stop at the gravel turnaround area next to the roaded catchment. The table below shows an example of a completed site investigation sheet for this stop.

<table>
<thead>
<tr>
<th>Indicator vegetation</th>
<th>Wandoo, some jam nearby.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>About 300 metres upslope is brown mallet woodland with red morrel near the highway. Red morrel normally indicates more mafic parent material. On slopes and uplands, brown mallet is often associated with latentic duplex soil in mafic influence landscapes, so there may be shallower or loamier soils there that may have influenced the soil at the stop.</td>
</tr>
<tr>
<td>Where are you in the landscape</td>
<td>On the break of slope at the base of a large but fairly evenly sloping hill. It is difficult to say more without going up the hill, but the indicator vegetation suggests a granitic landscape with mafic influence (dykes?)</td>
</tr>
<tr>
<td>Surface clues</td>
<td>A few gravel stones only</td>
</tr>
<tr>
<td>Other clues</td>
<td>The roaded catchment indicates yellowish clay subsoil within about 40 cm, and there is some gravel from the soil scattered on the catchment surface. The colour and hard setting nature indicates a largely granitic soil, although the gravel stones are mafic (possibly from upslope).</td>
</tr>
<tr>
<td>your conclusion re the Landscape and soil(s)</td>
<td>The soil profile has about 40 cm of fawn sand pH 5 CaCl$_2$ with a few gravel stones over orange grey mottled clay pH5.1 (deep grey sandy duplex). Break of slope location is more liable to waterlogging, but the relatively deep topsoil reduces the severity.</td>
</tr>
</tbody>
</table>
9.0 km—Stop 2  553382/6265190. Note the dolerite outcrop on right hand side.

Investigate this site using a site investigation sheet and compare your results with the completed sheet at the end of this chapter.

Figure 45  Stop 2

9.5 km—Stop 3  553380/6264879. Stop at the corner of the northern (upslope) paddock near the gate. Investigate this site using a site investigation sheet and compare your results with the completed sheet at the end of this chapter.

Figure 46  Stop 3 Park opposite the gate

10 km—Stop 4  553380/6264220. Note the flooded gum (*E. rudis*) in the waterway that is common on non-saline winter wet areas, often granitic sandy duplex soils on slopes, mainly west of the Great Southern Highway. On the right hand side are separate clumps of jam (*Acacia acuminata*) and Manna wattle (*Acacia microbotrya*). Check the indicator vegetation guide to distinguish between the two species.

You are moving into a mafic influence landscape. Note the hilly landscape, more frequent waterways and rock outcrops, York gum-jam vegetation and darker soils. This is Carrolup 3 subsystem on the map.
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12.5 km—Stop 5  553349/6261586. After the 'Greenhills' entrance, stop at the water supply downpipe (on the right) and cross the road to the corner of the paddock. The ridge to the left of the dividing fence (see Figure 47) is a dolerite dyke with a large mafic laterite mesa (note the red-coloured gravel pit) vegetated by wandoo and brown mallet. Below this on the ridge you are on is a red brown loamy duplex soil formed from dolerite. In the pit to the right of the fence, exposed grey duplex soil indicates a sudden change from dolerite to granite with mainly wandoo vegetation.

![Figure 47 Stop 5](image)

As you leave this site and veer right, the vegetation on the right changes from York gum to brown mallet. Brown mallet is often found on mafic lateritic clay soils on or near lateritised dykes. However the mallets by the road here are on hard setting grey pallid zone clay.

17.3 km—Stop 6  552295/6256875 on a ridge just past a pallid zone dam. This is the Jarrahwood axis that is the major drainage divide between north-west and south flowing waterways. Investigate this site using a site investigation sheet and compare your results with the completed sheet in the appendix.

![Figure 48 Stop 6](image)

Note the landscape change back to a mafic influence area. At the T-junction, turn left towards Broomehill.

21.9 km—Stop 7  556496/6254697 just past Clinic Road turnoff.

This is a good example of a 'yate flat', with large flat-topped yate, (*E. occidentalis*). Yate commonly indicates soils that can have winter waterlogging, and are often formed on colluvium from weathered igneous rock (but not always, as for example Yate swamps).
This is a sandy landscape with a deep sandy duplex soil where you have stopped. Note the wandoo upslope to the west, and the saprock dam. Also notice the granite outcrops to your right on the southern slope of the flat.

![Image](image.png)

**Figure 49  Stop 7**

**24.8 km—Broomehill** (public toilet available). Turn south, and as you drive, note the subdued mainly duplex soil landscape that is typical of the north-south area that runs from just west of Katanning to Tambellup, with wandoo/flat-topped yate/brown mallet woodland. Numerous east-west dolerite dykes of the Gnowangerup dyke swarm (Mulligan S, (1999)) cross the road, and can easily be seen by the red soils supporting brown mallet on the road verge.

