3 Soil-landforms

Across the WCMA region a number of land and soil surveys exist that have been carried out by government organisations including the Soil Conservation Authority (SCA), Commonwealth Scientific and Industrial Research Organisation (CSIRO) and the former Department of Agriculture and Rural Affairs (now known as the Department of Primary Industries (DPI)). These studies have used different scales for specific purposes.

For example an agricultural and horticultural land suitability for the Shire of West Wimmera at 1:100 000 (Baxter, Williamson & Brown 1996) focused on providing 'information for broad scale planning' by defining the 'capability of the different types of land to support various land uses'.

Studies at 1:100 000 scale aim to provide the reader with base information to 'examine the nature and interactions of features of the natural environment' while focusing on 'sustained productivity of the land, its use and management' (Pitt 1981). As a result, information presented by these previous studies (Table 1) is varied in detail. This posed a primary constraint in the development of consistent and seamless map coverage for the entire WCMA region at 1:100 000 scale. This is further discussed in Section 3.2 (Map creation).

3.1 Concept and definitions

Mapping of environmental features or landscape attributes can have decidedly different terminology and accompanying definitions. Terms such as landsystems ('areas of land each with a characteristic pattern of the environmental variables, climate, geology, topography, soil and vegetation') and terrain ('land uniquely defined in terms of topography, underlying lithological and structural characteristics, and soil and vegetation characteristics) have been encountered as part of this study.

The definition of mapping units is based upon an ecosystem concept in which several land features are integrated (defined in previous terms and definitions). Climate, geological material, landform and soil are each considered because they affect the inherent properties of the land, and its response to management (Charman & Murphy 1991). In this study the term 'soil-landform' is used to describe the map units. The soil-landform unit is an association of a specific landform pattern and its accompanying soils while considering other environmental variables in delineating areas of homogenous soil-landform relationships. At the scale of mapping in this study the soil-landform unit itself is made up of land components or elements. Where possible we have defined the specific associations that exist between soils and land components within a soil-landform. Some of these map units are simple, having only one land component (e.g. some of the larger swamp units or simple plains), whereas others are more complex having several components.

3.2 Map creation

In generating a soil-landform map for the WCMA region, a number of factors were considered in the editing and compilation phases. These factors include which studies to include or use, and issues with studies and datasets used in derivation of unit boundary linework.

Issues arising from incorporation of existing studies into mapping

For the WCMA region, a number of soil and land related studies and surveys have been published (Table 1). These soil and land surveys have varying spatial coverages and were created for a number of purposes and this is reflected in the style and contents of the survey reports. In total, eleven soil and land surveys have been used in assembling the soil-landform units for WCMA region. These surveys are briefly described in Table 1 according to their author, year of publication, responsible organisation, mapping scale and reference locality. Brief comments for all surveys regarding their functional role in the creation of the soil-landform map is discussed further in Table 2 with many of these descriptions sourced from Robinson et al. (2003c).

Table 1 Existing soil and land surveys within the WCMA region used in mapping the catchment

	Survey title	Author	Year	Organisation	Reference locality	Scale
1	Agricultural and horticultural land suitability for the West Wimmera Shire	Baxter, Williamson and Brown	1996	Department of Natural Resources and Environment	Shire of West Wimmera	1:100 000
2	Lowan land inventory assessment	Imhof, Rees and Thompson (Williamson ed.)	1997	Department of Natural Resources and Environment	Shire of Lowan	1:100 000
3	Landform mapping and recharge estimations for the Old Dimboola Shire	Muller and Hocking	2002a	Department of Natural Resources and Environment	Old Dimboola Shire	1:100 000
4	Landform mapping and recharge estimations from Horsham to Dimboola	Muller and Hocking	2002b	Department of Natural Resources and Environment	Old Dimboola Shire	1:100 000
5	Soil association of the Horsham mapsheet	Badawy	1977a	Department of Agriculture	Horsham	1:100 000
6	Major agricultural soils of the Wimmera Irrigation Area	Martin et al.	1996	Department of Natural Resources and Environment	Wimmera Irrigation area	1:100 000 and 1:35 000
7	Soils of the eastern Wimmera	Badawy	1984	Department of Agriculture	Charlton, Donald, Rupanyup	1:100 000
8	Land inventory of the Wimmera Systems and Rocklands Water Supply Catchment	White et al.	1985	Department of Conservation Forest and Lands	Upper Wimmera catchment	1:100 000
9	A study of land in the Grampians area	Sibley	1967	Soil Conservation Authority	Grampians Ranges	1:250 000 and 1:100 000
10	A reconnaissance survey of the soils of the Shire of Kowree, Victoria	Blackburn and Gibbons	1956	CSIRO	Kowree	1:250 000