Turn left on the Gnowangerup Road. As you drive down this road, note the vegetation change from wandoo (grey sandy duplex on rises formed over pallid zone), to flat-topped yate (often poorly drained soil on a low slope formed over mixed igneous rock and sap rock), to York gum (more dissected better drained areas, often with brown duplex soils formed over gneiss and dolerite).

**37.6 km** Turn left on to Fletcher Road.

Figure 50 shows a more detailed view of the transition from the Upper Pallinup system to the Tieline system upland plain that straddles the Jarrahwood Axis.

Note the vegetation change as you cross the waterway. York gum vegetation changes to wandoo-rock sheoak (deep and sandy duplex soils), then to flat-topped yate on the gently sloping land down to the waterway around the corner. Continue to the left up the slope (Upper Pallinup subsystem 2) and note the vegetation changes and associated soils.
Figure 50  Map showing the transition from the Upper Pallinup system to the Tieline system.

40.6 km—Stop 8  575755/6253554. This is the Jarrahwood axis again, and marks the start of the Tieline soil landscape system, that is often underlain by pallid zone. As the landscape has little relief, sandy rises, duplexes with poorly structured pallid subsoils are common, and frost and waterlogging are limiting factors for crop and pasture production.

Investigate this site using a site investigation sheet and compare your results with the completed sheet at the end of this chapter.

Figure 51  Stop 8

When you turn left after leaving Stop 8 note that there is a narrow band of brown soil in the paddock on the left. There is no change to the wandoo vegetation and the band is mainly a hard setting brownish lateritic soil except for one small patch of doleritic loamy duplex
42.2 km—Stop 9  574150/6253758. Note the change to sandplain vegetation on the rise.

Species include Christmas tree (*Nuytsia floribunda*), slender banksia (*Banksia attenuata*), roadside tea tree (*Leptospermum erubescens*), and introduced perennial grasses.

Note that mallees have been planted in alleys in this paddock due to the poor soils. Loamy duplex soils downslope are more productive.

43.4 km—Stop 10. 573822/6254606 After you pass a pallid zone dam you cross the mafic dyke again, and the soil changes to a shallow red loamy duplex.

Turn right at the T-junction (Norrish Road). Continue across the cross road to Curnow Road.

50.8 km—Stop 11. 575823/6261450. Note the moort and melaleuca vegetation, hard setting soil and the lime nodules. This and the position in the landscape indicate a poorly drained alkaline shallow duplex.
Turn left on to Scotchmans Road: note the change to a more undulating landscape as you enter the East Katanning system. Turn right on Tieline Road then veer right up Langaweira Road then left on to Belmont Road.

67.8 km—Stop 11  566562/6265739. Enter the track to the right near the top of the ridge, drive until you reach the tree lined fence line on the right hand side. Note the large mafic laterite ridge and red loamy soils formed from mottled zone and underlying mafic rock, of a north-south trending dyke.

At the stop, you can see the red mottled subsoil clay, and the blue mallet (*E. gardneri*) vegetation with wandoo. Many people could confuse blue mallet (dull blue green leaves) with brown mallet (shiny green leaves), particularly here where the mallet stem is quite brown. Blue mallet is more specific in its distribution, occurring on mafic gravelly hill tops, where it occurs with brown mallet and/or silver mallet.

Return to Belmont Road and turn left towards Katanning. As you cross the ridge the soil changes dramatically to a deep grey sandy duplex that probably has been influenced by aeolian sand blown up from the major valley system that you are entering.

87 km  Arrive back at Katanning district office.
### Completed site investigation sheets

#### Stop 2

**Indicator vegetation**  
Mainly York gum and jam. Occasional flooded gum downslope.

**Where are you in the landscape**  
At the base of a low spur in an almost level area with a slope to the south. It is difficult to determine landscape type here apart from soil colour and remnant vegetation.

**Surface clues**  
Mafic outcrop and stones on the soil surface.

**Other clues**

**Your conclusion re the Landscape and soil(s)**  
Rocky red brown loamy soil.

The soil is a brown loamy earth with a brown sandy clay loam pH 5.6 over a brown sandy clay pH 5.8 (calcium chloride pH).

#### Stop 3

**Indicator vegetation**  
Manna wattle with some stinkwood (*Jacksonia sternbergiana*) that is often an indicator of sandy soils. Wandoo to the west.

Note the difference between manna wattle here and jam upslope.