Continued next page

Table 1 continued

	Survey title	Author	Year	Organisation	Reference locality	Scale
11	Natimuk	Maher and Martin	1990	Department of Agriculture and Rural Affairs	Natimuk	1:100 000
12	Landscapes and soils of the Goroke area	Maher and Martin	1990	Department of Agriculture and Rural Affairs	Goroke	1:100 000

Note that all soil and land surveys are provided as appendices accessable via the CD-ROM as reports and/or maps.

Table 2 Functional role of soil surveys in creation of the soil-landform map for the WCMA region

Survey title	Functional role in map creation
Agricultural and horticultural land suitability for the West Wimmera Shire	The maps and accompanying report provided a basis for soil-landform mapping in the west of the Wimmera region. Landform information is of a particularly high standard using aerial photography interpretation procedures. Soil pit data was collected as part of the project, however inspection site data is missing. The survey had some inconsistencies with overlapping surveys including *A reconnaissance survey of the soils of the Shire of Kowree, Victoria* and *Landscapes and soils of the Goroke area*.
Lowan land inventory assessment	This land assessment report describes nine mapping units and has been used as a mapping base with little refinement over the Lowan Shire area. Soils information that relates to units is quite detailed and informative with toposequence schematics provided. Mapping with the neighbouring surveys was consistent as the earliest survey (West Wimmera) was effectively continued to the east.
Landform mapping and recharge estimations for the Old Dimboola Shire	Mapping builds upon the soil-landform assessment of the Lowan land inventory assessment and continues mapping further east past the Wimmera River. The units were generated for a hydrogeological assessment, however they are extremely similar in nature to that of the Lowan shire mapping. Soil attribution and point data is absent here and therefore some of the units have been refined, deleted or added to in the development of a consistent map base. No neighbouring mapping exists to the east, placing a lower confidence on units along the eastern extent.
Landform mapping and recharge estimations from Horsham to Dimboola	Mapping builds upon the soil-landform assessment of the Lowan land inventory assessment the recharge estimation landform mapping further north (*Landform mapping and recharge estimations for the Old Dimboola Shire*). The units were generated for a hydrogeological assessment and are likely to exhibit a higher degree of uncertainty than mapping in the north. Mapping also has numerous overlaps with the Natimuk soil-landform mapping and new mapping generated as part of this project for the Horsham mapsheet. Little mapping has been preserved through new mapping as a result.
Soil association of the Horsham mapsheet	The mapping units used are strictly soil association units and don't necessarily conform to landforms. The map base has been used in the development of new mapping for the Horsham mapsheet.
Major agricultural soils of the Wimmera Irrigation area	High intensity mapping (1:35 000) has been preserved in the final soil-landform map. Soil and landform information is of the highest standard from previous settlement soil surveys (Murtoa, Horsham, Quantong). Soil descriptions for the map units are extremely detailed and informative relating to landscape and formation processes. While overlap occurred with mapping of the soil associations, this mapping took precedence due to scale and detail of mapping.