**Where are you in the landscape**  
Lower slope near the break of slope.

**Surface clues**

**Other clues**  
Gritty sand surface and stones visible on the soil surface upslope indicate a colluvial soil with a granitic or quartz soil upslope.

**Your conclusion re the Landscape and soil(s)**  
An auger hole at this stop showed a sandy earth soil that doesn’t fit into any common soil category, but is associated with grey deep sandy duplexes further west.

- 0–10 cm Grey brown loamy sand pH 4.5.
- 10–25 cm grey sand with occasional gravel stones pH 4.4.
- 25 cm pale hard setting sandy loam pH 4.6.

Note that this soil requires liming.

Further downslope the sand becomes deeper to grey deep sand (note the stinkwood shrubs).

#### Stop 6

**Indicator vegetation**  
Wandoo, manna wattle.

**Where are you in the landscape**  
Ridge. The smooth landscape indicates a granitic area.

**Surface clues**  
Quartz, pallid zone, hard setting surface.

**Other clues**  
Pallid zone dam downslope.

**Your conclusion re the Landscape and soil(s)**  
This is a sandy granite area where erosion has stripped the upper layers off a laterite to the pallid zone. A hard setting grey shallow sandy duplex (Indinup1 series) has formed from pallid clay.
## Stop 8

**Indicator vegetation**

Mallee (*E. thamnoides*, a mallee equivalent of brown mallet often found on shallow duplex soils), low melaleuca and wandoo. This is a good example of mallee with sparse understorey found on poorly structured clays.

**Where are you in the landscape**

Slight rise on an upland plain.

**Surface clues**

Pallid zone fragments, very hard setting surface.

**Other clues**

- 

**Your conclusion re the Landscape and soil(s)**

Wandoo-mallee -mallet hard-setting grey duplex.

This is a hard-setting acidic shallow loamy duplex that is one of a group of soils commonly called grey clay. Alkaline versions occur in the broad valleys.
Moodiarup case study

This example features landscapes and soils of an area in the Darling Range that includes the Farrar, Boscabel, and Eulin Uplands systems.

Numbers in Figure 57 indicate stops that you can locate with your car odometer or GPS. The yellow arrows in subsequent maps indicate the direction in which photos were taken.

Land forms in this area formed on a basement of mainly granitic rock, with overlays in areas, of lake and aeolian sediments that have been modified by lateritisation and landscape dissection. The orange areas show areas of soil derived from granitic rock with mafic dykes (that are often on ridges). A rise in sea level in the Eocene period led to widespread lakes and swamps in an undulating plain. Grey-brown areas in Figure 57 are remnants of the 5 to 20 m of silty and sandy deposits interspersed with (orange) igneous rock 'islands'.

![Map of Moodiarup case study](image)

Figure 56  Case study location

Figure 57  Relief and soil landscape systems map of the case study area
After sea levels fell, laterite formed on the sediments to form the grey lateritic duplex upland plains of the Eulin Uplands system (that are more liable to waterlogging than granitic laterites), with mainly yellow-brown sandy laterites occurring on surrounding granites.

The Darling Range was gradually uplifted, and this elevation provided the gradient for rivers to cut through the laterites. The blue area in Figure 57 is the Boyup valleys system where tributaries of the Blackwood River have eroded through the Eulin sediments and the underlying granites. In this area the soils in these valleys are mainly gravelly and sandy duplexes, but in other areas loamy soils are also common.

In more recent arid climatic phases, sands were deposited by strong winds on the south of dry sandy paleochannels on, or close to the Blackwood River. These coated the landscape with deep grey sands to form sandy duplex soils, sandy gravels, deep sands and gravelly sands of the Boscabel system (grey areas).

0.0 km—Stop 1  GPS zone 50 470371/6265050. Start at the corner of Balgarup and Kulikup South roads. View 1A to the west shows duplex gravel soils. Note the dispersive clay below the gravel layer that is exposed in the cutting on the left side of the road.

In view 1B the river valley has cut through the sediments to the underlying granite. The slope in the distance has sandy and gravelly duplex soils with granite outcrops. On the south-east corner of the road, the soil is a colluvial fine dark brown over pale fine sand that was derived from upslope gravel.

Figure 58  Views at Stop 1

Drive north along the Kulikup south Road. Turn left at Westcliffe Road.
3.8 km—Stop 2  470292/626827. This is a waterlogged mildly saline valley in the Boyup Brook valleys system that has been planted to phalaris perennial pasture.

3.85 km—Stop 3  470092/6268025. View 3A shows a laterite ridge formed on a dolerite dyke, and view 3B shows a granitic rocky landscape (note the granitic dam). Downslope are colluvial loamy soils, with a brown gravelly loam over loam at the fenceline.

From Stop 3 turn around, cross Kulikup South Rd and continue down Westcliffe Road.

7.8 km—Stop 5  473430E/ 6267880. This is a grey sand over gravel over clay soil slope. The soil profile exposed in the dam has 30 cm fine sand over 30 cm hard setting sandy gravel that merges into orange clay loam. In most winters there would be lateral water flow above the clay loam. Note the doleritic mafic gravel ridge in the distance.
Figure 61  **Stops 5 and soil profile exposed in the dam**

**11.4 km**  Note the change in soil type from the grey lateritic duplex plain of the Eulin Uplands system to brown granitic gravelly soils.

![Map of stops](image)

Figure 62  **Views of Stops 6 to 9**

**11.8 km—Stop 6**  476406/6269148. Gravel pit with a deep colluvial gravel face. Turn left down Old Mail Road.

**12.7 km—Stop 7**  475953/6269687. You are now in a grey sandy landscape of the Boscabel system, with aeolian grey deep sands, gravelly sands and deep sandy duplex soils. Note the deep sand vegetation that is typical of this area. Plants include Jarrah, Christmas tree, woolly bush, parrot bush, and slender banksia (*Banksia attenuata*).

Turn around at the white road peg and drive back up the hill and then continue across Westcliffe Road. You are now in the Farrar system that has a dissected landscape with igneous basement rock.
Landscapes and soils of the Katanning district

15 km—Stop 8  477363/ 6268217.  This is a deep sandy duplex valley with seepage from lateral flow through the sandy topsoil of surrounding slopes.  Note the flooded gums, and sedges.

After this stop there is change to a dissected granite landscape.  Soils are mainly grey sandy gravel, grey sand over gravel, grey deep sandy duplex, because the granite is quartz-rich, with at least one quartz vein crossing the road.  The road crosses the waterlogged and saline Balgarup River flat.  Turn right on to Balgarup Road.

21.2 km—Stop 9  476178/ 6264978.  This is a mafic soil area (see Figure 65).  View 9A shows mafic stony gravel and Cummings series loamy gravel.

View 9B has mixed soils formed from granite and dolerite with a rock heap in the middle distance.

View 9C looks downslope where landscape erosion has cut through the laterite and the loamy gravel merges into Muradup series red brown loamy duplex (rocky red loams and duplex soil).  Such soils in this area are neutral to mildly alkaline and are rarely calcareous unlike the mafic red brown loams and clay soils on uplands east of Katanning.
Figure 65  Stop 9 views

27.4 km  Return to Stop 1.
East Tambellup case study

This example features landscapes and soils of an area east of Tambellup where a Carrolup system rejuvenated landscape merges into the extensive flats of the North Stirlings system and the adjoining aeolian sandplain of the Hydenup system.

Numbers indicate stops that you can locate with your car odometer or GPS. The yellow arrows in subsequent maps indicate the direction in which photos were taken.

The eastern part of the study area is an upland underlain by granite with numerous mafic dykes that underlie nearly all of the ridges and spurs. This upland is the eastern edge of broad north-south trending rise that runs west of Katanning and through Tambellup. This rise that appears to have been uplifted as a consequence of the Darling Range uplift has blocked west/north-west flowing rivers to create lakes and plains of the North Stirlings system.

In the last 100,000 years there have been arid periods when sand was blown from the North Stirlings sump to coat surrounding uplands and form the Hydenup system sandplain in the eastern part of the study area.

Figure 67 shows a complex series of east-west, north-west/south-east, and north-south lineaments (faults or dykes) that are reflected in river, ridge, and spur direction, and large lakes that tend to be at lineament intersections. Nearly all the ridges and spurs are underlain by dykes, but most have a shallow aeolian sand overlay that has lateritised to unusual grey fine sandy gravel or gravelly sand duplex with dense dark gravel. The seemingly isolated peaks usually occur where dykes have intersected and formed more erosion resistant areas of rock.

Vegetation on most soils is dominated by mallees, but with practice you can see soil type variations by changes in the shrub understorey with other soil and landscape clues.
February 2011

0.0 km—Stop 1  GPS zone 50 470371/6265050. Start at the (Chudleigh) farm entrance. Soil at the gateway is a near neutral red-brown loamy duplex soil formed from an east-west mafic dyke. Note the brown hard setting surface with mafic and gneissic rock fragments and the mallee-melaleuca vegetation. *Eucalyptus thamnoides* (the mallee equivalent of brown mallet) is the main mallee species on shallow duplex soils in the study area. Going south the soil quickly changes to shallow sandy duplex formed on granitic gneiss and then a duplex sandy gravel downslope.