Continued next page

Table 2 continued

Survey title	Functional role in map creation
Soils of the eastern Wimmera	Mapping for the Rupanyup, Donald and Charlton 1:100 000 mapsheets as landforms and soil associations provides the base for the final soil-landform map. Units were refined using radiometrics, especially prior stream complexes and plains. The survey extends to the east beyond the WCMA boundary and has only limited overlap with the *Land inventory of the Wimmera Systems and Rocklands Water Supply Catchment* mapping. The report is quite detailed from a soils perspective with numerous representative profiles included. Landforms defined have been incorporated, however due to the subtlety of the landscape are dubious in certain areas.
Land inventory of the Wimmera Systems and Rocklands Water Supply Catchment	This report entails mapping for the upper Wimmera, Grampians Ranges and western Black Range areas as 150 topographic (landform)-soil combinations. Based around the Grampians Ranges storages, the mapping has been produced using aerial photography interpretation procedures and soils information assigned using the Factual Key (Northcote 1979) classification scheme. The survey is quite extensive and provides a very useful mapping base in the upper Wimmera area. There were modifications made to mapping using DEM, geology and radiometrics to improve the precision of boundaries as well as define new units. While soils information was collected as part of the original mapping process, this information has been lost and therefore placed a limitation on the usefulness of the assigned soils data. Overlap with the soil-landform mapping for the *Natimuk* 1:100 000 mapsheet, *A study of land in the Grampians area* and new mapping for the Horsham mapsheet saw numerous inconsistencies with these surveys.
A study of land in the Grampians area	The landsystems mapping for the Grampians area provides 18 landsystem descriptions with numerous disaggregations of these landsystems into land units. Soil and landscape information is captured in tables and has been used extensively owing to the useful level of detail recorded in this report. Mapping covers the Grampians Ranges, Horsham south plains and Mount William Creek catchment areas. Overlap with the Wimmera Systems and Rocklands Water Supply Catchment and new mapping for the Horsham 1:100 000 mapsheet occur.
A reconnaissance survey of the soils of the Shire of Kowree, Victoria	Undertaken in the 1950s, this reconnaissance survey provides very useful background mapping that overlaps with the West Wimmera shire mapping and mapping of the Goroke/Natimuk 1:100 000 mapsheets. Unit descriptions have often been reserved through all mapping overlaps, however the boundaries and extent of units fluctuates from survey to survey. Soil point information is limited while the mapping provided an extremely useful quality checking base for more recent mapping.

Continued next page

Table 2 continued

Survey title	Functional role in map creation
Natimuk	Map units represent major landform patterns across the Natimuk 1:100 000 mapsheet. All map units include landform elements, morphology and element type as well as dominent soils and other soils. Descriptions of dominant soils are provided along with a reference site. The mapping has proved extremely useful and is of high quality when viewed against the DEM, geology and radiometrics. Little modification occurred to linework except along mapsheet boundaries where linework was altered to allow for seamless mapping along all tile boundaries. No mapping at the designated scale (1:100 000) existed south of this tile apart from landsystems mapping of the Grampians area and the Kowree reconnaissance mapping.
Landscapes and soils of the Goroke area	Map units represent major landform patterns across the Goroke 1:100 000 mapsheet. All map units include landscape (including percentage coverage), landscape position as well as dominent soils. Descriptions of dominant soils (depth, texture and colour) are provided for all units. The mapping proved extremely useful and is of high quality when viewed against the DEM, geology and radiometrics in addition to pre-existing mapping of the Shire of Kowree and Shire of West Wimmera. Linework was integrated with the Shire of West Wimmera mapping to develop a seamless map along all tile boundaries. Mapping at the designated scale (1:100 000) to the south of this tile included soil-landform mapping of Kowree Shire and West Wimmera Shire.

As a number of surveys have been edited to develop a seamless map coverage of the WCMA region, some of existing units (soil-landform or landsystem) have been preserved. All soil-landform units created were assigned a unique numerical code to represent either an existing map unit, or newly created unit. The extents of the surveys and data gaps in information are presented in Table 2 and Figure 20. The soil-landform units developed as part of the LRA project for the WCMA region are to be used at 1:100 000 scale. Soil-landform units are listed in the Section 2 (Geomorphology) under relevant geomorphic tiers. The soil-landform data has also been used to produce inherent susceptibility to land degradation maps.