0.4 km—Stop 2  584631/6231006. The understorey has changed to mixed roadside tea tree, pea flower shrubs (similar to poison plants), native grasses and sedges. This indicates a sandier topsoil with the soil being a grey duplex sandy gravel.
Figure 69 shows a major lineament that initially coincides with the main creek on the right (west). The lineament continues east-west north of, and parallel to Carr Road, but is intersected by frequent north-west/south-east and south-west/north-east dykes that have diverted the creek and cut the lineament into a series of winter wet and/or saline loamy depressions that culminate in the large salt lake in the left corner of Figure 69.

0.7 km—Stop 3  584631/ 6230627. You have been driving down a narrow ridge, that dips here where it crosses a depression associated with the east-west lineament. Note the melaleucas on the road verge that indicate a change to a relatively shallow duplex or water gaining soil.

This stop illustrates the large effect basement rock structures have on hydrology in the study area.
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View 3A to the west shows a hollow and dam that have become saline due to groundwater that moves along the lineament then trapped behind intersecting dykes. View 3B to the east shows a series of salt affected hollows caused by a similar mechanism. The landscape relief in figure 69 has been exaggerated to make dykes and hollows more visible. View 3B shows a plain of criss-crossing mainly mafic dykes with a very shallow aeolian sand overlay on which a shallow stony sandy gravel soil has formed, with the exception of the loamy duplex salt affected hollows (see Stop 10). Immediately after Stop 3 you cross a sandy duplex gravel spur.

1 km—Stop 4  584629/ 6230334. This begins at the Carr Road intersection with a duplex sandy gravel (note the shallow gravel pit), that changes to another mafic dyke. The dyke trends north-west/south-east, and has diverted the direction of the adjacent waterway from east to the south-east. On the right is a stony gravel rise, with an outcrop of underlying rock on the left. The rocks are silcrete (a silica impregnated saprock that commonly underlies mafic laterites), and gabbro. The soil then changes to a granitic shallow loamy duplex with a soil profile exposed in the deep drain excavated in the waterway.

Figure 71  Stop 4. 1: South-east view from the gravel pit showing the duplex sandy gravel soil profile  
2: North-east view from the creek showing the mafic dyke loamy duplex  
3: Pale silcrete and dark gabbro rocks  
4: Grey shallow loamy duplex profile at the deep drain.

After the deep drain the soil on the slope changes to grey duplex sandy gravel (yellow line in Figure 72). The soil (30 cm water repellent gravelly sand over creamy clay loam) is liable to cereal manganese deficiency. The soil changes to shallow sandy duplex (green dotted line), without any noticeable change in the mallees, but you can pick a change in remnant understorey from Proteaceae to melaleucas.
3.4 km—Stop 5 584864/6227952 (note the telephone pole in the paddock on the left). The large melaleuca shrubs on the right, and hard setting surface with lime nodules indicates an alkaline shallow duplex soil.

4.9 km—Stop 6 585239/6226654. Stop at the entrance to the old gravel pit.

The mallee with dryandra dominant roadside vegetation is typical of a shallow sandy gravel soil. Mallee species here are also typical of gravelly soils. The most common mallee here is E. phaenophylla (also common on sandy soils) with silver mallee (E. falcata), and E. flocktoniae.

The top of Figure 72 shows a fine sand sheet that has blown right up to the ridge from the North Stirlings flats, and influenced the soil at Stop 6. Figure 74 shows a laterite profile at the gravel pit. The laterite is an unusual sandy gravel with a dense ironstone that has formed in the sand and becomes sandier with depth. This overlies weathered gneiss (which is evident in the floor of the gravel pit). The adjacent paddock view shows a valley that follows a north-south lineament, with deep grey sandy duplex soil (sandy overlay) with scattered hollows of loamy duplex soil (from the underlying gneiss). The variation is evident in the spotted appearance of the paddock to the west of Stop 6 in Figure 73.
Turn left down Anderson Road.

5.1 km—Stop 7  GPS 585543/6226406. See Figure 75. The north-west/south-east trending mafic ridge crossing the road here has a red-brown loamy soil with moort and *E. annulata* roadside vegetation. Moort is more commonly associated with hard-setting grey clay, but *E. annulata* is often found on these soils further east.

The scraped catchments for the dams on either side of the road show that the soil changes downhill to a shallow sandy gravel over clay. Banded clays from decomposed gneiss can be seen in catchment gullies.
5.5 km—Stop 8  586201/6226430. This is just past the swamp that marks a change to a valley with aeolian sand over Eocene sediment. The roadside vegetation has changed to sandplain mallee heath (*E. uncinata* with cabbage hakea, roadside tea tree, stinkwood, perennial grasses). The soil is a deep sandy duplex (40 to 60 cm fine pale to yellow sand over pale clay).