In future the availability of soil-landform unit information and soil point site data will allow for more specific and detailed applications. These may be used to provide a clear understanding of the potential to develop land for specific agricultural enterprises and to identify specific limitations inherent within the natural resource base. The ability to access detailed soil point information, as well as soil and land spatial units will benefit many modelling applications currently used to assess land resource management and water quality aspects, for example, Land Use Impact Model (LUIM), Soil and Water Assessment Tool (SWAT) and the Catchment Assessment Tool (CAT).

Detailed soil-landform unit descriptions are accessible via the CD-ROM. Soil profile descriptions are provided in Section 4 (Soils) under relevant soil group headings.

Datasets used to refine map boundaries, and create units for areas with no previous survey coverage

A number of geospatial datasets were used in a GIS to aid in refining boundaries between overlapping soil and land surveys, and to map new soil-landform units for areas with no existing coverage at an adequate scale. Some of these datasets and their use in these processes are explained.

Geology

Geology mapping is available for this region at 1:250 000 scale from the DPI Corporate Geospatial Dataset GEOL250 (O'Brien 2001) and was used as a consistent base to assist in boundary refinement,

but also in defining likely sources for soils. Improved 1:100 000 scale geology digital map base was released by DPI's Geological Survey of Victoria (GSV) for the Ararat 1:100 000 mapsheet and proved invaluable in associating soils and landforms with the geology of the Western Uplands. Geological information was also used in soil-landform tabular descriptions (refer to tabular descriptions in following section). The nomenclature used conforms to that developed and recently revised by the GSV.

Radiometrics

Airborne gamma radio spectrometry (GRS) was useful in the detection of changes in soil properties, but required validation by ground truthing to determine intrinsic soil properties. The use of radiometrics was particularly relevant in differentiating terrain with unconsolidated material, such as the plains country, and complemented the digitial elevation data in the Western Uplands. Radiometrics was also used with geology to identify topographical relationships concerning colluvial and alluvial material.

Digital elevation models

Digital elevation models (DEMs) have become widely used in the last 20 years as they enable better visualisation and interrogation of topographic features.

A DEM is generically described as 'a spatially geo-referenced dataset that is a popular way of encoding the topography for environmental modelling purposes'. DEMs are directly compatible with remotely-sensed data sources and can be used to represent complex terrain units, given an adequate resolution.

Generally, DEMs have been derived from topographic data using contour data, spot heights, hydrology and boundaries (shore line, state, 1:100 000 tile) and provide the data to analyse the shape of the surface which affects the soils and hydrological properties of the landscape.

Some general derivatives from DEMs include:

- slope, slope length and slope position
- aspect
- drainage network and catchment boundaries
- hydrological indices and watertable indices
- climate variables
- input to estimation of soil parameters
- input to land component and soil type mapping
- viewshed analysis and visualisation
- visualisation
- environment modelling including salinity, species distribution, spread models etc.

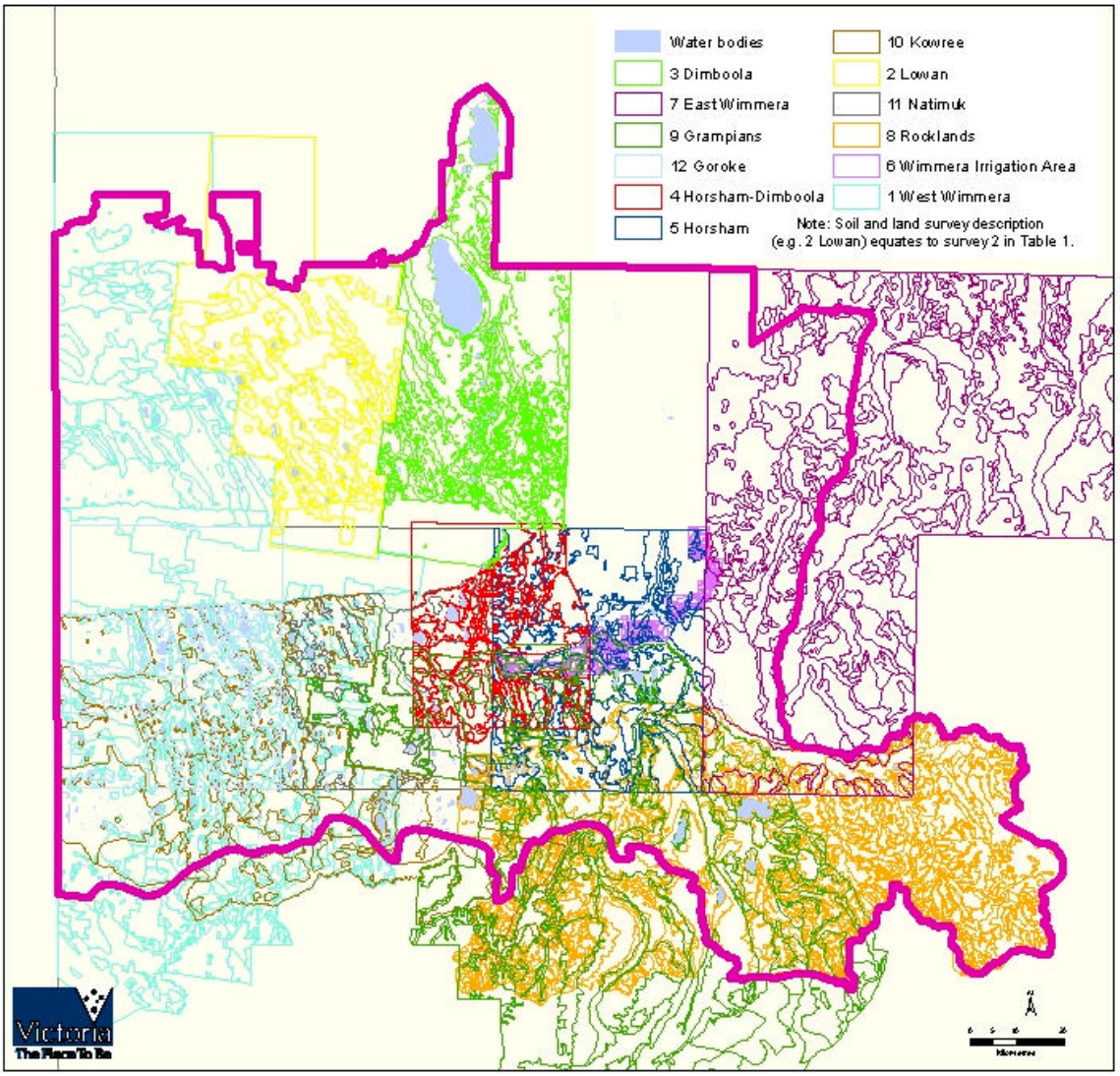
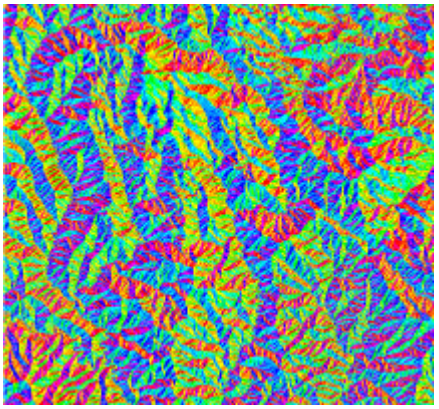


Figure 20 Existing soil and land surveys within the WCMA region used in mapping soil-landforms of the catchment

One of the most useful properties of DEMs is the ability to reclassify datasets. For example, slope, aspect and elevation can be classified to meet requirements or parameters of landscape components (as seen in Figure 21).