From this site you travel up a deep sand slope with mafic influence sandy gravel on the ridge and down to a deep drain in the course of the major waterway from the study area. The deep sandy duplex soil profile is exposed here.

Figure 76  **Mallee sandplain heath at Stop 8 (left), deep sandy duplex soil profile in the drain (right).**

7.3 km  Turn right down Tallents Road. Note the vegetation changes to flat-topped yate with a bottlebrush understorey (winter-wet sandy duplex) then mallee sandplain heath on grey deep sandy duplex.

8.3 km—Stop 9  587768/6225394. Flat topped yate patch where the drain crosses the road. This gives a view of the extensive flats of the North Stirlings system. Further south the soil grades into shallow alkaline duplex with frequent saline areas. Return to Anderson Road and turn right.

For the next 6 km, you will travel through a sandy landscape. Soils are mainly deep sandy duplex, with sandy gravels on sand-covered mafic dyke rises and scattered areas of deep sand.

9.3 km—Stop 10  588378/6230660. This is a deep sand dune. Note the slender banksia and sandplain heath.

9.6 km  Turn right at the T-junction and drive past the salt lake surrounded by flat-topped yate and York gum vegetation, with deep sand soils on your left.

11.4 km  You are returning to slightly more undulating country with duplex sandy gravel soils on dyke rises and waterlogged and poorly drained hollows. As you drive note the isolated moort patch (mafic soil) on the left.

13.1 km—Stop 11  584922/6236357. This is typical of the almost flat lowland gravelly plain you have been driving through. This area is a part of the complex arrangement of mafic dykes and lineaments, and thin sand sheets that you saw at Stops 3 and 4. The mallee understorey is very variable containing grasses, dryandras (gravelly soil), cabbage hakea, and roadside tea tree (sandy soil) and melaleucas (this flat area may become waterlogged in wet years). The main soils are duplex sandy gravel and shallow gravel, with loamy duplex waterlogged depressions.
Figure 77  Stop 11 views. Roadside mallee heath (top); north view of the duplex sandy gravel plain of the east west trending lineament with saline loamy hollows (11A); north view of the duplex sandy gravel plain with shallow gravel (mafic dyke) rises (11B).

Return to South Pallinup Road. End.
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## Glossary

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
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<tbody>
<tr>
<td>Adamellite</td>
<td>A form of granite with roughly equal calcium and potassium-bearing minerals.</td>
</tr>
<tr>
<td>Alluvium</td>
<td>Material transported and deposited by flowing water such as rivers.</td>
</tr>
<tr>
<td>Bleached layer</td>
<td>Subsurface soil that is white, near white or much paler than adjacent soil layers, caused by the leaching of soil minerals.</td>
</tr>
<tr>
<td>Breakaway</td>
<td>A landform found on the edge of a plateau or plateau remnant, where a relatively flat lateritic upland ends abruptly in a low scarp above a debris slope</td>
</tr>
<tr>
<td>Colluvium</td>
<td>Materials transported and deposited by gravity.</td>
</tr>
<tr>
<td>Craton</td>
<td>A large stable mass of the Earth’s crust.</td>
</tr>
<tr>
<td>Crystalline rock</td>
<td>An igneous or metamorphic rock consisting of interlocking crystals, e.g. granite or gneiss.</td>
</tr>
<tr>
<td>Dispersion or clay dispersion</td>
<td>The complete breakdown of aggregates into sand, silt and clay-sized particles when wet and usually occurs slowly, often taking hours to complete. The dispersed clay can block pores, reducing rainfall infiltration and gas exchange. A characteristic sign of dispersion is muddy or cloudy water, the cloudiness being dispersed clay in suspension.</td>
</tr>
<tr>
<td>Dolerite</td>
<td>A medium grained basic igneous rock that has crystallised near the surface, typically occurring as a dyke, sill or plug.</td>
</tr>
<tr>
<td>Diorite</td>
<td>A granular intermediate igneous rock consisting essentially of felspar and hornblende.</td>
</tr>
<tr>
<td>Duplex soil</td>
<td>A soil with a sudden increase in texture between the topsoil and subsoil of 1.5 or more texture groups, e.g. a sand over a clay loam or clay, or a loam over clay</td>
</tr>
<tr>
<td>Dyke</td>
<td>A sheet-like body of igneous rock cutting across the bedding or structural planes of the host rock. They typically appear on the surface as relatively narrow, linear features</td>
</tr>
<tr>
<td>Effective rooting depth</td>
<td>Refers to the rooting depth of the soil in which plants may have an unimpeded path until an obstruction such as a dense layer of clay or rock is encountered. It is only approximate, as good subsoil structure may allow more root penetration</td>
</tr>
<tr>
<td>Erosion</td>
<td>The wearing away of the land surface and removal of soil by running water, rain, wind, frost or other geological agents.</td>
</tr>
<tr>
<td>Fault</td>
<td>A fracture in rock along which there has been movement.</td>
</tr>
<tr>
<td>Felsic (acidic) rock</td>
<td>Crystalline rock with a high content of silica and light coloured minerals, e.g. granite. Cf. Mafic</td>
</tr>
<tr>
<td>Ferricrete</td>
<td>A layer of material strongly cemented by iron which looks like rock, or a dense ironstone gravel layer.</td>
</tr>
<tr>
<td>Gabbro</td>
<td>A coarse-grained mafic igneous rock similar to dolerite</td>
</tr>
<tr>
<td>Gilgai surface relief</td>
<td>Gilgais are irregular small depressions (20-60 cm deep) and mounds</td>
</tr>
</tbody>
</table>
Landscapes and soils of the Katanning district