Aspect classification

Slope classification

Figure 21 Three dimensional classification of DEM to three different datasets (aspect, slope and elevation)

DEMs have been developed to generate slope ranges and formulate relationships between slope, landform and soil characteristics. DEMs with a 20 m pixel resolution were developed for the WCMA region from 1:25 000 scale topographic data. In the more steeply dissected country the DEMs provided an excellent background dataset to assess for changes in landform and associated soils/soil distribution. The DEMs were also used to generate slope classes and relative elevations that conform to erosional landform patterns as defined in McDonald et al. (1990). These derivatives are useful to identify areas of changing landforms and break-of-slope, indicating the occurrence of a changing process, as well as assisting classification of landforms into a consistent format (e.g. cones classified to hills, low hills and rises).

Soil point data

The collection of soil point site information has been used to define the associations between soils and landforms. Soil point information has also provided a basis for allocation of dominant soil attributes within each soil-landform unit. Nearly 1000 sites exist from soil and land surveys, including those collected during the course of this project. Additional soil site information has been used from various soil site programs across western Victoria. These programs include the National Soil Fertility Program (CSIRO 1968-1972), Top Crop (Imhof unpublished), Horsham historic sites (Newell & Thorn 1967; Forrest 1978), Wimmera core service (Martin 1969). Over 190 soil profile descriptions are provided on the CDROM with 161 of these geographically located on the 1:100 000 soil-landform maps. A review of known existing soil sites for studies and surveys of the WCMA region is documented in Robinson et al. (2003c).

Units

In this study, the soil-landform unit is the principal mapping unit and has been classified and mapped at 1:100 000 scale across the entire WCMA region. Within the geomorphological framework these soil-landform units occur at or below the geomorphological sub-regional level (Tier 3). The generation of these units incorporated information from historic reports and office-based GIS techniques in association with fieldwork, to ascertain and validate soil descriptions for unique soil-landform units.

These soil-landform units provide the base dataset from which the susceptibility to land degradation themes are derived. This study has identified and provided an inventory of soil-landform units across the area with inherent susceptibility to erosion, waterlogging and soil structure decline.

Soils descriptions, classifications and groupings have been defined using soil point data from existing studies and new fieldwork. Soils are described to national standards and are compared on the basis of their attributes and classification, using *The Australian Soil Classification* (Isbell 1996). Landform (or landform pattern) has also been classified on the basis of relative relief, such as plains, low hills and mountains, and modal slope variations (gently, undulating, rolling, moderately steep, steep, very steep-inclined and precipitous). These comply with national standards as set out in the *Australian Soil & Land Survey Field Handbook* (McDonald et al. 1990). Landforms were further distinguished according to changes in their lithology (geology).

The soil-landforms of the relevant studies used have been delineated by a combination of aerial photo interpretation, correlation and quality control using airborne radiometrics, DEM and field examination. All soil and land survey prior to 2000 used black and white aerial photographs stereoscopically at a scale of approximately 1:80 000 (1:100 000 soil-landform mapping) and 1:25 000 (1:35 000 soil-landform mapping), and reveal geomorphic patterns for the soil-landform mapping of each study. Each area was examined in the field to check the accuracy of the aerial photograph interpretation and to collect data regarding the nature of the soils, the native vegetation, the angle and shape of slopes and the nature of the parent material. Climatic data was also considered in delineation of soil-landform units.

Representative sites or ‘type sites’ were chosen for each of the most commonly occurring land components in order to examine in detail the nature of the soils, the structure and floristics of the associated native vegetation and their interrelations with other variables.

From the assembly of these studies and additional mapping, over 100 soil-landforms have been defined for the WCMA region. These range in size from less than 250 ha, to in excess of 100 000 ha. Some of the smaller units occurring near the edge of the study area are widespread in adjacent CMA regions.

Data collected on each soil-landform unit is presented in tabular form with accompanying background unit information, photographs, topographic section, three-dimensional representation and location of where the unit occurs within the catchment.