<table>
<thead>
<tr>
<th>Term</th>
<th>Description</th>
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<tbody>
<tr>
<td>(or crabhole country)</td>
<td>separated by level or gently sloping land. They are caused by soils with shrink-swell properties</td>
</tr>
<tr>
<td>Gneiss</td>
<td>Distinctly foliated generally coarse-grained igneous rocks formed through high grade regional metamorphism. Gneisses and banded granites are often confused (Lane P 2004)</td>
</tr>
<tr>
<td>Granite</td>
<td>A coarse-grained igneous rock consisting essentially of quartz (20 to 40%), feldspar and very commonly mica.</td>
</tr>
<tr>
<td>Gravel</td>
<td>Any coarse mineral material or fragments from 2 to 60 mm in diameter. These could be ironstone, quartz, other rock fragment or any concretions or nodules.</td>
</tr>
<tr>
<td>Horizons</td>
<td>A term used to describe individual layers in a soil profile. Each horizon has morphological properties different from those above and below it.</td>
</tr>
<tr>
<td>Igneous rock</td>
<td>Those that have been crystallised by magma or become “plastic” due to heat and pressure.</td>
</tr>
<tr>
<td>Indurated layer</td>
<td>A layer of material hardened by cementation or pressure.</td>
</tr>
<tr>
<td>Intrusive rock</td>
<td>Magma that has not reached the rock surface before cooling.</td>
</tr>
<tr>
<td>Landscape</td>
<td>Part of an area of land that is characterised by processes of erosion, weathering, sedimentation, and movements in the earth’s crust. It includes all identifiable and measurable features such as climate, geology, soils and land use.</td>
</tr>
<tr>
<td>Laterite</td>
<td>The lateritic profile typically consists of sand or gravel on top of a ferruginous duricrust where the iron oxides have accumulated. This often overlies a mottled clay and then a pallid zone (white clay on acidic laterites) from which the leaching has occurred.</td>
</tr>
<tr>
<td>Lineament</td>
<td>A major, linear, topographic feature of regional extent of structural or volcanic origin; e.g. a fault system.</td>
</tr>
<tr>
<td>Lime (or calcium carbonate)</td>
<td>Usually found in heavier soils that are alkaline. Lime can be present as soft segregations or nodules, or be finely mixed through the soil. The presence of lime can be detected with a simple test using dilute acid (1M hydrochloric). Drops of acid are placed on a clod of soil and if lime is present the soil effervesces immediately (i.e. bubbles of gas are released), due to the release of carbon dioxide.</td>
</tr>
<tr>
<td>Loam</td>
<td>A medium-textured soil of approximate composition 10 to 25% clay, 25 to 50% silt and less than 50% sand.</td>
</tr>
<tr>
<td>Map unit</td>
<td>A representation of a soil or group of soils, that occurs within an area. A soil-landscape area is a topographic unit (e.g. low hills and rises or a level to gently undulating plain) that contains a series of common soil units. These units can be found on the corresponding soil-landscape map produced for the area.</td>
</tr>
<tr>
<td>Mafic (basic) rock</td>
<td>Rock with a major component of ferromagnesium (dark coloured) minerals. Cf. Felsic.</td>
</tr>
<tr>
<td>Mesa</td>
<td>Isolated table-top hill with steep sides</td>
</tr>
<tr>
<td>Metamorphic rocks</td>
<td>Rocks which have been altered by heat and/or pressure.</td>
</tr>
<tr>
<td>Migmatite</td>
<td>Rock composed of two sources: the metamorphic host rock and an invading</td>
</tr>
</tbody>
</table>
granitic material.