Tabular descriptions

Components are allotted numbers to aid in identification. Representative parts of each soil-landform unit have been mapped on stereo air photographs at a scale of approximately 1:25 000 to define and measure the areas of the individual components. These areas have been extrapolated to give an estimation of the relative proportions of each component. For soil-landform units near the edge of the study area, these proportions may not be relevant to adjacent areas. This methodology for defining

components within units has been adopted for many soil-landform units with soil and land surveys pre 2000 using an almost identical procedure with varying scales of photomosaics/stereo pairs for identification of components (refer to existing studies for comprehensive methodology).

Climatic data is derived from climatic geospatial datasets for Victoria. These datasets have been interpolated from existing weather station information provided by the Bureau of Meteorology. Data presented includes: annual rainfall for each soil-landform unit, the wettest month and the driest month.

Temperature data are the average annual daily values in February (maximum) and July (minimum) extremes.

The major *seasonal growth limitaton* (precipitation less than evapotranspiration) has also been provided.

Restrictions to plant growth (growing season) occur to varying extents due to low temperatures in winter, and lack of available water in summer. These restrictions are of somewhat lower impact today with a range of summer dormant, winter active pasture species available on the market. It should be noted that soil moisture storage extends the growing season beyond the point where potential evapotranspiration exceeds precipitation.

Local relief is a measure of the average change in elevation from the top of a hill or ridge to the nearest drainage line within the landsystem. The DEM combined with representative topographic sections enabled an assessment of the relative relief variations across these landscapes. The 1:25 000 stream hydrology network geospatial dataset has been used to determine drainage patterns as well as drainage density.

Native vegetation descriptions for soil-landform units have been assigned using Ecological Vegetation Class (EVC) information from the geospatial dataset. Area of disturbance, plantations or waterbodies have not been included in totals of these units.

Soil profile information including parent material, description, surface texture, permeability, depth and soil type sites has been included. This information has been derived from previous soils allocated to landforms of existing studies, thus preserving the detail and integrity of this data as well as incorporating new investigations. Soil descriptions derived from existing studies have been updated to reflect changes in soil classification and the adoption of the Australian Soil Classification (Isbell 1996). A key change has been the adoption of the soil colour classes defined within the ASC. Due to the varying age of soil data earlier soil classification/descriptions (Northcote 1979) are given where available. This should provide a link for those who are mainly familiar with the older scheme.

Additionally these soils have all been assigned to *soil groups* (Wimmera Soil Groups) that reflect a combination of geomorphology and soil relationships. There are 41 soil groups. Land component soils have been assigned to a Wimmera Soil Group (WSG). This was developed to encompass the variety of soils in the existing studies (greater than 200) and to simplify presentation of soil information.

Soil site information has been included for sites that are either located specifically within that unit and component (denoted in bold text), or are considered sites suitable as representative of the described soil.

A five-class system has been used for the estimation of *permeability* based on profile characteristics such as porosity and texture. The estimate refers to the vertical hydraulic conductivity of the solum, which is limited by the least permeable horizon. Sands with no compacted layers have very high permeabilities while clays, with few pores or cracks, have very low permeabilities. This system has been adopted along with information captured from all the landsystem surveys of the catchment.

Soil depth refers to the distance below the surface to solid rock or to a layer that serves as an impediment restricting root penetration and water movement.

The main existing *land uses* have been listed. Active recreation includes the use of vehicles such as trail bikes, dune buggies, four-wheel drive vehicles and other forms of ‘adventure sports’. Passive recreation refers to less potentially destructive pursuits such as picnicking, camping and bushwalking.

The forms of *soil deterioration* found to occur in each component, the critical features of the landscape, and the processes leading to these forms of soil deterioration are also outlined.

An example of a tabular description is presented in Table 3 along with a description of where information derived for soil-landform unit descriptions has been sourced.