**Mottles**

Patches of different colours, often red, brown, orange or blue-grey spots in a soil horizon.

**Orogen**

A zone of weakness in the earth’s crust along which movement and deformation has taken place during a period of tectonic plate movement. The rocks of an orogen may include deformed and reworked older cratons as well as new volcanic and sedimentary rocks.

**Pallid zone**

White to pink kaolinitic clay formed in the lower part of the lateritic profile.

**pH**

Measures the concentration of hydrogen ions in the soil. The pH is measured on a logarithmic scale (i.e. pH = negative logarithm of concentration of hydrogen ions). A soil with a pH of 5 contains 10 times as many hydrogen ions as a soil with a pH of 6.

Two systems are commonly used to measure pH, one in calcium chloride solution and the other in a soil:water suspension. As a general rule, to convert from pHw to pHCa, subtract 0.8, although the difference can range between 0.6 and 1.2, and in extreme cases from 0 to 2.

<table>
<thead>
<tr>
<th>Soil reaction</th>
<th>pHCa</th>
<th>pHw</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strongly acid</td>
<td>Less than 4.5</td>
<td>Less than 5.5</td>
</tr>
<tr>
<td>Acid</td>
<td>4.5-6.0</td>
<td>5.5-6.5</td>
</tr>
<tr>
<td>Near neutral</td>
<td>6.0-6.5</td>
<td>6.5-7.5</td>
</tr>
<tr>
<td>Alkaline</td>
<td>6.5-7.5</td>
<td>7.5-8.5</td>
</tr>
<tr>
<td>Strongly alkaline</td>
<td>More than 7.5</td>
<td>More than 8.5</td>
</tr>
</tbody>
</table>

**Plateau**

A level to rolling landform pattern of plains, rises or low hills standing above a cliff or escarpment.

**Profile**

A soil profile is a vertical exposure of soil extending from the surface to the decomposing rock or other underlying consolidated material.

**Quartz**

A mineral composed of silicon dioxide (main component of sand).

**Regolith**

All material including the soil from bedrock to the surface.

**Reticulite**

Indurated layer in a laterite profile, usually with residual root channels.

**Rooting condition**

Refers to the soil volume available for plant roots and the mechanical impedance to root development. Soil volume can be reduced by rock and gravel content, by dense pans and clay layers.

**Salinity**

The presence of high concentrations of soluble salts in the soil. It is estimated from the electrical conductivity of a mixture of soil and water.

**Saprolite, saprock**

Soft, more or less decomposed rock remaining in its original place.

**Sedimentary deposits**

Materials which have been moved from their site of origin by the action of wind, water, gravity or ice and then deposited. When these materials become consolidated and hard they are known as sedimentary rocks.

**Segregations**

Gravels or other accumulations of material which occur in the soil. They are formed by the concentration of some constituent by chemical or biological action. ‘Ferruginous’ describes concentrations of iron.

**Silcrete**

Rock in-filled with cemented silica.
<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Slope</strong></td>
<td>An incline either upward or downward from the horizontal.</td>
</tr>
<tr>
<td><strong>Sodicity</strong></td>
<td>A measure of exchangeable sodium in the soil. Soils that are sodic have a high percentage of cation exchange sites occupied by sodium ions. Sodicity adversely affects the stability of the soil and increases the likelihood of the soil dispersing.</td>
</tr>
<tr>
<td><strong>Texture</strong></td>
<td>A measure of the proportion of sand, silt and clay-sized particles in a soil.</td>
</tr>
<tr>
<td><strong>Truncated laterite</strong></td>
<td>A lateritic profile where the upper layers have been stripped by erosion. Soils on truncated laterites have often formed from mottled or pallid zone materials.</td>
</tr>
<tr>
<td><strong>Volcanic rock</strong></td>
<td>Either ejected material or lava flow.</td>
</tr>
<tr>
<td><strong>Waterlogging</strong></td>
<td>Excess water in the root zone either present as a perched watertable or water ponded on the soil surface.</td>
</tr>
<tr>
<td><strong>Water repellence</strong></td>
<td>A condition which affects the wetting pattern of soils, especially sandy soils, and results in an uneven wetting pattern in autumn.</td>
</tr>
<tr>
<td><strong>Weathering</strong></td>
<td>Weathering is the physical and chemical disintegration, alteration, and decomposition of rocks and minerals at or near the earth's surface by atmospheric and biological agents.</td>
</tr>
<tr>
<td><strong>Water availability</strong></td>
<td>Describes the amount of moisture in the soil that is available to be absorbed by plant roots.</td>
</tr>
</tbody>
</table>