Table 3 Tabular unit description example with described sources for relevant information

Component *Proportion of landsystem*	Component no. (e.g. 1, 2, 3 etc.) Percentage of overall unit (e.g. 10%)
CLIMATE	
Rainfall (mm)	Annual average rainfall: calculated from the climate geosptial datasets held at CLPR for rainfall (derived from weather stations across Victoria)
Temperature (^{o}C)	Minimum (July) and Maximum (January) average
Precipitation less than potential evapotranspiration	Geospatial datasets have provided the source for months where precipitation is less than potential evapotranspiration
GEOLOGY	
Age and lithology	Sourced from the 1:250 000 geological mapping held by DPI's Minerals and Petroleum group
Geomorphology	Defined in accordance with recent mapping by the Victorian Geomorphological Reference Group
LAND USE	Land use is a general assessment of major practices within units. This information is derived from surveyor knowledge and observations collected in field survey
TOPOGRAPHY	
Landscape	Source: existing land resource assessment surveys and field assessment
Elevation range (m)	Source: 1:25 000 DEM
Local relief (m)	Source: 1:25 000 DEM
Drainage pattern	1: 25 000 stream hydrology network
Drainage density (km/km^{2})	1: 25 000 stream hydrology network
Landform	Aerial photograph interpretation and field assessment
Landform element	Aerial photograph interpretation and field assessment
Slope and range (%)	Aerial photograph interpretation and field assessment
Slope shape	Aerial photograph interpretation and field assessment
NATIVE VEGETATION	
Ecological Vegetation Class (EVC)	Derived from the EVC geospatial dataset
SOIL	
Parent material	Sourced from the 1:250 000 geological mapping held by DPI's Minerals and Petroleum group and field survey descriptions
Description (Wimmera soil group)	Local soil description (provided via existing soils information or from analysis of soil sites)
Soil type sites	Soil type sites have been captured allowing the user to refer to sites that are either located specifically within that unit and component (denoted in bold text), or are considered sites suitable as representative of the described soil.
Surface texture	Representative soil site textural information
Permeability	Representative soil site textural information
Depth (m)	Representative soil site textural information
LAND CHARACTERISTICS, POTENTIAL AND LIMITATIONS	The land characteristics are a base interpretation by the soil surveyor of the important critical land features, processes and forms. This is derived from soil-landform properties and land features that increase likelihood of erosion and degradation.

Soil-landform unit descriptions

Soil-landform units have been developed using processes outlined previously. There are 106 discrete soil-landform units mapped for the WCMA region excluding the Horsham township and lakes (terminal lakes and Grampians storages). A soil-landform unit is based primarily on land pattern while the land component, or element is a subset of these (refer to *Australian Soil & Land Survey Field Handbook*, McDonald et al. 1990). Although historical surveys and existing land resource information were used as a guide in the development of these soil-landform units, nearly 150 additional soil sites were collected as part of this project. These additional sites contributed to the detailed soil profile information, and when related to the local landform features provide the basis of the soil-landform unit.

The soil-landform units defined for this study are listed under geomorphological units in Section 2 (Geomorphology) numerically with a brief unit description, as well as the area and proportion of land each unit consists of. Soil-landform units can be accessed from the 'soil-landform' drop-down list on this CD-ROM and accessed on the CD-ROM by following links from the soil-landform map base.

Within the soil-landform unit descriptions the landform features and characteristics are defined and described. The land component descriptions provide a major soil type, relating this to soil groupings identified for the Wimmera region.

Map products generated from the soil-landform units for the project include:

- Soil-landform unit base map
- Soil-landform unit base map with sites provided on the CD-ROM
- Land degradation susceptibility maps covering:
    - gully and tunnel erosion
    - sheet and rill erosion
    - wind erosion
    - soil structure decline (compaction)
    - soil pH (topsoil and subsoil)
    - soil sodicity (topsoil and subsoil).

These maps can be found on the CD-ROM accompanying this report and can be accessed by following the links from the CD-ROM index to the map section.